

The herpetofauna of the offshore islands of South Africa and Namibia

by

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ABSTRACT

The herpetofauna of the continental offshore islands of South Africa and Namibia is reviewed. Historical and recent records are discussed and the origin and affinities of the herpetofauna are considered. A total of 23 species has been recorded from 11 islands. The greatest diversity (16 species) occurs on the largest island, Robben Island in Table Bay. The commonest island species are *Phyllodactylus porphyreus* (seven islands) and *Cordylus cordylus* (four islands). All of the islands have rocky coastlines and are unsuitable for nesting sea turtles.

The islands have been affected to different degrees by sea-level fluctuations associated with periods of glaciation. All were connected to the mainland during the last Glacial Maximum (16 000 BP). Human disturbance has occurred on all the islands and many species have been introduced. A number of islands have relict populations of some species, and these probably date from the time when the islands were connected to the mainland. No significant correlation exists between species richness and an island's size or its distance from the mainland. This is attributed to the relatively small size of the islands, their depauperate herpetofaunas, and the habitat requirements of the species. The spotted gecko *Pachydactylus maculatus* grows to a much larger size on St Croix Island than on the adjacent mainland but gigantism does not occur in reptile populations on other islands.

INTRODUCTION

The continental shelf of southern Africa includes a total of 69 small rocky islets and offshore islands (Skead, 1975). These range in size from small, wave-swept rocks that harbour a few resting seals or seabirds to the large and well-vegetated Robben Island that has been colonised for many years, albeit unwillingly, by the many inmates of the old leper colony, insane asylum and penal settlement (De Villiers, 1971). Almost all the islands are small and uninhabited. Only two islands exceed 100 hectares in size. Most were periodically visited by early settlers and seamen who came to collect food, skins and oil from the prolific colonies of seals and seabirds. Nowadays all of the islands are protected although accumulated guano is still harvested from some, particularly those along the Namibian coast. The larger islands (Robben, Dassen, Dyer and Bird islands) have lighthouses, some of which are now automated and require only periodic visits for maintenance. Human disturbance occurs regularly on most islands and some are permanently inhabited.

The islands may be conveniently grouped; those of Algoa Bay in the Eastern Cape (St Croix and Bird islands); those of the southwestern Cape (Robben and Dassen islands, and those associated with Saldanha Bay, i.e. Marcus, Malgas, Jutten, Meeuw and Schaapen islands); and those along the Namibian coast near Lüderitz Bay (Pomona and Possession islands). More isolated is Dyer Island, situated off the Bredasdorp coast, southern Cape. All the islands are situated on the continental shelf and have been affected by sea level changes during periods of glaciation. During the last Glacial Maximum (16 000 BP) sea levels were very low (approximately -130 m) and during this period all of the present islands along the southern African coast would have been joined to the mainland (Tankard, 1976). With the onset of warmer climates and the subsequent rise in sea level, the islands became progressively cut off from the mainland. Some very low-lying islands may have been affected by a brief and slight rise (3m) in sea-levels 2 000 BP during the last climatic optimum or hypsithermal (Flemming, 1977).

Variation in species richness of the major islands of the southwestern Cape has been analysed by Brooke and Crowe (1982). Alien species on all South African offshore islands have been reviewed by Brooke and Prins (1986) and Cooper and Brooke (1986). Although these authors list a number of reptiles from some islands, they do not comprehensively review old records (Brooke and Crowe, 1982, state explicitly that they have not consulted literature prior to 1971). The present account is the first detailed review of the herpetofauna of these islands and the first to consider origins and affinities.

The historical references derive mainly from Skead (1975). Recent literature was reviewed for references to reptiles and amphibians on the islands. Specimens from the islands housed in

the major herpetological collections in South Africa were recorded (see appendix for acronyms and catalogue numbers); other records, where noted in the literature, are given. Searches for reptiles and amphibians were made during trips by the author to a number of the major islands: Dassen Island, 4–10 April 1987 and 4 November 1988; Bird Island (Algoa Bay), 22–26 May 1980; St Croix Island (Algoa Bay), 7 July 1979 and 22 March 1989.

Historical and recent records of island species were assessed and compared to determine which were likely to represent introductions and which represent naturally occurring species. The latter may have reached the islands through rafting or may be relict populations from periods of sea-level fluctuations.

HERPETOFAUNA OF THE OFFSHORE ISLANDS

The geographical situations of the islands discussed are shown in Fig. 1, and the reptiles and amphibians recorded from the islands are listed in Table 1. Specific details for the islands and their recorded herpetofauna are given, prefaced by a short note on the marine reptiles found in the coastal waters of southern Africa.

A number of sea turtles (Hughes, 1974a and b) and a single sea snake occur. The yellow-bellied sea snake *Pelamis platurus* is common in Algoa Bay (PEM R 13, 61, 1128, 1130–31, 1492, 2360), and there are sporadic records along the southern Cape coast as far as False Bay (Broadley, 1983). However, the species is excluded from the Atlantic Ocean by the cold Benguela Current that sweeps up the western Cape coast, bringing cold Antarctic waters close inshore. Although green sea turtles have recently been reported to bask on desolate beaches near the Cunene River mouth in northern Namibia (Tarr, 1989), the steep rocky shoreline of most of the southern African offshore islands precludes sea turtles from beaching. The shoreline of Bird Island is less steep but still rocky, although sea turtles do forage close inshore. A large (carapace length approximately 1 m) loggerhead sea turtle, *Caretta caretta*, was caught by a fisherman using squid bait from the Bird Island jetty on 24 May 1980, but was subsequently released (Branch, pers. obs.). None of the islands has sandy beaches suitable for nesting sea turtles, even though two species, *Caretta caretta* and *Dermochelys coriacea*, nest in northern Natal (Hughes, 1974a,b) and occasionally further south (Branch, 1988a). The only sea turtle record for any offshore island is a single hawksbill turtle, *Eretmochelys imbricata*, shell recorded from the beach of Dyer Island. The specimen was initially catalogued from Dassen Island but this was later corrected to Dyer Island. This is more likely in view of the cold Benguela Current on the west Cape coast.

St Croix Island, Algoa Bay (33° 48'S, 25° 46'E; 625 m × 250 m, 2.5 ha, 3.9 km from coast, 59.4 m a.s.l., not manned; Fig. 2.)

Hewitt (1920) noted that the common girdled lizard, *Cordylus cordylus*, was abundant on the island and presumed this to be due to the absence of predation by kestrels. He also noted that they were smaller, had narrower heads, and as adults lacked the bright brick-red colours of Grahamstown specimens. During a brief (3 hr) visit to the island by the author (21 March 1989), many *Cordylus cordylus* were seen basking on rocks or foraging around penguin nests (Fig. 3). The island is home to a major breeding colony of the Jackass penguin, *Spheniscus demersus*, and has a resident population of 13–18 000 individuals. Nine lizards were caught, weighed and measured. Numerous other specimens were seen, a number of which were slightly larger than any captured. The largest lizards measured (male, snout-vent (SV) 70 mm, tail 70 mm, weight

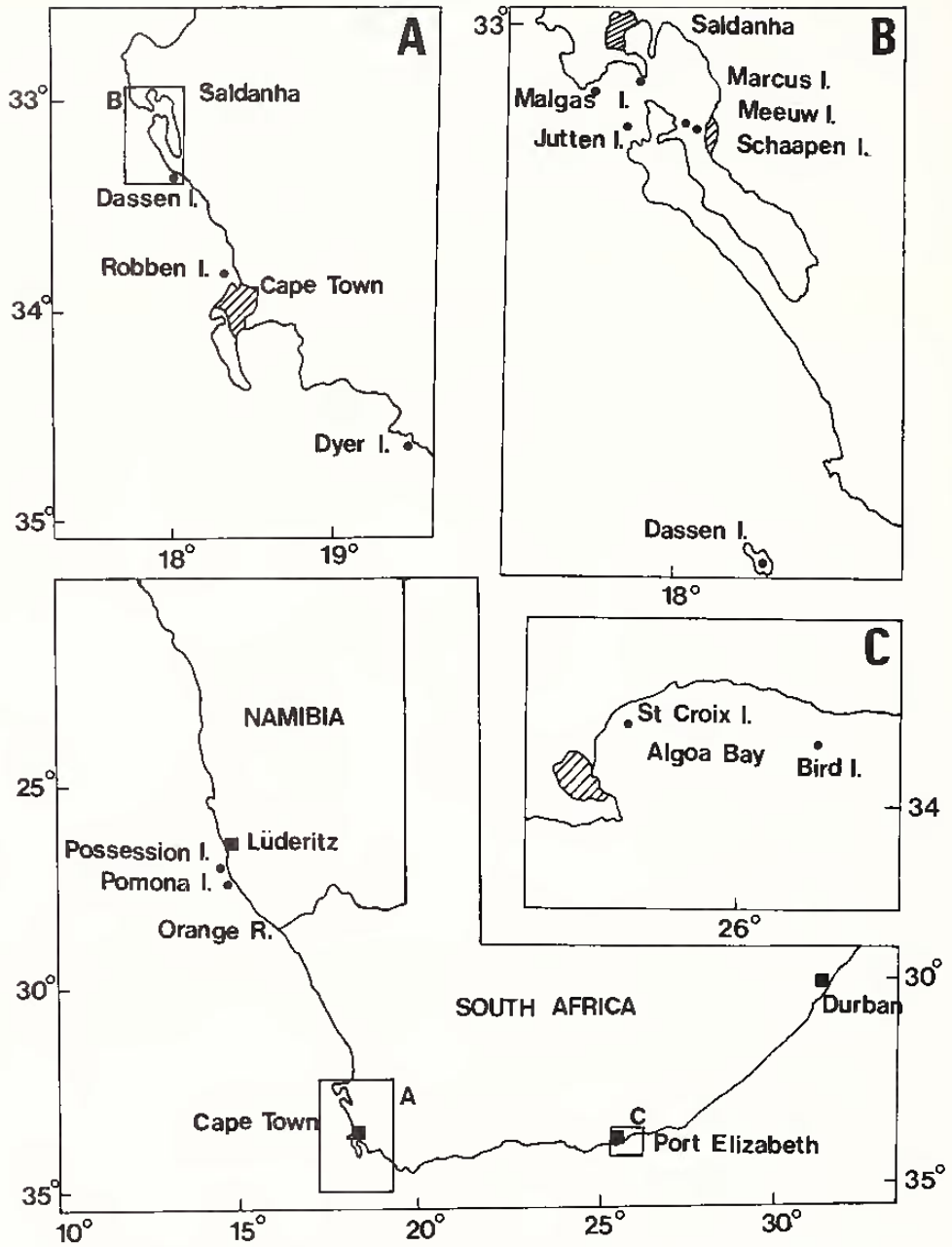


Fig. 1. Geographical location of the offshore islands of South Africa and Namibia.

BRANCH: HERPETOFAUNA OF OFFSHORE ISLANDS OF SOUTH AFRICA AND NAMIBIA

TABLE 1.

Herpetofauna of the offshore islands of South Africa and Namibia

SPECIES	SOUTH AFRICAN AND NAMIBIAN OFFSHORE ISLANDS											TOTAL
	1	2	3	4	5	6	7	8	9	10	11	
Size of island (ha)	507	222	41	7	11	9	46	20	2.5	3	90	
Distance from coast (km)	6.7	9	0.5	0.14	1.2	0.8	0.8	7	3.9	0.2	2.7	
Human habitation	*	*			*	*	*	*			*	7
Amphibians												
<i>Strongylopus grayii</i>	*											1
<i>Breviceps rosei</i>	*											1(?)
Reptiles												
Snakes												
<i>Pseudaspis cana</i>	*											1
<i>Lamprophis inornatus</i>	*											1
<i>Lycodonomorphus rufulus</i>	*											1
<i>Aspidelaps lubricus</i>										?		1(?)
Lizards												
Gekkonidae												
<i>Phyllodactylus porphyreus</i>	*	*	*	*	*	*	*					7
<i>Phyllodactylus lineatus</i>			*	*								2
<i>Pachydactylus maculatus</i>									*			1
<i>Pachydactylus geitje</i>	*											1
Chamaeleonidae												
<i>Bradypodion pumilum</i>	*											1
Agamidae												
<i>Agama atra</i>		?										1(?)
Scincidae												
<i>Mabuya capensis</i>	*		*					*				3
<i>Mabuya homalocephala</i>	*											1
<i>Scelotes bipes</i>	*											1
<i>Scelotes gronovii</i>	?	*	*	*								3(4?)
<i>Acontias meleagris</i>	*		*				*					3
Cordylidae												
<i>Cordylus cordylus</i>	*		*				*		*			4
<i>Tetradactylus seps</i>	*											1
Chelonians												
<i>Eretmochelys imbricata</i>								*				1
<i>Chersina angulata</i>	*	*						*			*	4
<i>Geochelone pardalis</i>	*											1
<i>Pelomedusa subrufa</i>											?	1(?)
TOTAL (excluding doubtful records)	16	3	6	3	1	1	3	3	2	0	1	
Southwestern Cape	1, Robben Is; 2, Dassen Is.; 3, Schaapen Is., 4, Meeuw Is., 5, Marcus Is.; 6, Malgas Is., 7, Jutten Is., 8, Dyer Is.											
Algoa Bay	9, St Croix Is.											
Namibia	10, Pomona Is.; 11, Possession Is.											



Fig. 2. St Croix Island, Algoa Bay, South Africa.

11.7 g; female SV 72 mm, tail 74 mm, weight 11.5 g) were not significantly smaller than specimens on the adjacent mainland (Branch, unpubl. obs.). They are a dull dark brown in coloration. Their relationship to typical *Cordylus cordylus* and to the more arboreal, closely-related species *Cordylus tasmani*, which is endemic to the Valley Bushveld thicket of the adjacent Algoa Basin, needs to be investigated further. Pending the results of such a study, the population on St Croix is provisionally referred to typical *Cordylus cordylus*.

Hewitt (1920) also recorded the spotted gecko, *Pachydactylus maculatus*, from the island, noting that it was less abundant than the girdled lizard. During a visit to the island (22 March 1989) the author found six geckos sheltering among stone piles on the barren island. Two were recent hatchlings. The other four were adult females and were very large and had short, regenerated tails (snout-vent 55–60 mm, mean 58.00 mm; tail 27–31 mm, mean 29.25 mm; weight 7.19–7.53 g, mean 7.32 g). Eight preserved specimens, three females and five males, from the island support these findings. The females all measure over 50 mm SV (50–56 mm) and the males range from 38–53 mm SV. In a study of the spotted gecko on the adjacent mainland 253 specimens were weighed and measured. Females grew larger than males: largest male, SV 41 mm, weight 2.6 g; largest female, SV 42 mm, weight 3.1 g. Even the largest mainland female weighs less than half that of the smallest St Croix female, and the size of males is also much smaller. These results demonstrate that the geckos on St Croix grow substantially larger than on the adjacent mainland. Whether this is due to reduced predation or abundant food is unknown.

Of the six live geckos collected all but the smallest hatchling had regenerated tails. Similarly all eight preserved geckos have regenerated tails. The incidence of regenerated tails on the island is therefore very high (91.67%). Tail regeneration frequency on the mainland was found



Fig. 3. The common girdled lizard *Cordylus cordylus* foraging among nesting Jackass penguins on St Croix Island, Algoa Bay, South Africa.

to be dependent upon age. All geckos over 40 mm SV had regenerated tails. Tail autotomy in geckos is usually considered to serve as an antipredator device although tail-loss may occur for other reasons (Arnold, 1988). Some geckos on the mainland were observed to undergo 3–4 tail regenerations; a principal predator was found to be the Natal hunting spider, *Palystes natalius* (Branch, unpublished data). Snakes are also often considered to be major predators of lizards. The potential efficacy of tail autotomy was noted when a spotted skaapsteker, *Psammophylax rhombeatus* was found to contain a complete spotted gecko and the autotomised tail of another spotted gecko (Branch and Braack, 1987). The cause of the high frequency of tail loss in spotted geckos from St Croix is unknown as the normal predators (snakes, viverids, large spiders, etc.)



Fig. 4. Size difference between populations of the spotted thick-toed gecko, *Pachydactylus maculatus*, from St Croix Island, Algoa Bay (right), and the adjacent mainland (left).

are absent from the island. Penguins, which were observed to peck at girdled lizards that came to close to their nests, may be responsible for some tail loss. Whether the nocturnal spotted gecko is treated in the same manner is unknown. Intra-specific fighting may also be responsible for some tail loss but it is unlikely to be solely responsible for the high percentage observed.

Bird Island, Algoa Bay (33° 51'S, 26° 17'E; 548 m × 320 m, 19 ha, 8.4 km from coast, 9.1 m a.s.l., manned)

No early visits to the island mention the presence of reptiles on the island (Skead, 1975) and Hewitt (1937) observed that "On Bird Island there are no reptiles whatever". However, Rand (1963) stated "... lizards, tortoises and occasionally snakes are found here too". There are no preserved voucher specimens in any museum collection to validate this claim. Jordan, ex-lighthouse keeper on Bird Island, 5 Dec 1951—24 Jan 1953, records (*in litt.* Skead, April 1971) that "There were lizards on the island, also one tortoise, small type. My children collected a few on my brother-in-law's farm and took them over for company for him. There were no snakes ... There were also a few frogs, mainly brought over with our vegetables ... my brother-in-law ... used to dig out cabbages, carrots ... [etc.] ... intact and we used to replant them on Bird Island". The identity and the fate of these animals are unknown. The Port Elizabeth Museum has had an active research program studying the gannet population on the island for the last ten years. During this period, of almost monthly visits, no reptiles or amphibians have been discovered living on the island. In 1981, an angulate tortoise was found freshly dead on the shore of Bird Island (A. Batchelor, pers. comm.) following heavy rain on the

mainland. The old records noted by Rand (1963) can either be discounted or they document temporary colonizations that have subsequently died out.

Dyer Island, Southern Cape (34° 40'S, 19° 25'E, 731 m × 180 m, 20 ha, 3.5 km offshore, 6 m a.s.l., manned)

Brooke and Crowe (1982) record the Cape skink *Mabuya capensis* and the angulate tortoise *Chersina angulata* from the island but give no further details. Symons (1924) visited the islands to collect bird eggs but records no observations of tortoises, suggesting that these introductions may have occurred recently, perhaps in a similar manner to that noted above and by Haacke (1965) for Possession Island (see below).

Robben Island, South-western Cape (33° 49'S, 18° 22'E; 4 km × 2 km, 507 hec., 7 km from land, 30 m a.s.l, colonised since 1652)

Robben Island is the largest South African offshore island and also the closest to Cape Town which was one of the first areas on the subcontinent to be settled by Europeans. It has been continuously inhabited since 1652 and has been substantially altered by more than 300 years of human occupation. In the 19–20th century it was used as a leper colony and insane asylum (both of which have now been closed). It has been used as a penal colony from the earliest days (Thunberg, 1793, notes that "criminals [are] exiled there"). At present access to the island and possibilities for biological surveys there are restricted.

Amphibians

Robben Island is the only offshore island from which an amphibian has been recorded (i.e. the spotted stream frog, *Strongylopus grayii*) (Rose, 1950). The species was recently confirmed to be present at the old quarry (Baard, *et al.*, 1986). This, the only permanent source of freshwater on the island, dates from the settlement established by Van Riebeeck in 1652. Due to their intolerance of salt water amphibians do not easily colonise off-shore islands. However, *S. grayii* is common in the southern Cape coastal regions and can be found breeding in pools of freshwater in the dune slacks. It is probable that the species was introduced to Robben Island by man, possibly in a manner similar to that noted for frogs to Bird Island in Algoa Bay (see above). That the spotted stream frog can be successfully translocated is shown by its introduction to St Helena in the middle of the Atlantic Ocean (Frost, 1985).

The absence of standing fresh water need not preclude all amphibians, development in some terrestrial species being direct. Such a reproductive mode is characteristic of rain frogs (*Breviceps* spp.), which are common in the Cape coastal region. Poynton (1964) records Rose's rain frog (*Breviceps rosei*), a species restricted to the sandveld of the western Cape coastal foreland where it may be locally common, from the island. This record is based on three specimens in the South African Museum. It should be noted that these specimens and that of the olive water snake from Robben Island (see below) were donated (collected ?) by Rev. G. Fisk and accessioned into the SAM collection between 1895 and 1896. Boulenger (1910) does not record any amphibians from Robben Island and furthermore no recent collections of *B. rosei* confirm the presence of the species on the island.

Reptiles

Numerous reptiles have been recorded from the island but it is difficult to determine which species have been introduced during the period of human settlement. However, early records do give some idea of the island's relatively diverse herpetofauna before European settlement. The

indigenous Khoisan population did not use boats at sea and there is no evidence that they visited any of the offshore islands. They were thus not responsible for herpetological introductions.

SNAKES

The earliest references note the presence of snakes on Robben Island:

1610 "Upon the Illand be . . . [an] abundance of great snakes lying upon the ground against the Sune . . ."—Thomas Best (in Raven-Hart, 1967).

1614 ". . . the illande is very full of Snakes . . ."—Nicholas Downton (in Raven-Hart, 1967)

1615 ". . . there are a very great number of snakes in that island . . . , so many of them venomous worms that a man cannot tread safely in the long grass which grows in it for fear of them . . ."—Edward Terret (in Raven-Hart, 1967)

Such is the universal fear of snakes that soon attempts were made to eradicate them from the island.

1638". . . the blacks while there had destroyed almost all the penguins and the snakes."—Arthur Gijssels (in Raven-Hart, 1967)

1654 ". . . there are snakes which we notice do them (i.e. the sheep) no harm, and of these our men are instructed to exterminate as many as possible"—Van Riebeeck (in Thom, 1952–1958)

1658 "You must make every effort to destroy the numerous snakes during periods of idleness, so that the island may once and for all be cleared of these poisonous vermin."—Van Riebeeck (in Thom, 1952–1958)

That these attempts were unsuccessful is indicated by Le Vaillant's comment in 1782 quoted by Skead (1975) that he had

". . . seen here a great many black serpents four feet (1.21 m) in length but they are not venomous . . ."

More recently Siegfried (*in litt.* Skead, November 1965) noted that when the Cape Department of Nature Conservation wanted mole snakes to restock the Cape Peninsula in order to control small rodents they "took gangs of men over to Robben Island and found a mole snake under every pile of rubbish they turned up."

The first identifications of snake species from the island, based on specimens housed in the South African Museum, are by Boulenger (1910). He records the brown water snake *Lycodonomorphus rufulus* and the olive house snake *Lamprophis inornatus*. FitzSimons (1962) repeats these records and also includes the mole snake *Pseudaspis cana*. It is surprising that Boulenger did not document this large, non-venomous colubrid as it fits best the early descriptions of snakes on the island (e.g. 'great size', 'black'). Specimens from the western Cape populations of this impressive snake are often a uniform black and grow much larger than those from elsewhere (in excess of 2 m; Broadley, 1983). The mole snake was probably present before settlement by man. It is possible that the other species were also present but overlooked as both are small and nocturnal. Small mammals form the usual diet of the olive house snake although this species will also take small reptiles (Branch, 1988). The brown water snake feeds almost exclusively on frogs but may occasionally take fish and exceptionally geckos. Its existence on the island is probably dependent upon the presence of amphibian prey.

LIZARDS

Very early references note the presence of chamaeleons and other lizards on the island:
1620 "There are . . . also some chamaeleons and other lizards"—Augustin de Beaulieu (in Raven-Hart, 1967)

1773 "Now a resort of chamaeleons and quails."—Thunberg (in Skead, 1975).

Boulenger (1910) includes Robben Island as a locality for a number of lizards, based on specimens in the South African Museum, but gives no further information on their origin or details of their capture. These are:

Ocellated gecko, *Pachydactylus geitje* (as *P. ocellatus*)

Cape girdled lizard, *Cordylus cordylus cordylus* (as *Zonurus cordylus*)

Red-sided skink, *Mabuya homalocephala homalocephala*

Silvery dwarf burrowing skink, *Scelotes bipes*

Cape legless skink, *Acontias meleagris meleagris*

Short-legged seps, *Tetradactylus seps*

Rose (1926 and 1929) records a number of additional lizard species from the island, as well as giving notes on the above species:

Marbled leaf-toed gecko, *Phyllodactylus porphyreus*

" . . . very common . . . on Robben Island".

Ocellated gecko, *Pachydactylus geitje* (as *P. ocellatus*).

" . . . may be seen in very large numbers on Robben Island",

" . . . closely associated with *Zonurus cordylus*, *Phyllodactylus porphyreus* and *Acontias meleagris*."

Cape girdled lizard, *Cordylus cordylus cordylus*

"On Robben Island yellow-brown ones (flavus) are extremely numerous in the stone heaps . . . but no black ones (niger) were seen."

Silvery dwarf burrowing skink, *Scelotes bipes*

"A specimen we obtained from Robben Island produced two active young . . . during . . . March."

Cape legless skink, *Acontias meleagris*

"On Robben Island it is particularly abundant and we once obtained nine specimens in little over an hour by turning over large stones by the side of the road that skirts the island."

FitzSimons (1943) records most of these species and adds the Cape dwarf chamaeleon, *Bradypodion pumilum* (as *Microsaura pumila pumila*), based on a specimen in the Albany Museum.

Baard *et al.* (1986) in a recent survey of the island confirm the presence of eight of the above species, including the mole snake, and also document the presence of the Cape skink *Mabuya capensis* (two were preserved and nine others observed). As the survey occurred during the dry summer, the presence of other amphibian species on the island could not be determined.

Bustard (1963) records reproduction in 50 captive ocellated geckos received from Robben Island. Mouton (1987) discusses the relictual distribution of melanistic girdled lizards, *Cordylus cordylus*, in the southwestern Cape and confirms Rose's record of the typical form on Robben Island and the presence of the melanistic *C. c. niger* on Jutten Island and Schaapen Island in the Saldanha Bay area. Mouton *et al.* (1987) include Robben Island as a locality for *Scelotes gronovii*

prior to 1978 but give no further indication of the provenance of this record and exclude it from their present distribution map. The record is repeated in Baard (1988). It is based on a specimen in the Transvaal Museum the identity of which has been confirmed (W. Haacke, pers. comm.). The species is not known from the adjacent mainland and may either be mis-labelled or represent a northern retraction of the species' range following separation of the island from the mainland. During a recent search on the island the only fossorial skinks found were *Scelotes bipes* and *Acontias meleagris* (Baard, pers. comm.). Further searches on the island are required to resolve the issue.

CHELONIANS

Tortoises are mentioned in the earliest references to Robben Island:

1503 "On this island they killed many birds, . . . and sea wolves and tortoises, of which there is great abundance."—Antonio da Saldanha (in Raven-Hart, 1967).

These have not been discussed by recent authors (Skead, 1975). It is probable that they are the angulate tortoise. The presence of the angulate tortoise on the island was confirmed by Baard *et al.* (1986). As in many other places in the south-western Cape, the leopard tortoise *Geochelone pardalis* has been introduced to Robben Island. D'Ewes (1967) noted that in 1959 a police launch had discovered an adult leopard tortoise swimming in the sea "a couple of miles offshore from Robben Island, and swimming strongly for the mainland." Skead (1975) has traced the origin of this specimen to one of 25 tortoises taken to the island from the Paarl Roller Flour Mills (now SASKO) in 1959. They had been kept as pets by workers at the mill, and were disposed of to Robben Island (C. W. van der Westhuizen *in litt.* Skead, 3.3.1971). This species was not present during the survey of Baard *et al.* (1986).

Dassen Island, Southwestern Cape (33° 26'S, 18° 05'E; 2.5 km × 1.05 km, 222 ha, 9 km offshore, 19 m a.s.l, manned)

Records of early visits to the island note the abundance of wildlife, e.g. both Sir Edward Michelbourne, 1601 (in Raven-Hart, 1967) and Van Riebeeck, 1652 (in Thom, 1952–8) comment on the "unbelievable multitude of seals, black birds (cormorants) and penguins.". They also noted the presence of a 'rabbit'; in fact the rock hyrax or dassie *Procavia capensis*. The island's early name, i.e. Cony Island, and its present name are based on the presence of this species on the island. They were later eradicated and were replaced with the European rabbit *Oryctolagus cuniculus* which was introduced as food late in the administration of the Cape by Van Riebeeck (1652–1662). There are no early records of any reptiles or amphibians. Four reptile species have been reported in recent years although only three are recently confirmed.

Boulenger (1910) includes Dassen Island as a locality for *Agama atra* and *Scelotes gronovii*, based on specimens in the South African Museum but he gives no further information on the specimens. FitzSimons (1943) repeats the record for the rock agama but with no further documentation or proof that a viable population existed on the island. These rock-living, diurnal, and brightly-coloured (at least in males) lizards are highly visible but no evidence of their presence on the island was found during the author's recent visits nor has any evidence of their presence been reported subsequently. Rose (1929) records receiving a specimen of *Scelotes gronovii* from Dassen Island but does not mention the rock agama.

During the author's first trip to the island (4–10 April 1987), 12 *Scelotes gronovii* were collected in sandy, gritty soil under cover (granite slabs, old corrugated iron sheets, wooden logs, etc.), some only a few metres above the high water mark and others among the roots of

scrub vegetation. All were adults ($N = 11$, SV 65–82, mean 73.44 mm), and all but the two smallest (SV 65–67 mm) had regenerated tails (i.e., 81.82%). Specimens from Elands Bay and Langebaan on the adjacent mainland are slightly smaller in size ($N = 5$, SV 61–77 mm, mean 66 mm) but there are too few specimens to determine whether this size difference is statistically significant. Two young were born whilst the above specimens were retained in a collecting bottle but it was not possible to determine whether they came from the same or separate mothers. They measure; 1. $40 + 21$ mm (SV + tail); 2. $38 + 12$ (tail broken). In adults with original tails the tail ranges from 74.3–93.8 % (mean 84.5%, $n = 5$) of the SV length. This contrasts with 52.5–73.6 % (mean 62.0 %, $n = 3$) in new born specimens, indicating that tails are relatively smaller in juveniles than adults.

McLachlan (1978) queried the safety of this species on Dassen Island following disturbance during guano collection. However, little guano collecting now occurs on the island and is restricted to the northern, barren peninsulas. The dwarf burrowing skink is distributed throughout the island in areas not disturbed by guano collecting. The species is still included in the revised *South African Red Data Book—Reptiles and Amphibians* and, although not currently threatened, is placed in the Restricted category (Branch, 1988c).

Neither Boulenger (1910), FitzSimons (1943) nor Rose (1929, 1950 and 1962) records the presence of the marbled gecko *Phyllodactylus porphyreus* on Dassen Island, even though FitzSimons (1943) does record the species from Robben and Jutten islands. Its presence on Dassen Island was first documented by Brooke and Crowe (1982), however, no further details were given or voucher specimens documented. Numerous specimens of the marbled gecko were found by the author during a short trip to the island (4–10 April 1987). Twenty one specimens were found sheltering under a single granite flake (c 35 cm \times 40 cm) on granite bed rock, 50 m NW of the lighthouse on 7 April 1987. Another nine geckos were sheltering under a slightly larger slab in the same region. Another granite slab, partially embedded in sandy soil in the centre of the island, sheltered three geckos. An additional four geckos were found individually sheltering under stones or building debris around the keeper's house.

The SV and tail length of 29 geckos were measured, and the state of regeneration of their tails noted. The development of eggs or enlarged endolymphatic sacs (ELS) in the neck region of females was also recorded. Adult males are easily sexed by the prominent hemipeneal bulge at the base of the tail. The sex ratio was 0.69 (11:16 M:F). Very few juveniles were found. No females had obvious well-developed eggs but 5 had well-developed ELSs. Cray (1976) notes that females produce two eggs in spring and that ELS development occurs in late winter to meet the stress of rapid calcification of eggs-shells in spring. Two geckos lost their tails during capture. Of the remaining 27 geckos 14 (51.85%) had regenerated tails. Cray (1976) observes that tail autotomy is well-developed in the marbled leaf-toed gecko but gives no details of frequency. The number of Dassen Island geckos with regenerated tails, in a situation where many of the normal predators (e.g. snakes) are absent is relatively high. However, the spotted gecko on St Croix Island also has a very high tail break frequency, that may be caused by pecks from penguins defending their nest sites.

The date of introduction of the angulate tortoise, *Chersina angulata* to Dassen Island is undocumented. In numerous early references to the island (from 1601 onwards) there is no mention of tortoises (Skead, 1975). This contradicts the conclusion of Brooke and Prins (1986) that the species is "probably indigenous". The first record of tortoises occurs as an appendix in Rose (1929), who notes that "*Testudo angulata* is plentiful on Dassen Island, having probably

been introduced somewhat recently from the mainland." Sclater (1896) makes no reference to tortoises on the island during a visit in 1896, which indirectly supports Rose's comment. It is now known to be present in high densities on the island.

Studies by Apps (1983) and Berruti (1986) on the impact of feral cats on the island's fauna revealed only minimal predation on the reptiles. Small cats were found to occasionally take *Scelotes gronovii* (<1% prey mass), but no tortoise or gecko remains were present in numerous scats or gut contents studied. The feral cats on the island have recently been eradicated (Berruti, 1986) to protect the endangered jackass penguin colony.

Marcus Island, Saldanha Bay (32° 02'S, 17° 58'E; 650 m × 200 m, 11 ha, 1.2 km offshore, 7.3 m a.s.l., usually manned)

Brooke and Crowe (1982) record *Phyllodactylus porphyreus* from the island but give no further details. The record postdates the connection of the island to the mainland by a causeway in 1977. It is possible that the gecko colonised the island via this land connection.

Malgas Island, Saldanha Bay (33° 03'S, 17° 55'E, 300 m × 300 m, 9 ha, 800 m offshore, 7 m a.s.l., manned)

The only herpetological record from the island is that of two adult and one juvenile *Phyllodactylus porphyreus* collected 25 January 1951 by the Swedish Expedition to southern Africa (FitzSimons, 1957).

Jutten Island, Saldanha Bay (33° 05'S, 17° 57'30"E, 1550 m × 650 m, 46 ha, 800 m offshore, 60.5 m a.s.l., manned)

FitzSimons (1943) records *Phyllodactylus porphyreus* and *Cordylus cordylus* from the island and both species were also collected there by the Swedish Expedition to southern Africa (FitzSimons, 1957). Brooke and Crowe (1982) also record *Acontias meleagris*. Mouton (1987) notes that the population of the girdled lizard on the island is referable to the melanistic form (*niger*).

Meeuw Island, Saldanha Bay (33° 05'S, 18° 00'30"E, 500 m × 300 m, 7 ha, 140 m offshore, 9 m a.s.l., not manned)

McLachlan (*in litt.* to Skead, April 1971) records *Phyllodactylus porphyreus* and *Scelotes gronovii* from the island, whilst Brooke and Crowe (1982) also record *Phyllodactylus lineatus*.

Schaapen Island, Saldanha Bay (33° 06'S, 18° 01'E, 650 m × 600 m, 41 ha, 500 m offshore, 18 m a.s.l., not manned)

Lichtenstein in 1803 noted that "the inhabitants of this as well as the other islands are chiefly sea-fowl, serpents and lizards" (quoted by Skead, 1975), and later Symons (1926) recorded that "... Schapen has a very bad reputation for snakes, cobras and puff-adders being said to be very plentiful". However, this has not been confirmed recently, and Grindley (*in litt.*, Skead, April 1971) found that "Some years ago I did some work on Schaapen island in Saldanha Bay where I found *Cordylus cordylus* to be common and the burrowing lizard *Acontias meleagris* to be present." Similarly, Brooke and Crowe (1982) record the lizards *Phyllodactylus lineatus*, *Scelotes gronovii* and *Mabuya capensis* on the island. The *Scelotes gronovii* are of typical size (N = 6, SV 60–74 mm, mean 68.83 mm), not noticeably larger than those on the adjacent mainland.

Pomona Island, Namibia (27° 12'S, 15° 16'E, 91 m × 366 m, 3 ha, 200 m offshore, 2.5 m a.s.l., not manned)

This small, barren guano island lacks vegetation or permanent water. Nonetheless, Bogert

(1940) records a single specimen of the Coral snake *Aspidelaps lubricus lubricus* from the island. Mertens (1954 and 1955) transferred this specimen to his newly-described race, *A. l. infuscatus*, subsequently followed by FitzSimons (1962). However, Broadley (1983) does not list this specimen in his revision although he makes no further comment on its identity or provenance. It should be noted that Bogert (1940), in his original description of the specimen, records that "The stomach of this snake contained a small unidentified rodent and nineteen eggs, presumably of some lizard. The eggs measure approximately 10 mm × 6 mm, with soft shells, typical of many species of gecko". No southern African gecko has soft-shelled eggs and no geckos have been recorded from Pomona Island. The small size and barren nature of the island make it a most unlikely habitat for this nocturnal, semi-fossorial elapid and it is probable that the specimen was collected elsewhere.

Loveridge and Williams (1957) record an angulate tortoise from Pomona, based on a specimen in the AMNH. It is not known whether this specimen came from the adjacent mainland or the island to which it might have been taken by a guano worker. It is pertinent that whereas FitzSimons (1950) lists a number of other specimens from Pomona it is obvious from his text that he refers to the mainland adjacent to Pomona Island in Lüderitz District. Specimens of the angulate tortoise are still found around Lüderitz Bay, probably having escaped from captivity. The nearest natural population occurs 220 km to the south at Oranjemund (Branch, 1989).

Possession Island, Namibia (27° 01'S, 15° 12'E; 5.6 km × 0.8 km, 90 ha, 2.7 km offshore, 20 m a.s.l., manned)

This is the largest of the guano islands off the Namibian coast. It has a sparse scrub cover. Werner (1910) recorded one male and three female marsh terrapins (*Pelomedusa subrufa*) from the island but queried the record. Haacke (1965) discounted the record, noting that the small island contains no standing water and that the original collector (L. Schultze) made no reference to this unusual discovery in his account of his journey. During a two day visit to the island (May, 1963) Haacke found no evidence of the marsh terrapin but did note the presence of two angulate tortoises "brought from the Cape as pets". The permanent resident supervisor also noted that "the only wild reptiles ever noticed were the odd skink and gecko found amongst timber or empty bags from Cape Town" (Haacke, 1965).

RECENT GEOLOGICAL HISTORY OF THE ISLANDS

All the offshore islands discussed in this paper occur on the continental shelf and are relatively close to the South African mainland (maximum distance 9 km offshore). All have been affected, to a greater or lesser degree, by sea level fluctuations associated with periods of glaciation. Tankard (1976) has reviewed sea level fluctuations in the region during the Cenozoic. He notes a rapid fall in sea-level with the advance of the final Würm glaciation (17–18 000 BP) and a minimum sea level 130 m lower than present. At this time all of the South African offshore islands would have been connected to the mainland. Following the maximum glacial advance, the rate of retreat of the ice was nearly constant. The present level was reached about 6500 BP. This infers a sea-level rise of some 1.125 m per 100 year for the period 18 000–6500 BP. The islands are separated from the mainland by water of different depths. Most channels are under 20 m deep. The maximum depth (approx. 40 m) occurs between Ysterfontein and Dassen Island (which is also the farthest offshore). This island would thus have separated from the mainland

about 14–13 000 years BP, whereas the islands with the shallowest channels (i.e. those of Saldanha Bay, and Pomona (9 m) and Possession (12.8 m)) would have separated between 8–7000 BP. The Algoa Basin islands are separated from the mainland by water of depths of 17–23 m and would thus have separated 10–9000 BP.

During the last climatic optimum or hypsithermal, which ended c 2000 years ago, sea levels were at least 3 m higher than at present (Flemming, 1977). At this time many of the low-lying islands (e.g. Bird Island, Algoa Bay; Dyer Island; and Pomona Island, Namibia) even if still exposed, would have been seriously affected by storm swells. They now either lack a herpetofauna or have one only recently introduced.

INTRODUCED SPECIES

The larger islands have a longer and more intense history of human habitation and there has therefore been a greater chance for species introductions, be they deliberate or accidental. Tortoises are the only group for which evidence of deliberate introduction is known: *Chersina angulata*, Dyer Island, after 1924; Bird Island (Algoa Bay), 1951–3; Possession Island, 1960–3; *Geochelone pardalis*, Robben Island, 1959. It is highly likely that the colony on Dassen Island was deliberately introduced between 1896 and 1929.

It is difficult to determine which of the remaining species on the offshore islands represent accidental introductions. It is possible that many of the species recorded from Robben Island were present naturally before colonization by European settlers. The early records confirm the presence of snakes, chamaeleons, lizards and tortoises. Mouton and Oelofsen (1988) present a model explaining the distribution of melanistic girdled lizards in the region and note the importance of mountains as refugia for melanistic populations during the current amelioration of the climate following the last Glacial Maximum (16 000 BP). It is proposed that the rapid warming of the climate along the coastal lowlands since 14–12 000 BP allowed the typical form to rapidly expand its range and to colonize Robben Island before it became separated from the mainland. Whether at this period the species also managed to colonize St Croix Island in Algoa Bay is not known. The species is common in many coastal regions of the Cape Province (Burrage, 1974), particularly in the southwestern and Eastern Cape.

The same events probably allowed the burrowing skinks *Acontias meleagris* (Robben, Schaapen and Jutten islands), *Scelotes gronovii* (Robben (?), Dassen, Schaapen, and Meeuw islands) and *S. bipes* (Robben Island) and Rose's rain frog *Breviceps rosei* (Robben Island) to colonise a number of the islands on the southwestern Cape coast. It is extremely unlikely that so many islands could subsequently be colonised by small, fossorial lizards and a terrestrial, burrowing frog following separation from the mainland. It is equally unlikely that they could reach the islands by natural rafting or be accidentally introduced by man. They are therefore likely to represent relict populations, isolated following the rise in sea-level. The comments in Haacke (1965), concerning the introduction of geckos and skinks to Possession Island with cargo from Cape Town, offer a probable explanation for the presence of *Phyllodactylus porphyreus* on so many islands in the southwestern Cape and for the presence of the Cape skink *Mabuya capensis* on Dyer Island. The marbled leaftoed gecko is common throughout the coastal regions of the southern Cape and is very common in human habitations (Branch, 1988b). The introduction of geckos to ports in ship cargo is well-established (e.g. Branch, 1987; Loveridge, 1961).

When discussing Robben Island, it was noted that no permanent freshwater source existed on the island until the colony was established by Van Riebeeck in 1652. It is thus likely that the spotted stream frog *Strongylopus grayii* was introduced during the period of human settlement and that the brown water snake *Lycodonomorphus rufulus* which feeds on amphibians was also subsequently introduced.

The slight rise (3 m) in sea-level during the last hypsithermal (Flemming, 1977) may account for the current absence of reptiles on Bird Island in Algoa Bay, Dyer Island (where the herpetofauna is probably all introduced), Marcus and Malgas islands in Saldanha Bay (where the only record for both islands is the marbled leaf-toed gecko which has probably been introduced), and Pomona Island, Namibia. All are low-lying islands and, although they would still have been exposed during the hypsithermal, they would have been drastically affected by storm swells.

Among the species that have been introduced to the offshore islands, a number have been translocated even further distances. The small stream frog, *Strongylopus grayii* has become established on St Helena (Frost, 1985). Loveridge (1947) notes a record of the ocellated gecko *Pachydactylus geitje* from Ascension Island but does not mention it in subsequent papers on the introduced herpetofauna of the island (Loveridge, 1959 and 1961). The specimens may have been mislabelled or the population may subsequently have died out.

ISLAND-SPECIES RICHNESS RELATIONSHIPS

The islands for which a herpetofauna has been identified were studied to determine whether a relationship between species richness and island size/distance from the mainland exists. Marcus Island was excluded from the analysis as it was connected by a causeway to the mainland in early 1977. The only record from the island (the gecko *Phyllodactylus prophyreus*) (Brooke and Crowe, 1982) occurs after the causeway was constructed. The species could have invaded the island naturally after connection to the mainland. The islands of Dyer, Pomona and Possession have also been excluded because in all cases the recorded reptiles have probably either been deliberately or accidentally introduced, or mistakenly assigned to the island. The angulate tortoise on Dassen Island and the leopard tortoise on Robben Island are introduced species and have been excluded from the following analysis.

Linear and log-log simple regression models (Sokal and Rohlf, 1969) were computed to test statistical relations between island herpetofauna richness and island area and distance offshore. Log/log plots for species/island area and species/distance offshore revealed no significant correlation. Brooke and Crowe (1982) found a highly significant relation between South African offshore island area and species richness for the total biota and also for various higher taxonomic categories (vertebrates, birds and plants). They found no significant relation in these categories between island species richness and island distance from the mainland. The absence of any significant correlation for the herpetofauna can be attributed to a number of factors: a) the small size of the islands (only two exceed 100 ha in extent); b) the depauperate herpetofauna which on most islands is restricted to 1–3 species; c) the low mobility of many reptiles and amphibians; d) the low salinity tolerance of most amphibians; and e) the lack of freshwater and thus suitable breeding sites for most amphibians.

RAFTING AND THE EFFECT OF FLOODS ON REPTILES AND AMPHIBIANS

It is often proposed that species may reach offshore islands by rafting. Arnold (1976) has discussed the history of fossil reptiles on Aldabra Atoll which has been inundated by rising sea

levels on at least two occasions. The giant land tortoise *Geochelone elephantina* has colonised the atoll on three occasions and it is probable that it originated from the northern areas of Madagascar. This large tortoise may either enter the sea voluntarily to cool itself or is washed out to sea by floods. It floats easily in water and could have drifted northwards in sea currents to wash ashore on Aldabra. This ability is well-illustrated by the discovery of a large leopard tortoise, *G. pardalis*, alive and well, drifting in the sea about 4 km offshore between Robben Island and the mainland (D'Ewes, 1967). The small land tortoises of South Africa, including the angulate tortoise *Chersina angulata* and the genera *Homopus* and *Psammobates*, are unable to swim (Branch unpubl. obs.) and can only colonise islands by rafting on flotsam in association with floods.

The effects of floods on reptiles and amphibians have rarely been documented but some indication of their impact may be judged by the following record. During the period 22–24 August 1971 the Port Elizabeth region experienced heavy rains and the Gamtoos, Swartkops and Sundays rivers flooded. Afterwards local newspapers recorded the capture of 93 snakes sheltering among debris on the beaches at the river mouths. The common slug eater *Duberria lutrix* was the most common snake. Other reptiles caught included the puffadder *Bitis arietans*; sand snakes *Psammophis* spp.; the skaapsteker *Psammophylax rhombeatus*; the night adder *Causus rhombeatus*; house snakes *Lamprophis* spp.; the garter snake *Homoroselaps lacteus*; the aurora house snake *Lamprophis aurora*; the Cape cobra *Naja nivea*; and at least 100 unidentified tortoises (Ross, *in litt.* to Skead, Sept 1971).

Although no tortoises are currently found on either of the major islands in Algoa Bay, following heavy rain on the mainland in 1981 an angulate tortoise, *Chersina angulata*, was found freshly dead on the shore of Bird Island (A. Batchelor, pers. comm.). It is possible that the two lizard species on St Croix Island in Algoa Bay could have been introduced to the island by rafting following floods in the rivers of the adjacent mainland. The spotted gecko *Pachydactylus maculatus* regularly shelters under bark on dead logs in the region (Branch, 1989), as does Tasman's girdled lizard *Cordylus tasmani*, a mainly arboreal cordylid endemic to the Algoa Basin (Branch and Braack, 1987). The Cape girdled lizard *Cordylus cordylus* is common among rocks along the Eastern Cape coast (Branch, 1988d).

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APPENDIX

Voucher specimens—AMNH, American Museum of Natural History, New York; CDNEC, Chief Directorate of Nature and Environmental Conservation, Jonkershoek; PEM R, Port Elizabeth Museum; SAM, South African Museum, Cape Town; TM, Transvaal Museum, Pretoria.

AMPHIBIA.

Breviceps rosei: **Robben Island**. SAM 2147, 2149, 2154, no date, Rev. G. H. R. Fisk. *Strongylopus grayii*: **Robben Island**. Poynton (1964) lists specimens from the Albany Museum, Grahamstown but these are unlocated.

REPTILIA.

Serpentes.

Colubridae. *Pseudaspis cana*: **Robben Island**. SAM 1725, 1882, H. W. Oakley; SAM 1847, no date, Sir R. Southey. *Lamprophis inornatus*: **Robben Island**. SAM 3528, 31 January 1899, D. Denysen. (?) *Lycodonornorphus rufulus*: **Robben Island**. SAM 1857, no date, Rev. G. H. R. Fisk.

Elapidae. *Aspidelaps lubricus infuscatus*: **Pomono Island**. AMNH 51836, October 1925, H. Lang.

Sauria.

Gekkonidae. *Pachydactylus geitje*: **Robben Island**. SAM 157–158, 7 March 1881, H. W. Oakley; SAM 2049, December 1896, W. F. Purnell; SAM 43947–65, 10 June, G. R. McLachlan and U. van der Heever; TM 3575, 32791. *Pachydactylus maculatus*: **St Croix Island**. PEM R 239, 245, 250–52, 254, 262, 264; J. Spence, 8 October 1963. *Phyllodactylus porphyreus*: **Robben Island**. SAM 43979–80, 10 June 1976, G. R. McLachlan and U. van der Heever. **Jutten Island**. 9431–32, no date, Government Guano Department; SAM 44827–29, 4 November 1979, R. Brooke. **Dassen Island**. SAM 44830, 4 November 1979, R. Brooke; SAM 44833–34, 7 November 1979, R. Brooke; PEM R 4607–4623. **Meeuw Island**. SAM 44770–71, 27 April 1979, R. Brooke. **Marcus Island**. SAM 44776–77, 27 April 1979, R. Brooke. **Malgas Island**. TM 26162, 25 January 1951, Swedish Southern Africa Expedition. **Schaapen Island**. PEM R 1572–73, 1575–78, 1580, 1588–89, 18 April 1965, J. Spence and G. McLachlan. *Phyllodactylus lineatus*: **Schaapen Island**. SAM 44765–68, 27 April 1979, R. Brooke. **Meeuw Island**. SAM 44772–75, 27 April 1979, R. Brooke.

Chamaeleonidae. *Bradypodion pumilum*: **Robben Island**. FitzSimons (1943) records specimens in the Albany Museum but these are unlocated.

Agamidae. (?) *Agama atra*: **Dassen Island**. SAM 2644, April 1897, R. M. Lightfoot.

Scincidae. *Mabuya homalocephala*: **Robben Island**. SAM 1090–91, 1881, H. W. Oakley; SAM 1420–1446, 17 March 1881, H. W. Oakley. *Mabuya capensis*: **Dyer Island**. SAM 44836, 16 June 1979, R. Brooke. **Robben Island**. CDNEC 5612–13. *Scelotes gronovii*: **Meeuw Island**. SAM 44769, 27 April 1979, R. Brooke. **Schaapen Island**. SAM 43240, 4 May 1961, C. Gow; SAM 44764, 27 April 1979, R. Brooke; PEM R 554, 556–57, 561–64, 566–68, 18 April 1965, J. Spence and G. McLachlan. **Robben Island**. TM 35741, 16 May 1968, Dr J. M. J. Meier. **Dassen Island**. SAM 44835, 7 November 1979, R. Brooke; SAM 44831–32, 4 November 1979, R. Brooke; PEM R 4624–4632, 4566–67, TM 65844, 4–10 April 1987, W. R. Branch. PEM R 4633–4634, born in captivity to previous specimens. *Scelotes bipes*: **Robben Island**. SAM 1458–59, 1881, H. W. Oakley; SAM 1524–25, 1882, H. W. Oakley; SAM 1982–88, 21 April 1897, Dr Spencer; SAM 2025, 2027–29, 2031–40, 2042–43, no date, H. W. Oakley; SAM 2050, December 1896, R. M. Lightfoot. *Acontias meleagris meleagris*: **Schaapen Island**. SAM 44538, 2 May 1954, University of Cape Town Ecology Survey; PEM R 2007, 2010–11, 18 April 1965, J. Spence and G. McLachlan. **Robben Island**. SAM 1454–57, 1881, H. W. Oakley; SAM 2026, 2030, 2041, 2051, no date, H. W. Oakley; SAM 43937–46, 10 June 1976, G. R. McLachlan and U. van der Heever.

Cordylidae. *Cordylus cordylus*: **Jutten Island**. SAM 9430, no date, Government Guano Department; SAM 44825–26, 4 November 1979, R. Brooke. **Robben Island**. SAM 1104–06, 1880, R. Southey; SAM 2048, December 1896, W. F. Purnell; SAM 43932–36, 10 June 1976, G. R. McLachlan and U. van der Heever. **St Croix Island**. PEM R 521, J. Spence, 8 October 1963; R 1358–59, W. R. Branch, 7 July 1979. *Tetradactylus seps*: **Robben Island**. SAM 164–165, 1881, H. W. Oakley; SAM 1086–87, 1880, R. Southey; SAM 1187–1193, 7 March 1881, H. W. Oakley; SAM 1396–1419, 17 March 1881, H. W. Oakley.

Chelonii

Eretmochelys imbricata: **Dyer Island**. SAM 9403 (shell), 2 February 1906, H. Jackson, Government Guano Department.



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