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## COLOR FEATURES OF SAND LIZARDS, *LACERTA AGILIS* (SAURIA, LACERTIDAE), IN KYIV REGION (UKRAINE)

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**Color Features of Sand Lizards, *Lacerta agilis* (Sauria, Lacertidae), in Kyiv Region (Ukraine).** Nekrasova, O. D., Oskyrko, O. S., Marushchak, O. Yu. — The article describes the study of distribution and morphological features of different morphotypes of sand lizards (*Lacerta agilis*) of the Kyiv Region. To sum up, 5 morphotypes of *L. a. chersonensis* were found in the Kyiv Region: bilinear (61.9 %); intermediate form (intermediate version) (17.3 %); trilinear (3.2 %); var. *erythro-(viridi)-nota* (16.2 %); and the rarest var. *con-(bi)-color* (1.4 %). According to the morphological features' varieties erythro-(*viridi*-)*nota* lizards differ mostly from all other morphs (Na/Lor)(2/1 — 44.4 %), in the 15–17 rows 18(14–23) scales. They are most often found in forest biotopes. The remaining bi- and trilinears are characterized by Na/Lor (1/1 — 50.9 %), in the 15–17 rows 9.5 (6–13) scales.  
Key words: sand lizard, *Lacerta agilis*, Kyiv Region, features color.

### Introduction

Kyiv Region is located in the Polissia and Forest-steppe zones of Ukraine and is divided into two parts — right and left banks of the Dnipro River (Kyiv — 50.423682, 30.549541). It is known that features of body coloration vary greatly among sand lizards, *Lacerta agilis* Linnaeus, 1758 (Tarashchuk, 1959; Kalayabina et al., 2001; Kotenko, Sviridenko, 2010). Rare coloration variants such as “erythronotus” mutation have been previously reported in the subspecies *L. a. agilis*, *L. a. chersonensis* (reaching 15 % in some populations) and *L. a. euxinica*, that has an isolated distribution, being presented only in the Danube Delta and some vicinal locations from the Black Sea coast in Romania (Gherghel, Strugariu, 2009). There are reports of “erythronotus” coloration morph in *Lacerta agilis bosnica* from Zelengora mountain, Bosnia and Herzegovina, and in *Lacerta agilis argus* from Croatia and Slovenia (Vogrin, 1999; Burić, Jelić, 2011; Jelić, 2010).

Classification of morphs in sand lizard's has been investigated by many scientists on the territory of the former Soviet Union (Tarashchuk, 1959; Baranov, 1984; Sytnik, 2004; Kotenko, Tarashchuk, 1982; Zinenko et al., 2005; Kotenko, Sviridenko, 2010). However, many of the works show personal techniques of the researchers and poorly correlate with other works on this topic of foreign authors. As a result, there is a lack of a unified approach to the classification of morphs of sand lizards and a unified methodology for their distinguishing.

A. S. Baranov distinguished 4 color variants, when describing the basic coloration of sand lizards: green, brown, reddish and black (Baranov, 1984). Later on 6 color variants of the basic color of dorsal part of the body (green, brown, reddish, brown-green, gray and black) were allocated (Kotenko, Sviridenko, 2010). In most cases relatively young specimens and females have gray-brown dorsal parts of the bodies. Green color of the lizard depends on its age: old specimens are greener than the younger ones. Green shade appears on the lateral sides and on the front half of the body of older females (Kotenko, Sviridenko, 2010). Peculiarities of the distribution of these lizards and their population characteristics were described in the paper "Lacertidae in the conditions of the Central Forest-steppe of Ukraine" (Sytnik, 2004). About a half of the males were green, and the females were brown in Kyiv Region according to these data. Rare variants of coloring were detected for females in the village Rzhyshev: var. *concolor* (= *immaculata*) — 10 % and var. *erythronota* — 30 % of the sample (Sytnik, 2004). But these variations were also found in Cherkassy Region. For example, *L. agilis* populations of Smiini Islands (Kaniv District, Cherkassy Region) had up to 60 % of var. *erythronota* specimens.

So the purpose of this study is a creation of a unified classification of body coloration variants in sand lizards (*L. agilis*) on the territory of Kyiv Region. The main task of the investigation is a revision of the methodology of description of complex of *L. agilis* coloration features that is necessary for further comparison of different populations of sand lizards in Ukraine and Europe. Also the study of distribution and morphological features of different morphotypes of sand lizards of the Kyiv Region was conducted, as since 2010 (Kotenko, Sviridenko, 2010) more detailed studies were not carried out to study the topic mentioned above.

### Material and methods

Beginning from 1997, the cartographic database has been compiled of the points of findings of the sand lizards in Kyiv Region and now it consists of 324 points. Color and picture patterns of lizards were studied in 42 locations since 2010 to 2016. For the analysis of phenetical and morphological features the studied populations were divided according to areas of river basins. The following river basins (plots) were studied: 1) basin of the Vita River (Feofaniya–Pyrohiv (Kyiv), Krenichi and Kruglik villages); 2) Koncha-Zaspa (Kyiv); 3) basin of the Stuhna-Bobritsa River (Plute, Novi Bezradichi, Tatsenko, Ukrainka, Zdorovka villages and Obukhov town); 4) basin of the Irpin River (Moschun, Pushcha-Voditsa (Kyiv), Bucha, Parsley, Shpitki, Gnatovka, Boyarka, Zhornovka villages); 5) basin of the Teteriv River (Palahtyanka, Raska-Kuhar, Brusilov villages); 6) basin of the Desna River (Letku, Voropayev villages and Lubich island); 7) basin of the Trubezh-Supiy River (Pereyaslav-Khmelnytsky, Baryshevka towns and Selishche, Veselinovka, Zgurovka villages); 8) Trahtemirovsky peninsula (Khodorov village) 9) basin of the Ros River (Bila Tserkva town and Buki village) (fig. 1). 279 specimens of sand lizards (96 males, 96 females and 87 juveniles) were studied in Kyiv Region to make the analysis of color and body picture patterns. The variability of color and body pictures was studied according to standard methods (Tarashchuk, 1959; Baranov, 1984; Roytberg, 1994; Zinenko et al., 2005; Kotenko, Sviridenko, 2010) in vivo. Electronic collection of photos of lizards was produced by a digital camera Olympus SP570UZ.

Morphometric characters were as follows: 1 — body length (snout-to-vent length) (L.); 2 — caudal length (L.cd.). For the analysis, 2 metric and 3 quantitative characteristics were used: snout-to-vent length (L.), tail length (L.cd.), number of nasales (Na.), number of loreal scales (Lor.), number of scales in 15–17 row from occipitale between dorsal-lateral lines (fig. 2 (II), Zinenko et al., 2005). For subspecies determining followind indexes were counted: L./L.cd., Na./Lor., and Na.+Lor. (Zinenko et al., 2005). Number main features of color and foldosis was reduced to basic elements: 3 basic color options for body background: green (turquoise, light green, etc.), brown (including dark, platinum, etc.), green-brown (intermediate); 5 color options for body picture: second marginal dorsal lines (bilinear), third dorsal lines (trilinear), intermediate form (incomplete line along the spine); brown back without picture — var. *erythronota*; green back without picture — var. *viridinota*; monochromatic background of the body without picture — var. *concolor*; bicolour background of the body without picture — var. *bicolor* (fig. 2). Color var. "*euxina*" represents a separate interest in the Kyiv Region, that it is similar to the species *L. a. euxinica* from Romania (Dobrudja) (Kotenko, Tarashchuk, 1982).

Database was created using spreadsheets Excel 7.0. Statistical processing of data was carried out with the program Statistica for Windows 10.0. For visualization of cartographic data OziExplorer and QGIS were used (Nekrasova, 2015).

### Results

In Kyiv Region there exists *L. a. chersonensis* Andrzejowski, 1832. Body length of juveniles from the same region: L = 30–55 mm ( $42 \pm 0,1$ ); L.cd. = 33–90 mm ( $55 \pm 0,3$ ). Body length of adults: L (males) = 60–100 mm ( $74 \pm 0,3$ ), L.cd (males) = 75–150 mm ( $105 \pm 0,5$ ); L (females) = 55–100 mm ( $75 \pm 0,3$ ), L.cd (females) = 70–140 mm ( $98 \pm 0,5$ ).

Places of rare varieties of coloring lizards *erythro-(viridi-)nota* (fig. 1):

1) basin of the Vita River (50.2869929, 30.4848518; 50.3355668, 30.4910233; 50.3477348, 30.5086075);

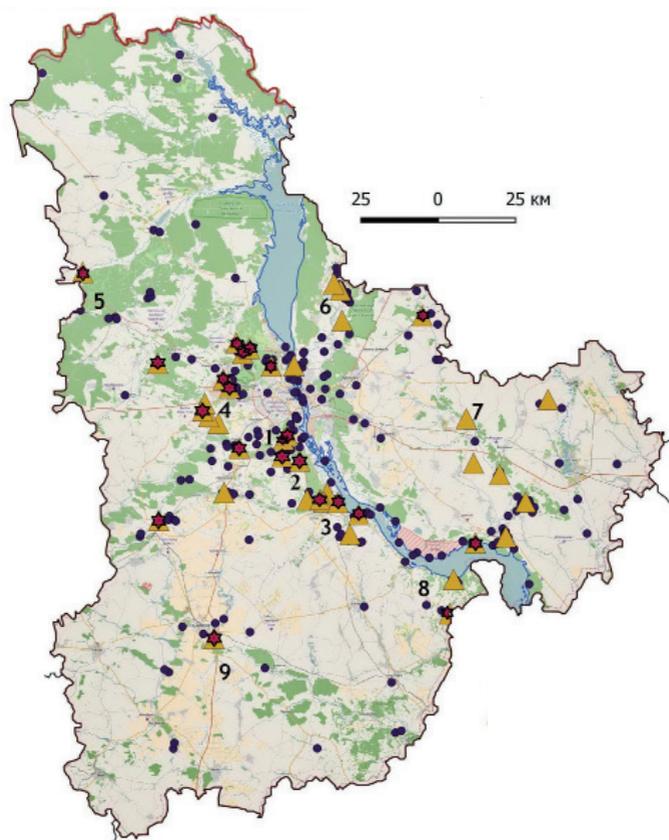


Fig. 1. Map of sand lizard distribution and places of sampling in Kyiv Region:

- — distribution of sand lizards in Kyiv Region (1996–2016);
- ▲ — places, from which samples were taken for studying of coloration (2010–2016);
- ★ — places where rare coloring variants were observed (star — var. *erythro-(viridi-)nota* and var. *con-(bi-)color*).

2) Koncha-Zaspa (50.2744381, 30.5623413);

3) basin of the Stuhna-Bobritsa River (50.1640638, 30.6529551; 50.1221802, 30.8235392; 50.1555009, 30.7321315);

4) basin of the Irpin River (50.3106761, 30.2946574; 50.4170142, 30.1323407; 50.5065192, 30.2239319; 50.5801589, 30.3100888; 50.5945326, 30.3389818; 50.6104373, 30.2804025; 50.5443146, 30.4367244; 50.4832827, 30.2515692; 50.1041183, 29.9373928);

5) basin of the Teteriv River (50.5520991, 29.9326408; 50.8098738, 29.5998669; fig. 5);

6) basin of the Desna River (coloration variants were only found in the Chernihiv Region, but not in Kyiv Region);

7) basin of the Trubezh-Supiy River (50.0396918, 31.3415205; 50.6871070, 31.1056296);

8) Trahtemirovsky peninsula (49.8356280, 31.2264931);

9) basin of the Ros River (49.7658570, 30.1828859).

The most common rare forms of lizard color *erythro-(viridi-)nota* found in basin of the Irpin River (4) and prefer forest biotopes.

## Discussion

*L. a. chersonensis* subspecies is characterized by the following picture of dorsal body part: the central vertebral stripe with dark dorsal spots, as a rule, is bordered by light marginal lines, the distance between which is about 4 mm (fig. 2). There are specimens with a full or incomplete dorsal light line along the spine — trilinear (fig. 2, B, C) with very rare instances in which the line along the spine forms ocelli. The following set of signs was

**Table 1.** Peculiarities of postnasal area folidosis of *L. a. chersonensis* in Kyiv Region

Feature	Forms						
	bilinear	trilinear	intermediate form	NOT	CC	“euxinica”	Total
Na, %							
1	72.5	50	69.2	48.1	100	63.6	67.1
2	27.5	50	30.8	51.9		36.4	32.9
Lor., %							
1	71.4	87.5	69.2	70.4	50	63.6	71.6
2	23.1	12.5	11.5	22.2	50	36.4	20.7
3	5.5		15.4	7.4			7.10
4			3.8				0.7
Na/Lor., %							
1/1	51.1	50	57.7	25.9	50	45.5	47.7
2/1	22.8	37.5	15.4	44.4		18.2	25.8
1/2	18.5		3.8	22.2	50	18.2	16.1
1/3	3.3		3.8				2.6
2/2	4.3	12.5	7.7			18.2	4.5
2/3			7.7	7.4			2.6
1/4			3.8				0.7
Na+Lor., number	2.60 (2–4)	2.63 (2–4)	2.85 (2–5)	2.88 (2–5)	2.5 (2–3)	2.73 (2–4)	2.7 (2–5)
15–17 row, number	9.3 (6–13)	10.7 (10–13)	9.6 (7–12)	18 (14–23)	-	8.4 (6–10)	10.5 (6–23)
Number	92	8	26	27	2	11	166

Note: “NOT” — var. *erythro-(viridi)-nota*; “CC” — var. *concolor*; “euxinica” — var.

typical for lizards of the Kyiv Region. The background of the body was almost brown in all the females (97.9 %), the rest of females showed green-brown color (green sides and bottom of the body). Among males 67.7 % were green, 22.9 % — green-brown, 9.4 % — were brown. Among the juveniles: 3.6 % had a green-brown background (greenish sides and bottom of the body), 1.2 % — greenish, and the rest were brown. As the lizard grows up, the color changes and becomes brighter.

In fact, in all age groups, 5 morphotypes (including rare ones) were encountered. Juveniles are generally striped, but some of the pattern elements differ badly. However, even at this age there are rare color variants — var. *erythronota* (to 27.7 %) and var. *concolor* (to 1.2 %).

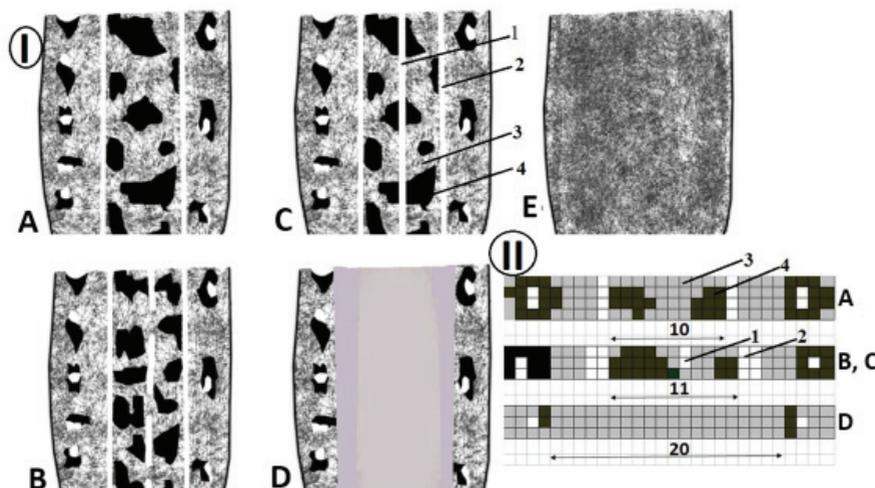


Fig. 2. Features of sand lizards coloring in the Kyiv Region: I — 5 types of color and body picture (A — bilinear, B — intermediate form between bilinear and trilinear, C — trilinear, D — var. *erythro-(viridi)-nota*; E — var. *con-(bi)-color*); II — calculation of the number of scales in the 15–17 rows; elements of the picture: 1 — dorsal line; 2 — marginal line; 3 — vertebral stripes; 4 — dark dorsal spots.

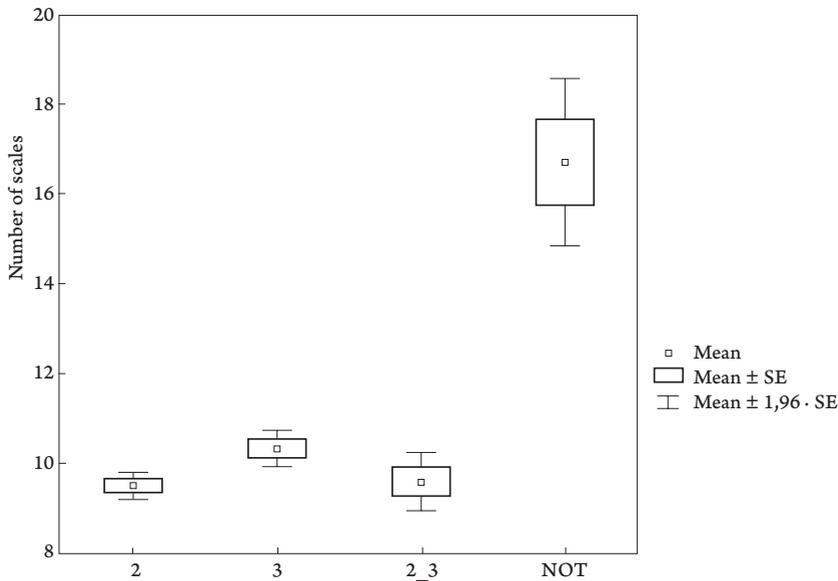


Fig. 3. Number of scales in 15–17 rows of neck scales between lateral light lines in different color morphs of *L. agilis*: “NOT” — var. *erythro-(viridi-)nota*; “3” — trilinear; “2\_3” — intermediate form; “2” — bilinear.

Among the females, 60.4 % were bilinear, 3.1 % were trilinear, and 17.7 % had intermediate form with incomplete dorsal line. Moreover, rare forms were also encountered: var. *erythronota* (to 16.7 %), mostly found in forest habitats and var. *concolor* (to 2.1 %). The light dorsal lines of males were not always contrast and they were often yellow-green and merged with the general bright background color of the body. Among them 80.2 % were bilinear, 3.1 % were trilinear and 8.3 % had intermediate form with incomplete dorsal line. Also, rare color variants were found: var. *viridinota* (found only among males) + var. *erythronota* (7.3 %); var. *con-(bi-)color* (1 %).

Near the railway station Snetynka (photo A. Tsyba) only males had variants as *viridinota* (with a green back without a pattern) and bicolor (all green-brown without a pattern). Var. *erythro-(viridi-)nota* were not found on the left bank of the Dnipro in Polissia area.

There exists another interesting coloration variant with green sides and bottom of the body and brown back with a pattern, that is very similar to *L. a. euxinica* Fuch et Vancea, 1964 (var. *euxinica*), which was described in Dobrudja (Romania) and the Black Sea (Kotenko, Tarashchuk, 1982; Kalayabina et al., 2001; Burić, Jelić, 2011). Lizards with “euxinica” pattern were also found in Kyiv Region: among juveniles — 2.4 %, among females — 1 %, and among males — 17.7 %.

As a result of study of the foliodosis of postnasal area in wild populations of sand lizards in Kyiv Region it was found that the lizards with a combination of scales 1/1 — 47.7% (Na./Lor.) (table 1) were the most common. The most common variants

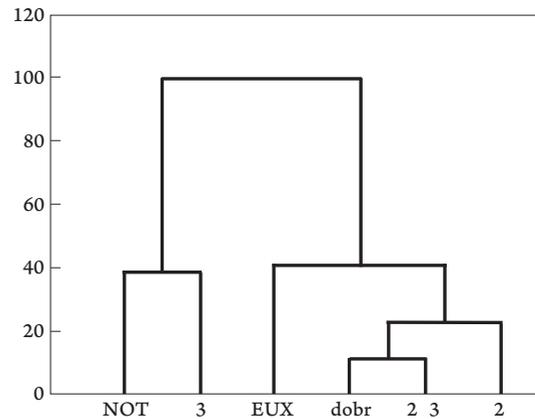


Fig. 4. Results of cluster analyses (Ward’s method) of peculiarities of postnasal area foliodosis of various morphs of *L. agilis*: “NOT” — var. *erythro-(viridi-)nota*; “3” — trilinear; “EUX” — «*euxinica*»; “dobr” — *L. a. euxinica* from Romania (Dobrudja) (Kotenko, Tarashchuk, 1982); “2\_3” — intermediate form; “2” — bilinear.



Fig. 5. Foto of *L. a. chersonensis* of the Teterev River basin.

are the following scutes' sums of the postnasal area (Na.+Lor.): "bilinear" — 45.8 %; "trilinear" — 41.9 %. In this case, the proportion and spectrum of different versions of scutes in different color morphs differs.

Lizards with var. *erythro-(viridi-)nota* have the biggest differences in all combinations of scutes, the largest sum of postnasal scales and the number of scales (15–17 rows of cervical scales, after the occipital scute) in the cervical region between marginal light lines (14–23 scales, table 1, fig. 3). Similar differences are observed between following subspecies — *L. a. chersonensis* (6–13 scales, table 1, fig. 3) and *L. a. exigua* Eichw., 1831 (15–16 scales, Zinenko et al., 2005), and morphotypes of lizards var. *erythro-(viridi-)nota* (fig. 5).

According to the results of the cluster analysis it can be seen, that *L. a. euxinica* from Romania (Dobruja) (Kotenko, Tarashchuk, 1982) is the closest to *L. a. chersonensis* (bilinear and intermediate form morphotypes) of the Kyiv Region (fig. 4). And trilinear and var. *erythro-(viridi-)nota* are rare enough to stand out and break away into a separate group.

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