

ALTITUDINAL DISTRIBUTION OF FOUR *PLECOTUS* SPECIES (MAMMALIA, VESPERTILIONIDAE) OCCURRING IN CROATIA

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The altitudinal distribution of bats of four *Plecotus* species in Croatia was analysed. *P. austriacus* and *P. kolombatovici* are restricted to lower altitudes, under 800 m a.s.l.. *P. auritus* inhabits continental forest habitats, preferably beech forests, with the exception of Pannonian lowland riparian forests of common oak which also lie under 100 m a.s.l.. As distinct from the other three *Plecotus* species, Croatian specimens of *P. macrobullaris* have an extremely wide altitudinal distribution, ranging from sea level to mountain tops, but with most localities under 800 m a.s.l.

Key words: *Plecotus macrobullaris*, *P. auritus*, *P. austriacus*, *P. kolombatovici*, altitudinal range, Croatia

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Analizirano je visinsko rasprostranjenje četiri vrste šišmiša roda *Plecotus* u Hrvatskoj. *P. austriacus* i *P. kolombatovici* su ograničeni na niže visine, do 800 m nad morem. *P. auritus* nastava kontinentalna šumska staništa, uglavnom bukove šume, ali u Panonskoj nizini i šume hrasta lužnjaka na nadmorskim visinama manjim od 100 m. Za razliku od ostalih vrsta roda *Plecotus*, nalazi vrste *P. macrobullaris* u Hrvatskoj imaju osobito široki raspon nadmorskih visina, od morske razine do vrhova planina, ali uz većinu nalazišta ispod 800 m nadmorske visine.

Ključne riječi: *Plecotus macrobullaris*, *P. auritus*, *P. austriacus*, *P. kolombatovici*, visinska rasprostranjenost, Hrvatska

INTRODUCTION

HANAK (1969) was the first to report differences in the altitudinal distribution of *Plecotus austriacus* Fischer, 1829 and *P. auritus* Linnaeus, 1758 in central Europe. HORAČEK *et al.* (2004) summarized observations which characterise *P. austriacus* as a species that lives in the lowlands of Europe. The altitudinal range extends from the

mountain to the submontane belt (600/800 m a.s.l.), with individual exceptions of up to 1350 m a.s.l. (hibernacula – SPITZENBERGER, 2002). In Bulgaria, 80% of a total of 75 sites of *P. austriacus* are situated below 1000 m a.s.l. (BENDA & IVANOVA, 2003).

HORAČEK & ĐULIĆ (2004) stated that *P. auritus* is a planar/colline to subalpine species of mesophile mixed broadleaved forests, with most findings ranging in elevation from 200 to 1920 m a.s.l., and winter findings reaching up to 2350 m in the Alps. Findings across northeast Europe are generally within the planar belt, mostly in boreal coniferous forests. From 22 sites in Bulgaria, 86% lie in altitudes over 1000 m a.s.l. (BENDA & IVANOVA, 2003). The Iberian subspecies, *P. auritus begognae* (PAZ, 1994) has a similar distribution pattern in supra-Mediterranean forests lying higher than 1000 m a.s.l.. The lowest nursery roost of *P. auritus* reported for Austria was known from 150 m a.s.l. (SPITZENBERGER, 2002).

Like *Plecotus austriacus*, *P. kolombatovici* Đulić, 1980 is restricted to the planar / colline belt (ĐULIĆ, 1980; HANAK *et al.*, 2001; SPITZENBERGER *et al.*, 2002), but in the European East Mediterranean. *P. macrobullaris* Kuzyakin, 1965, newly discovered to occur in Croatia (KIEFER & VEITH, 2002; SPITZENBERGER *et al.*, 2003) is distributed in the Caucasus, Alps (SPITZENBERGER 2002; KIEFER & VEITH, 2002), Greek mountains (KIEFER & VEITH, 2002; SPITZENBERGER *et al.*, 2003), Pyrenees (GARIN *et al.*, 2003; KIEFER & HELVERSEN, 2004), and mountains of Crete, Syria and Iran (JUSTE *et al.*, 2004). KIEFER & VEITH (2002), relying on a small sample of specimens from the Western Alps, maintained that this species was restricted exclusively to the montane and alpine belt ranging from 800 to 1800 m a.s.l.. As exceptions, KIEFER & HELVERSEN (2004) noted findings from 480 m (Pesina near Verona, N-Italy; KIEFER & VEITH, 2002) and 688 m (Lienz, Austria; SPITZENBERGER *et al.*, 2001). SPITZENBERGER (2002) reported an altitudinal range of this species in the Austrian Alps from 670 to 1221 m a.s.l., and GARIN *et al.* (2003) found the summer population in the rocky bare ground of Brecha de Rolando (Pyrenees) at an altitude of 2807 m.

The aim of this paper is, to describe the altitudinal distribution of these four *Plecotus* species in Croatia, using revised and new material from Croatia. Special attention is given to *P. macrobullaris*.

MATERIAL AND METHODS

The total sample of altitudinal data of *Plecotus* in Croatia consists of findings from 75 localities. *Plecotus kolombatovici* was found in 20 localities, *P. macrobullaris* in 28, *P. austriacus* in 16 and *P. auritus* in 18 localities. Most of the data were collected during intensive field work in 2001 – 2004, investigating the distribution and identification of *P. macrobullaris*. Altitudes were noted with GPS devices, and the results were proved on state geographical maps on a scale of 1:25.000. A list of localities and the method of species identification are presented in another paper (TVRTKOVIĆ *et al.*, in press). Preserved specimens are housed in the mammal collections of the Croatian Natural History Museum in Zagreb; the Zoological Department of Faculty of Science, University of Zagreb; Natural History Museum Wien; Zoological Museum Berlin; Zoological Museum Budapest; Senckenberg Museum, Frankfurt am

Main; Zoological Museum St. Petersburg, and the British Museum /Natural History). The most intensive investigation was conducted in the region of Mt Velebit. Description of altitudinal belts and their connections with regional vegetation of this mountain are in TVRTKOVIĆ & KLETEČKI (1993).

RESULTS

Only *P. macrobullaris* occurred in all altitudinal zones in Croatia (Fig. 1), findings ranging from sea level to the top of mountains (max. 1800 m/asl; subalpine belt). The greater part of our findings (19 out of 28 localities) are from altitudes lower than 800 m a.s.l. (Fig. 1). According to our results, most *P. austriacus* and *P. kolombatovici* were restricted to the planar or colline belt, and occurred just occasionally in the submontane or montane belt. In the case of *P. austriacus*, the highest findings were recorded in caves (Lokve in Gorski kotar area, 740 m a.s.l.; Barića pećina, Ličko Petrovo Selo, 400 m a.s.l.). *P. austriacus* is restricted to areas with continental influences (Istria, Kvarner Bay, part of Gorski Kotar and Lika, the Pannonian lowland). *P. kolombatovici* inhabits only the Mediterranean area near the Adriatic coast (from Istria to Dubrovnik) and is restricted completely to xerophilous habitats. Fif-

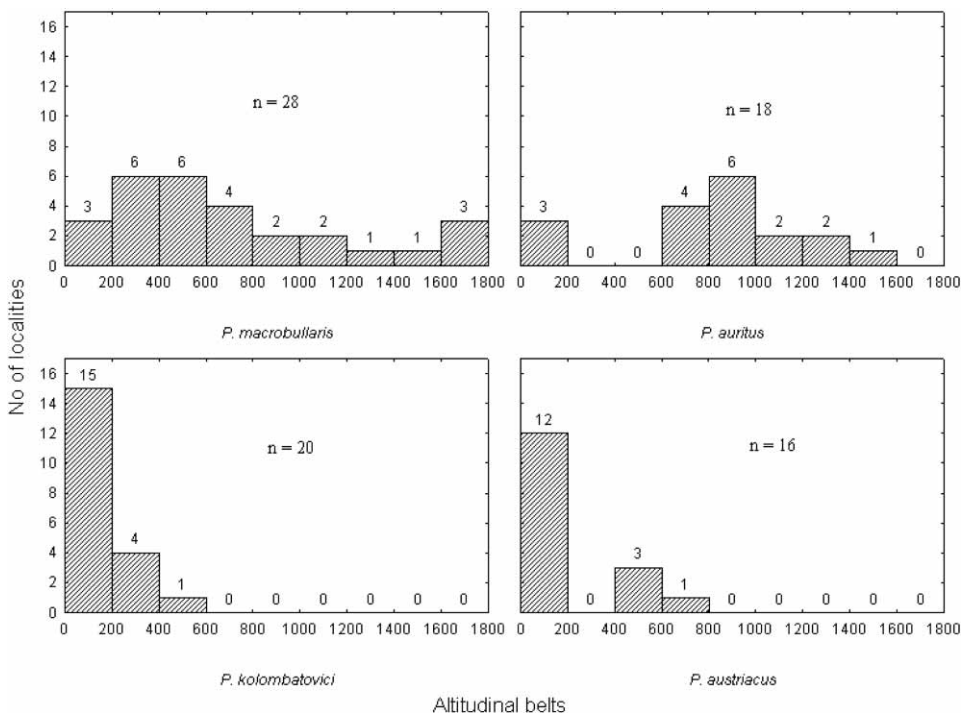


Fig. 1. Distribution of four *Plecotus* species findings in different altitudinal belts in Croatia.

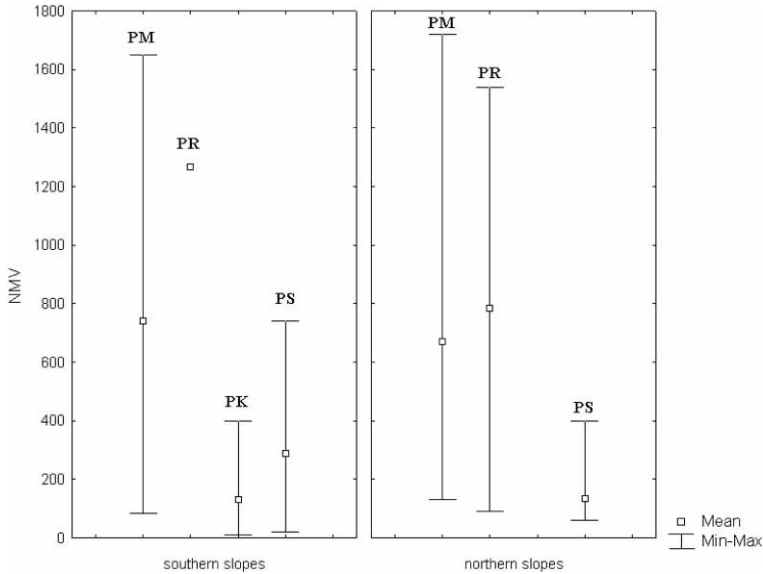


Fig. 2. Altitudinal distribution of different *Plecotus* species *P. macrobullaris* (PM), *P. auritus* (PR), *P. kolombatovici* (PK) and *P. austriacus* (PS), on southern and northern slopes of the Dinaric mountains near the Adriatic coast.

teen records of the Dinaric subpopulation of *P. auritus* are distributed between 200 to 1600 m a.s.l., but the Pannonian findings (3 sites) ranged from 90 to 900 m a.s.l. There is only one finding of this species from southern slopes (Fig. 2) near the Adriatic coast (Živa voda, N Velebit, 1240 m a.s.l.)

DISCUSSION

In case of *Plecotus austriacus* and *P. kolombatovici* our results corresponded with data from ĐULIĆ (1980) and HANAK *et al.* (2001). While populations of *Plecotus auritus* from the Dinaric Alps and Medvednica mountains had a similar altitudinal and ecological pattern to that described in HORAČEK & ĐULIĆ (2004), populations from the southwest part of Pannonian lowlands inhabited planar riparian forests of common oak situated at altitudes from 90 to 110 m a.s.l. (Turopolje forests, Drenov Bok; both near Sava river). One *P. auritus* specimen was found wintering in the Uviraljka swallow-hole; TVRTKOVIĆ *et al.*, 2001) in the isolated Pannonian mountain Papuk at 855 m a.s.l.. This distribution is actually the same as in Austria (SPITZENBERGER, 2002).

Records of *P. macrobullaris* from the planar and colline belts of the northern Adriatic coast in Croatia as well those from the southern slopes of Alps in northern Italy (SPITZENBERGER *et al.*, 2001; 2002; 2003) contradict the assumptions of KIEFER & VEITH (2002) and KIEFER & HELVERSEN (2004) about the altitudinal distribution of

this species only »at heights above 800 m«. All along the Adriatic coast, *P. macrobullaris* occupies Mediterranean pubescent oak woods with hop-hornbeam and oriental hornbeam that cover the southern slopes of the coastal mountains from the sea level to 800 m a.s.l. From here, the altitudinal range of this species extends to the subalpine belt consisting of beech or mountain pine scrub at elevations of 1550 to 1800 m a.s.l.

JUSTE *et al.* (2004) suggested that the small genetic differentiation within the *P. macrobullaris* lineage corresponds to a recent recolonization from a refuge east of the montane areas in western Europe that were not covered by glaciers during the Ice Ages. JUSTE *et al.* suggested the Middle East as a potential refuge, but they noted that the finding of two differentiated »western« and »eastern« clades (SPITZENBERGER *et al.*, 2003) would indicate the existence of more than one refuge. The recent distribution of *P. macrobullaris* suggests a glacial refuge along the northern and eastern Adriatic coast.

In Croatia, *P. macrobullaris* has a distribution pattern similar to that of some other karst rock-dwelling species, for example the voles *Chionomys nivalis* (KRYŠTUFEK & KOVAČIĆ, 1989) and the endemic *Dinaromys bogdanovi* (KRYŠTUFEK, 1999). Unlike other species, these rodents inhabit all altitudinal belts, but only in karstic limestone areas with crevices and caves. Also most of the Austrian range of *P. macrobullaris* (SPITZENBERGER, 2002) lies in areas of Alpine karst or very close to it (BOBEK, 1961). Nursery roosts (SPITZENBERGER, 1993; 2002) are situated in churches mostly in the upper Drau valley (Carinthia) within a few kilometres of the karst slopes. The same situation with nursery roosts can be found in Croatia, particularly in Istria (Boljun), the Lika region (Ogulin, Stajnica, Smiljan), Žumberak Mt. (Liješće, Sošice, Kašt, Mrzlo Polje) and Mt Medvednica (Podsused) (position of localities shown in TVRTKOVIĆ *et al.*, in press).

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