

The First Finding of *Lepidurus couesii* Packard, 1875 (Crustacea, Notostraca) in Western Balkans: A Record Based on the Level of Development of Diagnostic Body Characters in a Bisexual Population from Serbia

Ivana D. Šaganović, Vladimir T. Tomić, Luka R. Lučić & Dragana M. Miličić*

University of Belgrade, Faculty of Biology, Studentski trg 16, 11000 Belgrade, Serbia; E-mails: b3039_2014@stud.bio.bg.ac.rs; vlada@bio.bg.ac.rs; luka@bio.bg.ac.rs; draganam@bio.bg.ac.rs

Abstract: *Lepidurus couesii* PACKARD, 1875, a new large branchiopod species for Serbian fauna was reported. Specimens of both sexes were collected on the periphery of the city of Belgrade in northern Serbia, in the flooded area of the Sava River. The finding is based on the analysis of mature individuals of both sexes. The evidence of new taxon has derived from a level of development of the main body parts which are considered as diagnostic for this species. Present results will expand the knowledge of distribution of this species in Europe to the area of Western Balkans. Since the bisexual population is recognized as highly female-biased, there is a need for further detailed information about the mode of reproduction in Serbian population of *L. couesii*.

Key words: *Lepidurus couesii*, gonochoric, female-biased, Balkan Peninsula, Serbia

Introduction

The Notostraca are branchiopod crustaceans with a world-wide distribution. Recent Notostraca are present in all continents, except Antarctica (BRTEK & THIÉRY, 1995, BRENDONCK *et al.* 2008). Data derived from the recent and fossil records, revealed a high morphological stasis in this group of crustaceans (WALLOSSEK 1993, MATHERS *et al.* 2013). Remarkable fossil evidence has been dating back to the Devonian, providing notostracans to be referred to as “living fossils” (DARWIN 1859, OLESEN 2007). However, based on molecular data, current species have evolved quite recently and are not living fossils. Its close resemblance with fossil taxa is result of the highly conserved general morphology and of homoplasy, rather than the evolutionary stasis in this group (VANSCHOENWINKEL *et al.* 2012). The only family, Triopsidae, has two extant genera: *Triops* SCHRANK, 1803 and *Lepidurus* LEACH, 1816. These two genera show clear morpho-

logical differentiation, and can be distinguished on the basis of caudal lamina (supra-anal plate, according to LINDER 1952), present only in *Lepidurus*.

Within the genus *Lepidurus*, the most widely distributed species is *L. apus* L. referred from Europe, Asia, Africa, America, New Zealand and Australia (LONGHURST 1955, BRTEK & THIÉRY, 1995). The North-American endemics are *L. bilobatus* PACKARD, 1877, *L. lemmoni* HOLMES, 1894 and *L. packardi* SIMON, 1886 (KING & HANNER 1998) as well as *L. lynchi* LINDER, 1952 and *L. cryptus* D. C. ROGERS, 2001, which has been described recently from Nevada and California (LINDER 1952, ROGERS 2001), respectively. For the taxon *L. apus lubbocki* BRAUER, 1873 (which distribution is limited to the Mediterranean region), MANTOVANI *et al.* (2009) suggested full species status as *L. lubbocki* BRAUER, 1873. Same authors also documented a sister rela-

*Corresponding author draganam@bio.bg.ac.rs

tionship between the Holarctic species *L. couesii* PACKARD, 1875 and the circumpolar, glacial relict *L. arcticus* (PALLAS, 1793) (MANTOVANI *et al.* 2009).

L. couesii was first described from the North American continent (PACKARD 1875). However, this species is considered as a widely distributed complex (according to MATHERS *et al.* 2013), which presence was being subsequently reported from Mongolia (BRTEK *et al.* 1984), Syria (THIÉRY 1996), Apennine Peninsula (SCANABISI *et al.* 2006), Romania (DEMETER & STOICESCU 2008), and from the European part of Russia (SIDOROVSKY *et al.* 2014). According to BRTEK & THIÉRY (1995), it is a typical “North American and Asian species that has spread westwards to eastern Romania”.

So far, only *L. apus* has been recorded in Serbia (PETROV & CVETKOVIĆ 1997). This species occurs mainly in spring in a wide variety of ephemeral wetland habitats, and may be able to tolerate temporary drying conditions. Beside their adaptation to desiccation, another adaptation to the habitat ephemerality is the short life cycle of two weeks (CVETKOVIĆ-MILIČIĆ & PETROV 1999). However, during the period

2008–2016, we identified several new sites with large branchiopods (LUKIĆ *et al.* 2012). For some samples, an additional taxonomic analysis was needed.

This paper reports the first record of *L. couesii* in the territory of Serbia and Western Balkans, contributing to the knowledge of the distribution range of this species in Europe.

Material and Methods

Site description

The survey for this study was carried out in different periods between April and September 2008 in the several parts of Serbia. During the survey period, we visited many potential habitats and identified some new sites with the large branchiopod fauna. One of the sites lies in the vicinity of Belgrade in the flooded area near Sava River (N 44.770445; S 20.350340) at the altitude of 132 m (Fig. 1). Geographical position of the site and the altitude were recorded by a handheld GPS. This area is a part of the wider drainage canal network, constructed in the purpose of controlling the regime of groundwa-

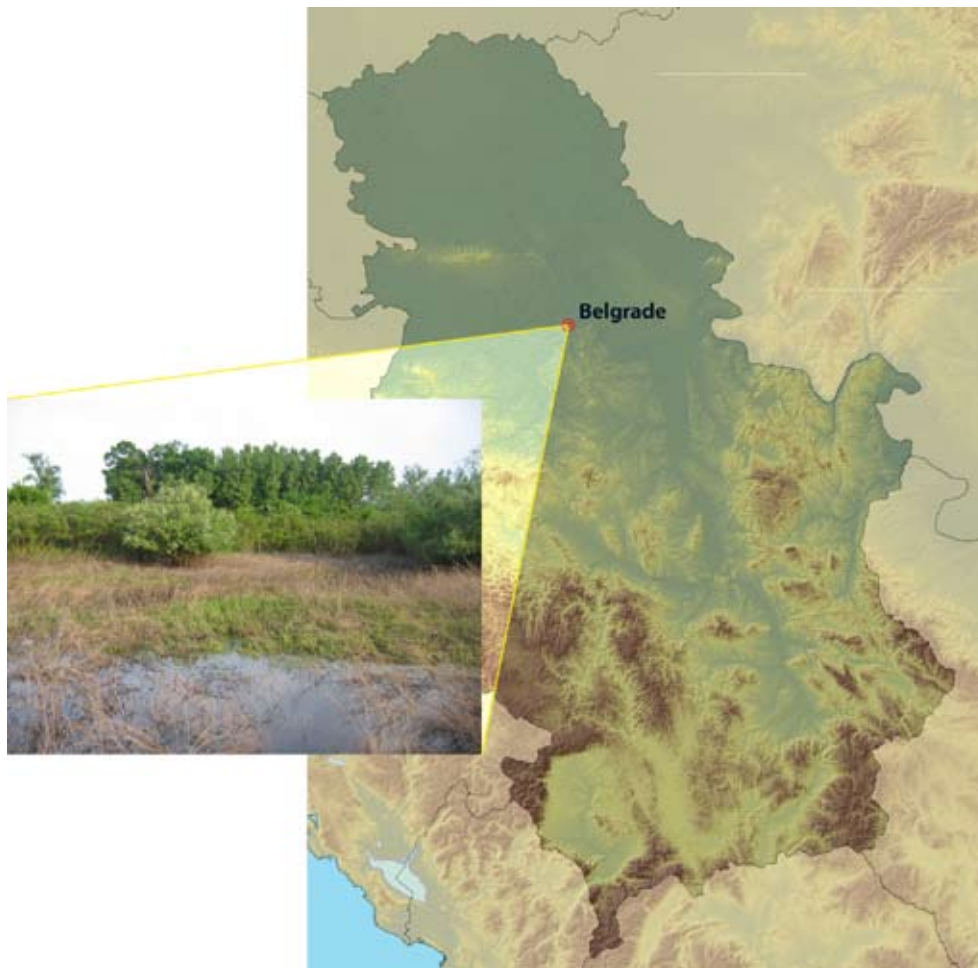


Fig. 1. Geographic position of the site referred to in this study (the original habitat is shown in small picture)

ter and prevention the overflow of excess water from the northern lowlands. The amount of water and the water retention at the site is also affected by precipitation and hydrological characteristics of the Sava River. Area receives about 680 mm of precipitation a year, with late spring being wettest. The annual humidity is between 60% and 80%. In the period of sampling, average air temperatures were between 12 and 22°C.

The sampling habitat is situated in a marshy area near the channel. It was covered with grassy vegetation, and scarce forest alongside the river flood plain. The depth was between 10 and 50 cm. Specimens were collected from 0.3–0.5 m deep zone. The bottom was covered with rotting leaves, mud and soil. Physical properties of water were as follows: temperature 19°C, conductivity 0.04 S m⁻¹, salinity 0.02 mg/l, pH 7–8, dissolved oxygen concentration 6.8 mg/l. Parameters were measured in the field using the WTW Multi-Parameter Meter 340i Set. Other invertebrates, i.e. cladocerans, copepods, ostracods, gastropods, insect larvae and the freshwater cnidarian *Hydra* sp. were main co-existing animals at the site.

Sample analysis

Samples were collected with a hand nets (mesh size 150 µm for plankton and 1 mm for epibenthos) and immediately fixed *in situ* in ethanol. The taxonomical diagnosis of species was based on analysis of individuals collected in May 2008. Smaller specimens have not attained complete development, and males may resemble young females of the same length. Due to this reason, we used only the specimens with a carapace length of 15 mm or more for morphological analysis (LYNCH 1972, ROGERS 2001). Sex was identified by the presence of a hemispherical ovisac in the eleventh thoracopod, which is the character that unequivocally separates females (and hermaphrodites) from the males (MATHERS *et al.* 2013). Specimens were determined according identification keys given by LONGHURST (1955), LINDER (1952), LYNCH (1972) and ROGERS (2001). All specimens were stored in the Institute of Zoology, Faculty of Biology in Belgrade.

A total of 5 males and 32 ovisac-bearing individuals (females) of the same size class were selected for taxonomical analysis. Due to the fact that we found a small number of males, only ovisac-bearing individuals were considered for statistical analysis. However, since the male characters occur as an integral part of species descriptions in the literature, we included them in morphological analysis. However, we considered them only for descriptive purpose and to obtain the tentative impression of sexual di-

morphism in examined population. Taxonomically important morphological characters were studied in both sexes, as follows: a total body length (^{tot}L), measured from the anterior edge of carapace to the end of caudal lamina (without the rami); length of carapace measured along the median line and width of carapace (CL and CW); length of abdomen (AL); and length of the caudal lamina in dorsal view (^dL). The ratios of ^dL/CL, AL/CL, CL/CW were calculated from each individual. A total number of pairs of legs (PL), number of body rings not covered by the carapace (PS) and number of legless rings (L_{less}S) were counted. All variables were tested for normality. We also recorded the following character states: the number of body rings, the arrangement of the spines on posterior margin of the carapace (*sulcus* according to ROGERS 2001), the presence/absence of spines of dorsal side of carapace (the carinal armature). We also studied the shape of exopodit of the first trunk appendage, as an important distinctive character between *L. apus* and *L. couesii* (according to BRTEK *et al.* 1984). Further, we observed a position of a nuchal organ with respect to the zone of the compound eyes (LINDER 1952).

A Carl Zeiss Stemi 2000 binocular stereomicroscope with an AxioCam MRc digital camera was used in this study. Digital images of whole specimens were taken with Sony DSC F828 (resolution 8.0 MP; Sony Corp., Tokyo, Japan). All measurements were made on digital photographs using the program AxioVision SE64 Rel. 4.9.1 Software (ver. 4.2 for Windows, Carl Zeiss, München, Germany). A detailed morphological structure of diagnostic body parts significant for determination of species were examined with a Nikon SMZ 1270 binocular stereomicroscope connected with a Nikon DS-Fi2 digital camera and Nikon DS-L3 camera controller. Statistical analysis was conducted with IBM SPSS Statistics software.

Results

Data of the occurrence of *L. couesii* in Serbia are based on the analysis of several morphological characters significant for determination of species. The bisexual population is recognized as highly female-biased. The mean male/female ratio in population was of approximately 1/25, and males comprised a mean of 3.94% of the whole population. The range of the key characteristics (based on females' morphology) and measurements (mean, minimum, maximum and standard deviation) is provided in Table 1. The extent to which diagnostic body parts were developed is presented on illustrations (Fig. 2 and 3).

Table 1. Body characteristics of *L. couesii* from Serbia (based on female data): CL=carapace length, CW=carapace width, AL=length of abdomen not covered by the carapace, ^cL=length of caudal lamina, ^{tot}L= total length, PS=number of posterior segments not covered by the carapace, L_{less}S= number of segments without legs, PL= pair of legs (lengths expressed in mm, measured to the nearest 0.1 mm)

	CL	CW	AL	^c L	^{tot} L	PS	L _{less} S	PL	^c L/CL	CL/CW	AL/CL
Mean	18.43	11.06	1.85	3.04	23.33	3.19	4.31	37.31	0.16	1.67	0.10
Min	15.86	9.85	0.21	2.32	19.14	0	4	34	0.14	1.46	0.01
Max	21.06	12.51	4.05	3.66	27.36	7	5	39	0.20	1.79	0.23
SD	1.49	0.74	1.08	0.39	1.94	2.07	0.47	1.23	0.01	0.08	0.06

Relative size of the caudal lamina to the carapace length (^cL/CL) was in range of 0.14–0.20. It surely represents the most relevant taxonomic criterion of those tested here, at least in gonochoric females (SD=0.01; N=32). Also, variability of the characters CW, ^cL, L_{less}S, CL/CW and AL/CL were comparatively low. On the other hand, a total body length and number of posterior segments not covered by the carapace were the most variable characters.

Large, shield-like carapace covers the anterior half of trunk of animals (Fig. 2 a,b). All analyzed specimens possess an elongated caudal lamina (supra-anal plate), which is slightly widening medially, then narrowing towards the apex. Its median carina is slightly bulging, covered with numerous spines of different size (Fig. 2 c,d). Other diagnostic body parts significant for determination of species are presented on Fig. 3. Oval nuchal organ lies partly between the lobes of the ocular tubercle of fused eyes, as is shown in Fig. 3a. Medio-dorsal carina on the carapace is smooth. The spines on carina were not recorded in any specimen. Terminal carina-spine is present in both sexes. Larger sulcal spines are slightly rounded and single smaller spines separating the larger ones (Fig. 3b). Exopodite of the first thoracic appendage is elongated proximally and distally, with medial constriction (Fig. 3c, arrow).

Differences between sexes

A total body length of females from anterior margin of carapace to tip of caudal lamina (without the ceropod rami) was 19.14 to 27.36 mm. The number of body rings (body segments) was 25 – 27. Mature females have segmented body with 34 to 39 pairs of legs (trunk limbs) and 4 – 5 apodous segments, respectively. Carapace is elongated, covered almost all trunk segments. It is bent ventrally and completely covers the lateral sides of the body. Sulcus is with 45 – 69 spines. The number of posterior segments not covered by the carapace was 0 to 7.

Similarly as in females, males had body length of 19.26-24.53 mm. The number of body rings was

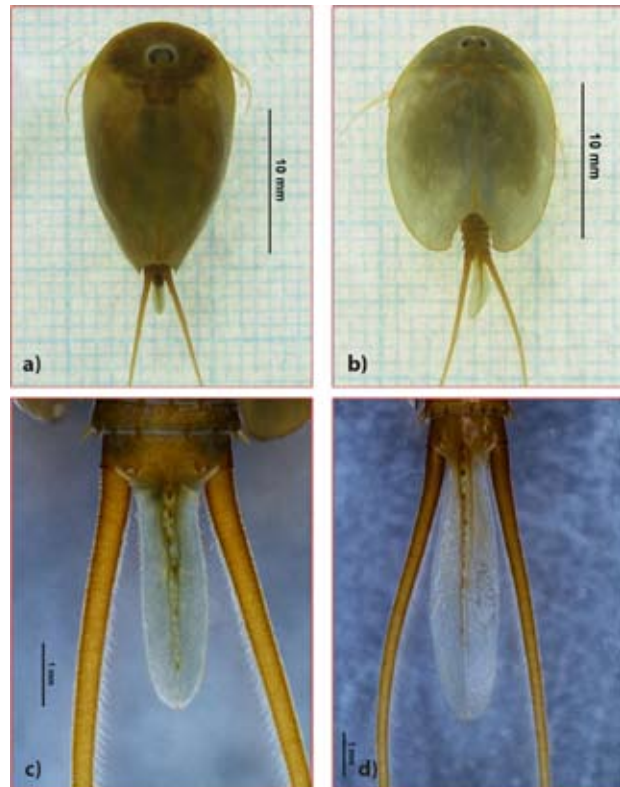


Fig. 2. General aspect of adults (dorsal view): a) Male external morphology; b) female external morphology; c) degree of development of the caudal lamina in males; d) degree of development of the caudal lamina in females

25–26. They had 33–38 pairs of legs and 4–5 apodous segments. However, they possessed shorter, flatter and more rounded carapace than the females. On average carapace covered a smaller area of the trunk than in females. Sulcus was with 41–62 spines. Males had smaller telsons but longer caudal lamina relative to the females (Fig. 4). Also, the relative size of the caudal lamina to the carapace length (^cL/CL) had higher values in males compared to females (Fig. 5).

Since only 5 males were available for morphological analysis, morphological parameters indicating the sexual dimorphism are rather descriptive and should be considered with caution.

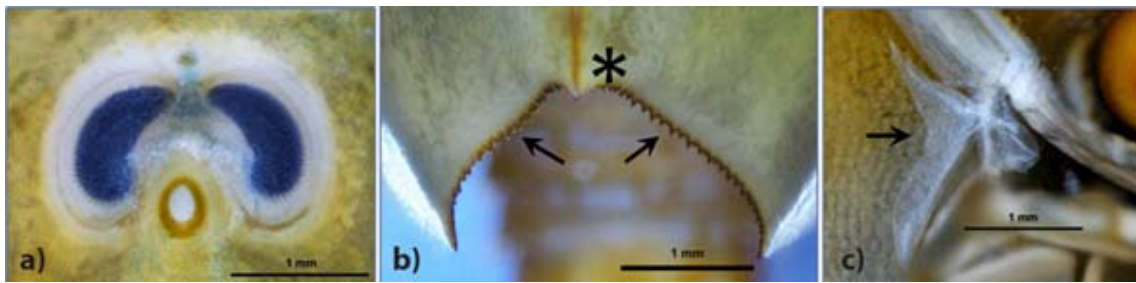


Fig. 3. Diagnostic body parts significant for determination of species: a) Shape and position of nuchal organ; b) spineless carina with the terminal carina-spine (*), and sulcus with spines (arrows); c) exopodit of first leg.

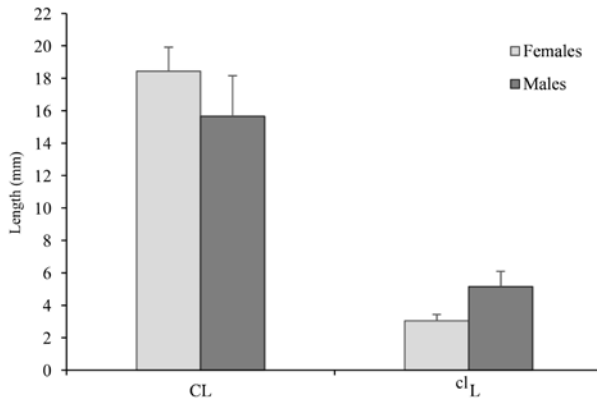


Fig. 4. Mean carapace length (CL) values and mean length of caudal lamina (^{cl}L) values for females and males, with one standard deviation. Values are expressed in mm

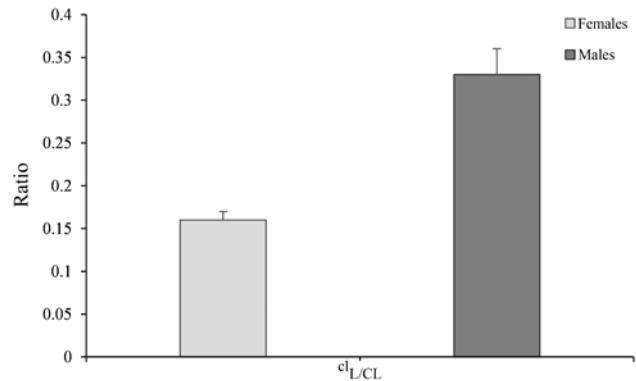


Fig. 5. Mean ratio of caudal lamina length and carapace length (^{cl}L/CL) values for females and males, with one standard deviation

Discussion

Despite of the extensive publishing of new data on distribution of large branchiopods, information of *L. couesii* in Europe has remained scarce. So far, this species was reported from several habitats in Mediterranean region (eastern Italy) and from steppe zone of Eastern Balkans in Romania (BRTEK & THIÉRY 1995, SCANABISI *et al.* 2006). This also suggested to the possibility that *L. couesii* could also inhabit other steppe lowlands of Balkan Peninsula. The new record in Serbia presented herein extends distribution of this species to the territory of Western Balkans.

Based on common morphological criteria (cf. LONGHURST 1955), the size of the supra-anal plate in the recently founded population is distinctively larger than in the closely related species *L. apus*, which has previously been reported from Serbia (CVETKOVIĆ-MILIČIĆ & PETROV 1999). In addition, the long caudal lamina (supra-anal plate) with prominent median carina (“middorsal keel” according to LINDER 1952) and other characters provided a strong correlation with the species *L. couesii* (compared to data published in LINDER 1952, LYNCH 1972, BRTEK *et al.* 1984, ROGERS 2001). According to body length, our specimens could be attributed to the small

ones (*sensu* ROGERS 2001). Body length was similar in males and females. However, LINDER (1952) and LONGHURST (1955) suggested that this character might not be of a higher discriminatory power due to a high variation, even within the same population. This is because the body segments can be naturally incomplete, partially reduced, extended or even spiral-developed. Also, there is no always strong correlation between the number of legs and the body rings. This plasticity in external morphology and extensive variation in individual characters makes the obstacles in accurate classification of species (ROGERS 2001). Variation in body size could be also appear due to contraction of segments when placed in ethanol, since the fixation fluids can affect the size of soft tissues of crustaceans (BELADJAL & MERTENS 1999, JÄRVINEN *et al.* 2014). However, shrinkage takes place only in the body segments, not in the chitinized parts such as the carapace, or last segment (*telson*) with caudal lamina. Results obtained from Serbian specimens proved that those characters are the most relevant for taxonomy and very useful for distinguishing males from the females in the particular population.

Data reported here also indicate that carapace measurements showed a relatively low variability

within population, and that the shape of the carapace can be relevant for distinguishing males from the females. Carapace widely covers the animal body in females, which means better protection from predators and greater safety for the eggs. This could have a strong influence on survival, since the Serbian population of *L. couesii* is located nearby the permanent water body (the Sava River) from which predators could switch to the habitat. On the other hand, broader, flattened, short, and rounded carapace of the males is probably associated with the increased general mobility and a more active behaviour. Long and freely abdomen not covered with carapace can provide better swimming and searching for prey (LAKKA 2015). In environment, the above differences can also be seen as a response to predation pressure (KORN & HUNDSDOERFER 2016) and to other local environmental factors, or even as adaptation to escaping, or avoiding cannibalism, which is common in Notostraca (LAKKA 2013, 2015; personal observations). Cannibalistic behaviour by females can make increasing mortality rate in males, which could lead to biased female/male ratio in population (BERNING *et al.* 2012).

Even the small abundance of males suggests bisexual nature of Serbian population of *L. couesii*, with assumed presence of cross-fertilization within the population. It was to be expected, considering that glacial refugia in the southern parts of Europe (where the Balkan Peninsula is geographically located) was marked as area of spreading the bisexual populations of Notostraca with high haplotype diversity. In accordance with this, the presence of gonochoristic mode of reproduction has been hypothesized to be the ancestral state in the group (ZIEROLD *et al.* 2007).

On the other hand, the hermaphroditic and androdioecious reproductive modes could be rather found at higher latitudes (at about N49.329 and above) compared to gonochoric ones (MATHERS *et al.*

2013). Sexual system in Notostraca is considered as highly labile, with the development of resistant stages (dormant eggs or cysts) and the occurrence of different reproductive modes in populations (MATHERS *et al.* 2013). Such rather unusual reproductive strategies are attributed to the ephemerality of their extreme habitats (MANTOVANI *et al.* 2004).

The record of a new notostracan species in Serbia proves that this country is still not well-studied. Due to an efficient dispersal of the large branchiopods via birds and flying insects, amphibians, fish, or by hoofs of grassing cattle (BOHONAK & WHITEMAN 1999, BILTON *et al.* 2001, BELADJAL *et al.* 2007, BELADJAL & MERTENS 2009, ROGERS 2014), more discoveries of this species could be expected both in lowland ponds or lower highland ephemeral habitats. There is the need to survey the other marshes in Serbia and the region in order to identify those who might hold other viable populations. Potential habitats could be grouped into ponds situated on the floodplains that have a significantly longer duration than those on the surroundings. Further studies are also necessary in order to investigate what environmental parameters influence distribution and reproduction of *L. couesii*.

In addition, both developmental and histological studies are needed in the Serbian population of *L. couesii* in order to establish whether the ovisac-bearing individuals show histological signs of hermaphroditism. Also, the exact significance of small number of males in the reproduction of *L. couesii* needs further investigation. This will upgrade understanding of the real mode of reproduction, and routes defining the primary body plan during early development of individuals.

Acknowledgments: This work was a part of IŠ's Ph.D. It was funded by the Ministry of Education, Science and Technological Development of Serbia, Grant No 173038.

References

- BELADJAL L. & MERTENS M. 1999. Direct preservation in alcohol causes deformation of taxonomic key-characters in Anostraca (Crustacea). *Internationale Revue der gesamten Hydrobiologie*, **84**: 17–22.
- BELADJAL L. & MERTENS J. 2009. Diaspore dispersal of anostraca by flying insects. *Journal of Crustacean Biology*, **29**(2): 266–268.
- BELADJAL L., DIERCKENS K. & MERTENS J. 2007. Dispersal of Fairy Shrimp *Chirocephalus diaphanus* (Branchiopoda: Anostraca) by the Trout (*Salmo trutta*). *Journal of Crustacean Biology*, **27**(1): 71–73.
- BERNING A. W., GADD R. D. H., SWEENEY K., MACDONALD L., ENG R. Y. Y., HESS Z. L. & PRUITT J. N. 2012. Sexual cannibalism is associated with female behaviour type, hunger stage and increased hatching success. – *Animal Behaviour*, **84**: 715–721.
- BILTON D. T., FREELAND J. R. & OKAMURA B. 2001. Dispersal in freshwater invertebrates. *Annual Review of Ecology and Systematics*, **32**: 159–181.
- BOHONAK A. J. & WHITEMAN H. H. 1999. Dispersal of the fairy shrimp *Branchinecta coloradensis* (Anostraca): Effects of hydroperiod and salamanders. *Limnology and Oceanography*, **44**: 487–493.
- BRENDONCK L., ROGERS D. C., OLESEN J., WEEKS S. & HOEH W. R. 2008. Global diversity of large branchiopods (Crustacea: Branchiopoda) in freshwater. *Hydrobiologia*, **595**: 167–176.

- BRTEK J., FORRÓ L. & PONYI J. E. 1984. Contributions to the knowledge of the Branchiopoda (Crustacea) fauna of Mongolia. *Annales Historico-naturales Musei Nationalis Hungarici*, **76**: 91–99.
- BRTEK J. & THIÉRY A. 1995. The geographic distribution of the European Branchiopods (Anostraca, Notostraca, Spinicaudata, Laevicaudata). *Hydrobiologia*, **298**: 263–280.
- CVETKOVIĆ-MILIČIĆ D. & PETROV B. 1999. Life histories of *Triops cancriformis* (Bosc, 1801) and *Lepidurus apus* (Linnaeus, 1758) (Crustacea, Notostraca) in a group of rainpools in the Banat Province in Yugoslavia. In: von Vaupel Klein J. C. & Shram F. R. (eds.): *Crustacean Issues*, **12**: The Biodiversity Crisis and Crustacea. Rotterdam. The Netherlands (A. A. Balkema), 411–417.
- DARWIN C. R. 1859. On the origin of species by means of natural selection or the preservation of favoured races in the struggle for life. London: John Murray. 251 p.
- DEMETER L. & STOICESCU A. 2008. A review of the distribution of large branchiopods (Branchiopoda: Anostraca, Notostraca, Spinicaudata, Laevicaudata) in Romania. *North-Western Journal of Zoology*, **4**(2): 203–223.
- JÄRVINEN A., LAKKA H. K. & SUJALA M. 2014. Arktinen kilpikidusjalkainen, tunturivesien elävä fossiili, löydetty jälleen Suomesta. *Luonnon Tutkija*, **1**: 19–24.
- KING J. L. & HANNER R. 1998. Cryptic species in a 'living fossil' lineage: taxonomic and phylogenetic relationships within the genus *Lepidurus* (Crustacea: Notostraca) in North America. *Molecular Phylogenetics and Evolution*, **10**: 23–36.
- KORN M. & HUNDSDOERFER A. K. 2016. Molecular phylogeny, morphology and taxonomy of Moroccan *Triops granaries* (Lucas, 1864) (Crustacea: Notostraca), with the description of two new species. *Zootaxa*, **4178**(3): 328–346.
- LAKKA H. K. 2013. The ecology of a freshwater crustacean: *Lepidurus arcticus* (Branchiopoda; Notostraca) in a High Arctic region. M.Sc. Thesis No. **111**. The University of Helsinki, Lahti.
- LAKKA H. K. 2015. Description of the male *Lepidurus arcticus* (Branchiopoda: Notostraca) and the potential role of cannibalism in defining male form and population sex ratio. *Journal of Crustacean Biology*, **35**(3): 319–329.
- LINDER F. 1952. Contributions to the morphology and taxonomy of the Branchiopoda Notostraca, with special reference to the North American species. *Proceedings of the United States National Museum*, **102** (3291): 1–69.
- LONGHURST A. R. 1955. A review of the Notostraca. *Bulletin of the British Museum of Natural History*, D, **3**: 1–57.
- LUKIĆ D., NAHIRNIĆ A., MARKOVIĆ A., KARAN ŽNIDARŠIĆ T., ŠČIBAN M. & MILIČIĆ D. 2012. An Updating of Large Branchiopods (Crustacea: Branchiopoda) distribution in Serbia. *Acta Zoologica Bulgarica*, Supplement **4**: 19–23.
- LYNCH J. E. 1972. *Lepidurus couesii* Packard (Notostraca) redescribed with a discussion of specific characters in the genus. *Crustaceana*, **23**: 43–49.
- MANTOVANI B., CESARI M. & SCANABISSI F. 2004. Molecular taxonomy and phylogeny of the 'living fossil' lineages *Triops* and *Lepidurus* (Branchiopoda: Notostraca). *Zoologica Scripta*, **33**: 367–374.
- MANTOVANI B., CESARI M. & SCANABISSI F. 2009. Molecular taxonomy and phylogeny of Italian *Lepidurus* taxa (Branchiopoda: Notostraca). *Italian Journal of Zoology*, **76**: 358–365.
- MATHERS T.C., HAMMOND R.L., JENNER R.A., ZIEROLD T., HÄNFLING B. & GÓMEZ A. 2013. High lability of sexual system over 250 million years of evolution in morphologically conservative tadpole shrimps. *BMC Evolutionary Biology*, **13**: 30.
- OLESEN J. 2007. Monophyly and phylogeny of branchiopoda, with focus on morphology and homologies of branchiopod phyllopodous limbs. *Journal of Crustacean Biology*, **27**(2): 165–183.
- PACKARD A. S. 1875. New phyllopod crustaceans. *American Naturalist* **9**: 311–312.
- PETROV B. & CVETKOVIĆ D. 1997. Community structure of branchiopods (Anostraca, Notostraca and Conchostraca) in the Banat Province in Yugoslavia. *Hydrobiologia*, **359**: 23–28.
- ROGERS D. C. 2001. Revision of the Nearctic *Lepidurus* (Notostraca). *Journal of Crustacean Biology*, **21**: 991–1006.
- ROGERS D.C. 2014. Larger hatching fraction in avian dispersed anostracan eggs (Branchiopoda). *Journal of Crustacean Biology*, **34**: 135–143.
- SCANABISSI F., ALFONSO G., BERGAMASCHI S. & MANTOVANI B. 2006. Primo Ritrovamento di *Lepidurus couesii* Packard, 1875 in Italia. *Thalassia Salentina*, **29**: 113–124.
- SIDOROVSKY S. A., KARGAPOLTSEVA I. A. & Kholmogorova N. V. 2014. New data on the fauna of Anostraca, Notostraca and Conchostraca of the Udmurt Republic. *Amurian Zoological Journal*, **6**(1): 12–14 (In Russian).
- THIÉRY A. 1996. Large branchiopods (Crustacea: Anostraca, Notostraca, Spinicaudata, Laevicaudata) from temporary inland waters of the Arabian Peninsula. In: KRUPP F. & MAHNERT V. (eds.): Fauna of Saudi Arabia, Riyadh, Saudi Arabia. National Commission for Wildlife Conservation and Development. Basle Pro Entomologica, c/o Natural History Museum, 37–98.
- VANSCHOENWINKEL B., PINCEEL T., VANHOVE M. P. M., DENIS C., JOCQUE M., TIMMS B.V. & BRENDONCK L. 2012. Toward a Global Phylogeny of the "Living Fossil" Crustacean Order of the Notostraca. *PLoS ONE*, **7**(4): e34998. doi:10.1371/journal.pone.0034998
- WALLOSSEK D. 1993. The Upper Cambrian *Rehbachella* and the phylogeny of Branchiopoda and Crustacea. *Fossils and Strata*, **32**: 1–202.
- ZIEROLD T., HANFLING B. & GÓMEZ A. 2007. Recent evolution of alternative reproductive modes in the 'living fossil' *Triops cancriformis*. *BMC Evolutionary Biology*, **7**: 161 doi:10.1186/1471-2148-7-161

