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# Finding of the Alpine salamander (*Salamandra atra* Laurenti, 1768; Salamandridae, Caudata) in the Nature Park Žumberak - Samoborsko gorje (NW Croatia)

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**ABSTRACT**

This study confirms the presence of Alpine salamander (*Salamandra atra*) in the Nature Park Žumberak - Samoborsko gorje, where previously only one specimen was recorded in 1989. Species presence and distribution were investigated at ten different localities in stands of montane beech forest, during the vegetation season 2004. In July 2004 five individuals (four males and one female) of Alpine salamander were found in the virgin beech forest at site Kuta (about 900 m a.s.l.), during weather conditions characterized by heavy rain. This is the northernmost finding of the species in Croatia, as well as a confirmed disjunctive part of its areal in the Dinarids. Conservation measures for the species are proposed but for more precise conservation plan further research of species distribution and ecology is needed.

*Keywords:* Alpine salamander, *Salamandra atra,* Nature Park Žumberak - Samoborsko gorje, distribution, amphibians

Alpine salamander (*Salamandra atra*) is a montane species occurring between 400 and 2,800 m a.s.l., but is usually found from 800 to 2,000 m a.s.l. (ARNOLD & BURTON, 1978). It inhabits mainly forests (beech, mixed deciduous and mixed deciduous-coniferous), but may also be found above the tree-line, in cool, damp alpine meadows, pastureland and other, slightly modified habitats. The young are born completely metamorphosed, and therefore, its life cycle is not associated with water. Alpine salamander is mainly nocturnal and during daylight it hides in shady places, holes or beneath stones and logs, but can be encountered in the open during the day, after rain or in overcast weather (ARNOLD & BURTON, 1978).

Distribution range of Alpine salamander (Figure 1a) is restricted into two areas: bigger area on the north, encompassing Swiss, Austrian, Italian, German, French and Slovenian Alps, and geographically isolated populations in the Dinaric Alps in Slovenia, Croatia, Bosnia and Herzegovina, Serbia, Montenegro and northern Albania (ANDREONE ET AL., 2008). While in most part of European Alps species still has abundant populations and is not considered endangered, isolated populations of Dinaric Alps appear to be rarer and more fragmented (KALEZIĆ & DŽUKIĆ, 2001, ANDREONE ET AL., 2008, LELO ET AL., 2008, ŠUNJE & LELO, 2010). Upon that, Dinaric populations are especially threatened by localised habitat alteration through the cutting and removal of ground cover during forestry practices, intensification of farming (in lower regions), tourism and infrastructure development. Negative effects of air pollution, rain and soil acidification as well as climatic changes are also likely.

There are three currently recognized subspecies: *S. atra atra*, *S. a. aurorae* (restricted to an extremely small area of northeastern Italy) and *S. a. prenjensis*. However, their status remains questionable. While *S. a. aurorae* has sometimes been considered as a separate species, *S. a. prenjensis* is often not considered to be valid subspecies (ANDREONE ET AL., 2008). Molecular studies based on mtDNA cyt *b* gene (RIBERON ET AL., 2001) and AFLP markers (RIBERON ET AL., 2004) failed to show clear genetic structure of the first two subspecies, however, the

analyses of mtDNA D-loop sequence (STEINFARTZ ET AL., 2000) support the assignment of *S. a. atra* and *S. a. aurorae* into separate subspecies, while *S. a. prenjensis* is shown to be more closely related to *S. a. atra*.

*Salamandra atra* is strictly protected under the Bern Convention on the Conservation of European Wildlife and Natural Habitats (Appendix II) and is listed on Annex IV of the Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats Directive). Subspecies *S. atra aurorae* is also listed on Annex II of the Habitats Directive. According to the IUCN Red List of Threatened Species *S. atra* is considered as Least Concern in view of its wide distribution, tolerance of a degree of habitat modification, presumed large population, and because its decline is not considered fast, while subspecies *S. a. aurorae* is considered as Critically Endangered. *Salamandra atra* is protected by national legislation in most range countries (e.g. Switzerland, Austria, Slovenia, Croatia).

Findings of the Alpine salamander in Croatia include Gorski kotar area (Mala Kapela, Velika Kapela, Samarske stijene, Bijele stijene, Risnjak), Učka and Žumberak Mountain, (KLETEČKI, 1990, ĐURIĆ ET AL., 2004, GRBAC ET AL., 2006). On the Žumberak Mountain, until this study, Alpine salamander was recorded only once, in 1989, when one dead individual was found on the bottom of jama Tomaševićka pit (KLETEČKI, 1990), located nearby bigger Pogana jama cave. It is worth mentioning that the whole area of Žumberak Mountain is rich in karst phenomena (dolines, blind valleys, caves and pits) (BUZJAK, 2002).

Aim of this study was to confirm the presence of Alpine salamander on the Žumberak Mountain inside the Nature Park Žumberak - Samoborsko gorje, and to determine other potential habitats in the scope of the Nature Park. Overall goal was to contribute to the conservation of the Alpine salamander at Nature Park Žumberak - Samoborsko gorje but also at national level where little is known about this species and its distribution.

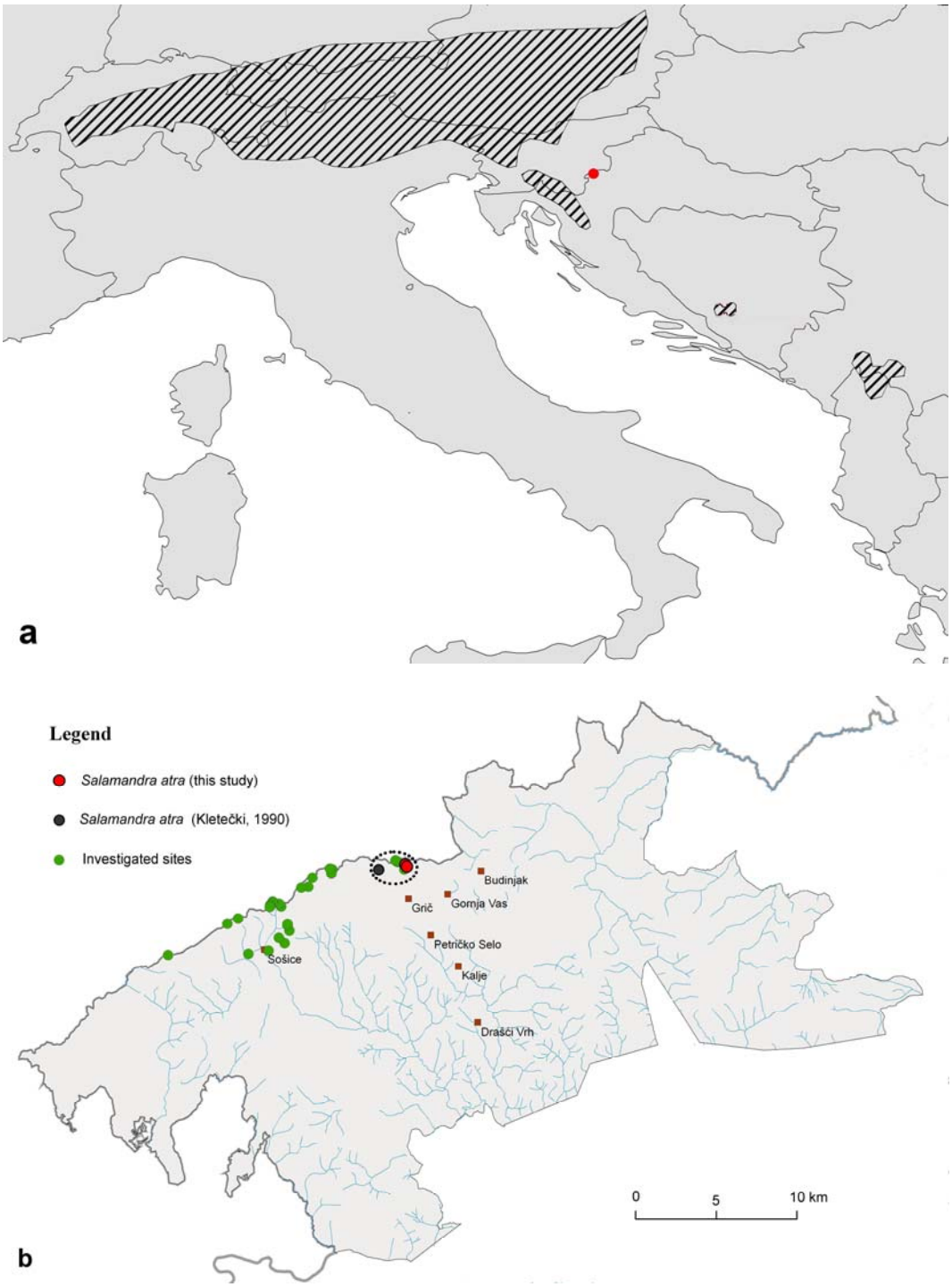


Figure 1. (a) Currently known areal of *Salamandra atra* (redrawn form http://www.iucnredlist.org; localities in Bosnia and Herzegovina corrected according to Šunje & Lelo, 2010), with added finding from this study (red dot). (b) Map of the Nature Park Žumberak – Samoborsko gorje, with investigated sites in the zone of montane beech forest and villages in which interviews were conducted. Finding of *Salamandra atra* from this study is marked with red dot, previous finding from 1989 near Pogana jama shaft with black dot, and all other sites with green dots. Dashed line indicates the smallest probable areal of the species in the Nature Park.

Slika 1. (a) Trenutno poznati areal vrste *Salamandra atra* (nacrtano prema http://www.iucnredlist.org; lokaliteti iz Bosne i Hercegovine izmijenjeni prema Šunje & Lelo, 2010), sa dodanim nalazom iz ovog istraživanja (crvena točka). (b) Karta Parka prirode Žumberak – Samoborsko gorje, sa istraživanim lokalitetima planinske bukove šume i lokacijama sela u kojima je provedena anketa. Nalaz vrste *Salamandra atra* iz ovog istraživanja označen je crvenom točkom, prethodni nalaz iz 1989. g. kraj Pogane jame sa crnom točkom, a ostali istraživani lokaliteti sa zelenim točkama. Iscrtana linija označava najmanji vjerojatni areal vrste u Parku prirode.

Field investigations of species presence and distribution were carried out during the vegetation season 2004, in altogether nine days in May (3 days), July (5 days) and October (2 days). Field research was concentrated mostly on stands of montane beech forests scarce in watercourses in upland parts of Žumberak Mountain, above 700 m a.s.l., which were regarded as the most suitable habitats for Alpine salamander in this region. During the field research we have searched ground vegetation layer in detail, and also turned logs, stones and layer of deep leaves. Scanning of the terrain was conducted in conditions when, according to the literature data, Alpine salamanders had the greatest activity (rainy and cloudy weather, mostly early in the morning but also during other parts of the day, if weather conditions were suitable). We used Garmin Summit GPS receiver for determination of coordinates and ArcMap in ArcGIS 9.2 program package (1999-2006 ESRI Inc.) for production of maps.

In addition, we made personal interviews with local inhabitants (altogether 61 persons) from Nature Park (villages Grič, Kalje, Petričko selo, Gornja Vas, Budinjak, Drašči Vrh and Sošice) about their possible observations of Alpine salamander. Interviewees were shown the picture of the Alpine salamander and they were warned about differences between this and other possibly similar species (e.g. Fire salamander, newts).

We scanned ten different localities of beech forest stands in different stage of degradation and in each we recorded coordinates for one or few points (Figure 1b). On 27$^{th}$ July 2004, between about 1 and 2 p.m. in the old virgin montane beech forest Kuta, at about 900 m a.s.l., we

found five individuals of Alpine salamander, out of which four males and one female. Weather conditions were characterised by heavy rain and high air humidity. First individual was noticed two hours after the beginning of heavy rain, when deep layer of leaves was impregnated with water (Figure 2). It was found at the bottom of shallow karst sinkhole; female and another three males were found in a range of few hundred meters. After the rain stopped at 3 p.m., we have continued the search for another hour but were unable to find any new individual of Alpine salamander. One additional interesting finding was noted. Triggered by putting them together into a plastic box, one male caught female in amplexus (Figure 2). Thereafter, we have returned the pair on the forest soil and continued to observe and document this reproductive behaviour for another 1.5 hour. This behaviour, together with measured prominence of cloacae in male implies that in July this population is in reproductive period.

Forest stand Kuta corresponds to an adequate habitat for Alpine salamander according to its altitude (between 800 and 900 m a.s.l.) and its distance from the watercourses. The site is positioned in the zone of montane beech forest (as. *Lamio orvalae – Fagetum sylvaticae* Ht. 1938/ Borhidi 1963). It is situated on a heavily-accessible terrain, with numerous rocks and karst sinkholes of different depths and elevations (Figure 3). Old beech trees are developed, since cutting is restricted. Rocks and trees are richly overgrown with mosses. Ground vegetation layer is sparsely developed, somewhere with a dense bushes of ferns and young trees of beech and sycamore maple. Many huge logs on the ground in different stage of decomposition, as well as rocky terrain with numerous holes, provides abundant shelters for salamanders. Forest at site Kuta is only about 1.5 km distant from the jama Tomaševićka pit, the locality of the only previous finding of Alpine salamander at Nature Park Žumberak - Samoborsko Gorje, also situated in a zone of old beech forest at around 900 m a.s.l (KLETEČKI, 1990). Jama Tomaševićka is a pit located on the mountain slope nearby well-

known locality Pogana jama, which is actually a stratified cave that serves as a permanent swallow hole for surface waters (BUZJAK, 2002). Both our and KLETEČKI (1990) findings enabled us to identify the smallest probable area of distribution for Alpine salamander in the Nature Park (Figure 1b). The area above 800 m a.s.l. where montane beech forests from association *Lamio orvalae – Fagetum sylvaticae* are prevalent, represent potential habitat for this species.

Figure 2. Alpine salamander (*Salamandra atra*) found in the virgin beech forest Kuta on 27th June 2004 (male - left, amplexus - right).

Slika 2. Crni daždevnjak (*Salamandra atra*) nađen u bukovoj prašumi Kuta 27. srpnja 2004. godine. (mužjak - lijevo, ampleksus - desno).

Figure 3. Stand of montane beech forest in Kuta, habitat of *S. atra*.

Slika 3. Sastojina planinske bukove prašume u području Kute (Žumberak), stanište vrste *S. atra*.

Regarding results from the interviews made among the local inhabitants, from altogether 61 examinees, 11 confirmed the observation of Alpine salamander in different sites, some of which coincide with area close to our finding. However, possible confusion with similar species should be taken into account.

Rare findings of Alpine salamander in Nature Park Žumberak - Samoborsko Gorje suggest very small and reduced population. During our study we were searching the area in appropriate weather conditions, for altogether 97 hours (per person) to find 5 individuals of Alpine salamander (or 19.5 hours per person for finding one individual). Moreover, additional fieldworks were undertaken (42 hours/person in 2009, and for 42 and 9 hours/person, respectively, in 2010) in the key site Kuta, during appropriate weather conditions (JELIĆ, D., Zagreb, pers. comm. 2011), but without any finding. Furthermore, educational leaflet was produced in hope that Nature Park visitors would report observations of the Alpine salamander, but also without any success. For comparison, at Bijele stijene site in Mala Kapela region (Gorski kotar), 18 hours of research yielded in finding 36 individuals of Alpine salamander (or 30 mins per individual) implying to abundant and preserved population (JELIĆ, D., pers. comm. 2011).

The conservation of Alpine salamander in the Nature Park Žumberak - Samoborsko Gorje should be maintained through the preservation of its known and potential habitats, mainly well developed beech forests. Since there are indications that this isolated population at Žumberak Mountain is very small it is necessary to implement stricter protection measures at its known distribution sites (site Kuta, jama Tomaševićka, with wider buffer area) where forest cutting should be avoided as well as other activities that could have negative impact on preservation of integrity of these beech forest habitats. If possible, we would suggest protecting site Kuta as a special forest reserve. Also, further spreading of coniferous plantations in Nature Park should be avoided at all known and potential habitats of the Alpine

salamander. Having in mind interesting disjunctive distribution area of Alpine salamander, further research of its distribution and ecology is needed in order to establish its exact distribution area and status of its populations in Croatia, as well as to propose and implement appropriate management and protection measures for the species and its habitats.

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## SAŽETAK

### NALAZ CRNOG DAŽDEVNJAKA (*SALAMANDRA ATRA* LAURENTI, 1768; SALAMANDRIDAE, CAUDATA) U PARKU PRIRODE ŽUMBERAK - SAMOBORSKO GORJE (SZ HRVATSKA)

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Ovim istraživanjem potvrđena je prisutnost crnog daždevnjaka (*Salamandra atra*) u Parku prirode Žumberak - Samoborsko gorje, gdje je prethodno zabilježena samo jedna jedinka 1989. godine. Prisutnost i rasprostranjenost vrste istraživani su tijekom vegetacijske sezone 2004. godine na deset različitih lokaliteta u sastojinama planinske bukove šume. U srpnju 2004. g. pronađeno je pet jedinki (četiri mužjaka i jedna ženka) crnog daždevnjaka u bukovoj prašumskoj sastojini Kuta (na oko 900 m n. v.), za vrijeme vremenskih prilika praćenih jakom kišom. Ovo je najsjeverniji nalaz vrste u Hrvatskoj, koji ukazuje da Žumberak predstavlja disjunktni dio njezinog areala u Dinaridima. U radu su predložene mjere zaštite vrste, međutim, za donošenje preciznijeg plana zaštite potrebna su dodatna istraživanja rasprostranjenosti i ekologije ove vrste.

*Ključne riječi:* crni daždevnjak, *Salamandra atra,* Park prirode Žumberak - Samoborsko gorje, rasprostranjenost, vodozemci