MORPHOLOGICAL COMPARISON BETWEEN *Podarcis Lilfordi* AND *Podarcis Pityusensis*

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RESUM

Ramón, M.M. i Castro, J.A. COMPARACIÓ MORFOLÒGICA ENTRE *Podarcis lilfordi* i *Podarcis pityusensis*. S'han duit a terme comparacions des d'un punt de vista morfològic, entre vuit poblacions de *Podarcis lilfordi*, set de *Podarcis pityusensis* (sargantanes endèmiques de l'Arxipèlag Balear) i una de *Podarcis hispanica atrata* de les illes Columbretes, mitjançant la mesura de 15 caracters morfològics. Les anàlisis de tipus cluster i discriminant aplicat als mascles i a les femelles, han permès posar de manifest les relacions existents entre les diferents poblacions, així com entre les espècies. Es fa palesa l'existència de tres grups: un format principalment per les poblacions de *P. lilfordi*, un altre on s'agrupen la majoria de les poblacions de *P. pityusensis* i el darrer format tant sols per la població de *P. hispanica*. Algunes poblacions estudiades fan de pont entre el grup de *P. pityusensis* i el de *P. lilfordi*. La possibilitat que *P. lilfordi* i *P. pityusensis* siguin dos patrons de variació dins la mateixa espècie o dues espècies ben diferenciades necessita de més estudis per a poder ésser dilucidada.

SUMMARY

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Comparisons among eight populations of *Podarcis lilfordi*, seven of *Podarcis pityusensis* (representative lizards of the Balearic Archipielago), and one of *Podarcis hispanica atrata* from the Columbretes Islands, have been made from a morphological point of view, measuring 15 morphometric characters of the lizards. Cluster and discriminant analyses were obtained for males and females to show the relations hips among the different populations and species. These analyses gave three groups: one of them with the most *P. lilfordi* populations, other with the most *P. pityusensis* populations, and a well separated group with the *P. hispanica atrata* species. Some populations connect the groups of *P. lilfardi* and *P. pityusensis*. The possibility that *P. lilfordi* and *P. pityusensis* be two pattern of variation inside the same species instead of two well differentiated species is considered, althrough further studies are necessary.

Key words: Lizard, *Podarcis lilfordi, Podarcis pityusensis, Podarcis hispanica atrata,* morphometric characters.

INTRODUCTION

The present work studies species from the Balearic Islands, whose endemic populations of Lizards show great differentiation. The first individuals colonized these lands during the Tertiary Period (Colom, 1978), then spread and evolved into different forms during the Quaternary Period, favou-

red by geographical barriers and lack of predators. At first, Boscá (1883) described *P. pityusensis* as a subgroup of P. muralis and Eisentraut (1928a,b) and Muller (1927, 1928) considered all populations of *P. pityusensis* as subspecies of *P. lilfordi* but, nowadays, most authors agree that they form two different species: *Podarcis lilfordi*, located in Gimnesies (Menorca, Cabrera and Islets) with 24 subspecies described at present (Salvador, 1979; Pérez-Mellado and Salvador, 1988) and *Podarcis pityusensis* from Pityusas (Eivissa, Formentera and surrounding islets) with 43 subspecies cited in different works (Cirer, 1981; 1987).

These two groups have been widely studied (Eisentraut, 1950; Salvador, 1979; 1984; Pérez-Mellado and Salvador, 1984). Cirer (1987) started to study the morphological relations within *Podarcis pityusensis* and suggested a reduction in the number of subspecies to 6, and Ramon *et al.* (1989) proposed something similar for *P. lilfordi.*

The aim of this work is to compare both species morphologically in order to stablish the degree of differentiation between them and with the control specie *Podarcis hispanica atrata,* also determining the most suitable characteristics in this comparison.

MATERIALS AND METHODS

Eight populations of *P. lilfordi* and seven of *P. pityusensis* were studied, and a population of *P. hispanica (P.h. atrata* from Columbretes islets, Castelló, SPAIN), clearly different from *P. lilfordi* and *P. pityusensis,* was included in the study to compare the interspecific differencies obtained. Specimens of *P. lilfordi* from the islets of Cabrera, Mallorca and Menorca were studied. In the case of *P. pityusensis,* the 6 subspecies proposed by Cirer (1987) were studied and a seventh sample was collected from a population found in Palma Harbour (Mallorca), the *Podarcis pityusensis pityusensis,* which is supposed to have its origin in Eivissa. Table I shows the sample size (males and females separately). Figure 1 shows the locations where samples were collected (Numbers correspond with those in Table I.

From each specimen, 15 morphological and follidosis characteristics were measured. Length parameters were measured with a slide caliper (mm, with 0.1 mm precision) and, when necessary, a stereoscopic microscope was used. The parameters mesured were:

1.– LBO: Body length, distance between snout and vent.
2.– LGU: Gular length, distance between the end of the snout and the border of the collar scales.
3.– WHE: Head width, mesured at the level of the tympanic plaques.
4.– LPI: Pileus length, distance between snout and occipital plaque.
5.– LEA: Length of the fore limb.

Tabla I.– Populations of lizards sampled.

Population		Subspecies	M	F	Total
1.	Bleda	*p. p. maluquerorum*	17	28	45
2.	Pou	*p. p. formenteras*	19	13	32
3.	Tagomago	*p. p. affinis*	15	32	47
4.	Espartar	*p. p. kameriana*	30	18	48
5.	Vedrà	*p. p. vedrae*	13	20	33
6.	Eivissa	*p. p. pityusensis*	9	22	31
7.	Palma	*p. p. pityusensis*	10	21	40
8.	Addaia	*p. l. addayae*	12	8	20
9.	Cabrera	*p. l. kuligae*	12	19	31
10.	Sargantana	*p. l. sargantanae*	13	7	20
11.	Aire	*p. l. lilfordi*	11	9	20
12.	Guardia	*p. l. jordansi*	14	6	20
13.	Moltona	*p. l. jordansi*	15	5	20
14.	Dragonera	*p. l. gigliolii*	25	13	38
15.	Rei	*p. l. balearica*	4	9	13
16.	Columbretes	*p. hispanica atrata*	4	10	14
Total			232	240	472

M = Males. F = Females.
p. p. = *Podarcis pityusensis*
p. l. = *Podarcis lilfordi.*

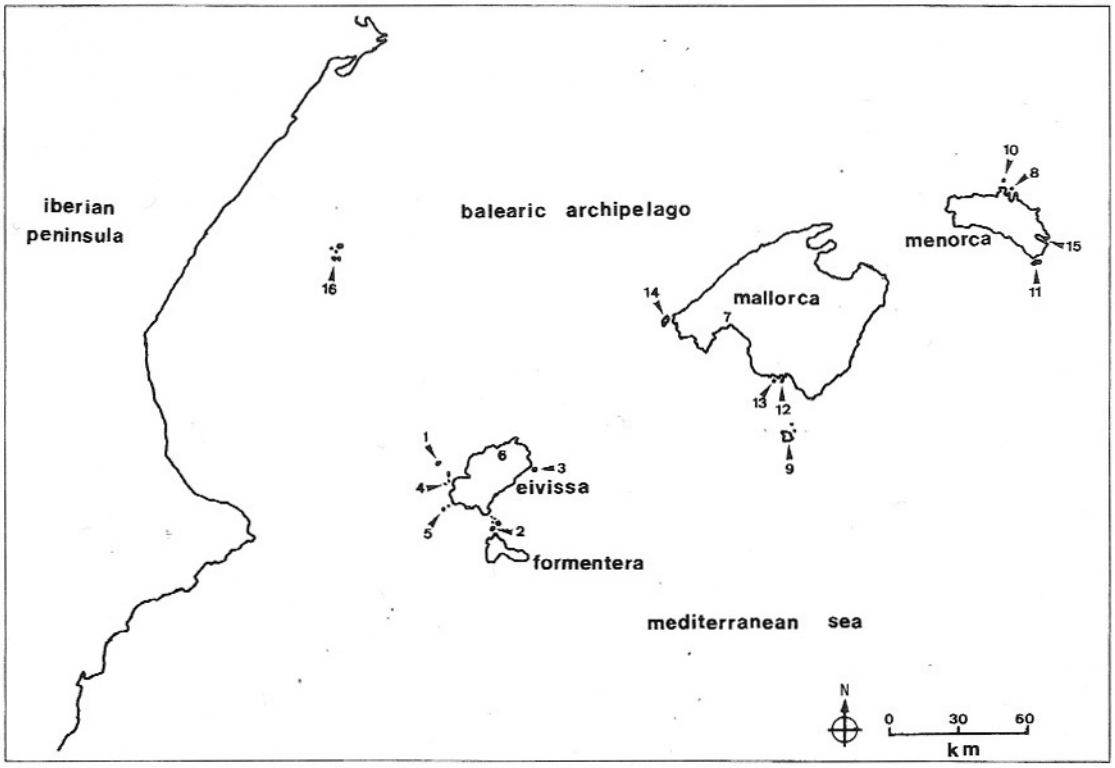

Figure 1.– Location of the different populations of *Podarcis lilfordi* and *Podarcis pityusensis*, as well as the *Podarcis hispanica atrata* population, employed in this study. The numbers correspond to those of Table 1. Names of the major islands are indicated.

6.– LEP: Length of the hind limb.
7.– LSO: Snout length, distance between the eye and tip of snout.
8.– WEI: Animal weight, in grams.
9.– L4F: Number of lamellas under the fourth toe.
10.–SVL: Number of ventral scales in a longitudinal row, counted from the collar to the vent.
11.–SGU: Number of gular scales.
12.–SCO: Number of collar scales.
13.–PFT: Number of total femoral pores.
14.–SDL: Number of scales in a longitudinal row along the dorsal medium line.
15.–SDT: Number of scales in a transversal row counted around midbody.

Stadistical analyses.

Means, standard deviations and standard errors of the means were obtained for every parameter and each population.

Cluster analyses were obtained to show the relationships between the different populations and species in males and females. Previous to any calculation, all the data from the different parameters were standardized to the same unit; the standardization is necessary since not all variables are in the same unities and, therefore, the relative weight of some of them can have different influences in the stadistical analysis according to the means and range of variation of the variables. Centroid linkage algorithm was used, and data were processed using the 2M programme of the BMDP Staditical Software (Dixon, 1985). Discriminant stepwise analyses were also calculated by means of the 7M programe of the BMDP for males and females.

RESULTS

In the Appendix is show the means with the standard errors for all variables and populations sampled. As can be seen, the ranges of morphologic similarity between *P. lilfordi* and *P. pityusensis* are grater than when either of the above species is compared to *P. hispanica atrata.* This later population shows some differential characteristics with respect to *P. lilfordi* and *P. pityusensis:* a small size, reflected in the measures of length, width and weight; a low number of lamellas (L4F), of collar scales (SCO) and of femoral pores (PFT). Also, we can see that SDL and SDT in *P. hispanica* are lower than in *P. lilfordi* but approximately the same as in *P. pityusensis.*

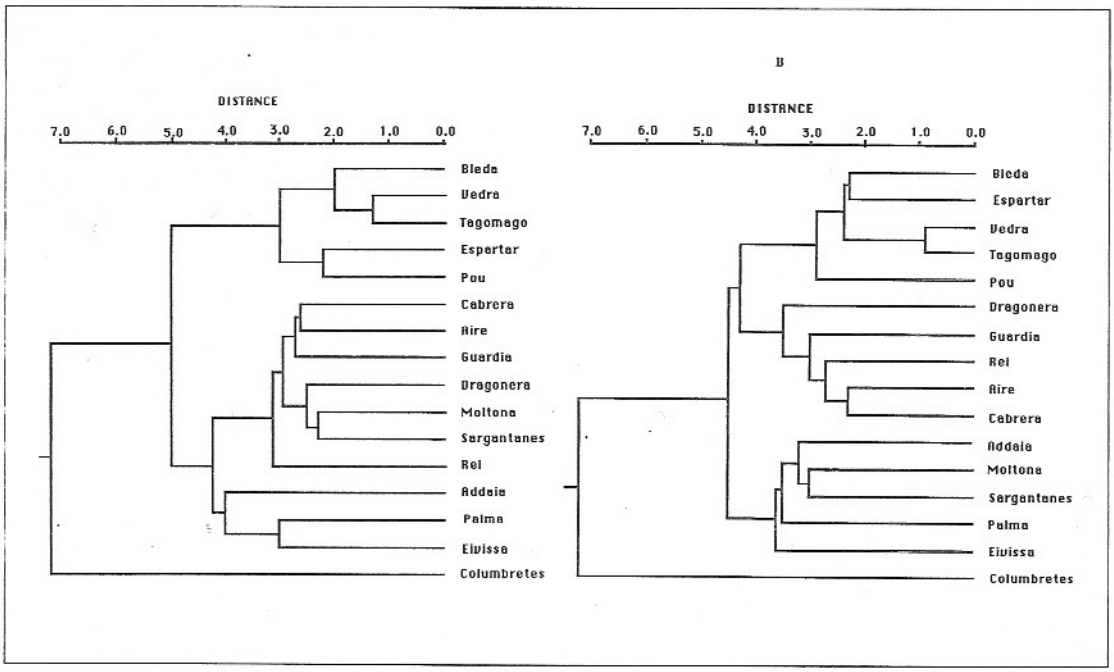

Figure 2.– Dendrograms for males (a) and females (b) of the different populations of lizards.

The number of longitudinal dorsal scales (SDL) can be used as a discriminant characteristic between *P. lilfordi* and *P. pityusensis:* Means obtained were higher in *P. lilfordi* than in *P. pityusensis* in both sexes (see Appendix). On the contrary, the variable SDT (number of transversal scales), normally used as a discriminant parameter between both species, does not show as much differentiation between populations as the SDL, i. e., values obtained in *P. lilfordi* were higher than those from *P. pityusensis,* but the differences were not so clear, and there is more overlapping between samples from both groups than is the case of SDL.

The snout length (LSO) is a good discriminant parameter but only in males. An exception is the *P. pityusensis* population from Palma Harbour, which has values closer to those of the *P. lilfordi* samples rather than to the *P. pityusensis* populations from Pityusas. The less length, in relation to the same width, which present the specimens of *P. lilfordi* could contribute to the robustness aspect of them. The rest of morphologic and follidosis variables used present a moderate but appreciate discriminant value; the populational means vary in a gradual way, with overlapping to great extent.

Cluster and discriminant analyses

Cluster analyses were calculated in males and females separately (figure 2). *P. hispanica* appeared to be different to *P. lilfordi* and *P. pityusensis* in both sexes. No clear differentiation was observed among groups in the Balearic populations, either males or females. *P. pityusensis* populations from the islets constitute a homogeneus group (2.9 units of internal distance). In comparison, *P. pityusensis* populations from large zones (i.e. Palma Harbour and Eivissa) cluster firstly between them (3 units of distance) (this support the idea that the Palma Harbour population could come from Eivissa) and they also cluster to the *P. lilfordi* populations before they do it with the rest of populations of *P. pityusensis.* The *P. lilfordi* group was found to be more homogeneous within the males rather than in the females.

Discriminant analyses calculated in both males and females (fig. 3) gave three separate groups: the populations of *P. lilfordi;* those of *P. pityusensis* and the population of *P. hispanica atrata.* In males and females, these three groups are clearly separated, in fact, the total correct classification is 86.2% in males and 81.3% in females, this indicating that practically in all the populations, the specimens are grouped around their corresponding group means. In males, the analysis was calculated using the following variables: LBO, LSO WHE, LEA, SDL, SDT, SVL, SCO, L4F, WEI and LEP. In females, the parameters chosen were the same, with exception of PFT istead os SVL. These variables (11 in both sexes) were chosen in the 15 total variables measured in the lizards by the stadistical programe employed in the calculations. Only the first two canonic variables were graphically represented, as they sxplain 80% of variability in males and 78% in females.

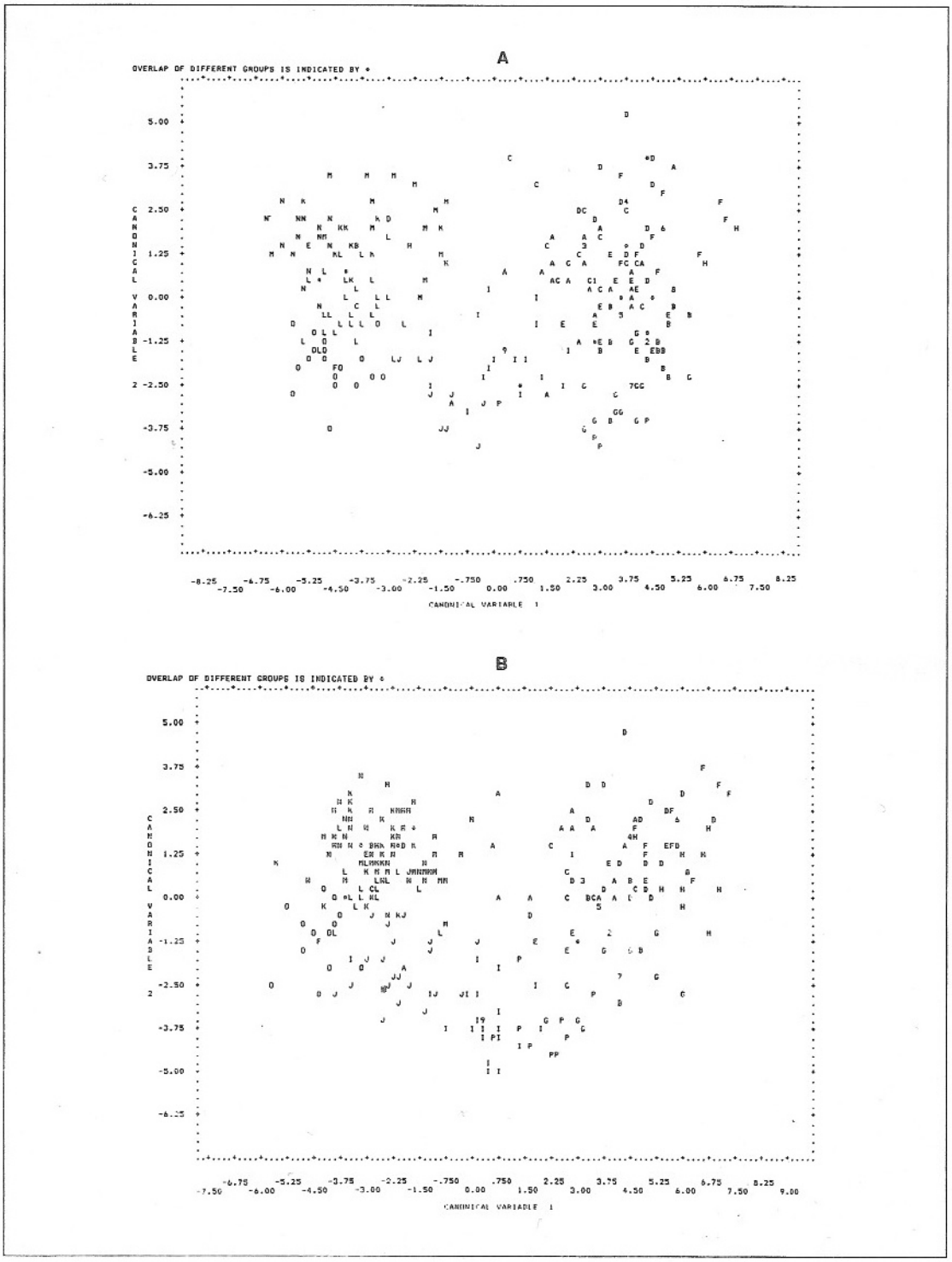

Figure 3.– Two dimensional representation of discriminant funtion analyses of morphometric data for the populations of males (a) and females (b) of *P. lilfordi, P. pityusensis* and *P. hispanica atrata*. In both representations, the means and the cases are indicated according to the following symbols (indicated as "Population (mean.cases)"): Dragonera (1.A); Moltona (2,B); Guardia (3.C); Cabrera (4.D): Sargantanes (5,E); Aire (6,F); Addaia (7.G); Rei (8,H); Palma (9,I); Eivissa (A,J); Vedrá (B.K.); Esparter (C.L); Tagomago (D.M); Bleda (E.N), Pou (F.O); and Columbretes (G,P);. In these diagrames, the overlapping of different groups is indicated by an asterisk.

DISCUSSION

There is no agreement in the degree of variability needed to define species and subspecies, it depends on the author and on the organism studied. In some cases only small differences separate two species, i.e.: between *Drosophila simulans* and *D. melanogaster* the differences are minimals (Ashburner, 1969), and in other cases several differences are needed to establish specific separation.

The most *Podarcis* subspecies were defined in the first half of this century (Mertens-Wermuth, 1960). This separation was based on a few morphological characteristics and/or colourness, but with special reference to the habitat where the samples were collected. In some cases, subspecies descriptions were based on a small number of individuals and these were not compared with samples from other zones. This resulted in a great number o subspecies being defined in the Balearic islands, nearly as many as there are islands and islets.

In this study we used several morphologic characteristics to describe populations. When only few characteristics are observed, it leads to misinterpretation of the true populations; for example, SDL looked at independently would show an overlap between specimens of *P. lilfordi* from Addaia and Moltona and specimens of *P. pityusensis*. Similary, individuals of *P. pityusensis* from Tagomago and Bleda islets have approximately equal number of SDL as some subspecies of *P. lilfordi*. A large humber of characteristics gives a more accurate description of the populations.

The cluster and discriminant analyses showed that to define the differentiation of subspecies within a species based on only morphologic characteristics is difficult, surely due to the influence of the SDL variable. Nevertheless, in the cluster analysis, the differences are reduced due to the standardization of the variables indicated. However, the cluster and discriminant analyses seem to indicate the existence of two groups: *P. lilfordi* and *P. pityusensis*, besides the species of *P. hispanica atrata*. From the cluster analyses we can infer that the samples collected from Palma Harbour and Eivissa seemed to form the connection between the two groups. This would agree with the hypothesis that the Palma Harbour populations come originally from Eivissa. Another explanation could be that the intermediate values observed in these populations (Palma Harbour and Eivissa town) are due to the high variability observed in *P. pityusensis pityusensis* caused by its large and diverse habitat.

In conclusion, the morphological results seem to indicate a clear differentiation between *P. lilfordi* and *P. pityusensis* which are not in accordance with the enzymatic studies, where the similarity of both species is surprising (Ramon *et al.*, 1986; Petitpierre *et al.*, 1987). So, it is not clear whether *P. lilfordi* and *P. pityusensis* are two well differentiated species or two pattern of variation inside the same species. Further studies are needed, specially in crossing speciments of differents populations which will give the final evidences.

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