

A PRELIMINARY STUDY ON THE HABITAT SELECTION OF  
EUROPEAN GLASS LIZARD (*PSEUDOPUS APODUS*)  
IN SOUTHEAST BULGARIA

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**Abstract:** The living area of the European glass lizard, *Pseudopus apodus* (Pallas, 1775) (also known as Scheltopusik) falls from the Balkan peninsula to the West and to Middle Asia to the East. In Bulgaria the main distribution of the species is concentrated in the southeastern part of the country and the Black Sea coast. However, the data concerning habitats selection and preferences of the species are scarce. In this connection, the main aim of this work was to do a preliminary study on the habitat selection of *P. apodus* in Southern Black Sea coast. The study was carried out in spring/summer period of 2014 near the protected areas "Poda", "Izvorska River mouth", the "Otmanli" area, and near Rezovo village. Several characteristics of the habitats, where *P. apodus* specimens were captured, such as: air temperature; humidity, habitat type and dominant plant species, distance to water/or wet area, distance to main roads, a number of other reptilian species, were described and discussed. Although more data are necessary to clarify all important proximate and ultimate factors, determining the habitat selection of *P. apodus*, the obtained results revealed some specifics in its habitat preferences – presence of shrubs, large stones and/or ruins and also the presence of wet areas. For sure, detailed knowledge of habitat selection of the legless lizard, *P. apodus* will be relevant to its preservation in hot spot areas.

## INTRODUCTION

Different aspects of habitat selection, such as thermal ecology, food, protection from predators etc. have been studied in a variety of lizard species in their natural areas (Beck and Jennings, 2003; Reaney and Whiting, 2003; Quirt et al., 2006; Schulte and Köhler, 2010). Thus, habitat selection of some limbless species representative of the family Anguidae as *Hyalosaurus koellikeri*, in Northwestern Africa depends mainly on closed deciduous forests and open deciduous shrubland with higher amounts of annual rainfall compared to the territories not populated by this species (Pous de et al., 2011). The genus *Dopasia* also can be found mainly in the forest area of Southeastern Asia (Nguyen et al., 2011). North American species of genus *Ophisaurus* also prefer the rich vegetation cover, grassy (*O. attenuatus*) or even wet meadow habitats (*O. ventralis*) (Fitch, 1989; Conant and Collins, 1991). Species of genus *Anguis* inhabit a large variety of habitats that cannot be described in the summary, but their general characteristic includes relatively high soil humidity and rich vegetation cover (Dely, 1981).

There are few data regarding the habitat selection and preference of the species of Anguidae family in Bulgaria (Tzankov, 2007, 2011; Stojanov et al., 2011; Tzankov and Popgeorgiev, 2011). Data on habitat characteristics and density were presented by Popgeorgiev and Kornilev (2009) for a polygon situated in the northernmost foothills of Eastern Rhodopes Mountains. To date, most of the studies concern the eastern and central parts of the natural areal (Crimean Peninsula, Caucasian region and Middle Asia). For Ciscaucasia, Siroitchkosky (1958) categorized habitats with dense vegetation as the most preferable by the European glass lizard. Wetlands were determined to be an important element of the species habitat preferences in Uzbekistan, but some contradicting examples were also provided (Bogdanov, 1960). According to Yakovlieva (1964), the dense grass cover was characteristic of the preferred habitats in Kirghizstan. In this study the author also gives an exceptional record of the species in the semi - desert area. Shcherbak (1966) established that in the Crimea peninsula, the Scheltopusik prefers rocky slopes with shrub communities, and avoids dense vegetation. In Azerbajdzan presence of the species in wide rocky habitats was mentioned, but dense grasses and bushes areas were stated to be most preferred (Aleksperov, 1968). According to Paraskiv (1956), Said-Aliev (1979), Bogdanov (1986) in Middle Asia (Kazakhstan, Tadzikistan, Uzbekistan) the species populations are closely associated with rivers and oases. Rifai et al., (2005) stated that the preferred habitats in Jordan are oak forests with small bushes, edges of agricultural fields with pills, rocky habitats along rock piles and stone terraces. In Armenia this species is common in habitats with rich vegetation (Arakelyan et al., 2011).

The distribution area of *P. apodus*, the biggest representative of Anguidae family, covers the Balkan and the Crimean peninsulas and Ciscaucasia region

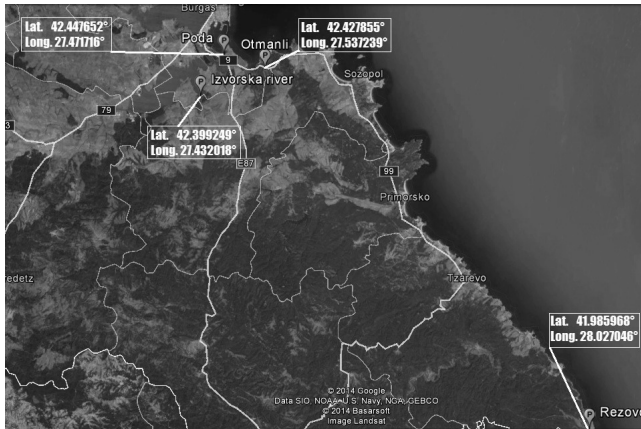
in Europe. This species is distributed also in Asia Minor, Middle East, the Transcaucasia region and Middle Asia (Obst, 1981). In Bulgaria it inhabits the southeastern parts of the country and the Black Sea coast area. Some isolated populations are located in the Rusenski Lom valley, the Sandanski-Petrich basin and East Rhodopes Mountains, where this species is present up to 800 m a.s.l. (Stojanov et al., 2011). The Scheltopusik is considered as Vulnerable [VU] in the national Red data book (Tzankov, 2011), being restricted along the Black Sea coast by increased anthropogenic pressure. The lizard is exclusively carnivorous and its food spectrum consists mostly of insects and gastropods. A small amount of other invertebrates and vertebrates of small size is also included in its diet (Siroitchkosky, 1958; Bogdanov, 1960; Yakovleva, 1964; Shcherbak, 1966; Muskhelishvili, 1970; Alekperov, 1978; Said-Aliev, 1979; Rifai et al., 2005).

In Bulgaria the studies of the ecology of the species are very scarce. The aim of the present study was to represent and discuss the preliminary results on the habitat selection of *P. apodus* along the Southern Black Sea coast – the core area of its distribution in the country. Knowledge of habitat selection of the legless lizard, *P. apodus* is beyond doubt relevant to its preservation and will further provide knowledge about the general ecology of the species.

## MATERIALS AND METHODS

The study was performed during the Spring and Summer (April-August) of 2014 in Southeast Bulgaria. The specific climate of the region is influenced by the Black Sea. The average annual temperature is 12.8°C varying from lowest (2.3°C in January) to highest (23.4°C in July). The average precipitation for the region is 578 mm and can vary between 500 to 1000 mm. The rainfalls are irregularly distributed throughout the year, having an autumn maximum and a summer minimum (Georgiev, 1991).

Based on literature data (Stojanov et al., 2011) of the distribution of *P. apodus*, the most suitable habitats, where the European glass lizard could be found, were visited and investigated. The plant cover of each chosen polygon (in the range from 100 to 250 m<sup>2</sup>) was described. The working fields were visited in the first part of the day when the lizard's activity was most intense (Figure 1). The age of the lizards was determined on the basis of coloration and size – adults have brown dorsals and yellow to white ventral scales; the juvenile is gray with black spots covering the whole body (Stojanov et al., 2011). An adult was considered to be a specimen, which had completely lost its baby coloration with a body length over 32 cm. Such animals reach sexual maturity at the age of 3-4 years, according to data given by Bogdanov (1960).



**Figure 1.** The ‘P’ marks represent the visited places with their GPS coordinates.

The “Poda” protected area is characterized by dense shrub vegetation and several scattered large stones. There was also a former quarry filled with small marshes in it. The “Otmanli” area is situated near the main coastal road. It is partly isolated from the urbanized territories by dense shrubs and tree patches. The localities, where the lizards were found were abandoned grasslands, with some house ruins. A small pond was found nearby. In the “Izvorska River mouth” area the main road runs over a 400 m long bridge. The road is surrounded by foothills covered with sparse vegetation. Rezovo area was near a small village situated near the border with Turkey. All investigated areas are regularly visited by humans. Average altitude among sites vary between 10 and 34 m a.s.l.

The relative density of the lizards was calculated as the number of individuals per km<sup>2</sup>. Using European Nature Information System (EUNIS), the habitat type and dominant plant species was determined. The distance between the water and/or wet areas and the points where the lizards were found was also measured on satellite images in Google Earth [Version 6.2.2.6613] software. In the same way was evaluated the distance to roads. These distances are given in meters [m]. The plant (shrubs/trees, grasses) and stones/ruins cover in the investigated areas was presented in percent [%]. All reptilian species co-inhabited with *P. apodus* were taxonomically identified and taken into account in the discussion. The characteristics of the habitats, in which *P. apodus* individuals were found, were described as follows: EUNIS habitat type, dominant plant species, distance from roads, plant cover, presence of water and/or wet areas and number of coexisting reptilian species.

## RESULTS AND DISCUSSION

The parameters of the habitats, where the European glass lizards were spotted are presented in Table 1. The studied habitats have some common features –

presence of unmanned grasslands with shrubs, small trees and stones. Dominant plant species, determined in “Poda” were the following species: *Marrubium peregrinum*, *Cichorium intybus*; *Elymus repens*, *Alisma plantago-aquatica*, *Eleocharis palustris*, *Phragmites australis*, *Ailanthus altissima*, in “Otmanli”: *Daucus carota*, *Xeranthemum annuum*, *Cichorium intybus*, *Dasypyrum villosum*, *Carduus acanthoides*, *Centaurea solstitialis*, *Verbascum* sp., in “Izvorska River”: *Botriochloa ischaemum*, *Chrysopogon gryllus*, *Daucus carota*, *Hypericum perforatum*, *Paliurus spina-christi* and near Rezovo village: *Dasypyrum villosum*, *Avena fatua*, *Picris echioides*, *Plantago lanceolata*, *Cichorium intybus*, *Lotus corniculatus*, *Paliurus spina-christi* respectively. All the areas had a water source nearby (up to 120 m) from the lizard’s shelter.

**Figure 1.** The ‘P’ marks represent the visited places with their GPS coordinates.

Place	Poda	Otmanli	Izvorska river	Rezovo
Relative density [ind./km <sup>2</sup> ]	0.04-0,09	0-0.11	0.01	0.13
EUNIS Habitat Type	Hedgerows	Unmanaged xeric grasslands	Eastern <i>Paliurus spina-christi</i> garrigues	Perennial calcareous grasslands and basic steppes
EUNIS Code	FA	E1.D	F6.28	E1.2
Distance to main roads [m]	440	130	200	50
The plant and stones/ruins cover [%]	85 shrubs, 10 grasses, 5 stones	70 grasses, 20 shrubs, 10 ruins	40 shrubs, 40 grasses, 20 stones	15 shrubs, 80 grasses, 5 stones
Type of nearby water and/or wet areas	swamps	pond	mouth	gully
Distance to water/or wet area [m]	20	120	90	100
Number of coexisting reptilian species	9	4	5	4

Similar results about habitat parameters described here, such as dense vegetation and/or presence of water source, were reported for the European glass lizard in other parts of its areal: Ciscaucasia (Siroitchkosky, 1958), Transcaucasia, (Alekperov, 1968; Milto, 2010; Arakelyan et al., 2011); Middle Asia (Paraskiv, 1956; Bogdanov, 1960, 1986; Yakovlieva, 1964; Said-Aliev, 1979) and South Asia (Anderson, 1999). Therefore, we can state that the Scheltopusik, as a typical member of the Anguidae family, prefers habitats with large amount of vegetation

and a higher humidity than the surrounding habitats/places. However, Shcherbak (1966) mentioned that *P. apodus* do not prefer dense vegetation. According to Strijbosch et al., (1989) dry, open areas with few or no trees and with a large number of shelter possibilities in the form of shrubs and stone heaps were the more preferred habitats in Eastern Rhodopes Mountains in Greece. Presence of *P. apodus* in semi-deserts and open slopes was also mentioned by Siroitchkosky (1958) for Ciscaucasia, Yakovlieva (1964) for Kirghizstan, Alekperov (1968) for Azerbajdzan and Rifai et al., (2005) for Jordan. Similarly Muskhelishvili (1970) state that this species commonly inhabit dry and waterless areas covered with *Paliurus spina-christi* shrubs in Western Georgia. It must be pointed that in Armenia this species avoids open semi-desert zones (Arakelyan et al., 2011).

The specific climatic conditions over the species distribution define the spatial niche preferences, thus explaining the difference of its habitat preferences. These differences may be explained by the seasonal changes that occur in the habitats, which are not pointed in the regions, mentioned above. Thus, in the driest lowlands of the areas (Central Asia) the species have also entered riparian habitats, avoiding the nearby dry ones. Conversely, in a Mediterranean climate, the species occurs in the drier habitats with xerophytic vegetation.

A more detailed view on the spots where the lizards were found shows that shrub coverage is on average 40% (varying between 15 and 85%), that of grasses 50%. (10-80%) and stones 10% (5-20%). In the “Otmanli” area, the two specimens were registered near old house ruins and those from Rezovo near a villa. Thus, in part of the cases (36%) the *P. apodus* individuals were found in abandoned fields, buildings as well as ruins. The European glass lizard seems to be well adaptable and actively populates such type of areas. This also could be determined by the lack of suitable natural shelters in the region. In part of its natural areal, *P. apodus* may survive in habitats totally lacking overground shelters, living in rodent holes and soil crevices and cracks (Bogdanov, 1960; Alekperov, 1968; Said-Aliev, 1979).

In the studied polygons, the distance to main roads was in average 205 m (range 50-440 m). In “Poda” and “Otmanli” areas the spotted specimens were in very close proximity (approximately 5 m) to regularly used roads. This fact is important, because the European glass lizard is a common victim of the road traffic (Strijbosch et al., 1989). Further studies will clarify whether the limited agility of the species on the roads with different overlay or other ethological and morphological factors are the reason for the increased number of run over lizards. It is also important for understanding whether the legless lizards are more vulnerable by crossing roads than other lizards and snakes.

One important and interesting circumstance observed was that in each of the days when *P. apodus* was found, the cloud coverage was limited (under 50%) and the sunlight was intense throughout the whole day. During the period when the animals were spotted, the weather was partly cloudy (50% cloudiness) or sunny

(less 10% cloudiness). When the weather was too hot (more than 31°C) or too cool (less than 22°C), the lizard preferred to hide. According to Meek (1986) in the region of Montenegro the European glass lizard hasn't been found to be active during cloudy weather. Interestingly, the lizards found under stones in "Poda" (in 9:55h, by 22°C air temperature) were not active, despite of the sunny weather. Meek (1986) stated that the species emerges mostly on sunny days and it is active on narrow ranges of temperatures which restricts the use of the habitat. Field body temperatures obtained by his study was on average 25.7°C (19-31°C) during sunny weather and 20.3°C (18-23°C) when the weather was cloudy. Body temperatures were lower than those found in other day-active temperate zone lizards - in particular the old world Lacertids. The mean body temperatures recorded in laboratory heat gradients were higher in open area experiment – 27.7°C (24-35°C) (Hailey, 1984). Some earlier studies from Daghestan revealed a wider body temperature range with similar average values – 27.2°C (14-34°C) (Bannikov, as cited in Shcherbak, 1966). Using thermogradient (16-55°C) was found that the air temperature diapason 20-26°C was commonly chosen by lizards, but the most preferable was 21.5-22°C (Shcherbak, 1966). Similar data for the spring air temperature activity range in Azerbaijan were provided by Alekperov (1968). According to that author, the preferable diapason was 18-27°C (range 16.7-32.5°C). Data from the present study supports previous observations and show a similar pattern. The average air temperature, which we had measured when specimens were found was 27.8 (range 22-30.5°C).

There was a small variation in relative density scores among sites, and average number was relatively low – 0.07 (0.04-0.11 ind./km<sup>2</sup>, n=7), (Table 1). In the areas with the highest population density in Bulgaria, up to 15 individuals on a three-hour route was found (Tzankov, 2011). Studying representative population at the northern foothills of Eastern Rhodopes Mountains, Popgeorgiev and Kornilev (2009) encounter in average 0.44 (range 0-1.56) individuals per 1 km transects (n=8). Lower values obtained in this study were probably due to the negative anthropogenic influence on or nearby the studied sites.

All of the lizards found during this study were adults. In "Poda" area the reptilian community showed the highest richness scores (Table 1). Here two *P. apodus* individuals were found hidden together with snakes under stones. In the first case one *P. apodus* was found with *Elaphe sauromates* and *Natrix tessellata*, and in another one Scheltopusik was found together with one *E. sauromates* (Figure 2).



**Figure 2.** *P. apodus* and *E. sauromates* found coiled together under a flat rock.

Some potential reptilian competitors for food sources were also found. Other lizards, like the lacertids *Lacerta viridis* and *Lacerta trilineata*, are species that commonly prey on large, mostly coleopteran insects (Peters, 1963; Angelov et al., 1966, 1972; Donev, 1984; Donev et al., 2005; Mollov et al., 2012; Mollov and Petrova, 2013).

The snakes, found under stones along with the lizards could not be considered as food competitors, as *E. sauromates* prefers rodents, small birds and their eggs (Shcherbak, 1966 and reference their), and *N. tessellata* uses the habitat only for shelter and not as a hunting field. This water snake prefers preying mostly on fishes and rarely on anurans (Beshkov and Dushkov, 1981). This co-existence could also be explained by the lack of expressed aggression between the species. It must be pointed out that preying on smaller snake in captivity as well as cannibalism has been reported for Scheltopusik (Shcherbak, 1966; Lisičić et al., 2012).

Some of the European glass lizards found in the range of the study inhabited secondary partly degraded habitats. As important habitat elements were considered the presence of large microhabitat structures used for shelters and the relative proximity of water sources, as well as dense vegetation cover. Further studies in a large scale are necessary to clarify all important proximate and ultimate factors, determining the habitat selection of *P. apodus*.

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