*Zootaxa* 3893 (2): 243–260
www.mapress.com/zootaxa/
Copyright © 2014 Magnolia Press

**Article**

ISSN 1175-5326 (print edition)
**ZOOTAXA**
ISSN 1175-5334 (online edition)

http://dx.doi.org/10.11646/zootaxa.3893.2.5
http://zoobank.org/urn:lsid:zoobank.org:pub:8336FFDA-F1A5-4026-A5B6-CCEBFF84F40A

# Zoogeography of epigean freshwater Amphipoda (Crustacea) in Romania: fragmented distributions and wide altitudinal variability

DENIS COPILAȘ-CIOCIANU[1], MICHAŁ GRABOWSKI[2], LUCIAN PÂRVULESCU[3] & ADAM PETRUSEK[1]

[1]*Charles University in Prague, Faculty of Science, Department of Ecology, Viničná 7, 12844, Prague, Czech Republic. E-mail: denis.copilas@yahoo.com, adam.petrusek@natur.cuni.cz*

[2]*University of Łódź, Faculty of Biology and Environmental Protection, Department of Invertebrate Zoology & Hydrobiology, Banacha 12/16, 90-237, Łódź, Poland. E-mail: michalg@biol.uni.lodz.pl*

[3]*West University of Timişoara, Faculty of Chemistry, Biology, Geography, Department of Biology and Chemistry, Pestalozzi 16A, 300115, Timişoara, Romania. E-mail: lucian.parvulescu@e-uvt.ro*

## Abstract

Inland epigean freshwater amphipods of Romania are diverse and abundant for this region has a favourable geographical position between the Balkans and the Black Sea. Excluding Ponto-Caspian species originating in brackish waters and freshwater subterranean taxa, there are 11 formally recognized epigean freshwater species recorded from this country. They belong to 3 genera, each representing a different family: *Gammarus* (Gammaridae, 8 species or species complexes), *Niphargus* (Niphargidae, 2 epigean species) and *Synurella* (Crangonyctidae, one species). Their large-scale distribution patterns nevertheless remain obscure due to insufficient data, consequently limiting biogeographical interpretations. We provide extensive new data with high resolution distribution maps, thus improving the knowledge of the ranges of these taxa. *Gammarus* species display substantial altitudinal variability and patchy, fragmented distribution patterns. They occur abundantly, particularly in springs and streams, from lowlands to sub-mountainous and mountainous regions. In the light of recent molecular research, we hypothesize that the complex geomorphological dynamics of the Carpathian region during the Late Tertiary probably contributed to their allopatric distribution pattern. Contrasting with *Gammarus*, the genera *Niphargus* and *Synurella* exhibit low altitudinal variability, broad ecological valences and overlapping distributions, being widespread throughout the lowlands. The current distribution of *N. hrabei* and *N. valachicus* seems to be linked to the extent of the Paratethys during the Early Pliocene or Pleistocene. We further discuss the taxonomic validity of two synonymized and one apparently undescribed taxon, and provide an updated pictorial identification key that includes all taxa and forms discussed in our study. The mosaic distribution of epigean freshwater amphipod species in Romania shows that this region is particularly suitable for phylo- and biogeographical analyses of this group.

**Key words:** geographic range, distribution patterns, habitat preferences, allopatry, sympatry, *Gammarus*, *Niphargus*, *Synurella*

## Introduction

Distribution patterns offer valuable insights towards understanding historical factors that have shaped the contemporary distributions of species (Brown *et al.* 1996). Freshwater amphipod crustaceans are particularly suitable for biogeographical studies because of their restricted dispersal capabilities and the fragmentary nature of freshwater habitats (Väinölä *et al.* 2008; Hou *et al.* 2011). Amphipods are predominantly aquatic benthic animals that do not possess free-swimming larval stages or resistant propagules, and thus are prone to genetic differentiation and isolation (J.L. Barnard & C.M. Barnard 1983). Furthermore, many freshwater taxa display allopatric or discontinuous distributions, frequently presumed to result from vicariant events of geological origin, such as island separation, sea level fluctuations, and continental break up, or that follow ancient drainage patterns (Hogg *et al.* 2006; Finston *et al.* 2007; Bauzà-Ribot *et al.* 2011, 2012).

The European continent is inhabited by a relatively high number of freshwater amphipod species with diversity increasing towards the south-east (Väinölä *et al.* 2008). The diversity of the amphipod fauna of Romania is rich due to the favourable geographical position of the country, being situated at the edge of the Balkan Peninsula and the

 *Accepted by J. Lowry: 28 Oct. 2014; published: 8 Dec. 2014*
*Licensed under a Creative Commons Attribution License http://creativecommons.org/licenses/by/3.0*

## References


Akbulut, M., Sezgin, M., Çulha, M. & Bat, L. (2001) On the occurrence of *Niphargus valachicus* Dobreanu & Manolache, 1933 (Amphipoda, Gammaridae) in the Western Black Sea Region of Turkey. *Turkish Journal of Zoology*, 25, 235–239.

Bálint, M., Ujvárosi, L., Theissinger, K., Lehrian, S., Meszaros, N. & Pauls, S.U. (2011) The Carpathians as a Major Diversity Hotspot in Europe. *In*: Zachos, F.E. & Habel, J.C. (Eds.), *Biodiversity Hotspots*. Springer-Verlag, Berlin, pp. 189–205.

Barnard, J.L. & Barnard, C.M. (1983) *Freshwater Amphipoda of the World*. Hayfield Associates. Mt. Vernon, Virginia, 830 pp.

Bauzà-Ribot, M.M., Jaume, D., Fornós, J.J., Juan, C. & Pons, J. (2011) Islands beneath islands: phylogeography of a groundwater amphipod crustacean in the Balearic archipelago. *BMC Evolutionary Biology*, 11, 221. http://dx.doi.org/10.1186/1471-2148-11-221

Bauzà-Ribot, M.M., Juan, C., Nardi, F., Oromí, P., Pons, J. & Jaume, D. (2012) Mitogenomic phylogenetic analysis supports continental-scale vicariance in subterranean thalassoid crustaceans. *Current Biology*, 22, 2069–2074. http://dx.doi.org/10.1016/j.cub.2012.09.012

Brown, J.H., Stevens, G.C. & Kaufman, D.M. (1996) The geographic range: Size, Shape, Boundaries, and Internal Structure. *Annual Review of Ecology, Evolution, and Systematics*, 27, 597–623. http://dx.doi.org/10.1146/annurev.ecolsys.27.1.597

Cărăuşu, S., Dobreanu, E. & Manolache, C. (1955) *Fauna Republicii Populare Romîne. Crustacea. Amphipoda Forme Salmastre şi de Apă Dulce.* Editura Academiei RPR, Bucharest, 407 pp.

Copilaş-Ciocianu, D. & Pârvulescu, L. (2012) Faunistic overview upon the aquatic malacostracans (Crustacea, Malacostraca) of Cefa Nature Park (Crişana, Romania). *Transylvanian Review of Systematical and Ecological Research*, 13, 99–106.

Copilaş-Ciocianu, D. (2013) *Gammarus komareki* Schäferna, 1922 (Peracarida, Amphipoda), a new amphipod species for the Romanian fauna, with remarks on its biogeography. *Crustaceana*, 86, 673–681. http://dx.doi.org/10.1163/15685403-00003201

Copilaş-Ciocianu, D., Grabowski, M., Pârvulescu, L. & Petrusek, A. (2014) Data from: Zoogeography of epigean freshwater Amphipoda (Crustacea) in Romania: fragmented distributions and wide altitudinal variability. *Dryad Digital Repository*. http://dx.doi.org/10.5061/dryad.fd8m9

Dancău, D. (1972) L'etat actuel de nos connaissances sur le genre *Niphargus* en Roumanie. Actes du I[er] Colloque International sur le genere *Niphargus*. *Museo Civico di Storia Naturale di Verona Memorie Fuori,* 5, 55–59.

Dick, J.T.A., Faloon, S.E. & Elwood, R.W. (1998) Active brood care in an amphipod: influences of embryonic development, temperature and oxygen. *Animal Behaviour*, 56**,** 663–672. http://dx.doi.org/10.1006/anbe.1998.0797

Dobreanu, E. & Manolache, C. (1933) Beitrag zur Kenntnis der Amphipodenfauna Rumaniens. *Notationes Biologicae*, 1, 103–108.

Fabricius, J.C. (1775) *Systema Entomologiae, sistens insectorum classes, ordines, genera, species, adiectis synonymis, locis, descriptionibus, observationibus*. Officina Libraria Kortii, Flensburg and Leipzig, Germany, 832 pp.

Finston, T.L., Johnson, M.S., Humphreys, W.F., Eberhard, S.M. & Halse, S.A. (2007) Cryptic speciation in two widespread subterranean amphipod genera reflects historical drainage patterns in an ancient landscape. *Molecular Ecology*, 16, 355–365. http://dx.doi.org/10.1111/j.1365-294X.2006.03123.x

Fišer, C., Çamur-Elipek, B. & Özbek, M. (2009) The subterranean genus *Niphargus* (Crustacea,Amphipoda) in the Middle East: A faunistic overview with descriptions of two new species. *Zoologischer Anzeiger*, 248, 137–150. http://dx.doi.org/10.1016/j.jcz.2009.03.003

Flot, J.F., Bauermeister, J., Brad, T., Hillebrand-Voiculescu, A., Sarbu, S.M. & Dattagupta, S. (2014) *Niphargus–Thiothrix* associations may be widespread in sulphidic groundwater ecosystems: evidence from southeastern Romania. *Molecular Ecology*, 23, 1405–1417. http://dx.doi.org/10.1111/mec.12461

Gervais, M. (1835) Note sur deux espèces de Crevettes qui vivent aux environs de Paris. *Annales des sciences naturelles*, 4, 127–128.

Grabowski, M. & Pešič, V. (2007) New data on the distribution and checklist of fresh- and brackishwater Gammaridae, Pontogammaridae and Behningiellidae (Amphipoda) in Bulgaria. *Lauterbornia*, 59, 53–62.

Grabowski, M. & Mamos, T. (2011) Contact zones, range boundaries, and vertical distribution of three epigean gammarids (Amphipoda) in the Sudeten and Carpathian mountains (Poland). *Crustaceana*, 84, 153–168. http://dx.doi.org/10.1163/001121611X554328

Harzhauser, M. & Piller, W.E. (2007) Benchmark data of a changing sea — Palaeogeography, Palaeobiogeography and events in the Central Paratethys during the Miocene. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 253**,** 8–31. http://dx.doi.org/10.1016/j.palaeo.2007.03.031

Hekmataraa, M., Zakšek, V., Heidari Baladehi, M. & Fišer, C. (2013) Two new species of *Niphargus* (Crustacea: Amphipoda) from Iran. *Journal of Natural History*, 47, 1421–1449. http://dx.doi.org/10.1080/00222933.2012.743616

Hogg, I.D., Stevens, M.I., Schnabel, K.E. & Chapman, M.A. (2006) Deeply divergent lineages of the widespread New Zealand amphipod *Paracalliope fluviatilis* revealed using allozyme and mitochondrial DNA analyses. *Freshwater Biology*, 51, 236–248. http://dx.doi.org/10.1111/j.1365-2427.2005.01491.x

Holsinger, J.R. (1994) Pattern and process in the biogeography of subterranean amphipods. *Hydrobiogia*, 87, 131–145.

Hou, Z., Fu, J. & Li, S. (2007) A molecular phylogeny of the genus *Gammarus* (Crustacea: Amphipoda) based on mitochondrial and nuclear gene sequences. *Molecular Phylogenetics and Evolution,* 45, 596–611. http://dx.doi.org/10.1016/j.ympev.2007.06.006

Hou, Z., Sket, B., Fišer, C. & Li, S. (2011) Eocene habitat shift from saline to freshwater promoted Tethyan amphipod diversification. *Proceedings of the National Academy of Sciences of the United States of America,* 108, 14533-14538. http://dx.doi.org/10.1073/pnas.1104636108

Hou, Z., Sket, B. & Li, S. (2013) Phylogenetic analyses of Gammaridae crustacean reveal different diversification patterns among sister lineages in the Tethyan region. *Cladistics*, 30, 352–365. http://dx.doi.org/10.1111/cla.12055

Jażdżewski, K. & Konopacka, A. (1989) *Gammarus leopoliensis* nov.sp. (Crustacea, Amphipoda) from Eastern Carpathians. *Bulletin of the Zoological Museum of the University of Amsterdam*, 11 (23), 185–196.

Jażdżewski, K. & Kupryjanowicz, J. (2010) One more fossil niphargid (Malacostraca: Amphipoda) from Baltic amber. *Journal of Crustacean Biology*, 30, 413–416. http://dx.doi.org/10.1651/09-3259.1

Jażdżewski, K. & Roux, A.L. (1988) Biogéographie de *Gammarus roeselii* Gervais en Europe, en particulier répartition en France et en Pologne. *Crustaceana*, Supplement 13, 272–277.

Jażdżewski, K., Grabowski, M. & Kupryjanowicz, J. (2014) Further records of Amphipoda from Baltic Eocene amber with first evidence of prae-copulatory behaviour in a fossil amphipod and remarks on the taxonomic position of *Palaeogammarus* Zaddach, 1864. *Zootaxa*, 3665 (5), 401–417. http://dx.doi.org/10.11646/zootaxa.3765.5.1

Juhász, P., Kovács, K., Szabó, T., Csipkés, R., Kiss, B. & Müller, Z. (2006) Faunistical results of the Malacostraca investigations carried out in the frames of the ecological survey of the surface waters of Hungary (ECOSURV) in 2005. *Folia Historico Naturalia Musei Matraensis*, 30, 319–323.

Karaman, G.S. (1974) Genus *Synurella* Wrzes. in Yugoslavia with remarks on its all World known species, their synonymy, bibliography and distribution (fam. Gammaridae). Contribution to the knowledge of the Amphipoda 58. *Poljoprivreda i Šumarstvo*, 20, 83–133.

Karaman, G.S. (1975) 56. Contribution to the knowledge of the Amphipoda. Several new and very interesting *Gammarus* species from Asia Minor (fam. Gammaridae). *Bollettino del Museo Civico di Storia Naturale di Verona*, 1, 311–343.

Karaman, G.S. & Pinkster, S. (1977a) Freshwater *Gammarus* species from Europe, North Africa and adjacent regions of Asia (Crustacea-Amphipoda). Part I *Gammarus pulex*-group and related species. *Bijdragen Tot De Dierkunde*, 47, 1–97.

Karaman, G.S. & Pinkster, S. (1977b) Freshwater *Gammarus* species from Europe, North Africa and adjacent regions of Asia (Crustacea-Amphipoda). Part II *Gammarus roeselii*-group and related species. *Bijdragen Tot De Dierkunde*, 47, 165–196.

Karaman, G.S. & Pinkster, S. (1987) Freshwater *Gammarus* species from Europe, North Africa and adjacent regions of Asia (Crustacea – Amphipoda). Part III. *Gammarus balcanicus*-group and related species. *Bijdragen tot de Dierkunde*, 57, 207–260.

Karaman, S. (1929) Beitrag zur Kenntnis der Amphipoden Jugoslaviens. *Glasnik Zemaljskog museja Bosni i Hercegovine*, 41, 83–99.

Karaman, S. (1932) Beitrag zur Kenntnis der Susswasser Amphipoden. *Prirodoslovne razprave*, 1, 179–232.

Ketelaars, H.A.M. (2004) Range extensions of Ponto-Caspian aquatic invertebrates in continental Europe. *In*: Dumont, J.H., Shiganova, T.A. & Niermann, U. (Eds.), *Aquatic Invasions in the Black, Caspian, and Mediterranean Seas*. Kluwer Academic Publishers. Amsterdam, Netherlands, pp. 209–236.

Koch, C.L. (1836) Deutschlands Crustaceen, Myriapoden und Arachniden. *Ein Beitrag zur Deutschen Fauna*, 5, 1–24. [in Panzer]

Konopacka, A. & Blazewicz-Paszkowycz, M. (2000) Life history of *Synurella ambulans* (F. Müller, 1846) (Amphipoda, Crangonyctidae) from central Poland. *Polskie Archiwum Hydrobiologii*, 47, 597–605.

Kováč, M., Andreyeva-Grigorovich, A., Bajraktarević, Z., Brzobohatý, R., Filipescu, S., Fodor, L., Harzhauser, M., Nagymarosy, A., Oszczypko, N., Pavelić, D., Rögl, F., Saftić, B., Sliva, L. & Studencka, B. (2007) Badenian evolution of the Central Paratethys Sea: paleogeography, climate and eustatic sea-level changes. *Geologica Carpathica*, 58, 579–606.

Linnaeus, C. (1758) *Systema naturæ per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Tomus I. Editio decima, reformata. Stockholm, 824 pp.

Luštrik, R., Turjak, M., Kralj-Fišer, S. & Fišer, C. (2011) Coexistence of surface and cave amphipods in an ecotone environment. *Contributions to Zoology*, 80, 133–141.

MacNeil, C., Dick, J.T.A. & Elwood, R.W. (1997) The trophic ecology of freshwater *Gammarus* spp. (Crustacea: Amphipoda): problems and perspectives concerning the functional feeding group concept. *Biological Reviews*, 72, 349–364. http://dx.doi.org/10.1111/j.1469-185X.1997.tb00017.x

MacNeil, C., Elwood, R.W. & Dick, J.T.A. (1999) Differential microdistributions and interspecific interactions in coexisting *Gammarus* and *Crangonyx* amphipods. *Ecography*, 22, 415–423. http://dx.doi.org/10.1111/j.1600-0587.1999.tb00578.x

MacNeil, C. & Dick, J.T.A. (2012) Intraguild predation may reinforce a species environment gradient. *Acta Oecologica,* 41, 90–94. http://dx.doi.org/10.1016/j.actao.2012.04.012

Mamos, T., Wattier, R., Majda, A., Sket, B. & Grabowski, M. (2014) Morphological vs. molecular delineation of taxa across montane regions in Europe: The case study of *Gammarus balcanicus* Schäferna, 1922 (Crustacea: Amphipoda). *Journal of Zoological Systematics & Evolutionary Research,* 52 (3), 237–248. http://dx.doi.org/10.1111/jzs.12062

McInerney, C.I., Maurice, L., Robertson, A.L., Knight, L.R.F.D., Arnscheidt, J., Venditti, C., Dooley, J.S.G., Mathers, T., Matthijs, S., Eriksson, K., Proudlove, G.S. & Hänfling, B. (2014) The Ancient Britons: Groundwater fauna survived extreme climate changes over tens of millions of years across NW Europe. *Molecular Ecology*, 23, 1153–1166. http://dx.doi.org/10.1111/mec.12664

Meijering, M.P.D., Jazdzewski, K. & Kohn, J. (1995) Ecotypes of Amphipoda in Central European inland waters. *Polskie Archiwum Hydrobiologii*, 42, 527–536.

Moran, P.A.P. (1950) Notes on continuous stochastic phenomena. *Biometrika,* 37, 17–23.

Motaş, C., Botoşăneanu, L. & Negrea, Ş. (1962) *Cercetări asupra biologiei izvoarelor şi apelor freatice din partea centrală a Cîmpiei Romîne.* Editura Academiei RPR, Bucharest, 366 pp.

Müller, F. (1846) Ueber *Gammarus ambulans*, neue Art. *Archiv für Naturgeschichte*, 12, 296–300.

Müller, J. (1998) Genetic population structure of two cryptic *Gammarus fossarum* types across a contact zone. *Journal of Evolutionary Biology*, 11, 79–101. http://dx.doi.org/1420-9101.1998.11010079.x

Nesemann, H., Pöckl, M. & Wittmann, K.J. (1995) Distribution of epigean Malacostraca in the middle and upper Danube (Hungary, Austria, Germany). *Miscellanea Zoologica Hungarica*, 10, 49–68.

Notenboom, J. (1991) Marine regressions and the evolution of groundwater dwelling amphipods (Crustacea). *Journal of Biogeography*, 18, 437–454. http://dx.doi.org/10.2307/2845485

Özbek, M. & Ustaoğlu, R. (2006) Check-list of Malacostraca (Crustacea) Species of Turkish Inland Waters. *Ege Journal of Fisheries and Aquatic Sciences*, 23, 229–234.

Özbek, M., Balik, S. & Topkara, E.T. (2009) Contribution to the Knowledge on the Distribution of Malacostraca (Crustacea) Species of Central and Southern Anatolia, with Some Ecological Notes. *Turkish Journal of Zoology*, 33, 47–55.

Papp, J., Kovács, K. & Kontschán, J. (2008) Asellota and Amphipoda species from Maramureş. *Studia Universitatis "Vasile Goldis", Seria Stiintele Vietii*, Life Sciences Series, 18, 181–184.

Papp, J. & Kontschán, J. (2011) First record of *Gammarus leopoliensis* Jazdzewski & Konopacka, 1989 (Peracarida, Amphipoda) from Hungary. *Crustaceana*, 84, 419–423. http://dx.doi.org/10.1163/001121611X559242

Paraschiv, G.M., Schroder, V., Samargiu, M.D. & Sava, D. (2007) Ecological study of zoobenthos communities from the Matita and Merhei lakes (Danube Delta). *Research Journal of Agricultural Science*, 39, 498–498.

Pârvulescu, L. (2008) The aquatic malacostracean fauna (Crustacea: Malacostraca) from the Mehedinţi Plateau Rivers. *Studia Universitatis Babeş-Bolyai – Biologia*, 53, 17–24.

Pârvulescu, L. (2009) The epigean freshwater malacostracans (Crustacea: Malacostraca) of the rivers in the Anina Mountains (SW Romania). *Studia Universitatis Babeş–Bolyai Biologia*, 54, 3–17.

Pârvulescu, L. & Hamchevici, C. (2010) The relation between water quality and the distribution of *Gammarus balcanicus* Schäferna, 1922 (Amphipoda: Gammaridae) in the Anina Mountains. *Carpathian Journal of Earth and Environmental Sciences*, 5, 161–168.

Petrescu, I. (1994) Contribution to the knowledge of amphipods (Crustacea) from Romania. II. *Gammarus aequicauda* (Martynov), *G. balcanicus* Schäferna and *Orchestia cavimana* Heller. *Travaux Du Museum d'Histoire Naturelle "Grigore Antipa"*, 14, 303–324.

Petrescu, I. (1996) Contributions to the knowledge of amphipods (Crustacea: Amphipoda) from Romania. III. Amphipods from south-western Dobrogea. *Travaux Du Museum d'Histoire Naturelle "Grigore Antipa"*, 36, 185–216.

Petrescu, I. (1997a) Contributions to the knowledge of amphipods (Crustacea: Amphipoda) from Romania. IV. Amphipods from Iza Basin (Maramureş). *Travaux Du Museum d'Histoire Naturelle "Grigore Antipa"*, 37, 167–192.

Petrescu, I. (1997b) Contributions to the knowledge of amphipods (Crustacea: Amphipoda) from Romania. 5. Amphipods from Săpânţa Basin (Maramureş). *Travaux Du Museum d'Histoire Naturelle "Grigore Antipa"*, 39, 345–359.

Petrescu, I. (1998) Contributions to the knowledge of amphipods (Crustacea: Amphipoda) from Romania. 6. Amphipods from Vişeu Basin (Maramureş, Romania). *Travaux Du Museum d'Histoire Naturelle "Grigore Antipa"*, 40, 497–507.

Petrescu, I. (2000) Situatia actuala a cunoasterii faunei de amfipode dulcicole (Crustacea) din Romania. *Armonii Naturale*, 3, 350–362.

Petrescu, I. (2009) New mentions of amphipods (Crustacea: Amphipoda) from Romanian waters of the Danube. *Travaux Du Museum d'Histoire Naturelle "Grigore Antipa"*, 52, 73–86.

Popov, S.V., Rögl, F., Rozanov, A.Y., Steiniger, F.F., Shcherba, I.G. & Kovac, M. (2004) Lithological-Paleogeographic maps of Paratethys: 10 maps Late Eocene to Pliocene. *Courier Forschunginstitut Senckenberg*, 250, 1–46.

Rangel, T.F., Diniz-Filho, J.A.F. & Bini, L.M. (2010) SAM: a comprehensive application for Spatial Analysis in Macroecology. *Ecography,* 33, 46–50. http://dx.doi.org/10.1111/j.1600-0587.2009.06299.x

Schäferna, K. (1922) Amphipoda balcanica, spolu s poznámkami o jiných sladkovodních Amphipodech. *Věstník Královské české společnosti nauk,* 2, 1–111.

Scheepmaker, M. (1990) Genetic differentiation and estimated levels of gene flow in members of the *Gammarus pulex*-group (Crustacea, Amphipoda) in western Europe. *Bijdragen Tot De Dierkunde*, 60, 3–30.

Schellenberg, A. (1937) Kritische Bemerkungen zur Systematik der Süsswassergammariden. *Zoologische Jahrbuecher Systematik*, 69, 469–516.

Schiödte, J.C. (1849) Bidrag til den underjordiske Fauna. *Kongelige Danske Videnskabernes Selskabs Skrifter, Naturvidenskabelig og Mathematisk Afdeling*, Series 5, 2, 1–39.

Schmitt, T. (2007) Molecular biogeography of Europe: Pleistocene cycles and postglacial trends. *Frontiers in Zoology*, 4, 11. http://dx.doi.org/10.1186/1742-9994-4-11
Sidorov, D. & Palatov, D. (2012) Taxonomy of the spring dwelling amphipod *Synurella ambulans* (Crustacea: Crangonyctidae) in West Russia: with notes on its distribution and ecology. *European Journal of Taxonomy*, 23, 1–19.
Sket, B. (1999) The nature of biodiversity in hypogean waters and how it is endangered. *Biodiversity and Conservation*, 8, 1319–1338.
Simčič, T. & Brancelj, A. (2006) Effects of pH on electron transport system (ETS) activity and oxygen consumption in *Gammarus fossarum*, *Asellus aquaticus* and *Niphargus sphagnicolus*. *Freshwater Biology*, 51, 686–694. http://dx.doi.org/10.1111/j.1365-2427.2006.01522.x
Straškraba, M. (1972) L'etat actuel de nos connaissances sur le genre *Niphargus* en Tchecoslovaquie et dans les pays voisins. Actes du I$^{er}$ Colloque International sur le genere *Niphargus*. *Museo Civico di Storia Naturale di Verona Memorie Fuori*, 5, 35–45.
Väinölä, R., Witt, J.D.S., Grabowski, M., Bradbury, J.H., Jazdzewski, K. & Sket, B. (2008) Global diversity of amphipods (Amphipoda; Crustacea) in freshwater. *Hydrobiologia,* 595, 241–255. http://dx.doi.org/10.1007/s10750-007-9020-6
Weiss, M., Macher, J.N., Seefeldt, M.A., Leese, F (2013) Molecular evidence for further overlooked species within the *Gammarus fossarum* complex (Crustacea: Amphipoda). *Hydrobiologia*, 721, 165–184. http://dx.doi.org/10.1007/s10750-013-1658-7
Wysocka, A., Grabowski, M., Sworobowicz, L., Mamos, T., Burzyński, A. & Sell, J. (2014) Origin of the Lake Ohrid gammarid species flock: ancient local phylogenetic lineage diversification. *Journal of Biogeography*, 41 (9), 1758–1768. http://dx.doi.org/10.1111/jbi.12335
Wrzesniowski, A.W. (1877) Ueber die Anatomie der Amphipoden. *Zeitschrift fur Wissenschaftliche Zoologie,* 28, 403–418. [Leipzig]
Zamanpoore, M., Grabowski, M., Poeckl, M. & Schiemer, M. (2011) Taxonomic review of freshwater *Gammarus* (Crustacea: Amphipoda) from Iran. *Zootaxa*, 3140, 1–14.

## Pictorial identification key to the epigean freshwater *Gammarus*, *Niphargus* and *Synurella* species of Romania

This key should be used as a complement to other identification resources rather than alone.

Meaning of abbreviations: A1—first antenna, antennules; A2—second antenna; E2—second epimeral plate; E3—third epimeral plate; P6—sixth pereiopod; P7—seventh pereiopod; U3— third uropod.

| | | |
|---|---|---|
| 1a. | Eyes present | 2 |
| 1b. | Eyes absent | 13 |
| 2a. | Urosome segments fused | *S. ambulans* |
| 2b. | Urosome segments free | 3 |
| 3a. | Metasome segments with large dorsal spines | *G. roeseli* |
| 3b. | Metasome segments without dorsal spines | 4 |
| 4a. | Setation of external margin of U3 outer ramus is scarce and as long as or shorter than the width of underlying segment | 5 |
| 4b. | Setation of external margin of U3 outer ramus is dense and longer than the width of the underlying segment | 7 |
| 5a. | Postero-inferior corner of E2 pointed, 4 setae on the dorso-posterior side of metasome segments | *G. balcanicus dacicus* |
| 5b. | Postero-inferior corner of E2 straight/slightly pointed, many setae on the dorso-posterior side of metasome segments | 6 |
| 6a. | Body length up to 8 mm, inner ramus of U3 is half length of the outer ramus | *G. balcanicus montanus* |
| 6b. | Body length longer than 8 mm, inner ramus of U3 is longer than half length of the outer ramus | *G. balcanicus* |
| 7a. | Setation of A2 peduncle dense and ca. 2x longer than the width of the underlying segment | *G. komareki* |
| 7b. | Setation of A2 peduncle scarce and shorter than or slightly exceeding the width of the underlying segment | 8 |
| 8a. | Flagellum of A2 swollen and bearing flag-like brush of setae as long as or exceeding the width of the underlying segment | *G. pulex* |
| 8b. | Flagellum of A2 slender | 9 |
| 9a. | Inner ramus of U3 reaches at most half length of the outer ramus | *G. fossarum* |
| 9b. | Inner ramus of U3 is longer than half length of the outer ramus | 10 |
| 10a. | Posteroinferior surface of P7 basis with setae, distal margin of E2 setiferous | *G. arduus* |
| 10b. | Posteroinferior surface of P7 basis without setae, distal margin of E2 not setiferous | 11 |
| 11a. | Postero-inferior corners of E2 & E3 pointed, upper quarter of external margin of U3 outer ramus setiferous | *G.* cf. *kischineffensis* |
| 11b. | Postero-inferior corner of E2 straight, upper half of external margin of U3 outer ramus setiferous | 12 |
| 12a. | First and 2$^{nd}$ peduncle segments of A1 have equal lengths, flagellum of A2 without calceoli | *G. leopoliensis* |
| 12b. | First peduncle segment of A1 longer than the 2$^{nd}$ one, flagellum of A2 with calceoli | *G. kischineffensis* |
| 13a. | Dactylus of P6 and P7 bears 1 spine | *N. hrabei* |
| 13b. | Dactylus of P6 and P7 bears at least 5 spines | *N. valachicus* |