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Observations on the Natural History, Present Status, and Conservation of the Insular Lizard *Podarcis hispanica atrata* on the Columbretes Archipelago, Spain

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ABSTRACT

The world range of the lizard Podarcis hispanica atrata *is retricted to the Columbretes archipelago in the Mediterranean. We examined its actual distribution, abundance and some aspects of its natural history. Lizards were found in four islets (combined area* c. *20 ha). Densities on the largest islet (13 ha) are high (>600 lizards/ha), at least in favourable habitats. Population sizes on the smaller islets are extremely small (<200 individuals). A considerable number of juvenile lizards was found in all populations. We report new information on body length distribution, sexual dimorphism, tail break frequency, escape behaviour, and diet composition. Recommendations for the conservation of this lizard and the improvement of its habitat are given and discussed in relation to landscape management programmes.*

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INTRODUCTION

Several species of lacertid lizards (mainly *Podarcis* spp.) have undergone a remarkable microevolutionary radiation on islands in the Mediterranean Sea (Eisentraut, 1950, see also species accounts in Böhme, 1986). The high degree of intraspecific variation and endemism has been considered a conservation priority (Corbett, 1989), the more so because most populations inhabit islets that are extremely small in size—most are 10–100 ha, some < 1 ha (see Pérez-Mellado, 1989)—and hence extremely vulnerable.

Podarcis hispanica atrata, one of the least known Mediterranean lizards, has a world range that is restricted to some small islets (total area *c.* 20 ha) in the Columbretes archipelago (Spain). According to IUCN definitions its status is considered as endangered (Corbett, 1989). This lizard has been the subject of several taxonomic studies (Boscá, 1916; Eisentraut, 1930; Klemmer, 1961), but its life history is little known (Castilla *et al.*, 1987). We recently undertook a short-term field study attempting to gather information relevant to its conservation, and here report on the present distribution, abundance and several aspects of its general biology. A detailed account of the activity rhythms, thermal ecology and habitat selection patterns during autumn is presented elsewhere (Castilla & Bauwens, 1991).

THE COLUMBRETES ISLANDS

The Columbretes islands (39° 54N, 0° 41E) constitute an archipelago of small uninhabited islets of volcanic origin situated in the Mediterranean, *c.* 57 km off the coast of Castellón (province of Castellón, Spain). The archipelago is formed by four groups of islets (Fig. 1): (1) Columbrete Grande—Columbrete Grande (13 ha), Mascarat, Señoreta, Mancolibre; (2) Ferrera—Ferrera (1·5 ha), Espinosa, Bauzá, Valdés, Navarrete; (3) Horadada—Horadada (1·6 ha), El Lobo (0·5 ha), Méndez Núñez; (4) Bergantín—Bergantín (0·1 ha), Cerquero, Churruca, Baleato.

The climate on the archipelago is characterised by an average annual temperature of 16·8°C and low rainfall (265 mm/year). Most precipitation occurs during autumn. Daily fluctuations in ambient temperature are low during spring and autumn.

The vegetation consists mainly of perennial shrubs (*Suaeda vera*, *Lobularia maritima*), herbs (*Lavatera mauritanica*, *Malva parviflora*) and patches of grasses. The vegetative cover by *L. mauritanica* and *M. parviflora* exhibits dramatic seasonal fluctuations, and depends strongly on precipitation levels. Trees are absent, except for one introduced individual of *Ficus*

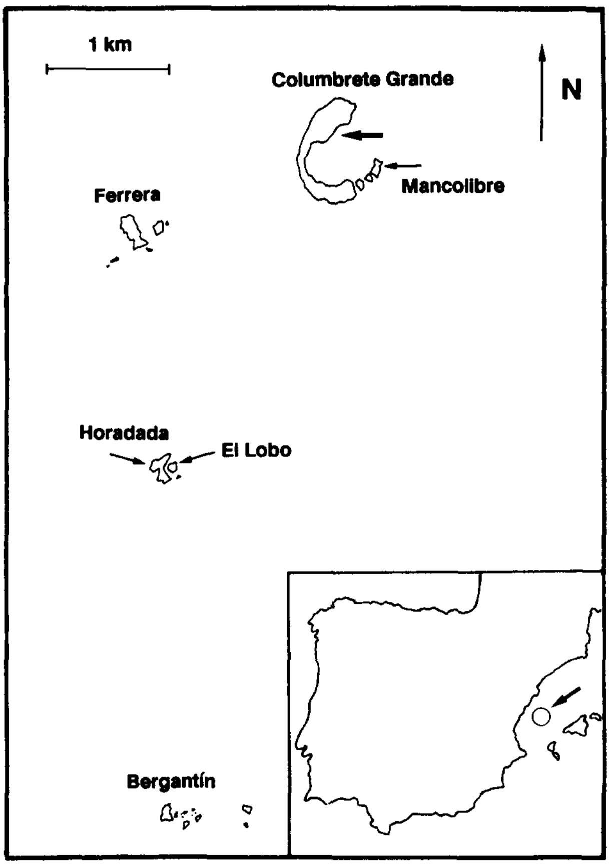

Fig. 1. Location (inset) and map of the Columbretes islands. Arrows point to islets where *P. hispanica atrata* was observed.

carica on Columbrete Grande (for detailed accounts on the geology, climate and vegetation see various chapters in the volume edited by Alonso Matilla *et al.* (1987)).

The islands were named 'Colubraria' by the Romans, who referred to the large number of vipers *Vipera latasti* which inhabited Columbrete Grande. The islands remained uninhabited by humans until 1855, when a lighthouse was built. Workmen started intensive campaigns to exterminate the vipers and scorpions *Buthus occitanus*. Apart from direct killing, these included burning of the vegetation and the release of domestic pigs. Vipers were exterminated by 1885 (see detailed account in Castilla *et al.*, 1987), scorpions are still abundant today. The lighthouse-keepers, who lived continuously on the island, also introduced rabbits *Orictolagus cuniculus*, domestic cats and goats, and created small vegetable gardens. These practices had devastating effects on the natural vegetation and fauna. In addition, until 1982 the islets

Horadada, Ferrera and Bergantín served as targets for military bombardment exercises. Human residence ended in 1975, when the lighthouse became fully automated. In 1988 the islands and their marine surroundings were declared a Natural Park by the Generalitat Valenciana and the Spanish government. As part of a programme to restore natural vegetation and to reduce soil erosion, all surviving rabbits were removed in 1987–88.

The terrestrial vertebrate fauna constitutes a major conservation priority of the archipelago. It consists exclusively of the endemic lizard *P. hispanica atrata* and following breeding bird species: Eleonora's falcon *Falco eleonorae*, herring gull *Larus cachinnans michahellis*, Audouin's gull *Larus audouinii*, Cory's shearwater *Calonectris diomedea*, shag *Phalacrocorax aristotelis* and storm petrel *Hydrobates pelagicus*. The islets are regularly visited by various species of songbirds and birds of prey during the periods of vernal and autumnal bird migration.

MATERIALS AND METHODS

The study was conducted between 27 September and 12 October 1989. We concentrated our efforts on Columbrete Grande, the only inhabitable islet. Some short visits were made to other islets: Mancolibre (4·5 h), El Lobo (4·5 h), Horadada (3·5 h) and Ferrera (2 h). Logistic constraints, difficult access, and precautions so as not to disturb nestling Eleonora's falcons, prevented us from increasing the number of visits to these islets.

On Columbrete Grande we laid out two fixed transects which covered most of the islet. Transect I (670 m) was a footpath which crossed distinct types of vegetation and an extensive area of peeled volcanic rocks. Transect II (180 m) was a cement path, with a low cliff of bare rocks on one side and fairly homogeneous shrubby vegetation on the other. Observations were made while one of us walked along these routes at known times for a total of 24·5 search hours between 0700 and 1700 h (Mean European Time). This interval covers the entire daily activity period of lizards at that time of the year. Upon sighting each undisturbed lizard, we recorded date, time, size ($\approx$age) class—juvenile: <48 mm snout–vent length (SVL); adult: SVL > 52 mm, sex of adults, approach distance (distance between the lizard and the observer when the lizard first moved) and flight distance (distance across which the lizard flees away from the observer).

During separate searches along these transects we also recorded, for each lizard observed, the rightangle distance from the point of initial sighting to the transect line. These data were used to obtain estimates of lizard densities by the transect count methods of Crain *et al.* and Gates (see Burnham *et al.*, 1980). The transect counts were made on sunny and calm days to reduce the possible effects of weather conditions on lizard activity and hence on the density estimates.

During visits to the smaller islets we counted all lizards observed as an estimate of the minimum number of individuals present there.

On Columbrete Grande we also surveyed two study plots where we attempted to capture most of the resident lizards. Plot F (864 m^2) was located near the lighthouse, on a steep south-facing slope whose floor was covered by numerous loose rocks and stones, debris of human constructions and *Suaeda* shrubs. Plot C (750 m^2), situated near the 'Casernas', had habitat characteristics representative of the whole island, including vegetation dominated by *Suaeda vera*, patches dominated by *Lavatera mauritanica* and *Malva parviflora*, grassy patches and piles of stones. Lizards were caught by noose or by hand, given a colour mark on their head or back and released after noting sex, snout–vent length (SVL), tail length (original and regenerated portions separately), length of pileus (tip of snout to posterior end of parietal scales), width of pileus (at widest point on parietal scales), and weight (to nearest 0·1 g on a portable electronic Sartorius balance). In an additional sample of lizards captured all over the island, we measured the above as well as the following morphometric traits: width and height of head (at widest and highest points, by closing the callipers until resistance was felt), length of the stretched left forelimb (armpit to base of fourth toe) and hindlimb (first femoral pore to base of fourth toe).

The relative size of morphometric traits (length and width of pileus, width and height of head, length of forelimb and hindlimb, weight) versus SVL was investigated in adult lizards by the application of the allometric equation ($Y = a\ \mathrm{SVL}^b$ or $\log Y = \log a + b \log\ \mathrm{SVL}$). The parameters, and their standard errors, of this equation were estimated through least-square regression analysis of log-log transformed data. Differences between sexes in the parameters of the allometric equation were assessed by analysis of covariance (ANCOVA).

The data on approach and flight distances were normalised by logarithmic transformation. The average values and their 95% confidence limits shown in figures and tables were obtained through back-transformation; the confidence intervals (CI) are therefore asymmetrical around the mean (see Sokal & Rohlf, 1981).

RESULTS AND DISCUSSION

Distribution

Salvator (1895) was the first to report the presence of lizards on Columbrete Grande. Boscá (1916), Eisentraut (1930) and Castilla *et al.* (1987) captured the first lizards on Horadada, Mancolibre and El Lobo, respectively. We confirm the actual presence of lizards on these four islets.

The absence of lizards on most of the remaining islets is not surprising, considering their small area (<0·1 ha) and lack of vegetation. The notable exception is Ferrera (1·5 ha), which has abundant vegetation hardly altered by human activities. Despite repeated visits during 1983–1989, no lizards have been observed on this islet.

Morphological characteristics

Most adult lizards are basically brown or grey-brown with dark spots on back and flanks, which may form a reticulated pattern. Some females have clear dorsolateral stripes. Unlike the nominate form *P. hispanica hispanica*, which usually has small punctate marks on the throat, many insular lizards have black blotches on chins and throat and sometimes on the belly. Vent colour is usually uniform and ranges from whitish to a conspicuous deep orange. The latter colour was seen most frequently in adult males, but also in some females. Males often have a row of blue spots on the outer ventral scales. Juveniles are brownish and many have irregularly scattered dark markings and ocelli on back and flanks. The smallest juveniles had greenish tails. We observed few clear-cut differences in colour pattern among lizards from the different islets. The exception was that all lizards captured on Mancolibre (seven adult males) had uniform whitish bellies.

Snout–vent length averaged 65·3 mm (SD = 4·03, (n = 76) in adult males, and 61·7 mm (SD = 3·40, n = 47) in adult females (Fig. 2). Mean SVL was 36·9 mm (SD = 3·57, n = 38) in the juveniles, which could not be sexed. The manifest bimodal length distribution (Fig. 2) strongly suggests that two age

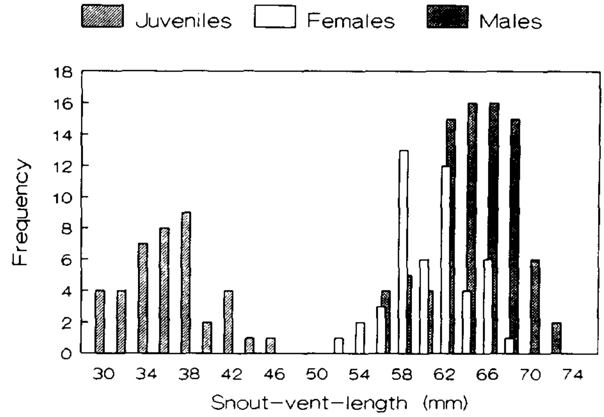

Fig. 2. Distribution of body size in juvenile, adult male and female *P. hispanica atrata* during autumn.

TABLE 1

Allometric Equations with Snout–vent Length as Independent Variable

	Adult males		*Adult females*		*ANCOVA*	
	log *a*	*b* ± *SE*	log *a*	*b* ± *SE*	*b*	*a*
Length of pileus	−0·375	0·742 ± 0·054	−0·158	0·647 ± 0·068	ns	***
Width of pileus	−1·675	0·870 ± 0·099	−0·687	0·593 ± 0·123	ns	***
Height of head	−0·993	0·218 ± 0·309	−1·194	0·686 ± 0·250	ns	***
Width of head	−0·363	0·452 ± 0·138	−0·044	0·492 ± 0·175	ns	***
Length of forelimb	0·924	0·382 ± 0·151	2·286	0·013 ± 0·283	ns	***
Length of hindlimb	0·572	0·559 ± 0·171	1·798	0·220 ± 0·169	**	
Weight	−7·595	2·285 ± 0·189	−7·396	2·180 ± 0·286	ns	***

Estimates are given for intercepts (log a) and slopes (b) of log-log regression equations and results of comparisons between the sexes ANCOVA. (ns: $p > 0·05$, *, $p < 0·05$, ***, $p < 0·001$).

classes are present: juveniles, born in the current year, and adults, which are in at least their second activity year. The wide size range within the juvenile class indicates a wide hatching asynchrony, possibly due to the production of multiple clutches.

P. hispanica atrata attains a considerably larger size and is more robust than the nominate form on the Iberian peninsula. On the nearest coast Levante), SVL ranges from 46·8 to 60·9 mm ($\bar{x} = 54·2$, SD = 4·42, $n = 15$) in adult males, and from 45·7 to 53·3 mm ($\bar{x} = 49·7$, SD = 2·95, $n = 11$) in adult females (Pérez-Mellado & Galindo, 1986).

Our analyses of sexual differences in the relative size of morphometric traits did not include the unsexable juvenile lizards. The data, which consist of a cross-section sample, hence only represent part of the range of body sizes that can be encountered in this lizard. Parameter estimates for the allometric equations are presented in Table 1. Lizards were sexually dimorphic for all traits examined (Table 1; Fig. 3). The differences in regression coefficients indicate that males have a bigger head, longer limbs and weigh heavier than the females, even after accounting for the effect of SVL (Table 1, Fig. 3). Comparable sexual differences in various body proportions have been described in representatives of different lizard families (e.g. Iguanidae: Schoener *et al.*, 1982; Scincidae: Vitt & Cooper, 1985; 1986; Lacertidae: Wermuth, 1955; Castilla *et al.*, 1989).

Density estimates and population composition

We used our empirical data to determine the width of the transect strips on Columbrete Grande. In transect I, the maximal rightangle distance from a

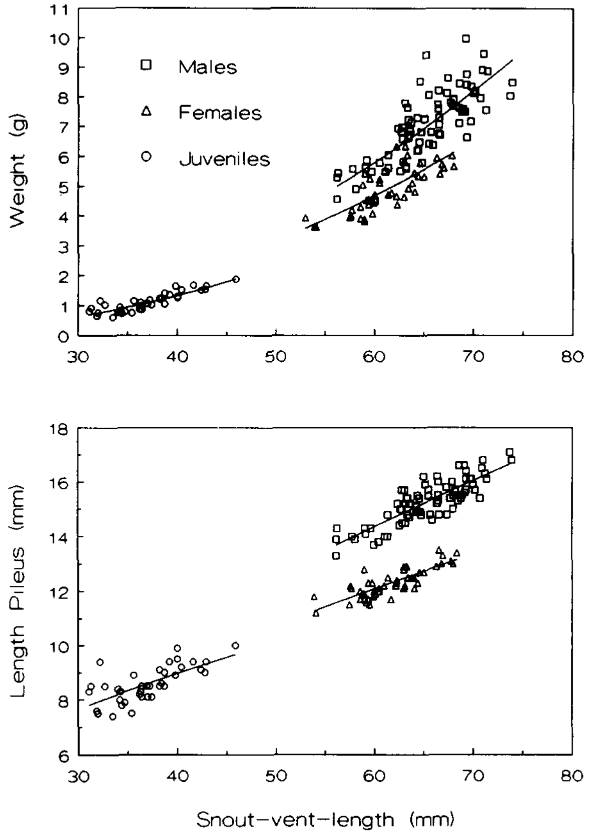

Fig. 3. Relations of weight and length of pileus to snout–vent length in juvenile, adult male and adult female *P. hispanica atrata*. See Table 1 for regression equations.

lizard sighting spot to the path of the observer was 6 m, but >95% of the individuals were within 4 m of the transect line. The maximal distance in transect II was 4 m, whereas >95% of the lizards were seen within 2 m of the line transect path. Strip width was therefore considered to be 8 and 4 m in transects I and II, respectively. As lizard activity, and hence the number of individuals observed, exhibits diel changes, density estimates were calculated for different time intervals. Density estimates obtained by both methods coincide reasonably well (Table 2). The results suggest that lizard density was notably highest in the area covered by transect II (Table 2). Several factors may account for this difference. First, the cement footpath and the low rock cliff that ran along transect II were extensively used by basking lizards, especially during the early morning and late afternoon hours. As the visibility of lizards that bask on such exposed sites is distinctly higher than for individuals foraging in vegetated patches, this might have inflated our estimates. Second, transect I crosses an extensive area of peeled

TABLE 2

Estimated Densities of *P. hispanica atrata* at Two Line Transects on Columbrete Grande during Different Periods of the Day

	Transect I (670 × 8 m)		*Transect II (180 × 4 m)*	
Time interval	*Crain* et al.	*Gates*	*Crain* et al.	*Gates*
0730–0930 h	139 (88–189)	146 (108–184)	424 (110–738)	243 (147–339)
0930–1030 h	54 (20–88)	87 (58–116)	374 (175–573)	362 (199–525)
1030–1230 h	166 (99–232)	166 (103–229)	—	—
1300–1500 h	104 (56–152)	101 (58–144)	658 (493–823)	1 055 (745–1 365)
1500–1700 h	47 (30–64)	77 (49–104)	545 (274–816)	709 (281–1 137)

Density estimates and their 95% confidence limits (in parentheses) were obtained by the line transect count methods of Crain *et al.* and Gates (in Burnham *et al.*, 1980).

volcanic rocks where lizard sighting frequency was very low. Lizard densities in the vegetated habitats along transect I have therefore probably been underestimated.

We captured and marked 67 lizards in plot F and 45 individuals in plot C. This represents densities of 775 and 600 lizards/ha, respectively. As we were unable to mark all resident lizards in both study plots, these figures should be considered as lower bounds of the minimum number of lizards present in both areas.

The available data indicate that densities of *P. hispanica atrata* on Columbrete Grande are high, at least in favourable habitats. However, more detailed and long-term work is required to obtain accurate estimates of lizard abundance in the different habitats. It should be noted that our present estimates are of the same order of magnitude as those obtained for similarly sized lacertids on the European continent (e.g. *Lacerta vivipara*: 100–270 (Heulin, 1985), 430–865 (Bauwens *et al.*, 1986), 400–1000 (Pilorge, 1987); *P. muralis*: 170 (Mou, 1987), 455–555 (Barbault & Mou, 1988).

The number of lizards seen during our visits to each of the smaller islets were: 18 on Mancolibre, 38 on Horadada, and 18 on El Lobo. As the visits were of short duration, we most probably counted only a fraction of those resident. It is obvious, however, that total population sizes must be extremely small (probably < 100 individuals on Mancolibre and El Lobo, and < 200 lizards on Horadada), due to the extremely small area of the islets.

Juveniles represented a considerable fraction of the total number of lizards on Columbrete Grande: 31% (79/255) of those observed during the transect counts, 36% (24/67) of lizards marked in plot F, and 33% (15/45) of those caught in plot C. The relative number of juveniles was very variable on the smaller islets: 17% (3/18) on Mancolibre, 37% (14/38) on Horadada, and 50% (9/18) on El Lobo.

Sex ratio (males/females) within the adults was 0·85 (81/95) for lizards seen in the transect counts, 1·26 (24/19) in plot F, and 1·31 (17/13) in plot C. These figures do not differ significantly from unity (χ^2-tests, $p > 0{\cdot}10$).

Tail break frequency and escape behaviour

In the absence of other terrestrial vertebrates, breeding and migrant birds are the only potential lizard predators on the islets. Our visit coincided with the period of autumnal bird migration, which is presumably associated with an increased predation pressure.

The percentage of lizards with broken or regenerated tails was high and increased with lizard age—juveniles: 53% ($n = 40$); adult males: 88% ($n = 83$); adult females: 85% ($n = 48$). A high incidence of tail breaks has been interpreted as reflecting a high predation pressure (Rand, 1954; Pianka, 1967; Turner *et al.*, 1982) or, alternatively, that predators are inefficient, resulting in large numbers of lizards escaping through tail autotomy (Schoener, 1979; Jaksic & Greene, 1984; Medel *et al.*, 1988). In any case, assuming that no tail breaks occur during intraspecific agonistic encounters (Vitt *et al.*, 1974), our data indicate that the vast majority of lizards experience at least one direct predatory contact during their lifetime. Remarkably, we observed only two lizards that had freshly autotomised tails, suggesting either that few direct predatory contacts occurred in autumn, or that predators were very efficient.

We gathered quantitative data on two components of the lizards' escape behaviour: approach distance, an index of lizard wariness, and flight distance, which probably reflects the distance to the nearest hiding place (Bauwens & Thoen, 1981; Snell *et al.*, 1988). Preliminary data analysis indicated that approach distances were significantly greater on windy than on calm days, and in a particular area (west-facing slope) of the island. To avoid any bias, we omitted data collected on windy days and on the west-facing slope from further analyses.

Age classes differed in approach and flight distances. Juveniles exhibited significantly shorter approach distances (juveniles: $\bar{x} = 62$ cm, CI = 52–74, $n = 83$; adults: $\bar{x} = 89$ cm, CI = 79–101, $n = 192$; $t = 3{\cdot}25$, 273 d.f., $p < 0{\cdot}01$) and longer flight distances (juveniles: $\bar{x} = 21$ cm, CI = 16–28, $n = 83$; adults: $\bar{x} = 14$ cm, CI = 12–17, $n = 192$; $t = 2{\cdot}40$, 273 d.f., $p < 0{\cdot}02$) than the adults. Adult males and females did not differ significantly in either of both variables (t-tests, $p > 0{\cdot}20$). Considering the observed differences between age classes, we restricted further analyses to the adults (sexes lumped), for which sample sizes were largest.

A significant diel variation in approach (ANOVA: $F = 5{\cdot}847$, 9 and 182 d.f., $p < 0{\cdot}001$) and flight distances ($F = 5{\cdot}413$, 9 and 182 d.f., $p < 0{\cdot}001$) was evident. Approach distances were largest during the early morning and late afternoon hours, and shortest near midday (Fig. 4). The diel variation in flight distances exhibited an inverse pattern (Fig. 4). Hence, lizards were warier (longer approach distance) and remained close to shelter (short flight distance) during the first and last hours of their daily activity period. During these intervals, most lizards were observed basking and were confined to sites with many stones and rocks (Castilla & Bauwens, 1991). Basking increases their conspicuousness (Huey, 1982), and they seemingly compensated for this by fleeing at greater distances from human predators,

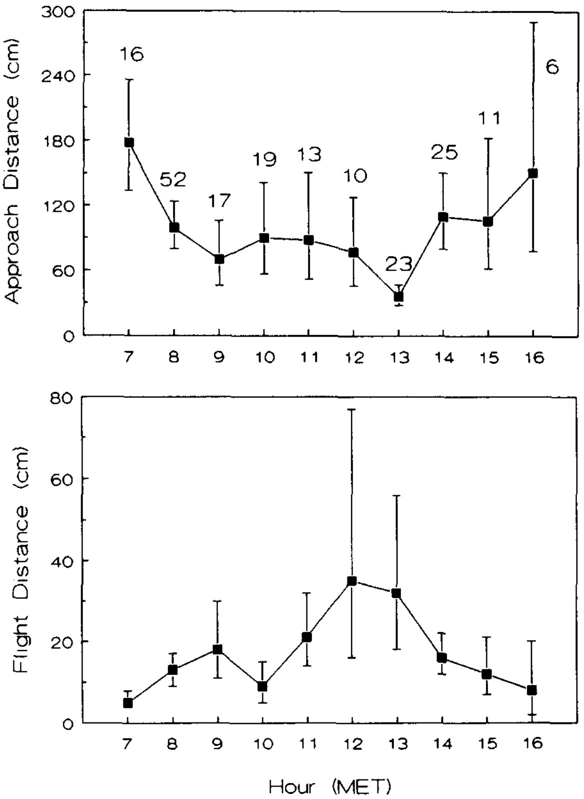

Fig. 4. Diel variations in approach and flight distances of adult *P. hispanica atrata* on Columbrete Grande, showing mean (■), 95% confidence interval (vertical bar) and sample size.

even though hiding places under and between stones and rocks were close by and amply available. An alternative hypothesis is that the increased wariness is a compensation for the reduced sprinting abilities associated with the low body temperatures of basking lizards (Rand, 1964; Huey, 1974, 1982). However, the supposition that basking lizards have reduced body temperatures is not supported by empirical data in the study population (Castilla & Bauwens, 1991). During the central hours of the day lizards used a wider range of microhabitats, and many were seen in open grassy patches (Castilla & Bauwens, 1991). The relatively short approach distances recorded during this time interval might indicate that they rely increasingly on their concealing colour pattern. The increased flight distances probably reflect the scarcity of appropriate hiding places in the grassy microhabitats.

The analysis of inter-island differences in escape behaviour was restricted to observations made between 1000 and 1400 h, when our visits to the islets took place. We found a marginally non-significant difference in approach distance ($F = 2{\cdot}37$, 3 and 104 d.f., $p = 0{\cdot}07$), and a highly significant variation in flight distance ($F = 7{\cdot}28$, 3 and 104 d.f., $p < 0{\cdot}001$). Lizards on Mancolibre exhibited remarkably large approach and flight distances (Table 3). This might be related to the presumed high predation pressure from the large breeding colony of herring gulls, although we cannot discount other factors such as differences in habitat structure or habituation to humans.

Overall, lizards on Columbrete Grande seemed to be less wary than *P. hispanica hispanica*. In the absence of quantitative data, we base this supposition on our field experience with both lizards. Maximal sprint speed in the laboratory is the only component of the lizards' escape behaviour for which comparative data are available. Sprint speed was on average slightly lower in island ($\bar{x} = 159$ cm/s, SD = 44, $n = 20$; Castilla & Bauwens, 1991) than in mainland ($\bar{x} = 185$ cm/s, SD = 47, $n = 9$, D. Bauwens, unpublished data) lizards, but the difference was not significant (t-test, $p > 0{\cdot}10$).

TABLE 3

Approach and Flight Distances (cm) of Adult *P. hispanica atrata* on Different Islets (mean, 95% confidence interval (CI) and sample size)

	Approach distance			*Flight distance*		
	$\bar{x}$	*CI*	*n*	$\bar{x}$	*CI*	*n*
Columbrete Grande	63	51–79	65	22	17–30	65
Mancolibre	120	74–193	12	118	79–179	12
Horadada	69	54–90	23	37	22–62	23
El Lobo	92	51–166	8	40	10–156	8

Data restricted to 1000–1400 h (see text).

Food and feeding habits

Limited data on diet composition were obtained through examination of faecal pellets. These evidenced the consumption of Coleoptera, Lepidoptera, spiders, scorpions and snails, confirming previous analyses based on the stomach contents of preserved specimens (Castilla *et al.*, 1987). Some faecal pellets exclusively contained plant material. The consumption of plant material was also proved by direct observation of lizards feeding on *Opuntia* fruits. Near midday, several adult lizards were observed actively searching for food in grassy vegetation.

CONSERVATION MEASURES

Legislation and wardening

P. hispanica atrata is protected by the Spanish species conservation legislation (royal decree 3181/1980 of 20 December 1980), is included in Appendix III of the Berne Convention, and has been the subject of a recommendation by the Standing Committee of the Berne Convention. The archipelago was declared a Natural Park by the regional authorities of the Generalitat Valenciana (decree 15/1988 of 25 January 1988), and a biologist has been appointed as the director of the Natural Park. The marine surroundings are protected by the national Spanish government (legislation 30/1987 of 18 December 1987, Ministerial order of 19 April 1990). The prospects for the future of *P. hispanica atrata* and its habitat have thus significantly improved during recent years.

Since 1988, two wardens have lived on Columbrete Grande from April until October. An informative leaflet is available for tourists (the natural harbour of the islet has considerable attraction for sailing yachts). Access for visitors is restricted to a marked footpath and limited to groups of maximum six persons at a time. The presence of the wardens provides a safeguard against the collecting of lizards for scientific purposes and the pet-trade. Considering the extremely limited population numbers, any collection on the smaller islets should not be allowed.

Clearing and management of habitats

Two rubbish dumps of former inhabitants and visitors, situated near the lighthouse, contain accumulations of empty bottles and tins which are entered by lizards, causing their death (remains of 140 animals were found in 1985). Although clearing of these dumps has been initiated, the complete removal of all bottles is urgently recommended to eliminate this cause of lizard mortality.

In an attempt to reduce soil erosion, the most acute landscape management problem on Columbrete Grande, planting programmes have recently been initiated. In addition, a project has been planned to remove all debris left by human activity. These works might influence the lizards' behaviour. As detailed elsewhere (Castilla & Bauwens, 1991), lizards move during the course of the day between shrubby sites with many stones/rocks and limited vegetation cover near ground level, and microhabitats with extensive cover of grasses, but few upright shrubs. This movement can be interpreted as a thermoregulatory mechanism. Care should be taken in the design and realisation of planting programmes to maintain an appropriate small-scale heterogeneity in microhabitat structure. Also, lizards often basked on remains of buildings. The total removal of these stone constructions might, at least locally, bring about a shortage of appropriate basking sites. We therefore recommend that clearance should be over several years and that they should be replaced by similarly sized natural rocks or stones.

A possible introduction experiment

To help increase the range of *P. hispanica atrata*, its introduction to the islet Ferrera could be considered. Actual conditions on this islet seem favourable enough to allow the establishment of a small but stable lizard population. If an introduction experiment is attempted, it seems most appropriate to release newborn lizards. Continuous monitoring of the experiment is recommended and would provide interesting information on population processes.

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