The conservation status of the Saldanha-Langebaan lizard fauna

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The conservation status of relic melanistic lizard species occurring in the Saldanha-Langebaan area has been investigated. A contact zone between one melanistic form and a closely related non-melanistic form has been examined in detail. Apart from melanistic populations of the girdled lizards, *Cordylus niger* and *C. polyzonus*, a melanistic morphotype of the Cape legless skink, *Acontias meleagris meleagris* also occurs in the area. The taxonomic status of this morphotype needs to be investigated. At Mauritz Bay, north of Saldanha, the ranges of *C. niger* and the non-melanistic *C. cordylus* are in contact over a distance of approximately 240 m, with maximum overlap of 70 m. The melanistic populations of *C. polyzonus* and *A. m. meleagris* have relatively large ranges in the Saldanha-Langebaan area and are not threatened by urban development. The *C. niger* population, however, is fragmented into several subpopulations, and those in the Saldanha area, including the contact zone, will be affected if urban development is allowed to continue in the area. As relic populations of other cool-adapted, melanistic invertebrate and lower vertebrate species may also occur in the area, the key areas demarcated by *C. niger* should be preserved.

Keywords: Saldanha, Langebaan, melanistic lizards, cool-adapted relics, refuge, urban development, conservation

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Introduction

The invertebrate and lower vertebrate faunas of the southwestern regions of southern Africa contain many archaic elements, which, with few exceptions, are melanistic and occur in the form of small, isolated populations in high-altitude refugia along the Cape Fold Mountains (see, e.g., Sirgel 1985; Endrödy-Younga 1988; Mouton & Oelofsen 1988; Mouton & Van Wyk 1995). Although melanistic forms mainly occur at high altitudes in the Western Cape mountains, melanistic girdled lizard populations are also to be found in lowland areas on the Cape Peninsula and in the Saldanha-Langebaan area (Mouton 1985, 1986; Mouton & Oelofsen 1988). Badenhorst (1990) established that these lowland melanistic populations occur in association with zones of upwelling of cold water in the Atlantic Ocean (Fig. 1). The coastal climatic conditions associated with these upwelling zones apparently provide refugia for cool-adapted forms in coastal lowland areas, comparable to those at high altitudes in the Cape Fold Mountains.

A survey of the lizard fauna of the Western Cape revealed that the black girdled lizard, *Cordylus niger*, occurs in the form of four isolated populations in the Saldanha-Langebaan area, one on the Langebaan Peninsula, one along the coast between Saldanha and Mauritz Bay, one on Jutten Island (Mouton 1987; Oelofsen *et al.* 1987) and one on Schaapen Island (Branch 1991; Dyer *pers. comm.*) (Fig. 1). Prior to this study, the geographical boundaries of these populations were unknown. A fifth isolated population occurs about 120 km to the south on the Cape Peninsula (FitzSimons 1943; Mouton 1987). This population is geographically separated from the Saldanha-

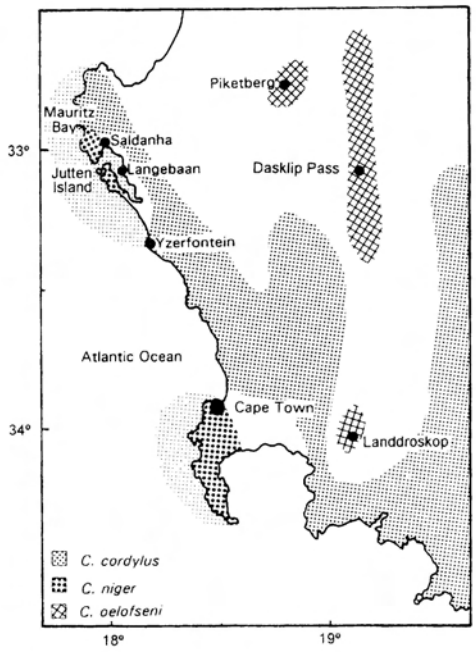

Fig. 1. Geographic distribution of the melanistic lizard species, *Cordylus niger* and *C. oelofseni*, and the non-melanistic species, *C. cordylus*. The cold upwelling zones in the Atlantic Ocean are shaded.

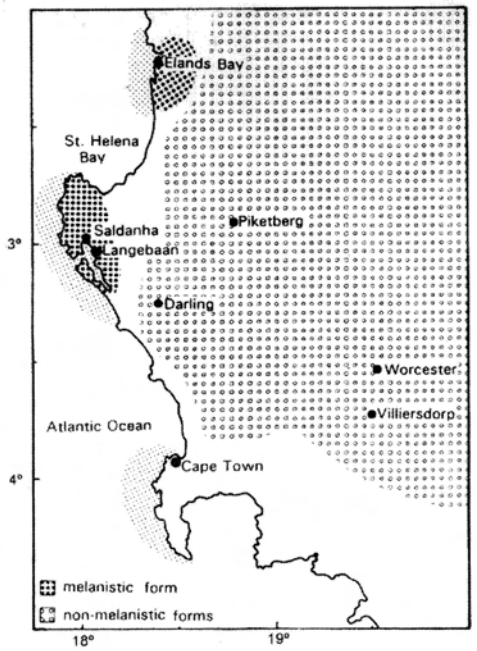

Fig. 2. Geographic distribution of the melanistic and non-melanistic morphotypes of the Karoo girdled lizard, *Cordylus polyzonus*, along the south-western coast. The cold upwelling zones in the Atlantic Ocean are shaded.

Langebaan populations by the closely related, non-melanistic species *C. cordylus* (Mouton 1987) (Fig. 1). *Cordylus niger* was formerly considered a subspecies of *C. cordylus* (Loveridge 1944; Branch 1988), but was later elevated to full species by Mouton & Van Wyk (1990). *Cordylus cordylus* has an extensive distribution in the Western Cape (FitzSimons 1943; Loveridge 1944; Mouton 1987) (Fig. 1). A contact zone between *C. niger* and *C. cordylus* occurs at Mauritz Bay, north of Saldanha (Mouton 1987) (Fig. 1), where the two species occur parapatrically and, along a narrow zone, also sympatrically (Mouton & Van Wyk 1990). No detailed information on this contact zone was available at the beginning of this study. Mouton (1987), Mouton & Oelofsen (1988), and Brody *et al.* (1993) demonstrated that the melanistic *C. niger* populations are remnants of a once larger melanistic population, stretching at least from the Cape Peninsula to Mauritz Bay. Herselman (1991) showed that *C. niger* and its sister species *C. oelofseni*, a melanistic form occurring in the form of isolated populations along the western section of the Cape Fold Mountains (Fig. 1), are two of the most basal species in the genus *Cordylus*.

The other species of which a melanistic population occurs in the Saldanha-Langebaan area, is the Karoo girdled lizard, *C. polyzonus*. Unlike *C. niger*, which is exclusively melanistic, *C. polyzonus* is a polymorphic species which comprises both melanistic and non-melanistic forms (Mouton & Oelofsen 1988; Badenhorst 1990). Further inland in

the Western Cape, turquoise, brown and reddish coloured forms occur, while along the coast, four melanistic populations are found. Melanistic populations have been reported from the Saldanha-Langebaan area (Fig. 2), Elands Bay, Lamberts Bay and Alexander Bay (Mouton 1986; Mouton & Oelofsen 1988; Badenhorst 1990). The turquoise form inhabits most of the southwestern coastal lowlands, and has never been found within a few kilometers from the sea (Mouton 1986). No transitional zone exists between the adjacent melanistic and turquoise populations south of Saldanha Bay, as the two colour morphs are separated by a stretch of sandy soil a few kilometers wide (Mouton 1986; Badenhorst 1990). Badenhorst (1990) established that the isolated melanistic populations of *C. polyzonus* at Saldanha and Elands Bay are not only smaller in body size than the non-melanistic forms of this species, but that they also share certain non-adaptive characters. This led to the conclusion that geographically isolated melanistic populations of *C. polyzonus*, like in the case of *C. niger*, belong to one primary gene pool and represent relics of a once larger melanistic population (Badenhorst 1990). This conclusion remains to be tested using molecular techniques.

The relic invertebrate and lower vertebrate forms in the Western Cape may contain a wealth of information regarding palaeoclimates (Endrödy-Younga 1988; Mouton & Oelofsen 1988) and the evolutionary history of the groups to which they belong. Furthermore, the lowland melanistic populations are ideally suited for monitoring the influence that climatic changes associated with the 'greenhouse effect' may have on animal populations. The presence of melanistic lizard species in coastal areas is an indication that these areas have the potential to serve as refugia for a wide range of other cool-adapted animals and possibly also plants. Extensive studies are still needed to evaluate the role of especially the Saldanha-Langebaan area as a refugium for animal and plant species. In the meantime, in the light of the rapidly accelerating urban development in the area, at least those areas demarcated by the presence of relic melanistic lizard populations, should be preserved. The aim of this study was to assess the conservation status of the melanistic lizard populations in the Saldanha-Langebaan area and to propose a long term strategy to ensure their survival. In our evaluation of the conservation status of the melanistic lizard populations in the Saldanha-Langebaan area, we paid particular attention to establishing the exact distributional boundaries of these forms, to whether there are other lizard species in the area showing concordant patterns, and to the contact zone between *C. niger* and *C. cordylus*.

Materials and Methods

Lizard species composition

To obtain a representative picture of lizard species composition and distribution in the Saldanha-Langebaan area, the region between Yzerfontein in the south (33°22'S; 18°10'E) and Stompneus Bay in the north (32°44'S; 18°00'E), and west of longitude 18°15'E was surveyed. In addition to the localities surveyed by Oelofsen *et al.* (1987) and Badenhorst (1990), 62 other localities were visited to cover those parts of the study area that were inadequately surveyed by these workers. Using specimens collected during this survey, as well as those from the other two surveys, lizard species occurring in the area were examined morphologically to investigate the possibility of geographical patterns in character variation concordant to those observed for *C. niger* and *C. polyzonus*.

Distribution of Cordylus niger *and* Cordylus polyzonus

Distribution records from the survey of Oelofsen *et al.* (1987) were used as a basis to establish the rough boundaries of the isolated *C. niger* populations in the Saldanha-Langebaan area. The boundary areas were then surveyed on foot and, using orthophotos and 1:50 000 maps, the exact boundaries were plotted. The islands in the area were not visited as previous records (Mouton 1987; Oelofsen *et al.* 1987; Branch 1991) were considered sufficient. In view of the rupicolous nature of *C. niger*, all rocky areas within the general study area were surveyed. A thorough survey of the distribution of *C. polyzonus* in this area was done by Mouton (1986) and Badenhorst (1990), and only a few additional localities in the study area

were visited to establish the range of the melanistic *C. polyzonus* population.

Contact zone between Cordylus niger *and* Cordylus cordylus

In establishing the distribution ranges of *C. cordylus* and *C. niger*, a rough estimate of areas of contact and overlap of their respective ranges was also obtained. The zone of contact in the Mauritz Bay area (Fig. 1) was surveyed on foot to establish its exact proportions. Within the contact zone, each specimen that was sighted was caught and identified as either *C. niger* or *C. cordylus*, and in few cases as a possible hybrid. To identify the specimens, diagnostic characters, described by Mouton & Van Wyk (1990), were used, namely body colour, subocular state, prefrontal state, number of longitudinal rows of ventrals and the condition of the occipital shields. Individuals displaying a combination of character states of both species were classified as possible hybrids. To avoid duplication, each lizard was marked with a semi-permanent pen and then released at the same location. The exact position where each lizard was found was marked with a flag, using different colours for the two species. After the area in and around the contact zone was thoroughly searched, a theodolite and a digitiser were used to transfer the locality data onto a map. The coordinates for the position of the theodolite were gauged from the trigonometric beacon on Kliprug (32°58'56"S; 17°54'58"E). The dimensions of the contact zone and the range of overlap were measured and calculated with the aid of the map and a 1:10 000 orthophoto. The findings of this study were combined with the preliminary data of Van Heerden, Mouton & Van Wyk (1992).

Urban development and land use

A survey to assess the present situation regarding habitat destruction and urban development has been carried out in the area between Saldanha Bay and Jacobs Bay. This area includes the contact zone at Mauritz Bay and the Saldanha population of *C. niger*. Since the Langebaan Peninsula, Jutten Island and Schaapen Island are presently administered as conservation areas and are not under pressure from urban development, these were not included in this part of the study. All man-made structures, such as residential areas, houses, roads, camp sites and holiday resorts, as well as areas used by the South African National Defence Force, were plotted with the help of existing maps and aerial photographs. Information on urban development planned for the near future was mainly obtained from the municipality of Vredenburg-Saldanha and the Cape Provincial Administration. Conversations with local residents also provided valuable information.

Results

The lizard fauna of the Saldanha-Langebaan area

Nineteen lizard species have been recorded in the study area (Appendix 1) and another two species, *Acontias lineatus* and *Scelotes bipes*, are expected to occur in the area. Only one species shows a pattern of geographical variation in morphology similar to that observed for *C. niger* and *C. polyzonus*. All specimens of the Cape legless skink, *Acontias m. meleagris*, collected in the study area are darkly coloured dorsally. Outside the study area, individuals of this species are much lighter in colour. To date, specimens of the dark phase have only been collected from four localities in the study area (Appendix 2). It is not known whether *A. m. meleagris* collected on Schaapen Island (Branch 1991) belongs to the dark phase. We conducted an investigation of external morphology in this species, but could not find any other character which covaries geographically with colour. Our investigation must, however, be seen as preliminary, and a more detailed investigation is suggested.

The distribution range of Cordylus niger *in the Saldanha-Langebaan area*

Langebaan Peninsula (Fig. 3a).

The Langebaan Peninsula can be divided into three parts, which differ considerably in terms of topography and geomorphology: a long, narrow proximal part, a broad distal part and, connected to it by a very narrow strip of land, a small peninsula at the tip (Fig. 3a).

The latter is part of Donkergat, the military training terrain for the parachute battalion of the South African National Defence Force.

Strict security regulations prevented a thorough survey of this section, and only two localities could be visited. The undulating interior of Donkergat is a sandy area with very few rocky outcrops, thus offering limited habitat for the rupicolous *C. niger*. Apart from sandy beaches in Riet Bay, Salamander Bay and Jutten Bay, most of the surrounding coast consists of a continuous belt of granite rock. At the two localities that were visited, namely Salamanderpunt and a part of the coast north of Jutten Bay, *C. niger* is well represented in the coastal rock. Although no records are available from the rest of the area, it is expected that the species will also be found in the rocky coastal strip between these two localities, where suitable habitat is abundant. In the broad, distal part of the Langebaan Peninsula, a boundary fence separates the Donkergat military territory in the north-west from the Postberg Nature Reserve to the south, which is part of the West Coast National Park and administered by National Parks Board.

In contrast to the low-lying Donkergat Peninsula, this area rises to relatively high altitudes, up to 190 m above sea level along the steep eastern coast.

The area consists of a flat, sandy interior with a few granite outcrops, while large boulders and high granite hills occur near the coast. Being rupicolous, *C. niger* occurs in most of the rocky parts in the area and is well represented on Konstabelberg, Postberg, Vlaeberg, along the coast of Riet Bay, Juttenpunt, South Head, Stoney Head, Kreeftebaaikop, and on lower rocky outcrops in the southern interior. The southern boundary of the population is at a point on the lagoon side in the narrow part of the peninsula, a few 100 m south of Preekstoel (33°09'00"S; 18°02'15"E), where *C. niger* specimens occur in a small, rocky patch. Southwards, the narrow section of the peninsula consists of a sandy coastline, and dune topography with patches of exposed limestone in the interior. This part of the Langebaan Peninsula is not populated by *C. niger*.

Jutten Island and Schaapen Island (Fig. 3a).

Jutten Island is 800 m offshore and is 46 ha in size. Although a large part of the island is flat and only a few meters above sea level, a rocky hillock in the centre of the island rises to an altitude of 34 m, making Jutten Island the highest island in the area. The rocks provide suitable habitat, and *C. niger* has been reported from the island by Mouton (1987) and Branch (1991). Schaapen Island, 41 ha in size, lies 500 m offshore in the Langebaan Lagoon and rises to a height of 18 m above

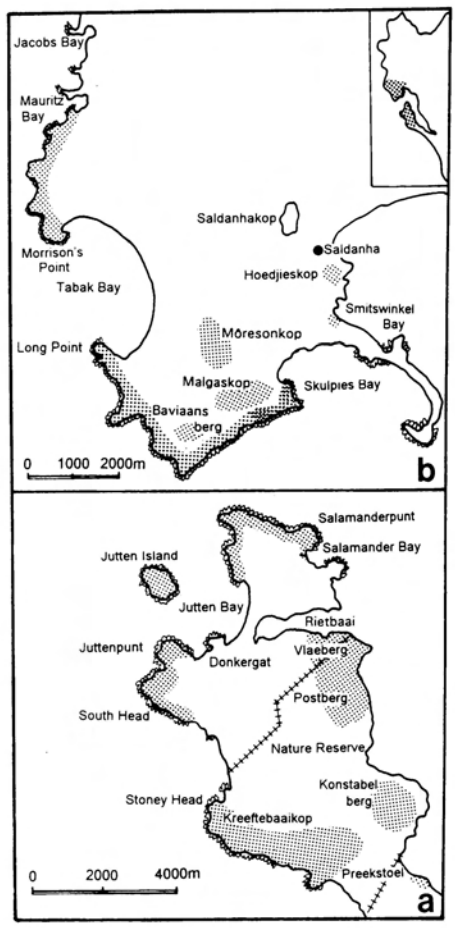

Fig. 3. The microdistribution (shaded areas) of *Cordylus niger* (a) on the Langebaan Peninsula and (b) in the Saldanha area.

sea level. *Cordylus niger* is known to occur in the rocks along the shoreline (Branch 1991; Dyer pers. comm.)

Saldanha area (Fig. 3b).

On the promontory south of Saldanha, and on a narrow coastal belt between Tabak Bay and Mauritz Bay, *C. niger* occurs where rocky habitat is available. In the middle of the town of Saldanha, the top part of a 71 m high granite hill, Hoedjieskop, is also populated by *C. niger*. Interestingly, however, on Saldanhakop, a hill a few hundred meters to the north, no specimens were found, despite suitable habitat. A small subpopulation of *C. niger* occurs along a rocky patch in the Saldanha harbour area in Smitswinkel Bay. The area southwest of Saldanha, a peninsula-like promontory, is sandy with a flat topography, interrupted by three granite hills. A 100-150 m wide belt of granite rock lines the coast from Skulpies Bay to Long Point. Specimens were found on Môresonkop, Malgaskop, Baviaansberg, as well as in the coastal granite belt. Northwards along Tabak Bay, the rocks are replaced by a sandy beach and dune topography, resulting in the absence of *C. niger* in this region. The shore to the north of Tabak Bay is characterised by a granite belt, 100-150 m wide, and numerous rocky ridges protruding into the sea. Between Morrison's point and Mauritz Bay, this narrow rocky zone is densely populated by *C. niger*. No specimens were found north of Mauritz Bay, despite the fact that there is no visible change in the habitat type. It is worth mentioning that in peninsular situations, like in the distal part of the Langebaan Peninsula and in the Saldanha promontory, *C. niger* specimens were found up to 1.5 km off the coast. However, along the coast north of Saldanha, all individuals were found within 200 m from the coast.

The distribution of Cordylus polyzonus

Cordylus polyzonus, like *C. niger*, is a rupicolous species and occurs at all the localities where *C. niger* is present. Furthermore, melanistic specimens are well represented further inland, on the eastern side of the Langebaan Lagoon, and northwards past Vredenburg, up to Stompneus Bay (Fig. 2). Outside the range of *C. niger*, *C. polyzonus* is the dominant species in rocky habitat.

The contact zone

No additional zones of contact between the ranges of *C. niger* and *C. cordylus* were identified during this study. The Mauritz Bay contact zone (Fig. 1) thus remains the only one. Altogether 156 specimens were collected along the contact area (Fig. 4). Of these, 113 were identified as *C. niger*, 33 as *C. cordylus* and 10 specimens were classified as possible hybrids, as they displayed a combination of characters of both species.

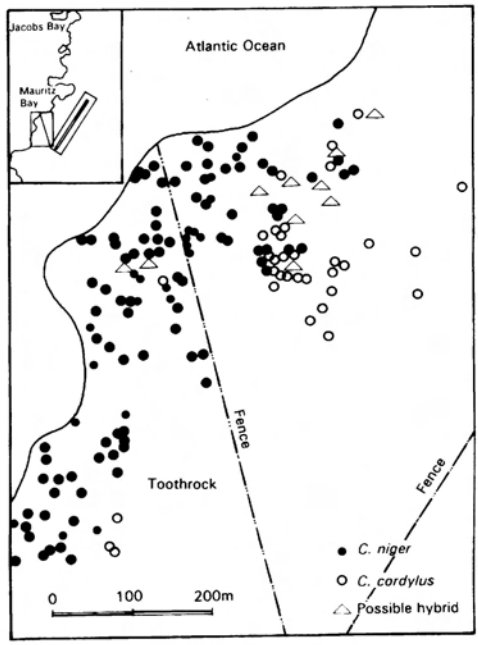

Fig. 4. The distribution of *C. niger* and *C. cordylus* in the contact zone at Mauritz Bay.

In the area of the contact zone, *C. niger* occurs in large numbers in the belt of continuous granite rock in a 100-120 m wide strip along the coast (Fig. 3b). However, its density decreases abruptly further inland, where isolated granite rock and exposed limestone form the habitat. In this zone, individuals inhabit both rock types. No specimens were found in the area beyond about 150 m from the coast, where isolated limestone heaps replace the granite rock. As one moves northwards along the coast, the numbers of *C. niger* also decrease abruptly, despite no visible change in habitat. The distribution of *C. cordylus* in the area east and north-east of the contact zone is relatively sparse, which is most likely related to a lack of suitable habitat beyond the rocky coastal belt. A sandy area, scattered with heaps of stacked limestone, witnesses widespread habitat destruction, probably resulting from farming activities in the past. The nature of these limestone heaps with a labyrinth of crevices, made it difficult to find and catch lizards here. The density at which *C. cordylus* occurs in this area could therefore not be established with certainty. In the vicinity of the contact zone, where both granite and limestone habitat is more abundant, *C. cordylus* is, however, well represented.

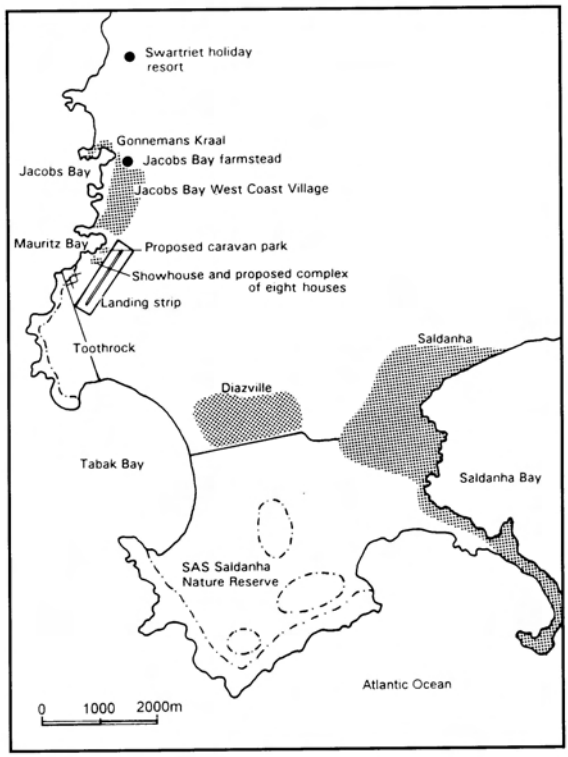

Fig. 5. Urban development in the Saldanha area. The ranges of the *C. niger* subpopulations are indicated by broken lines.

The contact zone itself is situated in the area east of the Toothrock boundary fence (Fig. 4), where isolated granite and limestone rock is scattered in dense coastal fynbos vegetation. Along a zone of approximately 240 m, individuals of both species occur sympatrically and in close proximity to each other, in some cases within one meter. At the widest part the two ranges overlap up to 70 m, and most of the suspected hybrids were found within the zone of overlap. Apart from four specimens recorded by Van Heerden *et al.* (1992), no *C. cordylus* specimens were found in the Toothrock territory.

Present use of land and proposed urban development

The present situation. The present developments and land use in the area between Saldanha Bay and Jacobs Bay are shown in Fig. 5. Saldanha, situated on the northwestern shore of Saldanha Bay, is the largest urban area in the region.

With a harbour and abundant fish resources available from the Atlantic Ocean, its most important economic contribution at present is the fish industry.

The promontory south of Saldanha is the property of the South African Navy and is administered by the local naval base, the SAS Saldanha. The base and a military academy are situated in this area, and part of the land is used for farming. The entire territory is administered as a nature reserve and is therefore relatively undisturbed. A nature trail is open to the public, but access is controlled, and visitors have to abide by strict regulations.

Bordering the naval territory in the north is Diazville, a residential area. Next to Diazville, the Tabak Bay Holiday Resort is situated close to the sandy beach of Tabak Bay. The adjacent area to the north is characterised by sandy coastal dunes, with a sparse plant cover. Judging by the amount of litter and other indications such as numerous paths and dirt roads between the dunes, human activity seems to be profuse and destructive in this area.

A north to south running fence separates this region from Toothrock bombtrack, an area along the coast which is administered by the South African Air Force (Fig. 5). In the past, the territory was frequently used for military drills and bomb demolition. Complaints from neighboring residents about excessive noise have, however, resulted in very strict regulations, reducing the military activities.

Habitat destruction is visible in the northern part of Toothrock near the fence, in the form of deep, crater-like pits and heaps of stacked limestone and granite rocks. However, most of the natural environment, and specifically the coastal granite belt, seems to be relatively undisturbed. Human activity is very limited, since the entire area is enclosed by a security fence, and public access is strictly prohibited.

A landing strip, which is also part of the air force territory, borders Toothrock in the north-east (Fig. 5). An area of 1300 m x 290 m around the landing strip, where bush clearance and removal of rocks have disturbed much of the natural habitat, is enclosed by a fence. Although the landing strip is still in a good condition, it is at present hardly in use, following complaints from the public. The landing strip, Toothrock boundary fence and the coastline up to Mauritz Bay enclose a triangular area which is part of Jacobs Bay Farm (Fig. 5). It contains the contact zone between *C. niger* and *C. cordylus*, as well as the northern limits of the *C. niger* range.

Indications of habitat destruction are visible. Litter between the rocks, traces of campfires and numerous paths in the narrow granite zone close to the sea, are signs of extensive human activity. Further inland, heaps of piled limestone and granite rocks are probably the result of farming activities in the past. The owners of Jacobs Bay Farm do not intend to develop this area in the near future.

The area near the southern shore of Mauritz Bay is a region of high potential for development. A sheltered bay with a small, sandy beach is a popular destination for numerous weekend campers. Apart from a single house, presently serving as the show house of a new development, a number of caravans are permanently established on the southern coast of Mauritz Bay. Spaces for additional caravans are available to the public at a daily charge.

Proposed future developments. In the area around the show house, the development of a new settlement in the form of a complex of eight houses, is planned (Fig. 5). Between this complex and the landing strip, the development of a caravan park, including tennis courts and other recreational facilities, has been proposed (Fig. 5). A large new settlement, Jacobs Bay West Coast Village, is arising in the area between Mauritz Bay and Jacobs Bay, where approximately 300 plots are sold as separate units (Fig. 5).

A crayfish factory on a small peninsula north of Mauritz Bay is not expected to expand in the near future. However, another new settlement, Gonnemans Kraal, is being developed on the northern shore of Jacobs Bay, where seafront cottages are built and sold to the public (Fig. 5). Along the coast in the study area, a 20-50 m wide zone, marked by concrete beacons, is the property of the state and not available for private development.

Discussion

The lizard fauna of the Saldanha-Langebaan area

If lizard populations have been isolated in the Saldanha-Langebaan area in the past, this will probably be more apparent in species displaying low vagility, such as rupicolous and burrowing forms. It is therefore not surprising that none of the terrestrial forms of high vagility, i.e. *Agama hispida*, *Bradypodion ventrale occidentale*, *Mabuya variegata*, *M. homalocephala*, *M. capensis*, *Meroles knoxii*, *Cordylus macropholis* and *Pachydactylus austeni* show patterns of geographical variation in morphology similar to that observed for the rupicolous species *C. niger* and *C. polyzonus*, and the burrowing form, *Acontias meleagris*.

Other non-melanistic, rupicolous forms occurring in the area probably represent later immigrants. While all indications are that *C. niger* and the black phase of *C. polyzonus* are relic forms (Mouton & Oelofsen 1988; Badenhorst 1990; Brody *et al.* 1993), we cannot, without further confirmation, accept that the dark phase of *A. m. meleagris* is also a relic form. The fact that the range of *A. m. meleagris* roughly coincides with that of *C. niger* and the black phase of *C. polyzonus*, however, strongly points to this possibility. A detailed study should be conducted to determine the status of the dark phase of *A. m. meleagris*. The fact that it has, to date, only been collected from four (possibly five) localities in the area, makes it difficult to delimit its range. More intensive collecting should be done in the area, especially in the sandy parts. The southernmost record for the dark phase is Rondeberg farm near Yzerfontein, and the northernmost one is Saldanhakop in Saldanha. The distributional data available show that the dark phase of *A. m. meleagris*, like in the case of the dark phase of *C. polyzonus*, occurs over a much wider area than *C. niger*, and from a conservation point of view, should not be in danger. The record for *Scelotes sexlineatus* (JEM 394) from Soetlandskop near Stompneus Bay represents a southern range extention for this species, formerly only known from as far south as Clanwilliam (Branch 1988). *Scelotes bipes* has been collected at Rondeberg farm (JEM 1689), and it is expected that this species will occur further north as well. *Acontias lineatus* is also expected to occur in the area as, according to Branch (1988), the Saldanha-Langebaan area falls within its range.

The distribution of Cordylus niger

Mouton & Oelofsen (1988) maintain that the disjunct distribution of *C. niger* resulted from range contraction and fragmentation of a once large melanistic population that inhabited more extensive areas during a previous cooler period. The results of our study for the first time provide a representative picture of the geographical structure of the four populations of *C. niger* in the Saldanha-Langebaan area. Both the Saldanha and Langebaan Peninsula populations are in fact fragmented into several subpopulations, in most cases separated from one another by sandy stretches. Owing to their close proximity to the Langebaan Peninsula, the Jutten Island and Schaapen Island populations could be considered subpopulations of the peninsula one, but because of their isolation we prefer to refer to them separately. In the Saldanha population, the subpopulation occurring between Mauritz Bay and Morrison's Point (Fig. 3), is separated from the other subpopulations by a distance of approximately 5 km. Genetic studies will probably show that this population has been genetically isolated from the other for quite some time.

The distributional data show that the availability of a rocky habitat plays an important role in the distribution of this rupicolous species. However, the absence of *C. niger* beyond 200-250 m to the interior, despite suitable habitat, suggests that climatic parameters are just as important. The association of *C. niger* with the occurrence of cold upwelling zones, and their presence in the immediate coastal regions where temperatures are

notably lower than in the lowlands further inland (Stuckenberg 1969; Badenhorst 1990), suggest that microclimatic parameters are the most important determinant of distribution of this species in the area. In the peninsular and insular situations, i.e. Langebaan Peninsula, Saldanha promontory, Jutten Island, Scaapen Island and Cape Peninsula, the occurrence of *C. niger* in the interior, up to 1.5 km off the coast, can be explained in terms of the stabilising effect that the surrounding water mass has on island temperatures (Mertens 1934).

The distribution of *C. polyzonus*

The isolated melanistic populations of *C. polyzonus* occur, like *C. niger*, in association with cold upwelling zones along the west coast. This suggests that the same vicariant event postulated for the isolation of *C. niger* in the Saldanha-Langebaan area (see Mouton & Oelofsen 1988), probably also led to the isolation of the *C. polyzonus* populations. The fact that *C. polyzonus* occurs over a larger area and further inland than *C. niger*, could be ascribed to a greater tolerance for warmer temperatures. While *C. niger* is jet black and unable to change its body colour, *C. polyzonus* displays limited metachrosis, which would allow greater thermal tolerance (Badenhorst 1990). As it has a more widespread distribution, *C. polyzonus* is not subjected to environmental pressure from urban development to the same extend as *C. niger*. However, it remains an important component of the Saldanha-Langebaan lizard fauna and should be preserved.

The contact zone

The short distance over which *C. niger* and *C. cordylus* are effectively in contact at Mauritz Bay, as well as the absence of other areas of contact, is most likely due to the lack of suitable habitat. Sandy stretches in the narrow part of the Langebaan Peninsula and adjacent to the rocky coast north of Saldanha form barriers, preventing *C. cordylus* from reaching the areas inhabited by *C. niger*. The low number of suspected hybrids found in the contact zone, confirmed former reports of limited introgression taking place between the two species (Mouton & Van Wyk 1990; Van Heerden *et al.* 1992; Brody *et al.* 1993). Since individuals from both species were found within meters from each other, the low rate of interbreeding cannot be attributed to spatial separation. It is more likely that differences in ecophysiological requirements, for example thermoregulation, result in different activity patterns, thereby preventing more pronounced interbreeding.

The contact zone provides an ideal opportunity to study, not only the genetic aspects of possible hybridisation, but also the ecophysiological differences between closely related melanistic and non-melanistic forms. As a potential source of valuable information, the contact zone should be preserved.

Urban development and a conservation strategy

The results of this study show that the Saldanha population of *C. niger* and the contact zone between *C. niger* and *C. cordylus* at Mauritz Bay, are currently under much greater pressure from urban development than the populations on the Langebaan Peninsula and Jutten Island. As the latter two areas are the property of the National Parks Board and part of the West Coast National Park, they are presently not subjected to urban development and excessive human activity. Although developments north of Saldanha are progressing rapidly, neither the contact zone nor the *C. niger* population has so far been directly affected. Species ranges are, at this stage, primarily determined by the climate and the availability of suitable habitat. However, being sandwiched between two expanding settlement areas, Saldanha in the south and Jacobs Bay in the north, the *C. niger* population will be subjected to increasing pressure from habitat destruction and human activities.

The Saldanha-Langebaan part of the west coast with its hinterland has, in the early sev-

enties, long been considered an area of enormous potential for development, mainly as a heavy industrial centre. The Saldanha-Sishen project was the focal point of this, and during 1972, prospective development projects to transform the region into a metropolitan area, were investigated (Thomas 1973). These plans, however, never realised. At present, the economy is based on harbour facilities, fish industry, agriculture and tourism (K.P.A. 1988). Proposals have, however, been made for the development of a steel plant and a cement factory at Saldanha. This will inevitably lead to economic growth and the *C. niger* population may come under immense pressure through urban development. Although a large part of the population occurs within the terrain of the South African National Defence Force, where development and public access are controlled, the future of this terrain is uncertain and it does not automatically provide a safe haven for this species. With an expected increase in the demand for housing, the use and allotment of land will probably be redistrubuted. It is therefore of paramount importance that urban development in Saldanha be directed away from the sensitive western coastal areas and that the terrain of the South African National Defence Force, including the Toothrock bomb track, be left intact and managed as a nature reserve. Jacobs Bay West Coast Village is, with 300 plots, the largest development project between Saldanha and Jacobs Bay. The resulting influx of people into that area will have an impact on the surrounding environment. It could also serve as a platform for more developments, and plans to develop a caravan park and a complex of eight houses southwards, are expected to be carried through in the near future. The contact zone will then almost certainly be affected or even destroyed. Developments in the Jacobs Bay area should therefore not be allowed to proceed further south than Mauritz Bay (Figs. 3 & 5). It is also suggested that the state owned coastal belt should be widened from 50 m to about 150 m. This would prevent the infiltration of developments into the immediate coastal zone.

The current trend in conservation is to conserve whole ecosystems and not only a single, unique element. Our preoccupation with the conservation of the black girdled lizard, *C. niger*, stems from the belief that relic populations of other organisms may also occur in the area demarcated by the presence of *C. niger*. With its fragmented distribution in the area it is apparently much more sensitive to environmental changes than the other two melanistic species and its current range probably highlights the most suitable spots for cool-adapted forms to survive in the Saldanha-Langebaan area. If other relic cool-adapted forms occur in the area they will most probably occur at least in these key areas inhabited by *C. niger*. The subpopulation of *C. niger* occurring between Morrison's Point and Mauritz Bay (Fig. 3b) is furthermore of special interest as it is an ideal population to monitor the effects of climatic changes, especially those associated with the greenhouse effect. As it is a completely flat terrain, any longterm small change in climate should be easily detected in the species' microdistribution and behavioural patterns. This subpopulation, including the contact zone with the closely related, nonmelanistic species, *C. cordylus*, also provides the opportunity for comparative studies regarding the physiological advantages of melanism in cool environments.

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Appendix 1

The lizard species recorded in the study area. Examples of reference material are given

Family Scincidae

Acontias meleagris (Cape legless skink) e.g. JEM 326-332; *Scelotes sexlineatus* (striped dwarf burrowing skink) e.g. JEM 394; *Scelotes gronovii* (Gronovi's dwarf burrowing skink) e.g. JEM 253; 254; 360; 395-401; *Scelotes kasneri* (Kasner's dwarf burrowing skink) e.g. JDV 4176; TM 46867; *Typhlosaurus caecus* (Cuvier's blind legless skink) e.g. JEM 439; 1737; *Mabuya capensis* (Cape skink) e.g. JEM 461-463; 392-393; *Mabuya homalocephala* (red-sided skink) e.g. JEM 618; 1683; *Mabuya variegata* (variegated skink) e.g. JEM 235-237

Family Lacertidae:

Meroles knoxii (Knox's desert lizard) e.g. JEM 27; 261; 288

Family Cordylidae:

Cordylus cordylus (Cape girdled lizard), e.g. JEM 111; 112; 351-357; *Cordylus niger* (Cape girdled lizard) e.g. JEM 219-227; 345-349; *Cordylus polyzonus* (Karoo girdled lizard) e.g. JEM 522-524; 270-271; 298-299; *Cordylus macropholis* (large-scaled girdled lizard) e.g. JEM 502; 934

Family Gekkonidae:

Phyllodactylus lineatus (striped leaf-toed gecko) e.g. JEM 16-17; 114-115; 228-229; *Phyllodactylus porphyreus* (marbled leaf-toed gecko) e.g. JEM 23-24; 125; 255-256; *Pachydactylus austeni* (Austen's gecko) e.g. JEM 25-26; 418; 538; *Pachydactylus geitje* (ocellated gecko) e.g. JEM 116-117; 386-387

Family Chamaeleontidae:

Agama hispida (spiny agama) e.g. JEM 444; 534-535; 615; *Bradypodion occidentale* (Namaqua dwarf chamaeleon) e.g. JEM 350

(JEM = John Ellerman Museum, University of Stellenbosch; JDV = Private collection of J. D. Visser; TM = Transvaal Museum, Pretoria)

Appendix 2

Localities where melanistic Acontias m. meleagris *specimens have been collected*

Saldanhakop:	33°00'18"S; 17°56'09"E	JEM 337
Agterklipvlei	33°02'22"S; 17°54'07"E	JEM 2597
Jutten Island	33°04'57"S; 17°57'19"E	JEM 326-332
Rondeberg Farm	33°25'18"S; 18°17'56"E	JEM 1256;1687; 1690; 1695; 110