Morphology and taxonomic revalidation of *Lacerta agilis garzoni*

Palacios and Castroviejo, 1975

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Abstract: A survey on the geographical variation of scalation in the Sand lizard was done by means of both univariate (ANOVA) and multivariate (Canonical discriminant Analysis and cluster of the Mahalanobis distances among centroids). Our results show the existence of two clearly separated groups, in concordance with previous authors. *Lacerta agilis garzoni* is enough differentiated to be considered a valid subspecies. *Lacerta agilis argus* is a mere synonym of *Lacerta agilis agilis*. *Lacerta agilis chersonensis* despite their overall similarity in pattern and coloration to the so-called Balcanic group belongs to the Caucasic one. Data on the currently known habitat and chorology of *Lacerta agilis garzoni* are given.

Key words. *Lacerta, Lacerta agilis*, Taxonomy, Geographical variation, Distribution, Habitat.

Introduction

Taxonomy and geographical variation patterns of *Lacerta agilis* have been the subject of a few reviews based on scalation and coloration (Boulenger, 1916, 1921, Bischoff, 1984, 1988, Yablokov *et al.*, 1980) and even monographs about his geographical variation and natural history (Yablokov, 1976). However it still lacks a comprehensive analysis of their systematics based on multivariate techniques or in genetic studies.

The aim of this paper is to compare, based on their scalation characters, the differentiation degree of *Lacerta agilis garzoni* Palacios and Castroviejo, 1975 in respect to other European and Asian populations.

Historical approach to Lacerta agilis garzoni

The first reference about the presence of *Lacerta agilis* in the Pyrenees appears in this century, when Boulenger (1916, 1921) gives the data of two females of the French side of the Eastern Pyrenees (Ax-les-Thermes and Porté) referring them to the nominal subspecies.

In 1933, Sagarra referred for the first time this species in Spain, from the surroundings of the Collada de Tosses (Girona province), based in a reference of the spanish lepidopterist Ramón Vilarrubia; and later by Martinez Rica and Balcells (1964) and Palaus and Schmidtler (1969) who also refer this species from La Cerdanya (Girona), mainly in the same area than Sagarra (*op. cit.*), and from other localities, some of they doubtful

(Vall Ferrera and Vall d'Aràn, in Lleida province).

Palacios and Castroviejo (1975) describe *Lacerta agilis garzoni* from the same area, the Puig d'en Bassa (in the Collada de Tosses, Girona). Camara *et al.* (1990), refer this species from the Puigmal massif, where it lives in the upper limits of the sub-alpine environments.

Other papers refer the species from several localities of Girona, such as Vidrá (Vilella, 1979). Very doubtful both because the area and height and because of the conditions of observation, as well as Camprodon *et al.*, 1991 from Santuari de la Cabrera, in the Guilleries area, where they bring two - admittedly (J. Baucells and M. Ordeix, pers. comm.) - very doubtful observations of very fast (!) lizards at somehow lower heights and unusual environments (see below).

Bischoff (1984) puts *Lacerta agilis garzoni* in synonymy of *Lacerta agilis agilis* mainly due to ecological and biogeographical reasons and the presence of the "garzoni-pattern" in other populations of *Lacerta agilis agilis*.

Material and methods

A total of 318 specimens of *Lacerta agilis* (both conserved and alive specimens in the case of the endangered Spanish populations) have been studied for 7 meristic characters in order to establish the taxonomic status of *Lacerta agilis garzoni*.

The characters studied were:

1. Dorsalia: Number of dorsal scales around mid-body.

2. Ventralia: Number of ventral scales in the left intermediate row, from the fold to the last row with six enlarged scales prior to the pre-anal plates.

3. Collaria: Number of plates in the collar, clearly bigger than the surrounding ones.

4. Gularia: Number of scales in a straight line between the collar and the sub-maxillary symphysis.

5. Femoralia: Number of femoral pores (Right and left separately).

6. Lamellae: Number of sub-digital lamellae beneath the fourth toe of the hind leg.

7. Postnasalia: Number of postnasal plus anterior loreal scales.

The samples studied were:

- *Lacerta agilis garzoni* (Spain and France): 23 males and 22 females.

- *Lacerta agilis agilis* (Great Britain) (From Boulenger, op. cit.) 13 males and 11 females.

- *Lacerta agilis agilis* (mainland Europe: France, Switzerland and West of Germany): 15 males and 21 females.

- Lacerta agilis argus (East of Germany, Austria and Romania): 36 males and 24 females.

- *Lacerta agilis bosnica* (Montenegro and Bosnia-Herzegovina): 3 females.

- *Lacerta agilis chersonensis* (Romania and Russia): 10 males and 10 females.

- *Lacerta agilis exigua* (Russia and Ukraine): 38 males and 42 females.

- *Lacerta agilis boemica* (Daghestan, Russia): 22 males and 28 females.

For each sample mean, standard error, standard deviation and coefficient of variation were calculated.

Samples were analysed by means of both univariate (ANOVA) and Multivariate methods (Canonical discriminant analysis) separated by sexes (all characters show significant differences between sexes).

One way ANOVA was performed to search for differences among populations. *A posteriori* Student-Newman-Keuls Test was performed between populations to find significant differences among them.

Distance of Mahalanobis (D2) of the different samples and clustered by UPGMA method.

Lacerta agilis bosnica is only included in the canonical analysis of females and represented by its centroid due to sample scarcity.

Results

Statistical values of the characters studied are given in table 1.

Significant differences among samples were found in all characters (see table 2 for the results of ANOVA and pairwise comparisons with SNK test).

ANOVA Males

Lacerta agilis agilis (G. Britain), *Lacerta agilis agilis* (mainland Western Europe) and *Lacerta agilis argus* show only one significant difference among them.

Lacerta agilis garzoni shows three (in respect to british specimens of the nominated subspecies and *Lacerta agilis argus*) or four (in respect to the mainland specimens of *Lacerta agilis agilis*) differences to this aforementioned samples. This degree of differentiation is similar to the inter-caucasian group number of significant differences (two to four).

The two main groups of subspecies show differences from three to six characters among their components.

ANOVA Females

Females of *Lacerta agilis agilis* (Mainland Western Europe) and *Lacerta agilis argus* (Eastern Europe) are identical. *Lacerta agilis agilis* from Britain differ from the latter in only one character.

Lacerta agilis garzoni differs from this *agilis* plus *argus* group in two (from mainland *agilis* and *argus*) or four characters (from British specimens).

The Caucasic group subspecies are identical (*Lacerta agilis chersonensis* and *Lacerta agilis exigua*) or differ from *Lacerta agilis boemica* in one to three characters respectively.

Differences between the two main groups of subspecies range from three to six characters.

Equally, the post-nasal configuration of *Lacerta agilis garzoni* has usually a characteristic shape, with the lower anterior loreal fused with the postnasal (as in Boulenger, 1916: fig. 2 f), giving a configuration of two superposed scales in this place in the 63.4% of specimens. The more usual in *Lacerta agilis agilis* (one postnasal and two anterior loreals) appears in 26.8% of specimens, whereas 9.8% have other variants, mainly of the first model. Similar results are given by Palacios and Castroviejo (1975) but have been overlooked up till now.

Canonical discriminant analysis

The canonical analysis was applied to the samples. The factorial structure of the canonical variables is shown in table 3. Both in males and females, the two main groups, Balcanic and Caucasic, appear clearly separated.

<u>Males</u>

The first two axes accumulated almost all the variance (85.9%).

Axis 1 discriminates two different groups, the Balcanic group in the negative part of this axis, that is characterised mainly by lower values of dorsalia and femoralia and slightly minor values of collaria, gularia and sub-digital lamellae, and by higher values of ventralia, whereas the Caucasic group, in the positive part shows the opposite tendency in each of this values.

The second axis discriminates among subspecies. In the Balcanic group there is a clear overlap between *Lacerta agilis agilis* as a whole and *Lacerta agilis argus*. Only *Lacerta agilis garzoni* is clearly separated in the negative part of this axis characterised by higher collaria and less sub-digital lamellae and postnasalia values.

In the Caucasic group, there is a gradual increase in lamellae and postnasalia parallel to a decrease in collaria, from the northern *Lacerta agilis chersonensis* to the more southern and Caucasic *Lacerta agilis exigua* and *Lacerta agilis boemica*, may be of clinal nature.

Also, there is a slightly increase in the characters that load the first axis, dorsalia and femoralia mainly, but also less in gularia, lamellae and collaria.

There is not parallel variation of scalation characters in the two groups with latitude.

Females

The first two axes explain 86.9% of variance.

Equally than in male analysis, in the females the first axis separates the two main groups, being the Caucasic one characterised by higher values of dorsalia, femoralia and lamellae mainly.

In the Balcanic group, there is a great overlap among samples without a definite separation of any of the subspecies studied. The three female sample of *Lacerta agilis bosnica* shows a centroid well separated from the 95% confidence limits of the other subspecies, but due to the scarce sample the results should be interpreted with caution. Despite this, it could be an indication of a good discrimination of *Lacerta agilis bosnica* from the other European subspecies.

In the Caucasic group, *Lacerta agilis boemica* is clearly differentiated by lower values of lamellae, with a broad overlap between *Lacerta agilis chersonensis* and *Lacerta agilis exigua*.

In this analysis, *Lacerta agilis garzoni* is not very differentiated for this two axes, but the third axis (8.2% of variance, 95.1 accumulated with the first two) that gives positive loadings for dorsalia and postnasalia and negative ones for collaria and lamellae, separates *Lacerta agilis garzoni* (and *bosnica*) in the negative part from the rest of the Balcanic group that rests in the positive one. Equally, this third axis separates *Lacerta agilis exigua* in the positive part from *Lacerta agilis chersonensis* and *Lacerta agilis boemica*.

Cluster analysis

Mahalanobis distances are given in table 4 for males and females. In both cases, the two groups appear clearly separated, again with *Lacerta agilis chersonensis* clearly belonging to the Caucasic group.

In males, the Balcanic group shows *Lacerta agilis agilis* and *Lacerta agilis argus* very closely related. The only sample clearly differentiated is *Lacerta agilis garzoni*, with even a greater distance (5.59) than other recognised subspecies among them (*Lacerta agilis exigua* to *Lacerta agilis boemica*: 4.24) and only slightly less than the greatest intra-Caucasic group distance after clustering (5.73).

In females, the results are very similar, with two well-differentiated groups and *Lacerta agilis chersonensis* undoubtedly belonging to the Caucasic one. In this cluster analysis, the samples are less differentiated than in the males one. In the Balcanic group, *Lacerta agilis garzoni* is the only clearly separated subspecies, with more distance to the other Balcanic group clusters (3.41) than the Caucasic group ones *Lacerta agilis chersonensis* and *Lacerta agilis exigua* among themselves (1.99).

The most differentiated of the Caucasic group is *Lacerta agilis boemica* (5.76).

Both male and female clusters show two very differentiated groups, with *Lacerta agilis chersonensis* belonging clearly to the Caucasic one. In both cases, the lowest distance among probably valid subspecies is 1,99 (*Lacerta agilis chersonensis* and *Lacerta agilis exigua*). *Lacerta agilis garzoni* and the three Caucasic subspecies appear as valid apart from the nominated one. *Lacerta agilis argus* seems to be a synonym of the latter.

Discussion and conclusions

ANOVA, canonical discriminant analysis and cluster analysis based in Mahalanobis distance among samples, show the presence of two clearly separated groups in the Sand Lizards studied: the so-called Balcanic group and the Caucasic group, in concordance with Bischoff (1988). This author states that there are two groups with a differentiation above the conventional subspecies level. He argues that they are not fully species because intergradation among representatives of the two groups is known (*Lacerta agilis chersonensis* and *Lacerta agilis exigua*; see Suchow, 1948 and Peters, 1962).

Our results, however, show unequivocally that *Lacerta agilis chersonensis* belongs to the Caucasic group and not to the European one. If it holds true, there is no current evidence of intergradation between the two groups. This relationship is clearly shown in all the analysis performed with meristic characters. Equally, the presence of two pre-anal plate scale rows in *Lacerta agilis chersonensis* is typical of the Caucasic group. Against this grouping is the presence of the colour morph *erythronotus* both in European populations of *Lacerta agilis agilis* (*argus*) and in *Lacerta agilis chersonensis* (Boulenger, 1916, plate 2, n° 1, Bischoff, 1988) and the more similar dorsal pattern of *Lacerta agilis chersonensis* to the Balcanic group. This could be explained, however, if the two subspecies being closely related and sharing a common origin still develop similar dorsal patterns.

The specimens of *Lacerta agilis garzoni* are the most differentiated sample studied of the Balcanic group. This fact do not fits well with the hypothesis of a recent colonisation of the Pyrenees as an extreme of the post-glacial expansion of the species from the Balcanic refuge (see Böhme, 1978) and questions the synonymy of Bischoff (1984) that appears as not justified, since other subspecies recognised in the Caucasic group are similarly or less differentiated.

On the other hand, *Lacerta agilis garzoni* is more differentiated than the British populations of *Lacerta agilis agilis*, which are isolated almost since 7500 years ago by the sea raise after the end of the last glaciation (Polunin and Walters, 1985) and gives us an *ante quem* data for the complete expansion of the Balcanic group from his Würmian refuge.

The shortening of the distance between the currently known populations of *Lacerta agilis garzoni* and the nearest populations of the nominated subspecies has been an argument to doubt of his taxonomic value. In fact, all the other recognised subspecies both from Balcanic and Caucasic groups are fully parapatric with long areas of contact and even intergradation among them, who invalids this argument.

Lacerta agilis argus is a mere synonym of *Lacerta agilis agilis* who was already stated by other authors (Rahmel, 1988, Rykena, 1988).

The three Caucasic group subspecies here studied could be considered as valid.

More researches are needed to ascertain what is the true taxonomic relationship between the two sharply defined groups in *Lacerta agilis*. Genetic and cariological researches could elucidate if these groups represent actually full biological species or not. Equally, could be very interesting to pay attention in the confluence areas between subspecies belonging to the different groups in order to ascertain if phenomenons such as convergence or intergradation occur.

In the case of *Lacerta agilis garzoni*, a more detailed survey of the morphological and genetic variation among different samples of Central and Southern France, compared with the western Pyrenean ones, could define the differentiation degree of this subspecies, as well as the origin of this taxon, that could be both an *in situ* differentiation in a small refuge area during Pleistocene or a recent coloniser ecotypically adapted to the extreme conditions typical of area border.

Distribution, habitat and status of Lacerta agilis garzoni

Distribution

Up to now *Lacerta agilis garzoni* is only known from the more Western Pyrenees, in the mountains surrounding the Cerdanya valley (upper Segre river valley), that includes from the Andorra foothills to the Carlitte massif in the northern parts of this area and the Cadí mountains in the south. Both two branches connect in the La Molina-Collada de Tosses area and continue to the east up to the Puigmal Massif in the northern Ripolles county. All the Spanish localities are included in the Girona province.

Other Spanish references, more southern and very low for the species (Vilella, 1979, Camprodon, 1991), are very dubious or confuse with other species, mainly juvenile *Lacerta viridis* (own data and Marc Ordeix, pers.com.). The Pica d'Estats reference, in extremely high altitude [2600 to 2800 m (Palaus and Schmidtler, 1969)] is an indirect reference from a Chamois hunter (X. Palaus, pers. com.) and probably a confusion with *Archaeolacerta aurelioi* Arribas, 1994, that inhabits this mountain area. Equally, the Aran Valley reference is ambiguous and has never been confirmed.

In the French side, apart from the Cerdanya area (Geniez and Cheylan, 1987) it has been reported from the Ariege (Castanet and Guyetant, 1989; Bertrand and Crochet, 1992) and perhaps from Haute Garonne (J.M. Parde, pers. comm.).

Habitat

It ranges from 1400 m a.s.l. in La Molina (in the bottom of a closed valley) to 2250 m a.s.l. in the Nuria area (Puigmal Massif), where it is a characteristic inhabitant of sub-alpine environments and, in part, the uppermost parts of the mountain belt.

In this areas, with Scots pine (*Pinus sylvestris*) in the more mild and lower heights and Mountain pine (*Pinus uncinata*) in the sub-alpine belt, *Lacerta agilis* favours the more open places, usually the result of natural clearings in the poorest slopes, or the result of ancient destruction of the forest, which are characteristically replaced by a broom heathland of *Genista balansae* ssp. *europaea* (= *Cytisus purgans sensu* auct.) frequently accompanied by *Juniperus communis* ssp. *nana* belonging to the *Genistion europae* and *Juniperion nanae* alliances that develop in this area from (725) 1200 m to 2200 m (2525) forming wide brushes moderately height (0.6 - 1 m) with numerous acidophilic plants, as *Viola alpina*, *Jasione montana*, *Deschampsia flexuosa*, *Linaria repens*, and others, with high number of thermophile species, usually developing upon acid not very deep schistous substrates, and frequently originated by fires for pasture management.

This broom heathland is one of the essential components of the Pyrenean landscape (especially in Western Pyrenees) upon siliceous substrates, mainly in southern slopes, in places typically very hot and sunny in summer and not very snowy in winter, from mountain environments to the lower limit of the alpine ones.

The upper limit of this characteristic vegetation is also the limit of *Lacerta agilis garzoni* that however, could be found in the border of the sub-alpine belt in pure *Festuca* grasslands and hygroturbose areas.

In fact, during summer there is a shift in the habitat of this species, that searches for more humid areas, usually wet meadows with dense growth of grass and *Juncus* in the foothill of the slopes covered by the aforementioned broom heathlands, where the forest is absent naturally by the excess of water in the ground. The reason of this habitat change is connected with the progressive dryness of the broom heathland and the high productivity of these wet areas during summer.

We feel this summer habitat as the primitive one of the Pyrenean Sand Lizard, together with the more poor parts probably naturally covered by broom and the upper limits of the usually not very closed mountain pine forest, before the ancient anthropic afforestation of this areas who has led to the more extensive broom heathlands now in regression (see below).

Conservation status

Lacerta agilis garzoni is locally common although very restricted to the aforementioned localities. In this area the species has a discontinuous area, being only common in some localities where it founds suitable habitat conditions.

Lacerta agilis garzoni is considered in the Spanish Red Data Book as Vulnerable (Banco and Gonzalez, 1992), due to his restricted area and the strong human pressure that receives his habitat.

La Cerdanya and Andorra have a wide tourist use, with Ski resorts and a strong landscape transformation. Broom is periodically burned to obtain pastures, and the lizard localities, well known, periodically decimated by collectors.

Equally, the reduction in the exploitation of the sub-alpine woods has led to a recovering of the forests and a reduction of the open areas inhabited by Sand lizards.

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Table 1. Scalation values. Mean, Standard error of the mean, standard deviation, variation coefficient and sample size. Abbreviations used are: GA (*Lacerta agilis garzoni*); AG (G.B.) (*Lacerta agilis agilis* from British Islands); AG (*Lacerta agilis agilis* from mainland Europe); AR (*Lacerta agilis argus*); CH (*Lacerta agilis chersonensis*); EX (*Lacerta agilis exigua*); BO (*Lacerta agilis boemica*).

	MALES					FEMALES				
DORSALIA	Mean	Std E	Std D	C.V.	n	Mean	Std E	Std D	C.V.	n
GA	36.50	0.40	1.92	0.05	23	35.40	0.32	1.50	0.04	22
AG (G.B.)	38.23	0.54	1.96	0.05	13	38.18	0.73	2.44	0.06	11
AG	39.06	0.50	1.94	0.04	15	37.23	0.51	2.36	6.34	21
AR	37.97	0.44	2.74	0.07	38	37.62	0.44	2.32	0.06	27
CH	41.80	0.72	2.29	0.05	10	42.10	0.69	2.18	0.05	10
EX	44.71	0.51	3.15	0.07	38	42.92	0.46	3.01	0.07	42
BO	44.58	0.47	2.34	0.05	24	42.75	0.60	3.24	0.07	29
VENTRALIA										
GA	26.82	0.18	0.88	0.03	23	29.77	0.20	0.97	0.03	22
AG (G.B.)	26.92	0.47	1.70	0.06	13	29.18	0.35	1.16	0.04	11
AG	27.66	0.31	1.23	0.04	15	29.33	0.30	1.39	0.04	21
AR	26.60	0.22	1.40	0.05	38	29.11	1.05	1.05	0.03	27
CH	25.40	0.22	0.69	0.02	10	28.20	0.32	1.03	0.03	10
EX	27.18	0.17	1.06	0.04	38	28.92	0.34	2.21	0.07	42
BO	25.95	0.23	1.16	0.04	24	28.06	0.21	1.16	0.04	29
COLLARIA										
GA	10.56	0.25	1.23	0.11	23	10.04	0.17	0.84	0.08	22
AG (G.B.)	8.92	0.21	0.75	0.08	13	9.09	0.25	0.83	0.09	11
AG	9.20	0.28	1.08	0.11	15	9.00	0.23	1.09	0.12	21
AR	9.63	0.20	1.26	0.13	38	9.37	0.16	0.83	0.09	27
CH	10.20	0.29	0.91	0.09	10	10.40	0.30	0.96	0.09	10
EX	10.63	0.14	0.88	0.08	38	10.21	0.17	1.15	0.11	42
BO	10.41	0.14	0.71	0.06	24	10.27	0.18	0.99	0.09	29
GULARIA										
GA	17.08	0.30	1.47	0.08	23	17.27	0.25	1.20	0.07	22
AG (G.B.)	18.00	0.27	1.00	0.05	13	18.36	0.41	1.36	0.07	11
AG	16.66	0.37	1.44	0.08	15	16.90	0.35	1.64	0.09	21
AR	16.40	0.29	1.80	0.15	38	16.81	0.26	1.35	0.08	27
CH	18.50	0.26	0.84	0.04	10	19.60	0.37	1.17	0.06	10
EX	19.00	0.23	1.41	0.07	38	19.11	0.27	1.79	0.09	42
BO	19.16	0.44	2.16	0.11	24	19.55	0.28	1.54	0.08	29
FEMORALIA										
GA	26.34	0.29	1.40	0.05	23	25.40	0.35	1.68	0.06	22
AG (G.B.)	25.30	0.64	2.32	0.09	13	25.81	0.56	1.88	0.07	11
AG	25.60	0.47	1.83	0.07	15	25.85	0.49	2.26	0.08	21
AR	26.21	0.48	3.00	0.11	38	25.40	0.36	1.88	0.07	27
CH	28.70	0.36	1.15	0.04	10	29.70	0.77	2.45	0.08	10
EX	29.47	0.31	1.94	0.06	38	29.19	0.31	2.05	0.07	42
BO	30.62	0.50	2.44	0.08	24	30.34	0.41	2.25	0.07	29

	MALES					FEMALES				
LAMELLAE										
GA	18.43	0.31	1.50	0.08	23	18.50	0.27	1.26	0.06	22
AG (G.B.)	19.92	0.41	1.49	0.07	13	19.54	0.34	1.12	0.05	11
AG	19.86	0.37	1.45	0.07	15	19.57	0.29	1.36	0.07	21
AR	20.00	0.30	1.90	0.09	38	19.29	0.31	0.31	0.08	27
CH	19.70	0.26	0.82	0.04	10	20.40	0.37	1.17	1.17	10
EX	19.81	0.22	1.35	0.06	38	19.05	0.19	1.27	0.06	42
BO	22.45	0.34	1.66	0.07	24	22.75	0.29	1.57	0.07	29
POSTNASALIA (Postn. + ant. Lor)										
GA	2.43	0.15	0.72	0.29	23	2.63	0.15	0.72	0.27	22
AG (G.B.)	3.07	0.17	0.64	0.20	13	3.63	0.15	0.50	0.13	11
AG	3.06	0.15	0.59	0.19	15	3.23	0.15	0.70	0.21	21
AR	3.00	0.06	0.40	0.13	38	3.07	0.09	0.47	0.15	27
CH	2.60	0.22	0.69	0.26	10	2.90	0.23	0.73	0.25	10
EX	3.13	0.12	0.23	0.23	38	3.40	0.16	1.03	0.30	42
BO	3.45	0.16	0.78	0.22	24	3.41	0.14	0.77	0.22	29

Table 2: ANOVA values F and p, and pairwise comparations among samples (1: *garzoni*, 2: *agilis* Great Britain, 3: mainland *agilis*, 4: *argus*, 5: *chersonensis*, 6: *exigua*, 7: *boemica*).
• p<0.05; •• p<0.01.

MALES	F	p	1.2	1.3	1.4	1.5	1.6	1.7	2.3	2.4	2.5	2.6	2.7	3.4	3.5	3.6	3.7	4.5	4.6	4.7	5.6	5.7	6.7
Dors.	45.64	0		••		••	••	••			••	••	••		••	••	••	••	••	••	••	••	
Ventr.	6.23	0				••					••			••	••		••	••			••		••
Coll.	8.82	0	••	••	••						••	••	••		•	••	••		••	••			
Gul.	10.13	0				•	••	••							••	••	••	••	••	••			
Fem.	19.70	0				••	••	••		•	••	••	••		••	••	••	••	••	••		•	
Lam.	13.80	0	••	••	••	•	••	••					••				••			••		••	
Postn.	5.73	0	••	••	••		••	••												••		••	
FEMALES																							
Dors.	34.64	0	••	•	••	••	••	••			••	••	••		••	••	••	••	••	••			
Ventr.	3.51	0.0028				•		••															
Coll.	7.05	0	•	••	•						••	••	••		••	••	••	••	••	••			
Gul.	15.23	0	•			••	••	••	•	••					••	••	••	••	••	••			
Fem.	27.55	0				••	••	••			••	••	••		••	••	••	••	••	••			
Lam.	25.88	0				••	••	••					••				••			••		••	••
Postn.	3.66	0.002	••				••	••															

Table 3 a: Factorial structure of the canonical variables for the first three canonical axes.

	MALES			FEMALES		
	V1	V2	V3	V1	V2	V3
Eigenv.	17.300	5.600	2.090	16.900	3.630	1.930
Cum. %	64.800	85.900	93.700	71.500	86.900	95.100
Dors.	0.720	0.228	-0.401	0.668	0.177	0.549
Vent.	-0.198	0.281	-0.744	-0.245	0.105	0.032
Coll.	0.241	-0.422	-0.252	0.266	0.365	-0.464
Gul.	0.321	-0.017	0.033	0.440	0.148	0.086
Fem. r.	0.482	-0.063	0.026	0.595	0.130	-0.133
Fem. l.	0.488	-0.133	-0.027	0.562	0.087	0.028
Lam.	0.277	0.466	0.506	0.509	-0.715	-0.272
Postn.	0.136	0.468	0.034	0.069	-0.289	0.582

Table 3 b: Coordinates of the centroids and 95% confidence limits of the samples (Centroids).

	MALES				FEMALES			
	V1	V2	V3	r (95 %)	V1	V2	V3	r (95 %)
GA	-1.440	-1.410	-0.101	0.855	-1.670	0.596	-0.900	0.874
AG (G.B.)	-1.440	0.657	0.288	1.140	-0.849	-0.452	0.558	1.240
AG	-1.370	1.060	-0.476	1.060	-1.280	-0.617	0.183	0.894
AR	-1.010	0.195	0.390	0.683	-1.400	-0.125	0.131	0.837
CH	1.030	-1.210	0.347	1.300	1.620	0.748	-0.282	1.300
EX	1.760	-0.046	-1.060	0.665	1.160	0.951	0.716	0.632
BO	2.480	0.760	0.612	0.874	2.420	-1.100	-0.406	0.775

Table 4: Mahalanobis distances (D2) among sample centroids. Males above diagonal, females below.

	GA	AG (G.B.)	AG	AR	CH	EX	BO
GA	0.00	5.77	6.73	3.16	7.77	13.40	20.60
AG (G.B.)	4.25	0.00	1.75	1.39	10.00	12.80	16.60
AG	3.06	1.24	0.00	1.76	12.00	11.70	16.40
AR	2.11	1.34	0.56	0.00	6.91	10.00	12.60
CH	11.80	8.60	11.00	10.30	0.00	4.30	7.16
EX	10.80	6.77	8.83	8.44	1.99	0.00	4.24
BO	19.90	12.50	14.40	16.00	4.49	7.12	0.00

Fig.1
Graphic representation for the two first axes of MALE SAMPLES (A) (1-garzoni, 2-agilis G. Britain, 3-agilis Mainland Europe, 4-argus, 5-chersonensis, 6-exigua, 7-boemica) and FEMALE SAMPLES (B) (1-garzoni, 2-agilis G. Britain, 3-agilis Mainland Europe, 4-argus, 5-bosnica, 6-chersonensis, 7-exigua, 8-boemica) Numbers as in table 2.

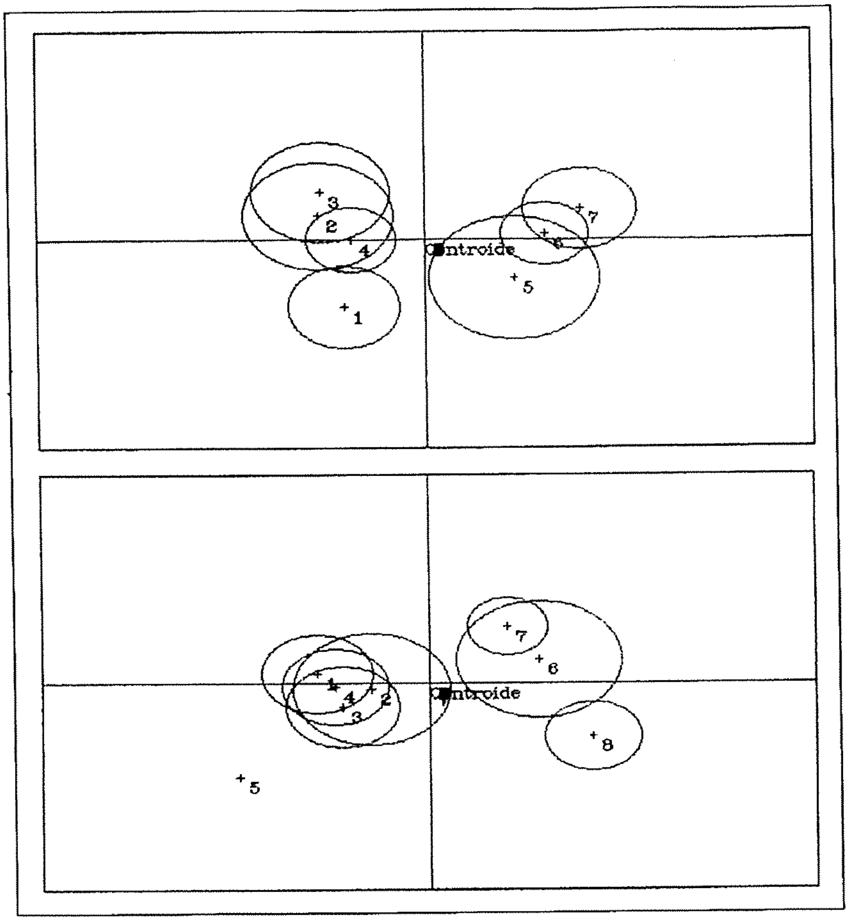

Fig.2 Clustering of the samples by UPGMA method, based in Mahalanobis distances (see Table 4).