On the ecology and conservation status of *Cordylus giganteus* A. Smith in the Transvaal

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The distribution of *Cordylus giganteus* in the Transvaal is discussed. Details of population density, burrow aspect and dimensions are incorporated including data on sex ratios, age structure and reproduction. Comments on the conservation status of the species in the Transvaal are made.

Die verspreiding van *Cordylus giganteus* in die Transvaal word bespreek. Besonderhede van bevolkingsdigthede, ligging en grootte van gate word ingesluit, asook data oor geslagsverhoudings, ouderdomstrukture en voortplanting. Kommentaar oor die bewaringstatus van die spesie in Transvaal word gelewer.

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The giant girdled lizard *Cordylus giganteus* Smith is an unusual Cordylid in that it is totally terrestrial. It inhabits the grasslands of the south-eastern Transvaal, north-eastern Orange Free State and a small area in adjacent Natal. Other members of the genus are mostly rupicolous but a few are arboreal.

Until recently the known distribution of *Cordylus giganteus* was the north-eastern Orange Free State with one unsubstantiated record from Vereeniging in the southern Transvaal (FitzSimons 1943; Branch & Patterson 1975; De Waal 1978). McLachlan (1978) listed the species as vulnerable in the South African Red Data Book.

During a survey of the distribution of reptiles and amphibians of the Transvaal, particular attention was paid to establishing the existance of the species in the Transvaal. This led to extensive farm-to-farm surveys in the south-eastern Transvaal from where verbal accounts of its presence had been received. Verification was soon made but simultaneously it became apparent that a large proportion of the population was under threat from the proposed construction of a power station.

In co-operation with the Electricity Supply Commission (ESCOM) the lizards were removed from the site ahead of development. This article reports on the data collected during this translocation as well as on the distribution of the species in the Transvaal.

Methods

Mention was made in the introduction regarding the farm-to-farm survey of the south-eastern Transvaal. The details were obtained by discussion with the farmers in the area followed by verification by sightings.

At the power station site the lizards were removed ahead of progressive development. Initially all burrows were located and marked with a painted stake. Burrows were recognized by the raised ridge along the middle of the hole, which distinguished them from the burrows of other small animals such as mongooses. Each burrow was subsequently dug up and the lizards removed. The animals were sexed by using external characters observed during the capture program, namely, enlarged glandular humeral scales exclusive to subadult and adult males, reinforced by more active and abundant glandular femoral scales. They were then weighed and measured from snout to vent (SVL).

The orientation of the burrow was noted according to aspect. Length and depth of the burrows were measured with a steel tape.

A portion of the power station site, 143,68 ha in extent, was monitored in greater detail. This was mapped and the location of each burrow plotted as well as the sex of the inhabitants where possible.

Results

The survey ascertained that *Cordylus giganteus* is limited in distribution in the Transvaal to an area of 1 790 km^2 between Standerton, Volksrust and Amersfoort (Figure 1). Here it was found in undulating grassland dominated by *Themeda triandra* belonging to Acocks (1975), Veld types 52 and 54. The height of the grass may reach one metre but is normally kept short by the grazing of cattle and sheep. Much of the area is under maize cultivation and the veld types are extensively, 79% and 64% respectively, degraded. The soil is mainly a silty, fine sand.

The lizards are found inhabiting self-excavated burrows scattered in the grassland, on average 17 m apart (n = 22). In the detailed study area there were 580 burrows or 4,04/ha, which is similar to the four to six per hectare recorded in the Orange Free State (Stolz & Blom 1981). Burrows were found to face in all directions as mentioned by Branch & Patterson (1975) and Marais (1984). A detailed analysis of 870 burrows can be seen in Figure 2.

Most burrows (68,5%) were found in a semi circle facing SW to NE, with 40,8% facing NW to NE, whereas Stolz & Blom (1981) in the Orange Free State observed 70% to face in a northerly direction. The burrow opening may or may not have a depression at the entrance which is mostly vegetated. The entrance is a flat oval with a high ridge along the middle of the floor of the

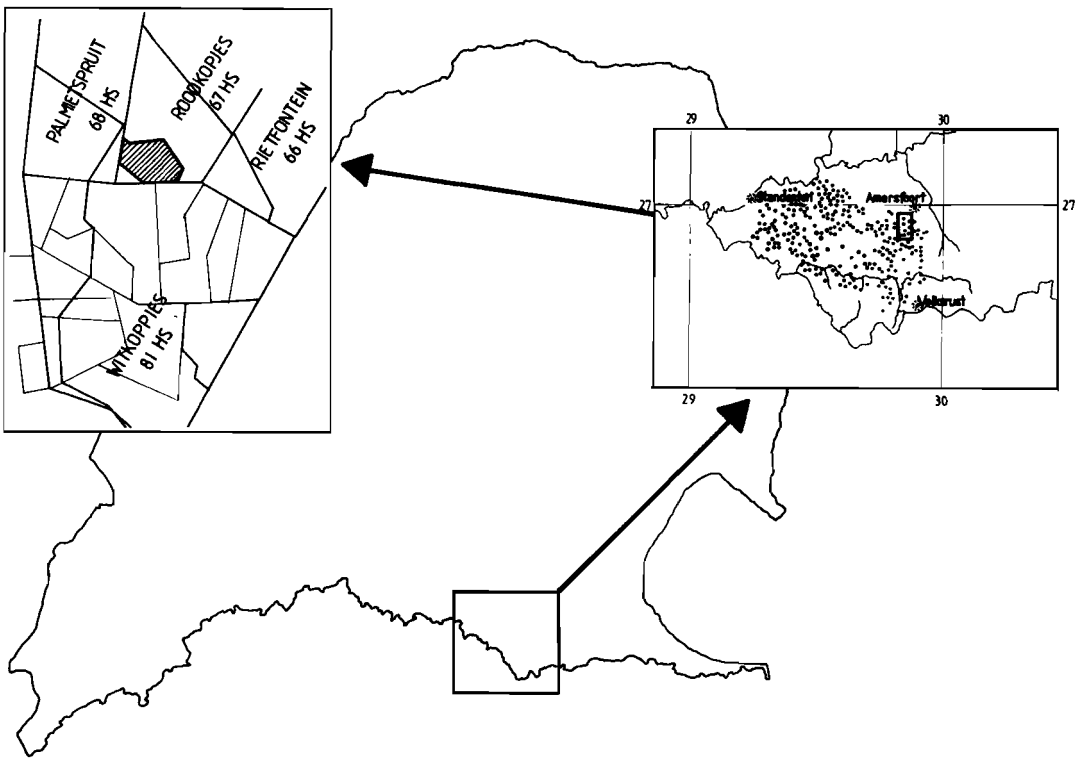

Figure 1 The distribution of *Cordylus giganteus* in the Transvaal showing the location of the power station site and intensive study site.

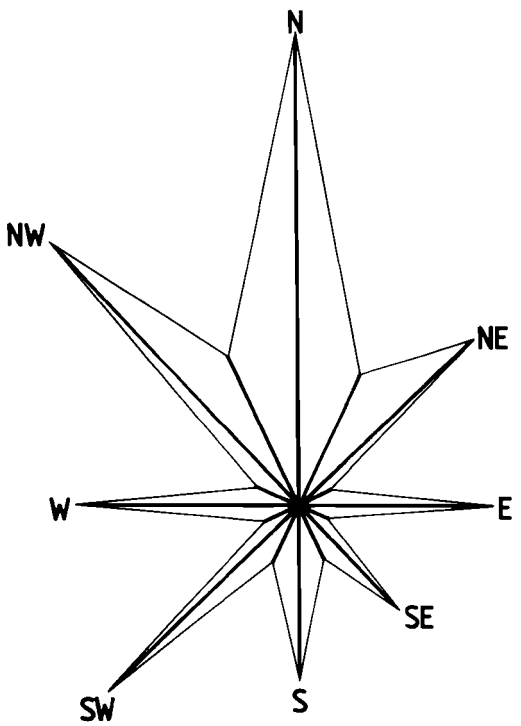

Figure 2 A diagrammatic representation of the orientation of the entrances of 870 burrows excavated on the Majuba site, according to aspect.

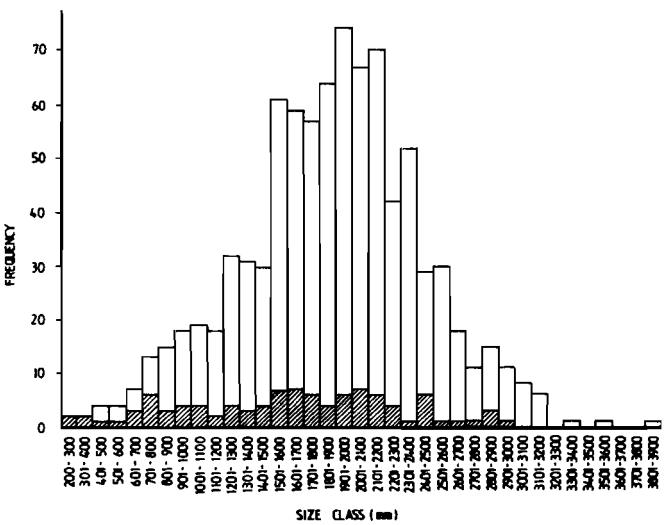

Figure 3 Frequency of burrow lengths with hatched area indicating unoccupied burrows.

burrow, caused by the drag of the feet eroding the floor on either side analogous to the nesting burrows of kingfishers and bee-eaters.

The burrows slope gently with one or more bends or kinks along the length. Burrow length was variable (Figure 3), but most (62,6%) were between 1,5–2,4 m. There was no correlation between burrow length and sex (p = 0,90; t = 1,172; df = 48). In the sample of 870 burrows, 100 or 11,49% were found to be unoccupied indicating a reservoir to be utilized by surviving young. This contrasts with the 15,62–18,5% recorded by Stoltz & Blom (1981). Empty burrows ranged in length from 20–300 cm, most being between 70–240 cm (Figure 3). The percentage of unoccupied burrows facing SW to NE was 67,92 which is not different from the total of all

burrows facing those points of the compass. It is probable that most burrows are re-used once the previous owner has died or moved out.

Burrow depth depended on length and ranged from 15–70 cm below the surface at the terminal end (Figure 4). The burrows did not appear to curve upwards at the end as has been suggested by De Waal (1978). Most burrows were between 35–45 cm at their deepest point below the surface (Figure 4). The burrows taper and at no point does it appear possible for the lizards to turn around in their burrows. Only in the immediate vicinity of the entrance is there sufficient room for this. This is contrary to what was recorded in the Orange Free State.

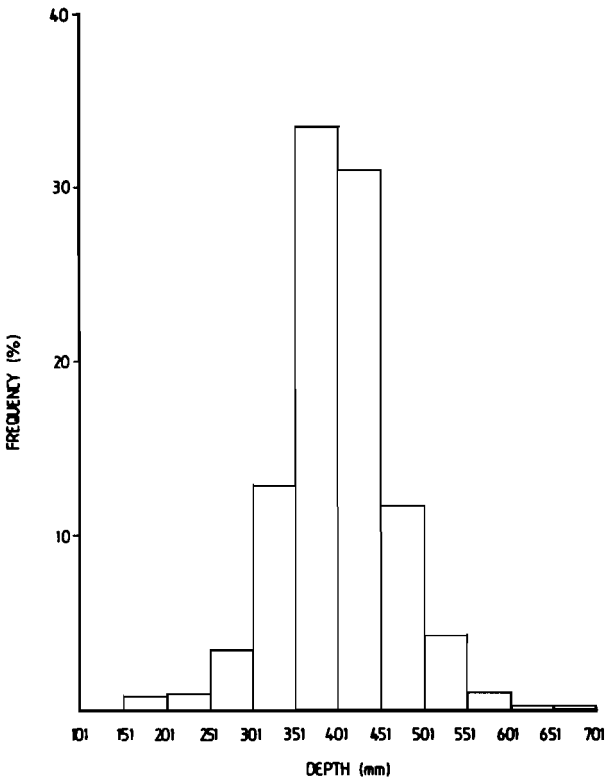

Figure 4 Burrow depth.

Most excavated lizards were found with the head wedged in the tapered, terminal part of the burrow. Occasional specimens were found at various distances along the burrow length. De Waal (1978) records finding lizards submerged under water during the rainy season.

This was substantiated during the relocation. The animals appear able to survive long periods of submergence and waterlogged conditions.

Figure 5 shows the approximate positions of the burrows in the intensive study site of 143,68 ha. Although appearing random some grouping of the burrows is evident suggesting the formation of communities. From the 580 burrows excavated here, a total of 931 lizards or 1,61 animals per burrow were captured. At a mean of 4,04 burrows / ha, a density of 6,5 lizards / ha was obtained.

Figure 6 shows the arbitrary age distribution of the population in the intensive study site. It is evident that the adults and juveniles form the largest percentage of the sample with smaller numbers of immature and subadult animals.

The paucity of neonates appears to indicate a low recruitment rate. Possible predation pressure on juveniles and immature animals is also suggested.

Out of a total of 1 568 individuals collected during the excavation of burrows only 429 (27,36%) comprised single individuals, mostly adults (89,51%). The number of animals per occupied burrow varied between one and seven (Table 1) with one to three most frequent. As

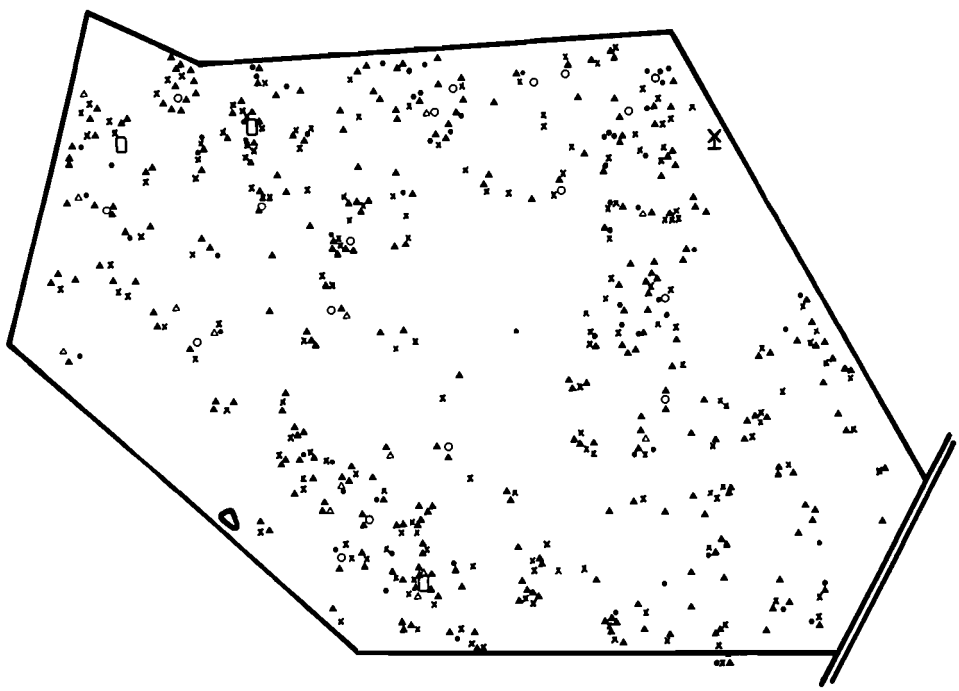

Figure 5 The location of 580 burrows in the intensive study site showing adult females (▲), adult males (×), adult males and females in the same burrow (△), juveniles or immatures only (○) and unoccupied burrows (●).

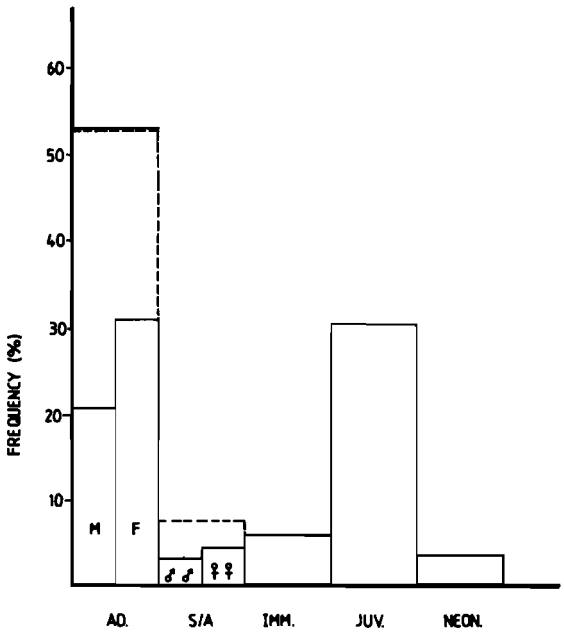

Figure 6 Percentage frequency of the various arbitrary age classes of *Cordylus giganteus* in the intensive study site.

translocations were mostly performed during the summer months it was not possible to determine whether the situation changed during the winter. It is considered unlikely as the animals are mostly dormant at this time of year although some may bask at the entrance to their burrows.

Reproduction

In the intensive study site a sex ratio of 1 male : 1,57 females was observed. As it was only possible to sex the adults and subadults with certainty immatures and younger individuals were excluded. Figure 5 shows the arrangement of males and females to one another as well as indicating burrows where only juveniles or immatures were found. Adult males and females were found in the same burrow on only 29 occasions (Table 1). These observations occurred during August (2), September (11), October (13), February (2), March (1), April (0), May (0) and July (0).

Owing to the greater relocation activities during September and October it was not possible to determine which months have the greatest frequency. However, as neonates were found during September, October, February and March, it is likely that mating takes place throughout the warmer months, with a possible extended gestation over winter.

Normally one to two young are born per season per female (FitzSimons 1943; De Waal 1978; Marais 1984). During the removal of the lizards from the power station site, neonates (SVL < 70,0 mm) were observed on 37 occasions. Of these 21 were single, 14 were of two individuals and two were of three individuals. On five of the occasions the neonates were together with adult males and/or other age classes, while on 32 occasions they were with adult or subadult females (Table 1) and/or other age classes.

FitzSimons (1943) and Marais (1984) recorded the size

Table 1 Sex, age and group composition of *Cordylus giganteus* removed from burrows at Majuba

Ad. ♀	Ad. ♂	Subad. ♀	Subad. ♂	Imm.	Juv.	Neon.	*N*
2	–	–	–	–	3	–	1
2	–	–	–	–	2	–	1
2	–	–	–	–	1	–	1
2	–	–	–	–	–	–	3
1	1	1	1	–	3	–	1
1	1	1	1	–	–	–	2
1	1	1	–	1	–	–	1
1	1	1	–	–	2	–	1
1	1	1	–	–	–	–	5
1	1	–	–	–	1	–	2
1	1	–	–	2	–	–	1
1	1	–	–	–	–	2	1
1	1	–	–	–	–	–	15
1	–	2	–	–	3	–	1
1	–	2	–	–	–	–	3
1	–	1	1	–	–	–	1
1	–	1	–	1	–	–	2
1	–	1	–	1	2	–	1
1	–	1	–	–	3	–	2
1	–	1	–	–	2	1	1
1	–	1	–	–	1	–	1
1	–	1	–	–	–	1	1
1	–	1	–	–	–	–	23
1	–	–	2	–	2	–	1
1	–	–	2	–	1	–	1
1	–	–	1	–	3	–	3
1	–	–	1	–	2	–	2
1	–	–	1	–	1	2	1
1	–	–	1	–	1	–	5
1	–	–	1	–	–	–	13
1	–	–	–	3	–	–	1
1	–	–	–	2	1	–	1
1	–	–	–	2	–	–	9
1	–	–	–	1	3	–	1
1	–	–	–	1	2	–	1
1	–	–	–	1	1	–	2
1	–	–	–	1	–	–	10
1	–	–	–	–	4	–	1
1	–	–	–	–	3	–	27
1	–	–	–	–	2	1	2
1	–	–	–	–	2	–	62
1	–	–	–	–	1	1	7
1	–	–	–	–	1	–	61
1	–	–	–	–	–	3	2
1	–	–	–	–	–	2	10
1	–	–	–	–	–	1	5
1	–	–	–	–	–	–	196
–	2	–	–	–	–	–	5
–	1	2	–	–	2	1	1
–	1	2	–	–	–	–	2
–	1	1	1	–	–	–	1
–	1	1	–	1	–	–	1
–	1	1	–	–	–	–	17
–	1	–	2	–	–	–	1
–	1	–	1	–	3	–	1
–	1	–	1	–	1	–	2
–	1	–	1	–	–	–	11
–	1	–	–	2	–	–	3
–	1	–	–	1	1	1	1
–	1	–	–	1	–	–	10
–	1	–	–	–	4	–	2
–	1	–	–	–	3	–	2
–	1	–	–	–	2	–	10
–	1	–	–		1	–	33
–	1	–	–	–	–	2	2
–	1	–	–	–	–	1	2
–	1	–	–	–	–	–	188
–	–	2	–	–	–	–	1
–	–	1	–	–	–	–	19
–	–	–	1	–	1	–	1
–	–	–	1	–	–	–	15
–	–	–	–	2	–	–	1
–	–	–	–	1	–	–	6
–	–	–	–	–	2	–	3
–	–	–	–	–	1	–	5

of neonates between 114–135 mm total length. The neonates removed from the burrows varied considerably in total length as follows (measurements in mm):

123	129	130	131	132	133	134	135	136	137
2	1	1	7	3	5	1	2	3	4

138	139	140	141	142
2	0	5	0	1

A female captured on 8 March 1988 gave birth to three neonates which measured 115,0 mm total length. This indicates that there is considerable variation in neonate size.

Measurements of the various arbitrary age classes of *Cordylus giganteus* can be seen in Table 2. The relationship between snout-vent length and mass is evident in Figure 7. Females achieve a greater mass than males, although the heaviest may have been gravid as the measurement was made in early May. De Waal (1978) during his survey, recorded the largest male and female as measuring 204,0 mm and 205,0 mm SVL respectively. This is larger than those recorded in the Transvaal. This is substantiated by Stolz & Blom (1981) who recorded masses of up to 300 g in the Orange Free State.

In the intensive study site the total mass of the 931 animals removed was 101 496 g or 706,27 g/ha.

Food

The stomach contents of six *Cordylus giganteus* were analysed (Figure 8). Coleoptera (beetles) and Hymenoptera (ants) appear to be important prey but the lizards are opportunistic as the variety of food consumed indicates. It appears that even plant material is at times consumed although this may be accidental. These results are substantiated by De Waal (1978) who recorded mostly beetles of the family Scarabaeidae. Also recorded were Curculionidae, Lepidoptera larvae, Orthoptera — Acrididae and Myriapoda. The prey consumed consists mostly of slow-moving easily captured invertebrates which is in keeping with their 'sit and wait' strategy and clumsy method of feeding discussed by Marais (1984).

Discussion and Conclusion

Although *Cordylus giganteus* is a typical K-selected

Table 2 Greatest and mean S/V length (mm), and mass (g) of the various arbitrary age classes of *Cordylus giganteus*

No.	Sex	Mean S/V length	Greatest S/V length recorded	Mean mass	Greatest mass recorded
27	♂ Ad.	166,15 ± 8,16	198,0	180,93 ± 29,12	236,0
25	♂ S/A	135,48 ± 6,35	145,0	92,02 ± 18,00	138,0
27	♀ Ad.	169,52 ± 7,42	188,0	208,00 ± 36,09	273,0
25	♀ S/A	135,66 ± 7,35	145,0	91,20 ± 21,22	138,0
25	Imm.	109,20 ± 7,94	120,0	47,21 ± 13,11	76,0
27	Juv.	77,00 ± 3,08	90,0	13,86 ± 2,98	22,0
25	Neon.	67,12 ± 2,73	70,0	9,87 ± 0,98	12,0

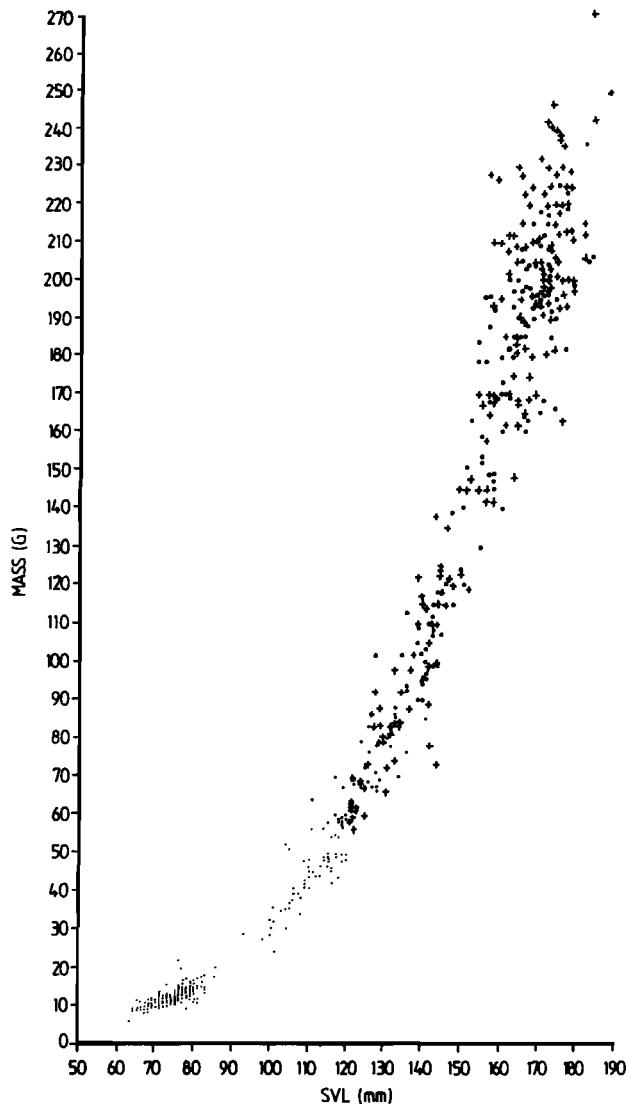

Figure 7 Relationship between snout/vent length and mass in *Cordylus giganteus*. Neonates and immatures (•), male (●), female (+).

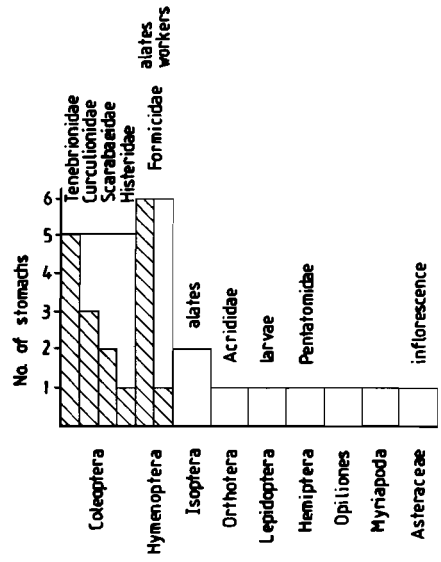

Figure 8 Stomach contents of six *Cordylus giganteus* from Amersfoort.

species its recruitment potential is more than adequate to maintain population levels. The apparent paucity of immature and subadult individuals indicates, as already mentioned, a greater predation pressure. Known predators include black-headed herons and rinkhals. However, as the lizards are very long-lived (*ca* 10 years) recruitment is adequate. The only real threat to their survival is habitat destruction and commercial trade in the species.

Habitat destruction is largely due to agricultural activities, particularly the cultivation of maize. However, current maize production appears adequate to meet the needs of the human population, and land use practices are not likely to change in the forseeable future.

A somewhat more insidious threat is that of mining. Large portions of the area inhabited by the sungazer are underlain by coal beds, some shallow and some deep. The erection of power stations dependent on coal for fuel is likely to proceed at a pace commensurate with the demand for electricity. The Majuba Power Station is an example. It covers a total area of about 3 200 ha, roughly 1,79% of the lizard's total distribution range in the Transvaal, from which to date approximately 2 000 lizards have been removed and relocated in adjacent areas. Most of the optimum available habitat was already occupied and the relocated animals have been placed in deserted burrows and others constructed with a soil auger around and among existing colonies. Areas without lizards but appearing suitable have been settled. The lizards do not appear to recolonize fallow lands owing possibly to the alteration of the soil structure and water-holding capacity. This means that as development encroaches on these lizards, less and less area will be suitable for recolonization.

The commercial demand for pets and 'muti' of these lizards was a threat in the past but is currently contained and will be monitored. It may be feasible to market some of the animals which may have to be removed in the future. This will depend on the Conservation authorities concerned.

An estimate of the total Transvaal population which is allopatric to those in Natal and the Orange Free State is approximately 50 000. It does appear that the Transvaal form is smaller than those from the Orange Free State. Although the population is large, a change in land-use patterns will have a dramatic impact and result in further fragmentation. It is therefore imperative that additional protective measures be implemented.

At present a small reserve (± 300 ha) has been set up by ESCOM in collaboration with the Transvaal Directorate of Nature Conservation at the Majuba Power Station site. This has only limited habitat available and a viable population cannot be maintained. It is necessary that suitable areas housing at least 1 000 individuals each be adequately conserved to ensure the continued survival of the species. These reserves would also protect remnants of the fast disappearing Veld types 52 and 54 and the specialized animal communities inhabiting them. Currently *Cordylus giganteus* is regarded as vulnerable according to Red Data Book criteria. Let us hope that it never exceeds this category.

Acknowledgements

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