



***Niphargus* (Crustacea: Amphipoda) species in Hungary: literature review, current taxonomy and the updated distribution of valid taxa**

GERGELY BALÁZS¹, DOROTTYA ANGYAL² & ELŐD KONDRÓSY³

¹ Department of Systematic Zoology and Ecology, Eötvös Loránd University, Pázmány Péter sétány 1/C, Budapest, H-1117.

E-mail: balazsgrg@gmail.com

² Department of Zoology, Hungarian Natural History Museum, Baross u. 13., Budapest, H-1088. E-mail: angyal.dorottya@gmail.com

³ Department of Animal Sciences and Animal Husbandry, University of Pannonia, Deák Ferenc u. 16., Keszthely, H-8360.

E-mail: kondorosy@georgikon.hu

Abstract

Research of the Hungarian *Niphargus* species is a rather neglected field. This is due to the growing distance between the level of knowledge about Hungarian species and the elaboration determined by the international publications, which had caused a hardly negotiable inconvenience in the judgment of the state of the Hungarian species. The clarification of species in questionable positions could be the starting point of further inland research. During our work, the species with Hungarian distributions were assigned based on the literature's data, and were evaluated with morphological examinations of the specimens collected by us from their type localities and other habitats. Considering the validity of the species we created three categories. Eight of the 20 species proved to be invalid or non-inland species, three remain in an uncertain taxonomic state, while nine are classifiable into the 'valid Hungarian species' category. During the 43 samplings in 27 localities we added new distributional data for seven species.

Key words: Hungary, checklist, new records, Amphipoda

Introduction

Although the blind amphipod genus, *Niphargus* Schiödte, 1849 is among the most significant elements of European subterranean communities, its research in Hungary has lagged behind in the past decades, in comparison with its other European counterparts. At the first half of the last century Endre Dudich and Lajos Méhely performed extensive taxonomic research on *Niphargus* species. As a result of their work, numerous species descriptions and other articles, which were concerned with morphological data and systematic problems, were published (e.g. Dudich 1924; 1926; 1927; 1932; Méhely 1927; 1937; 1941). However, the inland research of the genus was soon effaced and nothing more than sporadic contributions, announcing only distributional data, were published due to surveys of hydrobiologist specialists (e.g. Stiller 1953; Ponyi 1962; Bajomi 1969; Lantos; 1986), with the exception of the description of *Niphargus forroi* (Karaman, G. S. 1986).

While globally, the number of the known *Niphargus* species and subspecies has exceeded 300, taxonomic status of the few species described from Hungary has remained uncertain. When the descriptions and distribution data were published, many of the Hungarian caves known today were undiscovered, which had limited the chance of finding new species and even new populations. Most of the descriptions operated with insufficient morphological information and few drawings, and often the type locality cannot be exactly identified. The taxonomic review of the Hungarian species is aggravated by the fact that in most cases the holotypes are no longer available in the type collections for various reasons, like perished in the fire which ravaged the Hungarian Natural History Museum during the revolution in 1956 (Balázs & Angyal 2013).

Muskó (2007) lists 15 *Niphargus* species in her Hungarian Malacostraca checklist (*Niphargus foreli* Humbert, 1877, *N. forroi* G. Karaman, 1986, *N. gebhardti* Schellenberg, 1934, *N. hrabei* S. Karaman, 1932, *N. hungaricus* Méhely 1937, *N. leopoliensis* Jaworowsky, 1893, *N. longicaudatus* A. Costa, 1851, *N. magyaricus* Méhely 1941 ?,

N. matrensis Méhely 1941 ?, *N. molnari* Méhely 1927, *N. puteanus* C. L. Koch, 1836, *N. stygius* (Schlödte, 1847), *N. tatrensis* Wrzesniowsky, 1890, *N. thermalis* Dudich, 1941, and *N. valachicus* Dobreanu & Manolache, 1933.) Some of them though, cannot be considered as indigenous species yet, due to the translocation of country boundaries, while others are the results of misidentifications or using synonymised names. The mention of further five species, which can be related to Hungarian distribution (*N. aggtelekiensis* Dudich, 1932, *N. dudichi* Hankó, 1924, *N. mediodanubialis* Dudich, 1941, *N. baloghi* Dudich, 1940, *N. pater* Méhely, 1941) were found in the relevant literature (e.g. Dudich 1932; 1934; 1941b; Hankó 1924; Méhely 1941).

The aim of our work was to evaluate the collected information from the entire literature that was available, then to diagnose which species comprise the *Niphargus* fauna of the present-day Hungary. Furthermore, in case of the established valid species, or species with uncertain taxonomic position, we considered as an important issue the collection of individuals from the type localities and other surrounding localities to obtain a better knowledge about the distribution of the species. With the exception of *N. dudichi* and *N. forroi*, specimens from the type localities have not been found in museum collections of Hungary. During our work we created a collection—dissections and material preserved in ethanol—of all the known Hungarian subterranean *Niphargus* species collected from the type localities or from the nearest localities when necessary, which was deposited in the Hungarian Natural History Museum, Department of Zoology.

Material and methods

After the overview of the literature, based on the records and descriptions, we determined a list of the species with Hungarian distribution. Then, by establishing a criteria system, with further literary assay, the list was narrowed down to fewer species. We took into consideration the nominal changes had happened since the mention, the possibility of misidentifications and the alterations related to the translocation of country boundaries. We collected specimens from the type localities in case of the species with potential Hungarian distributions. Collections were carried out in 27 localities of six regions (Mecsek Mts., Bükk Mts., Aggtelek Karst, Budapest, Kőszegi Mts., Nyitra-Barsi-Hills, now Podunajská Pahorkatina, Slovakia) in 43 occasions. Most of the collected individuals were dissected and were fixed on slides, which were suitable for morphological comparison with the data found in the corresponding species descriptions. Both the methodology of the dissection and the data management were undertaken according to the modern *Niphargus*-taxonomic standard (Fišer *et al.* 2009), therefore the new samples and data could be applied in pending, expansive morphological comparative surveys as well. Drawings were made using a drawing tube attached to a Leica DM 1000 light microscope.

Results

After the study of the literature related to the relevant 20 *Niphargus* species, we established three categories. In the first category we find the species without distributional data from the present-day Hungary, either due to misidentifications or using synonym names that therefore cannot be considered as elements of the Hungarian fauna. Eight species belong to this category: *N. pater*, *N. baloghi*, *N. dudichi*, *N. stygius*, *N. longicaudatus*, *N. puteanus*, *N. foreli*, and *N. leopoliensis*. In the second group there are species with uncertain taxonomic positions. These three species are: *N. magyaricus*, *N. matrensis* and *N. mediodanubialis*. Into the third category belong the widely accepted, valid Hungarian *Niphargus* species. This means nine species, namely: *N. hrabei*, *N. valachicus*, *N. tatrensis*, *N. aggtelekiensis*, *N. forroi*, *N. gebhardti*, *N. molnari*, *N. hungaricus* and *N. thermalis*.

***Niphargus* species which taxonomic state have been changed since their record or species which can not revealed from the Hungarian fauna:**

Niphargus pater MÉHELY, 1941

The description of the species is detailed and contains several drawings (Méhely 1941). The type locality is the Kisnyíres (Mesteacăn) Cave in Máramaros (Maramureş) county, which today belongs to Romania. Due to regular name changes occurred since then, the cave could not be undoubtedly identified.

***Niphargus baloghi* DUDICH, 1940**

The later literature often refers to this species as *N. puteanus baloghi* subspecies (e.g. Cărașu *et al.* 1955). The type localities are wells and streamlets around Kerecke (Kerecki) village (Dudich 1940), which now belongs to Ukraine, Svaliava district.

***Niphargus dudichi* HANKÓ, 1924**

The type localities of the species are around Nagysalló (Tekovské Lužany) village (Hankó 1924). Today this territory belongs to Slovakia. The description of the species is detailed with numerous drawings. Approximately 200 individuals can be found in the Hungarian Natural History Museum's collection, preserved from the original collecting.

***Niphargus stygius* (SCHIÖDTE, 1847)**

N. stygius is one of the earliest described niphargid species (Schiödte 1847), and served as the example for the genus description (Schiödte 1849). Its distribution area covers the North-West Dinaric Karst and the South Alps. The Hungarian mention by Frivaldszky (1865) from the Baradla Cave is clearly a misidentification, due to the limited number of species known back then. By its morphology, the specimens found in the Baradla Cave were closer to *N. stygius* than to the other three species (*N. longicaudatus* A. Costa, 1851, *N. puteanus* Koch, 1836 and *N. fontanus* Bate, 1859) that had been described until the first faunistic research of the cave. Data connected to this misidentification can also be found in later literature-based publications (Bokor 1921; Dudich 1924).

***Niphargus longicaudatus* (A. COSTA, 1851)**

The species originally appears in a fauna list as *Gammarus longicaudatus*, referring to specimens collected in wells around Naples (Costa 1851). The morphological description and drawings of the whole body and the gnathopods were published a few years later (Costa 1857). The currently known distribution of the species is rather wide ranging from Italy through the Balkans to Greece (e.g. G. S. Karaman 1989). The Hungarian mention (Schellenberg 1940) treats *N. hungaricus* as a subspecies of *N. longicaudatus*. Since this classification was not widely accepted, the Hungarian occurrence of the *N. longicaudatus* can be rejected.

***Niphargus puteanus* (C. L. KOCH, 1836)**

The species was originally described from wells of Weichselmühle village close to Regensburg (Koch 1836). As it is obvious in the case of other "early" *Niphargus* species, a notable part of the mentions is originated from misidentification of individuals of the later described species. The Hungarian occurrence of *N. puteanus* fits this pattern, however with some influence of geopolitical changes. Within the present territory of Hungary, Dudich (1926) refers to the specimens collected from Bátorliget-marshland as an unknown species from *N. puteanus* species group. Later he describes this species as *N. mediodanubialis* with wide Hungarian distribution (Dudich 1941b). One year later, in his publication about Bátorliget-marshland he mentions *N. puteanus* occurrences from Zagreb and Budapest, without going into details (Dudich 1927). In this article Dudich evaluated the reliability of Hungarian *Niphargus* data as: "...except the lately described *N. dudichi* HANKÓ and *N. Molnári* MÉHELÝ, only of historical value, since the taxonomy of the genus is in its early stage". The data about the occurrence in Budapest, as it becomes clear in a later work (Dudich 1941a), was cited from Tivadar Margó who identified specimens collected from the lake of Orczy-garden, Budapest as *N. puteanus* (Margó 1879), most likely erroneously. Further Hungarian *N. puteanus* mentions can be found due to the changes of the country boundaries about subspecies, like *N. puteanus banaticus* DOBREANU & MANOLACHE, 1936, *N. puteanus (illidzensis) dalmatinus* SCHÄFERNA, 1922 (Doboreanu & Manolache 1936) from present Romania and *N. puteanus baloghi* DUDICH, 1940 from present Ukraine. The last being originally described on species level as *N. baloghi* (Dudich 1940).

***Niphargus foreli* HUMBERT, 1876**

The species' distribution area is the Alps, where it typically inhabits deep alpine lake bottoms. The type locality is Lake Geneva (Humbert 1876). The mention of its Hungarian occurrence has a historical root. *N. gebhardti*, which occurs in the caves of the Mecsek Mts. (Southwest Hungary) was originally described as a subspecies of *N. foreli*, named *N. foreli gebhardti* (Schellenberg 1934).

***Niphargus leopoliensis* JAWOROWSKY, 1893**

The species was described based on specimens collected from a well in the city of Lwow, Poland (Jaworowsky 1893) which now belongs to Ukraine as Lviv. The mention of its Hungarian occurrence is related to the fact, that the *N. molnari* from the caves of the Mecsek Mts. (Southwest Hungary) was repeatedly treated as a subspecies of *N. leopoliensis*, named *N. leopoliensis molnari* by authors (Schellenberg 1933; Gebhardt 1963; 1967).

***Niphargus* species with uncertain taxonomic state:**

***Niphargus magyaricus* MÉHELÝ, 1941**

Méhely in one of his papers (Méhely 1941) used this name for the specimens collected in wells around Szeged (South Hungary). In this paper he gives information only about two morphological characters: the ratio of the length of the palmar spine of the first gnathopod and the length of the seta on the palmar spine, and the shape of the spines of the proventriculus. He also adds a drawing of the palmar corner of gnathopod I. (Fig. 1). The missing holotype, the inaccurate data on the type locality and the fact that these morphological characters are barely used in other descriptions, makes it really challenging if not impossible to evaluate this species. Therefore it should be treated as *species inquirenda*.

***Niphargus matrensis* MÉHELÝ, 1941**

This species name can be found in the same paper of Méhely (1941), referring to the specimens he collected in springs near Galyatető, Mátra Mts. (North Hungary). He presents only a drawing of the lacinia mobilis (Fig. 2). Due to the missing holotype, the incomparable description and the inaccurate data on the type locality, the species should be treated as *species inquirenda*.

***Niphargus mediodanubialis* DUDICH, 1941**

The taxonomical status of the *N. mediodanubialis* is doubtful. Dudich (1941b) in his description of the species compares it with *N. valachicus*, *N. hrabei* and *N. thermalis*. The specimens used for description were from different parts of Hungary, therefore he presents telson drawings on specimens from localities like Révfülöp, Rendes and Bátorliget (Fig. 3.) while stating that he considered the ones from swamps near Szeged (Southeast Hungary) as morphologically typical. In the same paper he describes a separate form by the shape of the telson from Révfülöp as *N. mediodanubialis f. aschizotelson*. Later on, S. Karaman (1950) synonymised the species with *N. valachicus*. In non-Hungarian articles this was widely accepted (e.g. Karaman G. S. 1972), while Hungarian authors usually stayed with the separate species name in papers on faunistic studies from different locations of Hungarian surface waters (River Danube, River Tisza backwaters, Lake Balaton, etc.) (Berczik 1966; Dudich 1967; Forró 1990; Lantos 1986; Megyeri 1953; Ponyi 1962; Stiller 1953). In the contrary, Muskó (1994) treats *N. mediodanubialis* as synonym of *N. valachicus*.

Currently valid indigenous *Niphargus* species:

***Niphargus hrabei* S. KARAMAN, 1932**

The species was originally described as *N. tatrensis hrabei* S. Karaman, 1932 from lakes near the village Párkány-Nána (Nana Parkan, Southern-Slovakia). The surface dwelling species is widely distributed in the Danube's middle and lower river basin (e.g. Sket 1994). In Hungary it occurs in lakes at Little Hungarian Plain, Great Hungarian Plain, River Danube, River Dráva and the Lake Balaton catchment area (Nosek & Oertel 1980; Borza *et al.* 2010; 2013). The type locality is currently heavily polluted, being a possible reason for our inability to find specimens there. Based on our preliminary morphological and genetic unpublished studies, *N. hrabei* is closely related to *N. thermalis*, therefore their taxonomical relationship needs to be investigated further.

***Niphargus valachicus* DOBREANU & MANOLACHE, 1933**

In Dobreanu and Manolache's (1933) species description, based on samples collected in the lake of the "Dimitrie Brândză" Botanical Garden (Bucharest, Romania), it appears as *N. tatrensis valachicus*. In this rather short paper they present some drawings on the pereopod dactylus, epimeral plates, the uropod III, the telson and the maxilla I., together with some comparison notes with *N. tatrensis hrabei* and *N. illidzenzis* Schäferna, 1922. A few

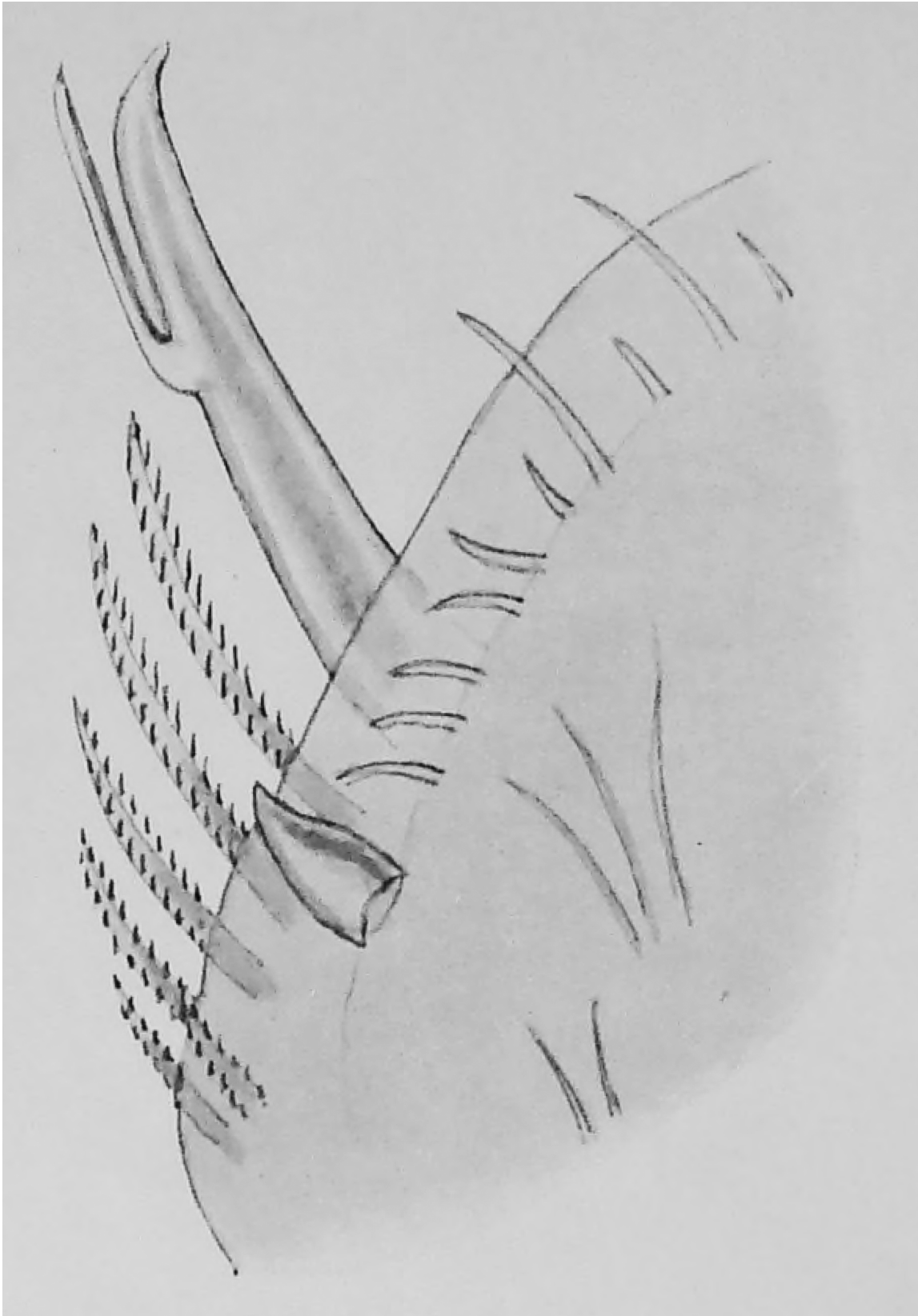


FIGURE 1. *N. magyaricus*, drawing on the palmar corner of the first gnathopod (Méhely 1941).



FIGURE 2. *N. matrensis*, drawing on the lacinia mobilis of the right mandible (Méhely 1941).

years later they treated it on a species level with the name *N. valachicus* (Doboreanu & Manolache 1936). The species is widely distributed across Europe, mainly in countries of the Danube catchment area (Sket 1981). S. Karaman (1950) in one of his works states that this is the same species as the one named *N. mediodanubialis* by Hungarian authors. The distribution of *N. valachicus* in Hungary is wide. There are regular records of relative high abundance from lakes and slow flowing river parts from the Great Hungarian Plain, and the catchment area of River Dráva, Lake Balaton, and River Tisza (Borza *et al.* 2010, 2013). Kontschán (2002, 2004) found the species in a small surface stream of the Vértes Mts., widening its possible habitat range. A paper about Crustaceans of Northwest Hungary (Kontschán *et al.* 2006) contains several new Hungarian distributional data from sites in catchment area of River Tisza, River Hernád and River Bodrog together with a short morphological description and a photograph. In a paper presenting keys for identification of the Hungarian amphipods (Kontschán *et al.* 2002) *N. valachicus* appears interestingly with the Hungarian name “középdunai vakbolharák” which is a loan translation and has been the common name for *N. mediodanubialis*.

***Niphargus tatrensis* WRZESNIEWSKY, 1890, *Niphargus aggtelekiensis* DUDICH, 1932**

Due to their close morphological relationship, these two species are to be evaluated as a single topic. The *N. tatrensis* was originally described from the foothills of the Polish Tatra from wells near Zakopane (Wrzesniewsky 1890). *N. tatrensis* is undoubtedly a valid species and its Hungarian occurrence is unquestionable while the taxonomic status of the *N. aggtelekiensis* is doubtful. During the detailed faunistic survey of the Baradla Cave, Dudich found out that the *Niphargus* inhabiting the cave were erroneously identified as *N. stygius*. Since it was clearly distinguishable from *N. stygius*, he identified it as a new species and described as *N. aggtelekiensis* (Dudich 1932, 1934). A few years later Schellenberg identified specimens from Domica Cave as *N. tatrensis* (Schellenberg 1938a). As the two caves are in fact one, and differ only in the name of the entrances (Baradla-Domica Cave System), this inconsistent species identification raised questions. Schellenberg had been trying to solve the taxonomical problems regarding to the great morphological variability of *N. tatrensis* for years (Schellenberg 1935; 1937), and distinguished seven forms, *N. tatrensis* f. *aggtelekiensis* being one of them (Schellenberg 1938b). The fact that there is a later paper by Dudich where he treats *N. aggtelekiensis* as a form of *N. tatrensis* like Schellenberg (Dudich 1941a), clearly shows his own doubts. According to our current knowledge, the *N. tatrensis* species complex contains populations that inhabit subterranean waters of higher than 400 meters altitude in

Slovenia, Austria, Hungary, Slovakia, Czech Republic and Poland. The Slovenian populations can be morphologically distinguished on species level as *N. scophicauda* FIŠER, 2010, while members of other populations do not provide clear morphological separations (Fišer *et al.* 2010). Fišer's study, based on museum samples, revealed the shape of the lateral margin of the telson and the number of flattened spines on the maxilliped inner lobe as more or less reliable characters for distinguishing *N. aggtelekiensis* (Fišer *et al.* 2010) as a species or even as a form. If we go with these characters, the *Niphargus* specimens we collected in the Bükk Mts. (Northeast Hungary) from permanent siphons of the Kecske-lyuk Cave, the Szepesi-Láner Cave System, the Szivárvány-Sebes Cave System, the Bolhási-Jávorkúti Cave System, the Speizi Cave and the István-Lápai Cave can be identified as *sensu stricto* *N. tatrensis*, while the ones we collected in the Aggtelek Karst from the flowing waters of the Kopolya Springcave, the main passage of the Baradla Cave, the Baradla Rövid-Alsó Cave, the Kossuth Cave and the Rákóczi 1. Cave can be identified as *N. aggtelekiensis* with smoother lateral telson margin and more flattened spines on the inner lobe of the maxilliped (Fig. 4). The clear separation and the valuation of the taxonomic level of *N. tatrensis*, *N. aggtelekiensis* and the other forms would require a wide molecular study based on samples collected from all of the 23 known populations.

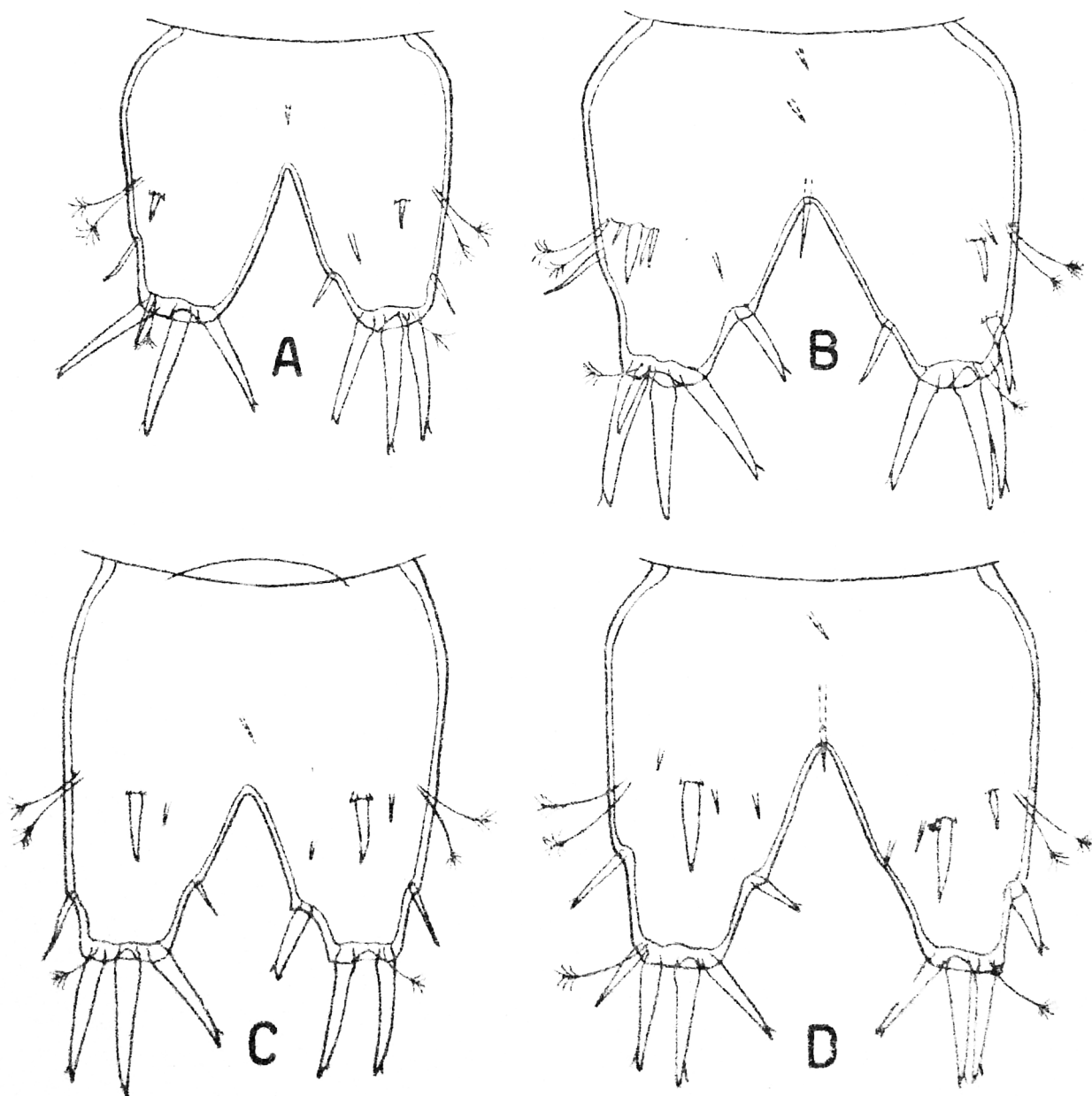


FIGURE 3. *N. mediodanubialis*, drawings on telsons (Dudich 1941). A: male from Rendes (Middle-West Hungary), B: female from Rendes, C: male from Révfülöp (Middle-West Hungary), D: female from Révfülöp.

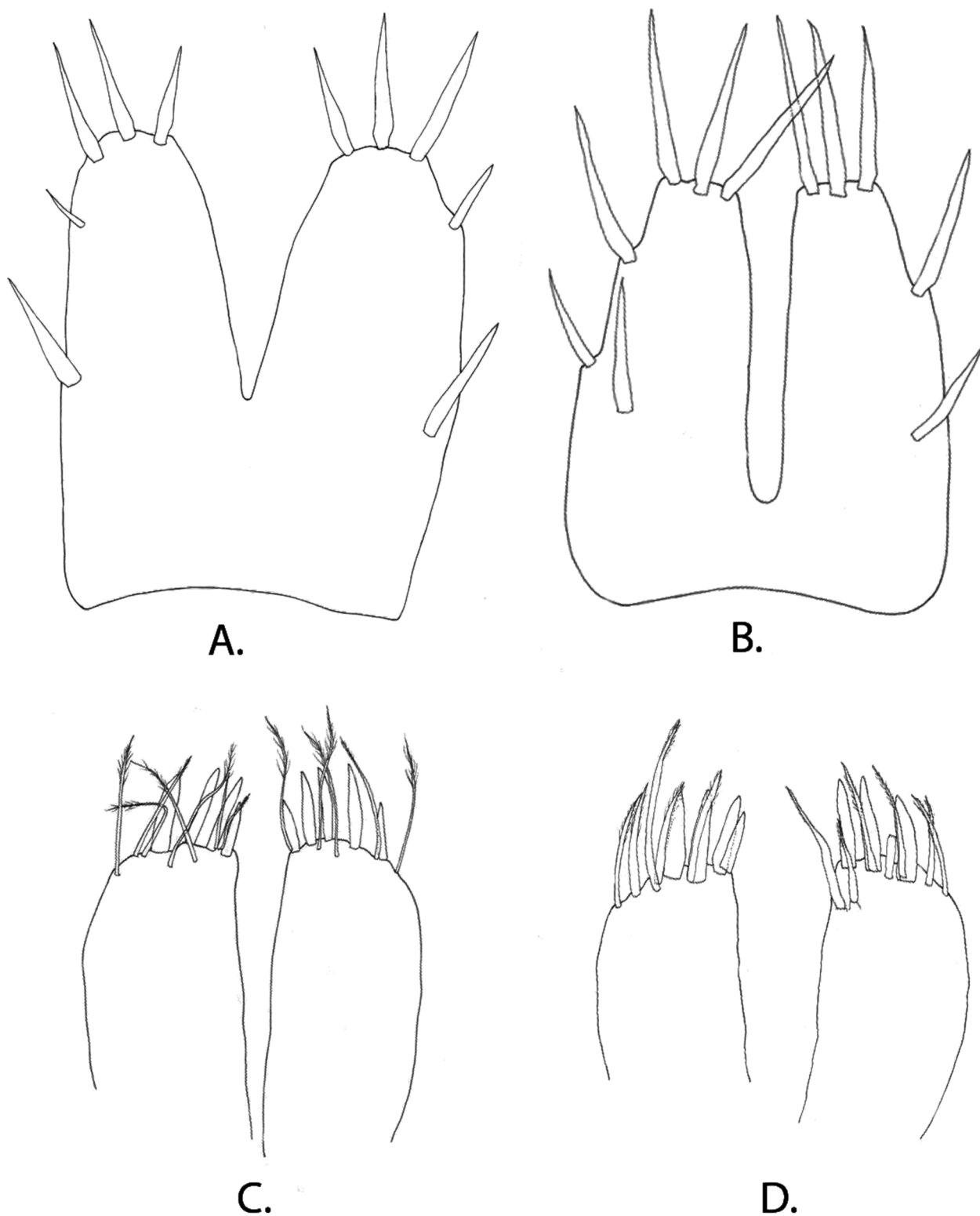


FIGURE 4. A. Telson of *N. aggtelekiensis* form Baradla Rövid Alsó Cave. B. Telson of *N. tatrensis* from the Szepesi-Láner Cave System. C. Maxilliped inner lobes of *N. aggtelekiensis* from Baradla Rövid Alsó Cave. D. Maxilliped inner lobes of *N. tatrensis* from Szepesi-Láner Cave System.

***Niphargus forroi* G. KARAMAN, 1986**

N. forroi was described from the Diabáz Cave (Bükk Mts., Northeast Hungary) by G. S. Karaman (G. S. Karaman 1986). The description is rather detailed and contains several drawings, thoroughly fulfilling the

requirements of a modern morphological description. The holotype is owned by the descriptor, however the paratypes can be found in the Collection of Crustacea of the Hungarian Natural History Museum. Prior to our investigations, the species was known only from the type locality. During our investigation carried out in the Bükk Mts., the species was found in the Szepesi-Láner Cave system, the Létrási-vizes Cave, the Szivárvány-Sebes Cave System, and the Speizi Cave too. In all locations the specimens were found in small pools formed by dripping water.

***Niphargus gebhardti* SCHELLENBERG, 1934**

The species was described by samples from pools of dripping water in the main passage of the Abaligeti Cave (Mecsek Mts., Southwest Hungary) originally as *Niphargus foreli gebhardti* subspecies (Schellenberg 1934). The description contains two drawings of the telson and the propodus of the second gnathopod and some information about the pereopods, antenna I and II, the maxilliped and the first maxilla. Later on, Schellenberg (1935) provides additional data on the telson and the body length, staying with the subspecies level. Since the presence of the *N. molnari* in the Abaligeti Cave had not been known that time, it is possible that this taxonomical rank by Schellenberg was caused by the mixed occurrence of *N. gebhardti* and *N. molnari* in samples from the Abaligeti Cave that he was examining. Thus it might have made him think characters fell in the variation range of the *N. foreli*'s. Méhélý (1941) together with data on the lacinia mobilis and a drawing of the retinacles changed the taxonomical rank using the name *N. gebhardti*. Antal Gebhardt presented further distributional data (Gebhardt 1934, 1963, 1967), always staying with the subspecies rank. The same subspecies ranking can be found in Dudich's work (1941a). The holotype is either in an unknown place or had been destroyed. Angyal & Balázs (2013a) collected the distinguishing characters of *N. gebhardti* and *N. molnari*, presenting comparative drawings of each of them. The sample collecting connected to the morphological work revealed new distributional data from the Mecsek Mts., namely: Vadetető Sinkhole, Szajha-felső Sinkhole, Spirál Sinkhole, Gilisztás Cave and Trió Cave (Angyal & Balázs 2013b).

***Niphargus molnari* MÉHELÝ, 1927**

The species was described from samples collected in streams of the Mánfai-kőlyuk Cave (Mecsek Mts., Southwest Hungary) (Méhélý 1927). Later it was found in the main stream of the Abaligeti Cave too (Gebhardt 1963). The original description is rather poor with only two drawings of the epimeral plates and the pereopod segments. Further drawing can be found in Méhélý's summarizing work (Méhélý 1941) of the right lacinia mobilis. Schellenberg (1933) mentions it as subspecies *N. leopoliensis molnari*, but later he treats on its original name and taxonomical rank again, presenting data about the seta number of the palpus of the first maxilla (Schellenberg 1935). The holotype is either in an unknown place or has been destroyed. Our sample collecting connected to the comparative morphological work revealed new distributional data from two caves (Vadetető Sinkhole and Spirál Sinkhole, Mecsek Mts., Southwest Hungary); these data are especially important since we could not find the species in its type locality, more likely caused by the anthropogenic changes of the cave (Angyal 2012).

***Niphargus hungaricus* MÉHELÝ, 1937**

N. hungaricus was described from some springs of the Kőszegi Mts. (Northwest Hungary) (Méhélý 1937). The type locality is the Jávör (Jámbor) Spring, while the other springs from where the paratypes were collected are not named. The description contains only few morphological data and does not contain any drawings. Méhélý, in his comprehensive study (1941), as an additional information published a drawing of the propodus of gnathopod I. (Fig. 5) and a formula about the pattern of its setae. Despite of our sampling efforts, specimen collection from the Jávör Spring was not successful neither in winter nor in summer. This could be attributed to the transformation of the spring's morphology since the description. Eszterhás (pers. comm.) had pointed out a new locality of the species, located in the same valley as the Jávör Spring, 300 meters from that in an abandoned mine tunnel. He found some specimens at the end of the tunnel (180 m) in small pools formed by percolated water. Individuals from this habitat were collected by us. The morphological characters were fitting with those published in the description.

***Niphargus thermalis* DUDICH, 1941**

First collection of the species was conducted by Dudich in 1926 in the Lake Malom of Lukács Bath (Budapest), however the description was published only in 1941 (Dudich 1941c). The paper, written in German is

rather detailed and contains many drawings. During the limnobiological investigations of Kender (1939), the species was found in high abundance in the lake. Later on though, only a single specimen was found by Berczik (1956). Drastical decrease of its abundance could be caused by the introduction of the guppy (*Poecilia reticulata*). This supposition was confirmed by stomach content analysis of some guppy individuals (Berczik 1956). We hypothesized that Lake Malom is not the only habitat of *N. thermalis* and that it may occur in the Molnár János Cave, as the two objects have direct hydrological connection. Therefore we laid an underwater live capture trap in the Kessler Hubert Hall of the cave in 2012, which was not successful. In 2013 though, we managed to collect some individuals by hand sorting, using cave diving techniques. In the same year *N. thermalis* individuals were collected from the plants of the Lake Malom and swimming specimens were also observed, which indicated that the species has not been extinct from the lake. Our morphological studies conducted on the cave population have shown that the characters are fitting with the ones that had been written in the description.

The *Niphargus* species are considered to show small distributional ranges (Trontelj *et al.* 2009) in general. Therefore we believe that it is important to present here new distributional data in case of the nine species with the indication of the type localities where we conducted collections and field studies during this survey (Table 1). The distribution of the species in Hungary and the type localities for species described from former Hungary before the border changes are also presented for better visualization (Fig. 6).

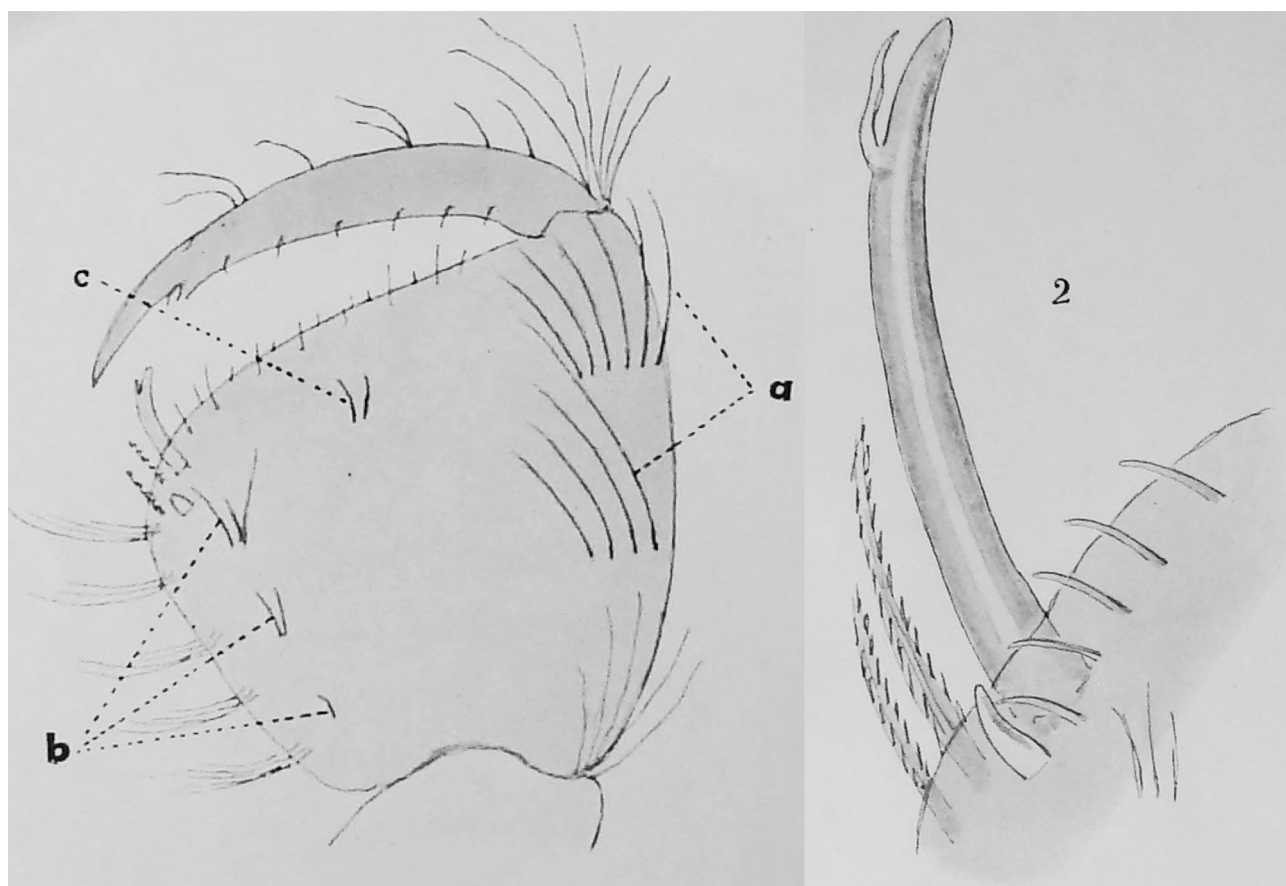


FIGURE 5. *N. hungaricus*, drawings on the propodus of the palmar corner of the first gnathopod (Méhely 1941).

Discussion

Since the first publication on *Niphargus* from Hungary (Frivaldszky 1865), dozens of studies were published, and besides sporadic reports, two influential Hungarian taxonomists had invested considerable efforts to reveal taxonomic and faunistic details of the Hungarian *Niphargus* fauna (see e.g. Dudich 1941a, Méhely 1941). However, our knowledge of the actual status was insufficient and the validity of the available data could be

questioned for at least two reasons: (i) the last species description was published ca. 30 years ago with the majority of publications coming from the middle of the 20th century and (ii) no review aiming to summarize and evaluate the available data has been compiled yet. Further, for various reasons, no type specimen and paratypes (with the exception of *N. forroi*), neither topotypes were available for the endemic Hungarian *Niphargus* taxa. Therefore, *Niphargus* taxonomy could be seen as an abandoned field in Hungary. As a result there is a gap in the knowledge of the biogeography, phylogeny and taxonomy of this European genus. Here, we compiled all literature publishing taxonomic or faunistic data on Hungarian *Niphargus*. Further, we collected topotypes for all endemic species to examine the validity of the published taxonomic status and distribution. We believe that this paper might serve as a baseline and springboard for the much needed future studies in this undeservedly neglected taxon.

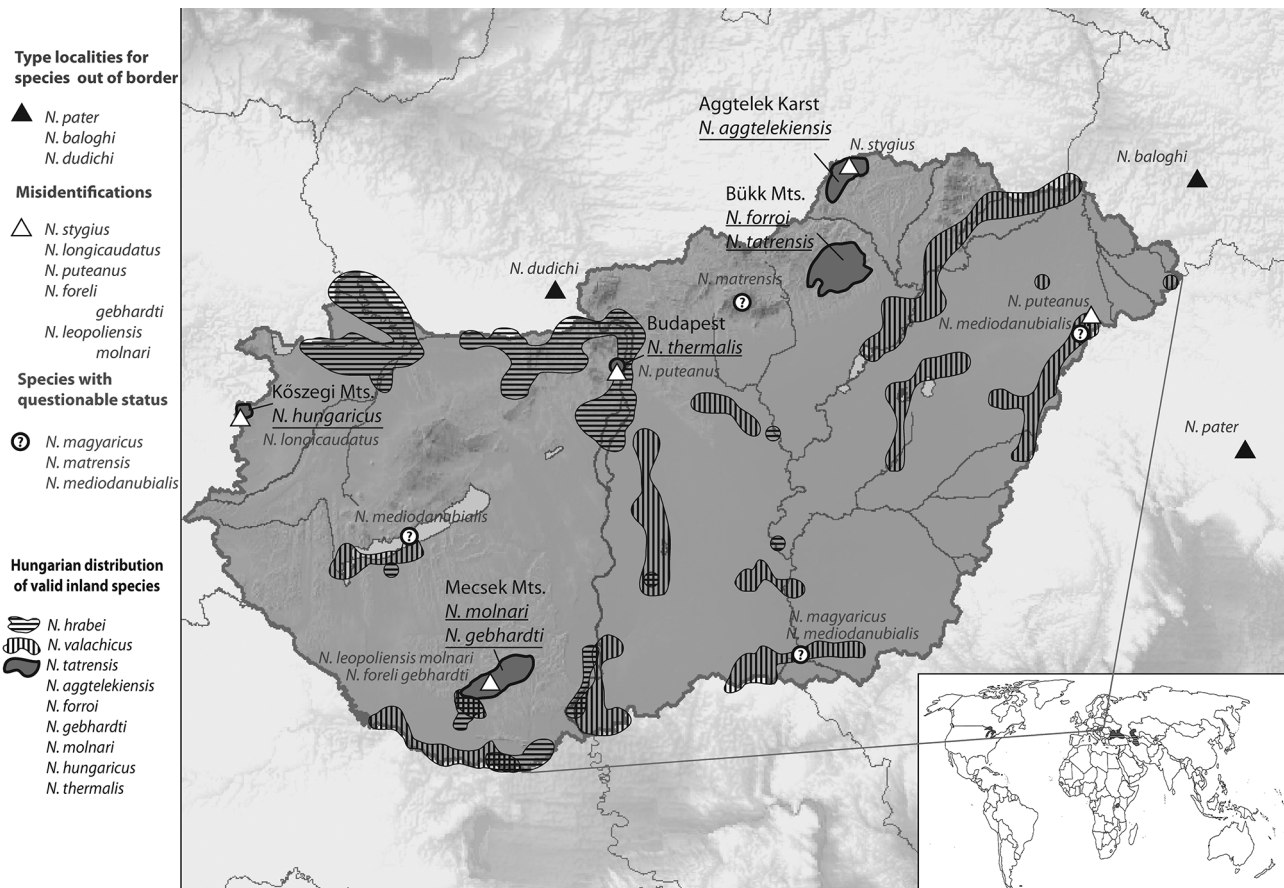


FIGURE 6. Hungarian distribution of valid and misidentified *Niphargus* species.

The literature listed 20 *Niphargus* species from Hungary. However, in some instances, species identification was speculative at best, based on an insufficient number or even type of characters (Dudich 1926). Further, especially in the early days, only a handful of species were known, hence, non-specialist zoologists simply chose the name of the most similar known species (Frivaldszky 1865) leading to great confusion. The situation was further complicated by the presence of *species inquirenda*, e.g. when new species names were given based on single characters without even exact information of the sampling localities (Méhely 1941). This situation led to a number of revisions and synonymisations, sometimes resulting in parallel nomenclature being in use. For instance, the species currently being accepted as *N. valachicus* was called *N. mediodanubialis* by Hungarian authors (Ponyi 1962), while other authors were using the correct name after the synonymisation published by S. Karaman (1950). In some cases, the historical change of political borders resulted in the exclusion of species from the current list of Hungarian species. It is noteworthy though that there are examples where species descriptions based on—by today's standards—questionable methodology turned out to be solid. A good example for this is *N. gebhardti*, which was first described as a subspecies (*N. foreli gebhardti*; Schellenberg 1934) but later was brought to species level based on the inclusion of a single new character (Méhely 1941). While probably such practice would be unacceptable today, the new taxonomic status stood the test of time. In sum, only nine out of the original twenty species proved to be valid and being part of the current Hungarian fauna at the same time.

TABLE 1. List of the valid Hungarian *Niphargus* species with additional data on distribution.

Species	Type locality	Recent presence in type locality	Region of the new localities visited by us	New locality, from where collection had been conducted by us	Coordinates of entrances
<i>Niphargus hrabei</i> S. KARAMAN, 1932	Slovakia , Nové Zámky, Backwater lakes at Nana-Parkan	absent			
<i>Niphargus valachicus</i> DOBREANU & MANOLACHE, 1933	Romania, Bucharest, "Dimitrie Brândză" Botanical Garden	not checked			
<i>Niphargus tatrensis</i> WRZESNIEWSKY, 1888	Poland, wells around Zakopane	not checked	Bükk Mts. (NE Hungary)	Bolhási-Jávorkúti Cave System, Jávorkúti Cave Szivárvány-Sebes Cave System, Szivárvány Cave Szivárvány-Sebes Cave System, Sebes Cave Kecske-lyuk Cave Speizi Cave István-lápai Cave Szepesi-Lánér Cave System, Szepesi Cave Baradla-Domica Cave System, Baradla Róvid-Alsó Cave Kopolya Springcave Kossuth Cave Rákóczi 1. Cave Létrási-vizes Cave Speizi Cave Szepesi-Lánér Cave System, Lánér Olivér Cave Szepesi-Lánér Cave System, Szepesi Cave	N 48° 6' 03,91", E 20° 32' 05,29" N 48° 6' 7,14", E 20° 33' 6,82" N 48° 6' 27,66", E 20° 33' 16,2" N 48° 7' 4,16", E 20° 38' 12,04" N 48° 6' 1,09", E 20° 35' 13,2" N 48° 5' 58,32" E 20° 36' 44,68" N 48° 5' 59,67", E 20° 35' 41,83" N 48° 29' 0,8", E 20° 32' 33,51" N 48° 29' 50,28", E 20° 37' 23,64", N 48° 29' 15,65", E 20° 33' 3,47", N 48° 31' 14,53", E 20° 44' 56,75", N 48° 6' 4,17", E 20° 34' 48,21", N 48° 6' 1,09", E 20° 35' 13,2", N 48° 6' 1,14", E 20° 35' 20,1", N 48° 5' 59,67", E 20° 35' 41,83"
<i>Niphargus aggtelekiensis</i> DUDICH, 1932	Hungary, Aggtelek Karst, Baradla Cave	present	Aggtelek Karst (NE Hungary)		
<i>Niphargus forroi</i> G. KARAMAN, 1986	Hungary, Bükk Mts., Diabáz Cave	present	Bükk Mts. (NE Hungary)		

.....continued on the next page

TABLE 1. (Continued)

Species	Type locality	Recent presence in type locality	Region of the new localities visited by us	New locality, from where collection had been conducted by us	Coordinates of entrances
<i>Niphargus gebhardti</i> SCHELLENBERG, 1934	Hungary, Mecsek Mts., Abaligeti Cave	present	Mecsek Mts. (SW Hungary)	Vadettős Sinkhole Szajha-felső Sinkhole Spirál Sinkhole Gilisziás Sinkhole Trió Cave	N 46° 07' 18,78" E 18° 06' 51,80" N 46° 8' 5,4", E 18° 7' 8,22" N 46° 07' 34,93", E 18° 10' 37,24" N 46° 7' 2,66", E 18° 9' 3,38" N 46° 07' 05,22", E 18° 09' 04,68"
<i>Niphargus molnari</i> MÉHELÛ, 1927	Hungary, Mecsek Mts., Mánfai-kőlyuk Cave	absent	Mecsek Mts. (SW Hungary)	Abaligeti Cave Vadettős Sinkhole	N 46° 08' 11,89", E 18° 06' 59,40" N 46° 07' 18,78" E 18° 06' 51,80" N 46° 07' 34,93", E 18° 10' 37,24"
<i>Niphargus hungaricus</i> MÉHELÛ, 1937	Hungary, Kőszegi Mts., Jávor Spring	absent (presents within 300 m from the type locality)	Kőszegi Mts. (NW Hungary)	Spirál Sinkhole Mine tunnel in Borha valley, near Velem	N 47° 21' 4,68", E 16° 29' 3,6"
<i>Niphargus thermalis</i> DUDICH, 1941	Hungary, Budapest, Lake Malom (Lukács Bath)	present	Budapest (Central Hungary)	Molnár János Cave	N 47° 31' 5,28", E 19° 2' 8,98"

Not only nomenclature was problematic *per se*, but the complete lack of museum material, including both type specimens and paratypes (with the exception of *N. forroi*) for the endemic Hungarian *Niphargus* species posed a serious shortcoming. The only way to circumvent this problem was to revisit the type localities and to collect new samples. It was impossible for *N. molnari*, where the *locus typicus* as a natural habitat was severely damaged by human activity (Angyal 2012) and for *N. hungaricus*, where the morphology of the type locality changed so much (it was an open spring orifice originally, now the water is filtrating through the sediment) that it became impossible to sample without invasive, habitat-altering techniques. In the above two cases, we sampled the closest possible habitat. In addition to resampling the *locus typicus* or the closest possible site, we also checked as many as possible suitable habitats representing the given geographical unit. We deposited the new topotypes in the Hungarian Natural History Museum together with samples from the new sites. In all cases, the original species was successfully confirmed based on the original description from the type localities or the nearby localities. Note that evaluating the validity of the original descriptions was out of the scope of the present paper.

Altogether, we validated the previously described Hungarian *Niphargus* species based on the original descriptions and updated their distributional data. This is particularly important, because a clear taxonomical and faunistic background is essential basically for any sound biological study targeting questions from intraspecific to interspecific level in any taxa. We hope that our work will facilitate research aiming to understand the phylogeography of the genus in the Carpathian Basin, which is necessary to resolve a number of yet unanswered questions in the evolutionary history of the genus in its whole distribution area. In fact, we are currently working on the genetic-based systematics of the discussed species. Future aims should include the identification of potential new species and re-description of the old species based on state of the art and standardized methodology (Fišer *et al.* 2009; Lefébure *et al.* 2006).

Acknowledgement

We are grateful to the following persons for their help in assembling all the literature related to the Hungarian species: Cene Fišer (University of Ljubljana), László Forró, László Dányi, Zoltán Korsós and Katalin Kovács from the Department of Zoology of the Hungarian Natural History Museum, and to Jenő Kotschán (Hungarian Academy of Sciences, Plant Protection Institute). Our thanks are due to our speleologist and zoologist colleagues for their help in sample collection, namely László Dányi and Dávid Murányi (Hungarian Natural History Museum, Department of Zoology), Andrea Illés, Zoltán Tegzes and Artúr Nyíró from the Pro Natura Karst and Cave Research Society, Márton Mede and Szabolcs Storoszinszky from the Amphora Diver Club. Jenő Kotschán and Gábor Herczeg are gratefully acknowledged for their valuable advices regarding our manuscript.

References

- Angyal, D. (2012) A Mátfai-kőlyuk gerinctelen faunájának alakulása a vízmű általi hasznosítás tükrében – előzetes eredmények. *Természetvédelmi Közlemények*, 18, 24–33.
- Angyal, D. & Balázs, G. (2013a) Distinguishing characters of *Niphargus gebhardti* Schellenberg, 1934 and *Niphargus molnari* Mehely, 1927 (Crustacea: Amphipoda): a clarification. *Opuscula Zoologica, Budapest*, 44 (1), 3–8.
- Angyal, D. & Balázs, G. (2013b) New data to the distribution of four aquatic troglobiont macroinvertebrate species in some caves of the Mecsek Mountains (SW Hungary). In: Filippi, M. & Bosák, P. (Eds.), *Proceedings of the 16th International Congress of Speleology, 21th to 28th July, 2013. Brno, Czech Republic, Proceedings, Volume 2*. Czech Speleological Society, Praha, pp. 426–429.
- Bajomi, D. (1969) Examen faunistique de la grotte “Météor” (Hongrie) (Biospeleologia Hungarica, XXIX). *Opuscula Zoologica, Budapest*, 9, 235–247.
- Balázs, G. & Angyal, D. (2013) Chase in history after the *Niphargus* (Crustacea) species of Hungary. In: Filippi, M. & Bosák, P. (Eds.), *Proceedings of the 16th International Congress of Speleology, 21th to 28th July, 2013. Brno, Czech Republic, Proceedings, Volume 2*. Czech Speleological Society, Praha, pp. 1–383.
- Berczik, Á. (1956) Újabb hidrobiológiai vizsgálatok a Lukács gyógyfürdő Malom-taván. *Állattani Közlemények*, 45, 35–44.
- Berczik, Á. (1966) Über die Wasserfauna im Anland des Ungarischen Donauabschnittes (Danubialia Hungarica XXXV). *Opuscula Zoologica, Budapest*, 6 (1), 79–91.
- Bokor, E. (1921) A magyarhoni barlangok ízeltlábúi. Arthropoden der ungarischen Grotten. *Barlangkutatás*, 9, 45–49.
- Borza, P., Nosek, J. & Oertel, N. (2010) Contribution to the macroinvertebrate fauna of the Hungarian Danube. V. Amphipods

- (Crustacea: Malacostraca: Amphipoda) *Folia Historico Naturalia Musei Matrensis*, 34, 17–27.
- Borza, P., Cser, B., Czirok, A., Deák, Cs., Ficsór, M., Horvai, V., Horváth, Zs., Kovács, K., Petri, A. & Vad, Cs. (2013) *Adatok a síkvidéki felszíni Niphargus-fajok* (Crustacea, Amphipoda, Niphargidae) magyarországi elterjedéséhez. *X. Makroszkopikus Vízi Gerinctelenek Kutatási Konferencia, Szalafő, abstract book*, 21 pp.
- Cărașu, S., Doboreanu, E. & Manolache, C. (1955) Amphipoda, *Fauna României*, Ed. Academia Române, 4, 310–311.
- Costa, A. (1851) In: Hope, F., W. *Catalogo Dei Crostacei Italiani E Di Molti Altri Del Mediterraneo*. Naples, 23 pp.
- Costa, A. (1857) Ricerche sui crostacei Amfipodi del regno di Napoli. *Memorie della Reale Accademia de Scienze di Napoli*, Naples, pp. 165–235.
- Doboreanu, E. & Manolache, C. (1933) Beitrag zur Kenntnis der Amphipodenfauna Rumäniens. *Notationes Biologicae, Bucarest*, 1 (3), 103–108.
- Doboreanu, E. & Manolache, C. (1936) Zur Kenntnis der Amphipodenfauna Rumäniens. *Bulletin. de la section. scientifique, Académie roumaine*, T. XVIII, Bucuresti
- Dudich, E. (1924) Eine für Ungarn neue Amphipoden-Art. *Annales Historico-Naturales Musei Nationalis Hungarici*, 21, 1–244.
- Dudich, E. (1926) Faunisztikai jegyzetek II. *Állattani Közlemények*, 23, 87–96.
- Dudich, E. (1927) Új rákfajok Magyarország faunájában. Neue Krebstiere in der Fauna Ungarns. *Archivum Balatonicum*, 1 (3), 343–387.
- Dudich, E. (1932) Biologie der Aggteleker Tropfsteinhöhle „Baradla“ in Ungarn. *Speläologische Monographien*, 13, 1–246.
- Dudich, E. (1934) Vak rákok. *Természettudományi Közöny*, 66, 175–178.
- Dudich, E. (1940) Ein neuer *Niphargus* aus Ungarn. *Fragmenta Faunistica Hungarica* 3, Supplement: 16 pages. *Niphargus Baloghi* sp. n.
- Dudich, E. (1941a) Die im Gebiete des historischen Ungarn nachgewiesenen Amphipoden. *Fragmenta Faunistica Hungarica*, 4 (1–4), 14–20.
- Dudich, E. (1941b) *Niphargus mediodanubialis* sp. nov., die am weitesten verbreitete *Niphargus*-Art des mittleren Donaubecken. *Fragmenta Faunistica Hungarica*, 4, 61–73.
- Dudich, E. (1941c) *Niphargus* aus einer Therme von Budapest. *Annales Historico-Naturales Musei Nationalis Hungarici*, 34 (Zool.), 165–176.
- Dudich, E. (1967) Systematisches Verzeichnis der Tierwelt der Donau mit einer zusammenfassenden Erläuterung. In: Liepolt, R. (Ed.), *Limnologie der Donau Stuttgart*, pp. 4–69.
- Fišer, C., Trontelj, P., Luštrik, R. & Sket, B. (2009) Towards a unified taxonomy of *Niphargus* (Crustacea: Amphipoda): a review of morphological variability. *Zootaxa*, 2061, 1–22.
- Fišer, C., Coleman, C.O., Zagmajster, M., Zwitnig, B., Gerecke, R. & Sket, B. (2010) Old museum samples and recent taxonomy: A taxonomic, biogeographic and conservation perspective of the *Niphargus tatrensis* species complex (Crustacea: Amphipoda). *Organisms Diversity and Evolution*, 10, 5–22.
<http://dx.doi.org/10.1007/s13127-010-0006-2>
- Forró, L. (1990) Aquatic crustaceans in the “Bátorligeti láp” Nature Reserve in NE Hungary. In: Mahunka, S. (Ed.), *The Bátorliget Nature Reserves – after forty years*. Studia Naturalia, Budapest, pp. 245–250.
- Frivaldszky, J. (1865) Adatok a magyarhoni barlangok faunájához. *Mathematikai és Természettudományi Közlemények*, III, 17–53.
- Gebhardt, A. (1934) Az Abaligeti barlang élővilága. *Mathematikai és Természettudományi Közlemények*, 37, 1–264.
- Gebhardt, A. (1963) A Mecsek hegység barlangjainak biológiai vizsgálata. *Janus Pannonius Múzeum Évkönyve*, 8, 5–32.
- Gebhardt, A. (1967) A Mecsek hegység állatvilágának térbeli elterjedése élőhelyek szerint. *Janus Pannonius Múzeum Évkönyve*, 12, 7–14.
- Hankó, B. (1924) Eine neue Amphipoden-Art aus Ungarn. *Annales Historico-Naturales Musei Nationalis Hungarici*, 21, 61–66.
- Humbert, A. (1876) Le *Niphargus puteanus* var. *Forelii*. *Bulletin de la Societe Vaudoise des Sciences Naturelles*, 14 (2), 278–398.
- Jaworowsky, A. (1893) Fauna studzienna Miast Krakowa i Lwowa. Akademia Umiejetnosci, Krakow, Kimisya Fizyograficana, *Sprawozdanie Komisji Fizyograficznej*, pp. 29–48.
- Karaman, S. (1932) 5. Beitrag zur Kenntnis der Süßwasser-Amphipoden (Amphipoden unterirdischer Gewässer). *Prirodoslovne razprave, Ljubljana*, 2, 179–232.
- Karaman, S. (1950) *Niphargus smederevanus* N. sp. aus Nordserbien. *Srpska Akademija Nauka* 2. 1950, 1–9.
- Karaman, G.S. (1972) Catalogus Faunae Jugoslaviae, Crustacea Amphipoda (Contribution to the Knowledge of the Amphipoda 60). – *Consilium Academicarum Scientiarum Rei Publicae Socialisticae Foederativae Jugoslaviae, Academia Scientiarum et Artium Slovenica, Ljubljana*, 3 (3), 1–44.
- Karaman, G.S. (1986) One new species of family Niphargidae (Gammaridea), *Niphargus forroi* sp. n. from Hungary. *Acta Zoologica Academiae Scientiarum Hungaricae*, 32, 61–72.
- Karaman, G.S. (1989) New species of the family Niphargidae and new localities of some other subterranean Gammaridean species from Yugoslavia (Contribution to the knowledge of the Amphipoda 166) *Glasnik Republičkog Zavoda za Zaštitu Prirode – Prirodnjackog Muzea, Titograd*, 19, 15–32.
- Kender, J. (1939) A Szent Lukács-fürdő tavának limno-biológiai vizsgálata. *Palaestra Calasactiana*, 25, 1–24.

- Koch, C.L. (1836) *Deutschlands Crustaceen Myriapoden und Arachniden*. In: Panzer, G.W.F. (Ed.), *Herrich-Schaeffer's Deutschlands Insecten*, vol. 5, Regensburg.
- Kontschán, J. (2002) A Dunántúli-középhegység (Gerecse, Vértes és Bakony-vidék) Peracarida faunája. I. vízi fajok (Amphipoda et Isopoda: Asellota). *Folia Historico-Naturalis Bakonyensis Zirc*, 19-2000 (2002), 24–30.
- Kontschán, J., Muskó, I. & Murányi, D. (2002) A felszíni vizekben előforduló felemáslábú rákok (Crustacea: Amphipoda) rövid határozója és előfordulásuk Magyarországon. *Folia Historico-naturalia Musei Matraensis*, 25, 151–157.
- Kontschán, J. (2004) The aquatic Amphipoda and Isopoda (Crustacea) of the Transdanubian Mountains in Northwest Hungary. *Lauterbornia*, 49, 73–76.
- Kontschán, J., Hegyessy, G. & Csordás, B. (2006) Abaúj és Zemplén tájainak makroszkopikus rákjai (Crustacea). *Információk Északkelet-Magyarország természeti értékeiről: 5. Abaúj-Zemplén Értékeiért Közhasznú Egyesület, Sátoraljaújhely*, 2006.
- Lantos, G. (1986) Data to the Amphipoda and Isopoda fauna of Töserdő and its environs in the Tisza valley. I. Amphipoda, Asellota (Crustacea, Peracarida). *Tiscia*, 21, 81–84.
- Lefébure, T., Douady, C.J., Gouy, M. & Gibert, J. (2006) Relationship between morphological taxonomy and molecular divergence within Crustacea: Proposal of a molecular threshold to help species delimitation. *Molecular Phylogenetics and Evolution*, 40, 435–447.
<http://dx.doi.org/10.1016/j.ympev.2006.03.014>
- Margó, T. (1879) *Budapest környéke állattani tekintetben*. Budapest, 1879, 1–41.
- Megyeri, J. (1953) Bátorliget rák-faunája. In: Székessy, V. (Ed.), *Bátorliget élővilága*. Akadémiai Kiadó, Budapest, pp. 146–154.
- Méhely, L. (1927) *Új férgek és rákok a magyar faunában. Neue Würmer und Krebse aus Ungarn*. Budapest, 1927, 1–19.
- Méhely, L. (1937) *Niphargus hungaricus*, ein neuer Amphipode aus Ungarn. *Zoologischer Anzeiger*, 120, 117–119.
- Méhely, L. (1941) A *Niphargus*-kutatás új útjai. *Neue Wege der Niphargus-Forschung. Budapest 1941*, 1–36.
- Muskó, I. (1994) Occurrence of Amphipoda in Hungary since 1853. *Crustaceana*, 66 (2), 144–152.
- Muskó, I. (2007) Checklist of Hungarian Malacostraca. Available from: http://www.freeweb.hu/mavige/dokument/hungarian_malacostraca_checklist.pdf (accessed 16 December 2014)
- Nosek, J.N. & Oertel, N. (1980): Zoologische Untersuchungen an Aufwüchsen in der Donau zwischen Rajka und Budapest. *Annales Universitatis Scientiarum Budapestinensis de Rolando Eötvös Nominatae Sectio Biologica*, 22–23, 187–204.
- Ponyi, J. (1962) Zoologische Untersuchung der Röhrichte des Balaton. I. Krebse (Crustacea). *Annales Instituti Biologici*, 29, 129–163.
- Schellenberg, A. (1933) Weitere deutsche und ausländische *Niphargiden*. *Zoologischer Anzeiger*, 102, 22–23.
- Schellenberg, A. (1934) Amphipoden aus Quellen, Seen und Höhlen. *Zoologischer Anzeiger*, 106, 200–209.
- Schellenberg, A. (1935) Schlüssel der Amphipodengattung *Niphargus* mit Fundortangaben und mehreren neuen Formen. *Zoologischer Anzeiger*, 111, 204–211.
- Schellenberg, A. (1937) Bemerkungen zu meinem *Niphargus*-Schlüssel und zur Verbreitung und Variabilität der Arten, nebst Beschreibung neuer *Niphargus*-Formen. *Mitteilungen aus dem Zoologischen Museum in Berlin*, 22, 1–30.
<http://dx.doi.org/10.1002/mmzn.19370220102>
- Schellenberg, A. (1938a) Tschechoslowakische Amphipoden. *Zoologischer Anzeiger*, 121, 239–244.
- Schellenberg, A. (1938b) Alters-, Geschlechts- und Individualunterschiede des Amphipoden *Niphargus tatrensis* f. *aggtelekiensis* Dudich. *Zoologische Jahrbücher (Syst)*, 71, 191–202.
- Schellenberg, A. (1940) Subterrane Amphipoden Osteuropas, ihre Variabilität und ihre verwandtschaftliche Beziehungen. *Zoologische Jahrbücher (Syst)*, 74, 243–268.
- Schiödte, J.C. (1847) Undersogelser over den underjordiske Fauna i Hulerne i Krain og Istrien. *Oversigt over det Kongelige danske Videnskabernes Selskabs Forhandling og dets Medlemmers Arbejder i Aaret*, 4, 75–82.
- Schiödte, J.C. (1849) Bidrag til den underjordiske Fauna. *Det kongelige danske Videnskabernes Selskabs Skrifter. Femte Raekke. Naturvidenskabelig og mathematisk Afdeling. Andet Bind. Kjobenhavn*, 2 (5), 1–39.
- Sket, B. (1981) Razširjenost, ekološki značaj in filogenetski pomen panonske slepe postranice *Niphargus valachicus* (Amphipoda, Gammaridae) (Distribution, ecological character, and phylogenetic importance of *Niphargus valachicus*). *Biološki Vestnik : Glasilo Slovenskih Biologov*, 29 (1), 87–103.
- Sket, B. (1994) Distribution patterns of some subterranean Crustacea in the territory of the former Yugoslavia. *Hydrobiologia*, 287, 65–75.
<http://dx.doi.org/10.1007/BF00006897>
- Stiller, J. (1953) Bátorliget limnológiai viszonyai. In: Székessy, V. (Ed.), *Bátorliget élővilága*. Akadémiai Kiadó, Budapest, pp. 75–100.
- Trontelj, P., Douady, C.J., Fišer, C., Gibert, J., Gorički, Š., Lefébure, T., Sket, B. & Zakšek, V. (2009) A molecular test for cryptic diversity in groundwater: how large are the ranges of macro-stygobionts? *Freshwater Biology*, 54, 727–744.
<http://dx.doi.org/10.1111/j.1365-2427.2007.01877.x>
- Wrzesniowski, A. (1890) Über drei unterirdische Gammariden. *Zeitschrift für wissenschaftliche Zoologie*, 50, 600–724.