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The use of ^{65}Zn for estimating group size of brown hyaenas *Hyaena brunnea*

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The applicability of a method of estimating group size based on the labelling of an individual within a group of hyaenas with the zinc isotope ^{65}Zn is evaluated. This isotope is detectable in faeces and the method is based on the assumption that the proportion of labelled faeces found at latrines, will equal the proportion of labelled hyaenas in the group. Group size estimates increased logarithmically with an increase in the number of stools included in the analysis but remained relatively constant after approximately 140 stools were included. Estimates were in agreement with direct observations.

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In die artikel word die toepaslikheid van 'n metode om groepgrootte, gebaseer op die merk van 'n lid van die groep met die sink-isotoop ^{65}Zn, bepaal. Die isotoop is in faeces waarneembaar en die metode is gebaseer op die aanname dat die verhouding gemerkte keutels wat in latrines gevind word, met die hoeveelheid gemerkte hiënas in die groep ooreenstem. Groepgrootteskattings het logaritmies met die hoeveelheid keutels wat by die analise ingesluit is, toegeneem maar gestabiliseer nadat ongeveer 140 keutels ingesluit was. Skattings het ooreengestem met direkte waarnemings aangaande groepgrootte.

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Brown hyaenas *Hyaena brunnea* are solitary foragers but live in small groups (Mills 1983) which share and defend a territory (Mills 1982) when neighbours of the same sex meet (Mills 1983). Brown hyaenas in the Central Namib Desert predominantly defaecate in latrines which appear as shallow depressions dug by them and in which faeces accumulate (Skinner & van Aarde 1981). Latrines are distributed throughout a territory with the highest densities in foraging areas and are used by all group members.

Group size in brown hyaenas which is an important component of the social organization of carnivores (see MacDonald 1983), is influenced by the quality of resources within a territory (Mills 1982). Group size is, however, difficult to determine accurately using routine methods (i.e., direct counts and mark recapture techniques) owing to the shy, elusive and nocturnal habits of brown hyaenas and the physiognomic characteristics of their habitats. The relative ease with which brown hyaenas could be observed along the coast of the Central Namib Desert, however, provided a unique opportunity to test the applicability of a method of estimating group size based on labelling an individual within the group with the zinc isotope ^{65}Zn. The method was developed by Kruuk, Gorman & Parrish (1980) and is based on the assumption that the proportion of labelled faeces found at latrines will equal the proportion of labelled animals in the group.

The present paper evaluates the use of this technique and is based on material and information collected from a group of three hyaenas studied between October 1982 and October 1983. This group's territory (approximately 130 km^2) surrounded the seal *Arctocephalus pusillus* colony at Wolfbaai (approximately 20 km south of Luderitz; 26°39'S/15°09'E). The seal colony also formed the focal point of activity of the group.

Materials and Methods

An adult male (45,5 kg) trapped at Wolfsbaai was immobilized and given an intramuscular injection of a 450 μCi hypotonic $^{65}ZnCl$ solution (37,0 MBq/ml, sp. act. 0,78 mCi/ml, Radiochemical Centre, Amersham, Bucks, U.K.) after being radio-collared (A.V.M. Instrument Co., California, U.S.A.). The animal thus received approximately 10 μCi/kg. All stools deposited in latrines were collected during four sampling periods (between October 1982 and July 1983) from 32 latrines within the territory of the group. The convex polygon resulting from interconnecting outer-

boundaries of their territory. All these latrines were cleared of stools before the release of the labelled male. Thereafter, each collected stool was stored separately in a paper bag. Stools were oven-dried for five days at 70°C and radioactivity of each stool was counted for 5 min in duplicate 1,0-g fractions using a Beckman Y 8000 counter. Counts of possible radioactive decay in 100 samples collected before the release of the labelled individual, served as controls to separate labelled and non-labelled stools. 'Radioactive decay' in 1,0-g samples of stools collected before the release of the labelled hyaena, varied from 196,6 to 401,8 d.p.m./g dry faeces ($\bar{x} = 316 \pm 50{,}1$ *S.D.*) and faecal samples with values larger than 417 d.p.m./g dry faeces (mean ± 2 *S.D.* of blanks) were thus considered labelled.

Group size (G) was estimated using the equation

$$G = I \times \frac{N}{n^+},$$

where I = number of labelled individuals, N = total number of stools collected, and n^+ = the number of labelled stools (Kruuk *et al.* 1980). Standard errors of the estimates were calculated using the equation

$$S.E. = \frac{I^2(N+1)(N-n)}{(n^+ + 1)(n^+ + 2)}$$

(see Caughley 1977).

Results

The 41 latrines identified in the group's territory were not utilized with the same intensity; 71,6% of all stools originated from 12 latrines along the coast, the remainder from 20 latrines sited throughout the interior. Nine latrines were not used by group members during the study period. The labelled male used 19 (59,4%) of the 32 latrines of the group, those along the coast being used more intensively by him than by other group members ($\chi^2 = 7{,}89$; $d.f. = 1$; $p < 0{,}001$). Only three latrines were used exclusively by the labelled male, these being sited throughout the interior of the group territory.

Observed rates of defaecation for 28 nights on which hyaenas were followed during their total activity period, varied from zero to two per night ($\bar{x} = 0{,}71 \pm 0{,}60$ *S.D.*). Estimated defaecation rates, based on the number of labelled stools collected during each sampling period, varied from 0,6 to 1,4 stools per night ($\bar{x} = 1{,}03 \pm 0{,}38$ *S.D.*; $n = 143$ stools and 147 nights), suggesting that most stools produced by the labelled male were collected.

Counts of 'radioactive decay' in labelled faeces decreased logarithmically with time ($r^2 = 0{,}50$) but these were still separable from non-labelled samples 205 days after injection of the isotope. Group size estimates increased logarithmically with an increase in the number of stools but remained relatively constant (2,8–3,0) after approximately 140 stools were included in the analysis (Figure 1). Estimates based on stools collected from 12 latrines in the proximity of the seal colony during each sampling period, varied from 2,2 ± 0,27 to 2,5 ± 0,38 ($\bar{x} = 2{,}3 \pm 0{,}16$) and that based on stools collected at the other latrines ($n = 20$), varied from 2,1 ± 0,29 to 19 ± 9,7 ($\bar{x} = 3{,}8 \pm 0{,}52$). Group size estimates based on all stools collected, varied from 1,9 ± 0,20 to 3,0 ± 0,33 for each of the sampling periods (Table 1). Observed group

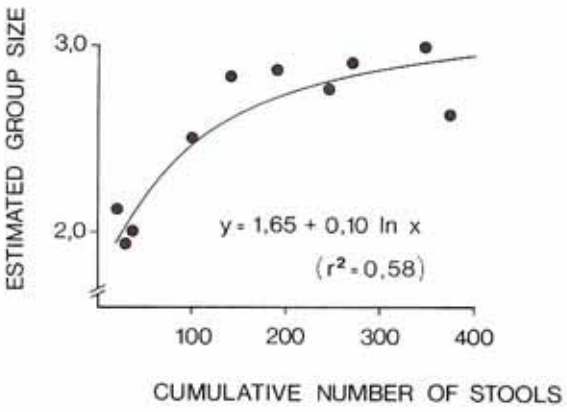

Figure 1 The effect of sample size (cumulative number of stools) on group size estimates.

Table 1 Seasonal changes in group size estimates of brown hyaenas in the Central Namib Desert

Sampling period	Number of stools collected (n)	Number of labelled stools (n)	Group size ($G \pm S.E.$)
9 Oct 1982 – 9 Nov 1982	71	38	1,9 ± 0,20
29 Dec 1982 – 24 Jan 1983	145	48	3,0 ± 0,33
20 Apr 1983 – 16 May 1983	79	28	2,8 ± 0,03
7 Jul 1983 – 28 Jul 1983	77	29	2,7 ± 0,34
Total	372	143	2,6 ± 0,17

Discussion

^{65}Zn, with a half-life of 245 days (Bailey, Linn & Walker 1973) is detectable in faeces over a considerable period and has been used in a number of ecological studies (Gentry, Smith & Beyers 1971; Nellis, Jenkins & Marshall 1967; Kruuk *et al.* 1980). Our analyses indicate that the method of labelling a group member with the isotope, followed by the collection of faecal stools, can be used for determining brown hyaena group size accurately. Accuracy, however, was affected by the number of stools included in the analysis, with under- and overestimates resulting from the inclusion of too few samples in the analysis.

In the present study reliable estimates were obtained when more than 140 stools were included in the analysis. Seasonal variation in estimates is ascribed to inadequate sample sizes, and the differential use of latrines also affected group size estimates (probably a factor of sample size) with the most accurate estimates being obtained when stools from all identified latrines were included. The large variation in estimates found for the outlying latrines is also ascribed to limited sample size, the highest estimate (19 ± 9 *S.D.*) resulting from only 20 stools being collected during the specific sampling period.

The method used to estimate group size is based on the assumptions that stools collected at latrines originated from a discrete group, that labelled and unlabelled stools had the same chance of being collected, and that the labelled individual did not leave the territory between labelling and sampling. These assumptions are valid since brown hyaenas live in discrete groups with limited overlap between neighbouring territories. In the Namib, most stools are

radio-tracking indicated that the labelled male's activities were limited to the delineated territory of the group. Estimates based on the collected stools are in agreement with our direct observations, thereby supporting the findings of Kruuk *et al.* (1980) that capture-mark-recapture techniques can be applied to faeces which can be adequately retrieved of group-living carnivores to estimate group size accurately. Furthermore, the method allows for immigration and births since each calculation provides an estimate over the time of production of the faecal stools (Kruuk *et al.* 1980).

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