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MARINE BIOTA OF RAGLAN, WAIKATO WEST COAST

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SUMMARY

351 species (including 116 gastropods, 63 bivalves, 47 polychaetes, 22 crabs and shrimps, 20 seaweeds, 12 amphipods, 11 echinoderms, 11 chitons, 10 sea anemones, 9 sponges, and 6 barnacles) of intertidal and subtidal organisms are recorded from the previously little-studied coast inside and outside Raglan Harbour, Waikato. We provide the first west coast records of 15 mollusc species and the southernmost record in New Zealand of a further two gastropods.

The habitat with the greatest diversity is the partly sheltered stable boulder and basalt platform shore around Whale Bay (104 living species), followed by the moderately sheltered intertidal lagoon at Whale Bay, the limestone rocky shore on the north side of Raglan Harbour, and the shelly sediment of Raglan Harbour channel (65-70 living species each). Of medium diversity is the clean fine sand offshore (10-20 m depth) from the harbour entrance (46 living species) and the intertidal sand and mud beaches around the Raglan Harbour's shoreline (30 species). The most exposed, wave-battered rocky shore at Papanui Point has a particularly low diversity (23 species) intertidal fauna, but more profuse than the mobile sand substrate of the shallow subtidal (4-6 m depth) offshore surf zone (16 species), and beaches just inside Raglan Harbour entrance (12 species) and on the open coast (1 living species).

INTRODUCTION

This study is one of several recently undertaken by the authors to document the poorly known diversity and biogeographic distribution of intertidal and shallow subtidal organisms along the west coast of the North Island of New Zealand. Until recently the only published accounts of the diversity and ecological distribution patterns of the intertidal marine biota along this stretch of coast from New Plymouth to Cape Maria van Dieman were from various parts of the large Manukau Harbour, west Auckland (Powell 1937, Grange 1979, 1982, Henriques 1980), from the rocky coast at Kawerua, south of Hokianga Harbour mouth (Hayward 1971, 1974, 1975, 1979, 1981, 1990, Hayward & Hayward 1974, 1991), and from north Taranaki (Miller 1974).

Our 1990s survey along the West Coast involved the following studies (from north to south):

1. Ahipara and Herekino Harbour (Hayward et al. in prep.);
2. Whangape Harbour (Hayward et al. 1994);
3. Waimamaku Estuary (Hayward & Hollis 1993);
4. Kawerua molluscs revision (Hayward et al. 1995);
5. Waitakere Ranges (Hayward & Morley in press);
6. Kawhia Harbour area (Morley et al. 1997);
7. Awakino to New Plymouth, north Taranaki (Hayward et al. 1999).

This study at Raglan provides further biogeographic information on the marine biota along the west coast of the North Island, from an area part way between previous studies on the coast of the Waitakere Ranges and Manukau Harbour in the north and Kawhia Harbour in the south (Fig. 1).

Raglan Harbour

Raglan Harbour (37° 48'S, 174° 52'E) is a drowned river valley system extending c.10 km inland from its mouth on the Waikato west coast. Like most west coast harbours it has a deep central channel extending up the axial arm with extensive intertidal and shallow subtidal flats on either side and up the many tributary arms. Inside the harbour entrance, where tidal flows are particularly strong, the channel is up to 20 m deep and is floored by clean medium sand. Between 2 and 4 km inside the harbour, adjacent to Raglan township, the channel sediment is shelly sand to sandy shell gravel. Moving up the harbour the channel shallows, narrows and its sediment fines through fine sand to sandy mud.

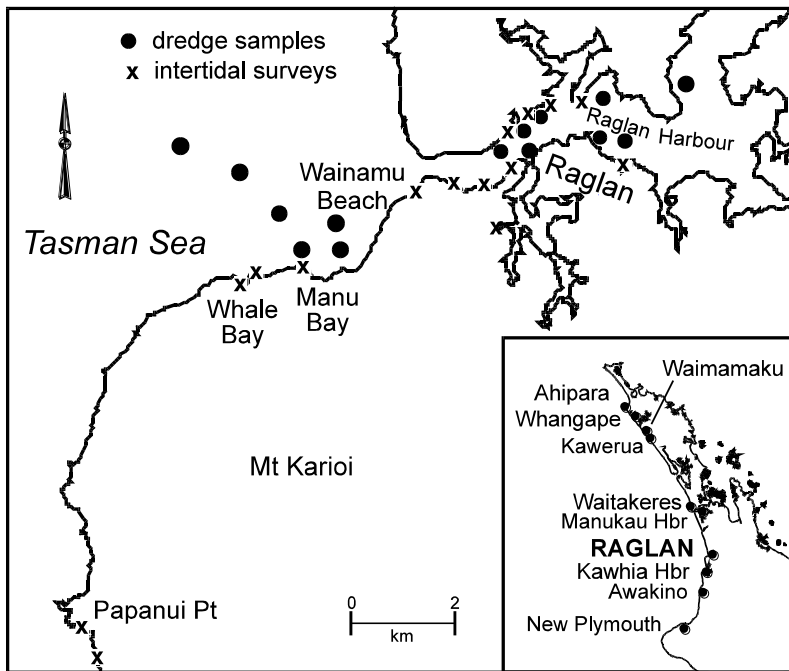


Fig. 1. Study areas around the Raglan coast on the west coast of the North Island, New Zealand.

The first 1.5-2 km of the harbour entrance is flanked by clean sandy beach, with Wainamu Beach on the southern shore. Inside this, the harbour coast is a blend of rocky shore platforms backed by low cliffs on the points, separated by intertidal mud flats and high tidal muddy sand beaches in the bays and arms. The rocky coast of Raglan Harbour is a mix of greywacke, calcareous mudstone and more erosion resistant crystalline limestone. Most of the rocky shore examined by us on the north side of the harbour opposite Raglan township was composed of crystalline Te Kuiti Group limestone (Waterhouse & White 1994).

Small areas of salt meadow and salt marsh are present at high tide around the fringes of the harbour. A single, small mangrove bush (*Avicennia maritima*) grows on the muddy foreshore on the outskirts of Raglan township - possibly the southernmost mangrove plant on New Zealand's west coast.

Exposed beaches

Two exposed sandy surf beaches were examined, largely to document the presence of molluscs that live offshore and whose shells are cast up on the beach. The beaches, one north (Ngarunui Beach) and one south (Ruapuke Beach) of the rocky shore of Mt Karioi (Fig. 1), are both backed by coastal sand dunes.

Exposed rocky shoreline

Mt Karioi is a large, partly eroded, Pliocene volcano that forms a high southern backdrop to Raglan. Its western slopes of basaltic lava flows and breccias, jut out into the Tasman Sea, forming 10 km of high cliffs, rocky shorelines and boulder beaches between Manu Bay and Papanui Pt (Fig. 1). We surveyed this rocky shore at its southern and northern ends. The huge basalt blocks and sheer cliffs at Papanui Point in the south are exposed to the full force of the Tasman Sea swells and storms. The north-facing Karioi shoreline around Manu and Whale Bays however, is relatively more sheltered with the dominant south-westerly swells and surf running nearly parallel to the coast. This northern coast is largely composed of a relatively steep, mostly stable boulder shoreline interspersed with short sections of lava flow shore platform.

At Whale Bay, the boulders form a breached spit across the seaward side of a small embayment (200 m across). In behind the breached spit is a shallow (0-1 m deep) mid tidal lagoon, floored with rock and sand and littered with cobbles and boulders. A small, relatively sheltered sandy beach is present on the landward side of the lagoon.

Offshore seafloor

Off the mouth of Raglan Harbour the seafloor slopes gently away to the west and is draped in clean medium sand down to a depth of about 10m, with clean fine sand further out, at least down to a depth of 20 m, 3 km offshore.

Methods and voucher specimens

This paper records all marine molluscs, polychaetes, echinoderms and algae, plus some members of other groups, that were found inside Raglan Harbour and along a 10 km length of exposed coastline south of the harbour mouth (Fig. 1) on a three day field trip by the first five named authors during a period of spring low tides (0 - 0.2 m low tides) in April 1998. Field work included extensive intertidal searching of the range of habitats present along the harbour and exposed coast, beach combing along the shore and a number of dredge hauls of sediment from the subtidal bed of Raglan Harbour and from the sea floor (20 m depth), up to 3 km off the entrance to Raglan Harbour (Fig. 1). Dredge samples were passed through a 1 mm sieve and all live animals retained were later picked and identified. Samples of low tidal seaweed and specimens from the underside and sediment beneath cobbles on several reefs were also taken and the associated biota picked and identified. Specific detail on dredge samples and intertidal study sites is presented in appendix 1.

Most records are supported by voucher specimens in the Marine and Botany Departments' collections of the Auckland War Memorial Museum (AK).

SPECIES LIST

Mollusc nomenclature follows Spencer and Willan (1996) and Marshall (1998).

Habitat where found:

- A = exposed intertidal rocky shores
- B = Whale Bay intertidal lagoon
- C = exposed sandy beach
- D = offshore subtidal seafloor
- E = harbour entrance sand beach
- F = subtidal harbour channel
- G = intertidal harbour rocks
- H = intertidal harbour soft shores

Qualitative assessment of abundance:

- a = abundant
- c = common
- f = frequent
- o = occasional
- r = rare
- d = only seen dead

* = apparent extension of recorded range

	A	B	C	D	E	F	G	H		A	B	C	D	E	F	G	H
MOLLUSCA: POLYPLACOPHORA - CHITONS																	
<i>Acanthochitona violacea</i>							r		<i>Caecum digitulum</i>					d			
<i>Acanthochitona zelandica</i>	c						o		<i>Calliostoma punctulatum</i>	d							r
<i>Chiton glaucus</i>	r						f		<i>Cantharidella tessellata</i>	c	d		d	d			
<i>Cryptoconchus porosus</i>	r						f		<i>Cellana ornata</i>	o							o
<i>Eudoxochiton nobilis</i>	o								<i>Cellana radians</i>	a	a		d				
<i>Ichnochiton maorianus</i>	f					r			<i>Chemnitzia</i> spp.				r	d		d	d
<i>Leptochiton inquinatus</i>	o					r			<i>Cominella adspersa</i>	r	r			f		f	
<i>Onithochiton neglectus neglectus</i>	d								<i>Cominella glandiformis</i>		r			d	d		r
<i>Plaxiphora murdochi</i>	r								<i>Cominella maculosa</i>		o			d	d		d
<i>Plaxiphora obtecta</i>	r								<i>Cominella quoyana</i>					d	d	d	r
<i>Sypharochiton pelliserpentis</i>	c							c	<i>Cookia sulcata</i>	r							r
MOLLUSCA: GASTROPODA - SNAILS									<i>Cymatium parthenopeum</i>					d			o
<i>Alcithoe arabica</i>						d			<i>Dendrodoris citrina</i>								r
<i>Amalda australis</i>				f	f	r		d	<i>Dicathais orbita</i>	o				d			o
<i>Amalda mucronata</i>			d	o					<i>Diloma arida</i>							d	
<i>Amalda novaezelandiae</i>				o					<i>Diloma bicanaliculata</i>	f	f						
<i>Amphibola crenata</i>	d	d					d	a	<i>Diloma nigerrima</i>		d						
<i>Amphithalamus semen</i>	c				d				<i>Diloma subrostrata</i>					d	d		c
<i>Argobuccinum pustulosum tumidum</i>					d				<i>Diloma zelandica</i>	c	c						o
<i>Asteracmea suteri</i>		r							<i>Doriopsis flabellifera</i>		r						r
<i>Austrofusus glans</i>					d		d		<i>Eatoniella albocolumella</i>					d			
<i>Austromitra rubiginosa</i>	r	r				d	d		* <i>Eatoniella globosa</i>					d			
* <i>Brookula finlayi</i>					d				<i>Eatoniella latebricola</i>	d							
<i>Buccinulum linea linea</i>						d	r		<i>Eatoniella limbata</i>						d		f
* <i>Buccinulum robustum</i>		d							* <i>Eatoniella notata</i>								d
* <i>Buccinulum pertinax pertinax</i>	r								<i>Eatoniella olivacea</i>	o	d				d		r
<i>Buccinulum vittatum</i>	o								* <i>Eatoniella roseospira</i>		d						
<i>Cabestana spengleri</i>					d				<i>Eatonina atomaria</i>	r							c
									* <i>Eatonina subflavescens</i>	r							

	A	B	C	D	E	F	G	H
<i>Epitonium jukesianum</i>	d	d			d			
<i>Epitonium tenellum</i>					d			
* <i>Eulima perspicua</i>					d			
<i>Eulimella levilirata</i>		d				d		
<i>Gadinia conica</i>	d	d						
<i>Haliotis australis</i>	r							
<i>Haliotis iris</i>	f							
<i>Haliotis virginea</i>		o						
<i>Haustrum haustorium</i>		d						
* <i>Incisura lytteltonensis</i>					d			
<i>Lepsiella albomarginata</i>	a						o	
<i>Leuconopsis obsoleta</i>		d			d		d	
<i>Linopyrga rugata</i>					d	d	d	
<i>Maoricolpus roseus manukauensis</i>					d	a		
<i>Marinula filholi</i>		d						
<i>Melagraphia aethiops</i>	r							
* <i>Merelina lyalliana</i>		d			d			
<i>Micrelenchus sanguineus</i>	c	d						
<i>Micrelenchus huttonii</i>					d	d	d	c
<i>Neoguraleus murdochi</i>					d	d		
<i>Nerita atramentosa</i>	r	o						
<i>Nodilittorina antipodum</i>	c	c					c	
<i>Nodilittorina cincta</i>	r							
<i>Notoacmea elongata</i>		d					r	
<i>Notoacmea helmsi</i>	o				d	d	d	o
<i>Notoacmea pileopsis pileopsis</i>		o						
<i>Notoacmea helmsi (scapha form)</i>					d			
* <i>Odostomia takapunaensis</i>		d			d	d		
* <i>Odostomia ?vestalis</i>					d			
<i>Onchidella nigricans</i>	f							
* <i>Ophicardellus costellaris</i>					d		d	
<i>Orbitesella parva</i>							o	
<i>Paratrophon cheesemani</i>	r				d	d		
<i>Patelloida corticata</i>	c							
<i>Penion sulcatus</i>	d							
<i>Pervicacia tristis</i>					f	d	d	
<i>Phenatoma zelandica</i>					d			
<i>Philine auriformis</i>						d		
* <i>Pisinna olivacea impressa</i>							r	
<i>Pisinna zosterophila</i>	r	d			d	d		
<i>Potamopyrgus estuarinus</i>								d
* <i>Pupa kirki</i>					o			
* <i>Pusillina latiambita</i>					d		d	
<i>Radiacmea inconspicua</i>	o							
<i>Risellopsis varia</i>	f	d			d		d	
<i>Rissoina chathamensis</i>	o	f				d	d	
<i>Scutus breviculus</i>	o	o						
<i>Semicassis pyrum</i>					d			
<i>Sigapatella novaezelandiae</i>					d	d		
<i>Sinezona brevis</i>					d			
<i>Siphonaria australis</i>	f				d		d	
<i>Siphonaria propria</i>		d						
<i>Siruthiolaria papulosa</i>					d			
<i>Trochus tiaratus</i>					d	d		
<i>Trochus viridis</i>	r							
<i>Tugali suteri</i>		f						
<i>Turbo smaragdus</i>	f	f			d	o		
<i>Xymene plebeius</i>					d	d	d	o
<i>Xymene traversi</i>	r							
<i>Zaclys murdochi</i>							d	
* <i>Zalipais lissa</i>	o				d			
<i>Zeacolpus vittatus</i>					d	d		
<i>Zeacumantus lutulentus</i>					d	d	o	
<i>Zeacumantus subcarinatus</i>	o	f				d		
<i>Zegalerus tenuis</i>					d	f		
<i>Zemitrella choava</i>	r	o				d	d	
<i>Zemitrella pseudomarginata</i>						d		
<i>Zethalia zelandica</i>					c	f		

	A	B	C	D	E	F	G	H
<i>Diplodonta globus</i>	d				d			
<i>Divaricella huttoniana</i>					d	d	r	
<i>Dosina zelandica</i>		d	d		d	d	f	d
<i>Dosinia anus</i>					d	d		
<i>Dosinia subrosea</i>					r	o	d	
<i>Felaniella zelandica</i>		d				r		d
* <i>Gaimardia finlayi</i>						d		
<i>Gari lineolata</i>					d			
<i>Gari stangeri</i>		d	d		d	o		
<i>Hiatella arctica</i>	r	d			d	d	d	
<i>Irus reflexus</i>	o							o
<i>Kellia cycladiformis</i>		r						d
<i>Lasaea hinemoa</i>		d			d		d	
<i>Leptomya retiaria</i>	d	d			d	f	f	d
<i>Macomona liliana</i>		o				f		c
<i>Mactra murchisoni</i>					d	d		
<i>Maorimacra ordinaria</i>					d	d		
<i>Modiolarca impacta</i>		r			d	d	d	
<i>Modiolus areolatus</i>	d							
* <i>Myadora antipodum</i>					f		d	
<i>Myadora boltoni</i>						d		
<i>Myadora striata</i>					f	f	d	
<i>Mylitella vivens vivens</i>						o		d
<i>Nucula hartvigiana</i>	d	o				d	c	f
<i>Nucula nitidula</i>					c	d		
<i>Ostrea lutaria</i>							d	
<i>Paphies australis</i>		d			d	d	d	c
<i>Paphies donacina</i>					d	o	d	
<i>Paphies subtriangulata</i>					d	d		
<i>Pecten novaezelandiae</i>					d	d	d	
<i>Perna canaliculus</i>	r				d	d	d	o
<i>Peronaea gaimardi</i>					d	d		
<i>Pholadidea suteri</i>								f
<i>Pododesmus zelandicus</i>								d
<i>Protothaca crassicosta</i>		r						
<i>Pseudoarcarpogia disculus</i>	d	o					o	
<i>Resania lanceolata</i>					d		d	
<i>Ruditapes largillierti</i>	r				d	d	d	f
<i>Scalpomacra scalpellum</i>					d	d	d	d
* <i>Soletellina nitida</i>						d	d	
<i>Spisula aequilatera</i>					d	d	d	
<i>Tawera spissa</i>					d	d	d	o
<i>Tellinota edgari</i>					d	d	d	
<i>Theora lubrica</i>						f	o	f
<i>Trichomusculus barbatus</i>								d
<i>Xenostrobus pulex</i>	r?	o			d	d	d	d
<i>Zelithophaga truncata</i>							d	f

MOLLUSCA: SCAPHOPODA - TUSK SHELLS

Antalis nana

MOLLUSCA: CEPHALOPODA - CUTTLEFISH

Spirula spirula

ECHINODERMATA: ASTEROIDEA - SEASTARS

Allostichaster polyplax

Coscinasterias muricata

Patiriella regularis

Stichaster australis

ECHINODERMATA: ECHINOIDEA - SEA EGGS

Echinocardium cordatum

Evechinus chloroticus

Fellaster zelandiae

ECHINODERMATA: HOLOTHURIA - SEA CUCUMBERS

Australocnus calcareus

Stichopus mollis

Taeniogyrus sp.

ECHINODERMATA: OPHIUROIDEA - BRITTLE STARS

Ophioneis fasciata

CRUSTACEA: REPTANTIA - CRABS

Cancer novaezelandiae

Cyclograpsus lavauxi

Elamena producta

Halicarcinus cooki

Halicarcinus varius

Halicarcinus sp.

Helice crassa

Hemigrapsus edwardsi

Leptograpsus variegatus

Macrophthalmus hirtipes

Notomithrax peronii

Notomithrax ursus

Ovalipes catharus

Ozium truncatus

Paguristes pilosus

Pagurus novaezelandiae

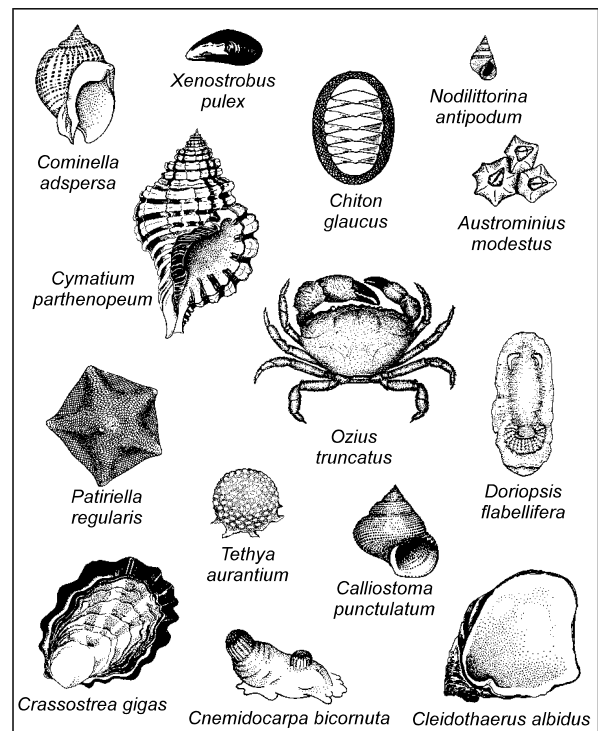
Petrolisthes elongatus

Pilumnus lumpinus

	A	B	C	D	E	F	G	H
<i>Plagusia chabrus</i>	f	f					f	
<i>hermits indet</i>						c		
CRUSTACEA: DECAPODA - SHRIMPS								
<i>Alope spinifrons</i>	f	o						
<i>Ogyrides delli</i>				o				
CRUSTACEA: AMPHIPODA								
<i>Gammaropsis typica</i>					o			
<i>Heterophoxus</i> sp.				c				
<i>Liljeborgia hansonii</i>				r				
<i>Melita awa</i>					f			
<i>Otagia neozelanica</i>				r				
<i>Paradexamine pacifica</i>						c		
<i>Paracentromedon hake</i>				o				
<i>Protophoxus australis</i>					o			
<i>Proharpinia</i> sp.				o				
<i>Torridoharpinia hurleyi</i>						c		
<i>Trichophoxus chelatus</i>				f	r			
<i>Trichophoxus spinibasus</i>				r				
CRUSTACEA: ISOPODA								
<i>Astacilla</i> sp.				r				
<i>Ligia novaezelandiae</i>	o	c						
<i>Macrochiridothea uncinata</i>				o				
<i>Natatalana</i> sp.				r				
CRUSTACEA: CUMACEA								
<i>Cyclaspis argus</i>				r				
<i>Cyclaspis triplicata</i>				r				
<i>Diastylopsis crassior</i>				r				
CRUSTACEA: LEPTOSTRACA				r				
CRUSTACEA: OSTRACODA				o				
<i>Diasterope grisea</i>					o			
CRUSTACEA: PYCNOGONIDA						r		
CRUSTACEA: CIRRIPELIDIA - BARNACLES								
<i>Austrorhynchus modestus</i>			f				a	
<i>Chamaesipho brunnea</i>		a						
<i>Chamaesipho columna</i>		a						
<i>Epopella plicata</i>		r						
<i>Notomegabalanus decorus</i>		r				d	r	
<i>Tetraclita purpurascens</i>		f						
BRACHIOPODA - LAMP SHELLS								
<i>Calloria inconspicua</i>							r	
CNIDARIA - ANENOMES, HYDROIDS								
<i>Actinia tenebrosa</i>		o						
<i>Actinothoe albocincta</i>		f		r				
<i>Amphisbetia bispinosa</i>			d					
<i>Cricophorus nutrix</i>		o						
<i>Culicia rubeola</i>						f		
<i>Diadumene neozelanica</i>						o		
<i>Edwardsia tricolor</i>				r				
<i>Isactinia olivacea</i>		o						
<i>Isocradactis magna</i>		r				o		
<i>Oulactis muscosa</i>		o						
POLYCHAETA - WORMS								
<i>Aglaophamus macroura</i>			c		r		o	
<i>Amphicteis philippinarum</i>				o				
<i>Armandia maculata</i>				r		c		
<i>Asychis ?theodori</i>						o		
<i>Axiothella quadrimaculata</i>						f		
<i>Boccardia</i> sp.				r			r	
<i>Bradabyssa</i> sp.				r				
Capitellidae						c		
Cirratulidae						r		
<i>Cossura</i> sp.						c		
<i>Enoe iphionoides</i>						r		
<i>Eupholoe</i> sp.						r		
<i>Flabelliderma</i> sp.		r						
<i>Galeolaria hystrix</i>								
<i>Glycera lamellipodia</i>				o		o		
<i>Glycinde dorsalis</i>				o		r		
<i>Goniada littorea</i>				f				
<i>Hemipodus simplex</i>						r		
<i>Paraidanthyrus pennatus</i>		r				r		
<i>Irmula</i> sp.						r		

	A	B	C	D	E	F	G	H
<i>Lepidastheniella</i> sp.							f	
<i>Lepidonotus polychromus</i>		o					o	r
Lumbrineridae		r					r	
<i>Lumbrineris aotearoae</i>							r	
<i>Lumbrineris coccinea</i>							r	
<i>Magelona papillicornis</i>					o			
<i>Marphysa depressa</i>						o		
<i>Megalomma</i> sp.		r						
Nereidae		o					f	r
<i>Onuphis aucklandensis</i>					r			
<i>Owenia fusiformis</i>						r		
<i>Paraprionospio</i> sp.						r		
<i>Pectinaria australis</i>					o			r
<i>Perinereis ambylodonta</i>		o					r	
<i>Pherusa parmata</i>							c	r
Phyllodocidae					r		r	
<i>Priospio</i> sp.					r		a	
<i>Spirobranchus cariniferus</i>	c				d		f	
<i>Sabellaria kaiparaensis</i>	o							
<i>Salmacina australis</i>	r	o						
<i>Schistomeringos</i> sp.						o		
<i>Spirorbis</i> sp.		f						
<i>?Sthenolepis</i> sp.					f			
<i>Streblosma gracile</i>						f		
Syllidae							r	
<i>Terebellanice</i> sp.							o	
Terebellidae		r						r
POGONOPHORA							o	
NEMERTEA - UNSEGMENTED WORMS					r		o	r
PLATYHELMINTHES - FLAT WORMS								
<i>Stylochoplana</i> sp.		o						
PORIFERA - SPONGES								
<i>Aaptos confertus</i>								c
<i>Ancorina alata</i>		o						
<i>Ciocalyptra polymastia</i>								f
<i>Corticellopsis novaezelandiae</i>		o						r
<i>Halichondria moorei</i>								c
<i>Microciona coccinea</i>		r						
<i>Polymastia granulosa</i>								r
<i>Tethya aurantium</i>		o						c
<i>Tethya australis</i>		r						o
ASCIDIA - SEA SQUIRTS								
<i>Asterocarpa coerulea</i>		r						
<i>Cnemidocarpa bicornuta</i>								a
<i>Corella eumyota</i>		f						f
<i>Pyura</i> sp.		o						a
ALGAE - SEAWEEDES								
<i>Aeodes nitidissima</i>		o						
<i>Apophloea sinclairii</i>		o						
<i>Carpophyllum maschalocarpum</i>		a						
<i>Codium fragile</i>			r					
<i>Corallina officinalis</i>		a	c					c
<i>Cystophora torulosa</i>		o						
<i>Dictyota ?intermedia</i>								r
<i>Gigartina alveata</i>		a						
<i>Gigartina marginifera</i>		f						
<i>Hormosira banksii</i>		c	c					c
<i>?Kallymenia</i> sp.								r
<i>Melanthalia abscissa</i>		o						
<i>Monostroma</i> sp.								o
<i>Pachymenia lusoria</i>		c						
<i>Placentophora colensoi</i>		o						
<i>Pterocladia lucida</i>		o						
<i>Sargassum sinclairii</i>								o
<i>Splachnidium rugosum</i>								r
<i>Ulva lactuca</i>		o						
<i>Zonaria turneriana</i>		o						
LICHENS: INTERTIDAL								
<i>Lichina confinis</i>	f	f						
VASCULAR PLANTS: INTERTIDAL								
<i>Avicennia marina</i> var. <i>australasica</i>								r
<i>Zostera</i> sp.		c						f

Fig. 2. Some of the more common or characteristic members of the faunas of the rocky shores of Raglan Harbour. Specimens drawn by Margaret Morley, Powell (1987) and Morton & Miller (1968).



ECOLOGICAL NOTES

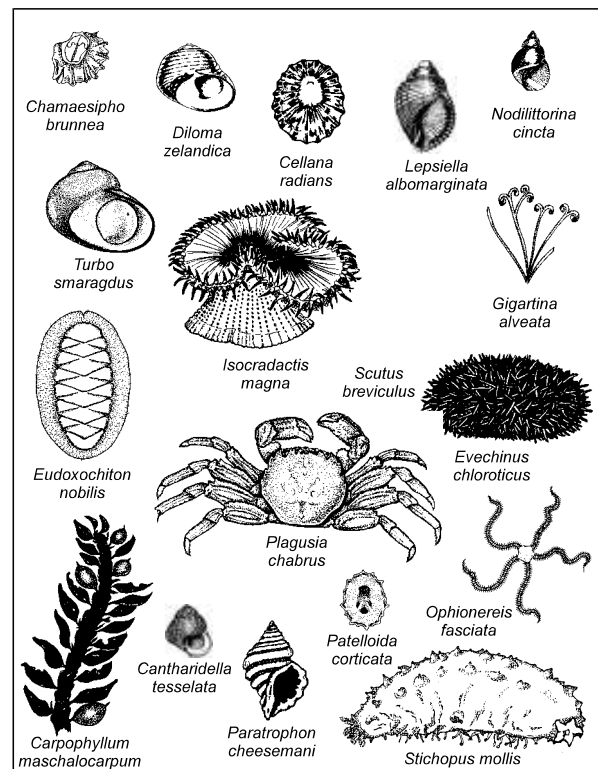
Sheltered harbour rocky shore (Fig. 2)

94 species (70 living) were recorded from the dominantly limestone rocky shore on the north side of Raglan Harbour. In places horizontal stretches of reef are draped in a thin veneer of mud, and further up the harbour deep drifts of mud have built up in depressions and hollows between the rocks. The dominant high and mid tidal zoning organisms are the acorn barnacle *Austrominius modestus* and the profuse Pacific oyster *Crassostrea gigas*, with sparse flea mussel *Xenostrobus pulex*, tube-worm *Spirobranchus cariniferus*, and Neptune's necklace *Hormosira banksii*. Common grazers and detritivores at these levels are *Nodilittorina antipodum*, *Diloma subrostrata*, *Sypharochiton pelliserpentis* and *Chiton glaucus*.

The diversity of the biota increases towards low tide levels, particularly towards spring low tide levels where the murky water usually cuts down light penetration and allows colourful sponges (e.g., *Aaptos confertus*, *Halichondria moorei*, *Polymastia granulosa*, *Tethya aurantium*, *T. australis*) and tunicates (e.g., *Cnemidocarpa bicornuta*, *Corella eumyota*, *Pyura*) to live in the open on the rocks, as well as in crevices and under the few boulders present. Also common around this level are a number of crabs, such as the hermits *Pagurus novizelandiae*, black-finger crab *Ozius truncatus*, half crab *Petrolisthes elongatus*, and larger *Leptograpsus variegatus* and *Plagusia chabrui*. The polychaete *Pherusa parramatta* is frequently encountered here, together with less common *Perinereis novaehollandiae*. The low tidal chitons present are mostly *Acanthochitona zelandica* and *Cryptoconchus porosus*, with rare *Plaxiphora violacea*. Low tide herbivores include *Cookia sulcata*, *Evechinus chloroticus*. Carnivores include the gastropods *Dicathais orbita*, *Cymatium parthenopeum* and rare *Buccinulum linea* and *Calliostoma punctulatum*, and seastars *Coscinasterias muricata* and *Patriella regularis*. Colourful nudibranchs on this shoreline are *Dendrodoris citrina* and *Doriopsis flabellifera*, together with the colonial coral *Culicia rubeola*. The anenomes *Diadumene neozelanica* and *Isocradactis magna* are occasionally present. Also of note are a few live specimens of the small red brachiopod *Calloria inconspicua* attached to low tide rocks. Cemented to low tide rocks in several places is the bivalve *Cleidothaerus albidus*.

A short stretch of softer sandstone reef at low tide level is bored by *Zelithophaga truncata* and the pholads *Pholadidea suteri* and rarer *Barnea similis*, their empty hollows sometimes occupied by *Irus reflexus*.

Fig. 3. Some of the more common or characteristic members of the rocky shore at Whale Bay, south of Raglan Harbour mouth. Specimens drawn by Margaret Morley, Powell (1987) and Morton & Miller (1968).



Exposed rocky shore (Fig. 3)

On the exposed, intertidal boulders and shore platform at Papanui Point, biodiversity is low (23 species recorded). This is partly because of the exposure to pounding surf, and partly because of scouring by the shifting sand. At mid and high tide levels the dominant zoning organisms are the barnacles *Chamaesipho columna* and *Epopella plicata*, the flea mussel *Xenostrobus pulex* and the sand tubeworm *Sabellaria kauparaensis*. Less obvious are the grazing limpets, chitons and slugs *Cellana ornata*, *C. radians*, *Sypharochiton pelliserpentis* and *Onchidella nigricans*. Under the shaded edges of boulders are the dark red anemones *Isactinia tenebrosa*. The most common carnivores on the upper shore are the oyster borers *Lepsiella albocolumella* and the purple crab *Leptograpsus variegatus*.

Lower on the shore the dominant alga is *Gigartina alveata* and *Corallina* turf, and the dominant zoning bivalve is the green-lipped mussel *Perna canaliculus*, with its associated predator seastar *Stichaster australis*. Also present around lower tide levels are the orange golf ball sponge *Tethya aurantium*, the encrusting crimson sponge *Microciona coccinea*, the large chiton *Plaxiphora obteata*, the carnivorous thaid *Dicathais orbita* and the fierce red crab *Plagusia chabrus*.

Where the shore is more sheltered outside the lagoon around Whale Bay, there is a greater variety of microhabitats and consequently much greater diversity of plant (14 seaweeds) and animal (91 species) life, including the seaweed fauna (below). At high and mid tide levels on the bouldery and rocky shore the dominant zoning organisms are the barnacles *Chamaesipho brunnea* and *C. columna*, tube-worm *Spirobranchus cariniferus*, grazing herbivores *Nodilittorina antipodum*, *Cellana radians*, *Diloma zelandica*, *Siphonaria australis* and *Sypharochiton pelliserpentis*, and carnivorous oyster-borer *Lepsiella albomarginata*. Moving down towards low tide these are progressively replaced by the common zoning algae *Hormosira banksii*, *Gigartina alveata*, *Carpophyllum maschalocarpum* and *Corallina*, with associated grazing fauna of *Acanthochitona zelandica*, *Patelloida corticata* and less frequent *Eudoxochiton nobilis*, *Ischnochiton maorianus*, *Haliotis iris*, *Turbo smaragdus* and *Evechinus chloroticus*. Among the diverse carnivores and scavengers at lower tidal levels are seastars *Allostichaster polyplax*, *Stichaster australis* and *Patiriella regularis*, the crabs *Leptograpsus variegatus*, *Ozius truncatus* and *Plagusia chabrus*, and gastropods *Buccinum vittatum* and *Dicathais orbita*.

Beneath and between the large stable boulders at low tide level is a profusion of colourful sponges, such as *Tethya aurantium*, *T. australis*, *Ancorina alata*, *Microciona coccinea*.

Seaweed molluscs

Many small gastropods live on low tidal brown and red algae, with a lower diversity found in the rocky habitats inside Raglan Harbour (6 species) than outside at Whale Bay (10 species), where there is also a greater diversity of seaweeds. Only two mollusc species were found at both localities - *Eatoniella olivacea* and *Eatonina atomaria*. On rocks on the north shore of the harbour the seaweed fauna is dominated by *E. atomaria*, *Eatoniella limbata*, *Amphithalmus semen* and *Orbitestella parva*, with fewer live *E. olivacea* and *Pisinna olivacea impressa*. At Whale Bay the seaweed fauna is dominated by *Cantharidella tessellata*, *Amphithalmus semen* and *Micrelenchus sanguineus*, with less common *Eatoniella atervisceralis*, *E. olivacea*, and *Zalipais lissa*. Also present on the seaweed in low numbers are *Eatoniella latebricola*, *Eatonina subflavescens*, *E. atomaria*, and *Pisinna zosterophila*.

Whale Bay intertidal lagoon

103 species (69 living) were found living in the Whale Bay intertidal lagoon, around its rocky margins or washed up on its small sheltered sandy beach. Large patches of *Zostera* live in and around the edges of the permanently ponded parts of the lagoon with wedge shells *Macomona liliana* living in the sediment amongst its roots. Clumps of the tall branching *Codium fragile*, and Neptune's necklace *Hormosira banksii* also grow in the lagoon, together with the large sea cucumber *Stichopus mollis*, cushion star *Patiriella regularis* and three scavenging species of whelk *Cominella adspersa*, *C. glandiformis* and *C. maculosa*. Numerous stable cobbles or small boulders are half submerged in the lagoon. Sheltering beneath them are often found the crab *Ozius truncatus*, the black slug *Scutus breviculus*, limpet *Tugali suteri*, tunicate *Corella eumyota*, brittlestar *Ophionereis fasciata* and polychaetes *Perinereis novaehollandiae* and *Lepidonotus polychromus*.

On low basalt cliffs at high tide level around the side of the lagoon grows a black stubble of *Lichina confinis*, the grazing limpets *Notoacmea pileopsis* and *Cellana radians*, and periwinkles *Nodilittorina antipodum*. Beneath stable cobbles in relative shelter at high tide level at the head of the lagoon live *Diloma bicanaliculata*, *Nerita atramentosa*, and the fast-running crustaceans *Ligia novaezelandiae* and *Cyclograpsus lavauxi*.

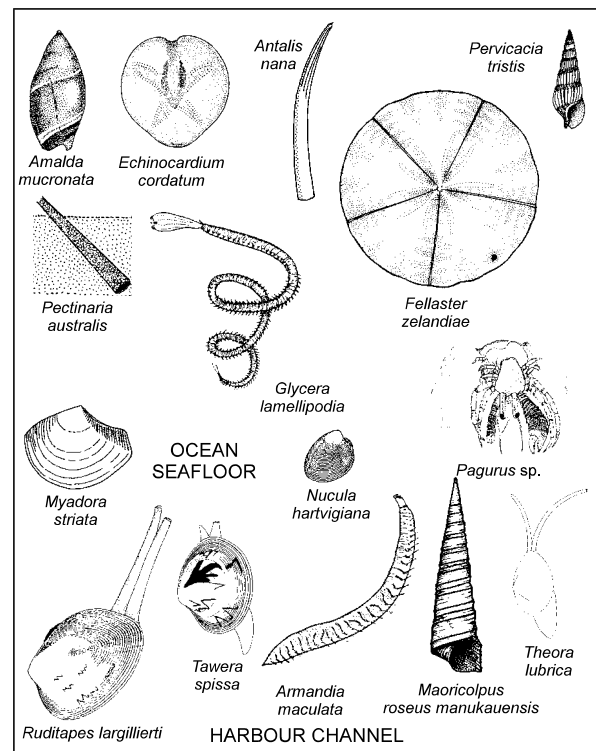
Exposed ocean beaches

Like exposed beaches elsewhere, sandy Ngarunui and Ruapuke Beaches, either side of Mt Karioi's rocky shore, support an extremely limited number of organisms. The only living organisms were low numbers of the swimming crab *Ovalipes catharus*. Numerous shells are washed up on these beaches reflecting the composition of the fauna around low tide mark and just offshore mostly in the shallow subtidal surf zone - these include abundant surf clams *Macra murchisoni*, *Peronaea gaimardi*, *Resania lanceolata*, *Spisula aequilatera*, *Tellinota edgari* and the two tuatua species *Paphies donacina* and *P. subtriangulata*. Also washed up is a range of less common species washed in from slightly further offshore or washed out by tidal currents from Raglan Harbour (e.g., olive shell *Amalda mucronata*, bivalves *Dosinia zelandica*, *Gari lineolata*, *Gari stangeri*, *Maorimacra ordinaria*, *Pecten novaezelandiae*, *Scalpomacra scalpellum*, *Tawera spissa*, and cuttlefish shell *Spirula spirula*).

Harbour entrance beach

Twelve species were found living in the fine to medium sand of Wainamu Beach, on the south shore of Raglan Harbour entrance, and the remains (mostly shells) of another 84 species were found washed up. The two most common live organisms are the small gastropod *Zethalia zelandica* and the cushion star *Patiriella regularis*, both of which live on and in the surface sand at spring low tide level and below. Also found in fewer numbers in the same habitat are the sand dollar *Fellaster zelandiae* and heart urchin *Echinocardium cordatum*, olive shell *Amalda australis*, whelk *Cominella adspersa*, horse mussel *Atrina zelandica*, and the bivalves *Dosinia subrosea*, *Macomona liliana*, *Myadora striata*, *Mylitella vivens vivens* and *Theora lubrica*. Washed up on the beach are a wide variety of mollusca sourced from both inside and outside the harbour, including the wood borer *Bankia australis* in a driftwood log.

Fig. 4. Characteristic members of the subtidal sediments of the channel in Raglan Harbour and also of the inner shelf seafloor offshore from the entrance to Raglan Harbour. Specimens drawn by Margaret Morley, Powell (1987) and Morton & Miller (1968).



Subtidal harbour channel (Fig. 4)

121 species (68 living) were identified in the eight small dredge hauls taken in Raglan Harbour. The living fauna includes 29 species of polychaete worms, 13 bivalves, 6 amphipods, 4 gastropods and 4 crabs. No live organisms were recovered from the mobile clean sand bottom in the deepest (16 m) and most strongly current-swept part of the entrance channel. Opposite Raglan township the channel sediment is sandy shell gravel and it becomes progressively finer moving up the harbour to where it is fine sandy mud 6km up off Motukokako Point. Channel sediment is usually dominated by the large turret shell *Maoricolpus roseus manukauensis* (up to 1000 per sq. m) together with the nutshell *Nucula hartvigiana*. In the coarser sediment are the more robust bivalves *Ruditapes largillierti*, *Dosina zelandica*, *Gari stangeri* and *Tawera spissa*, together with numerous hermit crabs and the slipper limpet *Zegalerus tenuis*. The polychaete *Armandia maculata* is common in the coarse sediment, whereas in fine sediment the dominant polychaetes are capitellids, *Cossura* and *Prionospio*.

The most diverse faunas were recovered from two dredge stations taken in sand and shell gravel just below spring low tide level on the edge of the channel. These also have abundant live turret and nut shells, together with smaller or thinner-shelled bivalves such as *Arthritica bifurca*, *Divaricella huttoniana*, *Felaniella zelandica*, *Leptomya retiaria*, *Pseudoarcopagia disculus* and *Theora lubrica*. Also common are the pillbox crabs *Halicarcinus*, hermit crabs, amphipods *Paradexamine pacifica* and *Torridoharpinia hurleyi*, and numerous polychaetes, particularly *Prionospio*, *Armandia maculata*, *Lepidastheniella*, *Axiiothella quadrimaculata*, *Lepidonotus polychromus*, *Streblosoma gracile*, capitellids and nereids.

Of interest was the presence of a living specimen of the small scaphopod *Antalis nana* in less than 1 m of water at low tide.

Offshore seafloor (Fig. 4)

72 species (46 living) were identified from the six small dredge hauls taken from the clean sand seafloor offshore from the entrance to Raglan Harbour. The live fauna includes 15 species of polychaete worms, 7 amphipods, 5 bivalves, 4 gastropods, 3 isopods and 3 cumaceans. Inshore (shallower than 10 m) in slightly coarser sediment (medium sand), faunal diversity is low and dominated by amphipods, isopods and a few bivalves and polychaetes. The most common amphipods are *Trichophoxus chelatus* and *T. spinibasus*, and the most common isopod is *Macrochiridothea*

uncinata. *Sthenolepis* and *Magellona papillicornis* are the most frequent polychaetes, and the live bivalves are the nut shell *Nucula nitidula* and the tuatua *Paphies donacina*.

In the clean fine sand further offshore (11-20 m depth), the fauna becomes increasingly more diverse and abundant with increasing depth and presumably stability. It is dominated by diverse polychaetes, with subdominant bivalves, amphipods, cumaceans and gastropods. The most common polychaetes are *Aglaophamus macroura*, *Sthenolepis*, *Pectinaria australis*, *Goniada littorea*, *Glycera lamellipodia*, *Amphictis philippinarum* and *Glycinde dorsalis*. Live molluscs in order of decreasing abundance are *Myadora striata*, *Amalda mucronata*, *Nucula nitidula*, *Pervicacia tristis*, *Myadora antipodum*, *Chemnitzia*, *Dosinia subrosea*, *Pupa kirki* and *Antalis nana*. Common amphipods are *Heterophoxis*, *Proharpinia*, *Paracentromedon hake* and *Liljeborgia hansonii*. Also present are live sand dollars *Fellaster zelandiae* and heart urchins *Echinocardium cordatum* and common at 20 m is the small decapod *Ogyrides delli*.

Sheltered harbour beaches

Thirty species were found living on or in the sand or mud substrate of the sheltered beaches around the foreshore of Raglan Harbour. Most common at high tide level are the mud snail *Amphibola crenata* and the mud crab *Helice crassa*. At mid to low tide level the most common organisms are the cockle *Austrovenus stutchburyi*, wedge shell *Macomona liliana*, and pipi *Paphies australis*, the horn shell *Zeacumantus lutulentus* and lower tidal mud crab *Macrophthalmus hirtipes*. At low tide level and below are numerous nutshells *Nucula hartvigiana* and patches of the small introduced semeliid bivalve *Theora lubrica*. Mid to low tidal carnivorous gastropods include *Xymene plebeius*, *Cominella glandiformis* and *C. quoyana*. Eight worm taxa were found burrowing in the soft substrate at lower tidal levels, particularly *Aglaophamus macroura* and malidanids. Also present is the worm-like holothurian *Trochodota* and unidentified nemertine worms. Small patches of *Zostera* are present intertidally on the north shore.

MOLLUSCAN BIOGEOGRAPHIC NOTES

The mollusc species listed below and found in this Raglan study, provide the first published records of 15 taxa from New Zealand's west coast. The Raglan records of a further 4 mollusc species, extend their published range southwards down the west coast and a further 5 species extend their published northernmost range on the west coast of the North Island. Powell's and subsequent published ranges have been used when commenting on range extensions, because Spencer & Willan (1996) give zoogeographic provinces only. These provinces (Powell 1955) are used here to summarise the known range of each species (A = Aupourian, C = Cookian, F = Forsterian, M = Moriorian, An = Antipodean). Additional unpublished records from the collections of the Auckland Museum (AK), and Margaret Morley (MM), are cited where they additionally extend the published range of species found at Raglan.

First West Coast records

* *Brookula (Aequispirella) finlayi* Powell, 1965, Trochidae

Previously recorded from the Three Kings and Mokohinau Islands down the east coast to the Chatham Islands (Powell 1979). This Raglan specimen (AK140276) is the first record from the west coast of the North Island. The range is further extended by specimens from Cape Maria van Diemen, Northland, Whanganui Bight (24 m), and Kaikoura (all MM). The range for *Brookula finlayi* is now A, C, and M provinces.

* *Buccinum pertinax pertinax* (Martens, 1878), Buccinidae

Previously recorded from the southern half of the South Island, Stewart and Chatham Islands and the Subantarctic. This Raglan specimen (AK140146) found at Whale Bay is the first record from the North Island. Its range is updated to C, F, M and An provinces.

**Eatoniella globosa* Ponder, 1965, Eatoniellidae

Previously recorded from off north-east Northland, this specimen from Raglan Harbour (AK140273) is the first west coast record. We have additional records from New Plymouth (AK, Hayward and Morley in press). The range for *Eatoniella globosa* is now A and C provinces, including the west coast of the North Island.

**Eatoniella notata* Ponder & Yoo, 1977, Eatoniellidae

Previously recorded on algae in exposed situations off the east coast of the the northern North Island. These Raglan specimens (AK140282) are the first west coast records. We have an additional record from Mercer Bay, Waitakere coast (AK). The range for this species is now A and C provinces, including the west coast of the North Island.

**Eatoniella roseospira* (Powell, 1937), Eatoniellidae

Previously recorded from the Three Kings and down the north-east coast of Northland (Powell 1979). This Whale Bay specimen (AK140261) is the first record from the west coast and extends this species range to A and C provinces, including the west coast of the North Island.

**Eatonina (Otatara) subflavescens* (Iredale, 1915), Cingulopsidae

Previously recorded from the north east of the North Island and the Bounty Islands. This Whale Bay specimen (AK140249) is the first west coast record. We know of other unpublished west coast records from Cornwallis, Manukau Harbour (AK), and Ahipara (AK, Hayward et al, in prep). The range for this species is now A, C and An provinces, including the North Island west coast.

**Incisura lytteltonensis* (E.A. Smith, 1894), Scissurellidae

Previously recorded from all provinces, but this specimen (AK1402690) from algae in Raglan Harbour is the first from the west coast. We have an additional record from Destruction Gully, Waitakere coast (AK, Hayward and Morley in prep.).

**Odostomia vestalis* Murdoch, 1905, Pyramidellidae

Previously only recorded from Whangaroa Harbour, north-east Northland, these Raglan Harbour specimens (AK140271) from Wainamu Beach provide a significant range extension. The range is now A and C provinces, including the west coast of the North Island.

* *Ophicardelus costellaris* (H. & A. Adams, 1854), Ellobiidae

Previously recorded in high tidal situations from the North Island and northern parts of the South Island. This record from Raglan Harbour and another from Herekino Harbour (MM) are the first definite west coast records. This species is known from A and C provinces and now includes the west coast of the North Island.

* *Pisinna olivacea impressa* (Hutton, 1885), Anabathronidae

Previously recorded from Cape Maria van Diemen, Northland, down the east coast to Banks Peninsula and the Chatham Islands. This Raglan specimen (AK140289), found alive under rocks, is the first west coast record. We have an additional record from Chalky Inlet, Fiordland in anchor mud at a depth of 25m (MM). The range is now updated to A, C, F and M provinces including the west coast of the North and South Islands.

* *Pusillina (Haurakia) latiambia* (Ponder, 1967), Rissoidae

Previously recorded from the east of the northern North Island, from Tom Bowling Bay to Mount Maunganui (AK). This specimen from the north side of Raglan Harbour (AK140280) is the first west coast record. It is now known from A and C provinces, including the west coast of the North Island.

* *Acar sociella* (Brookes, 1926), Arcidae

Previously recorded from the east coast of Northland, and from Wellington Harbour (Marshall 1998). This specimen from Raglan Harbour (AK140299) is the first west coast record, but we have additional west coast records from Herekino, Northland, and Dusky Sound, Fiordland (MM). The range is further extended with records from Foveaux Strait (in 33m) and the Chatham Islands (all MM). The range for *Acar sociella* is now extended to include A, C, F and M provinces.

* *Gaimardia (Neogaimardia) finlayi* (Powell, 1933), Gaimardiidae

Previously recorded from shell sand at Tom Bowling Bay, North Cape and Parengarenga Harbour.

The Raglan specimens (AK139033) were attached to the narrow fronds of the red alga *Osmundaria colensoi* at Whale Bay. We know of additional west coast records from the coast of the Waitakere Ranges (Hayward and Morley in prep.) and Kiritehere, south of Kawhia (MM). *Gaimardia finlayi* is now known from A and C provinces.

* *Soletellina nitida* (Gray in Dieffenbacher, 1843), Psammobiidae

Previously recorded from North, South, Stewart and Chatham Islands as common in shallow water off sandy beaches. This Raglan specimen (AK) together with several recent finds on beaches of the Waitakere Ranges (Hayward and Morley in prep.) are the first records from the west coast of the North Island. This species is already known from A, C, F, M and An provinces and now includes the west coast of the North Island.

Southward extension of range on the west coast

* *Buccinulum robustum* Powell, 1929, Buccinidae

Previously recorded from the eastern side of northern New Zealand, from the Three Kings Islands to East Cape, and from Kawerua on the west coast of Northland. This Raglan record is the southernmost record of the species on either coast of the North Island. The range for this species is updated to A and C provinces, including the west coast of the North Island.

* *Merelina lyalliana* (Suter, 1898), Rissoidae

Previously recorded from the length of the east coast of the North Island including Lyall Bay, Wellington's south coast. This Raglan specimen (AK140256) extends its range southwards down the west coast, having been recorded previously from Kawerua, Northland (Hayward et al. 1995). We have additional records from South Bay, Kaikoura; Akaroa; Luncheon Cove, Dusky Sound (3m), and Puysegur Point, Fiordland (MM, AK). The range of *M. lyalliana* is now extended to A, C and F provinces, including the west coast of the North Island.

* *Odostomia takapunaensis* Suter, 1908, Pyramidellidae

Previously recorded from the inner Hauraki Gulf and from Kawerua on the west coast of Northland (Hayward et al. 1995). The specimen (AK141878) dredged in 11 m off Whale Bay, Raglan, is the southernmost record of this species on either side of the North Island. Its range is now known to be A and C provinces, including the west coast of the North Island.

* *Zalipais lissa* (Suter, 1908), Skeneidae

Previously recorded from eastern New Zealand from Tom Bowling Bay to Otago and the Chatham Islands, and south down the west coast to the North Island to the Manukau Harbour. This specimen, from algae at Whale Bay, Raglan (AK140246) and another recently collected from New Plymouth (Hayward and Morley in press) are now the southernmost records on the west coast. *Zalipais lissa*, already known from A, C, F, M and An provinces is now recorded from the west coast of the North Island.

Northward extension of range on the west coast

* *Eulima perspicua* (Oliver, 1915), Pyramidellidae

Previously recorded from the east coast of northern New Zealand (Powell 1979) and from New Plymouth (Hayward et al. 1999). This Raglan record extends its range northwards on the west coast.

* *Pupa kirki* (Hutton, 1873), Acteonidae

Previously recorded from the east coast of the North Island, south to Cook Strait (Powell 1979) and from off Urenui, north Taranaki (Hayward et al. 1999). These specimens dredged off the mouth of the Raglan Harbour extend its range northwards on the west coast.

* *Zemitrella pseudomarginata* (Suter, 1908), Columbellidae

Previously recorded from north-eastern North Island (Spencer & Willan 1996) and from the west coast at Kawhia (Morley et al. 1997). This specimen (AK140297), dredged in the Raglan Harbour channel, extends the species range northwards on the west coast.

* *Cardita aoteana* Finlay, 1926, Carditidae

Previously recorded from around all of New Zealand, but this Raglan record is the first from the west coast north of New Plymouth (Hayward et al. 1999).

* *Myadora antipodum* E.A. Smith, 1880, Myochamidae

Previously recorded from around all of New Zealand, but this Raglan specimen is the first from the west coast north of Urenui (Hayward et al. 1999).

DISCUSSION

In general the exposed rocky shores along the west coast of the northern half of the North Island, from New Plymouth to Ninety Mile Beach, have a relatively low diversity fauna similar to that recorded here from Papanui Point. The softer sandstone rocky substrates of north Taranaki have the lowest diversity of all (Hayward et al. 1999), whereas the harder volcanic, greywacke or limestone substrates provide a greater topographic diversity of microhabitats and more stable surfaces which allows colonisation by a greater diversity of organisms, like barnacles and limpets.

Four west coast localities have considerably greater diversity of intertidal rocky shore biota. These are New Plymouth swimming pool reef (Hayward et al. 1999), Whale Bay coast, Kawerua (Hayward et al. 1995), and Ahipara to Reef Point (pers. obs.). The Kawerua coast has large basalt flow reefs that extend a long way out into the surf and provide unusual shelter and diversity of habitats in the shallows on their landward side. The other three localities face north and are more sheltered than the rest of the coast from the dominant south-west to west swells. Similar increased diversity also occurs on rocky shores just inside the entrance to some of the west coast harbours, such as at Te Maika, Kawhia Harbour entrance (Morley et al. 1997), Paratutae to Cornwallis, Manukau Harbour entrance (pers. obs.), Herekino Harbour entrance (pers. obs.) and here on the north side of Raglan Harbour entrance.

The subtidal biota of the strong current-swept Raglan Harbour channel with its common turret shells, *Maoricolpus*, and thick-shelled bivalves such as *Ruditapes* and *Tawera*, is similar to the harbour channel fauna from the Manukau and Waitemata Harbours (Powell 1937, Hayward et al. 1997), but differs from the nearby Kawhia Harbour, which appears to lack the larger molluscs (Morley et al. 1997).

The subtidal biota living in fine sand beyond the surf zone (10-20m depth) off the exposed west coast of the northern half of the North Island has seldom been documented, except by beach wash-up material after storms. The only previous study we know of was our dredge survey off Urenui Beach, north Taranaki (Hayward et al. 1999) in similar conditions, slightly sheltered by a protruding point on the coastline. The fauna from both surveys is remarkably similar, although lower diversity was recorded here, probably because of fewer dredge samples. In both places the fauna is numerically dominated by amphipods, polychaetes, cumaceans and the decapod *Ogyrides delli*. All 14 polychaetes and most of the amphipods and cumaceans recorded off Raglan were also present, in approximately the same order of abundance, as off Urenui (Hayward et al. 1999). The total (live plus dead) molluscan faunas are similar between Raglan and Urenui, but the live records differ considerably with *Amalda mucronata* and *Myadora* 2 spp. common alive off Raglan, but only recorded dead off Urenui. Conversely *Maorimactra ordinaria*, *Scalpomactra scalpellum*, *Austrofuscus glans*, *Neoguraleus amoenus* and *Tanea zelandica* are among the more common live molluscs recorded off Urenui, but none of these were found live off Raglan. These differences between the live mollusca from both areas probably reflects patchiness and no real ecological difference.

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Appendix I: Study and sample sites along the coast of north Taranaki.

L numbers are the station localities recorded in Auckland War Memorial Museum Marine Catalogue.

Intertidal survey sites

Whale Bay	37°50'S	174°48'E	L25500-3
Wainamu Beach	37°48'S	174°50'E	L25504
Raglan Hbr south shore	37°48'S	174°52'E	L25505,19, 26
Raglan Hbr north shore	37°48'S	174°51'E	L25506-9
Papanui Point	37°53'S	174°46'E	L25525

Subtidal dredge stations

Outside Raglan Harbour				
L25510	37°48.8'S	174°48.5'E	11 m	clean fine sand
L25511	37°48.3'S	174°47.9'E	14 m	clean fine sand
L25512	37°48.0'S	174°47.1'E	20 m	clean fine sand
L25513	37°48.9'S	174°49.3'E	5 m	clean medium sand
L25514	37°49.1'S	174°49.4'E	4 m	clean fine-medium sand
L25515	37°49.2'S	174°48.8'E	6 m	clean medium sand

Inside Raglan Harbour				
L25516	37°47.6'S	174°51.9'E	9 m	fine sandy shell gravel
L25517	37°47.7'S	174°51.8'E	11 m	shelly medium sand
L25518	37°48.0'S	174°51.9'E	2 m	shelly medium sand
L25520	37°48.0'S	174°51.6'E	16 m	clean medium sand
L25521	37°47.4'S	174°53.0'E	0.5 m	shelly muddy fine sand
L25522	37°47.8'S	174°53.6'E	5 m	shelly fine sand
L25523	37°47.2'S	174°54.1'E	5.5 m	fine sandy mud
L25524	37°47.9'S	174°53.0'E	0 m	muddy shelly rocky sand

Appendix II. Census data for 10 litre dredge samples taken offshore from Raglan Harbour mouth

Dredge penetration averaged 0.1 m into the sea floor sediment. Live organisms are in numbers of individuals; presence of dead shells is indicated by d. Organisms found only dead are not listed.

L25..	Offshore dredging										Harbour dredging				
	510	511	512	513	514	515	516	517	518	518	520	521	522	523	524
POLYPLACOPHORA															
<i>Ischnochiton maorianus</i>	1	.	.	.
<i>Leptochiton inquinatus</i>	1	.	.	.
GASTROPODS															
<i>Amalda australis</i>	d	d	.	.	d	.	.	d	.	.	.	1	.	.	.
<i>Amalda mucronata</i>	3	1	2	.	.	.	.	.	.	.	.	.	.	.	.
<i>Chemnitzia</i> spp.	.	1	.	.	.	.	d	.	.	.	.	.	d	.	.
<i>Maoricolpus roseus manukauensis</i>	48	d	.	d	.	750	d	200	50
<i>Pervicacia tristis</i>	d	1	5	.	.	.	.	d	d	.	.	.	.	.	.
<i>Pupa kirki</i>	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
<i>Turbo smaragdus</i>	d	.	.	.	.	.	5
<i>Zegalerus tenuis</i>	d	d	.	.	d	d	6	d	d	d	3	d	d	d	d
BIVALVES															
<i>Arthritica bifurca</i>	d	.	.	.	4	.	.	.	.
<i>Corbula zelandica</i>	d	d	d	.	1	1	.	.	.
<i>Divarilucina huttoniana</i>	.	d	.	.	d	.	.	.	.	.	1	.	.	.	.
<i>Dosina zelandica</i>	2	.	.	.	.	.	1	2	.
<i>Dosinia subrosea</i>	.	1	.	.	.	d	.	d	d	d	.	d	.	.	.
<i>Felaniella zelandica</i>	d	.	.	1	.	.	.	.
<i>Gari stangeri</i>	d	13	d	.	.	.	d	.	.
<i>Leptomya retitaria</i>	.	d	.	.	.	.	d	.	d	.	4	d	d	d	2
<i>Macomona liliana</i>	1
<i>Myadora antipodum</i>	2	d	1	.	.	.	.	.	d	.	.	.	.	.	.
<i>Myadora striata</i>	5	2	2	.	.	.	.	.	d	.	.	d	.	.	.
<i>Nucula hartvigiana</i>	65	d	d	.	4	1	38	29	.
<i>Nucula nitidula</i>	.	d	8	3	.	d	.	.	.	.	.	.	.	.	.
<i>Paphies donacina</i>	.	.	.	1	d	.	.	.	.	.	.	.	.	.	.
<i>Pseudoarcopagia disculus</i>	1	.	.	4	.	.	.	2
<i>Ruditapes largillierti</i>	.	.	.	d	.	d	9	1	d	.	d	d	d	d	5
<i>Tawera spissa</i>	d	.	d	4	d	.	d	d	.	.	.
<i>Theora lubrica</i>	8	.	.	.	.
SCAPHOPODA															
<i>Dentalium nanum</i>	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.
ECHINODERMS															
<i>Echinocardium caudatum</i>	d	.	2	.	.	d	.	.	.	.	.	.	.	.	.
<i>Fellaster zelandiae</i>	3	1	.	.	.	1	d	d	.	.	1	.	.	.	.
<i>Ocnus calcarea</i>	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
<i>Trochodota</i> sp.	1	.	.
CRABS															
<i>Halicarcinus cooki</i>	7
<i>Halicarcinus varius</i>	1	.	.	.	16	.	.	.	.
<i>Ovalipes catharus</i>	1	.	.	.	.
<i>Paguristes pilosus</i>	4	.	.	.	.
hermits indet	50	2	.	.	25	.	.	.	25
SHRIMPS															
<i>Ogyrides delli</i>	.	.	7	.	.	.	.	.	.	.	.	.	.	.	.
AMPHIPODA															
<i>Gammaropsis typica</i>	4	.	.	.	.
<i>Heterophoxus</i> sp.	.	3	12	.	.	.	.	.	.	.	.	.	.	.	.

L25..	Offshore dredging									Harbour dredging				
	510	511	512	513	514	515	516	517	518	520	521	522	523	524
<i>Liljeborgia hansonii</i>	.	.	2	.	.	.	.	.	.	.	.	.	.	.
<i>Melita awa</i>	4	.	4	.
<i>Otagia neozelandica</i>	2	.	.	.	.	.	.	.	.	.
<i>Paradoxamine pacifica</i>	2	.	.	.	56	.	2	4
<i>Paracentromedon hake</i>	.	.	3	.	.	.	.	.	.	.	.	.	.	.
<i>Protophoxus australis</i>	3	.	.	.	.	.	.
<i>Proharpinia</i> sp.	.	5	.	.	.	.	.	.	.	.	.	.	.	.
<i>Torridoharpinia hurleyi</i>	3	.	.	.	52	.	4	5
<i>Trichophoxus chelatus</i>	.	.	.	1	13	1	1	.	.	.	.	.	.	.
<i>Trichophoxus spinibasus</i>	2	.	.	.	.	.	.	.	.	.
ISOPODA														
<i>Astacilla</i> sp.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
<i>Ligia novaezelandiae</i>
<i>Macrochiridothea uncinata</i>	2	5	.	.	.	.	.	.	.	.
<i>Natatolana</i> sp.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
CUMACEA														
<i>Cyclaspis argus</i>	1	.	.	.	.	.	.	.	.
<i>Cyclaspis triplicata</i>	.	.	2	.	.	.	.	.	.	.	.	.	.	.
<i>Diastylopsis crassior</i>	.	.	2	.	.	.	.	.	.	.	.	.	.	.
LEPTOSTRACA	.	.	1	.	.	.	.	.	.	.	.	.	.	.
OSTRACODA	.	.	3	.	.	.	.	.	.	.	.	.	.	.
<i>Diasterope grisea</i>	4	.	.	.
PYCNOGONIDA	1	.	.	.	.	.	.	.
COELENTERATA														
<i>Actinothoe albocincta</i>	.	.	1	.	.	.	.	.	.	.	.	.	.	.
<i>Edwardsia tricolor</i>	.	.	1	.	.	.	.	.	.	.	.	.	.	.
POLYCHAETA														
<i>Aedicera</i> sp.	2
<i>Aglaophamus macroura</i>	2	1	3	1	.	.	.	.	.	.	1	.	.	.
<i>Amphiteis philippinarum</i>	.	.	6	.	.	.	.	.	.	.	.	.	.	.
<i>Armandia maculata</i>	.	.	1	.	.	.	.	35	.	.	13	.	4	18
<i>Asychis ?theodori</i>	4	.	.	.
<i>Axiothella quadrimaculata</i>	1	.	.	8	.	.	.
<i>Bradabyssa</i> sp.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Capitellidae	1	.	.	22	.	13	14
Cirratulidae	1	.	.	.
<i>Cossura</i> sp.	21	4
<i>Enoe iphionoides</i>	1
<i>Eupholoe</i> sp.	1	.	.	1
<i>Glycera lamellipodia</i>	.	2	2	.	.	.	.	.	1	.	1	.	.	3
<i>Glycinde dorsalis</i>	.	1	3	.	.	.	.	1	.	.	.	.	.	.
<i>Goniada littorea</i>	.	1	4	2	.	.	.	.	.	.	.	.	.	.
<i>Hemipodus simplex</i>	1	.	.	.	.	.	.
<i>Idanthyrsus pennatus</i>	1	.	.	.
<i>Irmula</i> sp.	1	.	.	.
<i>Lepidastheniella</i> sp.	5	.	.	16
<i>Lepidonotus polychromus</i>	1	.	.	3
Lumbrineridae	2	.	.	.
<i>Lumbrineris aotearoae</i>	1	.	.	.
<i>Lumbrineris coccinea</i>	1	.
<i>Magelona papillicornis</i>	3	.	.	.	.	.	.	.	.
<i>Marphysa depressa</i>	1	.	.	2
Nereidae	4	.	2	3
<i>Onuphis aucklandensis</i>	.	.	1	.	.	.	.	.	.	.	.	.	.	.
<i>Owenia fusiformis</i>	1	.	.	.	.	.	.
<i>Paraprionospio</i> sp.	.	.	.	2	.	.	.	.	.	.	.	.	.	.
<i>Pectinaria australis</i>	.	1	5	.	.	.	.	.	.	.	.	.	.	.
Phyllodocidae	.	.	1	.	.	.	.	.	.	.	1	.	.	.
<i>Prionospio</i> sp.	1	.	.	.	.	.	1	1	.	.	43	.	46	33
<i>Schistomeringos</i> sp.	2	.	.	1
? <i>Sthenolepis</i> sp.	2	3	2	.	1	2	.	.	.	.	.	.	.	.
<i>Streblosma gracile</i>	14	.	.	5
Syllidae	1	.	.	.
<i>Terebellanice</i> sp.	6
POGONOPHORA	3	.	.	3
NEMERTEA	.	.	1	.	1	.	.	.	.	.	.	.	1	5