Acta Zoologica Universitatis Comenianae
47 (1): 9–19, 2005

CARPATHIAN ELEMENTS OF THE BENTHIC MICROCRUSTACEAN (CRUSTACEA: HARPACTICOIDA, OSTRACODA) FAUNA OF HUNGARY

Zsolt Gidó

University of Debrecen, Department of Applied Ecology, Egyetem tér 1, H–4010, Debrecen, Hungary
[gidozso@freemail.hu]

Abstract: Hungarian occurrences of some benthic microcrustaceans of special interest in the zoogeography of the Carpathians are presented in this study. A short bibliography of the lotic and subterranean microcrustacean fauna of Hungary is also included. *Ceuthonectes hungaricus* Ponyi, 1958 is known as an endemic harpacticoid species of Baradla Cave (Aggtelek Karst region, Northern Hungary). *Cryptocandona dudichi* (Klie, 1930) is classified as an endemic ostracod species of the Aggtelek Karst region, and its occurrence in the Slovak parts of the karst area (the Slovenský kras Mts) is also quite probable. This latter species is very closely related to *Cryptocandona matris* (Sywula, 1976) (occurring in Poland, Romania and Hungary) and *C. phreaticola* (Kiefer et Klie, 1927) (known only from Slovakia). All the three species are probably Carpathian endemics. *C. dudichi* and *C. matris* are synpatric at the Aggtelek Karst region, but seem to have different habitat preferences. *Cypria reptans* Bronstein, 1928 is very frequent in Hungarian springs. It is an almost krenobiont ostracod whose area suggests the "Balcano–Carpathian track" of postglacial recolonization. *Kovalevskiella* aff. *phreaticola* known from Zemplén Mts. (North–Eastern Hungary) represents a population with unique morphologic features of this relict, stygobitic and parthenogenetic genus having confusuous internal taxonomy. The benthic microcrustacean fauna of the areas and habitats with "sub–Carpathian" characteristics calls for further investigations. Some Hungarian karstic regions, such as those in Aggtelek or Bükk Mountains can even prove local biodiversity "hotspots", rich in endemic taxa.

Keywords: Harpacticoida, Ostracoda, zoogeography, Hungary, Carpathians.

INTRODUCTION

1. "Sub–Carpathian" areas and habitats of Hungary

The widely accepted classification of limnic zoogeographical regions presented by Illies (1978) defines the 500 m altitude line as a border between Carpathian and Pannonian zoogeographic regions. Some monographies use other definitions: for example Botosaneanu (1986) defines the 800 m altitude line as the border of the Carpathians, considering the Transylvanian Plateau with the Apuseni (Bihar) Mts. as individual region. According to these definitions, the present territory of Hungary has very few real Carpathian areas.

This contribution was presented at the "**2nd Fauna Carpathica Meeting**"
organised within the Fauna Europaea project at Smolenice, March 16-19, 2004.

Certainly, the real areas of several animal (and plant) taxa do not follow rigidly the borders of any biogeographical regions (which in most cases are inevitably more or less arbitrary). The hydrofauna of the northern low mountain chain of Hungary called Északi Középhegység, ranging north–eastwards in the Slovakian mountains, the Slovenský kras Mts. and the Slanské vrchy Mts. is very rich in montane and Carpathian elements. Some stony, fast–flowing Hungarian stretches of rivers originating from the Carpathians like the Tisza (Tisa) River, Ipoly (Ipeľ) River or Hernád (Hornád) River contain also several montane and Carpathian taxa. Some parts of this "sub–Carpathian" region, especially karstic areas even have some endemic taxa. Consequently, faunistic investigations carried out in this "peripheral" region can significantly contribute to gaining more comprehensive knowledge of the Carpathian zoogeography.

2. Potential contribution of benthic microcrustaceans to the zoogeography of the Carpathians

Limnic microcrustaceans are generally known as excellent dispersers with large (cosmopolitan, holarctic or palearctic) areas following much more climatic zones than historical zoogeographical pathways (Banarescu 1990). This generalization is undoubtedly true for the great majority of lenitic species, which live in more or less temporary habitats, and have drought–resistant stages (eggs, larvae or even the adults); they can be easily dispersed by the wind and/or migrating birds. However, very little direct information is available on the dispersal abilities of microcrustacean taxa specialised to the more stable lotic and subterranean habitats. It seems reasonable to suggest that a number of lotic and subterranean microcrustaceans do not have any drought–resistant, dispersive forms. The general assumption says that dispersal abilities and/or possibilities of lotic, and especially subterranean microcrustaceans are more restricted than those of their lenitic and habitat generalist relatives, and the former ones usually inhabit smaller areas. Considering the zoogeography of the Carpathians, taxa with restricted areas can be more informative than very widespread (cosmopolitan, holarctic, palearctic) ones. Thus, if the assumptions stated above are correct, the benthic microcrustacean fauna of the Carpathian (and "sub–Carpathian") flowing and subterranean waters holds special interest. The fact that the fauna of subterranean waters contains several (in most cases Tertiary) relict taxa also appreciates the zoogeographical value of the investigation on the "stygofauna".

3. Published data on the harpaticoid and ostracod fauna of Hungarian flowing and subterranean waters

Scientific investigations on the microcrustacean fauna of Hungary have started in the second half of the 19th century with the works of Chyzer and Daday. The latter, very voluminous author published also several comprehensive monographies on the microcrustacean fauna found in the territory of Hungary in those times (Daday 1884, 1888, 1900, 1918). In the 20th century a lot of works were published on cladocereans, calanoids and cyclopoids in Hungary. A detailed overview of these papers goes beyond the purpose of this article: we instance only to the recently published, comprehensive works of Gulyás & Forró (1999, 2001).

In contrast, very few data have been published on the Hungarian harpaticoid fauna. By today, neither a checklist, nor an identification key has been published on harpaticoids in Hungary. Yet, a very short synthesis has been published recently (Ponyi 2001). The number of taxonomic and/or faunistic articles published directly on the harpaticoids of Hungary is limited (Ponyi 1956a, 1957, 1958; Kiefer 1963; Gidó 2003; Gidó & Lakatos 2001b, 2003a, b).

The ostracod fauna of Hungary is somewhat more thoroughly investigated. Farkas (1958a) published a comprehensive identification key on the Hungarian ostracod fauna, including the related zoogeographical data. Due to the great evaluation of the ostracod taxonomy recently, nowadays this work has a rather historic value. A checklist of Hungarian ostracods was published by Meisch & Forró (1998). A catalogue of the ostracod collection of Daday – kept in the Hungarian Natural History Museum – with special reference to the new taxa described by Daday as published by Forró et al. (1987) is a really informative work. The monography of Meisch (2000) also covers the Hungarian ostracod fauna. Articles directly on Hungarian ostracods were published by Klie (1930, 1939), Farkas (1958b), Ponyi (1956b), Meisch & Wouters (1985), Györe (1976, 1985) and recently by Gidó (2003) Gidó & Lakatos (2001a, b, c, 2003a, b), Namiotko et al. (2001) and Kiss (2000, 2001).

Most of the data about harpaticoids and ostracods in Hungary are scattered in general hydrobiological works. Here, references are given only to works on the fauna of springs, brooks and streams, as well as different subterranean waters that offer data about microcrustaceans.

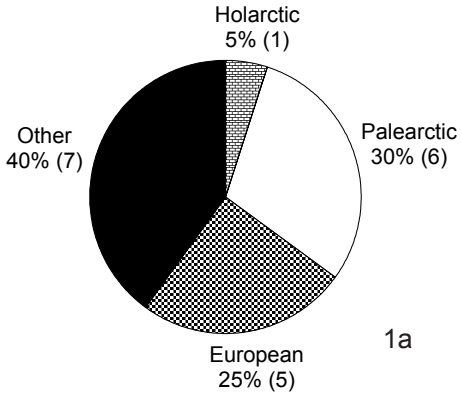
Microcrustacean species collected from small flowing waters (springs to streams) have been presented by Ábrahám et al. (1954, 1956a, b, 1959), Dvihally & Ponyi (1956), Entz et al. (1954), Farkas & Vágvölgyi (1955), Gebhardt (1933a; 1960) and Ponyi (1997).

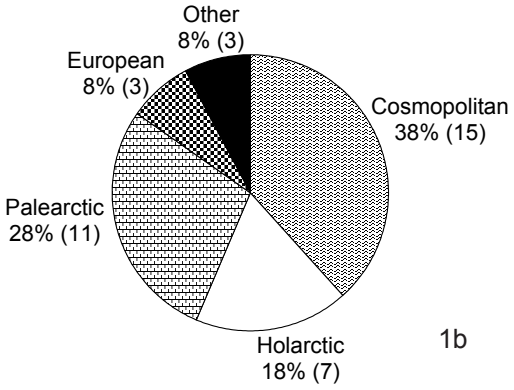
The available information on the subterranean hydrofauna of Hungary is very limited. Microcrustaceans from subterranean waters are mentioned and/or described (except for some of the above-mentioned works) by Bajomi (1969), Dudich (1932) Gebhardt (1934), Ponyi (1960; 2000), Ponyi & Zánkai (1962) Megyeri (1963) and Török (1935, 1951, 1954).

RATIOS OF ZOOGEOGRAPHIC DISTRIBUTION TYPES IN DIFFERENT LIMNIC MICROCRUSTACEAN GROUPS

In order to test the above-stated hypothesis, that is lotic and subterranean microcrustacean groups have generally more restricted areas than their lenitic and habitat generalist relatives, we have compared the ratios of different zoogeographic distribution types of some microcrustacean groups.

For limnic copepods, their way of the life and – as a consequence – habitat preference (in its broad sense) are more or less characteristic to major taxonomic groups. Calanoids are exclusively planktonic crustaceans, clearly preferring lentic habitats. Most cyclopoids prefer also lentic habitats, species charactheristic to the flowing and subterranean waters are habitat generalists in most cases. There are also some species, for example *Diacyclops languidoides* (Lilljeborg, 1901), which are specialised to subterranean waters, but their number is relatively low. (Recently some new stygobitic species have been described from Central Europe – see for example Stoch & Pospisil 2000a, b – and a significant rise in the number of closely related, but distinct subterranean cyclopoid species is also expectable). True limnic harpaticoids show strong tendencies towards adapting to lotic and subterranean habitats: only a few ameirid and canthocamptid taxa, for example *Nitocrella hibernica* (Brady, 1880), *Canthocamptus* genus or *Brehmiella* subgenus of *Attheyella* are habitat generalists clearly preferring lenitic habitats. All these taxa and thus lenitic habitat preference for harpacticoids are assumed as plesiomorphic. Consequently, we can regard freshwater calanoids and cyclopoids as mostly lenitic and habitat generalist groups, and freshwater harpacticoids as mainly lotic and habitat generalist groups.





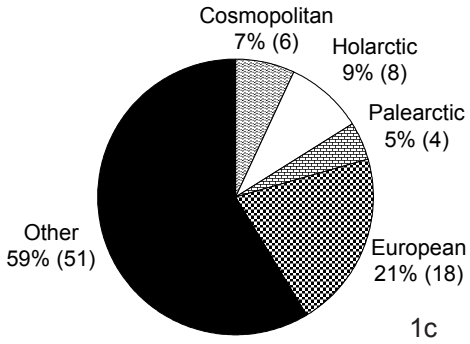
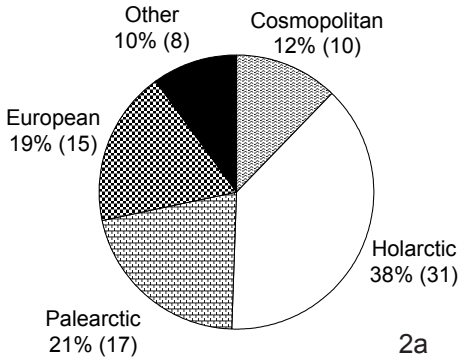
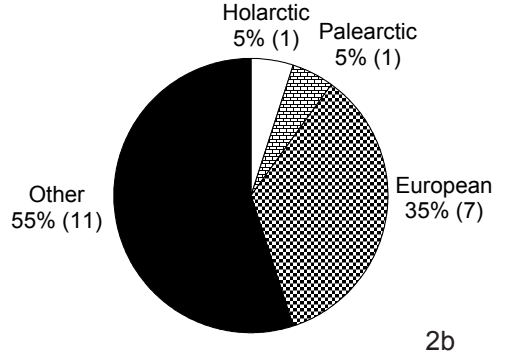


Figure 1a, b, c. Ratios of the different zoogeographic distribution types of calanoids (a), cyclopoids (b) and harpacticoids (c) of Hungary (calanoids and cyclopoids) and "Central Europe" (harpaticoids). Number of the species is given in paratheses. Details in text.

Figure 2a, b. Ratios of different zoogeographic distribution types of lentic/habitat generalist (a) and lotic/subterranean (b) ostracods of Hungary. Number of species is given in paratheses. Details in the text.





For ostracods, the taxonomical position is less strongly related to habitat demand. Although freshwater subterranean habitats are strongly dominated by the members of the *Candoninae* subfamily (DANIELOPOL, 1978), candonids have also many lentic and habitat generalist epigeic species, so they cannot be considered as a group specialised to subterranean waters. Consequently, most species of the *Cyprididae* family are lentic (or habitat generalist), but there are some taxa, which are clearly specialised to lotic and/or subterranean environments (for example the *Psychrodromus* or *Cavernocypris* genera).

The ratios of the different zoogeographic distribution types for the members of the three Hungarian (calanoids and cyclopoids) and "Central European" (sensu Janetzky et al, 1996, harpaticoids) freshwater copepod orders are shown in Fig. 1. Fig. 2 illustrates the ratio of the

different zoogeographic distribution types of lenitic/habitat generalist and lotic/subterranean ostracod species in Hungary. The harpaticoid fauna of Hungary is very poorly known, so we have decided to use data from Janetzky et al. (1996), though we have been aware of the fact that the much larger geographic area, including such centres of endemism, like Slovenia, covered by the op. cit. authors strongly biases the comparison with the calanoid and cyclopoid fauna of Hungary. For harpaticoids, zoogeographic data have been derived from Janetzky et al. (op. cit), Damian–Georgescu (1970) and Borutzki (1952). Costal brackish water species have been omitted. In the case of calanoids and cyclopoids, the Hungarian fauna has been focused on, as following Gulyás & Forró (2001). Yet, subsequent taxonomic and zoogeographic changes have been omitted.

For ostracods, all the taxonomic, zoogeographic and ecological data have been taken from Meisch (2000), only the species list has been completed with species subsequently found in Hungary.

We have divided the species to 5, broadly conceived distribution types: cosmopolitan (occurring at least in two biogeographic provinces, holarctic and palearctic species protruding in the Oriental region have been regarded as holarctic or palearctic); holarctic; palearctic (widespread boreal, boreomontan arctic and arctoalpine species have been considered as holarctic or palearctic, respectively); European; and other (for example Mediterranean, Eastern European or restricted). This classification is undoubtedly somewhat arbitrary. The fact that the real distribution of several species is very poorly known (this is especially true for subterranean species, which in a number of cases are only known from the type locality) causes a much more serious bias, since it increases artificially the number of taxa with "restricted area", and decreases the number of "widespread" taxa. This bias seems to be very considerable for harpaticoids. Systematic uncertainities give rise to further confusion.

Due to the above listed, major inaccuracies, diagrams on Figures 1–2 should be interpreted very considerately. Nevertheless, some tendencies are clearly observable.

In the Hungarian fauna, the high percentage (40%, 7 species) of calanoids having restricted distribution in Europe is surprising at the first glance, and seems to conflict the assumption on the excellent dispersal abilities and possibilities of these crustaceans. We suggest that the lack of these southern or eastern species from the northern and western parts of Europe is not connected to dispersion limits, but the specific ecological demands of these calanoids. Species of the steppe region inhabiting mostly shallow alkaline waters do not find suitable habitats in humid areas. Most probably, factors limiting the northwards expansion of southern species are also mainly climatic. In spite of the high percentage of species with "special" zoogeographic distribution, calanoids are not among the taxa that offer the most expedient means of understanding the origin and history of the Carpathian fauna.

The high percentage of the widespread cyclopoid taxa finely fits the pattern expected for a group of excellent dispersers. In spite of the overall low percentage (8%) of the taxa known to have "restricted" area, some cyclopoids, mostly subterranean species can be very informative in zoogeography; thus, a better understanding of the taxonomy and distribution of subterranean cyclopoids is required.

Although the very high percentage (58%) of harpacticoids having "restricted" area in Europe is almost certainly an instance of overestimation, this microcrustacean group seems to be a fairly suitable tool for zoogeographical analyses on different European regions, including the Carpathians. Beside the subterranean and lotic species, cold stenotermal, boreo–montane, boreo-alpine, arcto-alpine species of the *Articocamptus* (*Bryocamptus*) subgenus also hold special interest.

As expected, the ratio of species with restricted or special areas is considerably higher (55%) for the lotic/subterranean ostracods as compared to their lenitic/habitat generalist relatives (10%). The excellent fossil record of ostracods appreciates significantly their value in historical zoogeographic analyses. Unfortunately, lotic habitats, especially in mountain regions generally provide conditions being very unfavourable for fossilization. Remarkable exceptions include springs with limestone precipitation (Absolon 1973, 1975; Williams & Williams 1998).

SOME REMARKABLE BENTHIC MICROCRUSTACEAN SPECIES FROM THE "SUB–CARPATHIAN" AREAS OF HUNGARY

Ceuthonectes hungaricus Ponyi, 1958 – the endemic harpacticoid species of the Baradla Cave

Genus *Ceuthonectes* has 10 known stygobiont species, 9 in Southern and Central Europe, and one in Japan. Most species have very restricted areas, and some are known only from the type locality. Only *C. serbicus* Chappuis, 1924 seems to have a larger area in South–Eastern Europe. *C. hungaricus* was described from the waters of the Baradla Cave (Aggtelek National Park, North–East Hungary) by Ponyi 1958, and no other occurrence has been known. *Ceuthonectes* is assumed to be a Tertiary relict genus that has survived the Ice Age only in subterranean waters (Borutzki 1952). The Baradla Cave is the northernmost known occurrence of this genus, which probably extends northwards up to the Carpathians.

Cryptocandona phreaticola group: Carpathian endemisms

Cryptocandona is an ancient genus of the Candoniane subfamily (Ostracoda, Candonidae) being widespread in Europe, and has one living species in Japan. Fossils are known in Europe from as early as the Tertiary (Baltanás et al. 2000). This genus has either epigeic or subterranean species: epigeic species seem to prefer to permanently cool, clean waters (springs, bogs, deep lakes).

The group *"phreaticola"* within *Cryptocandona* is characterised morphologically with the backwards pointing conical female genital lobe and the combination of some less characteristic morphological features (shape of hemipenis, setation of the cleaning leg). All the three known species are stygobitic or stygophil. Parthenogenetic lineages being present at some other cryptocandonid populations are unknown for the "*phreaticola*" group.

The first species of this group, *C. phreaticola* (Kiefer et Klie, 1927) was described by Kiefer et Klie (1927) from groundwater wells in the Tekovské Lužany village (Slovakia) – see also Namiotko et Danielopol (2001). By now, only the type specimen has been known. Type locality is situated in a typical lowland area, close to the Hron River. Information on the real area of this species is required.

Cryptocandona phreaticola group: Carpathian endemisms

Cryptocandona is an ancient genus of the Candoniane subfamily (Ostracoda, Candonidae) being widespread in Europe, and has one living species in Japan. Fossils are known in Europe from as early as the Tertiary (Baltanás et al. 2000). This genus has either epigeic or subterranean species: epigeic species seem to prefer to permanently cool, clean waters (springs, bogs, deep lakes).

The group *"phreaticola"* within *Cryptocandona* is characterised morphologically with the backwards pointing conical female genital lobe and the combination of some less char-

acteristic morphological features (shape of hemipenis, setation of the cleaning leg). All the three known species are stygobitic or stygophil. Parthenogenetic lineages being present at some other cryptocandonid populations are unknown for the "*phreaticola*"–group.

The first species of this group, *C. phreaticola* (Kiefer et Klie, 1927) was described by Kiefer et Klie (1927) from groundwater wells in the Tekovské Lužany village (Slovakia) – see also Namiotko & Danielopol (2001). By now, only the type specimen has been known. Type locality is situated in a typical lowland area, close to the Hron River. Information on the real area of this species is required.

C. dudichi (Klie, 1930) was described from the waters of the above–mentioned Baradla Cave. Recently, new specimens have been collected from the surrounding karstic springs, as well as from the interstitial water of Jósva Stream, which springs from Baradla Cave. Morphologically, specimens from springs sligthly differ from the type specimen from cave waters: the latter one shows some probably apomorphic, "troglomorphic" charactheristics, while spring specimens are closer in morphology to the related species (Namiotko et al. 2001). To estasblish the consistency of these differences, and decide whether the spring populations are self–supporting and isolated from the cave populations or not, as well as to determine the real area of this species call for further examinations.

C. matris (Sywula, 1976), which is probably the most widespread species of the group was described from the Polish Carpathians (Sywula 1976). This species is also known from the Romanian Carpathians, Maramures county (D. L. Danielopol pers. comm.) and from Northern Hungary, the Aggtelek Karst region and Zemplén Mts. (Gidó & Lakatos 2003a,b). The species is probably endemic to the northern chain of Carpathians, and can be easily found in the interstitial waters of mountain areas. In the Aggtelek region, it is sympatric with the closely realated *C. dudichi*, though their habitat preferences are different. The former species prefers caves and springs, while the latter is restricted to interstitial waters. Further examination of this endemic ostracod group can contribute significantly to acquiring a better knowledge of Carpathian biogeography.

A crenobiont ostracod: *Cypria reptans* Bronstein, 1928

Most members of the world-wide distributed *Cypria* genus (Ostracoda, Candonidae, Cyclocyprinae) are typically lentic crustaceans with very long swimming hairs on the second antenna. *Cypria reptans* Bronsthein, 1928 has swimming hairs significantly reduced in length; laboratory observations of the movement of these ostracods have also corroborated that this species completely lost its ability to swim. *C. reptans* is known only from springs and cave waters. It has been detected in Southern Poland, the Czech Republic, Slovakia, Hungary, Montenegro, Slovenia, Northern Italy and the Caucasus (Meisch 2000). It is widespread and common in Hungarian springs. However, the lack of this species from the mountain areas of Western Europe is quite remarkable. Although our knowledge about ecological demands of this crenobytic species is very limited, we believe that the peculiar area of this ostracod is the consequence of historical zoogeographic processes. We can suggest that the crenobityc species had survived glaciations only in South-Eastern Europe, and after the retreat of ice penetrated northwards from stream to stream, following the mountain chains, the so–called "Balcano-Carpathian track". This kind of distribution is generally charactheristic to montan, rheophilic aquatic insects, like plecopterans (Banarescu 1990). Even the other crenophilic or crenobityc ostracods of Europe (*Psychrodromus* spp., crenophilic *Potamocypris* species) do not show this zoogeographic pattern.

An additional endemic taxa from Baradla Cave – *Potamocypris fulva aggtelekiensis* Meisch, 2000

Meisch (2000) described a new form of the *P. fulva* (Ostracoda, Cyprididae, Cypridopsinae) from Baradla Cave. The type form of this species is widespread in Europe, it is generally associated with spring waters and reproduces parthenogenetically. Subspecies *aggtelekiensis* shows some "troglomorphic" characteristics that distinguish it from the subterranean populations of the same species, but known from other sites.

Kovalevskiella Klein 1963 (Ostracoda, Limnocytheridae, Timiriaseviinae) – a relict genus

The *Kovalevskiella* genus is widespread in the subterranean waters of the south-eastern parts of Europe. Fossil occurrences are also known from Western Europe. *Kovalevskiella* is assumed to be a living fossil that had been widespread in the epigeic waters of Europe during the Tertiary, but survived the glaciation only in subsurface waters (Danielopol 1980, Colin & Danielopol 1980). Recently a new population with unique features have been found in the streaming interstitial waters of the Zemplén Mts. (North-East Hungary, see Gidó & Lakatos 2003a,b; Gidó 2004). The confusing internal taxonomy of this parthenogenetically reproducing genus is not concerned here.

CONCLUSIONS

Due to the relatively large number of species with restricted areas in Europe, benthic freshwater microcrustaceans, especially taxa specialised to lotic/subterranean waters can be suitable tools of studies on European regional biogeography, including the Carpathian region. Yet, much more information is required on the recent and paleo–distibutibution, taxonomy, systematics and ecology of these groups.

The hydrofauna of the peripheral Carpathian areas, including the "sub–Carpathian" regions and habitats in Hungary also contribute significantly to the diversity of the Carpathian fauna. Just from Baradla Cave (Aggtelek National Park) and from its surrounding areas, 3 endemic benthic microcrustaceans are known (*Ceuthonectes hungaricus*; *Cryptocandona dudichi, Potamocypris fulva* ssp. *aggtelekiensis*). Baradla Cave being the most famous cave of Hungary is relatively well studied. We know much less about the microcrustaceans in other Hungarian karstic regions, like those of Bükk Mountains. It is absolutely not unlikely that some other caves or karstic systems in Hungary will prove to be regional "biodiversity hotspots" with endemic taxa, similarly to the Baradla cave. Due to the rich interstitial and epigeic fauna of almost all the montan springs and streams, not only karst regions are interesting. A broad cooperation of researchers and nature protecting bodies of the neighbouring countries is required to survey and maintain the diversity of the Carpathian fauna.

REFERENCES

Absolon, A., 1973: Ostracoden aus einigen Profilen spat- und postglazialer Karbonatablagerungen in Mitteleuropa. *Mitt. Bayer. Staatssamml. Paleont. hist. Geol.,* **13:** 47–94.

Absolon, A., 1975: Ostracoda několka pramennych biotopú v okoli Krivolkátu. *Bohemia centralis (Praha)*, **4:** 141–144.

Ábrahám, A., Bende, S., Horváth, A. & Megyeri, J., 1954: Adatok a Bánvölgy hidrobiológiai viszonyaihoz. *Annales Biologicae Universitatum Hungariae,* **2:** 327–344.

Ábrahám, A., Biczók, F., Horváth, A. & Megyeri, J., 1956a: Hydrobiologische und faunistische Studien im südwestlischen Teile des Bükk-Gebirges. *Acta. biologica Szeged,* **2:** 137–154.

Ábrahám A., Horváth A. & Megyeri J., 1956b: Hidrobiológiai vizsgálatok a Szilvás patak vízgyűjtő területén. *Állattani Közlemények,* **45:** 13–24.

Ábrahám, A., Biczók, F. & Megyeri, J., 1959: Vergleichende faunistische Untersuchungen in der Kleingewassern des Bükk–Gebirges. Acta Biol. Szeged, **5/3–4**: 201–214.

Bajomi, D., 1969: Examen faunistique de la grotte "Meteor" (Hongrie). *Opusc. Zool. Budapest,* **9/2:** 235–247.

Baltanás, A., Namiotko, T. & Danielopol, D.L., 2000: Biogeography and disparity within the genus *Cryptocandona* (Crustacea, Ostracoda). *Vie et Milieu,* **50(4)**:297–310.

Banarescu, P., 1990: Zoogeography of fresh waters. Vol 1. *Aula, Wiesbaden*, 511 pp.

Borutzki, E.W., 1992: Fauna SSSR, Rakoobraznie, Harpaticoida presnih vod, III. 424. pp. (Translation: Freshwater Harpaticoida. Fauna SSSR., **III** (4). 398 pp. *Israel program for scientific translation (Jerusalem)*, 1964.

Botosaneanu, L. (ed.), 1986: Stygofauna Mundi. *E. J. Brill, Leiden*. 740 pp.

Colin, J.P. & Danielopol, D.L., 1980: Sur la morphologie, la systematique, la biogeographie et l'evolution des ostracodes Timiriaseviinae (Limnocytheridae). *Paléobiologie continentale,* **11/1**: 1–51.

Daday, J., 1884: A Magyarországon eddig talált szabadon élő evezőlábú rákok magánrajza. – *Term. Tud. Közl.,* **19:** 115–311.

Daday, J., 1888: A magyarországi Cladocerák magánrajza. *K. M. Term. Tud. Társ. Budapest*, 1–128.

Daday, J., 1900: A magyarországi kagylósrákok magánrajza. Ostracoda Hungariae. *Budapest*. MTA.

Daday, J., 1918: A Magyar Birodalom állatvilága – Fauna Regni Hungariae. III. Crustacea. *Budapest*, 1–11.

Damian–Georgescu, A., 1970: Fauna R. S. R., Crustacea, Copepoda, Harpaticoida (Forme de apa dulce),. **4/11**. *Ed. Acad. R.S. R., Bucuresti*.

Danielopol, D.L., 1978a: Über Herkunft und Morphologie der Süsswasser–hypogaischen Candoninae (Crustacea, Ostracoda) *Sitzungsberichte der österreichischen Akademie der Wissenschaften, mathematisch – naturwissenschaftliche Klasse*, Abt. I., **187 (1/5)**: 1–162.

Danielopol, D.L., 1980: An essay to asses the age of the freshwater interstitial ostracods of Europe. *Bijdr. Dierk.,* **50**: 243–291.

Dudich, E., 1932: Biologie der Aggteleker Tropfsteinhöhle "Baradla" in Ungarn. *Spaleolog. Monogr.,* **13:** 1–246.

Dvihally, Z. & Ponyi J., 1956: Adatok a Vörösvári völgy hidrobiológiai viszonyaihoz. *Hidiológiai Közlöny,* **36:** 211–217.

Entz, B., Kol, E., Sebestyén, O., Stiller, J.R., Tamás, G. & Varga, L., 1954: A Balatonba ömlő vizek fiziográfiai és biológiai vizsgálata. I. A Pécsely patak. *Annales instituti biologici (Tihany),* **22:** 61–83.

Farkas, H., 1958a: Kagylósrákok (Ostracoda). *Fauna Hungariae, Magyarország Állatvilága,* **39 (4/3)**: 1–68.

Farkas, H., 1958b: Candona Szőcsi n. sp. eine neue Ostracoden–Art der rostrata–Gruppe aus der ungarischen Brunnen – Fauna. *Zool. Anzeiger*, **160:** 110–112.

Farkas, H. & Vágvölgyi, J., (1955): On the fauna of the springs of Hungary. I. Mts. Dunazug. *Annales historico–naturales musei naturales musei nationalis hungarici,* **57**: 377–384.

Forró, L., Meisch, C., Petersen, H. & Martens, K., 1987: Ostracod taxa described by E. Daday, together with a catalogue of pertinent material in the Hungarian Natural History Museum. *Miscellanea Zoologica Hungarica,* **4.** pp. 33–63.

Gebhardt, A., 1933a: A Mecsekhegység forrásainak élővilága. *Mathematikai és Természettudományi Értesítő,* **49:** 148–165.

Gebhardt, A., 1933b: Az Abaligeti és a Mánfai barlang állatvilágának összehasonlítása. *Állat. Közlemények,* **30:** 36–44.

Gebhardt, A., 1934: Az abaligeti barlang élővilága. *Mathematikai és természettudományi Közlemények*, **37:** 1–264**.**

Gebhardt, A., 1960: A Mecsek hegység forrásainak faunisztikai és biológiai vizsgálata. *Janus Pannonius Múzeum Évkönyve*: 17–38.

Gidó, Z., 2003: Magyarországi és romániai hegyvidékek forrásainak és intersticiális vizeinek kisrákfaunisztikai vizsgálata. Hozzájárulások a stygobiont kagylósrákok taxonómiájához és evolúciójához. (Investigations on spring and phreatic microcrustacean fauna of some Hungarian and Romanian regions.) Contributions to the taxonomy and evolution of stygobiont ostracods. PhD thesis. *Manuscript. Univ. of Debrecen, Hungary*.

Gidó, Z. & Lakatos, G., 2001a: Faunisztikai eredmények forrásaink Ostracodáiról. – *Hidrológiai Közlöny,* **81/5–6**: 367–368.

Gidó, Z. & Lakatos, G., 2001b: Összehasonlító kisrák (Crustacea: Copepoda, Ostracoda) faunisztikai vizsgálatok a Mecsek, a Zempléni-, a Hargita-hegység és az Aggteleki-karszt forrásaiban. *II. Kárpát-medencei Biológiai Szimpózium, Magyar Biológiai Társaság és Magyar Természettudományi Múzeum, Budapest, 2001. november 20–22.* pp. 167–169.

Gidó, Z. & Lakatos, G., 2001c: Some new ostracods (Ostracoda) from Hungary. *Acta Biologica Debrecina,* **23:** 84–85.

Gidó, Z. & Lakatos, G., 2003a: Contribution to the knowledge of copepod and ostracod fauna of the stream interstitial habitats in Hungary and Romania. *Proc. of the Subsurface Organisms Int. Workshop, 30. March–1 April, Baile Felix, Romania,* pp. 49–52.

Gidó, Z. & Lakatos, G., 2003b: Hegyi patakok intersticiális kisrák (Copepoda, Ostracoda) faunája: adatok a Mecsek, a Zempléni- és a Hargita hegységből és az Aggteleki-karsztról. *Hidrológiai Közlöny,* **83:** 55–56.

Gulyás, P. & Forró, L., 1999: Az ágascsápú rákok (Cladocrea) kishatározója. 2. (completed) edition. *Vízi Természet–és Környezetvédelem* **9,** *KGI. Budapest*. 237 pp.

Gulyás, P. & Forró, L., 2001: Az evezőlábú rákok (Calanoida és Cyclopoida) alrendjeinek kishatározója. 2. (completed) edition. Vízi Természet– és Környezetvédelem. **14.** *KGI. Budapest*, 199 pp.

Györe, K., 1976: Kagylósrák (Ostracoda) összehasonlító vizsgálatok a Velencei–tavon. *Manuscript, Univ. of Debrecen, Hungary*.

Györe, K., 1985: Three ostracod species from Lake Velence new to fauna of Hungary. *Miscell. Zool. Hung.,* **3:** 65–72.

Illies, J. (ed.), 1978: Limnofauna Europaea. *Gustav Fisher Verlag*. 532 pp.

Janetzky, W., Enderle, R. & Noodt, W., 1996: Crustacea. Copepoda. Geyeloida und Harpaticoida. In: Schwoerbel, J. & Zwick, P. (eds): Susswasserfauna von Mitteleuropa, **8/2,** *Gustav Fisher Verlag, Stuttgart, Jena, New York*.

Kiefer, F., 1963: Elaphoidella simplex Chappuis aus einem Brunnen bei Szeged. *Tud. Közl*., **11:** 143–148.

Kiefer, F. & Klie, W., 1927: Zur Kenntnis der Entomostraken von Brunnengewassern. *Zool. Anz.,* **71**: 5–14.

Kiss, A., 2000: A hansági fehér tó Ostracoda faunája. *Hidrológiai Közlöny,* **80/5:** 314–315.

Kiss, A., 2001: A Pilisi Bioszféra Rezervátum kisvizeinek Crustacea fajegyüttesei. *Hidrológiai Közlöny*, **81/5–6**: 383–384.

Klie, W., 1930: Eine neue unterirdisch lebende Art der Ostracodengattungen *Candona. Állattani Közlemények,* **27**: 163–167.

Klie, W., 1939: Adatok Magyarország kagylós–rák faunájának ismeretéhez (Beitrage zur Kenntnis der Ostrakodenfauna Ungarns). *Állattani Közlemények,* **36:** 168–174.

Ponyi, J., 1958: Unterirdische Harpaticoiden aus Ungarn. *Zool. Anz.,* **160**, 3/4, 73–77.

Ponyi, J., 1960: Über im interstitialen wasser der sandigen und steinigen Ufer des Balaton lebende Krebse (Crustacea). *Annal. Biol., Tihany* **27:** 85–92.

Ponyi, J., 1997: A Balaton–felvidék patakjainak zoológiai vizsgálata. *Hidrológiai Tájékoztató*: 18–22.

Ponyi, J., 2000: Faunisztikai vizsgálatok a Tisza partszegélyén 1959–ben. *Hidrológiai Tájékoztató*: 18–22.

Ponyi, J., 2001: Evezőlábú rákok (Copepoda) kevéssé ismert fajainak előfordulása Magyarországon. *Hidrológiai Tájékoztató*: 31–33.

Ponyi, J. & P. Zánkai N., 1962: Adatok a Mánfa–patak (Mecsek–hegység) intersticiális faunájának ismeretéhez. *Állattani Közlemények,* **49:** 91–96.

Stoch, F. & Pospisil, P. 2000a: Redescription of Diacyclops disjunctus (Thallwitz, 1927) from Austria, with remarks on the Diacyclops languidus group in Europe (Copepoda, Cyclopoida, Cyclopinae). *Crustaceana,* **73** (4): 469–478.

Stoch, F. & Pospisil, P., 2000b: The Diacyclops languidoides – group (Copepoda, Cyclopoida) in Austria, with redescription of Diacyclops cohabitatus Monchenko, 1980. *Annls. Limn.,* **36.** (1): 21–29.

Sywula, T., 1976: New species of Ostracoda (Crustacea) from subterranean waters of Poland. *Bull. Acad. sci. Pol., ser. sci. biol.,* cl. II., 24 (5): 271–278.

Török, P., 1935: A budapesti vízvezetéki víz szűredékének faunája (Die Fauna im Filtrat des Budapester Wasserleitungwasser). *Matematikai és Természettudományi Értesítő*, **80/ 53:** 637–664.

Török, P., 1951: Quelques nouvelles écrevisses caracteristiques pour l'eau souterraine concernant la faune de la Hongrie. *Acta Biol. Acad. Sci. Hung.,* **2:** 281–285.

Török, P., 1954: Mikroorganizmen aus dem Wasser ungarischer Wasserleitungen. *Acta Microbiol. Acad. Sci. Hung*. **1**: 223–241.

Williams, D.D. & Williams, N.E., 1998: Invertebrate communities from freshwater springs: what can they contribute to pure and applied ecology? In: Botosaneanu, L. (ed.): Studies in crenobiology. The biology of the springs and springbrooks. *Backhuys Publishers, Leiden,* pp. 251–261.

Received 19 April 2004
Accepted 1 December 2004
Printed 20 July 2007