

DISTRIBUTION OF *TRITURUS CRISTATUS CARNIFEX* (AMPHIBIA: SALAMANDRIDAE) ON SÃO MIGUEL ISLAND (AZORES)

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MACHADO, E., L. SILVA & R. ELIAS 1997. Distribution of *Triturus cristatus carnifex* (Amphibia: Salamandridae) on São Miguel island (Azores). *Arquipélago. Life and Marine Sciences* 15A: 97-102. Ponta Delgada. ISSN 0873-4704.

This is the first study of the ecology of *Triturus cristatus* on São Miguel island (Azores), where it was introduced in the early 1900's. Morphological traits of the Azorean population are those expected for the subspecies *T. cristatus carnifex*, namely relatively smooth skin, reduced white punctuation, orange ventral surface with large, well defined dark spots, a vertebral yellow line in the females and a conspicuous dorsal crest in males. *T. cristatus carnifex* was found at 45 sites in the central part of São Miguel Island, from the western foot of Serra de Água de Pau to Furnas, between 200-700 m of altitude, mainly in ponds and water basins associated with pastures. The success of this species is related to the expansion of pasture land, so that its conservation, in the Azores, is greatly dependent on cattle raising practices.

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Este é o primeiro trabalho sobre a ecologia de *Triturus cristatus* na ilha de São Miguel (Açores), onde foi introduzido no início deste século. A população açoreana apresenta a pele relativamente lisa, com pouco ponteadado branco, ventre alaranjado, com grandes manchas cinzentas-escuras, bem definidas, e uma linha vertebral amarela nas fêmeas, características que a identificam como a subespécie *T. cristatus carnifex*. Foram mapeados 45 locais onde *T. cristatus carnifex* foi encontrado na zona central da ilha de São Miguel, entre o sopé ocidental da Serra de Água de Pau e a freguesia das Furnas, entre os 200 e os 700 m de altitude, sobretudo em charcos e bebedoiros, em pastagens. O sucesso desta espécie está relacionado com o aumento da área de pastagem, pelo que a sua conservação, nos Açores, está grandemente dependente da actividade pecuária.

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INTRODUCTION

In the Azores two species of amphibians, both introduced, are found, *Rana perezi* (Seoane, 1885) (Ranidae) and *Triturus cristatus* (Laurenti, 1768) (Salamandridae) (ULFSTRAND 1961; SVANBERG 1975). Individuals of *Salamandra salamandra* (Linnaeus, 1758) (Salamandridae) and *Pleurodeles waltl* (Michahelles, 1830) (Salamandridae), also introduced, have been

occasionally collected, and the possibility that these amphibians belong to natural populations on São Miguel island is now being evaluated. The green frog, which was probably introduced in 1820 (CHAVES 1949), is presently found on all the islands of the Archipelago. In 1922 the crested newt was already present in São Miguel, the only Azorean island where it is presently found (SVANBERG 1975), but the site and date of introduction are unknown. Interestingly, this

species does not occur in the Iberian Peninsula (ARNOLD & BURTON 1987), so the Azorean population is probably derived from an undetermined European population (MACHADO 1992). To our knowledge, this species is not present on other Macaronesian islands (KUNKEL 1976; ANONYMOUS 1990), and no ecological or biological research has previously been carried out on the Azorean population.

Since *T. cristatus* is a threatened species, included in Appendix II of Bern Convention, concerning the protection of wildlife and of the environment in Europe (ANONYMOUS 1981), the success of the Azorean population might be regarded as very interesting with respect to its habitat use and the protection of suitable habitats on the continent. It would likewise be important to determine in more detail the causes of this success in the Azores.

The objective of this work was to map the distribution of *T. cristatus* on São Miguel island and to confirm the identification of the subspecies *T. c. carnifex*.

MATERIAL AND METHODS

STUDY SITES

São Miguel is a volcanic island with an area of about 750 km², of which 40% of the surface has been turned to pasture. More than thirty small lakes are present, of different sizes, depths and surroundings. Many has become eutrophic due to direct contact with pastures and the associated input of nutrients. Many lakes are surrounded by *Cryptomeria japonica* woods, many more by pastures and some by endemic plant communities. In general, the vegetation associated with lakes in the Azores has been described as the alliance *Littorello-Eleocharion* (SJÖGREN 1973). Many ponds and water basins are also found, associated with cattle farms. Mean annual temperature in São Miguel varies from 12°C at 550 m to 17°C at 70 m of altitude, and rain fall from 1020 to 2309 mm/year (INMG 1991).

DISTRIBUTION

Since 1994 a thorough survey of ponds, lakes and water basins all around the island has been undertaken. Specimens of *T. cristatus* were searched by dragging a net close to the bottom or through the water column for adults and larvae, respectively, and by direct observation of eggs in submerged vegetation. The position of each positive site was recorded on a 1:25000 map (Serviços Cartográficos do Exército). Altitude and type of habitat was noted. The UTM (Universal Transverse Mercator) 1x1 km grid was used to locate each site.

CONFIRMATION OF THE SUBSPECIES

Several adults were captured and the external traits analysed, in order to check the validity of the attributed subspecies, according to the characteristics given by ARNOLD & BURTON (1987).

RESULTS

DISTRIBUTION

T. cristatus was found at 45 sites in the central part of São Miguel island, from the western foot of Serra de Água de Pau to Furnas (Table 1; Fig. 1), mainly in ponds (60 %) and water basins (31 %) (Fig. 2). Almost 40 % of the sites where *T. cristatus* was found were located between 500 and 600 m of altitude, and 60% between 400 and 600 m of altitude.

CONFIRMATION OF THE SUBSPECIES

Adults showed reduced white punctuation at the flanks, and the ventral surface was generally orange with large, well defined, dark spots. A vertebral yellow line was generally present in the females (Fig. 3). These traits are in agreement with what could be expected for the subspecies *T. cristatus carnifex* (ARNOLD & BURTON 1987). The typical crest of *T. cristatus* males has been found during the breeding season and also afterwards in males captured in water.

Table 1

Triturus cristatus sites on São Miguel island, in accordance with the UTM system (co-ordinates of the upper left corner of each 1x1 km square are given).

Habitat	UTM (1x1 Km)	Site
Water basin	628:4180	Cinco Caminhos
Pond	629:4178	Near Ribeira das Pedras
Pond	629:4179	Fontainhas
Water basin	629:4181	Chã da Macela
Water basin	"	"
Water basin	"	"
Water basin	629:4182	"
Water basin	"	"
Water basin	"	"
Pond	"	"
Pond	"	"
Pond	"	"
Pond	630:4182	"
Water stream	631:4185	Ribeira da Pernada
Water basin	632:4185	Near Pico Leitão
Water basin	634:4184	Mato do Jorge
Water stream	633:4181	Near Lagoa do Fogo
Pond	638:4180	North of Sanguinhal
Water basin	639:4177	Southeast of Mãe d' água
Lake	640:4184	Lagoa de São Brás
Pond	640:4181	Feira das Meias
Lake	640:4180	Lagoa dos Nenúfares
Pond	640:4179	West of Ribeira da Vida
Pond	641:4182	Northwest of Pico D'el Rei
Pond	"	Southwest of Pico D'el Rei
Pond	641:4181	North of Roça do Albano
Pond	"	Roça do Albano
Pond	"	"
Pond	641:4180	Lagoinhas
Pond	642:4180	Pico do Frescão
Pond	"	Dona Ermelinda
Pond	"	"
Water basin	643:4184	Southeast of Feira
Pond	643:4180	Pico da Cova da Catarina
Pond	644:4184	Macicira
Pond	644:4181	Cedros
Pond	644:4181	"
Water basin	644:4180	Cerrado dos Bezerros
Pond	"	East of Cerrado dos Bezerros
Pond	645:4184	Chã da Praia
Water basin	645:4183	Near Furnas Golf Course
Water basin	"	"
Pond	647:4180	Near Lagoa Seca
Pond	648:4180	Southeast of Pico do Gaspar

DISCUSSION

It is not known to us how and by whom *T. cristatus carnifex* was brought to the Azores from the European continent. This subspecies has a wide distribution, including northern Italy, north-eastern parts of the Alps, part of Austria, and northern ex-Yugoslavia.

Cattle raising may have been a decisive factor in the establishment of *T. cristatus carnifex* on São Miguel island, by making available an adequate and widespread habitat - ponds and water basins. In fact, the altitude range of *T. cristatus carnifex*, from 200 to 700 m, covers almost completely the distribution of pastures (OLIVEIRA 1989) and agrees with earlier observations by MACHADO (1992). On the other hand, at higher altitudes, higher humidity and rain fall are expected, which may favour the existence of amphibians.

The type of habitats occupied, mostly water basins and ponds, with low water flow, is in accordance with those found in Europe (ARNOLD & BURTON 1987). However, the majority of these habitats are artificial, and are used as watering places for cattle. The destruction or replacement of those habitats, by other structures, in order to improve the control of brucellosis and fasciolosis, for example, may threaten the existence of *T. cristatus carnifex* on São Miguel.

In some Azorean lakes, newts may be predated by *Micropterus salmoides*. In fact, the predation of eggs, larvae and adults, by introduced fish, is a potential limiting factor of *T. cristatus carnifex* population on São Miguel.

Water quality, for example pH (DOLMEN 1988), may also affect the distribution of the crested newt. For example, at Lagoa do Areeiro, located in the zone where *T. cristatus carnifex* is more frequent, this species was not found, despite the presence of potential food, like benthic Crustacea, Cladocera and

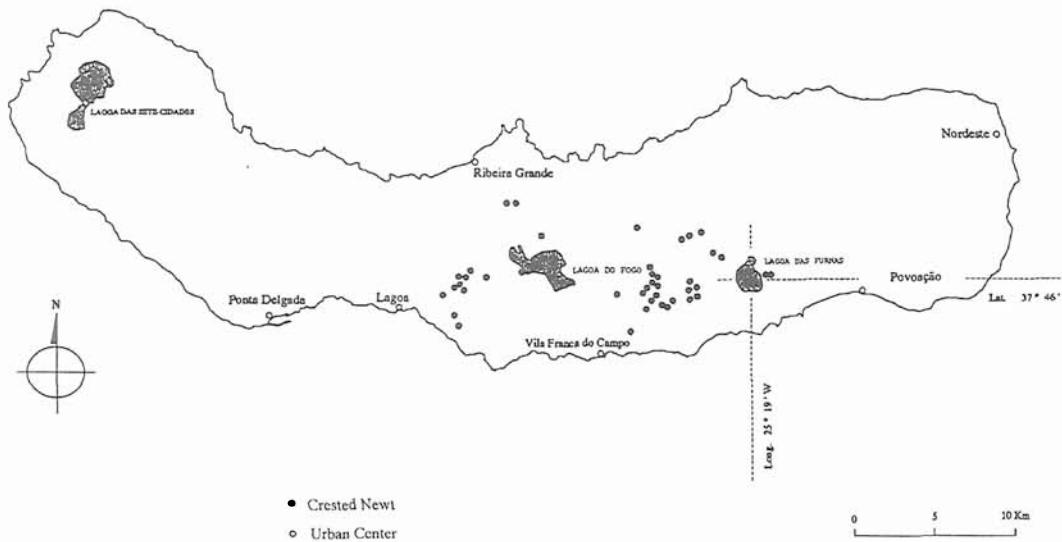


Fig. 1. Sites where *Triturus cristatus carnifex* was found on São Miguel island (Azores).

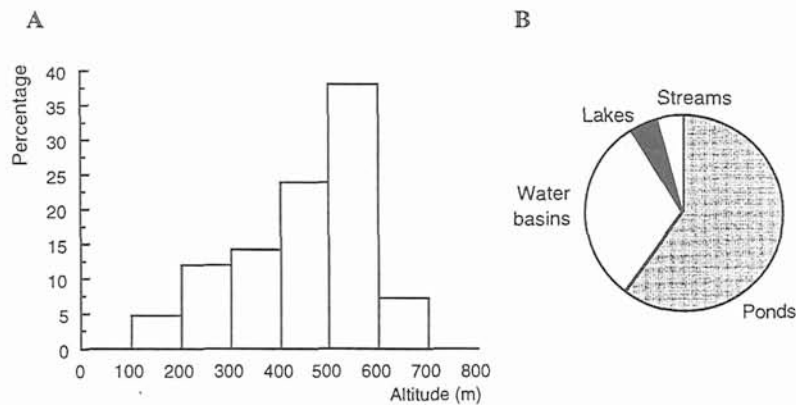


Fig. 2. Distribution of *Triturus cristatus carnifex* on São Miguel island, in accordance with altitude (A) and the habitat (B) (from a total of 45 sites).

Copepoda (DOLMEN & KOKSVIK 1983), and the absence of fish populations, perhaps due to strongly acidic water (pH = 5).

We can conclude that the success of *T. cristatus carnifex* on the Azores, is related to the expansion of pasture land and associated water reservoirs and that its conservation is greatly dependent, between other factors, on cattle raising practices.

ACKNOWLEDGEMENTS

We would like to thank Associação Ecológica/Amigos dos Açores and Centro de Conservação e Protecção do Ambiente (Universidade dos Açores). The manuscript was improved by comments and corrections from two anonymous reviewers.



Fig. 3. Some morphological traits of *Triturus cristatus carnifex*. (A) Female with its vertebral yellow line; (B) Female (left) and male on a wooden log which they used as a shelter; (C) Ventral view of a male, with its orange colour, and with large well defined, dark spots.

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Accepted 19 September 1997