ECOLOGIA BALKANICA

2014, Vol. 6, Issue 2 December 2014 pp. 109-112

Short note

Level of Synanthropy of the Amphibians and Reptiles from the City Of Plovdiv (Bulgaria)

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Abstract. The current study determines the level of synanthropy of the amphibians and reptiles in the city of Plovdiv, based on Nuorteva's Index of synanthropy, with slight modification, proposed here for the first time.

Key words: Amphibia, Reptilia, Synanthropy Index, Plovdiv, Bulgaria

In the conditions of the urban environment, some species undergo a process of synanthropization, i.e. adaptations and new mechanisms of regulation at population level to the new environment are formed (VERSHININ, 1987). According to the classification given by KLAUSNITZER (1987) there are four ecological groups of animals in subordination to their level of synanthropy: *hemerophobes* – species, which avoid urban environment; *hemerodiaphores* – species, which existence doesn't depend on the anthropogenic transformation of the landscape; *hemerophiles* – species, which prefer habitats made by humans and *synanthropes* – species, which are directly connected with habitats made by man and their existence depend on the human activity. Synanthropes on the other hand are *obligate* and *facultative*. Obligate synanthropes are species that occur in a (micro) climatic zone in anthropogenic conditions only in urban areas, usually within the human settlements and they do not or rarely occur elsewhere in nature. Facultative (optional) synanthropes are species found in urban areas and human settlements, where they find optimal conditions for existence, while they can form natural populations in natural biotopes.

Based on species distribution along the urban gradient and field observations an attempt for classification of the amphibians and reptiles in Plovdiv was made in previous studies (MOLLOV, 2005; 2011). That classification showed that from amphibians there are no species that can be classified as synanthropic. One species (*B. viridis*) was considered "hemerophilic", because it occurs mainly in urban and suburban areas of the city and has high ecological plasticity that allows it to occur in a variety of habitats (polytopic species). Two species (*H. arborea* and *P. ridibundus*) were also polytopic, but they were found in all three urban zones (urban, suburban and rural) and that's why they were considered "hemerodiaphoric", as *P. syriacus* was also added to this category. Two species (*B. bufo* and *R. dalmatina*) were

registered only in the suburban and rural areas, only in few habitat types (stenotopic), and they were classified as "hemerofobic" (MOLLOV, 2011). Only one reptile species (*M. kotschyi*) showed the characteristics of a typical synanthrope - polytopic species inhabiting a wide range of anthropogenically created urban habitats, some of which are unsuitable for habitation for all other reptiles. One species (*P. tauricus*) was classified as "hemerophilic", although it is found in all three areas, the numbers in the central urban part was significantly higher. Four species (*L. viridis, E. orbicularis, N. natrix* and *D. caspius*) were registered in all three zones of the city (with the exception of *N. natrix,* which is absent from the urban center) and were polytopic, occurring in a wide range of urban habitats (except *D. caspius,* which has a special preference for the habitats and is stenotopic species), which makes them "hemerodiaforic". Two species (*L. trilineata* and *N. tessellata*) were absent from the central zone and occur in several urban habitats (stenotopic species) and were classified as "hemerophobic".

Later PULEV & SAKELARIEVA (2013) made similar classification, based on the same criteria, for the amphibians and reptiles of Blagoevgrad (South-West Bulgaria). However, no quantification criteria was used in these classifications.

One known techniques for numerical expression of the level of synanthropy of a species is the Index of synanthropy (SI) proposed by NUORTEVA (1963), allowing more precise classification on a species level, whish even divides obligate and facultative synanthropes:

$$SI = \frac{2a+b-2c}{2}.100,$$

where: *a* – percentage (%) of the individuals in the urbanized area (human settlements), *b* – percentage (%) of the individuals in the agricultural areas, *c* – percentage (%) of the individuals in biotope, little affected by anthropogenic influence.

The Index of Synanthropy has values from +100 to –100, where:

+100 – Full preference to densely populated urban areas and human settlements;

+75 – Clear preference to urban areas and human settlements;

+50 – Slight preference to urban areas;

0 – Indifferent to urban areas and human settlements;

-25 – Preference to non-populated areas;

-50 – Avoidance of urban areas and human settlements;

-75 – Clear avoidance of urban areas and human settlements;

-100 – Complete absence in urban areas.

This index has been successfully applied to determine the level of synanthropy of dipterous insects (FORATTINI *et al.,* 1993; VIANNA *et al.,* 1998; MARÍ & JIMÉNEZ-PEYDRÓ, 2011), spiders (VALESOVA-ZDARKOVA, 1966; SACHER, 1983), birds (NUORTEVA, 1971) and others. The Index may have different values for the same group of animals in different cities at different altitudes and in different latitude. However, in the proposed by Nuorteva index, some difficulties in determining the so-called "urbanized area", "agricultural areas" and "biotope, little affected by anthropogenic influence" occur and each author interpreted them differently and used the Index with some qualifications and modifications. For example, in the case of Plovdiv, the Plovdiv hills may be characterized as "biotope, little affected by anthropogenic influence", but at the same time they are in the city center, which is an urban area. Maritsa River passes through the entire length of the city and passes through urban, agricultural and less affected by anthropogenic impact areas. More so the given definitions are also not clear about the size and the boundaries of these areas. Therefore, we propose some changes to the explanations of the Nuorteva's formula, based on the concept of the urban gradient (MCDONNELL & PICKETT, 1990; MCDONNELL *et al.,* 1997). We offer the formula to be used for the three urban zone, along the urban gradient. The "urban" zone (the central urban parts) to be used, instead of "urbanized area" (marked "a" in the formula); the "suburban" zone (suburbs) to

be used, instead of "agricultural areas" (marked as "b" in the formula) and the "rural" zone can be used instead of "biotope, little affected by anthropogenic impact" (marked as "c" in formula). In our opinion, the proposed explanations do not change the meaning of the Index of synanthropy, but bring more clarity in the definition of the three zones. Depending of the peculiarities of each city, the three zones from the urban gradient, in most cases are more easily identifiable for each city and more precisely defined. For this reason, their use in the formulation of Nuorteva's formula will be much more efficient, without changing the meaning of the Index of synanthropy.

For the identified amphibians and reptiles in Plovdiv (MOLLOV, 2011), for the first time in the current study, the Index of synanthropy was calculated and the species were categorized into ecological groups, depending on their level of synanthropy (Table 1), as proposed by KLAUSNITZER (1987). The Index of Synanthropy confirmed our previous classification of the species in four environmental groups with slight changes. We recommend using Nuorteva's index (with our proposed modification) as a measure of classification of species according to their level of synanthropy (based on Klausnitzer's classification), with the following values: SI = 100 - obligate synantropes; SI = 90 ÷ 99 - facultative synantropes; SI = 51 ÷ 89 - hemerophiles; SI = -50 ÷ 50 – hemerodiafores; SI = -100 ÷ -49 - hemerophobes. We believe that this proposed scale can be successfully applied to other groups of animals as different groups are likely to require some modifications, depending on their environmental peculiarities and characteristics. Our hypothesis can be tested with the conduct of other future similar studies with different organisms in an urban environment.

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Received: 11.11.2014
Accepted: 22.12.2014

Table 1. Level of synanthropy of the amphibians and the reptiles in the city of Plovdiv, based on SI values.

Description	Scale SI	Ecological group	Species and SI value
Full preference to densely populated urban areas and settlements	+100	**Synanthropes** (obligate) (facultative)	*Mediodactylus kotschyi* (93.72)
		Hemerophyles	*Bufo viridis* (89.82)
Clear preference to urban areas and human settlements	+75		*Podarcis tauricus* (89.63)
Slight preference to urban and human settlements	+50		
		Hemerodiaphores	*Hyla arborea* (34.85)
			Emys orbicularis (32.14)
	+25		
			Dolichophis caspius (7.14)
Indifference to urban areas	0		*Pelophylax ridibundus* (-3.68)
Slight avoidance of urban areas	-25		*Pelobates syriacus* (-25.00)
			Natrix natrix (-38.89)
			Lacerta viridis (-49.12)
Avoidance of urban areas and human settlements	-50		*Bufo bufo* (-50.00)
		Hemerophobes	*Natrix tessellata* (-50.00)
Clear avoidance of urban areas and human settlements	-75		
Complete absence from urban areas	-100		*Rana dalmatina* (-100)
			Lacerta trilineata (-100)