Ryland's rocks: well-travelled bryozoans with a story to tell

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1. The language of bryozoology

In a dark corner of the bryozoan collections at the Natural History Museum, Cromwell Road, London, is a pile of boxes full of rock slabs (Figure 1). These rocks are dotted with encrusting bryozoans, and all bear the label: "J. Ryland Collection, Leigh Marine Reserve, New Zealand." They were donated to the NHM in 2016. This paper aims to tell the story of these rocks: where they came from, how they travelled over 18,000 km, how they have been used for research so far, and what they may still have to tell us. These specimens connect the Natural History Museum with a marine reserve in New Zealand through a study made by bryozoologist John S. Ryland half a century ago.

2. John S. Ryland

John Stanley Ryland was born 26 February 1933 in Thames Ditton, England. He studied Natural Sciences at Queens' College, Cambridge from 1951 to 1954, then carried out his PhD at the Marine Biology Station, University College of North Wales (now Bangor University) on *Settlement behaviour in Polyzoa*, which he completed in 1959. He married Christine Riley in 1962, with whom he has three daughters. His life-long commitment to international travel was evident early on, with Postdoctoral Fellowships

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Figure 1. Bryozoan-covered rocks in storage at Natural History Museum, London (Photographs: A.M. Smith).

at University of Bergen, Norway, and Stazione Zoologica di Napoli, Italy in 1959–1960; these were followed by a post at the Ministry of Agriculture, Fisheries and Food Fisheries Laboratory in Lowestoft, on the east coast of England.

In 1965 Ryland was appointed to the Department of Zoology (later incorporated into the School of Biological Sciences), University College of Swansea (now Swansea University), where he worked for 35 years, being awarded a Chair in 1977 and retiring in 2000. His career continued to be punctuated by travel: he was Nuffield Fellow in Tropical Marine Biology, visiting Bermuda, New Zealand and Australia in 1971–72; was seconded to the University of the South Pacific in Fiji 1978–1980; visited the Australian Institute of Marine Science (AIMS) in Townsville as a Senior Queen's Fellow in 1985; and used a Fulbright scholarship to work at the Smithsonian Institution at Link Port, Florida in 1993. With Royal Society travel grants he made further working visits to AIMS, Woods Hole Oceanographic Institution, and laboratories in South Africa; and taught Summer Schools at Duke University Marine Laboratory, Beaufort, North Carolina and the Bermuda Biological Station for Research, all with extended stays. Even as an Emeritus Professor, he travelled to Scripps in La Jolla and to the Oregon Institute for Marine Biology in western USA in 2005.

It goes without saying that John Ryland was an active member of the International Bryozoology Association (IBA) throughout his career, serving as President from 1974 to 1977. He attended and presented research papers at almost every IBA meeting from 1965

Figure 2. John Ryland doing what he does: relaxing, helping out, holding forth (Photographs: Hans Arne Nakrem).

(Ryland, 1968; Ryland & Porter, 2010). He attended field trips with enthusiasm (Figure 2), always bringing binoculars and bird books along. In 1995 he co-hosted the 9th IBA meeting in Swansea, co-editing that conference volume and leading the mid-conference field trip to Worms Head.

Ryland's research has concentrated on aspects of reproductive biology, growth, ecology and taxonomy of modular invertebrates (Bryozoa, Entoprocta, Ascidiacea, Anthozoa (Zoantharia), and Hydroida), in Britain and other parts of the world. A word-cloud made from 78 titles of papers on which he was an author or co-author (from Web of Science) reveals these themes (Figure 3).

John Ryland has authored and co-authored influential books, ranging from classic *Bryozoans* (Ryland, 1970) to the *Handbook of the Marine Fauna of North-West Europe* (Hayward and Ryland 2017). The Web of Science lists 81 publications, with his most cited paper being Crisp and Ryland (1960) in *Nature*, cited 120 times (Web of Science 2020). Over 100 bryozoan species have been described by him and co-authors (e.g., *Parasmittina onychorrhyncha* Ryland and Hayward, 1992) and numerous taxa named for him (e.g., *Callopora rylandi* Bobin and Prenant, 1965; *Bugula rylandi* Maturo, 1966; and *Escharella rylandi* Geraci, 1974).

It was in the early 1970s that John Ryland's interest in bryozoans took him to New Zealand, and Echinoderm Reef.

3. Echinoderm Reef, Leigh, New Zealand

Echinoderm Reef (36.270˚S, 174.795˚ E) is a gently sloping intertidal shore platform of mudstone and sandstone (Waitemata Formation), jointed with crevices and channels,

Figure 3. Word cloud indicating frequencies of word usage from titles of papers authored by J.S. Ryland.

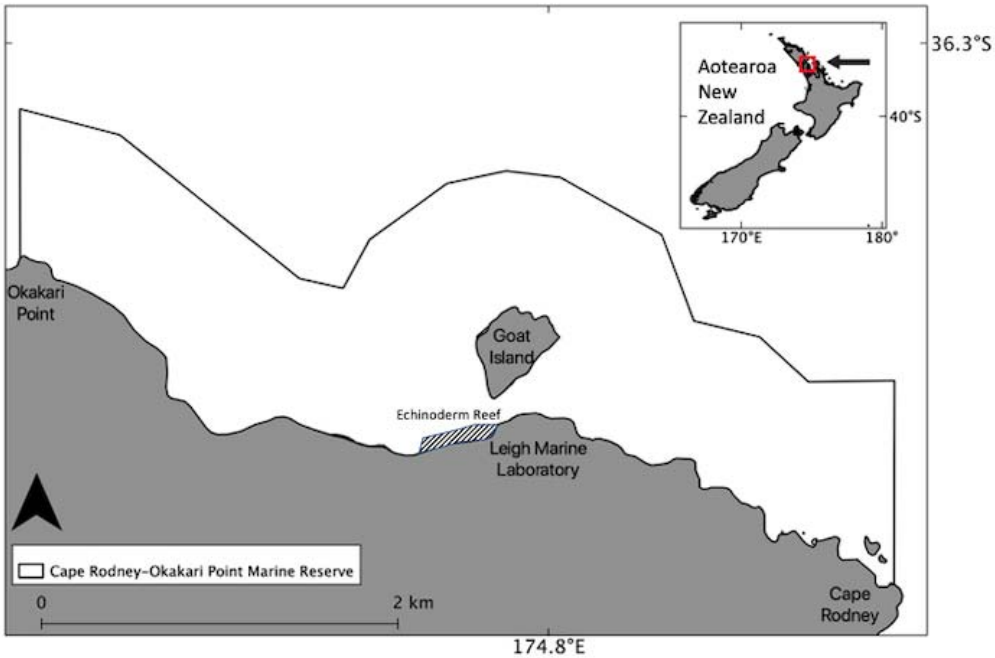

Figure 4. Echinoderm reef, Cape Rodney to Okakari Point Reserve, Leigh, North Island, New Zealand.

covered with loose rocks, occupying 3-4 ha (Sivaguru and McLay, 2010). It forms about 7% of the Cape Rodney to Okakari Point Marine Reserve (Figure 4), which covers 547 ha, stretching along 5 km of exposed rocky coastline and extending about 800 m offshore, north of the township of Leigh, about 100 km north of Auckland City, North Island, New Zealand (DOC, 2015). The reserve is New Zealand's first marine reserve, gazetted on 7 November 1975 (Government of New Zealand, 1975) but not officially opened or observed until May 1977 (Ballantine and Gordon 1977). It is located next to Auckland University's Leigh Marine Laboratory, which had been supporting marine research since 1962 (Babcock, 2013).

The local tidal range is 2.2m, in a warm temperate climate with mean sea surface temperatures of 21˚C in February (austral summer) and 14˚C in August (austral winter). Autumn water temperatures (April–June) have warmed at a mean rate of about 0.2 ˚C per decade over the last 50 years, whereas summer (November–December) water temperatures have cooled over the same period (Shears and Bowen, 2017). Although the marine reserve is open to the Pacific Ocean to the northeast, causing some storm waves to be significant (Ballantine and Gordon 1977), the Echinoderm Reef itself is sheltered to some extent by Goat Island.

Professor of Zoology John E. Morton (1924–2011) chose this site for the Auckland University marine laboratory, based on the diversity and accessibility of a number of

Figure 5. Views of Echinoderm Reef in 1971, facing (A, opposite top) westward toward Okakari Point; (B, opposite bottom); north-eastward toward Goat Island; and (C, below) eastward with the Marine Lab in the foreground and Little Barrier Island in the distance (Photographs by J.S. Ryland).

Figure 6. View of Echinoderm Reef in 2019, comparable to Figure 5A (Photograph by H. Lee Mello).

different marine habitats. He and Professor of Botany Valentine J. Chapman (1910–1980) produced a comprehensive review of the biology of the area (Morton and Chapman, 1968). As part of later work around protecting the marine reserve, Dr Dennis P. Gordon (b. 1944) and Prof. William J. Ballantine (1937–2015) surveyed the state of knowledge for the area, listing over 220 citations (Gordon and Ballantine, 1976). Dr Tony Ayling conducted a subtidal survey in 1978, including useful assemblage maps (Ayling1978).

A very wide range of studies in the marine reserve and on Echinoderm Reef have followed (e.g., Creese 1988; Cole *et al.* 1990; Shears and Babcock, 2002; Willis *et al.* 2003; Babcock *et al.*, 2010; Sivaguru and McLay 2010). A special issue of the *New Zealand Journal of Marine and Freshwater Research* in 2013 (volume 47 issue 3) focussed on 50 years of research at the Leigh Marine Laboratory.

Echinoderm Reef is named for the urchins, sea stars and brittle stars which are common. Pink coralline algae, sponges, spirorbid worms and herbivorous gastropods are abundant. Some of the boulders are stable enough to develop an "underside fauna" consisting of spirorbid worms, barnacles, and, in great abundance and diversity, bryozoans (Ryland 1975; Gordon, 1967; Morton, 2004). Dennis Gordon, who studied at the University of Auckland in the 1960s, became enchanted by bryozoans; he has listed over 64 species from these boulders; *Beania plurispinosa, Steginoporella magnifica,* and *Crassimarginatella papulifera* were the most common (Gordon, 1967; Morton, 2004).

Photographs taken by Ryland in 1971 (Figure 4) show the rocky reef flat as it was when he visited. Similar photos by Hannah Mello from 2019 (Figure 5) illustrate a higher level of sand on the reef, and turf-forming algae on the once-bare rock surfaces. Her preliminary survey suggests that bryozoan species diversity may have been reduced by as much as 50% from its level in 1971.

4. Rocks worth studying

John Ryland was inspired to visit Leigh, and what was to become the Cape Rodney/ Okakari Point Marine Reserve, by the reports of Gordon (1967) and Morton and Chapman (1968), which described the abundant and diverse bryozoans on the Echinoderm Reef rock flats (as compared to the then-prevailing misconception of bryozoan paucity in coral reefs). As part of a Nuffield fellowship in tropical ecology, Ryland had already planned a southern hemisphere visit to James Cook University, Townsville, Queensland, Australia and the Great Barrier Reef. He was allowed to add on a trip to New Zealand, bringing wife Christine and daughters Jane, Clare and Hazel with him in 1971–72.

In November 1971, the Ryland family arrived at Leigh, staying in Dulcie and Bill Ballantine's house while they were away, coincidentally on leave in the UK. During the six weeks he was there, John Ryland collected many fresh specimens, observing the wide variation in sizes of zooids and lophophores among the encrusting bryozoans.

The initial objectives of the study were (1) a comparative study the morphometry of the lophophore, how it varied with zooid size, and how such variation related to food capture; and (2) establishing the relative abundance of species and how this related to lophophore

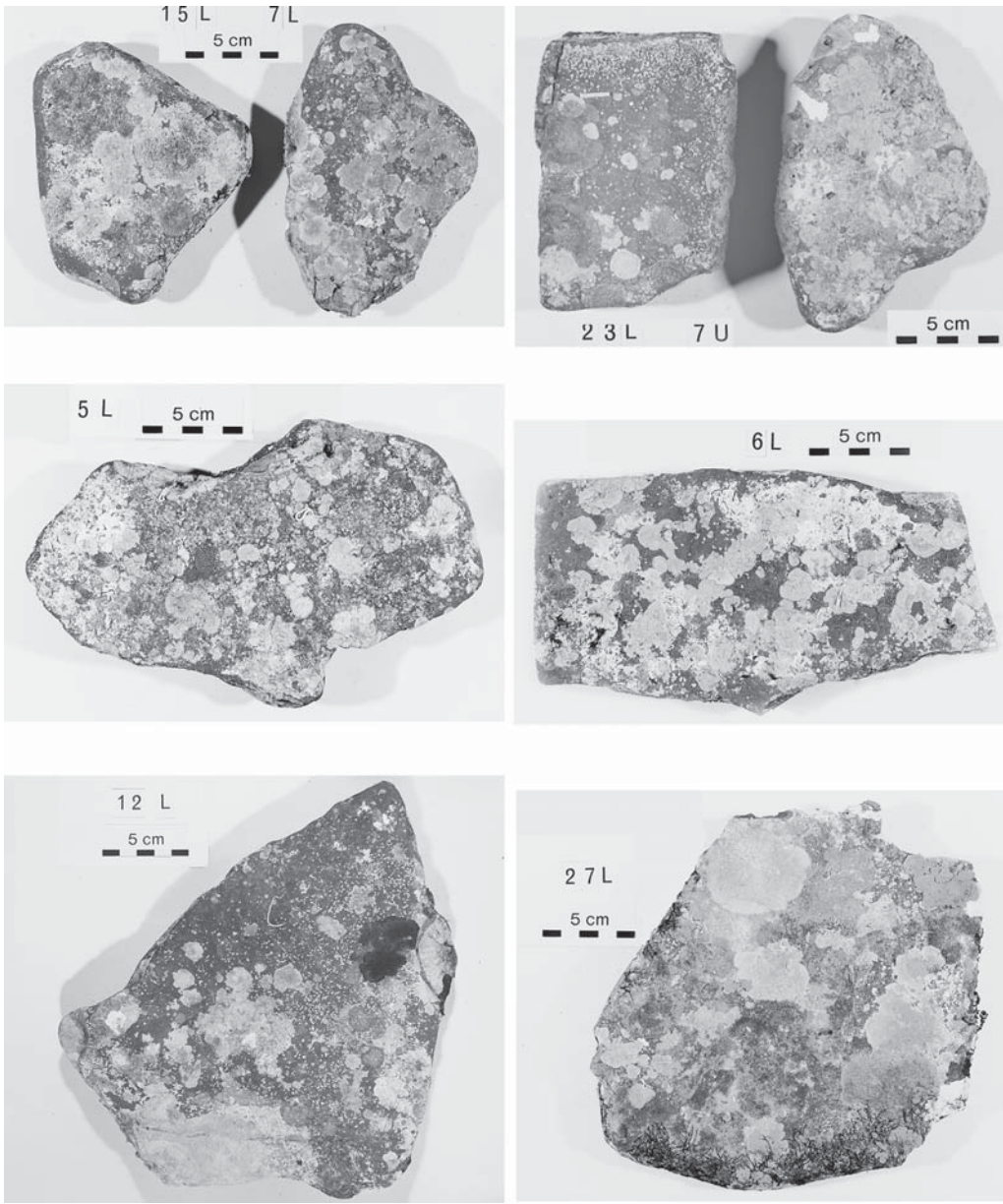

Figure 7. Examples of original photographs of Echinoderm Reef rocks from 1970s. (Photographs by J.S. Ryland)

size. The observed density of encrusting bryozoan colonies then suggested that the populations were ideal for an analysis of overgrowth and spatial competition.

"Parameters of the lophophore in relation to population structure in a bryozoan community" based on the Leigh material was reported at the IBA in Lyon in 1974, with an abstract published in 1975, then the full paper emerged in the *Proceedings of the 9th*

European Marine Biology Symposium later that year (Ryland, 1975). Ryland reported a bryozoan fauna on the undersides of stones comprising over 50 species, of which about 20 were abundant.

Time constraints and the demands of microscope work on fresh lophophores meant that representative encrusted stones had to be photographed and shipped to Swansea where in due course it was necessary to make zooid measurements, determine population parameters, and investigate colony interactions. In his notebooks of the time, Ryland recorded packing up and shipping 14 large stones (although the total number appears to have been about 80), which were sent by sea. A contemporary of the time commented: *"I do remember John Ryland visiting the Marine Lab at Leigh, but have no memory of him collecting rocks with bryozoan encrustations to be sent back to the UK. However it is just the sort of thing I can imagine him doing, for I remember him as being typical of a scientist visiting one of the colonies… John Ryland was a bit David Attenboroughesque… As for collecting and sea freighting whole rocks from the shore all the way back to Blighty, wasn't that just the sort of thing that might have happened in 1871?*" (John Walsby, then a PostDoc at Leigh, pers. comm).

Once in Swansea, the stones were photographed and enlarged prints produced from which the colony outlines were traced. The transparencies were used to determine relative (not absolute) species abundances by superimposing the tracings on a grid of 5mm coordinates, so providing 17,000 sampling points; this was, of course, fundamental to the study objectives. Unfortunately, the tracings no longer exist. Digital copies of the photos (Figure 6) are, however, available, archived along with the rocks at Natural History Museum in London.

In the 1976, Leo W. Buss (b. 1953) of Yale University visited Swansea and was excited about the possibilities the rocks offered for studying colony interactions. A subset of the collection was sent to the United States for this study, but Leo Buss and Jeremy Jackson decided to research spatial interactions using dive surveys, thereby introducing the time dimension, and study based on a "frozen moment" became unfashionable and was abandoned (perhaps prematurely given the remarkably wide range of bryozoan zooid sizes on the Leigh rocks and the relative absence of other encrusters). The rocks were returned to Swansea during the 1980s.

The stones were kept in the Swansea University Museum for some time, but as the need for teaching space became more and more pressing, it was deemed necessary to modify the museum and dispose of the stones. The collection, numbering about 80 numbered stones, was transferred to the Natural History Museum, London in 2016.

The Echinoderm Reef stones offer a glimpse back almost 50 years, to a time before the marine reserve, before increasing land use and development in the area, and before intensive tourism pressure from the growing City of Auckland. That city's population in 1970 was 635,000; in 2020 it has almost tripled to 1,610,000 (World Population Review, 2020). Over 350,000 people visit the marine reserve every year (Auckland Council, 2016) and many of them walk around on the rocky flats, perhaps crushing bryozoans as they go.

At the Natural History Museum, the stones have been photographed in great detail,

using a specially designed moveable stage for such large subjects; a study of colony interaction (as originally suggested) is underway. And back in New Zealand, PhD student Hannah Mello has re-examined the undersides of stones on Echinoderm Reef in 2019 as part of her wider study examining the effect of marine protection on bryozoans. She found more colonial ascidians and greater algal cover than was recorded in the past. Her preliminary results suggest that marine protection designed for large motile species may have little effect on small benthic invertebrates (Mello et al., 2021).

If old bryozoan-encrusted stones have anything to say, it is this: (1) Old collections can have real scientific value even in the modern day. How many museums would have thrown them away? It is fortunate that they were retained by NHM, and they will be put to good use for ongoing new research and comparative studies with earlier research. And (2) the necessity of labelling and recording exactly how collections are made and what is done with them – in 50 years nobody will remember. We contacted over 15 scientists from those days at Leigh, and literally not one can remember a single thing about shipping dozens of rocks to Wales, even though it must have been quite a effort at the time to do so.

"If the stones that we walked on could talk, they would surely tell our story" — Nico J. Genes.

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