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HOME RANGE AREA OF THE LIZARD *PODARCIS HISPANICA ATRATA*

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Home range is defined as the area traversed during the routine activities of food gathering, mating, seeking shelter, and caring for young (Burt, 1943). Studies of home range area (HRA) have been of enduring interest to population and behavioral ecologists (Turner, Jennrich & Weintraub, 1969; Christian & Waldschmidt, 1984; Garland, Dickerman, Janis & Jones, 1993). The aim of this study was to measure the home range area of the lizard *Podarcis hispanica atrata*. *Podarcis h. atrata* is an endangered heliothermic lizard endemic to the Columbretes islands (Castilla & Bauwens, 1991*a,b*; Castilla & Swallow, 1995). This is an actively foraging species that feeds mainly on arthropods (Castilla, Jiménez & Lacomba, 1987), although it also preys on conspecific eggs and juveniles (Castilla, 1995).

The Columbretes islands (39° 54' N, 0° 41' E) constitute an archipelago of small uninhabited islands of volcanic origin situated in the Mediterranean ca. 57 km off the coast of Castellón (province of Castellón, Spain). The climate of the archipelago is characterized by an average annual temperature of 17°C and low rainfall (265 mm/year). This lizard is present only on four islets, having an entire range of about 20 ha.

The study was conducted on the largest (13 ha) island, 'Columbrete Grande,' where the density of lizards in favourable habitats is very high (> 800 individuals/ha; Castilla & Bauwens, 1991*b*). The study site was a grid (2,800 m^2) marked with coloured flags on 1.5 m metallic wires spaced 5 m apart; each flag was marked with an ordinal coordinate. Vegetation in the study site consists mainly of perennial shrubs (*Suaeda vera*, *Lobularia maritima*) not higher than 60 cm, herbs (*Lavatera mauritanica*), and patches of grasses. The study plot was visited every day during 27 May - 1 July 1993 (34 days) between 0800-1100 and 1500-1900 hrs (Mean European Time, MET). A total of 96 adult lizards was captured by noose or by hand. We considered lizards with snout-vent length (SVL) > 50 mm as adults. Males were distinguished from females by head shape, and presence of femoral pores (Castilla & Bauwens, 1991*b*). Data recorded for each lizard included date of capture, site of capture (by cardinal ordinate), sex, SVL, and body mass. SVL was measured to the nearest 0.1 mm with callipers, and mass was measured to the nearest 0.1 g with a pesola scale. An individual identification code (four colour dots marked with paint spots on the back of the head and neck) was given to each lizard. The lizards were then released at their point of capture. Subsequent sightings and recaptures were recorded only with date and site of capture. Recapture data for an individual lizard caught within four hours of a previous recapture were discarded to minimize autocorrelation between data points and to allow lizards to return to their normal activity.

HRA was estimated using the convex polygon method (Waldschmidt, 1979; Rose, 1982) because this estimate can easily be graphed and visualized with a co-ordinate system. Furthermore, with adequate numbers of recaptures, estimation by convex polygon provides an accurate and comparable measure of HRA (Rose, 1982). Multiple regression analyses were used to estimate log HRA with log body mass, number of captures, interval between first and last capture, and a dummy variable for sex as independent variables. All analyses were performed using SPSS/PC+ version 5.0.

SVL ($\pm$ 1 SE) averaged 62.4 $\pm$ 4.89 mm (range 53.0 - 74.1 mm; n = 61) for adult males, and 59.2 $\pm$ 3.54 mm (range 52.0 - 65.2 mm; n = 35) for adult females. Body mass averaged 5.4 g $\pm$ 1.25 g (range 3.6 - 8.5 g; n = 61) for adult males and 4.0 g $\pm$ 0.68 g (range 2.8 - 5.5 g; n = 35) for adult females. Adult males were longer (ANOVA: $F_{1,94}$ = 11.28; P < 0.001) and heavier (ANOVA: $F_{1,94}$ = 41.01; P < 0.001) than females. ANCOVA indicated that males weighed more than females even after accounting for differences in SVL (P < 0.001). Allometric equations were: *log body mass =-4.14 + 2.71* x *log SVL* (R^2 = 0.823; 95% CI on slope = 2.384 - 3.038) for males, and *log body mass = -3.81 + 2.48* x *log SVL* (R^2 = 0.749; 95% CI on slope = 1.975 - 2.993) for females.

HRA was calculated for all individuals which were captured five or more times (mean = 12.5; Table 1). However, inspection of the relationship between cumulative HRA and number of recaptures indicated that many of the lizards may not have been recaptured a sufficient number of times to accurately predict HRA. As noted by many authors, an insufficient number of recaptures results in an underestimation of HRA (Jennrich & Turner, 1969; Schoener, 1981) whereas the use of a correction factor often leads to an overestimation of HRA (Rose, 1982).

A multiple regression approach was used to estimate HRA, accounting for log body mass, number of recaptures, interval between first and last recapture, and sex. We used a stepwise algorithm and various combinations of forced entry to determine the best model. Based on previous studies, we expected HRA to increase with increasing body mass, number of recaptures, and interval between first and last capture. We also anticipated that males would maintain a larger

TABLE 1. Home range size (HRA), number of captures, interval between first and last capture, sex, body mass, and snout-vent length (SVL) for individual adult male (M) and female (F) lizards with at least five captures.

HRA (m^2)	No. captures	Interval (days)	Sex	Mass (g)	SVL (mm)
123.5	27	27	M	6.1	66.1
50	23	34	M	5.8	63.6
75.5	21	26	M	5.0	59.1
54	21	21	M	5.3	62.0
165	20	29	M	6.7	65.7
109	20	27	M	8.1	74.0
34	20	21	M	4.2	57.6
61	15	16	M	7.4	67.3
34.5	15	18	M	5.6	60.8
39	14	17	M	6.2	65.9
111.5	12	29	M	6.8	67.2
67	10	14	M	8.5	72.1
26.5	8	12	M	5.2	60.4
40	6	11	M	6.2	67.0
15.5	6	11	M	4.9	57.6
90.5	5	26	M	5.6	64.9
26.5	5	12	M	5.2	60.4
37	17	25	F	4.6	61.1
31	14	20	F	4.3	59.2
17	5	13	F	4.3	62.9
15.5	5	5	F	4.1	59.9

HRA (Rose, 1982; Stamps, 1983; Christian & Waldschmidt, 1984). All of these predictions were met by these data. Interval of recapture had the strongest correlation with log HRA (r = 0.786), but log body mass (r = 0.479), number of captures (r = 0.611), and sex (males = 1, r = 0.412) were also positively correlated. The regression model which best fit the 21 individuals captured five or more times was as follows:

$$log\ HRA = 0.106 + 1.260 \times log\ body\ mass + 0.030 \times interval$$

The overall model was highly statistically significant (R^2 = .739; $F_{2,18}$ = 25.53; $P < .0001$; standard error of estimate = 0.180), and both log body mass (partial F = 8.45; $P < 0.01$) and interval of recapture (partial F = 35.23; $P < 0.001$) were significant predictors of HRA. Neither number of recaptures (partial F to enter = 0.08; $P > 0.5$) nor sex (partial F to enter = 0.03; $P > 0.5$) added significantly to the model. We then used the average log body mass of the 17 males (0.782) and of the four females (0.636) along with the maximum number of days between first and last recapture (34) to estimate HRA. We used the maximum value for the interval because we felt that many of the individual lizards were caught an insufficient number of times to accurately estimate HRA (Schoener, 1981), and we did not want to underestimate HRA. Using the foregoing values we estimated a log HRA of 2.11 (antilog = 132.3 m^2; 95% CI = 54.1 - 306.9 m^2) for males and of 1.93 (antilog = 86.5 m^2; 95% CI = 35.7 - 202.8 m^2) for females.

Our HRA estimate for male *P. h. atrata* (132.3 m^2) is slightly larger than that reported for conspecifics from the mainland (*Podarcis hispanica hispanica*) during the same month (mean = 120.0 m^2; Gil, Pérez-Melado & Guerrero, 1988). Our HRA estimate for female *P. h. atrata* (mean = 86.5 m^2) is considerably larger than reported for females from the mainland (29.1 m^2; Gil *et al.*, 1988). Adult *P. h. hispanica* are considerably smaller (adult males = 3.0 g; adult females = 2.8 g; Castilla, unpublished) than adult *P. h. atrata*. In any case, comparisons between these two populations are problematic because of differences in methodology and body mass. Furthermore, caution should be taken when making claims from comparisons that involve only two species or subspecies (Garland & Adolph 1994).

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