HERPETOZOA 18 (3/4): 155 - 170
Wien, 30. Dezember 2005

Atlas of the amphibians and reptiles of Peneda-Gerês National Park, Portugal

Atlas zur Verbreitung der Amphibien und Reptilien im Nationalpark Peneda-Gerês, Portugal

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KURZFASSUNG

Amphibien- und Reptiliennachweise im Nationalpark Peneda-Gerês (PNPG, im Nordwesten Portugals) wurden auf Karten unter Verwendung von 2 x 2 km großen UTM-Rastereinheiten graphisch dargestellt. Dreizehn Amphibien- und zwanzig Reptilienformen wurden beobachtet, einschließlich von vier bzw. fünf iberischen Amphibien- bzw. Reptilienendemiten. In beiden taxonomischen Gruppen wurden je drei unterschiedliche Vorkommenstypen identifiziert: Arten mit ausgedehnter Verbreitung in diesem Gebiet, auf Gebieten mit bestimmten Umweltcharakteristiken beschränkte Arten und solche mit geringer oder fragmentierter Verbreitung. Die Hierarchische Clusteranalyse gruppierte die Arten nach ihren Verbreitungsmustern im PNPG. Drei Gebiete mit hohem Artenreichtum konnten für Amphibien, Reptilien und die Herpetofauna insgesamt festgestellt werden. Diese Gebieten waren allen taxonomischen Gruppen gemeinsam und entsprachen weitgehend dem Übergangsbereich vom euro-sibirischen zum Mittelmeerklima, was den Kontakt zwischen unterschiedlichen biogeographischen Artengruppen ermöglicht. Bei den Amphibien waren diese Gebiete kleiner und fielen mit den speziellen Lebensräumen zusammen, in denen die seltenen Arten anzutreffen waren. Die komplexe Orographie des Nationalparks Peneda Gerês (PNPG) mit engen Tälern und steilen Hängen schafft mit ihren kleinräumigen Umweltbedingungen Vorraussetzungen für jede Gruppe und ermöglicht einen hohen Artenreichtum, nämlich 77% bzw. 74% der Gesamtzahl von Amphibien bzw. Reptilienarten Kontinentalportugals. Der Status eines biogeographischen Kreuzungspunktes macht den PNPG auf nationaler Ebene zu einem vorrangigen Zielgebiet für den Schutz der Amphibien und Reptilien.

ABSTRACT

Records of the amphibians and reptiles of Peneda-Gerês National Park (PNPG, northwest Portugal) were plotted on maps using the 2 x 2 km squares of the UTM grid system. Thirteen amphibian and twenty reptile taxa were observed, including four and five Iberian endemics, for amphibians and reptiles, respectively. In both taxonomic groups, three distinct categories of species were identified: species widely distributed in the area, species restricted to areas with particular environmental characteristics, and species with small and fragmented distribution. Species were grouped using Hierarchical Cluster Analysis according to their distribution patterns in PNPG (widespread vs. restricted). Three high species richness areas, which were common across the taxonomic groups, were identified for the amphibians, reptiles and herpetofauna. These areas broadly correspond to the transition between the Euro-Siberian and Mediterranean climates, which allow the contact between distinct biogeographical groups of species. For the amphibians these areas were smaller and corresponded to particular habitats where the scarcer species were located. The complex orography of the PNPG, with narrow valleys and steep slopes creating micro-environmental conditions for each group, enables high levels of species diversity: 77% and 74% of the total number of amphibians and reptiles of continental Portugal, respectively. The biogeographic crossroad status of the PNPG renders it as priority for the conservation of amphibian and reptiles, at a national scale.

KEYWORDS

Amphibia, Reptilia, distribution, biogeography, Peneda-Gerês National Park, Portugal

INTRODUCTION

Biogeographic crossroads are considered priority areas for biodiversity conservation due to the rapid spatial turnover of species, resulting in high beta species richness (SPECTOR 2002). Recent evidence suggests that the ecological heterogeneity and strong differing selection pressures in ecotones may stimulate rapid evolutionary changes in populations, driving evolution and speciation at the edges of habitats (SMITH et al. 1997; SCHNEIDER et al. 1999). Thus, biogeographic crossroads may be selected as conservation priority areas to allow the maintenance of the evolutionary processes of speciation and co-evolution.

In the northwest Iberian Peninsula there is a marked transition between the Euro-Siberian and Mediterranean biogeographic provinces (RIVAS-MARTÍNEZ 1987). Particularly, the series of mountains in the northern border area between Portugal and Spain are influenced by a clear transition between the Atlantic Mediterranean and Continental Mediterranean climates (GODAY 1953). The consequences of this climate transition on the geographical distribution of plants, invertebrates and vertebrates are remarkable, as they allow the co-existence of southern and northern Iberian species in a relatively small area, resulting in increased alpha and beta species richness (SERRA & CARVALHO 1989; GODINHO et al. 1999; PIMENTA & SANTARÉM 1996; MARAVALHAS 2003; MALKMUS 2004). In 1971 the empiric importance of this biogeographic crossroad has led to the establishment of the only Portuguese National Park, Peneda-Gerês National Park (PNPG), and currently the area belongs to the "Natura 2000" network of European priority conservation areas.

The amphibian and reptile communities of the northwestern Iberian Peninsula, and particularly of the PNPG, are noticeably rich (GODINHO et al. 1999), granting the international recognition of this area as priority for the conservation of the herpetofauna, both in Portugal and Spain (CORBETT 1989; ARAÚJO 1999; GALÁN 1999; MATEO 2002). Although, the PNPG has been visited by naturalists since the late 19th century (MOLLER 1894a, 1894b; NOBRE 1903; FERREIRA & SEABRA 1911) and more recently by contemporary authors (ALMAÇA 1972, 1974; ALMAÇA et al. 1976; CAETANO et al. 1979; MALKMUS 1986a, 1986b, 1987), there is no detailed survey of the herpetofauna. Many of the pioneering works do not present distribution maps, or in other cases the scale of the work is improper for conservation management of species and communities.

This study aimed to collect systematic information about the spatial distribution of amphibians and reptiles in the PNPG, assemble it in a georeferenced database using a Geographic Information System, establish biogeographical relationships between the species, and identify high species diversity areas in PNPG. These data constitute a framework for the PNPG to outline conservation strategies for these taxonomic groups.

MATERIALS AND METHODS

Study area

The Peneda-Gerês National Park (PNPG) covers an area of about 72000 ha (latitudes 41°36' to 42°07' N and longitudes 7°44' to 8°27' W) along the border with Spain (fig. 1). The PNPG is a series of complex mountains, with altitudes ranging from 50 to 1500 m a.s.l. The predominant Atlantic climate is characterized by high levels of precipitation and drainage, with an average annual rainfall and soil drainage above 2800 mm/year and 2000 mm/year, respectively (C. N. A. 1983). In the Mediterranean enclaves of the south facing slopes of the mountains and in the low altitude river valleys, average annual rainfall and soil drainage drops to 1600 mm/year and 1100 mm/year, respectively (C. N. A. 1983). Additionally, the diversified orientation of the relief and altitude variations provide a wide variety of microclimates. Correspondingly, deciduous oak-forests (*Quercus robur* and *Qu. pyrenaica*) and mixed deciduous and coniferous forests occupy most of the Atlantic areas whereas evergreen oak forests (*Qu. suber*) occupy the areas influenced by Mediterranean climate. Major shrubs include heath (*Erica* sp.), furze (*Ulex* sp.) and brooms (*Cytisus* sp.) (SERRA & CARVALHO 1989).

Field work and data analysis

Field work was performed between 1998 and 2003. Amphibian breeding sites were surveyed using dip-netting and egg search on water vegetation and margins, complemented with night search for calls (HEYER et al. 1994; GENT & GIBSON 1986). Reptiles were searched using visual encounter surveys (TELLERIA 1986). Both taxonomic groups were also searched in potential shelters, such as rocks and fallen logs.

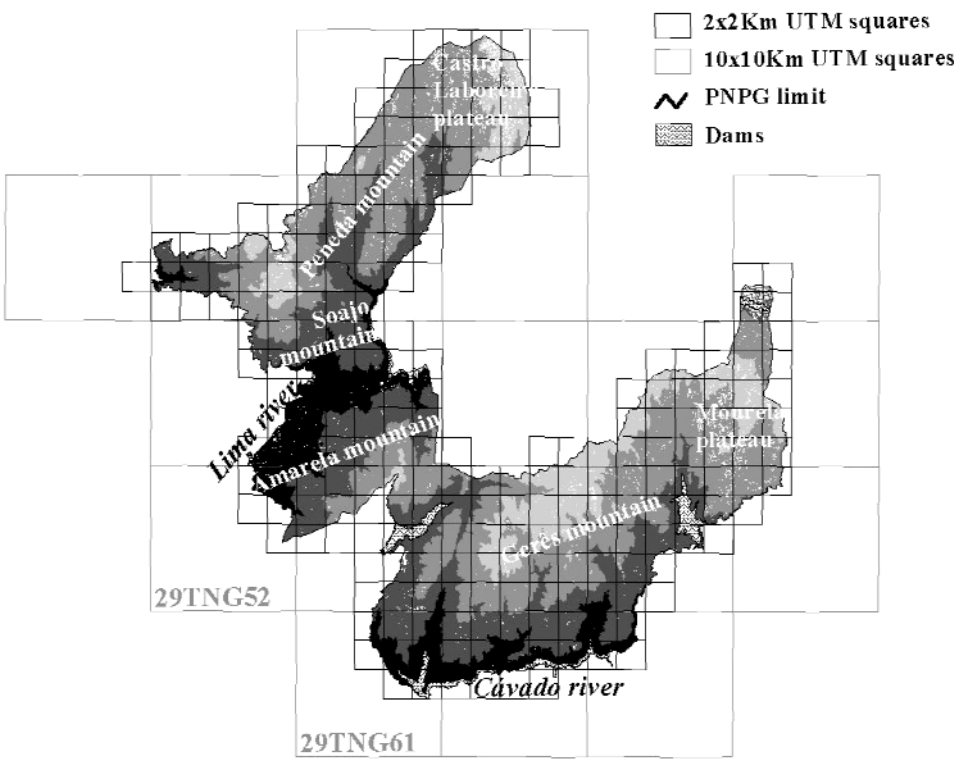


Fig. 1: Study area. Peneda-Gerês National Park (41°36' - 42°07' N; 7°44' - 8°27' W), Portugal.
Abb. 1: Untersuchungsgebiet Nationalpark Peneda-Gerês (41°36' - 42°07' N; 7°44' - 8°27' W), Portugal.

Published data (MALKMUS 1986a, 1986b, 2004) and ad-hoc observations (road-kills and live specimens) collected by the authors and National Park staff were also recorded in the database.

The study area was surveyed using the 240 UTM 2 x 2 km squares as a reference grid (fig. 1). However, the geographic location of the amphibians and reptiles was recorded at a 1 x 1 km UTM scale, using the Portuguese military cartography (1:25000) and inscribed in a georeferenced database. The observed distributions of the species, as well as the species richness maps for amphibians, reptiles and the whole herpetofauna were displayed using a Geographic Information System (ArcView® 3.2).

Hierarchical Cluster Analysis (HCA) was performed (SPSS® 11.0) to identify similar distribution patterns by means of the between-groups linkage cluster method and Jaccard's measure as the variable analyzed. Species with less than three locations (*Pelobates cultripes*, *Blanus cinereus*, *Chalcides bedriagai*) and probably introduced species (*Emys orbicularis*, *Mauremys leprosa*) were not considered in the analysis. Jaccard's index, also known as the similarity ratio, takes the form J = 100 C / (A+B-C), in which A represents the number of squares occupied by species a, B the number of squares occupied by all species other than a, and C the number of squares occupied by all species (REAL et al. 1992). This index excludes joint absences from consideration, and gives equal weight to matches and no-matches. Jaccard's index is considered as one of the most appropriate to apply to binary data and herpetological and biogeographical studies (BIRKS 1987; POLLS 1986; REAL et al. 1992).

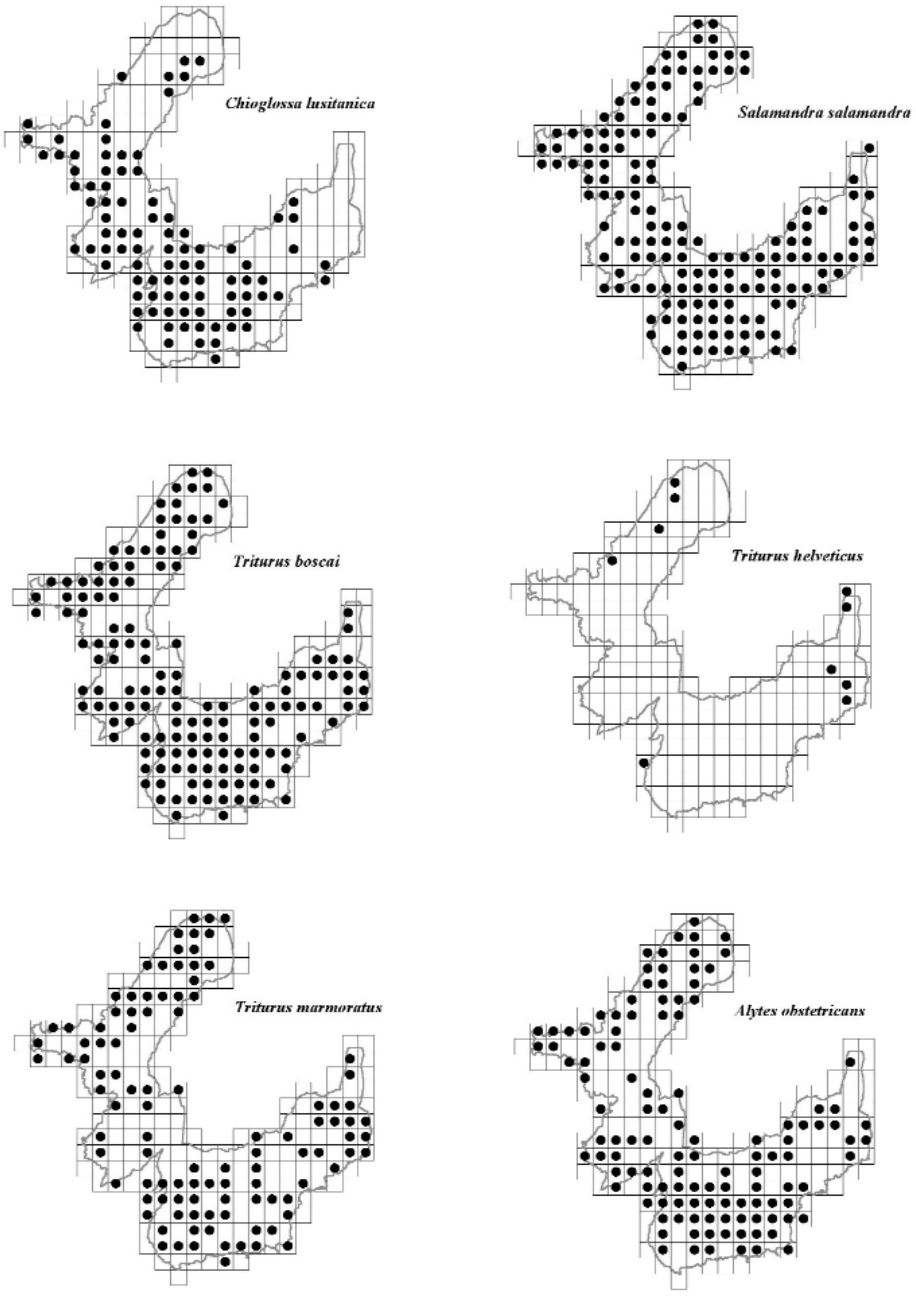


Fig. 2a: Distribution of the amphibian species in the Peneda-Gerês National Park at a 2 x 2 km UTM grid. Part 1.
Abb. 2a: Verbreitung der Amphibienarten im Peneda-Gerês Nationalpark (2 x 2 km UTM-Raster). Teil 1.

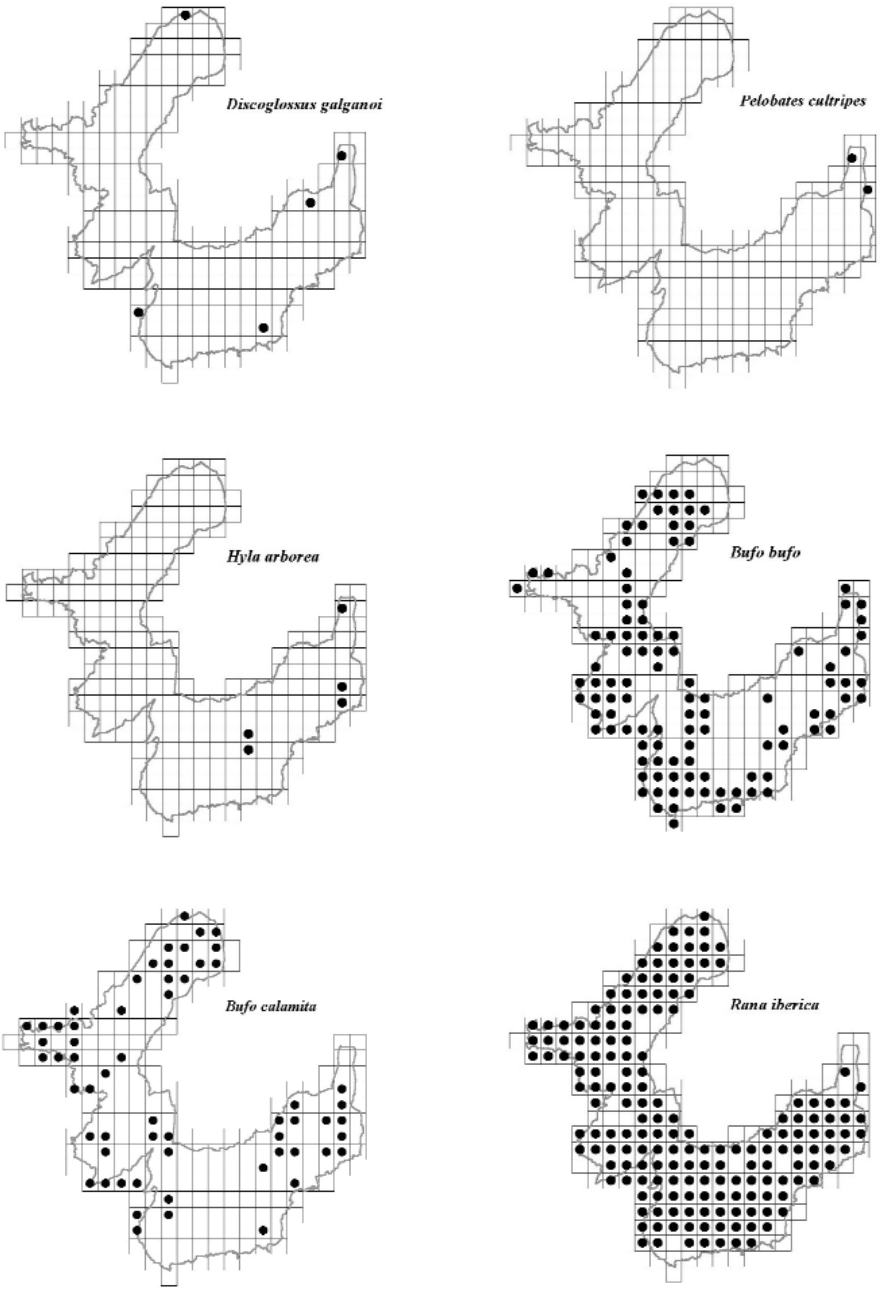


Fig. 2b: Distribution of the amphibian species in the Peneda-Gerês National Park at a 2 x 2 km UTM grid. Part 2.
Abb. 2b: Verbreitung der Amphibienarten im Peneda-Gerês Nationalpark (2 x 2 km UTM-Raster). Teil 2.

RESULTS AND DISCUSSION

The data collected comprised 1068 records from 13 amphibian species and 1397 records from 20 reptile species (table 1).

Three distinct groups of amphibian species were identified according to their distribution range in PNPG: (1) species widely distributed (*Salamandra salamandra*, *Triturus boscai*, *Triturus marmoratus*, *Alytes obstetricans*, *Bufo bufo*, *Rana iberica*, *Rana perezi*); (2) species widespread in PNPG, however restricted to areas with particular environmental characteristics, (*Chioglossa lusitanica*, *Bufo calamita*); and (3) species with small and fragmented distribution (*Triturus helveticus*, *Discoglossus galganoi*, *Pelobates cultripes*, *Hyla arborea*) (figs. 2a - 2c).

Chioglossa lusitanica, a northwest Iberian endemic (TEIXEIRA et al. 2001), was present in clear running water streams, and eventually, in ditches next to water springs, both with reasonable vegetation cover in the margins, and in steep slope areas. In the areas where the streams are sandier and the relief less accentuated, *Ch. lusitanica* was found only near large rock agglomerates that formed a microhabitat with little cascades, shadow and high humidity levels. At the opposite, *B. calamita* occurred mostly in plain and open areas, with loose soil, finding particular adequate conditions in the plateaus of the study area. This species breeds in shallow temporary ponds which are relatively common in the plateaus.

Triturus helveticus was detected in ten sites. This newt breeds in a wide variety of still or occasionally slow running waters, including tanks, ponds, and streams. It inhabited a wide variety of habitats near its breeding sites, such as woodlands, pastures, and bushy areas. The fragmented distribution of this species in the study area appears to reflect the species distribution in Portugal, where it is located in the southwestern limit of its geographic range (GASC et al. 1997).

Discoglossus galganoi is an endemic species of the occidental half of the Iberian Peninsula (GASC et al. 1997). This toad was observed in five locations, occurring in wet areas with dense herbaceous cover (with several species of low herbaceous plants and *Juncus* sp.), which are uncommon in the study area. Field surveys focused on this species might increase the currently known range.

Pelobates cultripes was detected only in the extreme eastern part of the study area, where suitable habitats for the species occur, such as sandy soils. This toad breeds in temporary ponds in open areas, using the sandy soils for hiding. The Mediterranean climate of the extreme east of PNPG should also enhance the occurrence of *P. cultripes*, as its distribution in the Iberian Peninsula follows areas of the Mediterranean type (PLEGUEZUELOS et al. 2002).

Hyla arborea was observed in five locations, corresponding to three ponds (Marinho lagoons, Covelães pond and Salas dam), of small peat bogs with dense aquatic vegetation, and dense herbaceous or bush cover, in the surrounding habitat. In the study area, other apparently suitable sites for this species included man-made structures, namely for agriculture water supply, or cattle pasture. PINO et al. (1993) also recorded this species from one site located in the bordering area between Galiza (Spain) and central PNPG. The eastern part of PNPG may represent a regional range limit for this species.

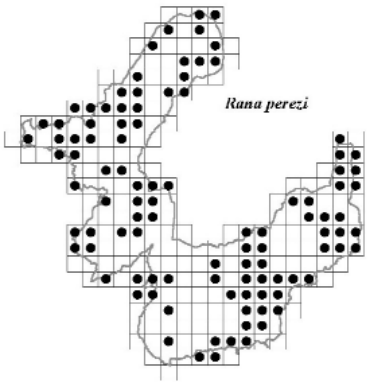


Fig. 2c: Distribution of the amphibian species in the Peneda-Gerês National Park at a 2 x 2 km UTM grid. Part 3.

Abb. 2c: Verbreitung der Amphibienarten im Peneda-Gerês Nationalpark (2 x 2 km UTM-Raster). Teil 3.

Table 1: Amphibian and reptile species present in the Peneda-Gerês National Park. Number and percentage of 2 x 2 km UTM squares in which the species were detected, and frequency classes (< 20% - scarce; 20-39% - intermediate; > 39% - abundant). * - Species endemic to the Iberian Peninsula.

Tab 1: Die Amphibien- und Reptilienarten im Peneda-Gerês Nationalpark. Anzahl und prozentueller Anteil der 2 x 2 km UTM-Rasterfelder, in denen die Arten gefunden wurden und klassifizierte Häufigkeit des Vorkommens (< 20% - selten; 20-39% - durchschnittlich ; > 39% - zahlreich). * - Iberische Endemiten.

Species	Number of 2x2 km UTM squares with records	Relative number of 2x2 km UTM squares with records (%)	Häufigkeit Frequency
AMPHIBIA Urodela			
**Chioglossa lusitanica* Bocage, 1864	91	37.9	Intermediate
Salamandra salamandra (Linnaeus, 1758)	150	62.5	Abundant
**Triturus boscai* (Lataste, 1879)	142	59.1	Abundant
Triturus helveticus (Razoumowsky, 1789)	9	3.7	Scarce
Triturus marmoratus (Latreille, 1800)	104	43.3	Abundant
AMPHIBIA Anura			
Alytes obstetricans (Laurenti, 1768)	116	48.3	Abundant
**Discoglossus galganoi* Capula et al., 1985	5	2.0	Scarce
Pelobates cultripes (Cuvier, 1829)	2	0.8	Scarce
Hyla arborea (Linnaeus, 1758)	5	2.0	Scarce
Bufo bufo (Linnaeus, 1758)	107	44.5	Abundant
Bufo calamita Laurenti, 1768	58	24.1	Intermediate
**Rana iberica* Boulenger, 1879	177	73.7	Abundant
Rana perezi Seoane, 1885	102	42.5	Abundant
REPTILIA Testudines			
Emys orbicularis (Linnaeus, 1758)	1	0.4	Scarce
Mauremys leprosa (Schweigger, 1812)	3	1.2	Scarce
REPTILIA Squamata			
**Blanus cinereus* (Vandelli, 1797)	1	0.4	Scarce
Anguis fragilis Linnaeus, 1758	54	22.5	Intermediate
**Chalcides bedriagai* (Boscá, 1880)	2	0.8	Scarce
Chalcides striatus (Cuvier, 1829)	57	23.7	Intermediate
Tarentola mauritanica (Linnaeus, 1758)	3	1.2	Scarce
Lacerta lepida Daudin, 1802	172	71.6	Abundant
**Lacerta schreiberi* Bedriaga, 1878	216	90	Abundant
**Podarcis bocagei* (Seoane, 1884)	196	81.6	Abundant
Podarcis hispanica (Steindachner, 1870)	111	46.2	Abundant
Psammodromus algirus (Linnaeus, 1758)	96	40	Abundant
Elaphe scalaris (Schinz, 1822)	23	9.5	Scarce
Coronella austriaca Laurenti, 1768	44	18.3	Scarce
Coronella girondica (Daudin, 1803)	49	20.4	Intermediate
Malpolon monspessulanus (Hermann, 1804)	72	30	Intermediate
Natrix maura (Linnaeus, 1758)	100	41.6	Abundant
Natrix natrix (Linnaeus, 1758)	115	47.9	Abundant
Vipera latastei Boscá, 1878	56	23.3	Intermediate
**Vipera seoanei* Lataste, 1879	26	10.8	Scarce

Concerning their distributional range in PNPG, three groups of reptile species were identified: (1) species widely distributed (*Anguis fragilis*, *Chalcides striatus*, *Lacerta lepida*, *Lacerta schreiberi*, *Podarcis bocagei*, *Podarcis hispanica*, *Coronella girondica*, *Malpolon monspessulanus*, *Natrix maura*, *Natrix natrix*); (2) species widespread in PNPG, however restricted to areas with particular environmental characteristics (*Psammodromus algirus*, *Elaphe scalaris*, *Coronella austriaca*, *Vipera latastei*, *Vipera seoanei*); and (3) species with small and fragmented distribution (*Emys orbicularis*, *Mauremys leprosa*, *Blanus cinereus*, *Chalcides bedriagai*, and *Tarentola mauritanica*) (figs. 3a - 3d).

Psammodromus algirus and *Elaphe scalaris* were located in the lower courses of the rivers Vez and Cávado, in the south orientated slopes of Gerês and Peneda mountains, and in Lima and Gerês river valleys. These species follow the Mediterranean climate, thus in the PNPG they occurred main-

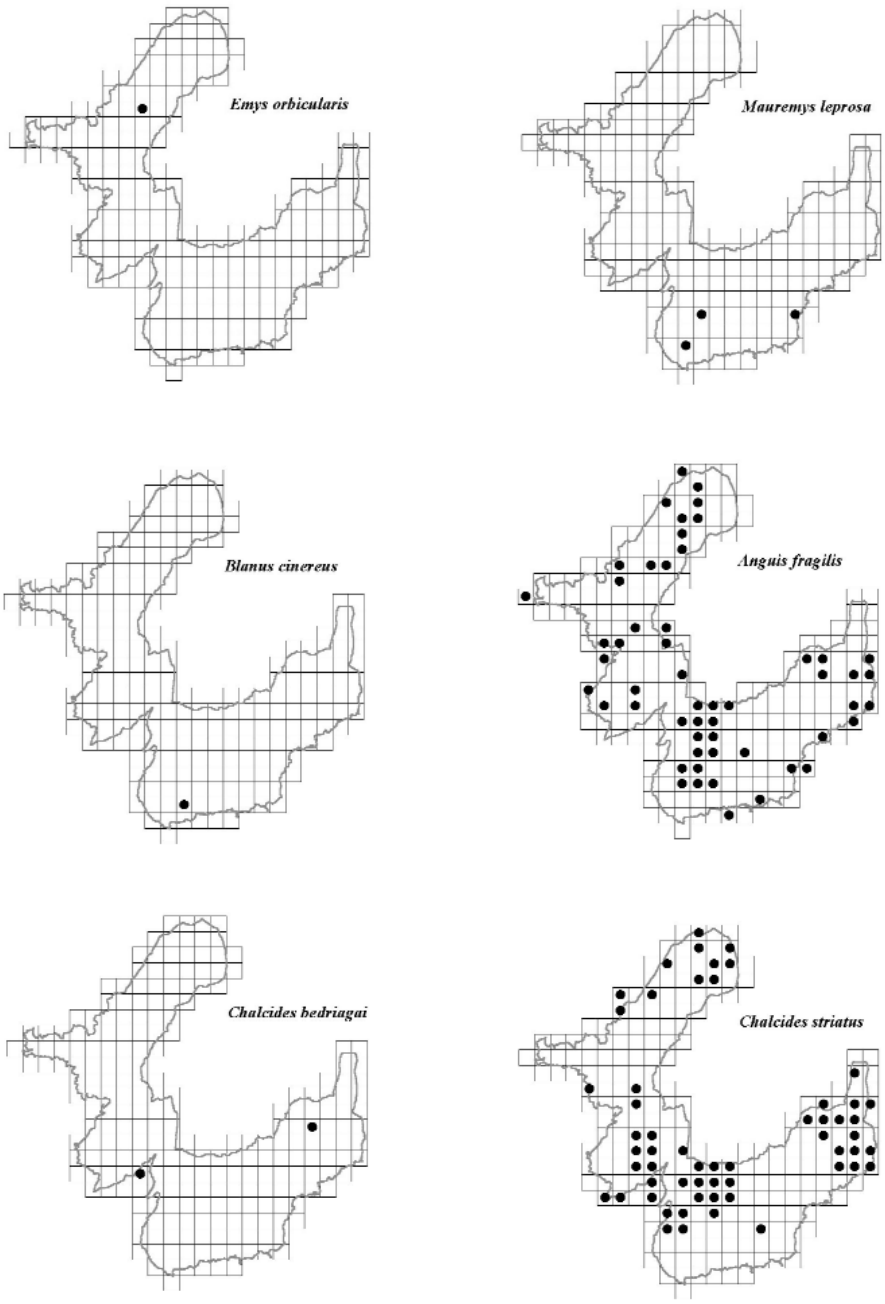


Fig. 3a: Distribution of the reptile species in the Peneda-Gerês National Park at a 2 x 2 km UTM grid. Part 1.
Abb. 3a: Verbreitung der Reptilienarten im Peneda-Gerês Nationalpark (2 x 2 km UTM-Raster). Teil 1.

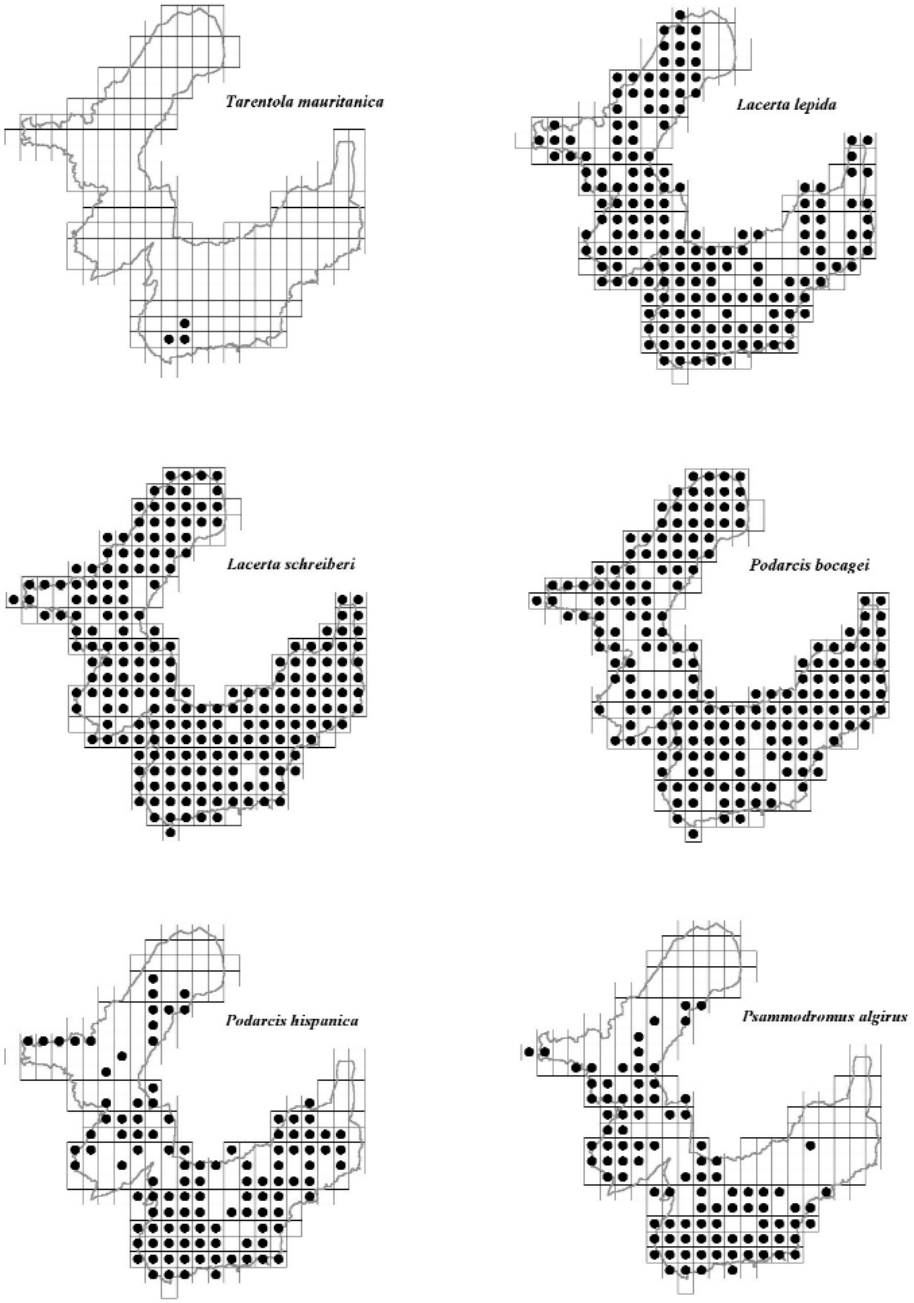


Fig. 3b: Distribution of the reptile species in the Peneda-Gerês National Park at a 2 x 2 km UTM grid. Part 2.
Abb. 3b: Verbreitung der Reptilienarten im Peneda-Gerês Nationalpark (2 x 2 km UTM-Raster). Teil 2.

ly in dry areas with elevated solar radiation, such as bushland, pinewoods, open areas with shrubs, rocky areas and also in arid areas with dense bush cover. Both species occur mainly at low altitudes, but *P. algirus* can be found up to 1000 m a.s.l..

Coronella austriaca and *Vipera seoanei* occurred more frequently in high altitude areas with high levels of humidity, the first in rocky and bushy habitats, while the latter in wet meadows with dense bush vegetation cover (ferns and brooms, *Erica* sp., *Genista* sp.). The geographic range of these species covers the Euro-Siberian climatic region (GASC et al. 1997; BRITO & CRESPO 2002; PLEGUEZUELOS et al. 2002), thus in the PNPG they are on the southwestern limit of their distribution area, and occur only in the areas that present the above characteristics. Although *V. seoanei* distribution in PNPG appears to reveal two isolated populations, these are connected in the neighboring Spanish territory (Baixa Limia) (BALADO et al. 1995).

Vipera latastei occurred in the central area of Gerês mountain and also in Soajo, Amarela and Peneda mountains. Although with a widespread distribution in the PNPG, it was found only in particular habitats, such as dry, rocky areas, covered or surrounded by open vegetation, usually in south-faced slopes. It was also found in English-oak (*Quercus robur*) and pine forests (*Pinus* sp.). The PNPG corresponds to the northwestern limits of its distribution area, although some small populations can be found in the Xurés mountain, Galicia (BRITO & CRESPO 2002; PLEGUEZUELOS et al. 2002). No syntopic populations of *V. latastei* and *V. seoanei* were found, however there are two areas of potential sympatry, the Beredo river valley and the northern slopes of Soajo and Peneda mountains (BRITO & CRESPO 2002).

Emys orbicularis was detected in the Peneda river, near the bridge next to the Monastery of N.ª Sr.ª da Peneda (UTM 29TNG6447) by a fisherman of a near town (Castro Laboreiro) and photographed by a Nature Guard of PNPG. *Mauremys leprosa* was detected in Gerês river, near Vidoeiro camping (UTM 29TNG7021 and UTM 29TNG6916), and also in Cávado river (UTM 29TNG8220). During the field work it was neither possible to find further isolated individuals nor stable populations of both species. These terrapins are frequently held in captivity and the observations of these species were made near tourist zones of the study area, and therefore these individuals were most likely accidental or deliberate introductions.

The Mediterranean thermophilic character of the distribution of *M. leprosa*, presumably, does not allow the occurrence of natural populations of this species in the PNPG. Regarding *E. orbicularis*, there are, however, historical references of its presence in the study area (Cávado river basin), namely in Caldo river (DA SILVA 1985), Pincães/Cabril (ANONYMOUS 1744), as well as in nearby areas, such as low Cávado river (Barcelos and Vila Verde counties) and Minho and Tâmega river basins (GALÁN 1999; ÁLVARES 2001). Probably, the species may have gone extinct or suffered an extreme reduction in the population size in these historical areas, as observed in nearby regions in Spain (VELO et al. 2004). An intensive and directed field methodology should be applied to allow better conclusions about the population size and conservation status of the terrapin populations in the study area.

Blanus cinereus and *Tarentola mauritanica* are known only from one and three locations, respectively, restricted to the south slope of Gerês mountain. *Blanus cinereus*, an Iberian endemic, presents cryptic and fossorial habits and inhabits underground excavated galleries, which can complicate its detection. In the PNPG, *T. mauritanica* was located in stone houses and boxes for beebreeding, where it can find shelter and prey. The PNPG is located at the northwestern limit of the distribution area of both species (PLEGUEZUELOS et al. 2002); therefore, populations are probably residual and isolated. In the case of *T. mauritanica*, human introduction might be suspected. However there are other suitable areas presenting Mediterranean microclimates such as the south facing slopes of Gerês and Peneda mountains, and the Lima river valley. These areas present a thermophilic vegetation cover (*Quercus suber* and *Qu. ilex*) with high insolation levels (C.N.A. 1983). Further field surveys in these areas are needed to clarify if

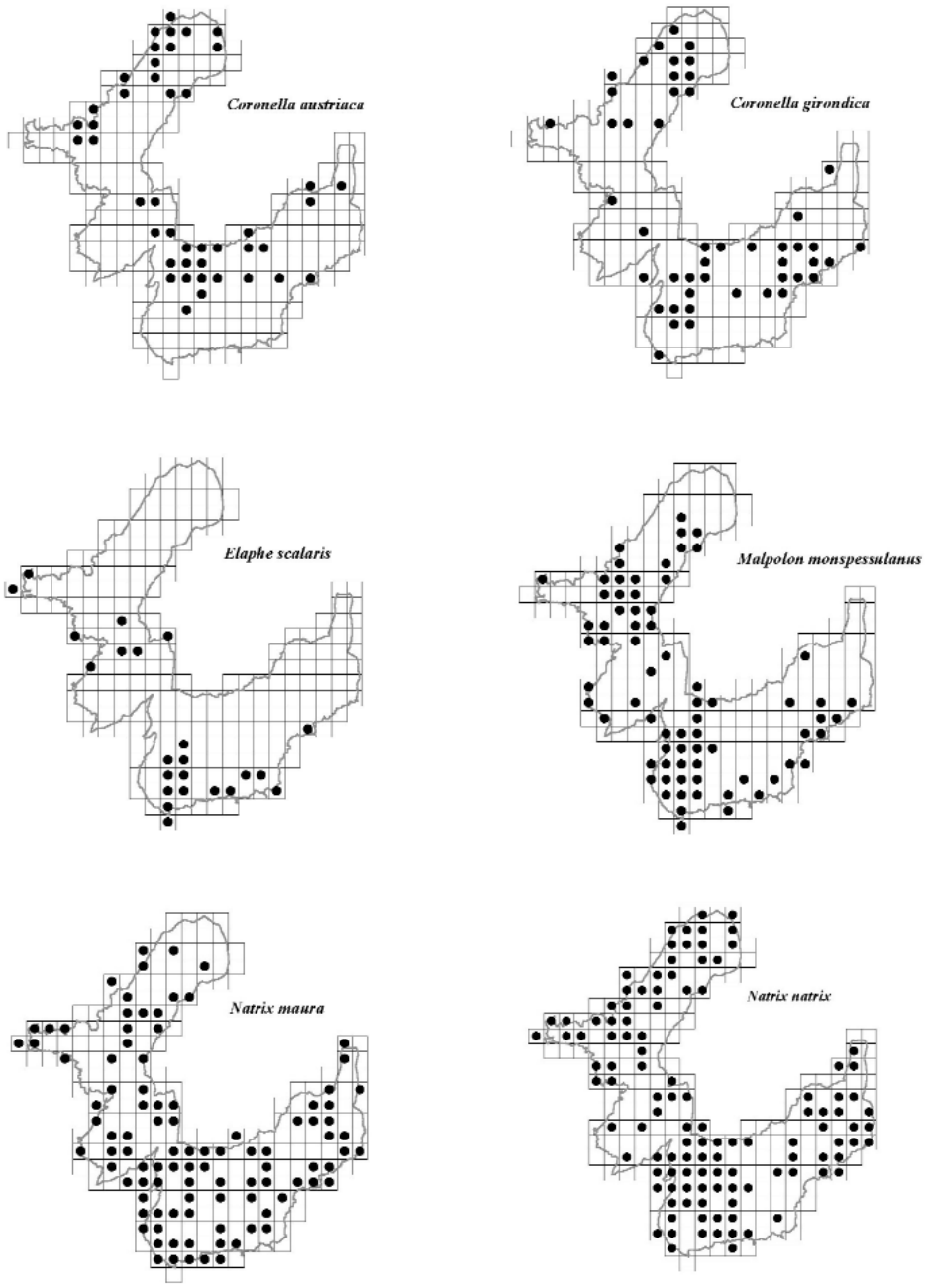


Fig. 3c: Distribution of the reptile species in the Peneda-Gerês National Park at a 2 x 2 km UTM grid. Part 3.
Abb. 3c: Verbreitung der Reptilienarten im Peneda-Gerês Nationalpark (2 x 2 km UTM-Raster). Teil 3.

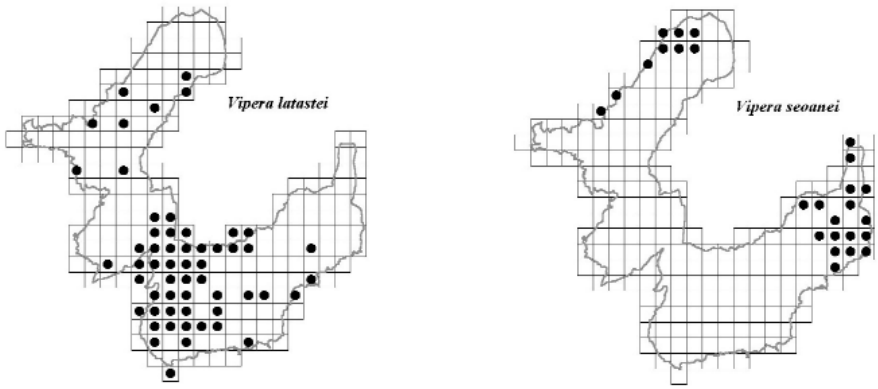


Fig. 3d: Distribution of the reptile species in the Peneda-Gerês National Park at a 2 x 2 km UTM grid. Part 4.
Abb. 3d: Verbreitung der Reptilienarten im Peneda-Gerês Nationalpark (2 x 2 km UTM-Raster). Teil 4.

there are other populations of these two species.

Chalcides bedriagai, an Iberian endemic, was documented from two locations in the study area by MALKMUS (1986a) during the 1980's: the south slope of Amarela mountain, near the village Vilarinho das Furnas (UTM 29TNG6526), and also in Gerês mountain, near the cemetery of Pitões das Júnias (UTM 29TNG8732). Despite the field work, the species was not detected during the surveys. This species generally occurs in sandy or soft soils that are uncommon in the study area. Focused field surveys should be used to evaluate the status of the species in this area.

Three additional species were referenced for the PNPG, during the late 19th and earlier 20th century: *Pleurodeles waltl* (MICHAHELLES, 1830) (MOLLER 1894a) and *Acanthodactylus erythrurus* (SCHINZ, 1833) (FERREIRA & SEABRA 1911) in the Gerês mountain, and *Psammodromus hispanicus* FITZINGER, 1826 in the Mourela plateau (NOBRE 1903). These records are perhaps due to incorrect identification. In the Iberian Peninsula, *P. waltl* and *A. erythrurus* are restricted to very dry and arid Mediterranean habitats (PLEGUEZUELOS et al. 2002), which do not occur in the PNPG. A similar explanation could be attributed to *P. hispanicus* although its known distribution range is closer to the study area (PLEGUEZUELOS et al. 2002).

Hierarchical Cluster analysis grouped amphibians in two major groups of species related with range and pattern of the distribution area in the PNPG: (1) the generalized and widespread species and (2) the specialized species of restricted distribution, *Hyla arborea*, *Triturus helveticus*, and *Discoglossus galganoi* (fig. 4). Differences in the availability of suitable habitats for each species, allowed for distinction within the clusters. The first group contains three species; which were placed in somewhat differentiated positions. *Chioglossa lusitanica* because it occurred in streams with running water that are more abundant in areas with rather accentuated relief, *B. bufo* because, although it occupies a wide variety of habitats, the vast majority of observations correspond to dor (dead on road) adult specimens, which may have caused bias in the detectability of the species; and *B. calamita* which occurred mostly in plain open areas. Moreover, this type of analysis highlighted the rarity level of the species, since the amphibians included in the group of specialized species of restricted distribution are classified as "scarce" regarding their rarity level (table 1).

As in the amphibians, HCA clustered the reptile species in two groups according

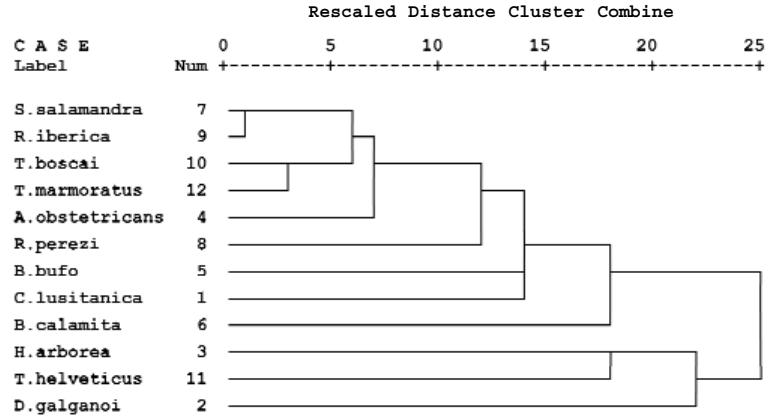


Fig. 4: Amphibian distributional relationships in the Peneda-Gerês National Park. Hierarchical Cluster Analysis (Average Linkage - Between Groups) using Jaccard's similarity index (see methods section for details).

Abb. 4: Die Beziehungen der Amphibienarten hinsichtlich ihrer Verbreitungsmuster im Peneda-Gerês Nationalpark. Hierarchische Cluster Analyse (Average Linkage - Between Groups) unter Anwendung von Jaccards Ähnlichkeitsmaß.

to the availability of suitable habitats (fig. 5): (1) generalized and widespread species, *P. bocagei* through *C. striatus*, and (2) specialized species of restricted distribution. Within the first group, three species were placed in somewhat differentiated positions because of particular habitat requirements: *Coronella austriaca* which occupies rocky habitats in high altitude areas, *Vipera seoanei* and *Chalcides striatus*, which occur in wet

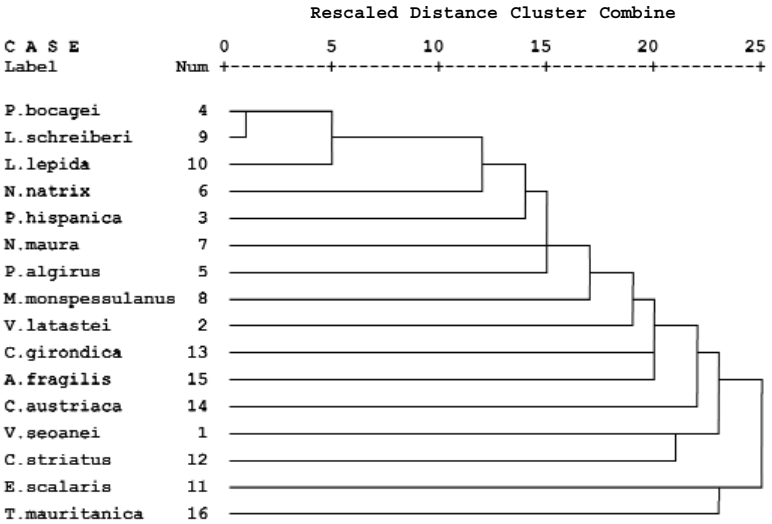
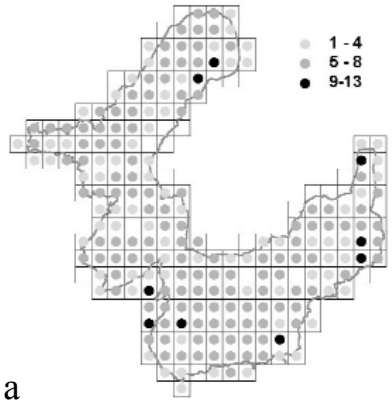
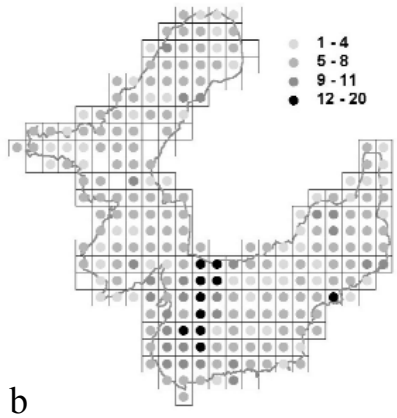


Fig. 5: Reptile distributional relationships in the Peneda-Gerês National Park. Hierarchical Cluster Analysis (Average Linkage - Between Groups) using Jaccard's similarity index (see methods section for details).

Abb. 5: Die Beziehungen der Reptilienarten hinsichtlich ihrer Verbreitungsmuster im Peneda-Gerês Nationalpark. Hierarchische Cluster Analyse (Average Linkage - Between Groups) unter Anwendung von Jaccards Ähnlichkeitsmaß.



a



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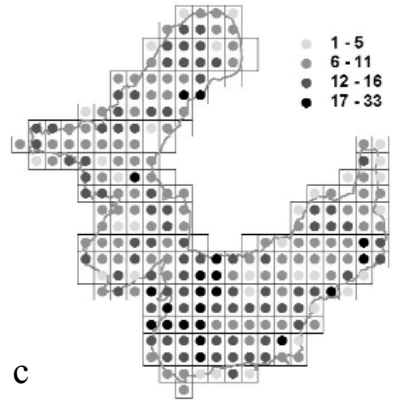

c

meadows in high altitude areas (the former species), and both low and high altitude areas (the latter species). The cluster of the specialized species contains *Elaphe scalaris* and *Tarentola mauritanica* which are restricted to the areas characterized by Mediterranean climate.

In the amphibians, the HCA clustered species chiefly according to the number of grid cells occupied, i.e. the size of the distribution area, whereas for reptiles it seemed to cluster species also somewhat according to their habitat requirements. A clustering method that combined information about the range of the distribution area and the ecogeographical factors of the study area would certainly produce results less biased by the number of locations.

Three high species richness areas were identified for the amphibians, reptiles and whole herpetofauna (figs. 6a - 6c), and these areas are commonly shared by the taxonomic groups: (1) Gerês river valley and Albergaria forest, (2) the transition area between Gerês mountain and Mourela plateau, and (3) the transition area between Peneda mountain and Castro Laboreiro plateau. These territories broadly correspond to the transition zone between the Euro-Siberian and Mediterranean climates, which allow the contact between distinct biogeographical groups of species. The first area, Gerês river and Albergaria forest, neighbor the Spanish Torneiros valley, which was also identified as one of the richest of Galicia as for the reptiles (BALADO et al. 1995). For the amphibians, however, these high species richness areas are smaller and correspond to particular habitats - Marinho lagoons, Covelães pond and Salas dam – where the scarcer amphibians were located (fig. 6).

The complex orography of the PNPG, with narrow valleys and steep slopes creating micro-environmental conditions for each group of species, enables high levels of species diversity. The number of amphibian

Figs. 6a – 6c: Species richness in the Peneda-Gerês National Park at a 2 x 2 km UTM scale.
a - amphibians, b - reptiles, c – amphibians and reptiles. Grey scale represents the number of species.

Abb. 6a – 6c: Artenreichtum im Peneda-Gerês Nationalpark (2 x 2 km UTM-Raster).
a - Amphibien, b - Reptilien, c – Amphibien und Reptilien. Die Grauskala gibt die Artenanzahl an.

and reptile species inventoried represents 76.5% and 74.4%, respectively, of the total number of species occurring in continental Portugal (GODINHO et al. 1999). The biogeographic crossroad status of the Peneda-Gerês National Park renders it as priority for the conservation of amphibian and reptiles, at a national scale.

ACKNOWLEDGEMENTS

We thank Eduardo CRESPO, António REBELO, Gisela MOÇO, Sara ROQUE, Francisco NETO, Henrique CARVALHO, Joana FERREIRA, Nuno NEGRÕES, Ana Isabel CATALÃO, Otto HANZ, Gonçalo COSTA, José ÁLVARES and all the National Park staff of the Gerês delegation for ad-hoc records, and Rudolf MALKMUS, (Wiesthal) for literature and data records. Field work was financed by Instituto de Conservação da Natureza (PNPG/ICN) and Plano Operacional do Ambiente. J. C. BRITO was supported by a post-doctoral grant (SFRH/BPD/11542/2002) from Fundação para a Ciência e Tecnologia (FCT).

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DATE OF SUBMISSION: January 1st, 2005 Corresponding editor: Heinz Grillitsch

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