

The density and abundance of juvenile *Varanus exanthematicus* (Sauria: Varanidae) in the coastal plain of Ghana

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Abstract. The density and abundance of *Varanus exanthematicus* was measured by single searches and mark-recapture studies at sites in the Great Accra Region of Ghana. One hour search effort yielded a mean of 0.42 lizards in August/September 1994 and 0.87 lizards in March/April 1996. Mark-recapture results indicated a density of 357 juveniles per km² in mixed farmland and grassland habitats.

Introduction

Bosc's monitor lizard (*Varanus exanthematicus*) is a large lizard with a wide distribution through the grasslands of West Africa. In Ghana the species is collected for the international pet trade, elsewhere it is exploited for its meat and skin (Luxmoore et al., 1988; de Buffrenil, 1993). I estimated the abundance and density of populations in the Great Accra Region of Ghana and investigated the efficiency with which licensed trappers caught lizards.

Materials and methods

Field work was conducted from 8 August to 14 September 1994 and 26 March to 14 April 1996. Search team consisted of the investigator and three or four licensed animal trappers. In 1994, 15 randomly chosen one ha quadrats between Abokobi (5°44'N, 0°12'W) and Ashonman (5°42'N, 0°12'W) were searched systematically for monitor lizards six times. First five searches took place between 14-27 August, the last 12-13 September. Eighteen other sites in the Great Accra Region were searched once between 28 August-

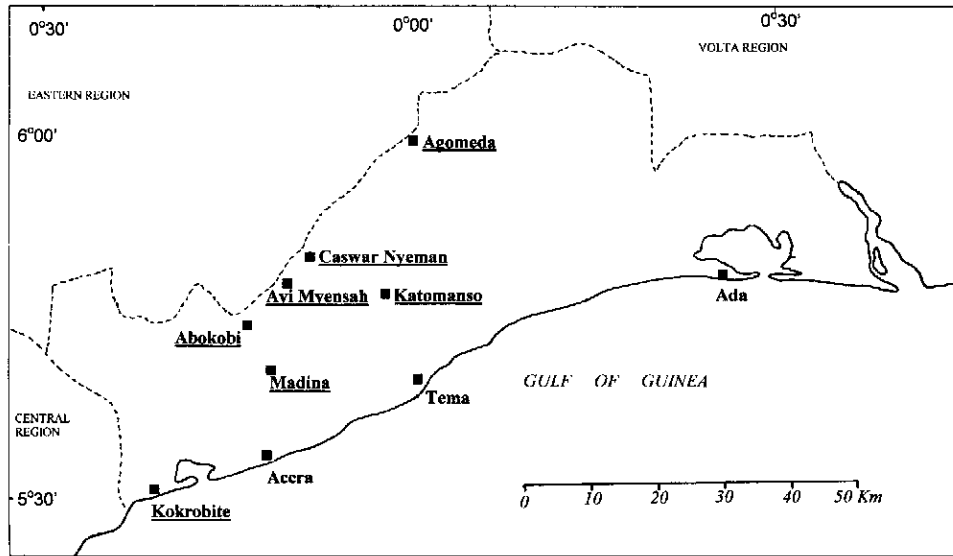


Figure 1. Location of study sites (underlined) in the Great Accra Region of Ghana.

17 September, totaling 18 search days. In 1996 seven sites were searched once using the same animal collectors employed in 1994 (totaling seven search days). All study sites were mosaics of farmland (cassava, maize, tomatoes, peppers and pineapples) and uncultivated areas (ca. 2 m high grass in abandoned fields and coastal savanna grasslands with sparse woodland) and were registered as collection sites for *V. exanthematicus* with the Ghana Wildlife Department (fig. 1). Searches were carried out between 0900 and 1700 hrs. Animals were found by searching for and excavating burrows, marked (at sites visited more than once) with a blob of enamel paint on the head or neck and a "V"-shaped notch in the tail crest and released at point of capture. Paint marks were specific to individuals, tail notches were not. In this study "juveniles" are animals born that year (probably between March and April) and "adults" are animals of all other age classes, not necessarily sexually mature.

Results

In 1994 during a total of 488 search hours at 19 sites 88 juveniles and two adults were caught. Mean daily yield per unit effort was 0.42 juveniles (s 0.47, range 0-1.81). One-hundred-and-seventy-five juveniles captured during the study period in 1994 had mean snout-vent length of 157 mm (s 27.1, range 103-243) and mean mass of 86.5 g (s 46.6, range 17-287). In 1996 a total of nine adults and 84 juveniles were collected from seven sites. Mean daily yield per unit effort was 0.87 juveniles per search hour (s 0.45, range 0.13-1.27). Forty-six juveniles caught during the study period in 1996 had a mean snout-

Table 1. Yield of *Varanus exanthematicus* at sites in the Great Accra Region in 1994.

Date	Site	Time	Hours	No. trappers	Effort	No. juveniles caught	No. juveniles per unit effort
8-Aug-94	Abokobi 1	1100-1735	6.58	4	26.3	29	1.81
9-Aug-94	Abokobi 2	1100-1735	6.58	4	26.3	10	0.38
10-Aug-94	Madina 1	1200-1430	2.5	4	10	12	1.2
11-Aug-94	Caswar Nyeman 1	0900-1700	8	4	32	3	0.09
12-Aug-94	Caswar Nyeman 2	1020-1530	5.6	4	22.4	0	0
13-Aug-94	Caswar Nyeman 3	1100-1500	4	4	16	0	0
15-Aug-94	Abokobi 3	1100-1730	6.5	4	26	11	0.42
16-Aug-94	Abokobi4	1100-1400	3	4	12	6	0.5
22-Aug-94	Caswar Nyeman 4	1000-1700	7	3	21	7	0.33
26-Aug-94	Ayi Myensah 1	1100-1730	6.5	3	19.5	5	0.26
28-Aug-94	Ayi Myensah 2	1100-1730	6.5	3	19.5	15	0.77
29-Aug-94	Ayi Myensah 3	1100-1730	6.5	3	19.5	12	0.62
30-Aug-94	Ayi Myensah 4	1100-1730	6.5	3	19.5	13	0.67
3-Sep-94	Agomeda 1	1000-1730	7.5	4	30	5	0.17
5-Sep-94	Agomeda 2	1000-1730	7.5	4	30	1	0.03
6-Sep-94	Madina 2	1100-1400	3	3	9	0	0
8-Sep-94	Kokrobite	1100-1730	6.5	3	19.5	0	0
9-Sep-94	Ayi Myensah 5	1100-1730	6.5	3	19.5	2	0.1
14-Sep-94	Ayi Myensah 6	1000-1530	6.5	3	19.5	13	0.67
TOTALS			113.26		397.5	144	

Table 2. Yield of *Varanus exanthematicus* at sites in the Great Accra Region in 1996.

Date	Site	Time	Hours	No. trappers	Effort	No. juveniles caught	No. juveniles per unit effort
26-Mar-96	Katomanso	1200-1715	5.25	3	15.75	20	1.27
27-Mar-96	Abokobi 1	1350-1715	3.4	3	10.2	9	1.13
28-Mar-96	Abokobi 2	1200-1700	5	3	15	2	0.13
29-Mar-96	Abokobi 3	1200-1700	5	3	15	5	0.33
12-Apr-96	Ayi Mysensah 1	1200-1700	5	3	15	15	1
13-Apr-96	Ayi Myensah 2	1200-1700	5	3	15	15	1
14-Apr-96	Abokobi 4	1200-1700	5	3	15	18	1.2
TOTALS			33.65		100.95	84	

vent length of 86.3 mm (s 10.06, range 70-110 mm) and 65 juveniles had mean mass of 14.6 g (s 6.58, range 6-36 g). Results are summarised in tables 1 and 2.

In the mark-recapture study 44 juveniles were captured a total of 78 times. A mean of 13.0 (s 4.86, range 7-19) captures were made per search and a mean of 3.47 (s 2.67, range 0-9) individuals caught per quadrat. Calculation of the standardized Morista index suggests a clumped distribution ($I = 0.5019$, $df = 14$, $\chi^2 28.769$, $P < 0.05$). Nine recaptured animals had lost paint marks. Because individuals could not be identified the Schumaker and Eschelmeyer (1943) method was used to estimate population size (fig. 2).

Schumaker & Eschelmeyer Estimator

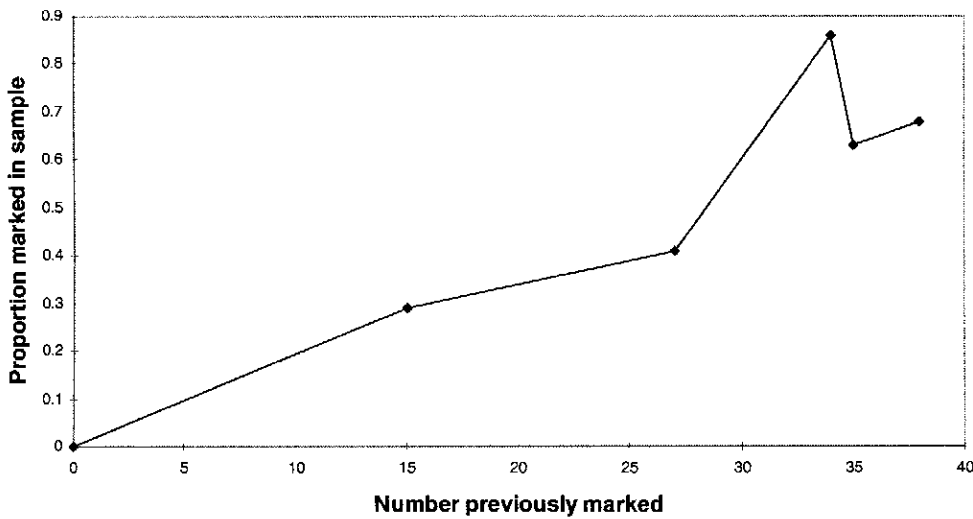


Figure 2. Schumaker and Eschelmeyer estimator for mark-recapture data.

Schumaker and Eschelmeyers' population estimate for total study area of 15 ha was 53.46 (95% confidence limits 44.2-67.6), equivalent to 356.58 individuals per km².

All juveniles were caught on cultivated land and only two captured above ground. Almost all lizards found underground were in the burrows of a large orthopteran (*Brachytrupes* sp.). Two adult *V. exanthematicus* were caught in 1994, both in coastal savanna at Agomeda and within 10 m of each other. One was in a shallow burrow, the other in the base of an abandoned termite mound. Eight of the nine adults caught in 1996 were in uncultivated savanna (two in termitaria, three in burrows and two caught above ground). The other was in a burrow at the edge of a field.

Discussion

The Schumaker and Eschelmeyer estimator indicates how the numbers of captures fell over successive searches and how the proportion of recaptures declined over the last two searches. The search method (excavation) will encourage emigration (though burrow destruction) and immigration (through subsequent recolonisation) in quadrats, and increase the likelihood of animals seeking shelters other than burrows. There was no apparent alternative to burrow excavation for surveys because juveniles were impossible to find above ground. Furthermore, because this is a method used in the commercial collection of lizards it was appropriate because it gave a direct measure of the effects of exploitation on

local abundance. The Schumaker and Eschelmeyer population estimate does not change considerably when later samples are omitted from analysis.

Densities of monitor lizards in Africa have been calculated for *Varanus albigularis* as 10-50 animals per km² in Kenya (Western, 1974) and 2.05 kg per km² at Etosha National Park in Namibia (Phillips, 1995). The present study suggests a density of 357 juvenile *V. exanthematicus* per km² (equivalent to a biomass of 30.9 kg per km²) in farmland/savanna mosaic in the coastal plain of Ghana. A measure of the number of reproductively active females the previous year can be estimated from the number of juveniles present. Cisse (1976) reported a maximum of 41 eggs in female *V. exanthematicus* from Senegal, Roder and Horn (1994) report two captive females laying 18 eggs each. The largest nest I have found in Ghana contained 29 eggs, two others contained six and 15. Assuming 100% hatch rate, nil mortality and a single clutch of 15 eggs per year, I suggest that the juveniles in 1 km² of farmland/savanna mosaic represent about 24 adult females.

Commercial interest in *V. exanthematicus* is for skins and live animals (Luxmore et al., 1988; de Buffrenil, 1993). Between 1990 and 1998 CITES recorded exports of 20,076 *V. exanthematicus* skins, from Guinea, Mali and Nigeria. The main exporters of live *V. exanthematicus* are Ghana, Togo, Benin and Mali. Between 1990 and 1998 declared exports of live *V. exanthematicus* from these countries totaled 214,067 animals (CITES trade statistics derived from WCMC CITES trade database). Between 1995 and 1998 an average of 13,202 live *V. exanthematicus* were exported from Ghana per year, totaling 52,809 for the four year period (Ghana Wildlife Department CITES statistics). Juvenile monitor lizards are preferred for the pet trade because they are more marketable and attract less freight charges. They are collected either by excavating burrows or by catching gravid females and incubating the eggs artificially (de Buffrenil, 1993). Traditionally, monitor lizards are not eaten in the Great Accra Region, there is no tradition of tanning lizard skins and the only obvious source of exploitation is the pet trade. The clustered distribution of juveniles suggests a lack of neonate dispersal which makes populations more vulnerable to overcollecting. Early in the season (February to April) trappers claim to find nests of eggs or hatchlings, and in this way can collect 50 or more animals in a single day. Assuming a 50% extraction rate and (perhaps unjustifiably) zero mortality between collection and export, 55.5 km² of coastal grassland/farmland mosaic would satisfy the declared yearly demand for *V. exanthematicus*. How much suitable habitat exists in the coastal plain of Ghana is not known. In the Great Accra Region many sites on the edge of the city have been destroyed for development since 1994, including some of the study areas at Madina and Abokobi visited during this study.

Acknowledgements. Thanks to G.A. Punguse, B.Y. Ofori-Frimpong, N.K. Ankudey, W. Akonnor, S. Adamu and B. Basuglo of Ghana Wildlife Department. I am particularly grateful to Basil and Julie Aryeteey of Accra for numerous acts of kindness. Valuable advice from two anonymous referees is gratefully acknowledged. Work in 1994 was funded by a Nuffield Foundation Undergraduate Bursary under the supervision of Dr R. Ralph (Aberdeen) and the 1994 Aberdeen University Zoology Department Undergraduate Travel Bursary.

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Received: 17 June 1999. Accepted: 1 December 1999.
