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REVIEW ARTICLE

Contribution of the Leigh Marine Laboratory to knowledge of marine species diversity

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We review the contribution of the Leigh Marine Laboratory, as an extension of the University of Auckland campus, to knowledge of marine taxonomic diversity, particularly in New Zealand. Increase in knowledge of the marine biota of the Hauraki Gulf region (and beyond) in the 1960s–2010s was achieved through targeted taxonomic studies and indirectly in the course of other research and fieldwork by staff, students and visitors. The Cape Rodney to Okakari Point Marine Reserve is the type locality for 46 species and the area including Leigh harbour, Matheson Bay and Whangateau Harbour includes the type localities for 21 additional species. Altogether, University of Auckland staff and their students, throughout their professional careers, have described 570 new species of New Zealand marine life, c. 3.2% of the known marine biota of the exclusive economic zone. The laboratory has had an immeasurable influence as a training ground for field work and experimentation and from decades of oral instruction, published books, monographs and papers, and the examples and inspiration of the key personalities. Current informatics activities at the laboratory, facilitating syntheses of biodiversity data in a global context, continue that legacy.

Keywords: Leigh Marine Laboratory; New Zealand; University of Auckland; biodiversity; bioinformatics; Valentine Chapman; John Morton

Introduction

This review developed out of an invitation to assess the contribution of the Leigh Marine Laboratory (LML) to knowledge of New Zealand's marine biodiversity for a symposium commemorating 50 years of the laboratory in June 2012. The key question framed by this request was: what can be said about the LML, its inception, and its key instigators and users in relation to the development of knowledge of the biodiversity of the immediate area, the wider region that encompasses the Hauraki Gulf and the Northland Peninsula, and the rest of New Zealand? In broad terms, the location of the laboratory has meant that the geographic focus has been mostly the northern North Island, but there are scale effects as the expertise applied to particular taxa has extended well beyond this region. Of course this knowledge is part of a continuum that began well before the LML was built; and also virtually nothing concerning the laboratory can be viewed independently of the main university campus and its staff at Auckland.

Materials and methods

Data were gleaned mostly from the literature, including obituaries of key individuals, a history of the University of Auckland's biological departments, a review of the history and knowledge of the Leigh Marine Reserve to 1976, the laboratory's publications records, the University

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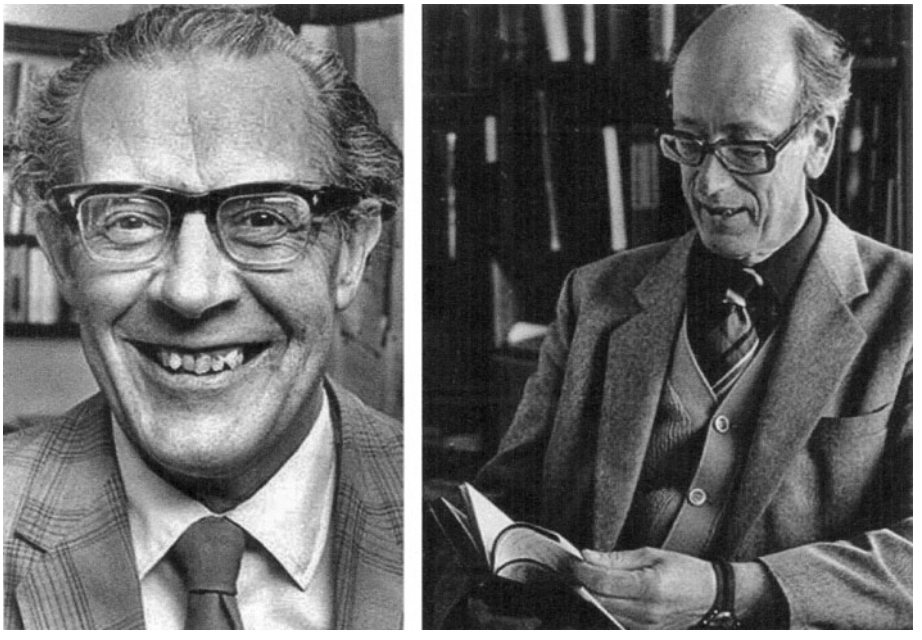

Figure 1 Left, Valentine Jackson Chapman, 14 February 1910–5 December 1980 (*Te Ara Encyclopedia of New Zealand*). Right, John Edward Morton, 1 April 1924–6 March 2011 (Anglican Diocese of Auckland).

of Auckland's list of student theses, natural history books, and the taxonomic literature and annual reviews of the New Zealand Marine Sciences Society. Additional information was contributed by some past and present staff and students of the university. The authors also have personal knowledge of individuals, the LML, its history and the region's marine biodiversity – the first author enrolled as a student at the University of Auckland in 1963 and did post-graduate research at the laboratory; the second author was on the university staff from 1965 to 2003, and was the first director of the laboratory (1965–1985).

Results

In order to assess the contribution of the LML to knowledge of New Zealand's marine biodiversity it is necessary to consider what was generally known prior to the laboratory's inception and the influence of the two key individuals in the laboratory's history – Valentine Jackson Chapman and John Edward Morton (Fig. 1) – in relation to that knowledge.

Putnam (1977 p. 202) gave a brief history of New Zealand marine biology from the time of the early European voyages of exploration, observing, inter alia, that 'the early part of the twentieth century saw steady progress being made by New Zealanders in almost all areas of marine biological research', noting major collections that had been made and taxonomic studies (including by offshore specialists who had been sent specimens) on a wide variety of groups, especially including Porifera (A. Dendy, H.B. Kirk), Cnidaria and Echinodermata (W.B. Benham, A. Dendy, H. Farquhar), Crustacea (C. Chilton, G.M. Thompson, et al.), and fishes (E.R. Waite, L.T. Griffin, W.J. Phillips, et al.). Hutton (1904) had published his *Index Faunae Novae Zealandiae* listing all known Animalia species and Suter (1913) gave a comprehensive update of molluscs in his *Manual of New Zealand Mollusca*. The latter was followed up by A.W.B. Powell, based at the then Auckland War Memorial Museum, with the

publication in 1937 of *The Shellfish of New Zealand* and in 1947 of *Native Animals of New Zealand* (with subsequent editions of both; Powell 1937a, 1947). Putnam (1977) noted that the 'flora of the New Zealand seas was almost an untouched field until R.M. Laing began his career' (p. 203), publishing more than 20 phycological papers between 1890 and 1940. The first marine examples of 'descriptive ecology' in the Auckland area were those of Oliver (1923; intertidal biota) and Powell (1937b; benthic communities). Putnam (1977) assessed the general state of New Zealand marine science immediately following World War II as 'in a somewhat sorry condition' and suffering from 'a dearth of organisation and co-ordination' (p. 207), but responses by the universities and government, including the establishment in 1949 of an Interdepartmental Committee on Oceanography (which led to the eventual creation of the New Zealand Oceanographic Institute in 1954), meant that: 'By the early 1950s, marine biology in New Zealand had a solid foundation from which to carry out future research' (Putnam 1977, p. 208). It was against this backdrop that Valentine Chapman and John Morton rejuvenated studies of marine biological science at the University of Auckland.

As a young botanist in the 1930s in the United Kingdom, Chapman's research interests had been phycology and the ecology of saltmarshes and mangroves. In 1941 he published his first book, *An Introduction to the Study of Algae* (Chapman 1941), which went to two further revised editions as *The Algae* (Chapman 1962; Chapman & Chapman 1973). These research interests continued after he came to New Zealand in 1946, following his appointment in 1945 to the newly established Chair of Botany at Auckland. Although essentially a marine ecologist, soon after his arrival he became aware of the urgent need for a comprehensive review of the seaweed flora of the New Zealand botanical region (Parsons 1982). Accordingly, Chapman initiated a series of six flora volumes (several co-authored) that were published between 1956 and 1979 (Chapman 1956, 1969, 1979; Lindauer et al. 1961; Chapman & Dromgoole 1970; Chapman & Parkinson 1974). His death in 1980 precluded completion of the series. In a biopic in the *Dictionary of New Zealand Biography* published many years after Chapman's death, John Morton (2010) wrote: 'His ongoing enthusiasm was marine algae, and his first research students were directed into studies of shore zonation rather than plant anatomy' (para. 3).

John Morton enrolled at Auckland University College in 1942 shortly before his eighteenth birthday and graduated with a BSc in 1945, the same year as Val Chapman's appointment. John had started university with an already well-formed interest in natural history and molluscs. His family also used to holiday at Milford Beach, Auckland, where young John became familiar with a range of seashore life. In the course of his developing familiarity with Auckland shores, he was the first to discover in New Zealand the hemichordate *Balanoglossus australiensis*, at Cheltenham Beach in 1946 (Morton 1950); it was previously known from New South Wales. He continued at Auckland on the functional anatomy of a range of molluscan taxa before undertaking doctoral research at the University of London on the relationship between form and function in the evolution of marine pulmonates of the family Ellobiidae. Functional-anatomical studies were continued during postdoctoral work at Plymouth, leading to the writing of his book *Molluscs* (Morton 1958). The 1950s was the most productive decade of his working life in terms of the volume of his output, during which he published 33 papers (31 of them sole-authored) and one book, all listed in Brian Morton's (2011) obituary, securing his international reputation in malacology and ensuring, inter alia, that the molluscan component of descriptive ecology in New Zealand would be high. This was the background to his return to New Zealand in 1960 to take up the newly established Chair of Zoology following the retirement of Associate Professor McGregor the previous year. [This was while the Auckland campus was still a part of the University of New Zealand, which was dissolved in 1961]. Brian Morton (2011) noted: 'With John's appointment to its chair the Zoology Department

Table 1 Numbers of senior staff (professors/lecturers, not junior lecturers, demonstrators or tutors), masters graduates and doctorates in the Departments of Botany and Zoology at Auckland University during five decades, showing the post-World War II growth in numbers. Data from Foster et al. 1983. Note that prior to 1933 the two departments together comprised a single Biology Department.

Decade	Botany senior staff	Zoology senior staff	Botany masterate/ BSc Hons degrees awarded	Zoology masterate/ BSc Hons degrees awarded	Botany doctorates awarded	Zoology doctorates awarded
1930s	7	1	7	3	0	0
1940s	6	5	6	9	0	0
1950s	8	11	26	7	4	0
1960s	10	13	36	43	8	7
1970s	14	19	51	99	26	22

at Auckland became much more marine oriented and although he was then a well-known malacologist, his research interests began to diversify and broaden' (p. 137). The first two decades of the post-World War II period saw dramatic growth in staffing and graduations in both the botany and zoology departments (Table 1) and Morton's appointment initiated another major pulse.

By this time, Chapman was in his fifteenth year of teaching at Auckland. Thus, with both heads of department strongly orientated to marine organisms, the stage was set for the next phase of their interests and influence, which was the establishment of a marine laboratory. The idea was jointly proposed by both Chapman and Morton. One of the four priorities that Morton returned to New Zealand with in 1960 was that of establishing a marine station, an idea that he had 'prearranged in principle' with Chapman (Foster et al. 1983, p. 76), and Parsons (1982, p. 412) noted that, as early as his inaugural lecture in 1946, Chapman:

> [T]ouched on the many topics toward which he was to turn his energies during the years that followed. He stressed the value of basic research, *the need for establishing scientific reserves*, and for vegetation mapping using aerial photography and the importance of ecology, physiology and utilization. It was his dream to establish a school of marine botany at Auckland, and much of his research and that of his students centred around projects associated with rocky coasts, mangrove swamps and salt marshes.

The location for the laboratory was chosen on the basis of its representativeness of the northeastern coast, the variety of marine habitats within the wider vicinity, the visually rich biodiversity underwater and proximity to Auckland. The same attributes, the popularity of the area with spearfishers and the perceived necessity for some kind of protection for experimental work in the marine environment adjacent to the laboratory, reinforced the idea of a companion marine reserve (Ballantine 1991). As chair of the Leigh Laboratory Committee, Chapman wrote to the government's then Marine Department in 1965 proposing the idea. Morton (2010) acknowledged: 'His was the vision behind the Marine Reserves Act 1971' (para. 4). The background and fuller history of the marine reserve are given in Gordon and Ballantine (1976), Ballantine and Gordon (1979) and Ballantine (1991).

Together, Morton and Chapman (1968) wrote the 44-page booklet *Rocky Shore Ecology of the Leigh Area*. Brian Morton (2011) interpreted it as being written as a justification for the marine reserve. In his review of the booklet, Michael Miller (1968a) stated that it 'was written primarily for those who do, or who are going to do, research at the Leigh Marine Laboratory' (p. 129) and noted: 'There are very few, if any, marine biological stations which can send a prospective visitor a neat account of the shores he is hoping soon to visit and study' (p. 130). The booklet acknowledges the influence of T.A. and Anne Stephenson, whom Morton had met in

Britain, in its shore zonation approach. Specific habitats described in the booklet, and their biota, include the conglomerate terraces below the cliffs, the exposed northern side of Goat Island, the Echinoderm Reef flat, and Omaha Cove (Leigh harbour). In terms of biodiversity, what is remarkable in the booklet is the number of taxa that are mentioned – 305 named species (including 122 molluscs and 61 algae) and 23 additional genera unnamed to species.

Where did all these names come from? Both authors had their own specific expertise, evidenced by the large numbers of algae and molluscs mentioned, but Morton had also been working for many years with Michael Miller on the seashore book that was published in the same year, and he had visited many New Zealand shores and had very broad knowledge of marine organisms. Any student who accompanied Morton on the zoology field trips to Piha and Whangarei Heads (the latter camp location had been used for several years before the LML came into being and was able to accommodate many more students) soon came to appreciate that; they were exposed to an intensive crash course in organism recognition. In the booklet, Chapman and Morton acknowledge the earlier works of Vivienne Dellow (later Vivienne Cassie Cooper) and others on intertidal algae. Patricia Bergquist had acquired her PhD (the first doctorate in the Zoology Department) in 1962 and she contributed her taxonomic knowledge of sponges. In the late 1960s, there were several masters and doctoral students based at the laboratory (including the first author of this review), studying a wide range of taxa, and they are acknowledged in the booklet as having contributed taxon names and/or biological information.

The New Zealand Sea Shore (Morton & Miller 1968) was a comprehensive synthesis of the coastal marine biodiversity then known to date. The seeds of the book were sown by Morton as early as 1950 when he started writing about seashore ecology with a book in mind (Foster et al. 1983). The 1968 first edition mentions 1128 species binominals, an additional 127 uninominals (*Genus* sp.) and 53 other genera. The authors acknowledged the taxonomic (and ecological) advice of Val Chapman and Vivienne Cassie (phycology), Patricia Bergquist (sponges) and Arthur Baden Powell (Mollusca) in Auckland, Dick Dell (Mollusca and decapod Crustacea), Pat Ralph (Hydrozoa) and Desmond Hurley (Amphipoda) in Wellington, George Knox (Polychaeta) in Christchurch, and Betty Batham (Actiniaria and some other taxa) and Beryl Brewin (ascidians) in Dunedin, among others. They also acknowledged the contributions of their own marine research students, including Mary Gordon (hymenosomatid crabs), Robin Harger (marine-fouling bryozoans and other taxa), Winston Ponder (rissoid and pyramidellid gastropods), and Mavis West and Jock Whitley (polychaetes), among others. Apart from some photos provided by D. J. (John) Slinn, John Morton and Michael Miller personally executed the illustrations in the book, aided by Derek Challis.

Many of the students at the laboratory in 1968 who first viewed the published book (including the first author) were impressed enough to buy a copy, which served as a motivation for some to anticipate that their own research findings might be acknowledged in the next edition. Such was the case, with many taxonomic updates, in the New Zealand section of *Seashore Ecology of New Zealand and the Pacific* (Morton 2004).

By the mid-1960s scuba-diving for biological research was coming out of its infancy and many students and some staff were being trained in its use. This tool significantly increased knowledge of biodiversity in the waters around the laboratory for at least a full decade before the marine reserve opened in 1975. As species were observed, photographed, and often collected, their names tended to be captured in the laboratory's card-based faunal index. Divers and enthusiastic amateurs also contributed species records, particularly of fishes and molluscs. Biodiversity knowledge extended offshore, as work was conducted on the dynamics of zooplankton and phytoplankton in the Hauraki Gulf. John Jillett's doctoral research on the diversity and distribution of

zooplankton, completed in 1966 and published as a *New Zealand Oceanographic Memoir* in 1971, added considerably to the small amount of information that previously existed (Jillett 1971). Additional work was carried out by Roger Grace on zooplankton vertical migration and Brian Foster, Penelope Luckens and Mike Barker did plankton sweeps just offshore, mainly to collect barnacle larvae (all referenced in Gordon & Ballantine 1976). Laboratory staff member John Taylor began regular sampling of phytoplankton at five stations from the Jellicoe Channel to Goat Island Bay and Whangateau Harbour in 1966, publishing the results from 1970 through 1974, adding to the phytoplankton sampling data and species inventory already published by Vivienne Cassie from 1960 through 1966 (see Taylor 1970, 1974a, b, 1978; Taylor & Durbin 1978; Cassie 1980).

As the new laboratory increased the extent of its operations, and as the effects of overfishing became widely appreciated, the idea of a marine reserve developed. Chapman (Chair of the Leigh Laboratory Committee) had first suggested the idea to the then Marine Department in May 1965. Ballantine and Gordon (1979) reviewed the beginnings of the marine reserve, which was gazetted in November 1975 and officially opened in May 1977. In their review of knowledge of the marine reserve, Gordon and Ballantine (1976) published a checklist of the marine and maritime fauna of the Leigh region, which also included the zooplankton of the Jellicoe Channel. Two main sources of information were used in compiling the checklist:

1) The 46 dissertations, one booklet, several reports and more than 80 research papers and popular articles produced from 1967 through to 1976 that were wholly or partly based on research conducted at or from the LML.
2) The laboratory's faunal index cards, which additionally recorded unpublished records provided by staff, students and visiting scientists.

All of the species in the checklist were attributed to a named source and/or to the faunal index cards. Visiting scientists who provided names and records of apparent new taxa in the period prior to 1975 included Richard Cloney (ascidians), Walter Clark (pycnogonids), Cadet Hand (actinians), John Holleman (polyclad flatworms), Willi Kuschel (maritime beetles), Malcolm Luxton (upper-shore mites) and Peter Vine (spirorbin polychaetes). Altogether, 942 species were recorded in the marine reserve and 1259 for the wider Leigh area including Omaha Cove, Whangateau Harbour and the waters of the Jellicoe Channel. Some of the new species were not described for years to decades. Ballantine and Gordon (1979) tallied the algae (including microalgae) for the wider Leigh area, which was 449 species (based on a list provided by F.J. Taylor). They compared the faunal diversity with that obtained for two areas in Britain adjacent to marine laboratories, namely Dale Fort (1296 species, tallied over 16 years) and Plymouth (3239 species, tallied over >100 years). One possible reason for the discrepancy between the faunal figures for the Leigh area and that for Dale Fort would be the lack of offshore dredging and taxonomy of benthos conducted from the LML up to that time.

The laboratory's faunal index has not been formally maintained for many years but Pam Brown created an Excel spreadsheet (provided by Richard Taylor) that includes additional species, raising the tally for the marine reserve from 942 species in 1976 to 1053. Preparing a detailed updated list of species, corrected for synonyms, for the marine reserve and wider area was beyond the scope of this review, but an examination of the literature (LML ecological publications with informal species lists and taxonomic works including *NIWA Biodiversity Memoirs*) and the use of Google to pick up overlooked records of type localities in the marine reserve and Leigh–Whangateau region gives a total of c. 1760 species (Bacteria including Cyanobacteria 11, Protozoa 4, Chromista 372, Plantae 125, Fungi including lichens 6, Animalia 1242) for the wider region including the Jellicoe

Channel and Leigh–Whangateau, with about 30% fewer species for the marine reserve. Wilcox (2008) recorded 135 macroalgal species in the reserve.

In summary, in relation to the laboratory and knowledge of the biodiversity of the area, the 20-year period from 1960 to 1980 (especially) drew on the expertise of marine biologists Valentine Chapman and John Morton and the coterie of younger staff and students that they inherited, appointed or supervised, with research ranging from organismal biology (such as form and function, feeding and life-history attributes), experimental physiology, descriptive ecology (what organisms co-inhabited particular parts of the shore and its microhabitats), some taxonomy, quantitative zooplankton studies, and the first manipulative experimental ecology, such as that conducted by Penelope Luckens using barnacles and grazing molluscs.

In the late 1960s and 1970s there was a continuing increase in experimental ecology and fish biology as well as physiology and even neurobiology. Scuba had become a potent tool for investigating the biology and ecology of fishes, leading to a growing interest in fish diversity (in its own right or supplementary to the other studies), not just in the marine reserve but from the Hauraki Gulf to the Three Kings Islands. Student ecologists Tony Ayling and Barry Russell came to discover and describe new species of fish and Tony Ayling and Malcolm Francis went on to publish professional guidebooks (Ayling & Cox 1982; Francis 1988; Cox & Francis 1997). In addition to Tony Ayling and Barry Russell, decadal student contemporaries Roger Grace, Avril Ayling, Chris Battershill and Ken Grange described assemblage composition and taxon diversity of macrobenthos and fishes in harbour entrances and on subtidal faces and, at smaller scales, Howard Choat, Peter Kingett, Bob Creese and Richard Taylor (among staff and students) recorded the smaller epifauna of macroalgae or that associated with turfing algae. Studies of fish diets and fish parasites (e.g. Sharples & Evans 1995a, b) also added to knowledge of taxon diversity in the region. No new species were named from these studies but they augmented knowledge of distributions within New Zealand of particular species and genera. Research fellow Michael Hawkes added to knowledge of the red and green algae of the area (e.g. Hawkes 1982a, b). Student theses (University of Auckland 2013), and guidebooks produced by staff, students, and New Zealand visitors, augmented and promoted knowledge of particular groups, including diatoms, foraminifera, sponges, hydromedusae, polychaetes, molluscs, bryozoans, barnacles, crabs and ascidians as well as the fishes and coastal birds (all the above reviewed or referenced in the New Zealand Marine Sciences Society's annual reviews of New Zealand marine science; see also Gordon & Ballantine 1976; Thompson 1981; Walsby & Morton 1982; Pritchard 1984; Willan & Morton 1984; McLay 1988; Taylor 2012). An analysis of LML publication titles compiled for the decades of the 1970s through 2000s (Taylor 2012) shows similar numbers of papers per decade that give lists of species in otherwise mostly ecological papers. These added new distributional records for the Northland–Auckland region. There have been far fewer taxonomic papers from the laboratory describing new species, the most recent being that of Cooper and Doherty (1993).

The marine reserve is the type locality for 46 species and the area including Leigh harbour, Matheson Bay and Whangateau Harbour includes the type localities for 21 additional species; 30 of the total of 67 species were described by staff and students of the University of Auckland, the balance by overseas visitors/specialists. Altogether, Auckland staff and their students have described 570 new New Zealand species of marine organisms, 3.1% of the approximately 17,970 marine species known in the exclusive economic zone (Gordon in press).

The School of Biological Sciences came into being in 1992, the Centre of Marine Science was established in 1993, the School of Environmental and Marine Sciences at Tamaki (but including Leigh) in 1997, and a Chair of Marine Science in 2001, occupied by John Montgomery. All of these developments effected changes in research priorities and staffing to one extent or another

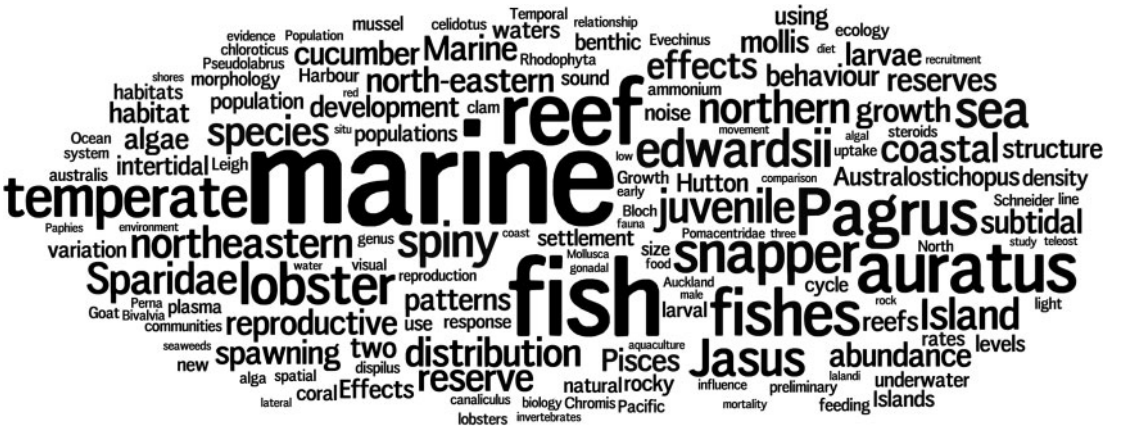

Figure 2 This map shows the relative frequencies of words in LML publication titles 1966–November 2012, with 'New' and 'Zealand' removed (otherwise they dominate). It was created using Jonathan Feinberg's utility at www.wordle.net/.

and the consequent dissertation research that students have undertaken. A word map (Fig. 2) based on the relative frequencies of words in the titles of LML publications (see Taylor 2012) shows an emphasis on ecology and physiology, particularly of fishes and especially of snapper (*Pagrus auratus*) and rock lobster (*Jasus edwardsii*). Words like 'taxonomy', 'systematics', 'taxa' and 'phylogeny' are noticeably absent.

Nevertheless, some taxonomic work continues at the university, augmented by molecular tools. University of Auckland staff and students continued to publish new taxa during the 1980s, 1990s and 2000s (Tables 2–4). Throughout the half century from 1961 to 2010, the entire range of taxonomic groups investigated by students has been quite broad, but the preponderance of studies has been on large, common, ecologically and/or economically important taxa like snapper, shellfish, rock lobster and algae (Table 5). Whereas the list of laboratory publications indicates that staff and students there described new taxa only among Rhodophyta, Mollusca, Brachiopoda, Bryozoa and fish, and only during the 1970s through 1990s, Patricia Bergquist and her students were hugely augmenting our knowledge of New Zealand sponge diversity well into the twenty-first century, including from the marine reserve and vicinity; similarly, Brian Foster (1979) had monographed the New Zealand barnacle fauna and his student John Buckeridge has continued to describe additional Recent and fossil taxa to the present day. In the meantime, some earlier students took up professional positions at other institutions and have continued to describe new New Zealand taxa through targeted taxonomic research (Table 2) or have contributed major biodiversity books like the *New Zealand Inventory of Biodiversity* (Gordon 2009a, 2010, 2012), *New Zealand Coastal Invertebrates* (Cook 2010) and *Coastal Fishes of New Zealand* (Francis 2013). Since the training and formative years of the students were at the University of Auckland and, for many, involved working at the LML and in the vicinity, the numbers of new taxa described in their later careers reflect the ongoing influence of that formative mentorship and field training. Indirectly (often serendipitously), overseas visitors, LML staff and students continue to add new species records to the area. For example, Richard Taylor and Mark Morrison reported from Omaha Bay the first record of the congrid eel *Scalanago lateralis* outside Australia (Taylor & Morrison 2008).

Visiting overseas taxonomists have been an important source of biodiversity knowledge.

Table 2 New marine New Zealand taxa (still validly in use) named by Auckland University staff (including research fellows) and their students, 1950s through 2010s. Insofar as the training and formative years of the students were at Auckland University and, for many, involved working at the LML, the number of new taxa described in their later careers is also given below, reflecting the ongoing influence of that formative mentorship and field training. All of the taxa are listed in Gordon (2009, 2010, 2012).

Valentine J. Chapman
- 25 new species of Chlorophyta, endemic new genus *Gemina*
- Six new species of Rhodophyta, alone or with others (including student Frank Dromgoole), endemic new genus *Catenellopsis* (monotypic for Catenellopsidaceae, endemic)
- One new family Pseudoanemoniaceae (Rhodophyta)

Una Vivienne Cassie Cooper
- Two new species of diatoms (Ochrophyta) (with co-authors)
- One new species of Chlorophyta

John E. Morton
- One new species of Vermetidae (Gastropoda), *Thylacodes aotearoicus* (Morton, 1951) (as *Serpulorbis*)

Winston F. Ponder
- 61 new species of Mollusca (one Aplacophora, four Bivalvia, 56 Gastropoda)

Patricia R. Bergquist
- 161 new species of Porifera alone or with students Kennedy Warne, Jane Fromont, Michelle Kelly, Steve Cook; one endemic new genus (student Kelly with 30 additional species and three new genera, alone or with co-authors)

Brian A. Foster
- 11 new species and one subspecies of barnacles (Arthropoda: Cirripedia) (student John Buckeridge with five additional species and one new genus, alone or with co-author)

Michael C. Miller
- 24 new species of Opisthobranchia, alone or with students Bill Rudman and Richard Willan, and three new genera (student Rudman with 11 additional species and Willan seven additional species, including one prosobranch and one bivalve)

John P. Leader
- Three new species of seashore Chironomidae (Diptera)

Dennis P. Gordon
- 210 new Recent species of Bryozoa, 17 new endemic genera, and two new endemic families, alone or with co-authors
- One new species of Foraminifera (with Bruce Hayward)

Anthony L. Ayling
- Two new species of teleost fish – elongate green wrasse *Pseudojuloides elongatus* Ayling & Russell, 1977 and blue-finned butterfish *Odax cyanoallix* Ayling & Paxton, 1983

Barry C. Russell
- Three new species of teleost fish – Doak's lizardfish *Synodus doaki* Russell & Cressey, 1979, crimson cleaner fish *Suezichthys aylingi* Russell, 1985 and rainbow fish *Suezichthys arquatus* Russell, 1985

Webber E. Booth
- Two new species of diatoms (Ochrophyta)

Michael W. Hawkes
- Two new species of Rhodophyta

Robert G. Creese
- One new species of chiton (Amphineura), *Sypharochiton aorangi* (Creese & O'Neill, 1989)

Peter J. Doherty
- One new species of Brachiopoda, *Calloria variegata* Cooper & Doherty, 1993

Kendall D. Clements
- One new genus of tripterygiid teleost fish, *Matanui* Jawad & Clements, 2004, with student Laith Jawad

Table 3 Currently valid species for which the marine reserve is the type locality (authors referenced).

Rhodophyta
- *Schmitzia evanescens* M.W. Hawkes, 1982a
- *Acrosymphyton firmum* M.W. Hawkes, 1982b

Porifera
- *Timea aurantiaca* Bergquist, 1968
- *Ophlitaspongia reticulata* Bergquist & Fromont, 1988
- *Pronax anchorata* Bergquist & Fromont, 1988
- *Pronax fulva* Bergquist & Fromont, 1988
- *Polymastia croceus* Kelly-Borges & Bergquist, 1997
- *Polymastia echinus* Kelly-Borges & Bergquist, 1997
- *Semitaspongia glebosa* Cook & Bergquist, 2000

Cnidaria
- *Barnettia caprai* Schuchert, 1996 (genus endemic)
- *Corymorpha intermedia* Schuchert, 1996

Platyhelminthes
- *Vatapa tumidosa* Sluys & Ball, 1989

Gnathifera
- *Austrognathia novaezelandiae* Sterrer, 1991

Mollusca
- *Serrata fasciata* (G.B. Sowerby II, 1846) (as *Marginella*) (neotype)
- *Eatoniella notalabia* Ponder, 1965a
- *Skenella spadix* (Ponder, 1965b) (as *Rufodardanula*)
- *Rissoella elongatospira* Ponder, 1966
- *Awanuia porcellana* Ponder, 1967
- *Amphithalamus falsestea* (Ponder, 1968) (as *Notoscrobs*)
- *Burnaia helicochorda* (Miller, 1968b) (as *Aeolidia*)
- *Caldukia rubiginosa* Miller, 1970
- *Babakina caprinsulensis* (Miller, 1974) (as *Babaina*)
- *Atagema molesta* (Miller, 1989) (as *Trippa*)

Bryozoa
- *Fenestrulina littoralis* Gordon, 2009b

Annelida
- *Simplaria ovata* (Vine, 1977) (as *Pileolaria*)
- *Laubieriopsis arenicola* (Riser, 1987) (as *Fauveliopsis*)
- *Petrocha notogaea* von Nordheim, 1987 (genus endemic)
- *Laubierpholoe riseri* Pettibone, 1992

Nemertea
- *Micrura pleuropolia* Cantell, 1994

Arthropoda
- *Tigriopus raki* Bradford, 1967
- *Microdeutopus apopo* Barnard, 1972
- *Hyphalus wisei* Britton, 1973
- *Telmatogeton mortoni* Leader, 1975
- *Agaue insignata* Bartsch, 1979
- *Agauopsis similis* Bartsch, 1979
- *Halacarus nitidus* Bartsch, 1979
- *Rhombognathus fractus* Bartsch, 1979
- *Rhombognathus lacunosus* Bartsch, 1979

Table 3 (*Continued*)

Dendrolaelaps terebratus Luxton, 1984
Leioseius australis Luxton, 1984
Agauopsis luxtoni Bartsch, 1986a
Halixodes novaezelandiae Bartsch, 1986b
Abrolophus zelandicus Luxton, 1989a
Amhyadesia punctulata Luxton, 1989b
Hyadesia microseta Luxton, 1989b
Hyadesia mollis Luxton, 1989b

Table 4 Species for which Omaha Cove/Matheson Bay/Whangateau Harbour and vicinity are the type locality (authors referenced).

Porifera
Eurypon hispida Bergquist, 1970
Stylopus australis Bergquist & Fromont, 1988
Tedania battershilli Bergquist & Fromont, 1988
Psammocinia maorimotu Cook & Bergquist, 1998
Ircinia undulans Cook & Bergquist, 1999
Semitaspongia incompta Cook & Bergquist, 2000
Spongia cristata Cook & Bergquist, 2001
Cnidaria
Euphysa problematica Schuchert, 1996
Platyhelminthes
Anoplodium leighii Cannon, 1990
Okakarus ballantinensis (Holleman, 2007) (genus endemic) (as *Aotearoa*)
Bryozoa
Antarctothoa tongima (Ryland & Gordon, 1977) (as *Hippothoa*)
Annelida
Nidificaria pocillator (Vine, 1977) (as *Pileolaria*)
Nemertea
Praealbonemertes whangateaunienses Cantell, 1993 (genus endemic)
Amphiporus mortonmilleri Gibson, 2002
Noteonemertes novaezealandiae Gibson, 2002 (genus endemic)
Parischyronemertes mathesonensis Gibson, 2002 (genus endemic)
Arthropoda
Dendrolaelaps crenatus Luxton, 1984
Halacarellus lubricus Bartsch, 1986a
Simognathus glaber Bartsch, 1986a
Microtrombidium aucklandicum Luxton, 1989a
Pontiobates denigratus Luxton, 1989a

These visitors have often filled in gaps in knowledge not provided by the indigenous pool, either for taxa or biotopes (e.g. ctenophores, athecate hydroids and their medusae, Scyphozoa, fish parasites, Gnathostomulida, Nemertea, Acari, Copepoda, Polychaeta, meiofauna including Gastrotricha and Tardigrada, and microplankton). The presence of the laboratory at Leigh has provided a focal point and 'base camp' for collecting, without which many new taxa might have gone undiscovered and unnamed (see Tables 3 and 4 for those new taxa with type localities in the marine reserve or adjacent Leigh–Whangateau area). While it is possible to obtain permits for specific kinds of sampling and collecting (www.doc.govt.nz/about-doc/concessions-and-permits/marine-reserve-research-permits/), anecdotal evidence suggests that the need for a permit has acted as a disincentive to taking samples from the marine reserve in recent years.

The twenty-first century has seen the flourishing of biodiversity informatics – the use of computer technology to manage the abundant and growing array of ocean biodiversity and taxonomic data – through capture, storage, search, retrieval, visualisation, mapping, analysis and modelling. Use of the available tools, and the collaborative input of biodiversity scientists locally and globally, has allowed for novel syntheses (e.g. Gordon et al. 2010) and projections of marine biodiversity. Through staff member Mark J. Costello, the LML is an active player in this field (e.g. Costello & Vanden Berghe 2006; Costello et al. 2010, 2012, 2013; Appeltans et al. 2012a, b).

Table 5 Numbers of submitted student theses pertaining to a particular organismal group per half decade, 1961–2010. Data largely from University of Auckland (2013); titles of additional theses and Botany IIIB and Zoology IIIB project dissertations not listed in 'Marine science theses at the University of Auckland' are cited by Gordon and Ballantine 1976.

Group	'61–65	'66–70	'71–75	'76–80	'81–85	'86–90	'91–05	'96–00	'01–05	'06–10	Totals
Porifera	1	2	0	1	0	1	1	4	1	1	12
Mollusca[1]	3	5	5	10	7	6	9	20	6	8	79
Arthropoda[2]	1	5	3	0	6	3	2	9	10	5	44
All other Invertebrates[3]	1	5	4	2	5	4	1	8	13	3	46
Vertebrates[4]	1	1	6	8	17	20	22	16	17	28	136
Algae, etc.[5]	1	2	5	3	4	1	6	8	7	7	44
Totals	8	20	23	24	39	35	41	65	54	52	361

[1]Especially economically and ecologically important shellfish/seafood taxa in Mytilidae, Ostreidae, Pectinidae, Haliotidae, Mesodesmatidae and Veneridae; [2]Especially economically and ecologically important seafood species in Palinuridae and Brachyura, as well as Cirripedia and zooplankton (Crustacea-dominated); [3]Including Cnidaria, Platyhelminthes, Brachiopoda, Bryozoa, Annelida, Sipuncula, Chaetognatha (in zooplankton), Echinodermata (especially *Evechinus* and *Australostichopus*) and Tunicata; [4]Mostly fishes (especially *Pagrus auratus* [including for physiology and neurobiology] and Tripterygiidae), also sea birds and marine mammals; [5]Mostly macroalgae (especially *Ecklonia radiata*), diatoms and mangroves but also including raphidophytes and dinoflagellates in phytoplankton.

Discussion

It is not surprising that there was an increase in the numbers of staff and higher degree awardees in the Botany and Zoology Departments at the University of Auckland following the cessation of World War II, but what is interesting is that this growth is evident first in botany in the 1950s and in zoology in the 1960s (Table 1). The offset in these growth pulses would seem to be attributable to the respective influences of Professors Valentine Chapman from 1946 and John Morton from 1960. Obviously, not all students were undertaking taxonomic/biodiversity research projects but this departmental growth and leadership enhanced the local pool of developing talent. What is undisputed is that Chapman and Morton were hugely influential in the increase in marine research at Auckland during the periods of their tenure and in the subsequent establishment of the LML, leading to the downstream creation of New Zealand's first marine reserve. It is beyond the scope of this review to compare the LML/University of Auckland city campus contributions to knowledge of New Zealand's marine biodiversity relative to the other major marine university campuses – Victoria University of Wellington, University of Canterbury, University of Otago – and their own marine laboratories at Island Bay, Kaikoura and Portobello, respectively, but an analysis would be possible using, in part, the archives of the New Zealand Marine Sciences Society (annual bulletins/newsletters/reviews).

Overall, we can say that increase in knowledge of the marine fauna and flora has arisen *indirectly* (species records obtained in the course of other work or through serendipitous discoveries) and *directly* (as a result of targeted systematics studies), whether by staff, students, visitors and even amateurs (divers, shell collectors). Altogether, the number of currently valid new New Zealand marine species described by University of Auckland staff (including post-doctoral fellows) and their students throughout their careers, who used the laboratory and/or for whom the laboratory and the Hauraki Gulf/Northland regional marine biota served in part as a taxonomic training ground through the 1950s through 2010s, totals 570 Recent New Zealand species and 78 additional fossil New Zealand

species that do not range into the Recent. Extramural New Zealand and overseas visitors have also described many new species in the course of visiting the Cape Rodney to Okakari Point Marine Reserve and its environs while using the laboratory as a base of operations. Importantly, the marine reserve is the type locality for 46 endemic species, potentially augmenting the conservation value of this protected area – if it should happen that any of these species were to suffer habitat extinction elsewhere in their range, the existence of the reserve would increase the chance of continuity. Likewise, if in the future a museum's holotype specimen of any of these species were to become lost or destroyed and no other type specimens existed, a neotype would ideally be sourced from the type locality (topotype). Willis (in press) assesses the scientific and biodiversity values of marine reserves in New Zealand but does not mention these aspects. Twenty-one additional endemic species have their type locality in the immediate area (Leigh harbour, Matheson Bay, Whangateau Harbour) and it is known that other new species (e.g. of Bryozoa), previously collected but not yet described, will be added to this list.

Beyond the many new taxa and new records described in papers and monographs by the authors in the Tables, there is also the immeasurable influence of the academic text books, popular-level books, decades of oral instruction and personal example. All of these are the legacy of the LML, the personalities that launched it and the many who benefited from it. The current biodiversity informatics activities conducted at the laboratory, facilitating syntheses of previous data and records, continue that legacy.

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