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Amphibians of the Aurunci Mountains (Latium, Central Italy). Checklist and conservation guidelines

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Abstract. The Aurunci Mounts are among the less investigated areas of Latium for herpetological researches. In this study we surveyed 72 potential breeding sites of amphibians within the Monti Aurunci Regional Park. Fifty-eight spawning sites, and nine amphibian species (64.3% out the 14 amphibian species living in Latium region) have been found. Green toad and European tree frog were recorded for the first time for the Aurunci Mounts. Reproductive activity was recorded for *Salamandrina perspicillata, Triturus carnifex, Lissotriton vulgaris*, *Lissotriton italicus*, *Bufo bufo, Pseudopidalea viridis*, *Hyla intermedia*, *Rana italica* and *Rana* synklepton *hispanica*. Unexpectedly, no amphibian species has been recorded within the Monte Redentore (pSIC IT6040027), despite this site was included within the Natura 2000 network also basing on the presence of *Triturus carnifex*.

Keywords. Monti Aurunci Regional Park, Italy, Amphibia, distribution, conservation.

INTRODUCTION

The southernmost portion of the Latium region is among those areas that are poorly studied by regional herpetological researches (cf. Bologna et al., 2000), particularly for that concerning Amphibians. The Volsci Chain is the western portion of this area, which comprises three mainly karstic subgroups: the Lepini, Ausoni and Aurunci Mounts. In 1997 a part of the Aurunci Mounts was acknowledged as a Regional Park, which overlaps the ZPS IT6040043 (ZPS area surface: ha 19.374) and four pSIC: IT6040026 (Monte Petrella), IT6040027 (Monte Redentore), IT6040028 (Forcelle di Campello e Fraile) and IT6050026 (Parete del Monte Fammera).

So far the knowledge on the herpetofauna of the Aurunci was only based on a preliminary account by Bonifazi and Carpaneto (1990), and a few other scattered information

are found in other papers concerning wider areas (e.g. Bruno, 1973; Bologna et al., 2000; Corsetti, 2006).

In 2004 the "Monti Aurunci" Regional Park supported financially both an updated checklist and a breeding sites' census of the amphibians species. The results of these surveys are hereby reported.

MATERIAL AND METHODS

Since there is not a clear hydrographical or geological boundary between the Ausoni and the Aurunci Mounts, conventionally the Aurunci Mounts are considered the mounts at the east of a line connecting Fondi-Lenola-Pico-S.Giovanni Incarico towns (Landi Vittorj, 1955). Furthermore, the Aurunci Mounts are delimited northward by the Liri river, south-eastward by the Garigliano river and southward by the planitial zones before to arrive to the Tyrrhenian sea. The Aurunci Mounts are mainly constituted by limestone. Altitude varies from hills to the 1,533 m of Monte Petrella. Main peaks include Monte Sant'Angelo (1,404 m), Monte Ruazzo (1,314 m), Monte Revole (1,285 m) and the Redentore (1,252 m). The minimum distance from the Tyrrhenian Sea is about 3 km. Due to karstic phenomena, freshwater ecosystems are limited to some minor springs (ephemeral or perennial) and to vernal ponds (sometimes residual pools in stream beds), while running waters, rivers or streams, are almost absent. Actually some piedmont perennial springs and rivers run only at low altitudes. Other still freshwater ecosystems are artificial stony wells, a very common aquatic typology in this area.

On the whole we surveyed 550 km^2. Field research was carried out mainly from spring to autumn 2003 and it was focused within the Park boundaries (almost the third part of the total surveyed area) and more specifically within the pSIC areas. Field researches included (*i*) the inspection of the sites reported in literature to check both species presence and their breeding activity, (*ii*) cartographic recognition of further potential aquatic habitats suitable for amphibian populations and the inspection of these sites, (*iii*) the collection of information from local peoples (mainly from shepherds).

Since several sites were very close to each other, two or more aquatic habitats less than 50 m apart, and inhabited by the same species, have been considered as a single breeding site.

Sites were georeferenced and assigned to six different freshwater typologies: springs, drinking places for livestock grazing, ponds, stony wells, lakes or marshes and streams or creeks. Sites were also distinguished between breeding sites and presence site (i.e. where spawning activity was not recorded). Since variance among altitudes of anurans and urodeles breeding sites was not homogeneous (data not shown), then the non parametric Mann-Whitney *U*-test was applied to estimate if any significant difference was detectable between altitudinal preferences showed by Anura and Urodela.

Statistical analyses was performed using Statistica® ver. 5.0/W Statistica package (Statsoft Inc., USA). Finally the Sørensen's coefficient of similarity (Hayek, 1994) was carried out among species and sites, using only amphibian breeding sites to detect the affinity among species in their reproductive habitats. Amphibian scientific names are here reported following the systematic revision suggested by Frost et al. (2006).

RESULTS

Ninety-six records of amphibians were collected, and breeding activity was recorded in 58 sites including 98 single spots of aquatic habitats (see Material and Methods), that is

about 80% out of the surveyed potential spawning sites (n = 72). Two presence sites were also recorded (one site for Green toad and one site for Common toad). Nine amphibian species were recorded within the Aurunci Mounts: Northern spectacled salamander, *Salamandrina perspicillata* (Savi, 1821); Italian crested newt, *Triturus carnifex* (Laurenti, 1768); Smooth newt, *Lissotriton vulgaris* (Linnaeus, 1758); Italian newt, *Lissotriton italicus* (Peracca, 1898); Common toad, *Bufo bufo* (Linnaeus, 1758); Green toad, *Pseudopidalea viridis* (Laurenti, 1768); Italian tree frog, *Hyla intermedia* (Boulenger, 1882); Italian stream frog, *Rana italica* (Dubois, 1987) and *Rana* synklepton *hispanica* (including Berger's green frog, *Rana bergeri* [Gunther, 1986] and its hybridogenetic hybrid *Rana* kl. *hispanica* [Bonaparte, 1839]). Their distribution in the study area is shown in Fig. 1 and Fig. 2. Compared to published data (Table 1), the Italian newt and the Northern spectacled salamander show the highest increments (1600% and 1100% respectively) while the toads show the lowest increments (80% and 100% for Common toad and Green toad respectively).

The mean altitude of records (Fig. 3) was 557 ± 218 m (mean ± SD) for urodeles and 314 ± 253 m for anurans. This difference in the altitudinal distribution was highly significant between the two amphibian orders (Mann Whitney U test = 472, $P < 0.0001$, n = 65 and n = 31 for Urodela and Anura respectively; see also Fig. 3). Sørensen's coefficients of habitat similarity among amphibian populations of Aurunci Mts and number of breeding sites for each species are shown in Table 1.

DISCUSSION

Our surveys increased knowledge on the amphibians' distribution in the study area (Table 1). We surveyed all sites previously reported by Bonifazi and Carpaneto (1990) and no species loss was recorded in these sites. Moreover spawning activity was recorded also in some sites where no amphibian presence were reported by these authors (e.g.: S. Maria Romana springs, IGM 160 III S.O.). The check list is improved by two new records and thus nine amphibian species have been found in the Aurunci Mounts, that is 64.3% of the species of Latium. The Green toad on the Aurunci Mounts is here reported for the first time (near Itri town) since it was previously recorded only in the nearby coastal zones (Bonifazi and Carpaneto, 1990; Bologna, 2000a). However breeding site has been recorded only in the coastal zone. The second new record is *Hyla intermedia* since it was previously reported only in the Lepini Mts (Corsetti, 1994) and in the Ausoni Mts (Bonifazi and Carpaneto, 1990; Venchi, 2000a). However both Green toad and the Italian tree frog have not yet been recorded into the Monti Aurunci Regional Park.

Among anurans more records were collected from piedmont areas surrounding the Park rather than within ZPS area (Fig. 1), conversely the records of urodeles (Fig. 2) were more frequent within the ZPS area and, therefore, at the medium and high altitudes (Fig. 3). The urodeles preferences for highest altitudes it is a datum that agrees to the one reported for wider Italian areas (Anonymous, 2006).

Rana synkl. *hispanica* was the most widespread anuran with the greatest habitat typology differentiation and the highest number of syntopy (Table 1). *R. italica* was found in its typical syntopy with Northern spectacled salamander (Table 1; cf. Corsetti and Angelini, 2000).

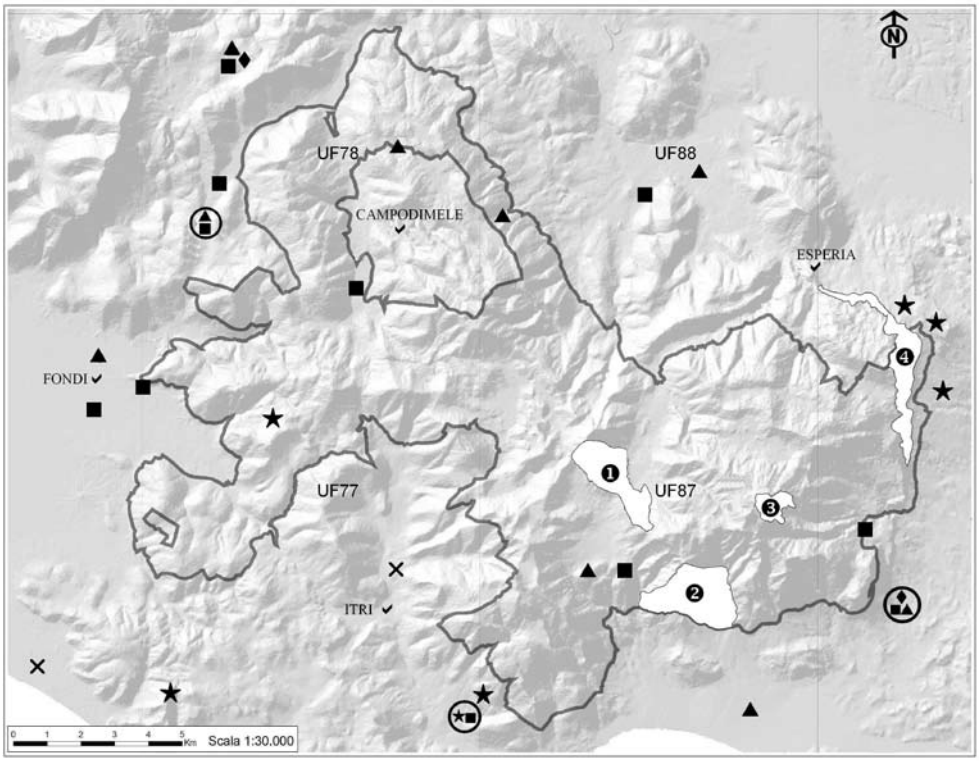

Fig. 1. Distribution of anurans in the Aurunci Mounts (Latium). Monti Aurunci Regional Park boundaries (grey line) and pSIC areas (white areas: 1 = IT6040028; 2 = IT6040027; 3 = IT6040026; 4 = IT6050026) are also showed. Crosses = *Pseudopidalea viridis*; triangles = *Bufo bufo*; stars = *Rana italica*; squares = *Rana* synkl. *hispanica*. Rhombuses = *Hyla intermedia.* Sites where two or more species are syntopics are indicated by a circle including the symbols of the species. Codes of UTM maps are also reported.

The abundance of urodeles on the Aurunci Mts is chiefly due to the widespread presence of newts in the stony wells. Indeed these artificial lentic water bodies show the characters of the typical breeding sites for the three newt species, that is large capacity and perennial hydroperiod. More specifically the Italian crested newt and the Smooth newt are almost exclusive of these artificial aquatic habitats while *L. italicus* spawns also in vernal ponds and drinking watering places for livestock grazing because this newt is a euriecious species adaptable to very different climatic and hydrobiological conditions (Scillitani et al., 2004). The similarity of habitat preferences shown by *T. carnifex* and *L. vulgaris* can be observed in Table 1 where the Sørensen's index value between these two species is the highest in comparison to other species pairs. This result confirms a trend already observed in other Italian regions (e.g. Barbieri and Cavagnini, 1999; Gentilli and Scali, 1999). Finally, it's worth mentioning that the breeding site "Fontana Canale" (1276 m a.s.l.), near the pSIC Monte Petrella, is the highest spawning site for *L. italicus* in the Latium region (cf. Bologna, 2000b; Corsetti et al., 2005; Corsetti, 2006) and it is also the

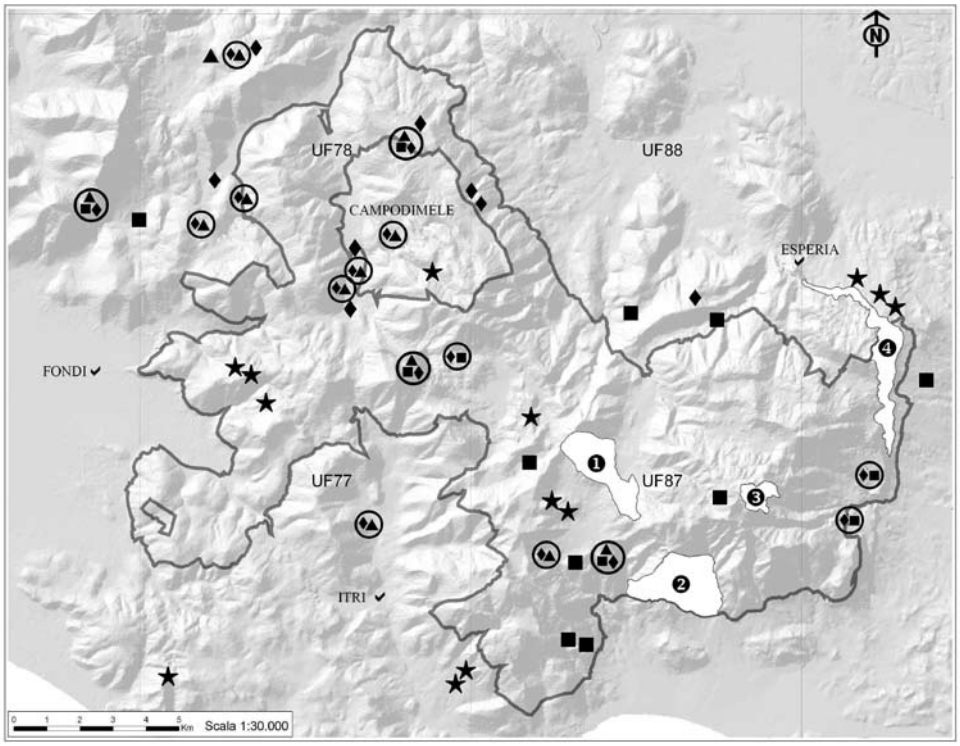

Fig. 2. Distribution of urodeles in the Aurunci Mounts (Latium). Monti Aurunci Regional Park boundaries (grey line) and pSIC areas (white areas: 1 = IT6040028; 2 = IT6040027; 3 = IT6040026; 4 = IT6050026) are also showed. Rhombuses = *Triturus carnifex*; squares = *Lissotriton italicus*; triangles = *Lissotriton vulgaris*; stars = *Salamandrina perspicillata*. Sites where two or more species are syntopics are indicated by a circle including the symbols of the species. Codes of UTM maps are also reported.

highest breeding site recorded for amphibians on the whole Volsci Chain so far (cf. Corsetti, 1994, 2006). Syntopy among *T. carnifex*, *L. italicus* and *L. vulgaris* was previously known only in the site Pornito, Aurunci Mounts (Lanza, 1983; Bonifazi and Carpaneto, 1990), in a site near Campobasso, Molise region (Lanza, 1977) and in a few sites on the Ausoni Mounts (Corsetti, 1999). We recorded the syntopy among these newts in other three sites on the Aurunci Mounts. Two of these sites (Piana di S. Onofrio and Piana dei Pozzi) are within the Park.

S. perspicillata has been found in 12 sites (7 springs, 4 drinking place for livestock, 1 residual pond). Some sites typically suitable for *Salamandrina* on the Volsci Chain (i.e. springs or drinking places for livestock animals) are often occupied exclusively by the Italian newt in the Aurunci Mts. Syntopy between Northern spectacled salamander and this newt was reported sporadically (e.g. Corsetti, 1999). However an aquatic site partitioning between these two species, due probably to food larval competition, cannot be excluded and could be revealed by further studies.

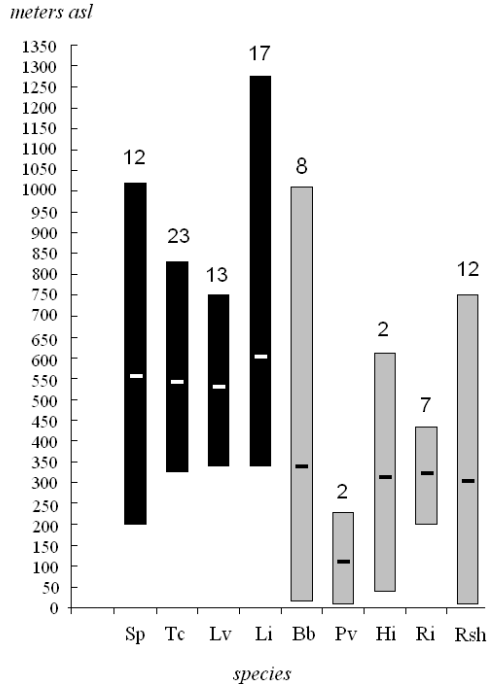

Fig. 3. Altitudinal ranges of amphibian species in the Aurunci Mounts (Latium). Black bars = Urodela; grey bars = Anura. Codes of species as reported in Table 1. Number of sites of each species is reported above the bar. Mean altitude for each species is indicated by an horizontal segments within the bar.

Finally, it is worth mentioning that two other species reported in the neighbourhood have not been recorded in the Aurunci Mts, namely *Bombina pachypus* (Bonaparte, 1838) and *Rana dalmatina* (Bonaparte, 1840). In the Volsci Chain, the first specie is relegated to the northernmost portion of the Lepini Mts (Angelini et al., 2004) and its occurrence on the Ausoni and Aurunci Mts. in few suitable habitats as vernal and residual ponds cannot be ruled out. On the contrary, the absence of *R. dalmatina* seems more realistic because the surveyed area shows no suitable habitats for this species, namely hygrophilous woods prevalently in planitial zones (Venchi, 2000b).

Conservation notes

The pSIC IT6040027 (Monte Redentore) has been established also because *T. carnifex* (a species listed in Appendix II of the Bern Convention and included in DPR n. 357/97: Habitat Directive, Annex II and IV) was previously reported as resident in this area by C. Bagnoli (cf. Bonifazi and Carpaneto, 1990). It is the only pSIC of Aurunci Mts. that includes an amphibian. Although a potential suitable aquatic habitat can be found (i.e. a stony tank near the S. Michele's sanctuary) no amphibian appears to live in this area. We argue that this record probably refers to an adjacent locality (Pornito) where some stony

Table 1. Sørensen's coefficients between amphibian populations on the Aurunci Mounts (Latium) and numbers of breeding sites for each species. *Sp = Salamandrina perspicillata*; *Tc = Triturus carnifex*; *Lv = Lissotriton vulgaris*; *Li = Lissotriton italicus*; *Bb = Bufo bufo*; *Pv = Pseudopidalea viridis*; *Hi = Hyla intermedia*; *Ri = Rana italica*; *Rsh = Rana* synklepton *hispanica*. Number of breeding sites for each species is reported in square brackets. Number of sites already known in literature is reported in round brackets.

	Sp [12] (1)	*Tc* [23] (6)	*Lv* [13] (4)	*Li* [17] (1)	*Bb* [7] (5)	*Pv* [1] (1)	*Hi* [2] (0)	*Ri* [7] (1)
Tc	0							
Lv	0	0.686						
Li	0	0.350	0.200					
Bb	0.1	0.133	0.190	0				
Pv	0	0	0	0	0			
Hi	0	0.083	0	0	0.200	0		
Ri	0.421	0	0	0.090	0	0	0	
Rsh [12] (2)	0	0.294	0.400	0.150	0.182	0	0	0.105

wells are syntopic breeding sites for *T. carnifex, L. vulgaris* (the second is included in Appendix III of the Bern Convention) and *L. italicus* (included in Appendix II of the Bern Convention and in Annex IV of Habitat Directive). Therefore we support the proposal of extending the perimeter of the pSIC IT6040027 to include the locality Pornito and, thus, the newt breeding sites above mentioned.

On the Aurunci Mts, amphibians typically breed in stony wells and drinking watering places because these artificial water bodies are the most common aquatic habitats available. A few of these sites are in a state of disrepair with fill-in phenomena and permeability loss because traditional rearing activities (i.e. grazing) are strongly reduced. Supporting the traditional methods of rearing appears, therefore, preserving the integrity of these reproductive sites, the best strategy for an appropriate conservation management of the amphibian populations in the Aurunci Mounts.

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