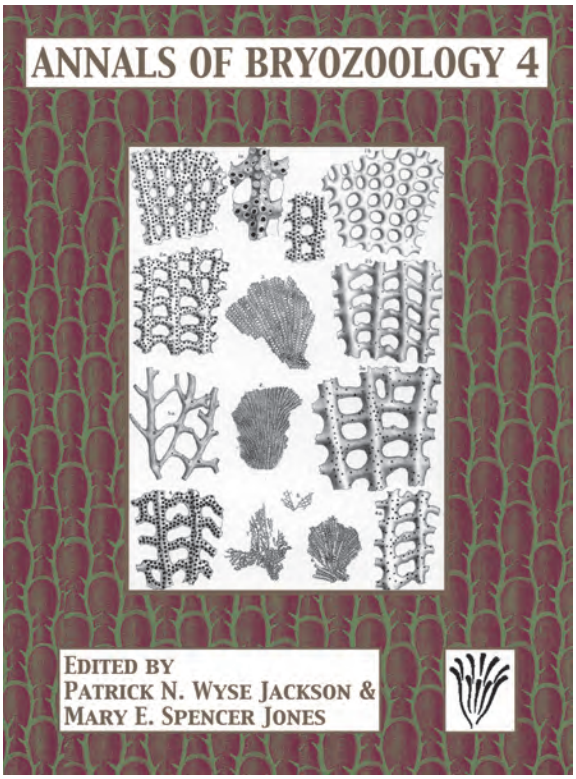


Paper in:

Patrick N. Wyse Jackson & Mary E. Spencer Jones (eds) (2014) *Annals of Bryozoology 4: aspects of the history of research on bryozoans*. International Bryozoology Association, Dublin, pp. viii+265.

Historical review of South African bryozoology: a legacy of European endeavour

M.K. Boonzaaier,[1, 2] W.K. Florence[1] and M.E. Spencer Jones[3]

[1]Natural History Department, Iziko South African Museum, Cape Town, 8000, South Africa

[2]Biodiversity and Conservation Biology Department, University of the Western Cape, Bellville 7535, South Africa

[3]Department of Life Sciences, Natural History Museum, London SW7 5BD, United Kingdom

1. Introduction

1.1 Oceanography

The coastline of South Africa, extending from about 21˚S, 14˚E to 28˚S, 33˚E, is influenced by two major current systems, namely the Benguela Current along the west coast and the Agulhas Current along the south and east coast. The Benguela Current passes three countries, namely Angola, Namibia and South Africa (Shillington *et al*. 2006), and is associated with coastal, seasonally variable, wind-driven upwelling (Shannon 1985,

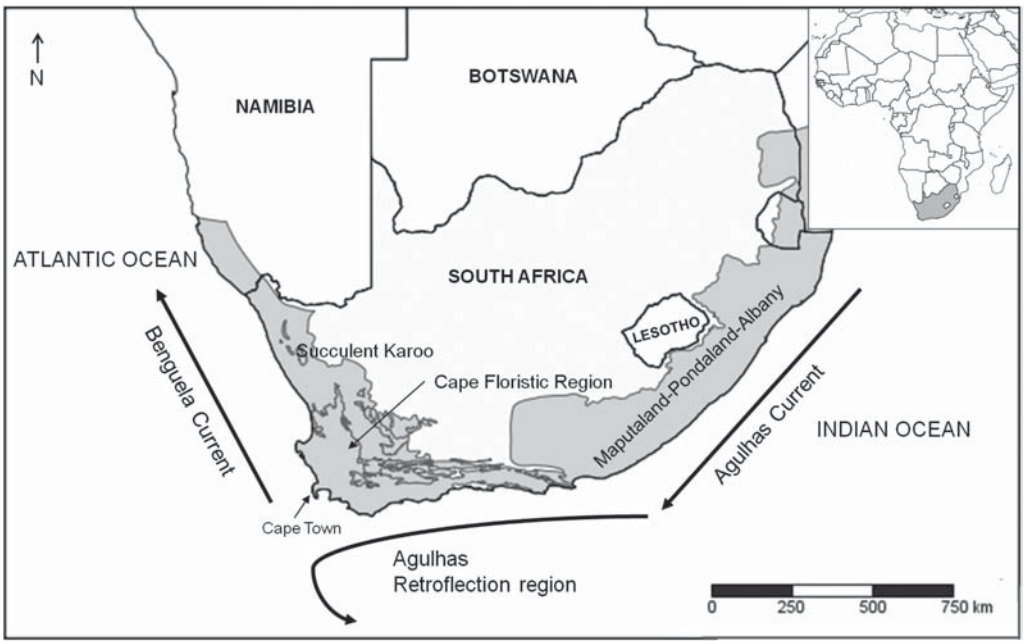


Figure 1. A schematic of the two major ocean currents around South Africa, the Benguela Current and Agulhas Current, also showing the retroflection of the Agulhas Current. The Angola Current (not shown) flows southward along West Africa. Three biodiversity hotspots (grey) are indicated, which includes the South African coast, according to Sloan et al. (2014).

Hill *et al*. 1998), while the Agulhas Current moves southward from the equatorial Indian Ocean (Lutjeharms 2006).

The intense upwelling of the Benguela Current carries cool (ranging between 10˚C-20˚C), nutrient-rich waters towards the equator (Shillington *et al*. 2006, Griffiths *et al*. 2010). Furthermore, the Benguela Current upwelling system is unique since it is restricted at the boundaries by two warm current systems, namely the tropical Angola Current in the north Atlantic and Agulhas Current System on the western boundary of the Indian Ocean in the south (Duda and Sherman 2002) (Figure 1). The nutrient-rich character of the Benguela Current supports high densities of pilchards, hake and rock lobster, but species richness is low (Griffiths *et al*. 2006). These include abundant fish populations (e.g. hake, *Merluccius capensis*; pilchard, *Sardinops ocellatus*), marine mammals (including the Cape fur seal, *Artocephalus pusillus*; southern right whale, *Eubalaena australis*; and the rare Heaviside's dolphin, *Cephalorhynchus heavisidei*), seabirds (such as the endangered African penguin, *Spheniscus demersus*) as well as important coastal lagoons and estuaries for migratory bird populations (Olson and Dinerstein 1998).

On the eastern coast of South Africa, the edge of the Agulhas Bank is the widest part of the shelf and stretches 250 km from shore to shelf edge (Lutjeharms 2006). A series of eddies move downstream with the current creating a sequence of currents in opposite directions (Walker 1989, Lutjeharms 2006). In contrast to the Benguela Current system,

the Agulhas Current brings warmer (20˚C-28˚C), nutrient-poor tropical waters that result in high species richness, but low abundance (Lutjeharms 2006, Griffiths *et al*. 2010). Here, fish species include the shallow-water Cape hake (*Merluccius capensis*), blackhand sole (*Solea bleekeri*), and yellowfin tuna (*Thunnus albacares*), and several dolphin species (Family Delphinidae) inhabit the region (Olson and Dinerstein 1998). Furthermore, two species of sea turtles, including the critically endangered leatherback (*Dermochelys coriacea*) and endangered loggerhead (*Caretta caretta*) turtle have nesting grounds in South Africa on the north-eastern coast, while green turtles (*Chelonia mydas*) forage along the east coast (Hughes 1974, Olson and Dinerstein 1998).

1.2 South African marine biodiversity

South Africa is one of the most biologically diverse regions in the world, being amongst the 17 megadiverse countries recognized by Conservation International, and ranking third for terrestrial species richness after Brazil and Indonesia (Mittermeier *et al*. 1997). Probably, the most important reason for this ranking is that South Africa, but more specifically the Cape Province, is recognized as one of the botanical kingdoms of the world (Olson and Dinerstein 1998). The Cape Floristic Region has the highest floral species richness in Africa, comparing to its size, with approximately 9,000 species of vascular plants of which 70% are endemic to South Africa (Goldblatt and Manning 2002). Along with the Cape Floristic Region, the Succulent Karoo and Maputaland-Pondaland-Albany regions in South Africa have been identified as three of the 35 biodiversity hotspots in the world (Sloan *et al*. 2014) (Figure 1). Owing to the high levels of endemic taxa and vulnerability to processes that threaten these regions, biodiversity hotspots have been identified as a global conservation priority (Mittermeier *et al*. 1998, Myers *et al*. 2000, Sloan *et al*. 2014).

In contrast, South Africa's marine biodiversity has rarely been assessed on a global scale. In 2010, South Africa's marine species richness per area (km^2) of 15.3 was higher than most countries, for example Australia (4.8 species per area km^2), but much lower than South Korea (32.3 species per area km^2) and China (26.9 species per area km^2) (Costello *et al*. 2010). Marine biota along the South African coastline is characterized by high levels of diversity with species that exhibit large environmental tolerance ranges and remarkable endemism for several taxa (Tittensor *et al*. 2010, Scott *et al*. 2012). Biodiversity assessments of the past decade use limited available biodiversity data (including endemic and introduced species) for systematic conservation planning (Lombard *et al*. 2004, Sink *et al*. 2011, Sink *et al*. 2012).

An estimated 12,915 described marine species are found within South African waters, of which 33% (4,233 species) are considered endemic; these figures are probably lower than in reality if one takes into account that the listing is far from complete (Griffiths *et al*. 2010) (Table 1). Molluscs, arthropods and fish (not less than 2,000 species for each group) were the most speciose taxa and already account for 59% of marine biodiversity. It is important to note that the aforementioned taxa may also be used in aquaculture (e.g.

Table 1. Summary of known marine biodiversity in South Africa, adapted from Griffiths et al. *(2010) ordered from highest to lowest diversity within each group or domain.*

Taxonomic group	No. species[1]	State of knowledge[2]	No. of introduced species[3]	No. experts	No. ID guides[4]
Domain Archaea	n/a	1	n/a	0	0
Domain Bacteria (incl. Cyanobacteria)	n/a	1	n/a	0	0
Fungi	1	1	0	0	0
Domain Eukarya					
Kingdom Chromista					
Other Chromista	225	2	n/a	2	3
Phaeophyta	111	5	0	2	2
Kingdom Plantae					
Rhodophyta	505	5	3	4	2
Chlorophyta	197	5	1	4	2
Angiospermae	7	5	2	0	4
Kingdom Protoctista (Protozoa)					
Dinomastigota (Dinoflagellata)	220	3	3	1	0
Foraminifera	15	2	0	1	0
Kingdom Animalia					
Mollusca	3,154	4	11	1	10
Crustacea	2,331	3	21	4	9
Vertebrata (Pisces)	2,000	5	1	5	6
Cnidaria	853	3	13	4	9
Annelida	787	3	7	1	1
Echinodermata	410	4	2	2	5
Platyhelminthes	354	2	0	1	0
Porifera	346	3	1	1	1
Bryozoa	270	3	6	1	1
Urochordata (Tunicata etc.)	227	3	9	1	3
Other invertebrates	630	3	3	2	8
Other vertebrates	272	5	0	1	7
TOTAL REGIONAL DIVERSITY[5]	12,915				

Notes:

[1] Sources of the reports: databases, scientific literature, books, field guides, technical reports.

[2] State of knowledge is ranked on a scale of 1-5, where 1 = very poor or unknown and 5 = well-known, n/a = no data available.

[3] Number of introduced species follows Mead *et al*. (2011) and excludes cryptogenic species.

[4] Identification guides lists major works only.

[5] Total regional diversity including all taxonomic groups.

fish, abalone, oysters, shrimps, lobsters), therefore sampling and research effort is strongly biased towards these groups. Despite some comprehensive, but sporadic, systematic research efforts on a few marine invertebrate taxa (e.g. Porifera, Bryozoa, Cnidaria), these groups are suggested to be more diverse, especially deep-sea benthic communities. Sampling in deep-sea regions, however, is hampered due to inaccessibility and shortage of taxonomic expertise.

Marine invertebrates are amongst the smallest and taxonomic challenging groups and account for more than half of the total regional diversity in South Africa (Griffiths *et al*. 2010). Of the 9,362 marine invertebrate species, mollusc (3,154 species) and arthropod (2,451 species) diversity largely contribute to this figure, but an estimated 7,590 species need to be described for South Africa's marine invertebrate taxonomic knowledge for it to be comparable to other regions like Europe (Griffiths *et al*. 2010).

In total, 86 introduced species and 39 cryptogenic (i.e. neither clearly native nor exotic) marine and estuarine species have been identified in South Africa (Mead *et al*. 2011). The majority of introduced species (55 species) were found in the cool-temperate region (west coast), with the least number of introduced species (15 species) found in the warm-tropical region (north-east coast). Furthermore, the majority of introduced species (65%) were native to the northern hemisphere, therefore, northern hemisphere species have established themselves on the cool-temperate west coast and the warm-temperate south-east coast. In this study, ship fouling (48%) since the 1600s, and the carrying of ballast water (38%) since 1880s were found to be the most common vectors of marine introduced species to South Africa. This is not surprising, since South Africa has a long history of shipping activities associated with European colonization and the beginning of the slave trade.

2. A European start to trade and biodiversity research in South Africa

2.1 An era of exploration in South Africa, 15th and 16th century

Exploration in South Africa started in the late 15th century when Portuguese explorers navigated along the South African coastline to establish trade connections to East India (Pletcher 2010) (Figure 2). Bartholomeu Dias, along with his crew, came to the Cape of Good Hope in February 1488, but originally called it *Cabo das Tormentas* ("Cape of Storms"), and sailed around the tip of southern Africa eastwards. They arrived at *Angra da Roca* (now Algoa Bay in Port Elizabeth), but after a few days of sailing along the east coast up to *Rio do Infante* (now the Great Fish River) in the Eastern Cape, his crew was unwilling to continue; therefore he decided to return to Portugal. For almost a decade, no known voyages to India were attempted and in 1500, Dias died after his ship was lost at sea near the Cape of Good Hope. In July 1497, another Portuguese captain, Vasco da Gama, commenced a long voyage from Lisbon to India, through the South Atlantic and around the Cape. The fleet arrived in Santa Helena Bay (St Helena Bay) in November 1497, continued along the south coast and anchored in Mossel Bay a few days later where they stayed until December 8. They reached the coast of Natal on Christmas Day and in

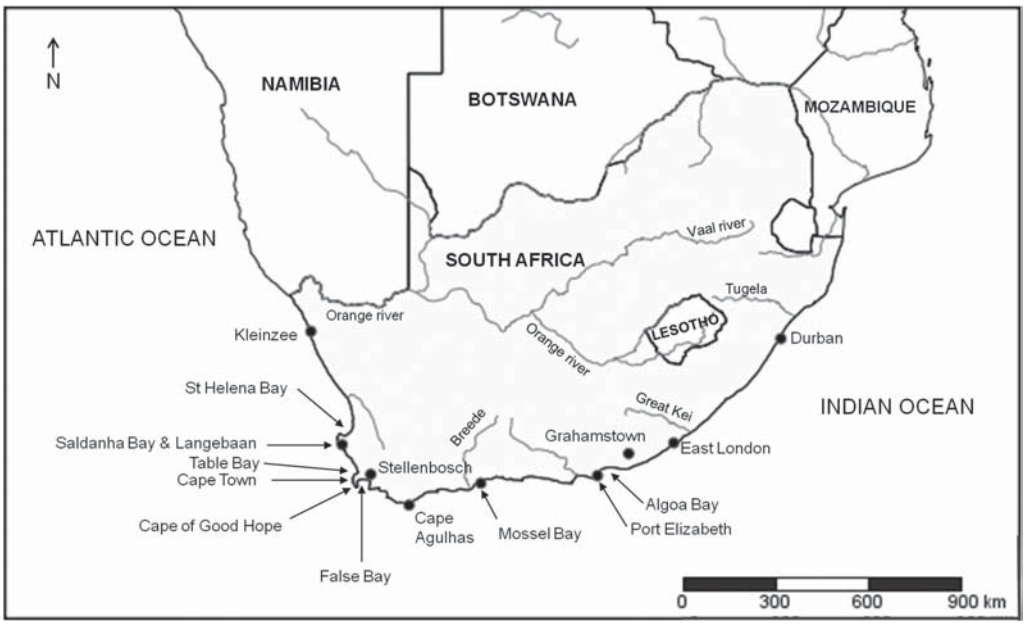


Figure 2. Map of South Africa indicating some places and rivers (grey lines) mentioned in the text.

January 1498 anchored for a few days near the mouth of *Rio do Cobre* (now the Copper River), a small river between Natal and Mozambique. Here, the route continued along East Africa to Mombasa (in Kenya) and finally, India. This route, and various other sea routes were established and exploited during the 16th century.

2.2 Colonialism in the Cape and the slave trade in 17th and 18th century

By the end of the 16th century, Portugal only held ports in Goa and Diu (India) and in Macau (China), while the English dominated the trade in India, and the Dutch in the East Indies (Indonesia) (Pletcher 2010). The Dutch East India Company was founded in 1602 by merchants from several Dutch cities (Thom 1952). The Dutch often repaired their ships in the Cape of Good Hope (Pletcher 2010), therefore a supply station was established in Table Bay by Jan van Riebeeck, a Dutch colonial administrator, who arrived in April 1652 (Thom 1952) (Figure 2). This led to South Africa's first European settlements and also, slavery at the Cape from the earliest days of settlement in 1652 (Worden and Groenewald 2005). Slaves provided the labour force on settler wine and grain farms, as well as domestic labour in private houses and on public works in and around the small European settlement in Cape Town.

The expansion of the Dutch colony in Cape and the importation of slaves, the majority from Madagascar since the Dutch East India Company's region of operation was in and around the Indian Ocean, continued until late 17th century. The Dutch East India

Company's slave trade practice was well-established in 1717 and near the end of the Company rule in 1795, about 16,789 slaves were reported in the Cape, although this was an under-reported total. In the early 18th century, half of the slaves in the Cape were from southern Asia (India and Sri Lanka), with roughly 20% from southeast Asia (including Jakarta, Bali and Makassar), and by the end of the century the majority of the slaves were imported from Mozambique, due to trading in Maputo. The indigenous people from the Cape, the Khoikhoi and San people, had been dispossessed from their land and enslaved by the Dutch East India Company, along with the Cape slaves (Worden and Groenewald 2005).

2.3 Arrival of the British settlers and institutional development in the Cape early 19th century[1]

By the end of the 18th century, the Dutch East India Company was taken over by the British through a military invasion. The British occupied the Cape in 1806, which also marked the abolition of the slave trade, and officially became a British colony in 1814. But, after the Napoleonic wars, Britain experienced a serious unemployment problem, consequently the British government sent migrants to the Cape Colony. The first group of British settlers arrived in Table Bay, 17 March 1820. Between April and June 1820, approximately 4,000 settlers arrived in the Cape. From the Cape Colony, the settlers were sent to Port Elizabeth, while Lord Charles Henry Somerset, the British governor in South Africa from 1814-1826, encouraged some settlers to migrate further into the Eastern Cape to places such as Grahamstown.

European colonization paved the way for migrant scholars such as doctors, zoologists, botanists, geologists and astronomers to conduct research in South Africa. The British naturalist Charles Darwin was amongst the scholars that briefly visited South Africa (Kennedy 2004), while others like the Scottish-born zoologist, John Dow Fisher Gilchrist (Brown 1997) and Dr Baron Von Ludwig, a German doctor and an avid collector (Summers 1975), both lived and studied in South Africa for many decades. It also became possible for scientific institutions to be established, the first of their kind in sub-Saharan Africa, as a result of increased research and taxonomic efforts by the visiting and migrant scientists (Cowling *et al*. 1996).

In 1818, the Cape Governor at the time, Lord Somerset, erected the South African Public Library in Cape Town (now Cape Town Campus) (Coates 2012). Less than two years later, on 20 October 1820, the British astronomer Fearon Fallows, erected the Royal Observatory in Cape Town, South Africa's first permanent modern observatory and research institution in Cape Town, and soon afterwards in 1825 the South African Museum was established by Somerset (Brown 1977). Though the South African Museum was founded in the early 1800s, the history of its collections originate from the mid-17th century in the early settlement years (Brown 1977).

2.4 The South African Museum in Cape Town, mid-17th century to present[2]

The oldest collections in the South African Museum, that would later form part of the museum displays, provide links to the earliest years of settlement from 1656 and zoological exploration of southern Africa (Summers 1975). Skins of lions and other wild animals killed, were preserved and often stuffed and mounted for display in the *Fort de Goede Hoop* ("Fort of Good Hope") built by Van Riebeeck upon his arrival in Cape Town. This was later replaced by the Castle of Good Hope built by the Dutch East India Company between 1666-1679. These collections continued to grow, and during the early 18th century, Willem Adriaan van der Stel, son of the former Dutch Governor of the Cape Colony, Simon van der Stel (after whom the town "Stellenbosch" and "Simon's Town" is named), established a small zoological museum as an appendage of the Governor's Menagerie and collection of live wild animals and birds near to the *Tuynhuys*, or "Garden House". The old Menagerie building which probably included the museum erected by (Willem) van der Stel, who succeeded his father as governor until 1707, is today occupied by the Michaelis School of Art of the University of Cape Town. Overseas demand for skins, skeletons or mounted specimens increased in the 18th century, but records of where these specimens were stored is not precisely known, although some specimens were used to decorate the *Tuynhuys* that was originally used as a toolshed for the Company's Garden established in 1653 by Van Riebeeck. After numerous renovations it later became the Governor's House after British occupation.

Figure 3. The first director of the South African Museum, Sir Andrew Smith (1797-1872). [Image taken from Summers (1975)]

Van der Stel's successor and the first British governor, Lord Somerset, founded the South African Museum on 11 June 1825 in Cape Town and it was situated at the bottom of Government Avenue in the Old Supreme Court. Lord Somerset appointed Dr Andrew Smith (Figure 3) as the director of Natural History at the museum (Kennedy 2004, Day 2000). Smith was a Scottish army medical doctor and naturalist who obtained his medical degree in 1816 at Edinburgh University and who then joined the British Army Medical Services. He was sent to the Cape Colony and Grahamstown in 1820 to supervise the medical care of European soldiers

and soldiers of the Cape Corps (Kennedy 2004). Soon after his appointment to the Museum he conducted a few expeditions around the Cape to collect specimens for its collections.

During his tenure, Smith published several reports on zoology and anthropology, including *On the origin and history of the Bushmen* in 1831 and the *Report of the expedition for exploring Central Africa* published in 1836 (Kennedy 2004). The Museum was moved to Looyer's Plein (today on the corner of Roeland and Hope Streets) in 1832, exhibiting interesting specimens Smith collected during the Cape of Good Hope Association's Expedition to the Interior. The Museum was at Looyer's Plein from 1832-1838 and seems to have influenced the cultural life of Cape Town.

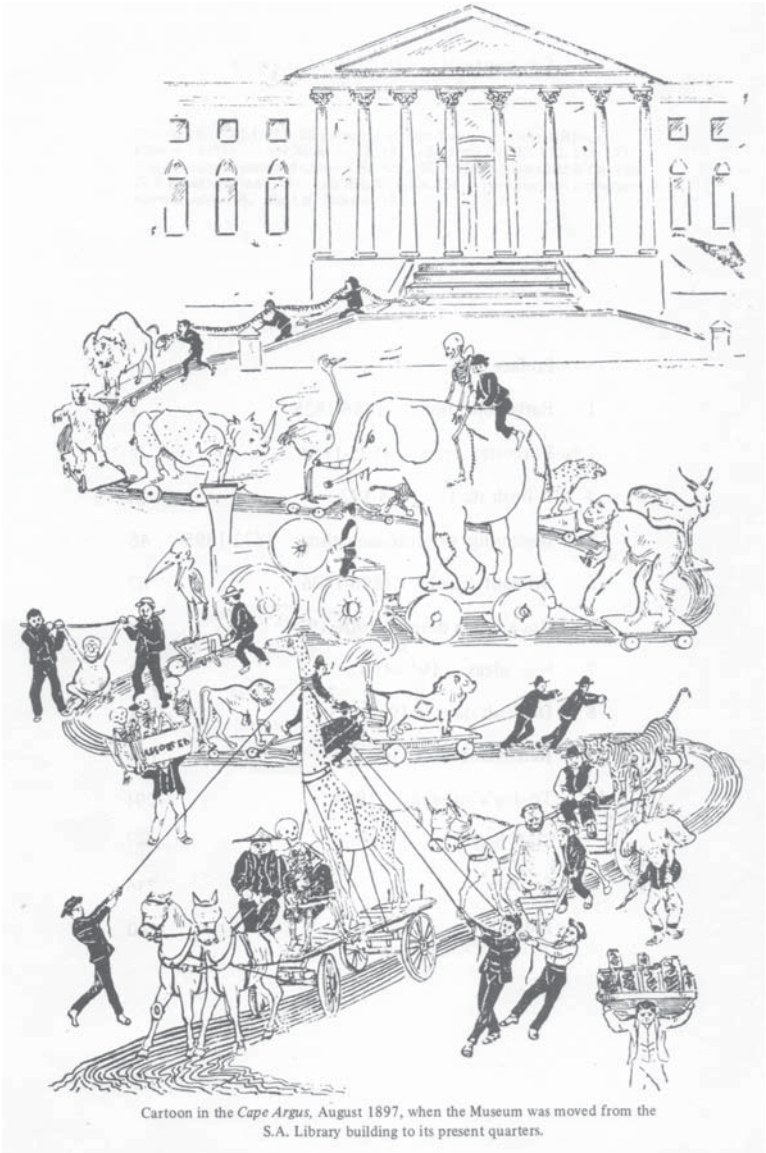
In May 1836, while on its second voyage, the HMS *Beagle* came to the Cape as it returned to England. Smith met Charles Darwin (Kennedy 2004, Day 2000), and together they spent a few days in and around the Cape, and Darwin made good use of Smith's valuable observations on large animals recorded during the excursions.

Shortly after Darwin's visit to the Cape, Smith returned to England in 1837 and took most of his collections with him (Day 2000). Baron von Ludwig, a doctor from Würtemburg, Germany, who settled in the Cape in 1805 and died in 1847, was an avid collector, and his collections of birds, insects and herbarium were sent to Europe. For more than a decade, after the greater part of the museum material was unavailable when Smith and von Ludwig removed their collections, the existing museum material decayed. Therefore, the interest in the museum collections decreased and there were no available funds to maintain the collections.

From 1838-1855, the collections were "lent" to the South African College (today, the *Weeshuis* or "Orphan House" on Long Street) on the condition that they be maintained. The Museum collection still contained important specimens, some were type specimens of great historical interest and unique zoological importance, which became teaching aids.

Fortunately, Sir George Grey, governor of the Cape Colony from 1854-1861, took an active interest in museum matters and on 25 June 1855 formed the Board of Trustees to govern the Museum. This meant that the Board of Trustees, initially consisted of three members, were to appoint staff, purchase equipment to maintain specimens and house the collections. The collection was moved from the South African College to a building on St Georges Street (today Barclay's Bank on Shortmarket Street), but it did not remain there for long. Edgar Leopold Layard was appointed as the curator at the Museum by the Trustees in 1855, and a few other men were appointed during those formative years. In the first report compiled by Layard to the Trustees of the South African Museum in August 1855, a small collection of insects, reptiles, birds, mammals and fish, of nearly 500 specimens were listed. Unfortunately the majority were in poor condition and had to be discarded.

Accommodating the specimens became increasingly difficult, and consequently the Government agreed to erect a building to house both the Museum and the Public Library at the lower end of the Botanical Gardens. During the summer of 1859/60, the Museum collection moved from St Georges Street to the new Museum and Public Library building.



Cartoon in the *Cape Argus*, August 1897, when the Museum was moved from the S.A. Library building to its present quarters.

Figure 4. In 1860 the Museum was part of the South African Public Library building. The museum's holdings were moved to its present day location in the Company's Gardens in 1897. [Image taken from Summers (1975)]

By 1886, the Museum was too small to cope with its rapidly increasing collection; as the Public Library faced the same problem, the Government decided to move the Museum to a new site and built a museum building in the upper part of the Botanical Gardens. The Museum, today known as the Iziko South African Museum (SAMC), moved to its present day location in 1897 on the site of the historic Company's Garden begun by Van Riebeeck in 1653.

Table 2. Summary of current collection objects in the specimen collections lodged at the SAMC. Adapted from a report compiled by Dr Hamish Robertson (Director of the Natural History Department, SAMC).

	Total no. coll objects		Est. no. uncatalogued. coll. objects		
Collection	**Catalogued[1]**	**ID'ed**	**ID'ed**	**Unidentified**	**Total coll. objects**
Terrestrial vertebrates	44,535	45,586	1,000	0	46,586
Marine Invertebrates	61,602	67,602	6,000	60,000	133,602
Ichthyology (fishes)	20,526	20,273	0	600	20,873
Marine mammals	1,437	1,437	0	7,598	9,035
Entomology	270,839	287,339	16,500	1,000,000	1,303,839
Cenozoic Palaeontology*	221,031	267,451	46,420	20,000	333,871
Karoo Palaeontology	7,670	7,770	100	0	7,870
Invertebrate Palaeontology and Geology	59,955	48,211	8,000	2,000	58,211
Total	**687,595**	**745,669**	**78,020**	**1,090,198**	**1,913,887**

Abbreviations: No. – Number; coll. – collection; Est. – Estimated; ID'ed – Identified.
[1]Total number of collection objects catalogued in the *Specify* database and hard copy catalogues. *Other databases were used, not *Specify*.

Today, this museum holds some of the largest collections in southern Africa which include fossils, insects, mammals, birds, fish, marine invertebrates as well as several archaeological artefacts. A recent inventory of SAMC's natural history collections were estimated at 1.9 million collection objects, of which 22.09% are catalogued on the *Specify version 6.5.02* database (Table 2). The current number of accessions dwarfs the figure of about 500 specimens reported by Layard in 1855 just over 150 years ago, and gives an indication of the scale of research and collecting during that time.

Figure 5. The South African Museum in the Company's Gardens in the 1940s. It has been at this location since 1897. [Image taken from Summers (1975)]

3. A brief history of scientific voyages around South Africa, 19th and 20th century

Early naturalists that visited the Cape were generally more interested in terrestrial organisms than marine life (Talbot 1977). Kolb (1726) published a book that included 24 pages on marine fish, whales, seals, molluscs and crustaceans; Thunberg assembled a fine marine collection between 1772-1775 (Day 1977), while Rennell (1778, 1832) investigated the Agulhas Bank and ocean currents around southern Africa. These all contributed to the understanding at that time of South African biodiversity during the late 18th century. Apart from these early studies, extensive marine fauna collections were made in the first half of the 19th century by visiting biologists, including Ferdinand Krauss, J.H. Wahlberg and Wilhelm Peters (Brown 1997). Opportunistic collections were made by passing ships such as the HMS *Beagle* (see above) (Day 2000). Yet, nearly five decades after the South African Museum was established in 1825, local marine collections and biologists were few and sporadic (Day 2000). Therefore, marine specimens were sent to Europe to be described by experts such as Carl Linnaeus (Brown 1997).

The late 19th century was dedicated to marine exploratory expeditions of which the first global marine research expedition was conducted during the years 1873-1876 by the British Royal Navy vessel, HMS *Challenger* (Figure 6) that had been launched in 1858 at Woolwich (Morris 1986). The main objectives of the expedition were to examine benthic (deep-sea floor) diversity and physical conditions of the ocean floor (Perry and Fautin 2003). The *Challenger Expedition* (named after the vessel) commenced on 7 December 1872 from Portsmouth (England), and its findings were considered the baseline of oceanography (Morris 1986, Perry and Fautin 2003).

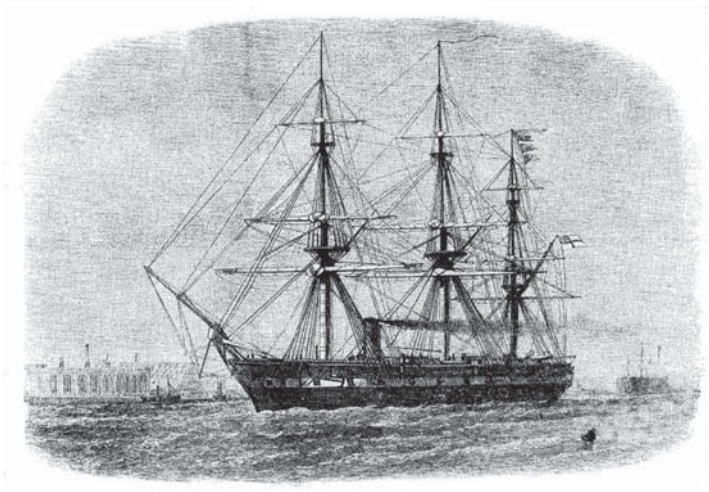


Figure 6. HMS Challenger. *[Image taken from* The Report of the Scientific Results of the Exploring Voyage of HMS Challenger during the years 1873–1876.*]*

Charles Wyville Thomson supervised the scientific exploration that sailed 127,580 km and which yielded many new discoveries. Over 4,000 unknown species were catalogued and 50 volumes of scientific reports on the results of the expedition were published between 1885-1895 (Perry and Fautin 2003). During the cruise, the vessel visited the Cape in October and November 1873 (Perry and Fautin 2003, Tizard *et al*. 1885). The benthic fauna collections from South Africa and other parts of the world, that range from fish to polychaetes to bryozoans, are lodged in the Natural History Museum in London.

During the next two decades, after the *Challenger Expedition*, few targeted scientific voyages were conducted along the South African coastline, but rather international scientific voyages visited as they passed (Day 2000). These included the German SS *Valdivia* which surveyed in the Atlantic, Indian and Antarctic oceans in 1898-1899, whose expedition was led by zoologist Carl Chun (Lutjeharms and Shannon 1997).

Nearing the end of the 19th century, it was evident that the Cape supported exploitable quantities of fish stock (Day 2000). Therefore, largely upon the recommendation of Sir John Murray of the *Challenger Expedition*, Scottish-born John Dow Fisher Gilchrist (Figure 7 and 8) was offered a job as the Government Fisheries Biologist in 1895 at the

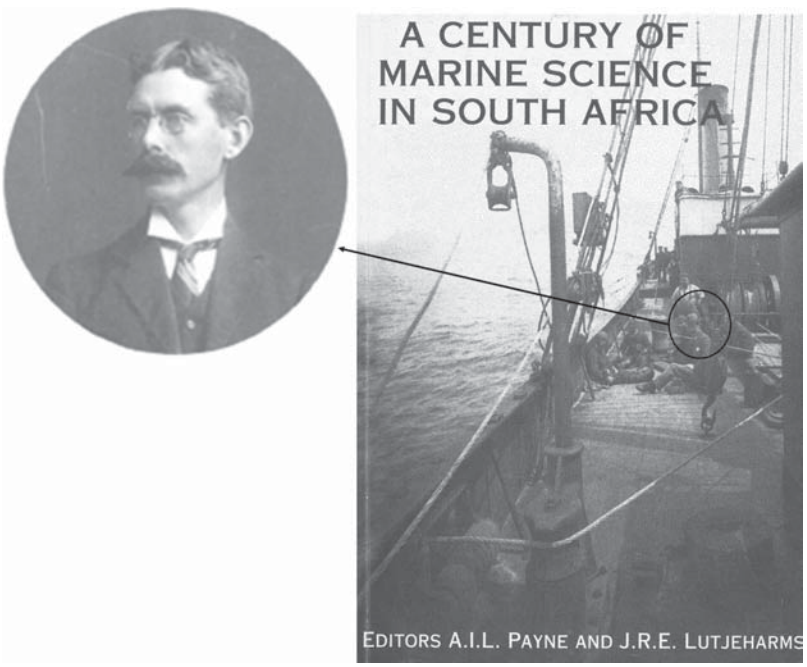


Figure 7 (left) . John D.F. Fisher Gilchrist (1866-1926) when Professor in Zoology at the University of Cape Town. [Image taken from Brown (1997, p. 8)]

Figure 8 (right). This is the cover page of the Transactions of the Royal Society of South Africa *volume 52, part 1, specially-bound to commemorate the arrival of John D.F. Gilchrist in South Africa in 1896. This photograph was taken around the beginning of the 20th century, with Dr J.D.F. Gilchrist sitting in the front with the rest of crew members on the SS* Pieter Faure*, the first oceanographic research ship in South Africa.*

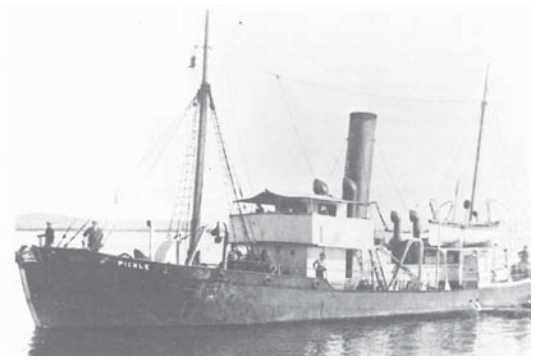


Figure 9 (left). The SS Pieter Faure*, in Cape Town harbour, commissioned by Gilchrist in 1897 for fisheries research in South Africa. [Image taken from Lutjeharms and Shannon (1997, p. 22)]*

Figure 10. (right) The SS 'Pickle' *replaced the* Pieter Faure *vessel in the early 1920s. [Image taken from Brown (1997, p. 10)]*

Cape of Good Hope (Brown 1997, Day 2000). At the time of the offer, Gilchrist was an assistant lecturer in Zoology at University of Edinburgh from 1892, but his research also included prior work done in Naples, Monaco and Port Erin, Isle of Man (Brown 1997). Gilchrist became associated with the South African Museum shortly after his arrival in Cape Town in 1896 and served both the Department of Agriculture (now the Department of Agriculture, Forestry and Fisheries) and the museum for more than a decade.

In 1897, the Cape Government imported a small trawling ship from Scotland, the SS *Pieter Faure* (Figure 9), which Gilchrist used to conduct research on fish stocks around the Cape, especially on the Agulhas Bank (Brown 1997, Day 2000). Within a year, Gilchrist and his team discovered rich stocks off Mossel Bay. Results from earlier voyages conducted by Gilchrist, including those undertaken in the *Pieter Faure*, was published in the Reports of the Marine Biologist (1896-1900) and the Reports of the Government Biologist (1901-1908) (Brown 1997). During this time, Gilchrist became Professor and Head of the Zoology Department of the South African College, which later became the University of Cape Town (UCT) in 1918, and remained in post until he retired.

Other surveys to collect data around South Africa, especially in the Cape, included the *Planet* in May 1906 (Brennecke 1909) and the Seiner Majestät Schiff (SMS) *Möwe* in April 1911 (Brennecke 1915). Thereafter, a lack of funding and the requisitioning of the *Pieter Faure* which was used by the Royal Navy during World War I, hampered surveying until the 1920s (Day 1980, Lutjeharms and Shannon 1997). However, Gilchrist continued to undertake research and published many papers during that period (see list of his publications in Brown, 1997, pp. 12-15).

Marine surveying markedly recommenced when the *Pieter Faure* was replaced by the converted whaler, the '*Pickle*' (Figure 10), in the early 1920s (Brown 1997). Not long after, in 1926, Gilchrist retired from the University of Cape Town owing to his failing health and on 28 October that year he passed away while working in his St James laboratory near Cape Town (Brown 1997).

Another giant of marine science of South Africa, John Hemsworth Osborne-Day (Figure 11), who specialised in polychaete taxonomy, came to University of Cape Town in 1937 as a junior lecturer from England (Simon and Van Niekerk 2012). However, his stay was short-lived as World War II was commenced, and his academic career was suspended when he became a squadron leader in the bomber command (Simon and Van Niekerk 2012). Day returned to the University of Cape Town in 1945 as a lecturer and became the Head of Zoology from 1946 until his retirement in 1974 (Day 2000, Simon and Van Niekerk 2012). During this time and into his retirement, Day authored more than 26 papers, four book chapters and three books (see list of Day's publications in Simon and van Niekerk 2012), and he was responsible for the erection and description of 156 new species.

Interest in marine sciences and physical oceanography of the South African coastline increased, due to the growing interest in the Agulhas Current System and the Indian Ocean (Lutjeharms and Shannon 1997), which lead to more scientific surveys. The German RV *Meteor* (1925-1927) conducted extensive research on the South Atlantic Ocean and came to Cape Town harbour in July 1925 (Lutjeharms and Shannon 1997) (Figure 12). Day also used a wooden trawling boat, the *John D.F. Gilchrist*, to train graduate students until the boat was replaced in 1966 when the University of Cape Town commissioned their own custom-made vessel, the RV *Thomas B. Davie* (Day 2000).

Figure 11. John Day at Langebaan with some students. [Image provided by Prof Charles Griffiths (UCT) from Simon and Van Niekerk (2012)]

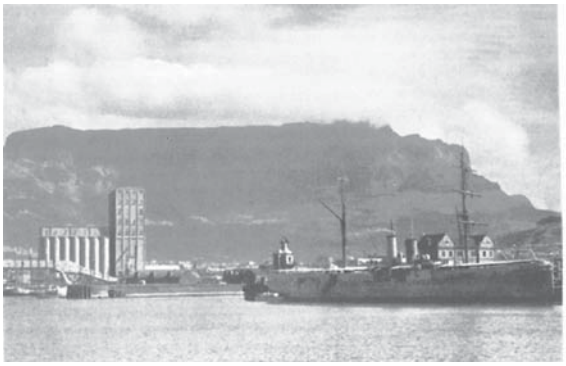


Figure 12 (left). The German RV Meteor *in Cape Town harbour in July 1925 upon the commencement of the South Atlantic expedition. [Image taken from Lutjeharms and Shannon, 1997, p. 30]*

Figure 13 (right). RV Meiring Naudé *research vessel in Durban, designed and built by the CSIR. [Image taken from Lutjeharms and Shannon, 1997, p. 35]*

The Council for Scientific and Industrial Research (CSIR) designed and built the first local coastal research vessel, RV *Meiring Naudé* (Figure 13), named after Dr Meiring Naudé, former president of the South African CSIR, which was launched in 1968 (Lutjeharms and Shannon 1997, Schumann 1998). The offshore research capabilities improved and the CSIR covered regions along the coast from the southeastern parts of the Cape up to Port Elizabeth (Schumann 1998), and completed coastal surveys of South Africa and preliminary surveys along the Namibian and Mozambican coastline (Day 2000). The FRS *Africana I* commissioned in 1982, replaced the '*Pickle*', which played a large role in the collection of benthic organisms and pelagic fish surveys along the south and east coast (Lutjeharms and Shannon 1997).

At this stage in the 20th century, a total of 14 coastal research vessels were managed and used to conduct research in South Africa, and a number of expeditions contributed largely to South African marine collections (Table 3). The SA *Agulhas*, a well-equipped Antarctic research vessel and the South African Navy vessel, the South African Ship (SAS) *Natal*, were also active during this period. These research vessels allowed for the advancement of international research collaborative programmes documenting physical oceanographical observations. During the 1980 and early 1990s, there was a sudden decline in marine research in South Africa, possibly due to funding that was cut to invest in other major marine research projects, for example the Antarctic research programme. As a result, only three of the 14 research vessels were still in use by 1994 - most vessels were sold ((Lutjeharms and Shannon 1997).

In conclusion to the aforementioned sections, the history of the European colonization and slave trade played a pivotal role in society (the imported Cape slaves and interactions with the indigenous people), infrastructure (e.g. establishment of institutions), exploration of southern Africa (including the coastline), scientific advancement (migrant scholars) and changes in faunal and floral community assemblages (e.g. introduced species due to

Table 3. List of special expeditions that resulted in the growth of marine invertebrate collection stored at SAMC. Adapted from a report compiled by Wayne K. Florence.

Expedition name	**Region covered**	**Period**	**Collected By**
SS *Pieter Faure*	St Helena Bay to Zululand	1897-1907	SS *Pieter Faure*
UCT Ecological Survey	Durban to Cape Town	1909-1989	*John D.F. Gilchrist* and RV *Africana II*
Lamont Geological Observatory	West Africa into south Atlantic	1950-1952	RV *Vema*
SA Museum's *Meiring Naudé* Cruises	Kosi Bay to south of East London	1975-1979	RV *Meiring Naudé*
Natal Museum's Dredging Programme	Zululand to Cape Columbine	1981-1990	RV *Meiring Naudé*
UCT Marion Island Survey	Marion Island	1984-1989	RV SA *Agulhas*
Cruise 060	Columbine and Cape Point Canyons	1988	RV *Africana*
Mozambique Scad Survey	Off Mozambique	1994	RV *Algoa*

shipping activities, agriculture, land development). As the interest in global marine faunal and floral biodiversity increased significantly in the mid-19th century, the number of migrant scholars and scientific research also increased.

4. Historical overview of the last 135 years of bryozoology in South Africa

Bryozoans were once thought to be plants and their animal affinities were confirmed around the mid-18th century. Globally, the diversity of marine Bryozoa is unknown (Florence *et al*. 2007). More so, the oft-quoted 4,000 species global bryozoan fauna has been grossly underestimated, especially considering the new level of taxonomic accuracy, available technology and exploration of unexamined habitats previously inaccessible (Hayward and Ryland 1999). In South Africa, the state of our regional taxonomic richness for marine invertebrate taxa, including Bryozoa, is largely incomplete (Griffiths *et al*. 2010, Gibbons 1999). Consequently, taxonomic studies on the South African Bryozoa are, in part, outdated and fragmented (Figure 14).

The first bryozoans from South African waters were collected during the *Challenger Expedition* in 1873. Thomas Hincks was the first to describe bryozoans from South Africa in 1880, while George Busk (Figure 15) in the late 19th century and Charles O'Donoghue (Figure 16) around the mid-20th century described a number of bryozoans from South Africa. In the late 20th century, Patricia Cook and Peter Hayward contributed significant papers on South African bryozoology.

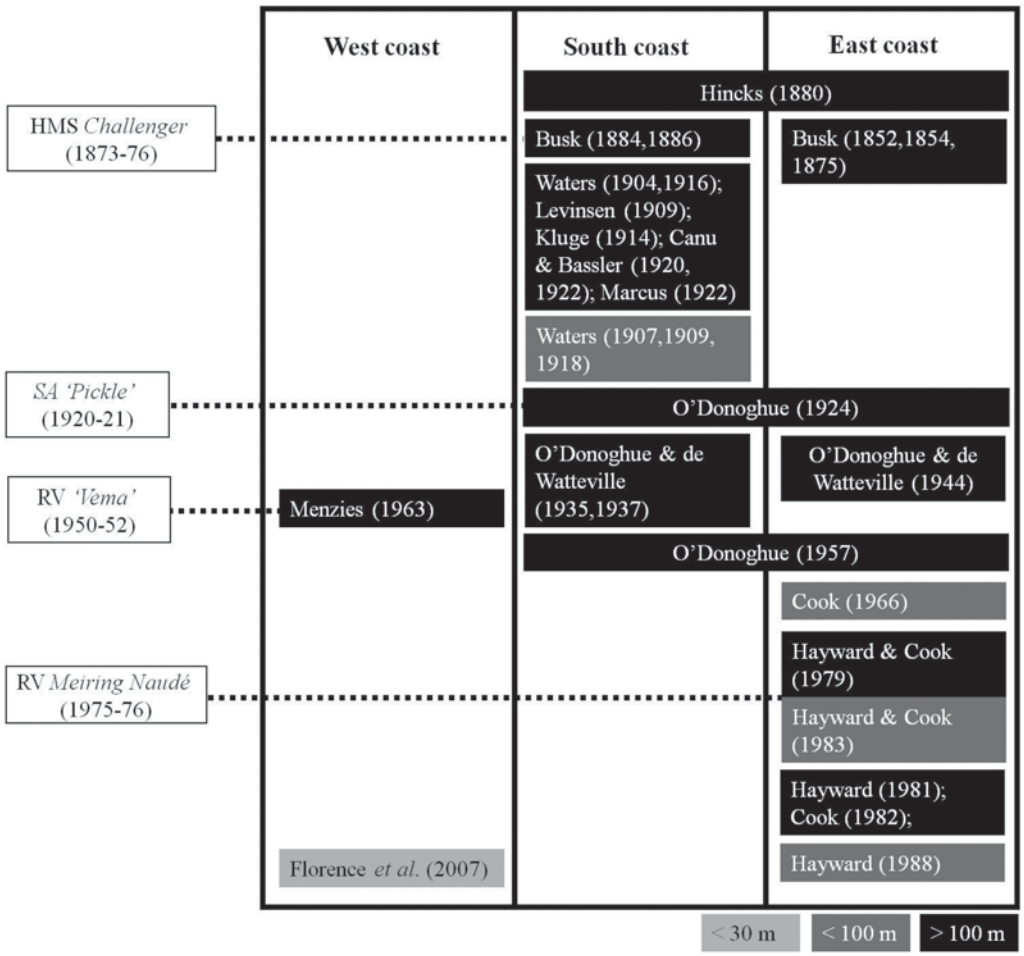


Figure 14. A summary of the published works of described South African Bryozoa since the 1800s, and, if applicable, the expedition cruise associated with the collected specimens.

4.1 Hincks and Busk, 19th century

Thomas Hincks (1818-1899) was born in Exeter, England (Wyse Jackson and Spencer Jones 2002, Calder 2009). As a Unitarian minister, he served in Ireland, in Cork and Dublin and later in England, but was also a naturalist and taxonomist. Two of his major publications were *A history of the British hydroid zoophytes* (1868) and *A history of the British marine Polyzoa* (1880), the latter publication included a large proportion of South African material.

Thirteen species, mainly from the east- and south coast of South Africa, including the new Indo-Pacific species, *Figularia fissa* (Hincks, 1880), were described (Hincks 1880). These specimens appeared to have been collected by W. Oates and some possibly by Eliza Jelly (Florence et al. 2007). In other reports, Hincks recorded *Schizoretepora tessellata*

(Hincks, 1878), *Exochella tricuspis* (Hincks, 1881) and *Rhynchozoon longirostris* (Hincks, 1881).

An additional seven species were described from Port Elizabeth in Hincks (1891), namely *Gregarinidra spinuligera* (Hincks, 1891), *Flustra nobilis* Hincks, 1891, *Laminopora bimunita* (Hincks, 1891), *Schizoporella inconspicua* Hincks, 1891, *S. scabra* Hincks, 1891, *S. pectinata* (Busk, 1884) and *Lepralia lancifera* Hincks, 1891. The latter genus *Lepralia* is considered invalid – some "*Lepralia*" species were moved to the *Schizoporella* genus – and need to be revised.

Born in St Petersburg (Russia), George Busk (1807-1886) was a British Naval surgeon, zoologist and palaeontologist (Woodward 1901, Cook 1997, Foote 2004). Elected as a Fellow of the Royal Society in 1850, Busk also served as Secretary and Vice-President of the Linnean Society of London. Additionally, he made some valuable contributions to the debate on hominid evolution (Cook 1997, Wyse Jackson and Spencer Jones 2002) having discovered the skull of Neanderthal Man, although it was another bryozoologist William King of Galway Ireland who coined the scientific name *Homo neanderthalensis*.

Figure 15. George Busk (1807-1886) who described numerous South African Bryozoa. [Image taken from http://britishbryozoans.myspecies.info/category/biographies/busk-george-1807-1886]

Figure 16. Charles H. O'Donoghue (1885-1961) who published five papers on South African bryozoans sampled from the south- and east coast. [Image taken from http://britishbryozoans.myspecies.info/content/odonoghue-charles]

Between 1849 and 1886, Busk made huge taxonomic strides in the field of bryozoology. He erected the Orders Ctenostomatida, Cyclostomatida and Cheilostomatida in a publication that reported on bryozoans collected during the HMS *Rattlesnake* expedition to Australia (Busk 1852a). Busk also examined a large amount of catalogued material in the British Museum (today, the Natural History Museum, London).

A number of specimens in this collection appeared to have been collected in Algoa Bay and Cape of Good Hope (South Africa) and published in a serial monograph, *Catalogue of Marine Polyzoa in the Collection of the British Museum (Parts 1-3)* (Busk 1852b, 1854, 1875). Altogether, in these three volumes, approximately 308 species were described (not taking into account the number of potential synonymies associated with various species), with 25 species recorded from South Africa. About 17 cheilostome species were described in Busk (1852b, 1854), while four cyclostome species, namely *Lichenopora ciliata* (Busk, 1875), *Tennysonia stellata* Busk, 1875 recorded from the Cape of Good Hope; *Mecynoecia clavaeformis* (Busk, 1875) and *Idmidronea contorta* (Busk, 1875) from Algoa Bay were described. *Discoporella algoensis* Busk, 1875 from Algoa Bay was described, but appears to be unrecognizable and not described in other known literature.

The *Challenger* collection (see "*A brief history of scientific voyages around South Africa, 19th and 20th century*" in this paper), lodged at the Natural History Museum, London, include various marine calcareous specimens such as ostracods, echinoderms, brachiopods, molluscs (gastropods and bivalves), foraminiferans, corals and bryozoans. The South African bryozoan material, collected in Simon's Bay and south of the Cape of Good Hope, was examined by Busk and published in the *Report on the Polyzoa collected by H.M.S. Challenger during the years 1873-1876 (Part 1 and 2)*. In these reports about 28 cheilostome and two cyclostomes bryozoans were described (Busk 1884, 1886).

4.2 After Busk, 20th century

In the early 1900s, the British bryozoologist Arthur William Waters (1846-1929), a Fellow of the Linnean Society, reported about 18 bryozoan species from South Africa in six publications (Waters 1904, 1907, 1909, 1916, 1918, 1919). In Waters (1904) seven species reported from Antarctic or sub-Antarctic regions, also occur in South Africa. The five Antarctic species included *Chaperiopsis cervicornis* (Busk, 1854), *Turritigera stellata* Busk, 1884, *Hippothoa divaricata* Lamouroux, 1821, *Exidmonea atlantica* (Forbes in Johnston, 1847) and *Neofungella claviformis* (Waters, 1904), while *Beania magellanica* (Busk, 1852) and *Microporella malusii* (Audouin, 1826) were recorded from sub-Antarctic regions.

Waters also examined material from the Cyril Crossland collection (Waters 1908, 1918) and reported eight species from the Sudanese Red Sea and Cape Verde Islands that occur in South Africa. However, in many of these works by Waters, species present in South Africa were merely noted, and therefore in many instances invalid (Florence *et al*. 2007).

A few other reports also included some South African bryozoan species (Levinsen

1909, Kluge 1914, Canu and Bassler 1920, 1922, Marcus 1922. Georg Marius Reinald Levinsen (1850-1914) was the museum curator at the Zoological Museum of Copenhagen. His work comprised mainly morphological and systematic studies on cheilostomatous bryozoans. Twelve cheilostome species from South Africa were listed in Levinsen (1909) and he referred to some of Hincks's and Busk's illustrations.

The Russian zoologist German (Herman) Avgustovich Kluge (1871-1956) examined bryozoan material collected from the Southern Ocean and from South Africa, as part of the German South Polar Expedition during 1901-1903 (Kluge, 1914). The six species described from South Africa, included *Bugula calathus* Norman, 1868, *Chaperiopsis multifida* (Busk, 1884), *Chaperia acanthina* (Lamouroux, 1825), *Beania vanhoeffeni* Kluge, 1914, *Membranipora polystachys* Kluge, 1914 and *Aetea annulata* Kluge, 1914, with the latter three species considered as erroneous. For example, *A. annulata* is considered to be the junior synonym of *Sertularia anguina* (Linnaeus, 1758), which is the basionym of *A. anguina*.

Ray Smith Bassler (1878-1961) grew up in Cincinnati (USA) and initially specialized in Ordovician fossils (Cuffey et al. 2002, Wyse Jackson and Spencer Jones 2007). Later, his expertise included Recent Bryozoa and published the first volume of the *Treatise on Invertebrate Paleontology* (Bassler 1953). In 1904 he was appointed as an assistant curator in the Department of Geology at the National Museum of Natural History in Washington DC and continued his affiliation at the museum until he retired.

Bassler began corresponding with the French palaeontologist Ferdinand Canu (1863-1932) in 1902, but they only met for the first time in 1926 (Sanner 2002). They developed a productive collaboration that resulted in a large number of important publications (Canu and Bassler 1920, 1922, 1927, 1929, 1930). Canu received the Daniel Giraud Elliot Medal in 1923 for his contribution on *North American Later Tertiary and Quaternary Bryozoa* (Sanner 2002). Canu and Bassler (1920, 1922) recorded one cheilostome species, *Mastigophora hyndmanni* (Johnston, 1847), and two cyclostome species, *T. stellata* (Busk, 1875) and *T. contorta* (Busk, 1875), from South Africa.

Ernst Gustav Gotthelf Marcus (1893-1968) was born in Germany and studied zoology in 1912 at the University of Berlin originally intending to become a coleopterist. Research towards his doctoral studies (on Coleoptora) begun in the Entomology Department at the Berlin Museum were interrupted by World War I. After the war he returned to the University of Berlin and completed his doctorate in 1919. Marcus continued working at the museum, but later immersed himself in taxonomic study of bryozoans, working up collections from German, Danish and Swedish expeditions to the Pacific, Australia, South Africa and from various European museum collections (Winston 2002).

From the South African material in Gothenburg Natural History Museum, Sweden, Marcus (1922) recorded 21 bryozoan species from the Cape of Good Hope. The cheilostome species include *Beania magellanica* (Busk, 1852), *Chaperia capensis* (Busk, 1884), *Chaperiopsis multifida* (Busk, 1884), *Gregarinidra spinuligera* (Hincks, 1891), *Hoplitella armata* (Busk, 1852), *Menipea crispa* (Pallas, 1766), *M. ornata* (Busk, 1852), *Foveolaria imbricata* (Busk, 1884), *Alysidium parasiticum* Busk, 1852, *Cellaria punctata*

(Busk, 1852), *Laminopora jellyae* (Levensen, 1909), *Schizoporella inconspicua* Hincks, 1891, *Calyptotheca nivea* (Busk, 1884), *Flustramorpha flabellaris* (Busk, 1854) and *Jellyella tuberculata* (Bosc, 1802).

Hayward (1988) noted that *Adeonella glypta* Marcus, 1922 was well described and figured from material collected off Port Alexander in Angola, but the type material was not available for examination and no other known material of this species has been collected. Three cyclostomes species, *Bicrisia edwardsiana* (d'Orbigny, 1841), *T. contorta* (Busk, 1875), *Hornera americana* d'Orbigny, 1842, and one ctenostome, *Alcyonidium flustroides* Busk, 1886 were recorded. The latter species was also recorded in O'Donoghue (1924).

Another major contributor to early South African Bryozoa taxonomy, was Charles Henry O'Donoghue (1885-1961) who was Professor of Zoology in the University of Reading from 1939 to 1952 (Anon 1939). O'Donoghue (1924, 1957), and together with Dora de Watteville (1935, 1937, 1944), attempted to record comprehensively the bryozoan fauna of South Africa. He reported on the bryozoan fauna collected by the SS '*Pickle*', commissioned by the Fisheries and Marine Biological Survey during 1920-1921 and headed by Dr J.D.F. Gilchrist (O'Donoghue 1924). In addition, this work also includes specimens collected along the shoreline and by trawlers, which were collected from Table Bay, False Bay, Cape Infanta and as far east as the mouth of the Illovo River. In this paper he recorded 55 bryozoan species of which 17 species were previously located from South Africa, 15 were reported from elsewhere and 25 were new.

In total O'Donoghue and de Watteville recorded a total of 68 species from South Africa of which 17 were new records for the region, and 14 were considered new. Professor T.A. Stephenson collected these specimens during ecological studies by the University of Cape Town. O'Donoghue (1957) recognised 36 species of which one, *Parasmittina natalense* O'Donoghue 1957, was new and three species, *Acanthodesia savartii* (Audouin, 1826), *Conopeum reticulum* (Linnaeus, 1767) and *Cryptosula pallasiana* (Moll, 1803) appeared to be new records for South Africa.

Despite the efforts by Busk and O'Donoghue to describe South African specimens, several taxonomic problems arose. Eurocentric tendencies to assign European names to South African specimens frequently arose (Hayward and Cook 1983). These synonymies are still to be resolved.

During the second half of the 20th century, the German expedition cruise of the RV '*Vema*' in 1950-1952 sampled the deep-sea fauna at depths exceeded 2000 m, along the Atlantic Ocean of West Africa. Specimens of *Kinetoskias* were examined within this collection; only one species, *Kinetoskias pocillum* Busk, 1881 was recorded off South Africa in the South Atlantic in a sample taken at 3,049 m (Menzies 1963). The genus *Kinetoskias* consists of abyssal species found mostly in the Arctic Ocean and near-Arctic localities (Kluge 1953).

Patricia Lynette Cook (b. 1927) worked as an assistant and later in 1964 became Head of the Bryozoa Section at the Natural History Museum, London. Her published work includes descriptions of African collections and studies of larval development in

Membranipora (Cook 1962, Cook and Hayward 1966). Cook (1966) described specimens collected by Dr J.D.F. Gilchrist between 1903 and 1904 off Durban on the east coast of South Africa; in this paper she erected four cheilostome species, namely *Conescharellina africana* Cook, 1966, *Anoteropora inarmata* Cook, 1966, *Batopora murrayi* Cook, 1966 and *Lacrimula pyriformis* Cook, 1966. Cook also examined some African species in the Family Adeonellidae, which included an assessmant of South African *Laminopora* and *Adeonella* species (Cook 1982).

Peter Joseph Hayward was first introduced to bryozoans as a scientific assistant at the Natural History Museum, London at the age 16. Subsequently, he graduated from University of Reading in 1970 in Zoology and received his Ph.D. in 1974 from the University of Swansea under the supervision of John S. Ryland, with whom he collaborated on the serial monographs of *Synopses of the British Fauna*. Hayward has published extensively on the taxonomy, morphology and biology of marine bryozoans of the North Atlantic, Antarctica, Southwest Pacific and the deep sea.

Cook and Chimonides (1981) examined a few specimens from the RV *Meiring Naudé* collection, and erected one new cheilostome species *Tropidozoum burrowsi*. Hayward and Cook co-authored two comprehensive taxonomic reports on RV *Meiring Naudé* material (Hayward and Cook 1979, 1983). In the first paper a total of one ctenostome, two cyclostomes and 48 cheilostome bryozoans were described, of these 23 species were considered new. Moreover, three new genera, *Notocoryne*, *Leiosalpinx* and *Inversiscaphos*, and one new family, Setosellinidae were introduced. These samples were collected during 1975 and 1976 at depths ranging from 376-1300 m along the south and east coast.

Samples collected in 1977 and 1979 from shallower depths (<100 m) of the same area yielded a total of 38 anascan cheilostomes, 76 ascophoran cheilostomes and 16 cyclostomes, of which 44 species were new and one new genus *Dactylostega* introduced (Hayward and Cook 1983). The authors noted that the South African bryozoan fauna includes a high proportion of endemic species, but also it exhibits a marked faunal affinity with the Indo-West-Pacific region.

Additionally, Hayward (1988) reviewed *Adeonella* by examination of the material in the Natural History Museum, London. Globally, 41 species were recorded, of which 15 species were newly defined in this paper. Of the newly described species, nine were recorded from South Africa, which now has yielded a total of 31 *Adeonella* species of which 27 species have not been found elsewhere. The highest diversity of *Adeonella* species occurs on the eastern coast of South Africa.

4.3 Bryozoology in 21st century

Florence *et al*. (2007) conducted the first study of the shallow-water (depths <30 m) bryozoans of the west coast of South Africa. Sixty three species were recorded, of which 15 cheilostome species (*Beania minuspina*, *Bicellariella bonsai*, *Bitectipora umboavicula*, *Celleporina solida*, *Chaperia septispina*, *Escharoides custodies*, *Fenestrulina elevora*, *Klugeflustra jonesii*, *Membranipora rustica*, *Micropora latiavicula*, *Microporella madiba*,

Rhynchozoon abscondum, *Schizosmittina lizzya*, *Thalamoporella spiravicula*) and one cyclostome species (*Eurystrotos planus*) was newly described. In total hitherto, more than 270 valid species (within the three orders Cheilostomatida, Cyclostomatida and Ctenostomatida) represented in 74 families and 130 genera have been recorded in South Africa.

Bryozoan projects are currently underway, for example, the compilation of a species list for shallow-water bryozoan species from the south and east coast. An incidental collection of bryozoans made by the *Dr Fritjov Nansen*, a demersal trawler, in deep-water (95 m) on the south coast of South Africa, revealed twelve species, with one as yet unnamed new species (Wayne K. Florence, unpublished data). Additionally, more than 1,500 undetermined specimens are estimated to be contained in the bryozoan collection lodged in SAMC—the majority of which were collected during the University of Cape Town Ecological Survey, and is currently being examined.

Future projects include sampling in deeper waters on the west coast and assessments of the molecular biology in conjunction with analyses of the morphological taxonomy of bryozoans. Taking into account that there are spatial gaps in bryozoan distribution (e.g. deep-water regions poorly sampled) and taxonomic bias (shortage of bryozoan taxonomists and lack of interest), the true species richness and diversity in South Africa may be grossly underestimated.

4.4 Iziko South African Museum marine invertebrate collections

Annual surveys such as the University of Cape Town Ecological Survey, pelagic and benthic surveys by the Department of Environmental Affairs and the Department of Agriculture, Forestry and Fisheries, has undoubtedly increased our biodiversity knowledge of the benthic invertebrate fauna. A set of comprehensive collections resulting from these surveys with undetermined specimens are housed in the Marine Collection at SAMC.

It is important to note that these extensive marine collections within SAMC are managed by only two curators - one for the Marine Invertebrate Collections and one for the Marine Fish Collections. Only three African bryozoologists (two from South Africa and one from Tunisia) attended the International Bryozoological Association meeting (June 2013) in Catania, Italy in June 2013. It is imperative that interest in bryozoans from Africa is raised so that targeted research will take place on bryozoans occurring along the African coast, There is also a need for additional trained taxonomists.

The primary marine invertebrate collections stored at SAMC comprises of approximately 129,000 records, and constitutes significant coverage of all major marine invertebrate taxa, excluding almost 17,000 catalogued marine invertebrate fossil records for this region (Table 4; also see Griffiths *et al*. 2010). The current Bryozoa collection at SAMC has 1,225 catalogued specimens, excluding unworked specimens within the collection estimated to be more than 1,500 samples, the majority of which are yet to be determined to species-level.

Table 4. Summary of extant marine invertebrates in the SAMC collections in decreasing order. An estimated number of unaccessioned lots per phylum are listed. Compiled by using Specify 6.5.02 *software and personal communication with collections' managers in SAMC.*

Taxonomic group	**Number of lots accessioned**	**Estimated number of lots unaccessioned**
Kingdom Protoctista		
Foraminefera	142	0
Dinoflagellata	33	0
Plankton	0	60,000
Kingdom Animalia		
Molluscs	26,658	1,700
Crustacea	18,406	4,500
Cnidaria	4,830	2,400
Echinodermata	2,607	600
Annelida	1,942	600
Bryozoa	1,225	1,000
Pycnogonids	391	44
Porifera	245	1,000
Ascidiacea	234	50
Helminth worms and Nemertea	157	70
Brachiopoda	138	0
Sub-totals	57,008	71,964

Estimated total number of specimens: 128,972

Of the 1,225 catalogued specimens, 1,028 specimen records have location data (Figure 17), and this shows that the known ranges of bryozoan species occurring in South African waters is very patchy. In addition to unstudied extant bryozoans samples, there are a large number of fossil bryozoans in the collection, but only one fossil bryozoan has been catalogued (Eugene Bergh, pers. comm.). Although bryozoans are considered to be one of the most abundant animal fossils (McKinney and Jackson 1989), to date, few studies have been conducted on fossil Bryozoa in South Africa. Tate (1867) reported on some South African Jurassic bryozoans, while more recently Kohring and Hörnig (2002) described rare fossilised statoblasts of freshwater bryozoans from the Triassic of the Molteno Formation of the Karoo Supergroup. This suggests either a lack of interest in fossil Bryozoa (which seems unlikely), or more probably a lack of specialist taxonomists in the country, which is unfortunate considering southern Africa's rich fossil record.

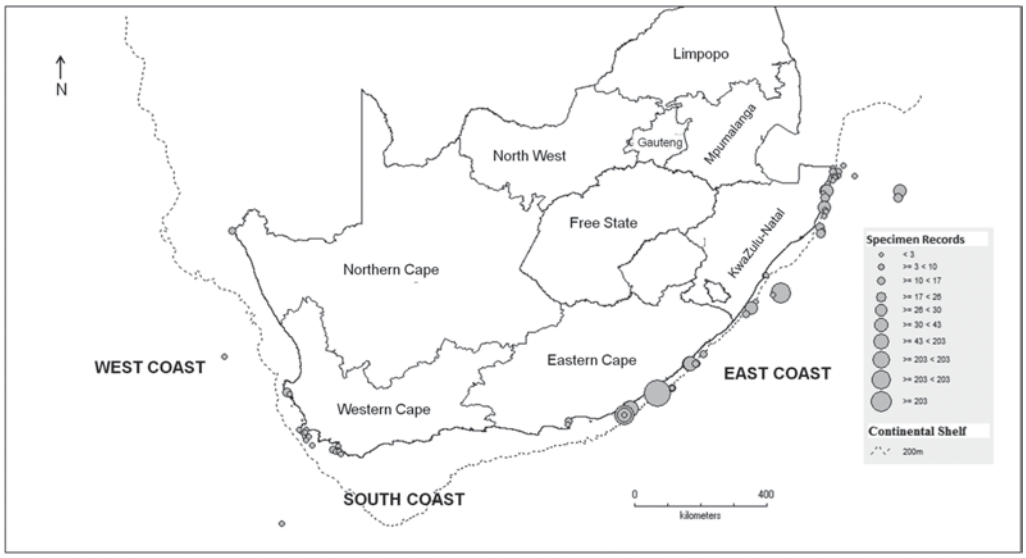


Figure 17. Approximately 1,028 catalogued bryozoan specimens (with location data) currently housed at SAMC. Clear gaps exist as west and south coast samples have remained unsorted and undetermined for years. Additionally, lack of sampling in deeper waters highlight gaps in biodiversity knowledge and bryozoan diversity.

5. Conclusion

Research on South African marine biology and biodiversity commenced during the colonial years in the 17th century. Infrastructure grew rapidly with an increase in the European settler population allowing for the establishment in 1825 of the first museum in sub-Saharan Africa, the South African Museum. The European settlers of South Africa included naturalists and taxonomists from Britain and Europe, who came to study the local biota. European colonialism, therefore, brought upon a new era of scientific discoveries, for example by conducting large marine surveys along the South African coastline, and bringing considerable scientific expertise to the region.

In addition to the large collections assembled by various scientific cruises such as the HMS *Challenger* and RV *Meiring Naudé*, systematic research was carried out in order to understand biodiversity and distribution patterns along the South African coast. These studies, however, were focussed mainly on fish, molluscs and crustaceans, and certain benthic marine invertebrates, such as sponges and bryozoans, were neglected. Consequently, taxonomic studies on the South African Bryozoa are, in part, outdated and fragmentary with spatial and temporal gaps in our biodiversity knowledge.

The first published account of South African bryozoan was that of Hincks (1880), but majority of description of species were provided by George Busk using specimens in the British Museum and *Challenger* collections. Most of the South African collections were taken back to Europe and lodged at various European museums, including the Natural

History Museum, London. The sensitive issue surrounding repatriation of collections belonging to South Africa is debatable. Assigning European names to South African specimens were very common and synonymies still need to be resolved.

Florence *et al*. (2007) estimated that, to date, over 270 valid bryozoan species have been recorded in South African waters, but temporal and spatial gaps in our biodiversity knowledge may yield several new species and records. Over 1,500 bryozoan samples, the majority from south coast collections stored at SAMC, have remained undetermined. Therefore, valuable historical and recent data "locked" in museum collections have the potential to aid in understanding marine benthic diversity and biogeography of the marine realm around South Africa.

Acknowledgments

MB would like to thank Mary Spencer Jones for hosting a research visit to the Natural History Museum in London in June and July 2013 that led to conceptualizing this paper. We thank Eugene Bergh (Iziko South African Museum, Cape Town) and Genevieve Thompson (South African National Biodiversity Institute) for their comments on the manuscript.

References

Anon. 1939. Dr. C.H. O'Donoghue. *Nature* **143**, 510.

Bassler, R.S. 1953. Bryozoa. Part G. *Treatise on Invertebrate Paleontology*. Geological Society of America, Boulder and University of Kansas Press, Lawrence.

Brennecke, W. 1909. Oseanographie. *Forschungsreise S.M.S. "Planet" 1906-1907*. Reichs-Marine-Ampt, Band 3, Berlin.

Brennecke, W. 1915. Ozeanographische Arbeiten S.M.S. *Möwe* im westlichen Indischen Ozean 1913. *Annalen der Hydrographie und Maritimen Meteorologies* **43**, 3–16.

Brown, A.C. (ed.) 1977. *A history of scientific endeavour in South Africa: a collection of essays published on the occasion of the centenary of the Royal Society of South Africa*. Royal Society of South Africa, Cape Town, pp. xx+516 pp.

Brown, A.C. 1997. John D.F. Gilchrist and the early years of marine science in South Africa. *Transactions of the Royal Society of South Africa* **52**, 2–16.

Busk, G. 1852a. An account of the Polyzoa, and sertularian zoophytes, collected in the Voyage of the Rattlesnake, on the coasts of Australia and the Louisiade Archipelago, pp. 343–402. *In* J. Macgillivray in *Narrative of the voyage of H.M.S. Rattlesnake*. T. & W. Boone, London.

Busk, G. 1852b *Catalogue of Marine Polyzoa in the collection of the British Museum. 1. Cheilostomata (part)*. Trustees of the British Museum, London, pp. 1–39.

Busk, G. 1854. *Catalogue of Marine Polyzoa in the collection of the British Museum. 2. Cheilostomata*. Trustees of the British Museum (Natural History), London, pp. 1–55–120.

Busk, G. 1875. *Catalogue of the marine Polyzoa in the collection of the British Museum. 3. Cyclostomata*. Trustees of the British Museum (Natural History), London, pp. 1–39.

Busk, G. 1884. Report on the Polyzoa collected by H.M.S. Challenger during the years 1873-1876. Part 1. The Cheilostomata. *Report on the Scientific Results of the Voyage of the H.M.S. "Challenger", Zoology* **10**, 1–216.

Busk, G. 1886. Report on the Polyzoa collected by H.M.S. Challenger during the years 1873-1876. Part II. The Cyclostomata, Ctenostomata and Pedicellinea. *Report on the Scientific Results of the Voyage of the H.M.S. "Challenger", Zoology* **17**, 1–47.

Calder, D.R. 2009. The Reverend Thomas Hincks FRS (1818-1899): taxonomist of Bryozoa and Hydrozoa. *Archives of Natural History* **36**, 189–217.

Canu, F. and Bassler, R.S. 1920. North American early Tertiary Bryozoa. *Bulletin of the United States National Museum* **106**, 1–879.

Canu, F. and Bassler, R.S. 1922. Studies on the cyclostomous Bryozoa. *Proceedings of the United States National Museum* **61**, 1–160.

Canu, F. and Bassler, R.S. 1927. Classification of the cheilostomatous Bryozoa. *Proceedings of the United States National Museum* **69**, 1–42.

Canu, F. and Bassler, R.S. 1929. Bryozoa of the Phillipine Region. *Bulletin of the United States National Museum* **9**, 1–685.

Canu, F. and Bassler, R.S. 1930. The bryozoan fauna of the Galapagos Islands. *Proceedings of the United States National Museum* **76**, 1–78.

Coates, P. 2012. Was the South African Library an Anthenaeum? *Quarterly Bulletin of the National Library of South Africa* **66**, 11–23.

Cook, G.C. 1997. George Busk FRS, 1807–1886, nineteenth-century polymath: surgeon, parasitologist, zoologist, and palaeontologist. *Journal of Medical Biography* **5**, 88–101.

Cook, P.L. 1962. The early larval development of *Membranipora seurati* (Canu) and *Electra crustulenta* (Pallas), (Polyzoa Ectoprocta). *Cahiers de Biologie Marine* **3**, 57–60.

Cook, P.L. 1966. Some "sand fauna" Polyzoa (Bryozoa) from Eastern Africa and the northern Indian Ocean. *Cahiers de Biologie Marine* **7**, 207–223.

Cook, P.L. 1982. Notes on some African Adeonellidae (Bryozoa, Cheilostomata). *Journal of Natural History* **16**, 833–846.

Cook, P.L. and Chimonides, P.J. 1981. Morphology and systematics of some interior-walled cheilostome Bryozoa. *Bulletin of the British Museum (Natural History), Zoology* **41**, 53–89.

Cook, P.L. and Hayward, P.J. 1966. The development of Conopeum seurati (Canu), and some other species of Membraniporine Polyzoa. *Cahiers de Biologie Marine* **7**, 437–443.

Costello, M.J., Coll, M., Danovaro, R., Halpin, P., Ojaveer, H. and Miloslavich, P. 2010. A census of marine biodiversity knowledge, resources, and future challenges. *PLoS One* **5**, 1–15.

Cowling, R.M., MacDonald, I.A.W. and Simmons, M.T. 1996. The Cape Peninsula,

South Africa: physiographical, biological and historical background to an extraordinary hot-spot of biodiversity. *Biodiversity and Conservation* **5**, 527–550.

Cuffey, R.J., Davis, R.A. and Utgaard, J. 2002. The Cincinnatian bryozoologists, pp. 59–79. *In* P.N. Wyse Jackson and M.E. Spencer Jones (eds) *Annals of Bryozoology: aspects of the history of research on bryozoans*. International Bryozoology Association, Dublin.

Day, J.A. 2000. Marine and estuarine studies in South Africa: an historical perspective. *Transactions of the Royal Society of South Africa* **55**, 101–105.

Day, J.H. 1977. Marine Biology in South Africa, pp. 86-108. *In* A.C. Brown (ed.) *A history of scientific endeavour in South Africa: a collection of essays published on the occasion of the centenary of the Royal Society of South Africa*. Royal Society of South Africa, Cape Town, pp. xx+516 pp.

Day, J.H. 1980. *Unpublished notes on the history of the Zoology Department, University of Cape Town*.

Duda, A.M. and Sherman, K. 2002. A new imperative for improving management of large marine ecosystems. *Ocean & Coastal Management* **45**, 797–833.

Florence, W.K., Hayward, P.J. and Gibbons, M.J. 2007. Taxonomy of shallow-water Bryozoa from the west coast of South Africa. *African Natural History* **3**, 1–58.

Foote, Y. 2004. Busk, George (1807–1886). *Oxford Dictional of National Biography* <http://dx.doi.org/10.1093/ref:odnb/4168>

Gibbons, M.J. (and numerous contributors) 1999. The taxonomic richness of South Africa's marine fauna: a crisis at hand. *South African Journal of Science* **95**, 8–12.

Goldblatt, P. and Manning, J. 2002. Plant diversity of the Cape Region of South Africa. *Annals of the Missouri Botanical Garden* **89**, 281–302.

Griffiths, C.L., Robinson, T.B., Lange, L. and Mead, A. 2010. Marine biodiversity in South Africa: An evaluation of current states of knowledge. *PLoS One* **5**, 1–13.

Hayward, P.J. 1988. The recent species of *Adeonella* (Bryozoa: Cheilostomata) including descriptions of fifteen new species. *Zoological Journal of the Linnean Society* **94**, 111–191.

Hayward, P.J. and Cook, P.L. 1979. The South African Museum's Meiring Naudé Cruises. Part 9, Bryozoa. *Annals of the South African Museum* **79**, 43–130.

Hayward, P.J. and Cook, P.L. 1983. The South African Museum's Meiring Naudé Cruises. Part 13, Bryozoa II. *Annals of the South African Museum* **91**, 1–161.

Hayward, P.J. and Ryland, J.S. 1999. Cheilostomatous Bryozoa. Part 2. Hippothoidea - Celleporoidea. *Synopses of the British Fauna*, New Series, **14**, 1–416. Field Studies Council, Shrewsbury.

Hill, A.E., Hickey, B.M., Shillington, F.A., Strub, P.T., Brink, K.H., Barton, E.D. and Thomas, A.C. 1998. Eastern ocean boundaries, coastal segment (E). Chapter. 2, pp. 29–67. *In* A.R. Robinson and K.H. Brink (eds). *The Sea*, Volume 11, *The Global Coastal Ocean: Regional Studies and Syntheses*, John Wiley & Sons, New York.

Hincks, T. 1880. *A history of the British Marine Polyzoa*. 2 volumes. Van Voorst, London.

Hincks, T. 1891. Contributions towards a general history of the marine Polyzoa. XV.

South African and other Polyzoa. *Annals and Magazine of Natural History* Series 6, **7**, 285–298.

Hughes, G.R. 1974. The sea turtles of south-east Africa II. The biology of the Tongaland loggerhead turtle *Caretta caretta* L. with comments on the leatherback turtle *Dermochelys coriacea* L. and the green turtle *Chelonia mydas* L. in the study region. *South African Association for Marine Biological Research. Investigational Report* **36**, 1–96.

Kennedy, D. 2004. Smith, Sir Andrew (1797–1872), army medical officer and naturalist. *Oxford Dictionary of National Biography* <http://dx.doi.org/10.1093/ref:odnb/25772>

Kluge, G.A. 1914. Die Bryozoen der deutschen Südpolar-Expedition 1901-1903 I. Die Familien Aetidae, Cellularidae, Bicellaridae, Farciminaridae, Flustridae, Membraniporidae und Cribilinidae. *Deutsch Südpolar-Expedition Zoology* **15**, 599–678.

Kluge, G.A. 1953. The distribution of Bryozoa belonging to the genus *Kinetoskias* (Danielssen). *Trudy Zool. Instituta, Ross. Akad. Nauk. St. Peterbg. [= Proc. Zool. Inst. Russ. Acad. Sci. St. Petersburg]* **13**, 210–215 (in Russian).

Kohring, R. and Hörnig, A. 2002. Freshwater bryozoan remains from the Molteno Formation (Upper Triassic) of South Africa, pp. 171–174. *In* P.N. Wyse Jackson, C.J. Buttler and M.E. Spencer Jones (eds). *Bryozoan Studies 2001*. A.A. Balkema, Lisse.

Kolb, P. 1727. *Naaukeurige en uitvoerige beschrijving van de Kaap de Goede Hoop*. Balthazar Lakeman, Amsterdam. Volume 1, i–xviii+1–529 pp.

Levinsen, G.M.R. 1909. *Morphological and Systematic Studies on the Cheilostomatous Bryozoa*. Nationale Forfatteres Forlag, Copenhagen.

Lombard, A.T., Strauss, T., Harris, J., Sink, K., Attwood, C. and Hutchings, L. 2004. *South African National Spatial Biodiversity Assessment 2004 Technical Report. Volume 4: Marine Component*. South African National Biodiversity Institute, Pretoria.

Lutjeharms, J.R.E. 2006. The ocean environment off southeastern Africa: a review. *South African Journal of Science* **102**, 419–427.

Lutjeharms, J.R.E. and Shannon, L.V. 1997. A century of physical oceanography in South Africa; in search of the legacy of John D.F. Gilchrist. *Transactions of the Royal Society of South Africa* **52**, 17–50.

Marcus, E. 1922. Südafrikanische Bryozoen aus der Sammlung des Gothenburger Museums. *Göteborgs Kongligen Vetenskaps och Vitterhets Samhalles Handlingar* **25**, 1–45.

McKinney, F.K. & Jackson, J.B.C. 1989. *Bryozoan Evolution*. Unwin Hyman, Boston.

Mead, A., Carlton, J.T., Griffiths, C.L. and Rius, M. 2011. Revealing the scale of marine bioinvasions in developing regions: a South African re-assessment. *Biological Invasions* **13**, 1991–2008.

Menzies, R.J. 1963. Abyssal Bryozoa collected by expeditions of the Lamont Geological Observatory 1. Bicellariellidae (Bugulidae of Authors), *Kinetoskias*. *American Museum Novitates* **2130**, 1–8.

Mittermeier, R.A., Myers, N., Thorsen, J.B., da Fonseca, G.A.B. and Olivieri, S. 1998.

Biodiversity hotspots and major tropical wilderness areas: approaches to setting conservation priorities. *Conservation Biology* **12**, 516–520.

Mittermeier, R.A., Robles-Gil, P. and Mittermeier, C.G. 1997. *Megadiversity: Earth's biologically wealthiest nations*. CEMEX conservation book series. Volume 5. 501, pp.

Morris, R.O. 1986. Surveying ships of the Royal Navy from Cook to the computer age. *The Mariner's Mirror* **72**, 385–410.

Myers, N., Mittermeier, R.A, Mittermeier, C.G., da Fonseca, G.A.B. and Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* **403**, 853–858.

O'Donoghue, C.H. and de Watteville, D. 1935. A collection of Bryozoa from South Africa. *Zoological Journal of the Linnean Society* **39**, 203–218.

O'Donoghue, C.H. and de Watteville, D. 1937. Notes on South African Bryozoa. *Zoologischer Anzeiger* **117**, 12–22.

O'Donoghue, C.H. and de Watteville, D. 1944. Additional notes on Bryozoa from South Africa. *Annals of the Natal Museum* **10**, 407–432.

O'Donoghue, C.H. 1924. *The Bryozoa (Polyzoa) collected by the S.S. "Pickle". Report on the Fisheries Marine Biological Survey of South Africa* **10**, 1–63.

O'Donoghue, C.H. 1957. Some South African Bryozoa. *Transactions of the Royal Society of South Africa* **35**, 71–95.

Olson, D.M. and Dinerstein, E. 1998. The Global 200: A representation on approach to conserving the Earth's distinctive ecoregions. *Conservation Biology* **12**, 502–515.

Perry, S.M. and Fautin, D.G. 2003. Challenger Expedition (1872-1876). <http://hercules.kgs.ku.edu/hexacoral/expeditions/challenger_1872-1876/challenger.html>

Pletcher, K. (ed.) 2010. *The Brittanica Guide to explorers and explorations that changed the modern world*. Brittanica Educational Publishing, Rosen Educational Services, 350 pp.

Rennell, J. 1778. *Chart of the Bank and Current of Cape Lagullas*.

Rennell, J. 1832. *An Investigation of the Currents of the Atlantic Ocean, and of those which prevail between the Indian Ocean and the Atlantic*. J.G. & T. Rivington, London, 359 pp.

Sanner, J. 2002. Canu and Bassler, pp. 243–250. *In* P.N. Wyse Jackson and M.E. Spencer Jones (eds) *Annals of Bryozoology: aspects of the history of research on bryozoans*. International Bryozoology Association, Dublin.

Schumann, E. H. 1998. The coastal ocean off southeast Africa, including Madagascar (15,W), pp. 557–581. *In* A.R. Robinson and K.H. Brink (eds). *The Sea*, Volume 11, *The Global Coastal Ocean: Regional Studies and Syntheses*. John Wiley & Sons, New York.

Scott, R.J., Griffiths, C.L. and Robinson, T.B. 2012. Patterns of endemicity and range restriction among southern African coastal marine invertebrates. *African Journal of Marine Science* **34**, 341–347.

Shannon, L.V. 1985. The Benguela ecosystem. I. Evolution of the Benguela, physical features and processes. *Oceanography and Marine Biology: an annual review* **23**, 105–182.

Shillington, F.A., Reason, C.J.C., Duncombe Rae, C.M., Florenchie, P. and Benven, P. 2006. Large-scale physical variability of the Benguela Current large marine ecosystem (BCLME), pp. 47–68. *In* Shannon, V., Hempel, G., Malanotte-Rizzoli, P., Moloney, C. and Woods, J. (eds) *Large Marine Ecosystems*. Volume 14. Elsevier Science.

Simon, C.A. and Van Niekerk, S.E. 2012. A brief history of John Day. *A Guide to the shell-infesting spionids of South Africa*. <http://www0.sun.ac.za/polychaete/>

Sink, K.J., Attwood, C.G., Lombard, A.T., Grantham, H., Leslie, R., Samaai, T., Kerwath, S., Majiedt, P., Fairweather, T., Hutchings, L., van der Lingen, C., Atkinson, L.J., Wilkinson, S., Holness, S. and Wolf, T. 2011. *Spatial planning to identify focus areas for offshore biodiversity protection in South Africa. Final Report for the Offshore Marine Protected Area Project*. South African National Biodiversity Institute, Pretoria.

Sink, K.J., Holness, S., Harris, L., Majiedt, P., Atkinson, L., Robinson, T., Kirkman, S., Hutchings, L., Leslie, R., Lamberth, S., Kerwath, S., von der Heyden, S., Lombard, A., Attwood, C., Branch, G., Fairweather, T., Taljaard, S., Weerts, S., Cowley, P., Awad, A., Halpern, B., Grantham, H. and Wolf, T. 2012. *National Biodiversity Assessment 2011: Technical Report*. Volume 4: Marine and Coastal Component. South African National Biodiversity Institute, Pretoria, pp. 325.

Sloan, S., Jenkins, C.N., Joppa, L.N., Gaveau, D.L.A. and Laurance, W.F. 2014. Remaining natural vegetation in the global biodiversity hotspots. *Biological Conservation* **177**, 12–24.

Summers, R.F.H. 1975. *A history of the South African Museum, 1825 - 1975*. Published for the Trustees of the South African Museum by A.A. Balkema, 245 pp.

Talbot, W.J. 1977. Pathfinders and pioneers, explorers and scientists 1487-1976, pp. 1-32. *In* A.C. Brown (ed.) *A history of scientific endeavour in South Africa: a collection of essays published on the occasion of the centenary of the Royal Society of South Africa*. Royal Society of South Africa, Cape Town, pp. xx+516 pp.

Tate, R., 1867. On some secondary fossils from South Africa. *Quarterly Journal of the Geological Society of London* **23**, 139–175.

Thom, H.B. 1952. *Journal of Jan van Riebeek*. Volume 1. A.A. Balkema, Cape Town (for the Van Riebeeck Society), pp. xlvi+393.

Tittensor, D.P., Mora C., Jetz W., Lotze H.K., Ricard D., Vanden Berghe E., and Worm B. 2010. Global patterns and predictors of marine biodiversity across taxa. *Nature* **466**, 1098–1103.

Tizard, T.H., Moseley, H.N., Buchanan, J.Y. and Murray, J. 1885. *Narrative of the cruise of H.M.S. Challenger with a general account of the scientific results of the expedition. Challenger Report (Narrative), Volume 1, Part I & II*. Her Majesty's Stationary Office, London, 1172 pp.

Walker, N.D. 1989. *Sea surface temperature-rainfall relationships and associated ocean-atmosphere coupling mechanisms in the southern African region*. Council for Scientific and Industrial Research, Division of Earth, Marine and Atmospheric Science and Technology, 171 pp.

Waters, A.W. 1904. Bryozoa. *Résultats du Voyage du S.V. 'Belgica', Zoologie. Expedition*

Antarctique Belge **4**, 1–114.
Waters, A.W. 1907. *Tubucellaria*; its species and ovicells. *Journal of the Linnean Society (Zoology)* **30**, 126–133 .
Waters, A.W. 1909. Reports on the marine biology of the Sudanese Red Sea, from collections made by Cyril Crossland, M.A., B.Sc., F.Z.S.; together with collections made in the Red Sea by Dr R. Hartmeyer, 7. The Bryozoa, Part 1, Cheilostomata. *Journal of the Linnean Society (Zoology)* **31**, 123–181.
Waters, A.W. 1916. Some species of *Crisia*. *Annals and Magazine of Natural History* Series 8, **18**, 469–477.
Waters, A.W. 1918. Some collections of the littoral marine fauna of the Cape Verde Islands made by Cyril Crossland, M.A., B.Sc., F.Z.S., in the summer of 1904. Bryozoa. *Journal of the Linnean Society (Zoology)* **34**, 1–45.
Waters, A.W. 1919. *Batopora* (Bryozoa) and its allies. *Annals and Magazine of Natural History* Series 9, **3**, 79–94.
Winston, J.E. 2002. Ernst Gustav Gotthelf Marcus (1893–1968) and Eveline Agnes du Bois-Reymond Marcus (1901-1990), pp. 339–361. *In* P.N. Wyse Jackson and M.E. Spencer Jones (eds) *Annals of Bryozoology: aspects of the history of research on bryozoans*. International Bryozoology Association, Dublin.
Woodward, B.B. 1901. Busk, George, pp. 357–358. *In* Lee (ed.) *Dictionary of National Biography*. *Supplement 1*. Smith, Elder & Co., London.
Worden, N. and Groenewald, G. (eds) 2005. *Trials of Slavery: Selected documents concerning slaves from the criminal records of the Council of Justice at the Cape of Good Hope, 1705-1794*. Van Riebeeck Society for the Publication of South African Historical Documents, Second Series, **36**, lxi+681 pp.
Wyse Jackson, P.N. and Spencer Jones, M.E. 2002. From Rondelet to Stockholm; four centuries of bryozoological research, pp. 363–381. *In* P.N. Wyse Jackson and M.E. Spencer Jones (eds) *Annals of Bryozoology: aspects of the history of research on bryozoans*. International Bryozoology Association, Dublin.
Wyse Jackson, P.N. and Spencer Jones, M.E. 2007. The quiet workforce: the various roles of women in geological and natural history museums during the early to mid-1900s. *In* Burek, C.V. and Higgs, B. (eds) *The role of women in the history of geology*. Geological Society Special Publication **281**, 97–113.

Notes

1 The majority of the information in this subsection was sourced from South African History Online, www.sahistory.org.za. Accessed 14 April 2014.
2 This subsection highlights some events that led to the establishment of the South African Museum and the first director, Dr Andrew Smith. It draws extensively on a detailed history of the South African Museum, including its holdings and directorship following Smith, that was compiled by R.F.H. Summers (1975) using museum records. Therefore, this section does not set out to repeat Summers' impressive compilation, but rather highlights certain events. While

specific references to Summers (1975) are not cited herein due to them being extensive, readers are advised to consult his history.