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Mollusc collections at South African institutions: Development and current status

There are three major mollusc collections in South Africa and seven smaller, thematic collections. The KwaZulu-Natal Museum holds one of the largest collections in the southern hemisphere. Its strengths are marine molluscs of southern Africa and the southwestern Indian Ocean, and terrestrial molluscs of South Africa. Research on marine molluscs has led to revisionary papers across a wide range of gastropod families. The Iziko South African Museum contains the most comprehensive collections of Cephalopoda (octopus, squid and relatives) and Polyplacophora (chitons) for southern Africa. The East London Museum is a provincial museum of the Eastern Cape. Recent research focuses on terrestrial molluscs and the collection is growing to address the gap in knowledge of this element of biodiversity. Mollusc collections in South Africa date to about 1900 and are an invaluable resource of morphological and genetic diversity, with associated spatial and temporal data. The South African National Biodiversity Institute is encouraging discovery and documentation to address gaps in knowledge, particularly of invertebrates. Museums are supported with grants for surveys, systematic studies and data mobilisation. The Department of Science and Innovation is investing in collections as irreplaceable research infrastructure through the Natural Science Collections Facility, whereby 16 institutions, including those holding mollusc collections, are assisted to achieve common targets and coordinated outputs.

Significance:

- Mollusc collections are among the oldest natural science collections in South Africa, dating from just before 1900. They provide an invaluable resource of morphological and genetic diversity, with associated spatial and temporal data. They are spread across the country in three comprehensive and seven smaller, thematic collections and this paper puts together available information about these scattered and diverse collections. Each has its own strengths and specialisations, and together they cater to a variety of the country's identified research priorities. Although staff complements are small, mollusc collections are well curated and conserved, expanding, actively researched and associated data are available online or on request.

Introduction

Mollusca is the second largest animal phylum with approximately 85 000 described species worldwide and just under 4000 in South Africa (approx. 75% marine, 20% terrestrial and 5% fresh water). Their range of size and body form is unparalleled – from minute species visible only microscopically to large forms of several hundred kilograms, such as the giant clam and colossal squid. Their importance to humans is as wide-ranging as their physical diversity: marine species are important as food, utensils, adornment and even currency; freshwater snails serve as intermediate hosts of platyhelminth parasites of significance to human and livestock health; land snails are both friend and foe, but are also pertinent to land-use planning due to their narrow-range endemism.¹

Mollusc collections are among the oldest natural science collections in South Africa and date to just before 1900; they are an invaluable resource of morphological and genetic diversity, with associated spatial and temporal data. They contribute material to address a variety of the country's identified research priorities. The taxonomy of many molluscan taxa is in need of revision, and a host of new species await description. An estimated 20–25% of the fauna remains to be described, based on numbers of described species^{1,2}, recently described taxa³ (see also Appendix 1) and current research. In addition, as marine material in our collections continues to be studied, Indo-Pacific species not yet recorded from South Africa are added to the species list. Opportunities and challenges facing mollusc collections reflect issues pertaining to all natural science collections and need to be seen in the context of systematics and other elements of biodiversity science in South Africa. With a growing emphasis on cultural heritage, only two museums have staff dedicated to mollusc collections, research capacity to unlock their wealth of information is limited and the total number of staff responsible for the country's mollusc collections is 19 (Table 1).

There are three major and several smaller mollusc collections at museums and universities spread across the country (Table 1). (No attempt was made to include any private collections.) The three major collections cover all taxa and regions, and have different strengths and specialisations, while the smaller collections focus on particular themes (Table 2). The KwaZulu-Natal Museum is the African centre of malacological reference and expertise. Here I collate and discuss available information about all the collections, from their inception to the present.

Material and methods

Formal questionnaires were not sent to institutions, but lists of questions were emailed to Curators and Collections Managers (Table 1) and dialogue ensued.



Table 1: South African mollusc collections: locations, administering authorities and size ranges (catalogued lots)

Institution's name, city, province and abbreviation	State authority administering the institution	Size range	Department	Number of staff who are responsible for any aspect of the mollusc collection	Information about collection supplied by
KwaZulu-Natal Museum, Pietermaritzburg, KwaZulu-Natal (KZNM)	National Department of Sports, Arts and Culture	150 000	Malacology	3 (dedicated), 1 shared	Igor Muratov (Curator), Linda Davis (Collections Manager, retired), John Midgley (Assistant Director: Natural Sciences)
South African Museum, Cape Town, Western Cape (SAM)	National Department of Sports, Arts and Culture	30 000	Marine Biology	4 and 1 3-year contract post	Wayne Florence (Head of Marine Biology), Albe Bosman (Collections Manager)
East London Museum, East London, Eastern Cape (ELM)	Provincial Department of Sport, Recreation, Arts and Culture	23 000	Malacology	1 (dedicated)	
Durban Natural Science Museum, Durban, KwaZulu-Natal (DNSM)	eThekweni Municipality, Libraries and Heritage Department	5000	'Orphan'	0	David Allan (Curator of Ornithology)
Albany Museum, Makhanda/ Grahamstown, Eastern Cape (AMG)	Provincial Department of Sport, Recreation, Arts and Culture	3500	Freshwater Invertebrates	2	Helen James, Musa Mlambo (both Curators of Freshwater Invertebrates)
South African Institute for Aquatic Biodiversity, Makhanda, Eastern Cape (SAIAB)	National Department of Science and Innovation: National Research Foundation	1500	Aquatic Biodiversity	2 and 1 part-time volunteer	Marek Lipinski (voluntary Curator), Roger Bills (Senior Curator), Willem Coetzer (Biodiversity Information Manager), Nkosinathi Mazungula (Collections Manager)
Port Elizabeth Museum, Port Elizabeth, Eastern Cape (PEM)	Provincial Department of Sport, Recreation, Arts and Culture	1400	Marine Biology	2	Malcolm Smale (retired Curator of Marine Biology), Greg Hofmeyr (Curator Marine Mammals)
McGregor Museum, Kimberley, Northern Cape (MMK)	Provincial Department of Sport, Recreation, Arts and Culture	1250	Zoology	1	Beryl Wilson, Head of Zoology Department
Wits Life Sciences Museum, Johannesburg, Gauteng (WLSM)	University of the Witwatersrand	905	Zoology	2	James Harrison (Curator)
Bartolomeu Dias Museum, Mossel Bay, Western Cape (BDSM)	Provincial Department of Sport, Recreation, Arts and Culture	2000	Malacology	1	Amanda Human (Malacologist)

Table 2: Taxon and regional specialisations of South African mollusc collections

Institution	Strength and/or specialisation
KwaZulu-Natal Museum	Marine molluscs of southern Africa and southwest Indian Ocean
	Terrestrial molluscs of South Africa
Iziko South African Museum	Early dredgings of South African continental shelf and slope
	Surveys of entire South African coast (intertidal to deep)
	Cephalopoda (largest collection in southern hemisphere)
East London Museum	Molluscs of Eastern Cape Province
	Terrestrial molluscs of South Africa
Durban Natural Science Museum	Marine molluscs of eastern South Africa (KwaZulu-Natal and Eastern Cape)
	Historical record of Durban area
Albany Museum	Freshwater molluscs of southern Africa
South African Institute for Aquatic Biodiversity	Cephalopoda (south and west coast of South Africa)
Port Elizabeth Museum	Cephalopoda beaks (mainly Indian, Atlantic and Southern Oceans)
McGregor Museum	Terrestrial molluscs of South Africa (marine collection not examined)
Wits Life Sciences Museum	Marine molluscs of Port Alfred and Jeffreys Bay, Eastern Cape

Results

Tables 3 and 4 contain a summary of the numbers of catalogued lots, specimens, types, species per habitat and geographic coverage of each collection, while Supplementary tables 1 and 2 contain statistics about taxon coverage and preparations. Where information was not supplied or the required detail could not be extracted, the collection has not been included in the particular table or the field(s) has been left blank.

KwaZulu-Natal Museum

The KwaZulu-Natal Museum (KZNM) is a national museum and holds the largest mollusc collection in Africa. This collection is one of the largest in the southern hemisphere, and in terms of its southern African holdings, is the largest in the world.³ There are approximately 150 000 catalogued lots, 2400 primary types, including 521 holotypes.⁴

History – Establishment

Amateur collector Henry Clifden Burnup (1852–1928) served as honorary curator from about 1897. This date is regarded as the beginning of the scientific study of molluscs at the then Natal Museum, and in South Africa as a whole.³ He built up the collection and much

of it was identified by foremost authorities of the day. Burnup was the first resident to publish on South African molluscs⁵, and produced five additional papers on terrestrial pulmonates.

Growth of the collection

The first professionally trained, salaried malacologist, A.C. van Bruggen, was appointed in 1962. He undertook collecting trips to distant areas of the country to augment the terrestrial mollusc collection and, after his departure to Leiden in 1966, continued to publish on South African snails. Richard Neil Kilburn (1942–2013) was appointed in 1969. Under his stewardship, the marine collection continued to grow steadily with the acquisition of several collections of regional importance including that of Rodney Wood (Mutare Museum) by exchange, and those of Clarice Connolly (largely South African), Kurt Grosch (northern Mozambique) and Eva Roscoe (Mozambique) by purchase.⁶ Rationalisation of natural history collections in South Africa and institutional specialisation led to the acquisition of the historically important collections of the then Transvaal Museum (Ditsong) and the Albany Museum in 1978 and 1980, respectively, and the creation of the second malacology research post, filled by David Guy Herbert in 1984.

Table 3: Numbers of catalogued lots, specimens, species and types in mollusc collections

Collection	Catalogued lots	Catalogued specimens	Approximate number of species	Primary types	Total types
KZNM	150 000	500 000 [†]	13 500 [†]	2399	3753
SAM	28 487	64 915	6800	583	940
ELM	22 815	127 987	4800	1	208
DNSM	5147	§	2300	0	0
AMGS	3555	not available	220	0	0
SAIAB	1077	1077	140	3	21
PEM	1363		>81	0	0
BDSM	2000	2000		0	0
MMK	1250			At least 2	
WLSM	905	15 640	905	0	0

[†]Estimate based on 3-4 specimens per lot

[‡]10 000 marine, 3500 non-marine

[§]Only 1529 lots indicate the number of specimens

Table 4: Habitat and geographic coverage of molluscs in collections

Collection	Number of lots	Number of lots per habitat					Proportion South African (%)
		Marine	Non-marine	Terrestrial	Freshwater	Estuarine	
KZNM	±150 000	113 206	29 497	23 171			58%
SAM	30 889	not available	not available				72%
ELM	22 815	15 580		5915	456	103	70%
DNSM	5147	4844		135	51		75%
AMG	3555	0	3555		3551	4	86%
SAIAB	1077	1077	0				At least 65%
PEM	1363	1363	0				Mainly South African
MMK	±1250	825	411				
WLSM	905	±905					Mainly South African
BDSM	2000						

It was mainly through fieldwork, both shore and ship based, that the marine collection was built up to its present status by Kilburn and Herbert. The highly successful Natal Museum Dredging Programme was initiated in 1981 with the aim of sampling the little-known faunas of the continental shelf and upper slope.³ Two of the most poorly investigated areas were targeted: the Transkei, which had never been dredged, followed by Zululand, and later the West Coast. For many known taxa, fresh material with bodies for anatomical investigation were preserved for the first time together with accurate depth, substratum and locality data. At least 27 malacologists in 12 countries worked on material from the Natal Museum Dredging Programme initially and described 164 new species and 18 supra-specific taxa.³ Revisionary papers on a range of families have been ongoing since then, published in the *Annals of the Natal Museum*, renamed *African Invertebrates*.

Research on terrestrial molluscs was renewed by Herbert in the mid-1990s and became a primary focus of research. A field guide to the land snails and slugs of eastern South Africa⁷ was published in 2004, the museum's centenary year.

Type holdings

The revision of types is ongoing^{4,8,9} and these publications include good-quality colour photographs. Over 200 types were photographed on request in the last 10 years, obviating the need to loan material.

Current status of collection and staffing

The intention for the two malacology posts was to have one marine and one terrestrial malacologist. Igor Muratov, appointed in 2009, works on continental molluscan faunas of sub-Saharan Africa. Elodie Heyns-Veale, appointed in 2019, has begun working on dredged samples. The post of Collections Manager of Mollusca is currently vacant; Linda Davis was appointed in 1991 and retired in 2020.

Cataloguing, digitisation and imaging

Specimens entering the collection are written in a catalogue register and given a catalogue number, then entered onto Specify and integrated into the collection. Tissue samples are linked to the catalogued specimens from which they were taken.

Radula slides are given their own number and are entered in the catalogue register and on the label of the specimen from which the radula was removed. Egg masses are kept with the specimen.

The collection is fully databased and has recently been migrated to Specify, but is not yet available online. Scientists or members of the public are granted access to information in the database and/or photographs of specimens by individual request. Photographs in the numerous publications by current and previous malacologists are linked to specimens in the collection by the catalogue number. However, specimens in the collection database are not linked to photographs in publications.

South African Museum

History – Establishment

The Iziko South African Museum (SAM) was founded in 1825. In 1897, the Museum moved to its present building in the historic Company's Garden. The collection became established in 1896, although South African molluscs from the Cape of Good Hope had made their way overseas for over 300 years.⁸ The SAM became the repository for large samples of all invertebrate taxa from early South African dredgings of the continental shelf and slope, beginning with the Government Fishery vessel, SS *Pieter Faure*, in 1897. Other sources of large quantities of molluscan and other marine invertebrate material were annual intertidal and shallow sub-tidal sampling of the entire coastline by the University of Cape Town Ecological Surveys, from the 1940s to about 1985, and Sea Fisheries Research Institute surveys which still take place under the banner of the Department of Environment, Forestry and Fisheries. The marine biology collections are focused on South Africa, extending into Angola, Mozambique and the Southern Ocean. The mollusc collection represents about one quarter of the total marine biology collection.

Growth of the collection

Among those individuals who made a significant contribution to the marine biology collections and research was Keppel Barnard (1887–1964), who was the first to deposit types in a South African institution. He was appointed in 1911 and retired in 1946 as Director (Florence W 2018, unpublished report). The first paper on South African marine molluscs by a resident was published in 1913 by Barnard¹⁰. A total of 593 mollusc collection records are attributed to him; he published 36 papers on molluscs and described 150 (valid) species.¹¹ Towards the end of his life, he mentored Brian Kensley (1944–2004) who also made an important contribution to the mollusc collections (over 550 lots) and to research. Other noteworthy contributors include Turton's collection of shells from Port Alfred during the 1920s¹², and Bill Liltved's contributions of over 900 lots.

The SAM contains the most comprehensive collection of southern African Polyplacophora and the wet collection of Cephalopoda is the largest in the southern hemisphere. Both assemblages date to about 1900. There are 17 specimens of giant squid (*Architeuthis dux*) – one of the largest collections in the world. The cephalopod collection is particularly important for Sepiidae and Ommastrephidae due to the work of Martina A. Roeleveld-Compagno (1943–2006). The southern African cephalopod fauna constitutes 20–30% of the world's species, so resolution of the many known systematic problems and undescribed taxa would contribute substantially to resolution at a global level.² Moreover, the sub-region includes at least 34 species of actual or potential commercial interest.² It is unfortunate that Roeleveld was not superseded, although Lipinski is working on Cephalopoda at the South African Institute for Aquatic Biodiversity (see below).

Nudibranchs are well represented and were one of Barnard's initial interests (see references in Gosliner¹³). Terence Gosliner added over 350 lots to the collection and continues to describe new species from South Africa.

The primary figure in terrestrial molluscan expertise was Matthew Connolly (1872–1947), a British soldier, sent to South Africa in 1900, and Henry Burnup became his mentor. In 1909, he presented a collection of South African land shells to the SAM and began publishing on the museum's non-marine mollusc collection. After World War I he became an honorary scientific worker in the then British Museum (Natural History). He soon became the foremost authority on southern African land and freshwater shells and published some 50 papers between 1910 and 1945. The majority of his holotypes are in the Natural History Museum. His most important publication was 'A monographic survey of South African non-marine Mollusca'¹⁴ which remains the most complete reference work on the subject⁴ and is still the only reference on several families. His publications on the non-marine Mollusca of other countries in southern Africa (Mozambique¹⁵ and Namibia¹⁶) remain the only reference works on terrestrial molluscs for those countries. Very few terrestrial molluscs have been added to the collection since Connolly's time; exceptions are paratypes of Western Cape endemics described by Sirgel^{17,18}.

Type holdings

The mollusc collection contains 936 types and 583 primary types.

Current status of collection and staffing

Towards the end of the 1990s, the SAM became just one of 11 institutions under the Iziko Museums of South Africa, an agency of the Department of Sports, Arts and Culture, and curatorship posts began to be frozen (Florence W 2018, unpublished report). The Curator of Marine Invertebrates is Wayne Florence, a bryozoan specialist. After a hiatus in collections management staff for the marine invertebrate collections, the staff complement has increased recently (Table 1). For the first time in over a decade, research is being conducted on Mollusca (Polyplacophora), by means of a 3-year postdoctoral contract. Another positive development is a huge building project to expand and upgrade storage, and the mollusc collections are currently being transferred to the new facility after being in storage since 2011. Mollusc material continues

to be deposited at the SAM following large national programmes such as demersal trawl surveys of the Department of Environment, Forestry and Fisheries, South African Environmental Observation Network sampling, and the SeaKeys programme (see below). Material is identified to family and catalogued. The SAM has always been the repository of such material, but has not consistently had a curator of molluscs throughout its history. It may be strategic to consider depositing mollusc material at the KZNM where expertise exists.

Cataloguing, digitisation and imaging

Material entering the museum is given an accession number and immediately entered onto Specify and then catalogued (only digitally).

A total of 290 types have been imaged (about 1000 images to show characteristic features). Other images also exist for specimens in the collection, e.g. 162 photographs of live nudibranch species. Images are not linked to specimen records in Specify.

East London Museum

History – Establishment and growth

The East London Museum (ELM) is a province-aided museum under the Department of Sport, Recreation, Arts and Culture. The collection was started with shells from Marjorie Courtenay-Latimer's family collections in the 1930s, and for 30 years she was the curator. The museum began to specialise in marine molluscs of the Eastern Cape in the early 1960s when the first curator, Denis Kennelly, was appointed part-time.¹⁹ He was followed in 1968 by Dick Kilburn who resigned when the post at the KZNM became vacant the following year. Kilburn did much to improve the scientific value of the collection, including starting the wet collection. During the next 20 years, the marine collection continued to grow under successive curators Maureen Latigan (local beached shells), Eva Roscoe (local and Mozambique species) and Sandra Muller (dredged and dived specimens).

Current status of collection and staffing

I was appointed in 1988 and am the first person to have served for more than just a few years. There are no other curatorial or technical staff in malacology or shared with other departments. There was an assistant for 10 years, Victor Mejane, who began his career at the ELM as a tourism student.

Recent research focuses on terrestrial molluscs – a previously neglected element of the biodiversity of the province. Collections-based research on terrestrial molluscs at the KZNM and ELM has produced several revisions and descriptions of 59 new species from South Africa (Appendix 1).

Type holdings

The ELM has a small type collection. Holotypes of species described by me are lodged at the KZNM with paratypes at ELM.

Cataloguing, digitisation and imaging

Specimens are catalogued in a written register and then entered onto Specify. Types are catalogued in a Type Register.

All catalogued lots have been digitised on Specify and this database was supplied to the South African National Biodiversity Institute (SANBI) so that the latter could make it publicly available together with other biodiversity data in South Africa (see below).

Photographs of specimens in publications or other associated photographs, e.g. habitats, are not linked to the specimens on Specify.

Durban Natural Science Museum

The shell collection of the Durban Natural Science Museum (DNSM) includes fine specimens donated by illustrious collectors. The DNSM collection contains the earliest date (1822) of a mollusc specimen in a South African collection. The first formal curator of the DNSM, J.F. Quekett, specialised in shells and he acquired many of the original specimens.²⁰ The collection is focused on the southeast coast of

South Africa – a region where extensive habitat destruction has taken place. Some 25% of the specimens are from the eThekweni (Durban) area including Durban Bay, and provide a valuable historical record of the fauna of this highly modified region where most of the natural habitat has been destroyed.

Albany Museum

Freshwater molluscs form a small component of the National Collection of Freshwater Organisms housed at the Albany Museum. The oldest record was collected in 1905. Between 1950 and 1970, the National Institute for Water Research of the Council for Scientific and Industrial Research undertook surveys of many South African rivers. This large collection was identified by local and overseas scientists and added to the Albany Museum. The collection is growing through an active programme of research as well as donations and voucher specimens from river surveys. Specimens are catalogued in written registers and then entered onto Specify. Most (86%) of the collection is South African. There are approximately 500 records from other African countries.

A freshwater mollusc collection stemming from academic and student research projects is housed at the Unit for Environmental Sciences and Management at North-West University. Despite repeated emails to three people, no replies were received, so no details can be reported on. It would therefore seem unlikely that any member of the scientific community or public would be able to access the collection or its data.

South African Institute for Aquatic Biodiversity

The South African Institute for Aquatic Biodiversity (SAIAB), where the National Fish Collection is held, received a donation in 2012 of an estimated 10 000 cephalopod specimens (Bills R 2019, written communication, September 20) from Sea Fisheries Research Institute demersal surveys on the *RS Africana* and *RS Dr Fridtjof Nansen* along the south and west coasts of South Africa. This collection potentially has as many types as the collection at SAM (Lipinski M 2019, written communication, September 19), but the majority of the collection is still uncatalogued. The voluntary curator, Marek Lipinski, assembled the collection while working for the Sea Fisheries Research Institute, and now visits SAIAB specifically to identify specimens. Data are entered onto Specify by SAIAB staff. No students are being trained in cephalopod taxonomy.

Port Elizabeth Museum

The Port Elizabeth Museum (PEM), a provincial museum under the Department of Sport, Recreation, Arts and Culture, holds a cephalopod beak collection assembled between 1975 and 2015 from stomachs of predators including cetaceans, seals, and cartilaginous and teleost fishes. The main focus of the collection was to support prey identification of apex predators – a major theme of PEM research since the 1970s. The collection has been cited in over 32 publications by M.J. Smale and co-workers. A fish otolith collection was built up concurrently. The squid beak collection is mainly South African with occasional material from nearby regions. Beaks from >81 species are represented, which is c. 42% of the known fauna of southern African. The collection also has a large number of vouchers that are not identified to species level, but are available for research.

The staff complement at the PEM is dwindling, and the number of natural science staff has shrunk from nine to three in recent years due to vacant posts not being filled. The retired curator of the squid beak collection is willing to assist as a Curator Emeritus and is actively publishing on the collection.

McGregor Museum, Kimberley

There is a small collection of marine and non-marine molluscs with separate written registers which appear to go back about 100 years. The collection has been dormant for many decades and was known only from the registers until about 10 years ago when it was rediscovered in locked cabinets (Wilson BA 2020, written communication, September 30). It contains type material¹⁴ and is a potentially valuable source of historic specimens and data.

Wits Life Sciences Museum

The Life Sciences Museum of the University of the Witwatersrand contains a collection of marine molluscs primarily from one source. The Edwin Knowles Jordan collection contains over 15 000 specimens of shells, representing 905 species, collected mainly at Port Alfred (about two thirds of the specimens) and Jeffreys Bay (about one third) over several decades around 1900. The collection also contains a few species from the former Transkei and a handful from Durban and from the Western Cape. Twenty-two species are labelled as rare.

Bartolomeu Dias Museum, Mossel Bay

This museum has a malacology department and collection originating from several small collections donated over the years and a limited amount of active collecting. The museum is well known for its extensive display of shells and aquariums of living specimens. The malacologist spends most of her time on management of the Shell Museum & Aquarium and research is not undertaken on the collection. There is a written register and a start has been made on an electronic register including photographs, but the majority of the specimens do not have provenance and are suitable for education only (Human A 2020, written communication, September 30).

Mollusc collections elsewhere in Africa

Collecting and study of natural history in Africa were historically conducted by overseas institutions. South Africa appears to be the only African country where some mollusc collections have dedicated staff and local collections are actively researched by local scientists who may deposit paratypes or other material in overseas institutions. The websites of the majority of museums outside South Africa do not supply any information about the museum's collections or staff. Information was gathered from Collections Managers (Table 5). No information about the possible existence of mollusc collections at museums in other southern African countries could be obtained, except for Mozambique which does

have a collection of mainly marine specimens at the National Museum of Maputo (Table 5). There is a written register dating to the mid-1900s, but it does not have catalogue numbers, and an electronic database with added numbering and photographs is in progress (Vetina A 2020, written communication, October 5). A collection was started in Antananarivo, Madagascar, following terrestrial surveys at several localities across the country from the mid-1990s, spearheaded by Kenneth Emberton and Owen Griffiths.²¹

The Global Taxonomic Initiative Africa Regional Workshop was held in South Africa in 2001 and represented 23 African countries.²² All national representatives indicated that major biological collections were kept in their countries, although only a few were reported to be electronically databased.²³ Staffing was inadequate and the number of taxonomists practising locally was insufficient to address biodiversity issues.²³ Building capacity in order to change this was identified as a priority.²²

Several projects had some successes in skills development and staffing posts for several years (Seddon M 2019, written communication, October 23), but few have been sustainable for mollusc collections. One exception is the Darwin Initiative (<http://www.darwininitiative.org.uk>) which supported research by Christine Ngereza at the National Museum of Tanzania and she now has a full-time post. Her PhD was supported by the German Research Foundation.²⁴ A malacology post was supported at the National Museum of Kenya, but there has been no dedicated curator of molluscs for 8 years and funds for the post have been redirected. A small proportion of the collection (59 records of 24 species of freshwater gastropods and bivalves) was digitised through a European Union Global Biodiversity Information Facility (GBIF) funding grant (<https://doi.org/10.15468/xt7aah>). The land snail team working out of the Naturalis Biodiversity Centre, Netherlands, also incorporated training into their programmes in West Africa; De Winter has published extensively but has not deposited any specimens in West Africa because there has not been a collection into which to deposit them (De Winter A 2019, written communication, September 19).

Table 5: Mollusc collections in African countries outside South Africa

Country and city	Institution's name	Department / collection	Information about collection supplied by	Size (Mollusca)	Taxon coverage	Cataloguing	Condition and growth
Kenya, Nairobi	National Museum of Kenya	Invertebrates	Laban Njoroge, Collections Manager of Invertebrates	115 000 specimens	All families, African	No register, data on specimen labels	Good, approximately 10 specimens per annum
Tanzania, Dar es Salaam	National Museum of Tanzania	Invertebrates (mainly Mollusca)	Christine Ngereza, Curator of Invertebrates	25 670 lots	All families	Written register	Good, growing
Mozambique, Maputo	National Museum of Mozambique	Invertebrates	Alvaro Vetina, Curator of Invertebrates	"Small"	All families, Mozambique	Written register and electronic database	Good, growing
Morocco, Marrakech	L'Institut Scientifique de Rabat (ISR)	National Museum of Natural History	Dirk van Damme, University of Ghent		All families		
Morocco, Marrakech	Faculté de Sciences Semlalia	Hydrobiological Laboratory	Dirk van Damme		Stygobiont Hydrobiidae		
Morocco, Tetouan	Abdelmalek Essaadi University	Saoud Collection	Dirk van Damme		All families		
Egypt, Cairo	Egyptian Environmental Affairs Agency	National Biodiversity Unit	Dirk van Damme		Freshwater Mollusca		
Madagascar, Antananarivo	Botanical and Zoological Gardens, Tsimbazaza	Museum	Hajanirina Ramino, Curator	153 lots, 117 species	Terrestrial Mollusca	Written and typed	

Surveys of snails of many forests in Nigeria have been published, but the papers do not state where the collections have been deposited. Specimens from Omo Forest²⁵ were photographed at KZNM and deposited there (Muratov IV 2019, written communication, September 27).

In relation to its low diversity (366 species of freshwater gastropods²⁶ and 117 species of bivalves²⁷), the freshwater mollusc fauna of the Afrotropical region has received disproportionate research attention, mainly by European and American scientists, but the majority of material is deposited in collections outside Africa. Some material has been deposited in collections in north Africa following local studies (Table 5), the most important being the collection at L'Institut Scientifique de Rabat, which includes historic material collected by Pallary, Pérès and Bédé (van Damme D 2020, written communication, March 4). There are also small collections at El Kala, Algeria and the University of Lubumbashi, Democratic Republic of the Congo (van Damme D 2020, written communication, March 4).

Discussion

Mollusc collections within the context of natural science collections in South Africa

Towards the end of the 1990s there was widespread concern that systematics was in decline in terms of capacity and resources.²⁸⁻³⁰ Needs, priorities and actions for zoological, plant and marine systematics were formalised³¹⁻³³ and audits of herbaria and zoological collections were undertaken^{34,35}. The South African Society of Systematic Biology was formed³⁶ and contributed to the development of the South African Biosystematics Initiative, funded by the then national Department of Science and Technology. KZNM malacologist Dai Herbert was at the forefront of this initiative. There was a call for a coordinated national body to provide focus and leadership for fundamental biodiversity research.³⁰

The *National Environmental Management: Biodiversity Act, No. 10 of 2004* led to the establishment and functions of SANBI (<http://www.info.gov.za/acts/2004/a10-04>). The mandate of SANBI includes responsibilities to coordinate and promote the taxonomy of South Africa's biodiversity and facilitate access to biodiversity data (<https://www.sanbi.org/biodiversity/>). An assessment of the state and needs of biological collections and expertise was commissioned in 2008 by the National Research Foundation. While there were pockets of excellence, the collections were under-resourced and not used to their full potential, with many at risk of deterioration or even loss, and a relatively small proportion of the data from collections was accessible.^{37,38}

Strategy documents for animal and plant taxonomy were released to address the taxonomic impediment to the sound management of biodiversity.³⁹⁻⁴¹ The Foundational Biodiversity Information Programme (FBIP) was initiated in 2013 to support integrated projects that generate and disseminate foundational biodiversity information. Over 144 small projects have been supported to date, including the migration of the

malacology database of the ELM to Specify. Six large projects have been supported: five for terrestrial biodiversity and one for marine biodiversity. The latter, SeaKeys, has led to the publication of over 113 000 records on GBIF (containing fish and invertebrates) including several historic data sets dating to 1884 (Pauw L 2021, written communication, July 13). Further outcomes of SeaKeys pertaining to molluscs are a field guide to offshore marine invertebrates⁴² and two Citizen Science projects, a Sea Slug Atlas and a Sea Shell Atlas. One of the two large terrestrial FBIP projects on forest fragmentation in the Eastern Cape included surveys of molluscs, incorporation in the ELM collection (282 catalogued lots) and 368 barcodes of 47 species. To date, 24 publications have emanated from this FBIP project, including records in the revision of an endemic mollusc genus.⁴³ Data from this and all the other projects will be published on the FBIP website and GBIF as soon as the data sets have been verified (Pauw L 2020, written communication, January 27).

Recent policies and programmes demonstrate that taxonomy has been re-energised and firmly incorporated into the mainstream of science policy. There have been responses to the calls of 20 years ago for increased infrastructural support and funding for collections and systematics, including the training of more taxonomists and systematists. However, a concern expressed over a decade ago²³, and which remains a shortfall in capacity-building, is the emphasis placed on molecular phylogenetic analysis and the neglect of morphological taxonomy.

The Department of Science and Innovation is investing in collections through the Natural Science Collections Facility, one of thirteen South African Research Infrastructure Roadmap projects⁴⁴, in recognition that the natural science collections of the country are irreplaceable research infrastructure, spread across museums and other institutions (Hamer M 2016, unpublished report). The overall aim of the Natural Science Collections Facility is to ensure that collections and associated data are used for high-quality research and decision-making to address issues of national and global relevance. Participating institutions are assisted to achieve common targets and coordinated outputs including excellence in care of collections, data mobilisation, and collections-based research. All institutions (except Bartolomeu Dias Museum) holding mollusc collections are participants, and are therefore supported by the Natural Science Collections Facility.

The ecological and economic importance of specimen collections can only be fully assessed and harnessed if the data are accessible in meaningful and comparable ways and data mining is greatly enhanced by unified collection portals such as GBIF⁴⁵ and iDigBio⁴⁶. Currently, SANBI publishes data on behalf of several South African institutions to GBIF. Through the Natural Science Collections Facility and SANBI's National Biodiversity Information System, progress is being made towards upgrading and expanding collection databases and making these openly accessible in an integrated way, using Darwin Core⁴⁷ as the data standard (Table 6).

Table 6: Digitisation and data accessibility of mollusc collections (lots)

Collection	Catalogued lots	Digitised lots	% digitised lots georeferenced	% on GBIF	Data searchable online or by request
KZNM	150 000	143 887	100		Request
SAM	30 889	30 889	31	30	Request
ELM	22 815	22 815	100	90	Online
DNSM	5147	5147	0		Request
AMG	3555	3555	93	100	Online
SAIAB	1077	1077	69	100	Online
PEM	1363	1363	Not supplied		Request
MMK	1250	0	0	0	
WLSM	905	0	0	0	

Some museums are in the process of setting up their own Integrated Publishing Toolkit and will be publishing their records directly to GBIF, and are setting up online access to their records via their own websites. The Natural Science Collections Facility is developing an online Virtual Museum, with images of type specimens, specimen data and archival documents.

A major stumbling block to long-term security and effective use of collections is the fragmentation of governance, and the inappropriate placement of the natural science collections under national and provincial departments of sports, arts and culture (Table 1) which have no mandate for the curation of biological collections.^{38,39} This could overturn the progress made over the past two decades to save and improve conditions for collections and taxonomic research. Because staff complements are small (Table 1), and replacement of staff who retire or resign is erratic, the loss of even a single staff member could leave a collection neglected and unused. Consolidation of collections at larger institutions has been proposed³⁸ and, where there is willingness, suggestions to send 'orphan' collections to institutions with a curator for that taxon. This may be strategic for a few of the smaller, but scientifically very important, mollusc collections.

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Competing interests

I have no competing interests to declare.

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Appendix 1: Recently described molluscan taxa

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