

# THE DISTRIBUTION PATTERN OF FRESHWATER CRAYFISH IN CROATIA

BY

I. MAGUIRE and S. GOTTSTEIN-MATOČEC

Department of Zoology, Faculty of Science, University of Zagreb, Rooseveltov trg 6,  
HR-10 000 Zagreb, Croatia

## ABSTRACT

In order to improve our general knowledge on the distribution of the various species of freshwater crayfish of the family Astacidae in Croatia, we gathered all the available unpublished data, as well as data from the literature and those of our own investigations. Our research confirmed the presence of three crayfish species in Croatia: *Astacus astacus* (Linnaeus, 1758), *Austropotamobius torrentium* (Schrank, 1803), and *Austropotamobius pallipes* (Lereboullet, 1858), and we officially recorded the presence of *Astacus leptodactylus* Eschscholtz, 1823 and *Orconectes limosus* (Rafinesque, 1817). Biogeographical data suggest the following distribution pattern: *A. astacus* is distributed in the continental part of Croatia, forming both river and lake populations. *A. pallipes* is distributed in south and southwest Croatia (Lika, Istria, Dalmatia, and on some islands in the Adriatic Sea). *A. torrentium* can be found in streams at higher altitudes in the continental part of Croatia. Finally, *A. leptodactylus* is found in the rivers of eastern and central Croatia (Slavonia and Posavina), while *O. limosus* was discovered recently in marshes of the Nature Park Kopački rit (Slavonia). Some mixed populations of *A. astacus* and *A. torrentium* were detected. Some specimens of *A. pallipes* and *A. torrentium* were found in underground habitats. Research on the distribution of freshwater crayfish should be more intensive, and will be continued in the future.

## RÉSUMÉ

Afin d'améliorer notre connaissance sur la répartition des différentes espèces d'Astacidae de Croatie, nous avons rassemblé toutes les données non publiées disponibles, les données de la littérature et les résultats de nos propres investigations. Nos recherches ont confirmé la présence de trois espèces d'écrevisses en Croatie: *Astacus astacus* (Linnaeus, 1758), *Austropotamobius torrentium* (Schrank, 1803), et *Austropotamobius pallipes* (Lereboullet, 1858), et nous avons enregistré la présence d'*Astacus leptodactylus* Eschscholtz, 1823 et d'*Orconectes limosus* (Rafinesque, 1817). Les données biogéographiques suggèrent le modèle de répartition suivant: *A. astacus* est répartie dans la partie continentale de la Croatie, formant des populations à la fois de rivières et de lacs. *A. pallipes* est présente dans le sud et le sud-ouest de la Croatie (Lika, Istrie, Dalmatie, et dans quelques îles de la mer Adriatique). *A. torrentium* peut être trouvée dans les cours d'eau, à des altitudes plus élevées, dans la partie continentale de la Croatie. Enfin, *A. leptodactylus* se rencontre dans les rivières de la Croatie orientale et centrale (Slavonie et Posavina) tandis que *O. limosus* a été découverte récemment dans les marais du Parc Naturel Kopački rit (Slavonie). Quelques populations mixtes d'*A. astacus* et *A. torrentium* ont été détectées. Quelques spécimens d'*A. pallipes* et d'*A. torrentium* ont été trouvés dans les habitats souterrains. Les recherches sur la répartition des écrevisses devraient être plus intensives, et seront poursuivies dans le futur.

## INTRODUCTION

Only one family from the infraorder Astacidea, i.e., the Astacidae, occurs autochthonously on the Eurasian continent west of the Ural. Various members of this family inhabit fresh water from the Ural on the east to the Iberian Peninsula and the British Isles on the west, and northwards up to Scandinavia. The exact number of native genera and species is under discussion (Holdich, 2002; Taylor, 2002), but the most widely used arrangement is to recognize five species from two genera. In the genus *Austropotamobius* there are two species, *Austropotamobius pallipes* (Lereboullet, 1858) and *Austropotamobius torrentium* (Schrank, 1803), and in the genus *Astacus* three: *Astacus astacus* (Linnaeus, 1758), *Astacus leptodactylus* Eschscholtz, 1823, and *Astacus pachypus* Rathke, 1837. The latest suggestion is to consider *A. pallipes* and *A. leptodactylus* as complexes rather than as monotypic species (Holdich, 2002).

*Astacus astacus* (the noble crayfish) is nowadays distributed over the eastern, central, and northern parts of Europe, *A. leptodactylus* (the narrow-clawed or Turkish crayfish) can be found mainly in north-west Asia and the eastern part of Europe, even though it was introduced into other European countries, and is spreading naturally westwards through waterways. *A. pachypus* (the thick-clawed crayfish) is mainly distributed around the Caspian, Black, and Azov Seas. *A. torrentium* (the stone crayfish) is distributed in central and south-eastern Europe and *A. pallipes* (the white-clawed crayfish) can be found in southern and western Europe, including the British Isles (Cukerzis, 1988; Laurent, 1988; Taylor, 2002).

Apart from the autochthonous species, we also find in Europe today allochthonous American and Australian species of crayfish. The most frequent of these are *Pacifastacus leniusculus* (Dana, 1852) also from the family Astacidae, *Orconectes limosus* (Rafinesque, 1817), *Procambarus clarkii* (Girard, 1852), both Cambaridae, and some species of the Australian genus *Cherax* Erichson, 1846, family Parastacidae. The American species were introduced into Europe at the end of 19<sup>th</sup> century (*Orconectes limosus*) and during the 20<sup>th</sup> century for the purpose of replacing native species that were strongly reduced by the crayfish plague, caused by the fungus *Aphanomyces astaci* Schikora (cf. Ackefors, 1998; Holdich, 2003). At that time, it was known that American species are resistant to the plague, but it was not known that they are the vectors spreading the fungus. In addition, they appeared to be more fecund and aggressive than the native species, which they displace in competition for space and food. So, the initial advantage of their introduction was heavily outweighed by their uncontrollability and the disruption they caused in the natural ecosystems. If all the effects caused by the introduction of this non-native crayfish are combined with the effects of alterations in habitat, human disturbance, and overfishing, then the loss of the native species is the only consequence to be

expected (Holdich, 1999; Taugbøl & Skurdal, 1999). Populations of *A. torrentium*, *A. astacus*, and *A. pallipes* are in such decline, that they are now considered rare and vulnerable species and are listed as to be protected in Appendix III of the Bern Convention (Taylor, 2002).

In Croatia, the distribution of freshwater crayfish has never been studied in detail or with any continuity. The existing data were collected either during taxonomic research on the family Astacidae (cf. Entz, 1914; S. Karaman, 1929; M. Karaman, 1961, 1962, 1963; Albrecht, 1982), during research in certain parts of Croatia (Grube, 1861; Sket, 1988; Delić, 1993; Gottstein, 1998; Gottstein & Kerovec, 1998; Gottstein et al., 1999; Maguire et al., 2002), or in the course of investigations on Crustacea in general (Šoštarić, 1888; Car, 1901; Sekulić et al., 1989; Brusina, 1995). During our field work we recorded the presence of *A. torrentium*, *A. pallipes*, *A. astacus*, and *A. leptodactylus* (cf. Maguire, 2002). Also, we have recently recorded the presence of the American species *Orconectes limosus*. This is the first record of an alien species of crayfish in Croatia. The stone crayfish, the white-clawed, and the noble crayfish are all treated as endangered, and are protected by the Croatian law: the Law of Nature Conservation (Anonymus, 1994) and the Rule Book on Protection of Crayfish (Crustacea, Astacidae) (Anonymus, 1998).

In comparison with the majority of European countries, Croatia distinguishes itself by a great diversity of ecological systems and habitats. As it is situated on a dividing line between several biogeographical regions, it consists of parts with different geological, pedological, hydrological, and climatic conditions (Radović, 2000). According to its natural features (Radović, 2000) Croatia can be divided into four different sections: (1) Lowland Croatia, the lowland Pannonian section bordered by the Sava, the Drava, and the Danube River; (2) Highland Croatia, the high zone of karst with “islands” of impermeable rocks, karst fields, and river valleys; (3) Coastal and Insular Mediterranean Croatia, the narrow coastal zone separated from the Hinterland by high mountains; and (4) the Adriatic Sea. A belt of mountains divides the Croatian waterways into two different drainage systems, towards the Black Sea and towards the Adriatic Sea, but the situation is not always clear due to the features of the area. According to those features (Herak, 1986, 1991) Croatia can be divided into the following belts: Panonicum, Supradinaricum, Dinaricum, Epiadriaticum, and Adriaticum. Supradinaricum, Dinaricum, Epiadriaticum, and Adriaticum are all part of the Dinaric karst system, and their hydrogeology is complex. The most complicated scene is in the inland karst area (Dinaricum: mostly the edges of the karstic “poljes” in Lika and Kordun) where a large number of exogenous cave rivers, originating from fresh surface waters, enter through sinkholes into the underground and then

appear again on the surface somewhere else, frequently under a different name (Gottstein-Matočec et al., 2002).

The purpose of this paper is to describe the distribution of freshwater crayfish of the family Astacidae in Croatia and, at the same time, to discuss the distribution patterns observed in relation to some ecological and hydrogeological features.

#### MATERIAL AND METHODS

To get a better insight into the distribution of the family Astacidae in Croatia, we pooled historical data and recent observations. Historical data were compiled from literature (Grube, 1861; Šoštarić, 1888; Car, 1901; Entz, 1914; S. Karaman, 1929; Bott, 1950, 1972; M. Karaman, 1961, 1962, 1963; Albrecht, 1982; Sket, 1988; Sekulić et al., 1989; Delić, 1993; Brusina, 1995; Povž et al., 1998) and the astacological collection of the Natural History Museum in Zagreb. In table I a list of the relevant synonyms for these species is given. Fieldwork meant to evaluate the current distribution of the crayfish was done between 1995 and 2003, taking into account various freshwater habitats throughout Croatia (Gottstein & Kerovec, 1998; Gottstein et al., 1999; Maguire, 2002).

Animals were caught either by hand, or with foldable cylindrical traps with two funnel-shaped entrances and a mesh size of 14 mm, so-called LiNi traps (Westman et al., 1978), or with traps made from PVC bottles (cylindrical shape, with funnel entrances at both ends made from plastic net, mesh size 2 mm). Traps were baited with fish or pig liver and were left in the water overnight. Trapped animals were identified according to Bott (1950, 1972), Froglija (1978), and M. Karaman (1961, 1963). For each finding and each catch, UTM coordinates were determined and the data were entered into the UTM grid map of Croatia (10 × 10 km) (Nikolić et al., 1998). The mean annual temperatures of the studied regions were taken from the Climatic Atlas of SFRJ (for 1931-1960).

#### RESULTS

##### Geographical distribution patterns

During our field work we confirmed the presence of *Astacus astacus*, *Austropotamobius torrentium*, and *Austropotamobius pallipes* in Croatian fresh waters. We also recorded the presence of *Astacus leptodactylus* at five localities, and the appearance of *Orconectes limosus* at two.

The distribution of the various species, as based on historical data is shown in fig. 1, while fig. 2 presents the data collected during our field research. In Appendix 1 a list of species and water bodies with their UTM coordinates is given, for

TABLE I  
List of synonyms for Croatian freshwater crayfish

Author	Name used for species	Current name of species
Grube (1861)	<i>Astacus saxatilis</i> Koch	<i>Austropotamobius pallipes</i> (Lereboullet, 1858)
Šoštarić (1888)	<i>Astacus fluviatilis</i> Lin. <i>Astacus saxatilis</i> Koch	<i>Astacus astacus</i> (Linnaeus, 1758) <i>Austropotamobius torrentium</i> (Schrank, 1803)
Car (1901)	<i>Astacus fluviatilis</i> var. <i>nobilis</i> Huxley <i>Astacus fluviatilis</i> varietas <i>saxatilis</i> Koch	<i>Astacus astacus</i> (Linnaeus, 1758) <i>Austropotamobius torrentium</i> (Schrank, 1803)
Entz (1914)	<i>Astacus fluviatilis</i> L. <i>Astacus pallipes</i> Lereboullet <i>Astacus torrentium</i> (Schrank)	<i>Astacus astacus</i> (Linnaeus, 1758) <i>Austropotamobius pallipes</i> (Lereboullet, 1858) <i>Austropotamobius torrentium</i> (Schrank, 1803)
S. Karaman (1929)	<i>Potamobius fluviatilis fluviatilis</i> L. <i>Potamobius leptodactylus</i> Eschscholtz <i>Potamobius pallipes orientalis</i> Karaman <i>Potamobius torrentium torrentium</i> (Schrank) <i>Potamobius torrentium dalmatinus</i> Karaman	<i>Astacus astacus</i> (Linnaeus, 1758) <i>Astacus leptodactylus</i> Eschscholtz, 1823 <i>Austropotamobius pallipes</i> (Lereboullet, 1858) <i>Austropotamobius torrentium</i> (Schrank, 1803) <i>Austropotamobius torrentium</i> (Schrank, 1803)
Bott (1950)	<i>Austropotamobius</i> ( <i>Atlantoastacus</i> ) <i>pallipes italicus</i> (Faxon)	<i>Austropotamobius pallipes</i> (Lereboullet, 1858)
Karaman (1961)	<i>Austropotamobius torrentium</i> Schr. <i>Natio danubica</i> Karaman <i>Austropotamobius italicus</i> ssp. <i>carsicus</i> Karaman <i>Austropotamobius italicus italicus</i> Faxon <i>Astacus astacus</i> Linne	<i>Austropotamobius torrentium</i> (Schrank, 1803) <i>Austropotamobius pallipes</i> (Lereboullet, 1858) <i>Austropotamobius pallipes</i> (Lereboullet, 1858) <i>Astacus astacus</i> (Linnaeus, 1758)
Albrecht (1982)	<i>Astacus pallipes</i> Lereboullet <i>Astacus astacus</i> (Linnaeus) <i>Astacus torrentium</i> (Schrank)	<i>Austropotamobius pallipes</i> (Lereboullet, 1858) <i>Astacus astacus</i> (Linnaeus, 1758) <i>Austropotamobius torrentium</i> (Schrank, 1803)
Brusina (1995)	<i>Astacus torrentium</i> Schrank	<i>Austropotamobius pallipes</i> (Lereboullet, 1858)

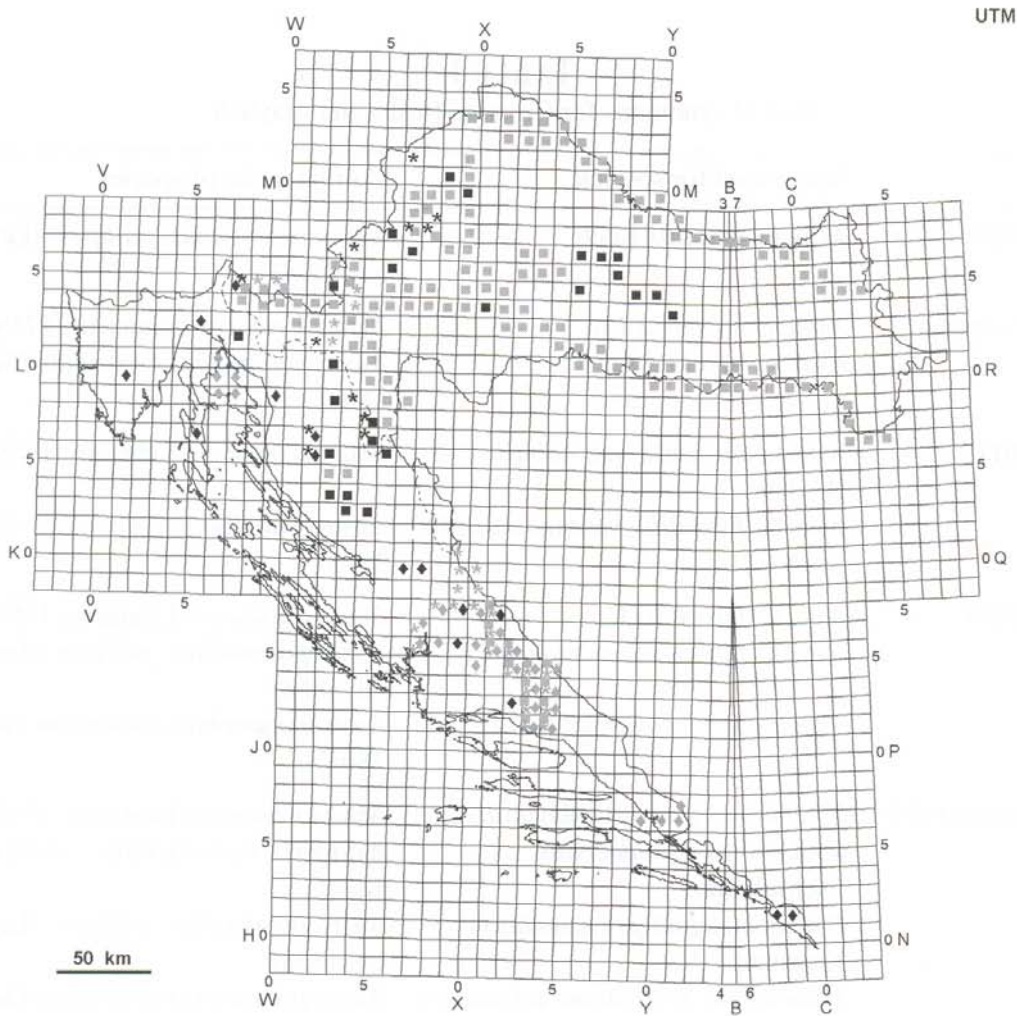


Fig. 1. Geographical distribution of various species of freshwater crayfish in Croatia, shown at the  $10 \times 10$  km UTM grid. Data collected from historical sources (black squares, *A. astacus* (Linnaeus, 1758); black asterisk, *A. torrentium* (Schrank, 1803); black diamond, *A. pallipes* (Lereboullet, 1858); grey coloured symbols are used to indicate that the crayfish site was not described precisely). Black dotted line represents the watershed (i.e., the border between the Adriatic and Black Sea drainage basins).

material in the Natural History Museum, Zagreb, and for data collected from the literature, and in Appendix 2 we present a similar list for the data we collected.

The original distribution of *Astacus astacus* in Croatia falls within the Black Sea drainage basin. It is commonly found in the Drava-Danube and Sava River basins (i.e., the palaeo-structural belts of Supradinaricum, Panonicum, and Dinaricum: table II). As seen from fig. 2, *A. astacus* also occurs in the Adriatic Sea basin (i.e., Adriaticum), but its presence there is of anthropogenic origin. The exact time of introduction for the population in Istra (WL 21) is unknown, but for the population in Velika Paklenica (WK 30) we got information from local inhabitants, that it has been introduced in the first half of the 20<sup>th</sup> century.

We recorded the presence of *Astacus leptodactylus* on the far east of Croatia in the Vuka River (CR 42) and Kopački rit (CR 35); and in the middle part of Croatia

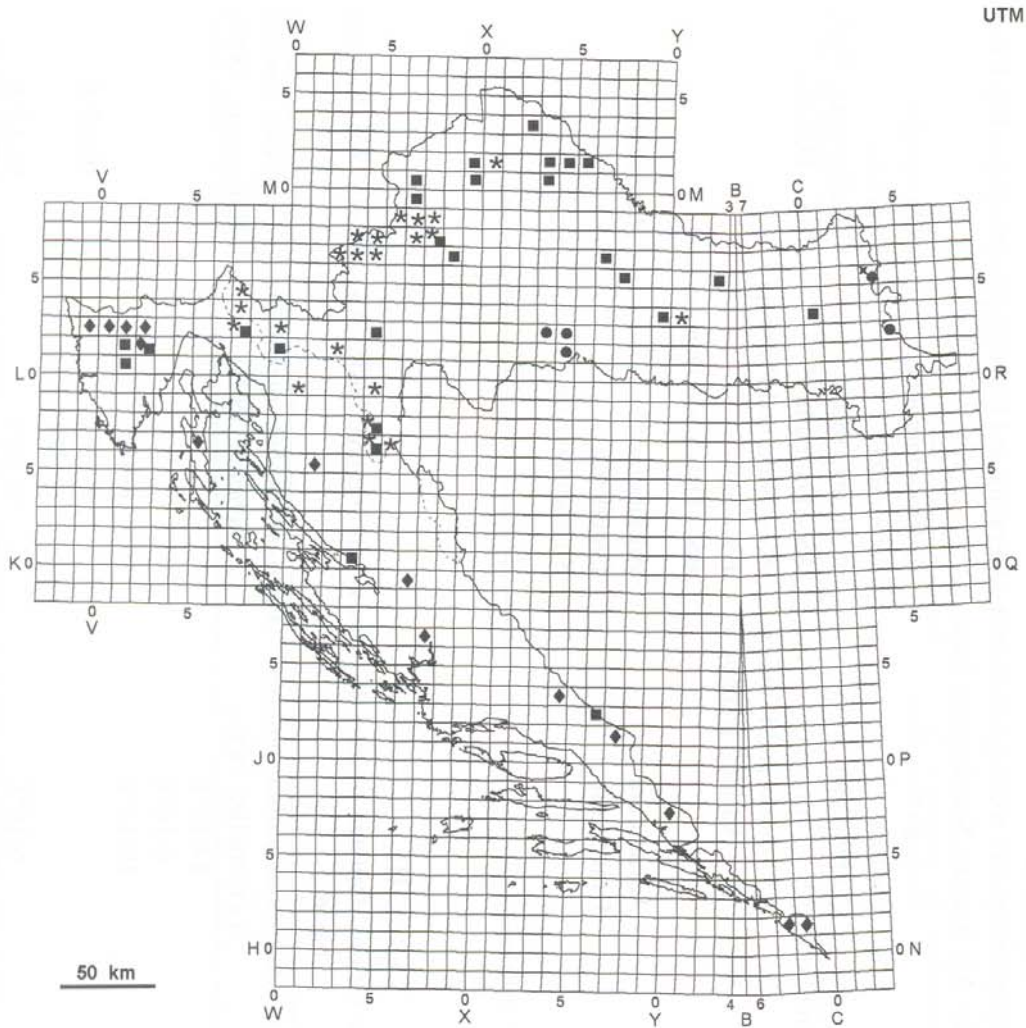


Fig. 2. Geographical distribution of different species of freshwater crayfish in Croatia shown at the  $10 \times 10$  km UTM grid. Data collected during our field work (black square, *A. astacus* (Linnaeus, 1758); black dot, *A. leptodactylus* Eschscholtz, 1823; black asterisk, *A. torrentium* (Schrank, 1803); black diamond, *A. pallipes* (Lereboullet, 1858); X, *Orconectes limosus* (Rafinesque, 1817)). Black dotted line represents the watershed (i.e., the border between the Adriatic and Black Sea drainage basins).

in the Sava River and its tributaries (XL 32; XL 41; XL 42) (i.e., Supradinaricum and Panonicum: table II) (fig. 2). Taking into consideration the literature data (fig. 1) and recent findings of *A. leptodactylus* in the central part of Croatia, it seems that this species is spreading from the east to the west.

The distribution of *Austropotamobius pallipes* is restricted to the limestone region, which belongs to the belts denoted as Adriaticum and Dinaricum (table II). It is found widely spread in rivers belonging to the Adriatic Sea basin (from the NW to the SE part of Croatia). According to our investigation, the white-clawed crayfish has a restricted pattern of distribution in the Dinaricum. Just four out of 20 localities in the Adriatic Sea basin, inhabited by *A. pallipes*, belong to the Dinaricum (BN 81; WK 50; XJ 43; YH 06).

TABLE II

Distribution patterns of species from the family Astacidae in two drainage basins in Croatia (data from the literature and from the present study). BS, Black Sea drainage basin; AS, Adriatic Sea drainage basin

Species	<i>Astacus astacus</i> (Linnaeus, 1758)	<i>Astacus leptodactylus</i> Eschscholtz, 1823	<i>Austropotamobius pallipes</i> (Lereboullet, 1858)	<i>Austropotamobius torrentium</i> (Schrank, 1803)	<i>Orconectes limosus</i> (Rafinesque, 1817)
Drainage basins	AS – Dalmatia* AS – Istria and Primorje* BS – Sava BS – Drava and Danube	BS – Drava and Danube BS – Sava River	AS – Dalmatia AS – Istria and Primorje AS – Adriatic Islands	AS – Dalmatia** AS – Istria and Primorje BS – Sava BS – Drava and Danube	BS – Danube
Palaeo-dynamic and palaeo-structural belts	Adriaticum* Dinaricum Panonicum Supradinaricum	Panonicum Supradinaricum	Adriaticum Dinaricum	Adriaticum** Dinaricum Supradinaricum	Panonicum

\* , Introduced species; \*\*, exclusively based on literature data.

TABLE III

Mean annual temperature ranges for different species of crayfish in various drainage basins. BS, Black Sea drainage basin; AS, Adriatic Sea drainage basin

Drainage basin	<i>Astacus astacus</i> (Linnaeus, 1758)	<i>Astacus leptodactylus</i> Eschscholtz, 1823	<i>Austropotamobius pallipes</i> (Lereboullet, 1858)	<i>Austropotamobius torrentium</i> (Schrank, 1803)	<i>Orconectes limosus</i> (Rafinesque, 1817)
AS – Adriatic Islands			14-15°C		
AS – Dalmatia	8-12°C		6-16°C		
AS – Istria and Primorje	6-12°C		10-14°C	6-8°C	
BS – Drava and Danube	10-12°C	10-12°C		8-10°C	10-12°C
BS – Sava	6-12°C	10-12°C		6-10°C	
Total temperature range	6-12°C	10-12°C	6-16°C	6-10°C	10-12°C



We found no evidence of *Austropotamobius torrentium* in the Adriatic Sea basin. All our findings indicate a distribution in rivers belonging to the Sava and the Drava River basins only (i.e., Supradinaricum and Dinaricum: table II). The only exception is the stream Križ (VL 72) that originally belonged to the Black Sea drainage, but was recently connected with the Adriatic Sea drainage after an artificial lake (Lokva Lake) was constructed (table II).

#### Habitat preferences and requirements

We found *Astacus astacus* in lowland rivers with clay bottoms in the continental part of Croatia. This species has been introduced into many gravel pits (frequently situated near or in towns, so consequently eutrophic) where it is abundant among aquatic vegetation (reeds, alder, and willow roots) near lake shores. Populations in rivers belonging to the Adriatic drainage are also of anthropogenic origin, and there the noble crayfish can be found in parts where the current is slower and where the substrate of the bottom consists of sand and pebbles.

*Astacus leptodactylus* was found only in eutrophic lowland rivers with soft clay-muddy bottoms and in marshes (Kopački rit).

*Austropotamobius torrentium* was found in springs and fast streams with stony bottoms at higher altitudes, usually situated in forests.

The distribution of *Austropotamobius pallipes* is restricted to waterbodies belonging to the Adriatic drainage. These waters are mainly unpolluted and the substrate of their bottoms consists of rocks and stones. Crayfish were found along the banks where the water current is slower and where aquatic vegetation is developed (willow, poplar, *Chara*).

During our research, we also found some mixed populations of *Astacus astacus* and *Austropotamobius torrentium* (site in VL 72) as well as crayfish in subterranean habitats (spring-caves, cave sources, and sinkholes), e.g., *Austropotamobius pallipes* in the tunnel Orlovac-Cetina (XJ 43) and the spring Bakovac (WK 50), *A. torrentium* in Sušik (WK 09) and sinkhole Kremen (WL 49). Crayfish that were occasionally found in vertical and horizontal caves, showed no troglomorphic adaptations, so it may be concluded they colonize the underground habitats from originally epigeal populations through sinking rivers, possibly during torrents or floods.

A comparison of the various species of Astacidae, based on annual mean temperature ranges, indicates that water temperature is a factor that could be crucial in determining their distribution (table III). The habitat with the widest temperature ranges and the highest seasonal oscillations is that in coastal rivers, and these were found to be inhabited by *A. pallipes*. The smallest range was observed at higher altitudes in cold, fast-flowing headwater sections of rivers, and these appear to be

the typical habitat of *A. torrentium*. Average yearly temperature ranges of *A. astacus* and *A. leptodactylus* overlap to some extent, but it seems that *A. astacus* can tolerate lower temperatures. If we take this into consideration, along with the fact that *A. astacus* is an economically valued species, we could explain its wide distribution.

#### DISCUSSION

Historical distribution data taken from literature were compiled and compared with recent data collected during our own research. We wanted to update our knowledge about the distribution of freshwater crayfish and verify if distribution patterns are determined by hydrogeological factors and some ecological factors, like water temperature. We also considered the geotectonic structural belts to gain a better understanding of the distribution patterns of the Astacidae in Croatia.

In the data from the literature, we frequently found contradictory cases with regard to geographical names, and also problems connected with terminology, the latter mainly as a result of the many synonyms that exist in the zoological nomenclature. For example, *Astacus astacus* has 12 synonyms (Cukerzis, 1988), *Austropotamobius pallipes* has 19, and *A. torrentium* has 10 (Laurent, 1988). The use of the same name for two different species was another complication. One example is *Astacus saxatilis*, which name was used for both *Austropotamobius torrentium* and *A. pallipes* (cf. Bott, 1950). So, when we came across *Astacus saxatilis*, described from Vransko Lake on the island of Cres (Grube, 1861), we were not sure whether this term actually referred to *A. pallipes* or to *A. torrentium*. However, later we found M. Karaman's (1961, 1962) and Sket's (1988) papers, in which they described *A. pallipes* from Vransko Lake. Our investigations also confirmed this (Gottstein & Kerovec, 1998).

Car (1901) described *Astacus fluviatilis* var. *saxatilis* for Gornja Švica (WK 17), Jasenica, and Kosinj (WK 25), while M. Karaman (1961, 1962) described *A. pallipes* from Kosinj and Gornja Švica, and *A. torrentium* for Jasenica, the same as Entz (1914). All the localities described here are names of villages situated in the region of Lika and are not names of watercourses. As seen above, we did not mention the UTM coordinate for Jasenica, and the reason for this is simply that we did not find the name Jasenica on any recent geographical map. So, we must suppose that either the name has changed and it was in reality different on old maps, or that the original author (Car, 1901) made an orthographic mistake that was taken over in later scientific papers (Entz, 1914; M. Karaman, 1961, 1962). According to our knowledge, the closest term to Jasenica is Jesenica, and that is found in the name Lička Jesenica, in Lika (WK 38). Fresh waters from this area belong to the Black

Sea drainage and we found *A. torrentium* living close by in Sušik (WK 09) and in Tounjčica (WL 21).

Car (1901), Entz (1914), and M. Karaman (1961, 1962) described *A. astacus* for the Plitvice Lakes (WK 46, WK 47), while Šoštarić (1888) described *A. torrentium* from there. During our research, we found both species present in the Plitvice Lakes and through communicating with local inhabitants we were informed that *A. astacus* is being introduced to the lakes from nearby fresh waters.

In the Krka River (on the Dalmatian coast) we found *A. pallipes*, like Entz (1914) and S. Karaman (1929), who described *A. pallipes* with a new subspecies, *Potamobius pallipes orientalis*. Albrecht (1982) described *A. pallipes* as *Astacus pallipes* from the Cikola River (= Čikola) a tributary of the Krka. He also described *A. pallipes* from Drnis (= Drniš), but according to our knowledge Drniš is a town on the Čikola River and not the name of a watercourse. In the Cetina River (inland region of the Dalmatian coast) we collected *A. pallipes* as did S. Karaman (1929), who actually referred to it as *Potamobius pallipes orientalis*. M. Karaman (1961, 1962) reported *A. pallipes* as *Austropotamobius italicus italicus* from the Cetina River on the basis of examination of specimens from museum collections. Apart from *A. pallipes*, S. Karaman (1929) reported *A. torrentium* (as *Potamobius torrentium dalmatinus*) from the Cetina and Krka Rivers. Albrecht (1982) described *A. torrentium* (as *Astacus torrentium*) from the Cetina and Butisnika Rivers (= Butižnica, a tributary of the Krka). He also found *A. astacus* in the Cetina. According to the information we gathered from local inhabitants, *A. astacus* is being introduced to the Cetina River from the population in Buško Lake (Bosnia and Herzegovina) to be used for consumption, so Albrecht's (1982) find confirms this introduction.

While examining the literature data on the distribution of crayfish in Dalmatia, we found Brusina's work (1995) that discusses the advantages of the name *Astacus torrentium* for the species *Astacus saxatilis*. According to him, *Astacus torrentium* inhabits watercourses belonging to the Adriatic drainage and he described it from the rivers Zrmanja (near Bilišane), Krupa, Krka, Cetina (near Sinj), and Ljuta (in Konavli) (fig. 1, Appendix 1). We recorded *Austropotamobius pallipes* from the rivers Zrmanja, Krka, Cetina, and Ljuta so we are of the opinion that Brusina used the term *Astacus torrentium* for *Austropotamobius pallipes*.

Another record of *Austropotamobius pallipes* is for the island of Krk, from which M. Karaman (1961, 1962) reported *Austropotamobius italicus italicus*. Sket (1988) and Gottstein & Kerovec (1998) did not find the white-clawed crayfish on that island, but from the local inhabitants they heard that the population in Vela Rika (southern part of Krk) was abundant in the 1950s.

From all the above examples it becomes clear that our knowledge of the distribution in coastal regions is extremely complicated and confused, so further

field research is needed to verify records from the coastal watercourses that are suggested in the literature and that have not been confirmed recently. In identifying species, next to using morphological characteristics, one should also use molecular methods (Fetzner & Crandall, 2002; Holdich, 2002), because the latest genetic studies (Grandjean et al., 2002) indicate that the genus *Austropotamobius* consists of 3 species; *torrentium*, *pallipes*, and *italicus*. *Austropotamobius italicus* includes 3 subspecies; *carinthiacus*, *italicus*, and *carsicus*. The latter was described from Slovenia (Grandjean et al., 2002) so it is quite probable that Croatian populations belong to that same subspecies.

*Austropotamobius torrentium* is, according to our research, distributed throughout the continental part of Croatia in streams that belong to the Black Sea drainage (Sava catchment and Drava catchment). Previously, this species probably had a larger distribution, but due to human impact on its natural habitats its range has been reduced. In Croatia, there are still quite a few places unaffected by anthropogenic activity and, consequently, the stone crayfish can be found throughout the whole flow of a watercourse (Maguire et al., 2002), but there are also lots of waterbodies where the crayfish inhabit mainly headwater sections on higher altitudes, because the lower stretches are canalized. A similar situation is common in the majority of European countries (Bohl, 1987a, 1997; Kappus et al., 1999) where crayfish populations are also isolated in headwater parts of the streams so that a natural dispersion of the animals is impaired.

We found two sites, the stream Križ and the Plitvice Lakes, that are interesting in terms of sympatry. In these waters, *A. astacus* and *A. torrentium* coexist, but their micro-habitat seems to differ. *A. astacus* lives in places where the watercourse is slower and where the substrate of the bottom is more earthy, while *A. torrentium* can be found in faster currents and on stony bottoms. We did not study the mechanism of segregation of the two species, but according to Bohl (1987b), wherever the stone crayfish and the noble crayfish occur in the same stream or river as separate populations, competition between these species seems not to be a limiting factor. Even though, in another article Bohl (1987a) suggests that in the waters he examined during his research, competition plays a more important role in separating noble and stone crayfish than niche separation, due to different requirements.

*Astacus astacus* is a widely distributed species, but we suppose that its original, natural distribution has changed considerably through history due to its economic value. As a much eaten species, it has been and it is, frequently transferred from one body of water to another for aquaculture and stocking purposes. There are no official data concerning transfers, but one gets that information in personal communication with local inhabitants (though that is not always reliable). Thus it is difficult to reconstruct the original pattern of the distribution of this species.

Taking into consideration hydrological and ecological features (tables II and III), we think that *Astacus astacus* has never naturally inhabited the rivers belonging to the Adriatic drainage, but belonged to the water bodies from the Black Sea drainage. Our supposition is supported by Brusina (1995), who wrote that in 1882 there was no record of *A. astacus* in rivers belonging to the Adriatic drainage.

S. Karaman (1929) mentioned *A. leptodactylus* from Kupinovo and Moravice (Serbia-Montenegro State Union). M. Karaman (1961) reported *A. leptodactylus* (as *A. leptodactylus salinus*) from the Danube, the Tisa River (Serbia-Montenegro State Union), and the Krivaja River, a tributary of the Bosna River (Bosnia and Herzegovina). If the spreading of *A. leptodactylus* to Bosnia was natural, it would be logical to conclude that that crayfish arrived in Bosnia through the Sava River (Croatia), but nobody ever reported them from there, even though Entz (1914) mentioned that they could probably live in the Sava River. Brusina (1995) wrote that in 1891 there was no evidence of *A. leptodactylus* in Croatia. Recently, Maguire (2002) officially recorded this species on three localities from the Sava River (XL 32; XL 41; XL 42). Apart from those findings, we have records of *A. leptodactylus* from eastern Croatia: CR 42 (Vuka River) and CR 35 (Kopački rit). Specimens from locality CR 42 date from the beginning of the 20<sup>th</sup> century and we found it in the collection of the Department of Zoology, University of Zagreb. As literature data (S. Karaman, 1929) suggest that the noble crayfish was living in the Sava River, but during our research we found no evidence of *A. astacus* there, just *A. leptodactylus*, we must suppose that *A. leptodactylus* is spreading from the east to the west of Croatia and possibly displacing *A. astacus*. It would be interesting to find a meeting point between the two species, therefore a comprehensive study on the distribution of the narrow-clawed crayfish and the noble crayfish in that part of Croatia is necessary.

According to Hobbs (2000), both active and passive dispersion of crustaceans, supported by hydrogeological structure and climatic conditions, play an important role in the distribution of astacideans. The frequency of epigeal freshwater crayfish in subterranean habitats is in positive correlation with high water velocity during the rainy seasons (Hobbs, 2000). This phenomenon applies particularly to the karstic region of Croatia. In this region, large amounts of fresh surface water enter the underground habitats through sinking rivers, and thus bring epigeal fauna underground. In some sinkholes and their exogenous cave rivers, epigeal astacideans have been collected repeatedly from the beginning of the last century onwards (Car, 1901; Gottstein-Matočec et al., 2002). As subterranean ecosystems constitute a food-limited environment, groups of individuals of epigeal crayfish can only occur in low numbers and have a low stability.

American crayfish (*Pacifastacus leniusculus*, *Orconectes limosus*) inhabit fresh waters in Austria (Füreder & Machino, 1999; Pöckel, 1999; Holdich, 2002) and

*O. limosus* has been recorded recently in Hungary (Holdich, 2002). As these species can easily adapt to new habitats, they can quickly occupy new spaces, so we have expected some of them spreading into Croatian waters. Our expectations have been confirmed, as we have recently recorded the presence of *Orconectes limosus* in the marshes of the Park of Nature "Kopački rit", in the far east of Croatia. Apart from being well adapted, American species are also vectors of the crayfish plague and they are more aggressive than European species, so in competition for space and food they tend to push native species out of their natural habitats (Holdich, 1999). All of this is a potential threat to the native Croatian species, and so constant monitoring of border waters is needed if we want to survey the spread of alien species.

As a conclusion, we can say that Croatian crayfish populations are not sufficiently studied and are probably suffering a reduction in range and abundance, mainly due to environmental degradation caused by anthropogenic activity. For any conservation plans to succeed, continuous monitoring of the situation in the field needs to be done, so that correct information can be gathered. A national database of crayfish records ought to be constructed and be updated regularly.

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## APPENDIX 1

## Collection of the Natural History Museum, Zagreb

Data are sorted alphabetically by UTM coordinates; w, name of waterbody; p, name of place (city, village)

Site	Species	UTM 10 × 10 km
Ljuta (w)	<i>A. pallipes</i>	BN 71, 81
? Martijanci (Martijanka) (w)	<i>A. pallipes</i>	VK 19
Senj (p)	<i>A. pallipes</i>	VK 98
Fužine (p)	<i>A. astacus</i>	VL 71
Gerovo (Gorski kotar) (p)	<i>A. torrentium</i>	VL 74
Sinkhole near Kosinj (p)	<i>A. pallipes</i>	WK 15
Gornja Švica (p)	<i>A. pallipes</i>	WK 16
Gospić (p)	<i>A. astacus</i>	WK 23
Lika (w) near Mlakva (p)	<i>A. astacus</i>	WK 25
Stajnica (p)	<i>A. astacus</i>	WK 28
Ribnik (p) (Lika)	<i>A. astacus</i>	WK 32
Plitvice Lakes (w)	<i>A. astacus</i>	WK 46, 47
Plitvica (w)	<i>A. astacus</i>	WK 47
Korenica (p)	<i>A. astacus</i>	WK 55
Dobra (w)	<i>A. torrentium</i>	WL 11, 21, 22, 33, 34
Muljevac (w) near Ribnik (p)	<i>A. astacus</i>	WL 24
Sošice (p)	<i>A. torrentium</i>	WL 36
Zdenčina (p)	<i>A. astacus</i>	WL 55
Samobor (p)	<i>A. astacus</i>	WL 57
Rakov Potok (p)	<i>A. astacus</i>	WL 66
Podsused (p)	<i>A. torrentium</i>	WL 67
Medveščak (w)	<i>A. torrentium</i>	WL 77
Gračani (p)	<i>A. torrentium</i>	WL 78
Sljeme (peak on Medvednica mt.)	<i>A. torrentium</i>	WL 78
In Kotar forest (Petrinja) (p)	<i>A. astacus</i>	XL 03
Source on Moslavačka Mountain	<i>A. astacus</i>	XL 25, 26, 35, 36, 45
Garešnica (p)	<i>A. astacus</i>	XL 54
Veličanka (w)	<i>A. astacus</i>	YL 03

## Literature data

w, name of waterbody; p, name of place (city, village)

Author	Site	Species	UTM 10 × 10 km
Grube (1861)	Vransko Lake (Cres) (w)	<i>A. pallipes</i>	VK 56
Šoštarić (1888)	Plitvice Lakes (w)	<i>A. torrentium</i>	WK 46, 47
	Korana (w)	<i>A. astacus</i>	WK 47, 49, 57, 58, 59, 68; WL 31, 32, 40, 41, 42, 43

Author	Site	Species	UTM 10 × 10 km
	Struga (w)	<i>A. astacus</i>	WL 55
	Krapina (w)	<i>A. astacus</i>	WL 67, 68, 69, 79, 89; WM 90, 91
	Medveščak (w)	<i>A. torrentium</i>	WL 77
	Zelina (w)	<i>A. astacus</i>	WL 97, 98, 99
	Moravščak (w)	<i>A. astacus</i>	WL 99
Car (1901)	Kosinj (p)	<i>A. torrentium</i>	WK 15
	Gornja Švica (p)	<i>A. torrentium</i>	WK 16
	Ribnik (p) (Lika)	<i>A. astacus</i>	WK 32
	? Jasenica (Lička Jesenica) (p)	<i>A. torrentium</i>	WK 38
	Plitvice Lakes (w)	<i>A. astacus</i>	WK 46, 47
	Zlatar (p)	<i>A. astacus</i>	WM 80
Entz (1914)	Ljuta (w)	<i>A. pallipes</i>	BN 71, 81
	? Martijanci (Martijanka) (w)	<i>A. pallipes</i>	VK 19
	Vransko Lake (Cres) (w)	<i>A. pallipes</i>	VK 56
	Fiuma (Riječina) (w)	<i>A. pallipes</i>	VL 52
	Fužine (p)	<i>A. astacus</i>	VL 71
	Gerovo (Gorski kotar) (p)	<i>A. pallipes</i>	VL 74
	Knin (p)	<i>A. pallipes</i>	WJ 97
	Kosinj (p)	<i>A. pallipes</i>	WK 15
	Gornja Švica (p)	<i>A. pallipes</i>	WK 16
	Perušić (p)	<i>A. astacus</i>	WK 24, 34
	Lika (w) near Mlakva (p)	<i>A. astacus</i>	WK 25
	Stajnica (p)	<i>A. astacus</i>	WK 28
	Ribnik (p) (Lika)	<i>A. astacus</i>	WK 32
	Lika (w) near Medak (p)	<i>A. astacus</i>	WK 32, 42
	Lika (w) near Gospić (p)	<i>A. astacus</i>	WK 33
	? Jasenica (Lička Jesenica) (p)	<i>A. torrentium</i>	WK 38
	Plitvice Lakes (w)	<i>A. astacus</i>	WK 46, 47
	Korenica (p)	<i>A. astacus</i>	WK 55
	Dobra (w) Ogulin (p)	<i>A. torrentium</i>	WL 11
	Oštarije (p)	<i>A. astacus</i>	WL 20
	Rakov potok (p)	<i>A. astacus</i>	WL 66
	Medveščak (p)	<i>A. torrentium</i>	WL 77
	In Kotar forest (Petrinja) (p)	<i>A. astacus</i>	XL 03
	Garešnica (w)	<i>A. astacus</i>	XL 54
	Veličanka (w)	<i>A. astacus</i>	YL 03
Karaman, S. (1929)	Krka (w)	<i>A. pallipes</i>	WJ 75, 76, 87, 97; XJ 07
	Krka (w)	<i>A. torrentium</i>	WJ 75, 76, 87, 97; XJ 07
	Sava (w)	<i>A. astacus</i>	WL 57, 67, 77, 86, 87, 95, 96; XL 03, 04, 05, 12, 13, 14, 22, 23, 32, 41, 42, 50, 51, 60, 61, 70, 80, 90; XK 99; YK 09, 19, 29, 39; YL 00, 10, 30; BR 60, 70, 80; BQ 69, 79, 89, 99; CQ 09, 19, 26, 27, 28, 36, 46
	Cetina (w)	<i>A. pallipes</i>	XJ 15, 16, 17, 24, 25, 31, 32, 33, 34, 41, 42, 43, 44

Author	Site	Species	UTM 10 × 10 km
	Cetina (w)	<i>A. torrentium</i>	XJ 15, 16, 17, 24, 25, 31, 32, 33, 34, 41, 42, 43, 44
Bott (1950)	Jadro (w)	<i>A. pallipes</i>	XJ 22
Bott (1972)	Vrnsko Lake (Cres) (w)	<i>A. pallipes</i>	VK 56
	Vrlika	<i>A. pallipes</i>	XJ 16
	Neretva (w)	<i>A. pallipes</i>	XH 96; YH 06, 16, 17
Karaman, M. (1961)	? tributary of Kupa (w)	<i>A. astacus</i>	?
	Ljuta (w)	<i>A. pallipes</i>	BN 71, 81
	Vransko Lake (Cres) (w)	<i>A. pallipes</i>	VK 56
	Krk (p)	<i>A. pallipes</i>	VK 68, 69, 78, 79; VL 60
	Gerovo (Gorski kotar) (p)	<i>A. torrentium</i>	VL 74
	Sinkhole near Kosinj (p)	<i>A. pallipes</i>	WK 15
	Gornja Švica (p)	<i>A. pallipes</i>	WK 16
	? Jasenica (Lička Jesenica) (p)	<i>A. torrentium</i>	WK 38
	Plitvice Lakes (w)	<i>A. astacus</i>	WK 46, 47
	Dobra (w)	<i>A. torrentium</i>	WL 11, 21, 22, 33, 34
	Sošice (p)	<i>A. torrentium</i>	WL 36
	Podsused (p)	<i>A. torrentium</i>	WL 67
	Medveščak (w)	<i>A. torrentium</i>	WL 77
	Gračani (p)	<i>A. torrentium</i>	WL 78
	? Strahnjevac (Strahinje) (p)	<i>A. torrentium</i>	WM 61
	Neretva (w)	<i>A. pallipes</i>	XH 96; YH 06, 16, 17
	Cetina (w)	<i>A. pallipes</i>	XJ 15, 16, 17, 24, 25, 31, 32, 33, 34, 41, 42, 43, 44
Karaman, M. (1962)	Ljuta (w)	<i>A. pallipes</i>	BN 71, 81
	Vransko Lake (Cres) (w)	<i>A. pallipes</i>	VK 56
	Krk (p)	<i>A. pallipes</i>	VK 68, 69, 78, 79; VL 60
	Kupa (w)	<i>A. astacus</i>	VL 73, 74, 83, 84, 93, 94; WL 02, 03, 12, 13, 23, 24, 25, 34, 35, 43, 53, 54, 63, 64, 73, 74, 83, 93, 94; XL 03
	Gerovo (Gorski kotar) (p)	<i>A. torrentium</i>	VL 74
	Sinkhole near Kosinj (p)	<i>A. pallipes</i>	WK 15
	Gornja Švica (p)	<i>A. pallipes</i>	WK 16
	? Jasenica (Lička Jesenica) (p)	<i>A. torrentium</i>	WK 38
	Plitvice Lakes (w)	<i>A. astacus</i>	WK 46, 47
	Dobra (w)	<i>A. torrentium</i>	WL 11, 21, 22, 33, 34
	Sošice (p)	<i>A. torrentium</i>	WL 36
	Podsused (p)	<i>A. torrentium</i>	WL 67
	Gračani (p)	<i>A. torrentium</i>	WL 78
	Neretva (p)	<i>A. pallipes</i>	XH 96; YH 06, 16, 17
	Cetina (w)	<i>A. pallipes</i>	XJ 15, 16, 17, 24, 25, 31, 32, 33, 34, 41, 42, 43, 44
Karaman, M. (1963)	? Danube's tributaries in Croatia	<i>A. astacus</i>	

Author	Site	Species	UTM 10 × 10 km
	Sava (w)	<i>A. astacus</i>	WL 57, 67, 77, 86, 87, 95, 96; XL 03, 04, 05, 12, 13, 14, 22, 23, 32, 41, 42, 50, 51, 61, 60, 70, 80, 90; XK 99; YK 09, 19, 29, 39; YL 00, 10, 30; BR 60, 70, 80; BQ 69, 79, 89, 99; CQ 09, 19, 26, 27, 28, 36, 46
	Drava (w)	<i>A. astacus</i>	WM 93; XM 03, 12, 13, 22, 23, 32, 33, 42, 43, 51, 52, 60, 61, 70; XL 79, 88, 89, 98, 99; YL 07, 08, 17, 27, 37; BR 67, 77, 86, 87, 96; CR 05, 06, 14, 15, 24, 34
Albrecht (1982)	Vransko Lake (Cres) (w)	<i>A. pallipes</i>	VK 56
	Čikola (w)	<i>A. pallipes</i>	WJ 85, 95; XJ 04, 05
	Drniš (p)	<i>A. pallipes</i>	WJ 95
	Butižnica (w)	<i>A. torrentium</i>	WJ 99, 98, 97; WK 90; XJ 09, 08
	Cetina (w)	<i>A. astacus</i>	XJ 15, 16, 17, 24, 25, 31, 32, 33, 34, 41, 42, 43, 44
	Cetina (w)	<i>A. torrentium</i>	XJ 15, 16, 17, 24, 25, 31, 32, 33, 34, 41, 42, 43, 44
Sekulić et al. (1989)	Markuševac (w)	<i>A. torrentium</i>	WL 78
	Bliznec (w)	<i>A. torrentium</i>	WL 78
Delić (1993)	Česma (w) Pavlovac (p)	<i>A. astacus</i>	XL 56
	Barna (w)	<i>A. astacus</i>	XL 66
	Grbavac (w)	<i>A. astacus</i>	XL 66
	Grđevica (w)	<i>A. astacus</i>	XL 66
	Rajčevica (w)	<i>A. astacus</i>	XL 75
	Peratovica (w)	<i>A. astacus</i>	XL 76
	Rastovica (w)	<i>A. astacus</i>	XL 76
	Ilova (w)	<i>A. astacus</i>	XL 84, 94
Brusina (1995)	Ljuta (w)	<i>A. pallipes</i>	BN 71, 81
	Zrmanja (w) (Bilišane - p)	<i>A. pallipes</i>	WJ 69
	Krka (w)	<i>A. pallipes</i>	WJ 75, 76, 87, 97; XJ 07
	Krupa (w)	<i>A. pallipes</i>	WJ 79
	Cetina (w)	<i>A. pallipes</i>	XJ 15, 16, 17, 24, 25, 31, 32, 33, 34, 41, 42, 43, 44
	Cetina (w) (Sinj - p)	<i>A. pallipes</i>	XJ 33, 34
Povž et al. (1998)	Čabranka (w)	<i>A. torrentium</i>	VL 74
	Kupa (w)	<i>A. torrentium</i>	VL 74, 83, 94

## APPENDIX 2

## Results of present study

Data are sorted alphabetically by UTM coordinates; BS, Black Sea drainage basin (S, Sava; DD, Drava and Danube); AS, Adriatic Sea drainage basin (AI, Adriatic Islands; D, Dalmatia; IP, Istria and Primorje)

Waterbody-site	Species	UTM 10 × 10 km	Drainage basin	M.A.T.R.
Ljuta (Konavle)	<i>A. pallipes</i>	BN 71, 81	AS (D)	12-14
Stream in Vladislavci (near Osijek)	<i>A. astacus</i>	CR 03	BS (DD)	10-12
Kopački rit (PP Kopački rit, Osijek)	<i>A. leptodactylus</i>	CR 35	BS (DD)	10-12
Kopački rit (PP Kopački rit, Osijek)	<i>O. limosus</i>	CR 35	BS (DD)	10-12
Vuka (Vukovar)	<i>A. leptodactylus</i>	CR 42	BS (DD)	10-12
Vransko Lake (Cres)	<i>A. pallipes</i>	VK 56	AS (AI)	14-15
Mirna (Motovun)	<i>A. pallipes</i>	VL 02	AS (IP)	12-14
Source Gradole (Brdo, Buje)	<i>A. pallipes</i>	UL 92	AS (IP)	10-12
Račice (Račice, Buzet)	<i>A. pallipes</i>	VL 22	AS (IP)	10-12
Butoniga (Motovun)	<i>A. pallipes</i>	VL 12	AS (IP)	12-14
Mirna (Buzet)	<i>A. pallipes</i>	VL 12	AS (IP)	12-14
Borutski stream (Dausi, Pazin)	<i>A. astacus</i>	VL 21	AS (IP)	10-12
Borutski stream (Dausi, Pazin)	<i>A. pallipes</i>	VL 21	AS (IP)	10-12
Pazinčica (Grande, Pazin)	<i>A. astacus</i>	VL 10, 11	AS (IP)	10-12
*Stream Križ (Homer, Delnice)	<i>A. astacus</i>	VL 72	AS (IP)*	6-8
*Lokve lake (Lokve, Delnice)	<i>A. astacus</i>	VL 72	AS (IP)*	6-8
Unnamed stream (entrance of NP Risnjak)	<i>A. torrentium</i>	VL 72	BS (S)	6-8
*Stream Križ (Homer, Delnice)	<i>A. torrentium</i>	VL 72	AS (IP)*	6-8
Unnamed stream (Crni Lug, Delnice)	<i>A. torrentium</i>	VL 72, 73	BS (S)	6-8
Gerovica (Gerovo, Čabar)	<i>A. torrentium</i>	VL 73, 74	BS (S)	6-8
Jasenačka stream (Vrelo, Ogulin)	<i>A. astacus</i>	VL 91	BS (S)	6-8
Unnamed stream (Zalesina, Kupjak)	<i>A. torrentium</i>	VL 92	BS (S)	6-8
Zrmanja (Ogari, Obrovac)	<i>A. pallipes</i>	WJ 69	AS (D)	12-14
Roški Falls (NP Krka, Šibenik)	<i>A. pallipes</i>	WJ 76	AS (D)	14-15
Sušik – sink hole (Drežnica, Brinje)	<i>A. torrentium</i>	WK 09	BS (S)	6-8
Velika Paklenica (NP Paklenica, Starigrad)	<i>A. astacus</i>	WK 30	AS (D)	10-12
Source Bakovac (Gornji Kosinj, Gospić)	<i>A. pallipes</i>	WK 15	AS (IP)	6-8
Plitvice Lakes (NP Plitvice, Korenica)	<i>A. astacus</i>	WK 46, 47	BS (S)	8-10
Plitvice Lakes (NP Plitvice, Korenica)	<i>A. torrentium</i>	WK 46, 47	BS (S)	8-10
Plitvice Lakes (NP Plitvice, Čujića krčevine, Korenica)	<i>A. torrentium</i>	WK 56	BS (S)	8-10
Riječica (NP Plitvice, Korenica)	<i>A. torrentium</i>	WK 56	BS (S)	8-10
Stream (Antonci, Motovun)	<i>A. pallipes</i>	VL 02	AS (IP)	10-12
Tounjčica (Tounj)	<i>A. torrentium</i>	WL 21	BS (S)	8-10
Stublenka (Radatovići, Ozalj)	<i>A. torrentium</i>	WL 26	BS (S)	8-10
Suvaja (Sošice, Ozalj)	<i>A. torrentium</i>	WL 26	BS (S)	8-10

Waterbody-site	Species	UTM 10 × 10 km	Drainage basin	M.A.T.R.
Unnamed stream (Mrzlo Polje Žumberačko, Samobor)	<i>A. torrentium</i>	WL 37	BS (S)	8
Stream Vuj (Leskovac Barilovički, Duga Resa)	<i>A. astacus</i>	WL 42	BS (S)	10-12
Javorečki stream (Cerinski Vir, V. Lipovec, Samobor)	<i>A. torrentium</i>	WL 46	BS (S)	8-10
Žumberačka reka (Podgorski grad, Žumberak, Ozalj)	<i>A. torrentium</i>	WL 36	BS (S)	8-10
Bregana (Kostanjevec Podvrški, Samobor)	<i>A. torrentium</i>	WL 47	BS (S)	8-10
Sinkhole (Gornji Kremen, Slunj)	<i>A. torrentium</i>	WK 49	BS (S)	8-10
Dubravica (Pušća, Zaprešić)	<i>A. torrentium</i>	WL 58	BS (S)	8-10
Ponikve (PP Medvednica, Zagreb)	<i>A. torrentium</i>	WL 67	BS (S)	8-10
Veternica (PP Medvednica, Zagreb)	<i>A. torrentium</i>	WL 67	BS (S)	8-10
Sarni potok (PP Medvednica, Zagreb)	<i>A. torrentium</i>	WL 68	BS (S)	8-10
Bundek – gravel pit (Zagreb)	<i>A. astacus</i>	WL 77	BS (S)	10-12
Dolje stream (Podsused, Zagreb)	<i>A. torrentium</i>	WL 67	BS (S)	8-10
Gračanski stream (PP Medvednica, Zagreb)	<i>A. torrentium</i>	WL 77	BS (S)	8-10
Jelenovac (Zagreb)	<i>A. torrentium</i>	WL 77	BS (S)	8-10
Kraljevec (PP Medvednica, Zagreb)	<i>A. torrentium</i>	WL 77	BS (S)	8-10
Mrzlak (PP Medvednica, Zagreb)	<i>A. torrentium</i>	WL 77	BS (S)	8-10
Veliki potok (Lukšići, Zagreb)	<i>A. torrentium</i>	WL 77	BS (S)	8-10
Bliznec (PP Medvednica, Zagreb)	<i>A. torrentium</i>	WL 78	BS (S)	8-10
Srnec (PP Medvednica, Zagreb)	<i>A. torrentium</i>	WL 78	BS (S)	8-10
Crno jezero – gravel pit (Velika Gorica)	<i>A. astacus</i>	WL 86	BS (S)	10-12
Ježevo – gravel pit (Velika Gorica)	<i>A. astacus</i>	WL 86	BS (S)	10-12
Malo jezero – gravel pit (Velika Gorica)	<i>A. astacus</i>	WL 86	BS (S)	10-12
Markuševec (PP Medvednica, Zagreb)	<i>A. torrentium</i>	WL 78	BS (S)	8-10
Krapinčica (Kamena Gorica, Novi Marof)	<i>A. astacus</i>	WM 91	BS (S)	10-12
Krapina (Konjščina)	<i>A. astacus</i>	WM 90	BS (S)	10-12
Selnica–Krapina's tributary (near Konjščina)	<i>A. astacus</i>	WM 90	BS (S)	10-12
Tunnel Orlovac I (HPP Orlovac, Sinj)	<i>A. pallipes</i>	XJ 43	AS (D)	10-12
Buško blato Lake (Bosnia and Herzegovina)	<i>A. astacus</i>	XJ 62	AS (D)	10-12
Matica (Kamenmost, Imotski)	<i>A. pallipes</i>	XJ 71	AS (D)	12-14
Matica (Zmijavci, Imotski)	<i>A. pallipes</i>	XJ 71	AS (D)	12-14
Jezerine Source (Imotski)	<i>A. pallipes</i>	XJ 71	AS (D)	12-14
Opačac Source (Imotski)	<i>A. pallipes</i>	XJ 71	AS (D)	12-14
Vrljika (Imotski)	<i>A. pallipes</i>	XJ 71	AS (D)	12-14
Sava (PP Lonjsko polje, Suvoj, Bobovac, Jasenovac)	<i>A. leptodactylus</i>	XL 32	BS (S)	10-12
Sava (PP Lonjsko polje, Krapje–Puska, Jasenovac)	<i>A. leptodactylus</i>	XL 41	BS (S)	10-12
Sava (PP Lonjsko polje Trebež, Jasenovac)	<i>A. leptodactylus</i>	XL 42	BS (S)	10-12
Rajčevica (Koreničani, Daruvar)	<i>A. astacus</i>	XL 75	BS (S)	10-12

Waterbody-site	Species	UTM 10 × 10 km	Drainage basin	M.A.T.R.
Toplica near quarry (Grubišno Polje)	<i>A. astacus</i>	XL 66	BS (S)	10-12
Ilova (near Ivanovo Selo, Grubišno Polje)	<i>A. astacus</i>	XL 75	BS (S)	10-12
Djedovica (Djedovica, Kamenski Vučjak, Požega)	<i>A. astacus</i>	XL 94	BS (S)	8-10
Brzaja stream (Kamenski Vučjak, Požega)	<i>A. astacus</i>	XL 94	BS (S)	8-10
Stream Stiper (Ljubeščica, Kalnik)	<i>A. torrentium</i>	XM 01	BS (DD)	10
Drava – drainage canal (Prelog, Čakovec)	<i>A. astacus</i>	XM 23	BS (DD)	10-12
Koprivnica (Koprivnica)	<i>A. astacus</i>	XM 30, 31, 41	BS (DD)	10-12
Mrtvica–Drava's backwater (Gabajeva Greda, Đurđevac)	<i>A. astacus</i>	XM 51	BS (DD)	10-12
Modro oko (Komin, Neretva delta)	<i>A. pallipes</i>	YH 07	AS (D)	14-16
Veličanka (near quarry Vidovići, Požega)	<i>A. torrentium</i>	YL 03	BS (S)	8-10
Vojlovica (Humljani, Čačinci)	<i>A. astacus</i>	YL 25	BS (DD)	8-10

NP, National Park; PP, Nature Park; HPP, Hydroelectric Power Plant.

\*, Originally belonged to Black Sea drainage; M.A.T.R., Mean annual temperature range.

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