Atti Mus. Civ. St. Nat. Trieste	62	2021	235-246	X 2021	ISSN: 0335-1576

BIENNIAL CENSUS OF HORVATH'S ROCK LIZARD *IBEROLACERTA HORVATHI* IN TWO ALPINE AREAS (NORTH-EASTERN ITALY)

GIANLUCA RASSATI

Via Udine 9 – 33028 Tolmezzo (Italy). E-mail: itassar@tiscali.it

Riassunto – Censimento biennale di Lucertola di Horvath *Iberolacerta horvathi* in due aree alpine (Italia nord-orientale)

Nel 2019 e nel 2020 sono stati effettuati censimenti con cadenza mensile lungo transetti prestabiliti in un'area sita sulle Alpi Carniche ed in un'area sita sulle Alpi Giulie. L'indice chilometrico di abbondanza (N° ind./Km) mensile è variato da 0 a 32 in un'area e da 0 a 21 nell'altra. L'andamento dei valori di abbondanza ha mostrato un'elevata variabilità fra i mesi. Tale variabilità e la differenza della stessa fra le due aree è stata influenzata dal clima e dai suoi diversi effetti in conseguenza delle differenze stazionali. È stata verificata una variazione della fenologia della specie con individui in attività durante tutto l'anno ad altitudini elevate.

Parole chiave: Lucertola di Horvath *Iberolacerta horvathi*, Censimento, Abbondanza, Fenologia, Alpi Orientali, Italia.

Abstract – In 2019 and 2020, monthly censuses were carried out along pre-established transect lines in an area in the Carnic Alps and an area in the Julian Alps. The monthly kilometric abundance index (No. ind./km) varied from 0 to 32 in one area and from 0 to 21 in the other. The abundance values showed high variability among months. This variability and its difference between the two areas were influenced by the climate and its diverse effects due to the site differences. Variation in the phenology of the species was verified, with individuals active throughout the year at high altitudes.

Key words: Horvath's rock lizard *Iberolacerta horvathi*, Census, Abundance, Phenology, Eastern Alps, Italy.

1. – Introduction

Horvath's rock lizard *Iberolacerta horvathi* (MÉHELŸ, 1904) has an Alpine-Dinaric distribution (SILLERO *et al.*, 2014) that is still little studied. Investigations carried out in recent decades have dealt with various aspects, but the field studies have often focused on the distribution, which is still being defined (cf. e.g. RASSATI, 2019; DE MARCHI *et al.*, 2020; COCCA *et al.*, 2021). They have highlighted a lack of quantitative data, only found in very few works (e.g. ŽAGAR, 2016; RASSATI, 2019) and resulting from censuses conducted in the months of greatest activity of the species. I am not aware of reports with censuses covering all the months of the year.

In north-eastern Italy, the dormant period begins at the end of October and hibernation usually lasts until April, with individuals already active in March when there are favourable climatic conditions (CORTI *et al.*, 2011).

Since active individuals were observed outside the aforesaid time frame and also in the winter months (RASSATI, 2019, unpublished data), it was decided to carry out censuses in every month to obtain quantitative data referable also to non-"conventional" periods and information about the possible change in the phenology of the species.

2. – Study areas and methods

The study was conducted in the same two areas where the first standardized censuses of the species in Italy were carried out: one in the Lumiei Valley (Carnic Alps), the other in the Raccolana Valley (Julian Alps) (RASSATI, 2019).

Figure 1 - Sector of the Zahre area / Settore dell'area Zahre (Photo G. Rassati)

Figure 2 - Sector of the Sclûse area / Settore dell'area Sclûse (Photo G. Rassati)

The first (Zahre area; Municipalities of Vigo di Cadore and Sauris; UM 14-UM 24; 1500-1510 m a.s.l.; Fig. 1), on the medium slope (with prevalent S to SE exposure) of Mounts Pezzocucco, Palone and Oberkovel, is made up of rocks and screes and is crossed by some streams. The gradient is generally high and even exceeds 100%. The area is crossed by a paved road along which the vegetation cover is zero or slight, with a wood of Norway spruce *Picea abies*, European larch *Larix decidua* and European beech *Fagus sylvatica* only in short stretches.
The second (Sclûse area; Municipality of Chiusaforte; UM 83; 990-1090 m a.s.l.; Fig. 2), on the lower slope (with prevalent SE exposure) of the Jôf di Montasio group, consists of rocks and, to a small extent, screes and is bordered in small part by a watercourse. The gradient is generally high and exceeds 100% for large tracts. The area is crossed by a paved road along which the vegetation cover is zero or slight, with a wood of European beech and Norway spruce only in small portions.
In both cases, there are concrete and stone retaining walls along the road; in the first area there are road protection works (e.g. gabions and barriers with wooden beams and metal uprights) above some walls, while the second area has some tunnels and stretches of concrete slope faces.
The mean annual temperatures are 5-6°C in the Zahre area and 8-9°C in the Sclûse area, while annual precipitation is 1400-1600 mm in the former and 2200-2400 mm in the latter (POLLI, 1971).
The first area covers territories belonging to both Friuli Venezia Giulia and Veneto, while the second is wholly within Friuli Venezia Giulia.
The two areas were chosen as they are easily identifiable and walkable. Hence, they are suitable for standardization of surveys so as to be repeatable also by other investigators over time. Moreover, the areas are representative since they belong to two different Alpine sections and involve both regions where *Iberolacerta horvathi* has thus far been found.
Individuals were counted along pre-established 1 km-long transect lines (BUCKLAND *et al.*, 2004); in the first area the path was continuous, while in the second some stretches were interrupted by tunnels. During 2019 and 2020, monthly censuses were carried out in each of the two areas on days with good weather conditions and during the hours of greatest activity of the lizards. To ensure a greater possibility of contact, the visits took place during climatically favourable periods, especially between November and March. There were no problems with species determination in the Zahre area where the Common wall lizard *Podarcis muralis* was never found (RASSATI, 2019). Examination of the individuals was performed at a very close distance and by means of photographs. Individuals were divided into adults (Fig. 3) and juveniles with blue-greenish tail. During the censuses, cases of road mortality were noted and individuals of *Podarcis muralis* were also recorded in the Sclûse area.
The kilometric abundance index (KAI; No. ind./km) was obtained for each month and for the entire year (Tabs. 1, 2): this index is easily calculated even in the case of line transects of variable length and thus the values can readily be compared with those obtained in other studies. The distance between closest individuals was measured: when it was within 15 metres, they were considered grouped (based on the home range size as derived from *in situ* observations and the consequent ease

of interactions), otherwise they were considered isolated. Finally, the mean distance between the grouped individuals was calculated.
In the two study years, the meteorological trend was constantly monitored by means of *in situ* recordings and acquisition of the ARPA FVG – OSMER and GRN data relating to the mountain sector of Friuli Venezia Giulia. The *in situ* recordings made it possible to verify the suitability of conditions to conduct the censuses and to plan the monitorings.

Figure 3 - *Iberolacerta horvathi*. Adult / Adulto (Photo G. Rassati)

3. – Results

In the Lumiei Valley the KAI ranged from 0 in both years to 27 in 2019 and 32 in 2020 (Mean 2019: 9.00 ± 9.69 SD; Mean 2020: 9.75 ± 9.70 SD), while in the Raccolana Valley it varied from 0 in both years to 21 in 2019 and 17 in 2020 (Mean 2019: 6.67 ± 6.49 SD; Mean 2020: 6.17 ± 5.89 SD) (Tabs. 1, 2). In both areas, the KAI was highest from June to September and lowest from November to March with the exception of May 2019 in the Zahre area.
The trend of the values was more regular in the Sclûse area, with a tendency to increase from January to August (absolute maximum) and then to decrease in the autumn months, albeit with opposite values in November-December 2019 (Figs. 4, 5); the comparison between the two years also showed a more similar trend.

	2019	**2020**
January	0	1
February	1	1
March	4	3
April	7	6
May	0	11
June	18	32
July	27	21
August	16	11
September	22	18
October	12	9
November	0	4
December	1	0
Total	108	117
Mean	9.00	9.75
SD	9.69	9.70

Table 1 - Kilometric abundance index (KAI; No. ind./km) in the Zahre area / Indice chilometrico di abbondanza (KAI; N° ind./Km) nell'area Zahre

In the Zahre area, the trend was more irregular both compared to the other area and between the two years: the maximum value was reached in July in 2019 and in June in 2020, while in the first study year no individuals were contacted in May (Figs. 4, 5). Common to both years was a decline in August and a subsequent increase in September.
Juveniles were observed from June to October in the Zahre area and from May to October in the other area; the percentage frequency was very low with respect to the total number of individuals and until August below 10% in the Lumiei Valley and 15% in the Raccolana Valley. In September and especially October the frequency increased, especially in the Sclûse area, where in October 2020 more than 80% of the individuals surveyed were juveniles, but also in the other area where they made up more than 20% in the same month. Taking all individuals into consideration, the percentage frequency of juveniles in both years was just over 5% in the Zahre area and between 10% and 15% in the other area.

	2019	2020
January	0	0
February	1	0
March	3	2
April	5	4
May	6	8
June	11	10
July	12	15
August	21	17
September	13	10
October	7	6
November	0	2
December	1	0
Total	80	74
Mean	6.67	6.17
SD	6.49	5.89

Table 2 - Kilometric abundance index (KAI; No. ind./km) in the Sclûse area / Indice chilometrico di abbondanza (KAI; N° ind./Km) nell'area Sclûse

Considering all the censuses, in the Zahre area 62% of individuals in 2019 and 55.6% in 2020 were grouped, while in the Sclûse area the values were 53.8% in 2019 and 51.4% in 2020. The mean number of grouped individuals was 3.05 ± 1.70 SD in 2019 and 3.10 ± 1.26 SD in 2020 in the Lumiei Valley and 2.87 ± 1.25 SD in 2019 and 2.38 ± 0.81 SD in 2020 in the Raccolana Valley. The maximum number of grouped individuals per single group was recorded in the Zahre area in July (n=9) in 2019 and in June (n=6) in 2020, and in the Sclûse area in September (n=6) in 2019 and in June (n=5) in 2020. Grouped individuals were not observed in January, February and December in both areas, in May and November 2019 and October 2020 in the Zahre area and in November 2019 and March, September and November 2020 in the Sclûse area. The percentage frequency of grouped individuals was very variable from one month to another; in the months in which groupings were observed (considering both years) it ranged from 25 (October 2019) to 85.19 (July 2019) in the Zahre area and from 42.86 (October 2019) to 87.50 (May 2020) in the Sclûse area. The mean distance between grouped individuals in the Lumiei Valley was 4.63 m ± 3.74 SD in 2019 and 5.79 m ± 4.67 SD in 2020, while in the Raccolana Valley it was 4.34 m ± 3.47 SD in 2019 and 4.99 m ± 3.98 SD in 2020.

Three cases of road mortality concerning *Iberolacerta horvathi* individuals were recorded in the Lumiei Valley (1 in August 2019 and 2 in September 2020), while none was detected in the Raccolana Valley.
In the Sclûse area, one individual (male) of *Podarcis muralis* was contacted in June and July 2019 and in April and May 2020.

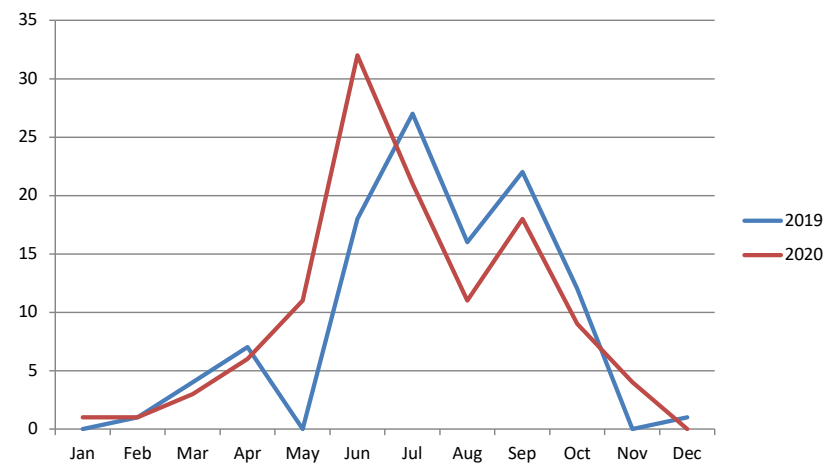

Figure 4 - Monthly trend of the kilometric abundance index (Zahre area) / Andamento mensile dell'indice chilometrico di abbondanza (Area Zahre)

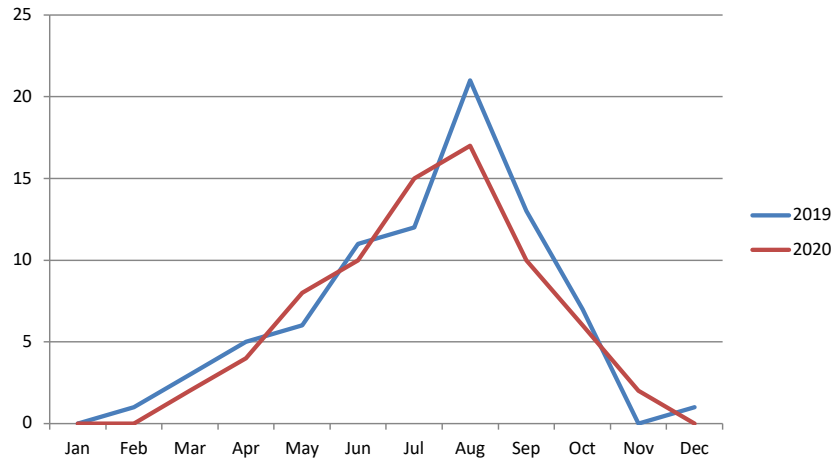

Figure 5 - Monthly trend of the kilometric abundance index (Sclûse area) / Andamento mensile dell'indice chilometrico di abbondanza (Area Sclûse)

4. – Discussion

The absence of previous publications dealing with the topic in the autumn and winter months does not allow comparisons. Nevertheless, the repetition of the censuses in 2020 highlighted some factors that influenced the abundance values and their trends. The results indicated a high variability among months, already found in 2018 albeit only in relation to May, July and September (RASSATI, 2019), and also confirmed a higher variability in the Zahre area. This variability is due not only to the change in many parameters that come into play in the case of research in the field and are intrinsically linked to the species and the environment, but certainly also to the climate which plays a key role especially in ectothermic species such as *Iberolacerta horvathi*. The KAI of 0 in May 2019 in the Zahre area was due to an exceptionally cold and rainy month (ARPA FVG – OSMER and GRN data); although the census was carried out at the end of the climatically unfavourable period, the lizards, having "suffered" a long period in which it was not "convenient" to leave the shelters, avoided doing do for a few more days. In the same manner but with opposite results, in both areas in December 2019, a warm period (ARPA FVG – OSMER and GRN data), subsequent to a November with abundant precipitation that caused the lizards to go into hibernation, induced at least one individual to interrupt it.

The climate most likely had a strong influence on the trend of the KAI values (Figs. 4, 5), acting differently in the two areas due to the site differences. The higher values and greater regularity of contact in winter in the Zahre area, despite being at a higher altitude, were probably due to the fact that, in addition to having a more favourable exposure at least in some portions, it is located at a greater altitudinal difference with respect to the valley floor. This gives two advantages compared to the Sclûse area: the first is the greater distance from the mountains on the opposite side of the valley which thus project less shade; the second (more important in relation to the low winter solar radiation) is less stagnation of cold air (thanks also to the valley's width) which, in the case of strong thermal inversions linked to prolonged high-pressure periods, is decisive in allowing the individuals to go outside to thermoregulate. In fact, in the Sclûse area, there is cold air stagnation in winter which, combined with the limited solar radiation, allows the snow to remain uniformly on the surface for a long time: confirming this is the fact that the only lizards contacted in February and December 2019 were in the highest sector of the area. The advantages of the winter period in the Zahre area are reversed in favour of the other area in the rest of the year. This is especially so in spring and autumn when a lowering of the temperature due to cloud cover, precipitation and cold winds, if prolonged, has a greater impact on the former area located at a higher altitude, while the effects are more mitigated in the Sclûse area: this is supported by the data for May 2019 when the cold and rainy period influenced the results more markedly in the Zahre area (KAI=0) than in the other one (KAI=6).

I believe that what has been reported explains the more regular trend of KAI in the Sclûse area also because the variations in the number of active individuals are lower in the winter period (and in late autumn and early spring) when, even in in the case of climatic parameters within the mean of the period, the number of individuals is in any case reduced or nil.

The results confirmed the hypothesis of variation of the phenology of the species, with individuals active throughout the year at high altitudes (especially for the investigated Alpine sections) like what was found for *Podarcis muralis* (author's pers. obs. in the village of Sauris di Sopra, 1405 m a.s.l., in conjunction with the censuses of *Iberolacerta horvathi*), as was evident for some time (RASSATI, 2012). The areas where the study was conducted have been used by the author to carry out zoological and forestry investigations since the 1980s when the climatic and site conditions in winter were much more difficult and prohibitive for the lizards. It can be hypothesized, therefore, that the alteration of the life cycle of *Iberolacerta horvathi* has been caused by climate change, since seasonal activities of reptiles such as reproduction and hibernation are closely linked to climatic conditions (cf. e.g. SAINT GIRONS, 1985; ADOLPH & PORTER, 1993; HENLE *et al.*, 2008). In fact, in recent decades there have been winters with little snow and with positive thermal anomalies and the 0° C isotherm at very high altitudes for several days (ARPA FVG – OSMER and GRN data): thus, some individuals, exploiting particularly favourable sites, remain active even in mid-winter.

Figure 6 - *Iberolacerta horvathi*. Neonate / Neonato (Photo G. Rassati)

The abundance values were higher (with the exception of May 2019 in the Zahre area) than those obtained in 2018 in May, July and September (RASSATI, 2019) and much higher than those recorded in lower altitudinal bands in Slovenia (ŽAGAR,

2016). If instead we consider the mean abundance in the months (from April to September) in which the censuses were conducted in Slovenia in the altitudinal band 900-1099 m a.s.l., the only one encompassing one of the two areas where the censuses were carried out in Italy (Sclûse), the values of 11.33 ind./Km in 2019 and 10.67 ind./Km in 2020 (Tab. 2) are slightly lower than that found in Slovenia (12.71 ind./Km; ŽAGAR, 2016).

With regard to the low percentage frequency of juveniles, it should be considered that, in addition to their small size which certainly makes contact more difficult, they tend to frequent marginal zones because of the risk of being preyed upon by adults. Their increased frequency in September and above all in October was due to the appearance of neonates (Fig. 6), also observed grouped.

Considering the months (May, July, September) in which the censuses were conducted in 2018 (RASSATI, 2019), the mean distance between grouped individuals in the Lumiei Valley was 3.54 m ± 3.53 SD in 2019 and 7.60 m ± 5.57 SD in 2020, while in the Raccolana Valley it was 3.05 m ± 2.45 SD in 2019 and 5.67 m ± 4.29 SD in 2020; this is in comparison with the 2018 values of 8.12 m ± 4.87 SD in the Lumiei Valley and 4.97 m ± 3.25 SD in the Raccolana Valley, demonstrating a high variability.

Individuals were observed crossing the road (little used by the lizards due to the greater suitability of the surrounding environments) only on very rare occasions. Given that the censuses took place monthly, it was relatively difficult to detect collisions since the subsequent passage of vehicles tends to remove the remains of the carcasses: this and the lizard's high degree of attention and response to immediate danger (e.g. the arrival of a vehicle) (cf. RASSATI, 2016) likely explain the very few recorded episodes of road mortality. In the Sclûse area, the absence of collisions despite the higher vehicular flow than in the other area (as recorded by the author with precise counts during the censuses) was probably also due to the smaller number of individuals than in the Zahre area and to the lower habitat suitability on both sides of the road, so that the individuals were less motivated to move.

The presence of a single individual of *Podarcis muralis* in the study area does not indicate the existence of a population but is symptomatic of an "ascent" of some individuals, to be considered biological-functional units of dispersion and eventual colonization. Given that in numerous surveys in the Raccolana Valley carried out in the last 20 years or so (RASSATI, 2020) *Podarcis muralis* was found only at altitudes lower than those of the Sclûse area (RASSATI, 2010, 2012) and that the first individual in this area was observed in 2016, it can be inferred that this phenomenon is most likely favoured by the climate change, as in other Alpine areas in which an altitudinal expansion of the distribution of *Podarcis muralis* has been observed in sites previously occupied only by *Iberolacerta horvathi* (RASSATI, 2019).

Lavoro consegnato il 07/05/2021

ACKNOWLEDGEMENTS

Giancarlo Rassati is thanked for his assistance with the surveys.

REFERENCES

ADOLPH S.C. & PORTER W.P., 1993 – Temperature, activity, and lizard life histories. *American Naturalist*, 142: 273-295.

ARPA FVG – OSMER and GRN. http://www.meteo.fvg.it/.

BUCKLAND S.T., ANDERSON D.R., BURNHAM K.P., LAAKE J.L., BORCHERS D.L. & THOMAS L., 2004 – Advanced Distance Sampling. Oxford University Press, Oxford.

COCCA W., ŽAGAR A., SILLERO N., JOWERS M.J., KROFEL M., LUŽNIK M., PODNAR M., TVRTKOVIĆ N., CARRETERO M.A. & CROTTINI A., 2021 – Genetic diversity of Horvath's Rock Lizard meets current environmental restrictions. *Conservation Genetics*. https://doi.org/10.1007/s10592-021-01351-4.

CORTI C., CAPULA M., LUISELLI L., RAZZETTI E. & SINDACO R. (Eds.), 2011 – Fauna d'Italia. Vol. XLV. Reptilia. Calderini-Edizioni Calderini de Il Sole 24 ORE S.p.A., Milano-Bologna.

DE MARCHI G., BOMBIERI G., BOZ B., LENARDI F., RICHARD J., 2020 – Has the West been won? A field survey and a species distribution model of *Iberolacerta horvathi* in the Alps. *Acta Herpetologica*, 15(1): 3-14.

HENLE K., DICK D., HARPKE A., KÜHN I., SCHWEIGER O. & SETTELE J., 2008 – Climate Change Impacts on European Amphibians and Reptiles. Convention on the Conservation of European Wildlife and Natural Habitats, Strasbourg, France.

MÉHELŸ L., 1904 – Eine neue *Lacerta* aus Ungarn. *Ann. Mus. Nat. Hist. Hung.*, 2: 362-367.

POLLI S., 1971 – Il clima della regione. In: Enciclopedia Monografica del Friuli-Venezia Giulia. 1: 442-488.

RASSATI G., 2010 – Contributo alla conoscenza della distribuzione della Lucertola di Horvath *Iberolacerta horvathi* e della Lucertola dei muri *Podarcis muralis* in Friuli Venezia Giulia e in Veneto. *Atti Mus. Civ. St. Nat. Trieste*, 54 (2009): 133-146.

RASSATI G., 2012 – Contributo alla conoscenza della distribuzione di alcune specie di *Amphibia* e di *Reptilia* in Friuli Venezia Giulia e in Veneto. *Atti Mus. Civ. St. Nat. Trieste*, 55: 91-135.

RASSATI G., 2016 – Road mortality of amphibians and reptiles along two roads in the Carnic Alps (Friuli, North-eastern Italy) before and after asphalting. *Atti Mus. Civ. St. Nat. Trieste*, 58: 161-170.

RASSATI G., 2019 – Horvath's rock lizard *Iberolacerta horvathi* in Italy: summary of its distribution, first quantitative data and notes on conservation. *Atti Mus. Civ. St. Nat. Trieste*, 60: 281-294.

RASSATI G., 2020 – First record of tail bifurcation in Horvath's rock lizard *Iberolacerta horvathi* (Julian Alps, Friuli, North-eastern Italy). *Atti Mus. Civ. St. Nat. Trieste*, 61: 269-272.

SAINT GIRONS H., 1985 – Influence des facteurs de l'environnement sur les cycles annuels et reproducteurs des reptiles. *Bulletin de la Société Zoologique de France*, 110: 307-319.

SILLERO N., CAMPOS J., BONARDI A., CORTI C., CREEMERS R., CROCHET P.A., ISAILOVIĆ J.C., DENOËL M., FICETOLA G.F., GONÇALVES J., KUZMIN S., LYMBERAKIS P., DE POUS P., RODRÍGUEZ A., SINDACO R., SPEYBROECK J., TOXOPEUS B., VIEITES D.R. & VENCES M., 2014 – Updated distribution and biogeography of amphibians and reptiles of Europe. *Amphibia-Reptilia*, 35: 1-31.

ŽAGAR A., 2016 – Altitudinal distribution and habitat use of the common wall lizard *Podarcis muralis* (Linnaeus, 1768) and the Horvath's rock lizard *Iberolacerta horvathi* (Méhely, 1904) in the Kočevsko region (S Slovenia). *Natura Sloveniae*, 18 (2): 47-62.