Subterranean Biology 23: 1–18 (2017)
doi: 10.3897/subtbiol.23.11877
http://subtbiol.pensoft.net

REVIEW ARTICLE

A peer-reviewed open-access journal
Subterranean Biology
Published by The International Society for Subterranean Biology

An overview of stygobiontic invertebrates of Poland based on published data

Elzbieta Dumnicka[1], Joanna Galas[1]

1 *Institute of Nature Conservation, Polish Academy of Sciences, al. A. Mickiewicza 33, 31–120 Kraków, Poland*

Corresponding author: *Elzbieta Dumnicka* (dumnicka@iop.krakow.pl)

Academic editor: *O. Moldovan* | Received 19 January 2017 | Accepted 13 June 2017 | Published 7 August 2017

http://zoobank.org/F13694C6-935A-4070-AB3C-EBB0104BC0F0

Citation: Dumnicka E, Galas J (2017) An overview of stygobiontic invertebrates of Poland based on published data. Subterranean Biology 23: 1–18. https://doi.org/10.3897/subtbiol.23.11877

Abstract

Based on published literature, at least eighty species of stygobiontic invertebrates are confirmed in Poland. The highest number of these species is found in interstitial waters and wells, while a lower number was discovered in caves and springs. Hydrachnidia is represented by 45 species living mainly in interstitial waters, Crustacea by 24, Annelida by eleven species, while Turbellaria and Gastropoda are each represented by one species. As many as 14 endemic species were described from Poland but the taxonomical status of some of them is unclear. The highest number of stygobionts was stated in southern part of Poland, an area onto which most of the studies were focused on.

Keywords

subterranean fauna, checklist, caves, wells, springs, interstitial waters

Introduction

Various classifications of subterranean aquatic habitats were made over the years (e.g., Thienemann 1926, Botosaneanu 1986) and occasionally some have been evaluated (Culver and Pipan 2011, Gutjahr et al. 2014). Stygobiontic invertebrates inhabit shallow underground waters, access to which is possible through caves, springs, and wells (Gibert et al. 1994, Gunn 2004) as well as through other man-made subterranean habitats such as adits, shafts or mines. Moreover, obligate subterranean fauna living in interstitial waters beneath streams and rivers (the hyporheic zone) and in the spaces among alluvial sediments deposited along the banks also is recognized as stygobiontic.

Literature reviews of subterranean invertebrates have been published from different perspectives, including a focus on obligate subterranean fauna in one country (Reboleira et al. 2012), for the whole cave fauna in one country (Strouhal and Vornatscher 1975, Kováč et al. 2014) or for particular taxonomic groups in selected geographic regions, such as shrimps (Anker 2008) or annelids (Martínez-Ansemíl et al. 2016, Artheau and Giani 2006).

In Poland, the southern part of the country has been the focus area for studies involving aquatic subterranean fauna and, to a lesser degree, the central parts of the country; unfortunately, there is little to no information from the northern regions. Moreover, for some taxonomic groups with stygobionts there are no detailed studies – i.e. there is almost a complete lack of information concerning Turbellaria and Copepoda. Even in the case of the Amphipoda, intensively investigated by Skalski (Table 1; entry no. 73–79, Hydrachnidia studied by Biesiadka (Table 1; entry no. 2–7, 9) and Ostracoda studied by Sywula and Namiotko (Table 1; entry no. 1, 64, 85–88, 90, 91) there have been no publications in recent years. Only Oligochaeta (Table 1; no 14–24, 28, 30–33, 35, 42–44, 46–48, 63) have been studied by Dumnicka and co-workers up to now. The only checklist of Polish troglobionts and stygobionts was compiled by Skalski (1981) as an appendix in a local journal. He stated the presence of 54 species. Thus, there is a need, after more than 35 years, to compile and update the list of stygobionts.

Methods

Species found on the present territory of Poland were taken into consideration. Papers with data concerning Polish aquatic subterranean fauna are scattered. We reviewed journal literature, conference abstracts, and monographs, but did not include synopses, reviews and syntheses based on previously published original papers.

Species names follow Fauna Europea (http://www.faunaeur.org). When the species is not included in Fauna Europea or incorrect information was published in it (as in the case of *Crangonyx paxi* – see Table 1) "Fauna of Poland" (Bogdanowicz et al., 2004, 2008) was referred to.

Results

Source publications and analysis of species taxonomical status

The literature concerning Polish invertebrate fauna from subterranean waters (including stygophiles and stygoxenes) is limited. Since the end of the 19th century, when the description of *Niphargus tatrensis* was published (Table 1; entry no 95), around 100 papers have contributed to the stygobiontic fauna of Poland. Relatively few studies reported on the fauna of subterranean waters prior to the 1960s, with most publications occurring from 1960 to 1999 (Fig. 1).

Table 1. List of stygobiontic species known of Poland and their association with the geographic regions and habitats. Abbreviations of geographic names: B. – Beskid Mts; K.-Cz. – Kraków-Częstochowa; Depr. – Depression; Lakel. – Lakeland; Up. – Upland; Val. – Valley. Abbreviations of habitat names: AS – artificial subterranean habitats; C – caves; HR – hypotelminorheic habitat; I – interstitial waters; SP – springs; SW – surface waters; W – wells.

Group/ Species	Region	Habitat	References
Tricladida			
Dendrocoelum cf. *carpaticum* Komarek, 1919	Małopolska Gap	W	79
Annelida			
Troglochaetus beranecki Delachaux, 1921	Kłodzko Basin	C	84
Cernosvitoviella parviseta Gadzińska, 1974	Łask Up., Kłodzko Basin, B. Śląski Mts, Tatra Mts	C,W	20, 23, 30, 35
Enchytraeus dominicae Dumnicka, 1976 E	K.-Cz. Up., Tatra Mts, Świętokrzyskie Mts, Kłodzko Basin, Łask Up.	C, W, I	14, 16, 20, 33
Enchytraeus polonicus Dumnicka, 1977 E	K.-Cz. Up.	C	15, 17
Gianius aquaedulcis (Hrabě, 1960)	K.-Cz. Up.	SP	24
Haber speciosus (Hrabě, 1931)	B. Śląski Mts	W	42
Rhyacodrilus subterraneus Hrabě, 1963	K.-Cz. Up., Ełk Lakel.	W, I	28, 29
Trichodrilus cernosvitovi Hrabě, 1937	Tatra Mts, Pieniny Mts, K.-Cz. Up.	I, SP, SW	20, 22, 47, 48
Trichodrilus moravicus Hrabě, 1937	Tatra, B. Śląski Mts, Pieniny Mts, K.-Cz. Up., Kłodzko Basin	C, I, SW, W	18, 20, 23, 28, 47
Trichodrilus pragensis Vejdovský, 1876	Kłodzko Basin	C	20
Trichodrilus spelaeus Moszyński, 1936 E	Kłodzko Basin	AS	63
Trichodrilus sp. juv. Claparède, 1862	Małopolska Gap	W	X
Amphipoda			
Crangonyx paxi [§] Schellenberg, 1935 E	Kłodzko Basin	AS, SP	71, 82
Gammarus pulex polonensis Karaman & Pinkster, 1977 E	Poznań Lakel.	I	41
Niphargus ? *aquilex* Schiödte, 1856	Central Oder Val.	W	37
Niphargus casimiriensis Skalski, 1980 E	Małopolska Gap	W, SP	79
Niphargus inopinatus Schellenberg, 1932	Tatra Mts	SP	73
Niphargus leopoliensis Jaworowski, 1893	Bieszczady Mts, K.-Cz. Up. Jędrzejów Plateau	SW, W	73, 76
Niphargus puteanus† Koch, 1836	Wałbrzych Mts, Central Oder Val.	C, SW, I	65
Niphargus tatrensis Wrześniowski, 1888	K.-Cz. Up., Orava-Podhale Depr., Tatra, B. Żywiecki, B. Śląski, B. Mały, B. Wyspowy, B. Niski, Gorce, Bieszczady Mts, Kłodzko Basin, Małopolska Gap	I, W, SP, C, SW	10, 11, 18, 22, 28, 31, 36, 59, 60, 69, 72, 74, 75, 76, 77, 79, 80, 84, 96, 97
Niphargellus arndti (Schellenberg, 1933)	Wałbrzych Mts, Kłodzko Basin	C, AS	38, 58, 70
Synurella tenebrarum (Wrześniowski, 1888)	Orava-Podhale Depr.	W	95
Synurella coeca | Dobreanu & Manolache, 1951	Małopolska Gap	W	79
Bathynellacea			
Bathynella natans Vejdovský, 1882	Kłodzko Basin, Orava-Podhale Depr.	I	89
Isopoda			
Proasellus slavus (Remy, 1948)	Orava-Podhale Depr.	I, W	89
Copepoda			
Acanthocyclops rhenanus Kiefer, 1936	Łask Up.	SW	92

Group/ Species	Region	Habitat	References
Diacyclops clandestinus (Kiefer, 1926)	Tatra Mts, Oświęcim Basin	C, W	11, 57
Graeteriella unisetigera (Graeter, 1908)	Central Oder Val.	W	94
Ostracoda			
Cryptocandona matris (Sywula, 1976)	Małopolska Gap, Silesian Foothill, B. Wschodni Mts, Pieniny Mts	W, I	1, 79, 87, 90, 91
Cyclocypris sp. Brady & Norman, 1889	B. Wyspowy Mts	I	85
Fabaeformiscandona latens (Klie, 1940)	Gorce Mts	SP	86
Fabaeformiscandona wegelini (Petkovski, 1962)	Vistula catch. down to Kazimierz Dolny town, Gorce Mts, Oder catch. down to outlet of Warta	W, I, SW	79, 85
Nannocandona stygia Sywula, 1976 E	Sudety Mts, B. Śląski Mts	W, I	87
Pseudocandona eremita (Vejdovský1882)	Małopolska Gap, Vistula Fen Country, Central Oder Val., Bóbr R. catchment	W, SW, I	64, 79, 88
Pseudocandona mira (Sywula, 1976) E	B. Żywiecki Mts, Orava-Podhale Depr.	W	87
Pseudocandona szoecsi Farkas, 1958	Małopolska Gap, Orava-Podhale Depr.	W	79, 88
Hydrachnidia			
Albaxona elegans Walter, 1947	Bieszczady Mts	I	7
Albaxona lundbladi Motas & Tanasachi, 1947 = *A. gracilis* Schwoerbel, 1962 (sensu Bogdanowicz et al. 2008)	Bieszczady Mts	I	7
Albaxona minuta Szalay, 1944	Bieszczady Mts	I	83
Arrenurus corsicus Angelier, 1951	Central Oder Val.	W	5
Atractides barbarae Biesiadka, 1972 E	B. Wyspowy Mts	I	4
Atractides gorcensis Biesiadka, 1972	Gorce Mts	I	2
Atractides latipalpis Motas & Tanasachi, 1946	Tatra Mts	I	5
Atractides latipes (Szalay, 1935)	B. Wyspowy, Bieszczady Mts, Wieliczka Foothills	I	3, 83
Atractides phreaticus (Motas & Tanasachi, 1948)	Pieniny Mts, B. Wyspowy Mts, Bieszczady Mts, Range of Babia Góra	I, SW	3, 6, 83, 96
Atractides pilosus Schwoerbel, 1961 = *A. tener* ? sensu Gerecke, 2003	Orava-Podhale Depr.	I	5
Atractides pumilus (Szalay, 1946) = *A. primitivus* (Walter, 1947) sensu Gerecke, 2003	Orava-Podhale Depr., Pieniny Mts, Bieszczady Mts	I	5, 6, 83
Atractides sokolowi (Motas & Tanasachi, 1948)	Pieniny Mts, Bieszczady Mts	I	6, 9
Aturus karamani Viets, 1936	Tatra Mts	I	5
Aturus paucisetus Motas & Tanasachi, 1946	Gorce Mts, Pieniny Mts, Bieszczady Mts	I	3, 6, 83
Aturus petrophilus Biesiadka, 1979‡ E	Pieniny Mts	I	6
Aturus pulchellus Biesiadka, 1975 E	Tatra Mts	I	5
Axonopsis cogitatus Biesiadka, 1975	Orava-Podhale Depr.	I	5
Axonopsis inferorum Motas & Tanasachi, 1947	B. Wschodni Mts	I	5
Axonopsis vietsi Motas & Tanasachi, 1947	Bieszczady Mts	I	83
Barbaxonella angulata (Viets, 1955)	Bieszczady Mts	I	7
Erebaxonopsis brevipes Motas & Tanasachi, 1947	B. Wschodni Mts	I	5, 83
Feltria mira (Motas & Tanasachi, 1948)	Orava-Podhale Depr., Tatra, B. Wyspowy Mts	I	3, 5
Feltria subterranea Viets, 1937	Bieszczady Mts	I	7
Frontipodopsis reticulatifrons Szalay, 1945	Bieszczady, Pieniny Mts	I, SW	5, 6, 83

Group/ Species	Region	Habitat	References
Hungarohydracarus subterraneus Szalay, 1943	B. Żywiecki Mts, Bieszczady Mts	I	5, 83
Kawamuracarus chappuisi Motas & Tanasachi, 1946	Orava-Podhale Depr.	I, W	5
Kongsbergia alata Szalay, 1954	Central Oder Val.	I	5
Kongsbergia arenaria Angelier, 1951	Orava-Podhale Depr., Bieszczady Mts	I	7
Kongsbergia clypeata Szalay, 1945	Bieszczady Mts	I	7
Kongsbergia dentata Walter, 1947	Tatra Mts, Pieniny Mts	I	5, 6
Kongsbergia d-motasi Motas & Tanasachi, 1958	Bieszczady Mts	I	7
Kongsbergia lundbladi Szalay, 1956	Bieszczady Mts	I	Biesiadka pers. com.
Kongsbergia pectinata Walter, 1947	Bieszczady Mts, Gorce Mts	I, SW	3, 83
Kongsbergia ruttneri Walter, 1930	Pieniny Mts	I	6
Kongsbergia wroblewskii ‡ Biesiadka, 1997 E	Bieszczady Mts	I	7
Lethaxona cavifrons Szalay, 1943	Orava-Podhale Depr., B. Wschodni Mts, Pieniny Mts, Gorce Mts	I	3, 4, 5, 6
Lethaxona pygmea Viets, 1932	Bieszczady Mts, Gorce Mts	I	7, 83
Neoacarus hibernicus Halbert, 1944	Orava-Podhale Depr. B. Wschodni Mts, B. Wyspowy Mts, Pieniny Mts	I	3, 5, 6
Neumania phreaticola Motas & Tanasachi, 1948	Bieszczady Mts	I	7
Sperchonopsis phreaticus Biesiadka, 1975 E	Tatra Mts, Bieszczady Mts	I	5, 83
Stygomononia latipes Szalay, 1943	Bieszczady, Pieniny, Tatra, B. Żywiecki, B. Wyspowy Mts, Kłodzko Basin	I	3, 5, 6, 83, 96
Wandesia thori Schechtel, 1912	Tatra Mts, Gorce Mts	SW	67, 68
Wandesia stygophila Szalay, 1944	Bieszczady Mts	I	83
Halacaroidea			
Loboharacarus weberi quadriporus Walter, 1947	B. Żywiecki, Pieniny, B. Wschodni Mts, Tatra Mts, Orava- Podhale Depr.	I	5, 6
Parasoldanellonyx parviscutatus (Walter, 1917)	Orava-Podhale Depr.	W	5
Gastropoda			
Falniowskia neglectissima Falniowski & Steffek, 1989 E	K-Cz. Up.	HR	34

†– misidentification, ‡ – nomen nudum; § – species known from Kłodzko Basin only, localization in Germany is false (Fauna Europaea); | – described as *S. coeca rafalskii* by Skalski (1981); E – species endemic to Poland; x – leg. A. Skalski 14.07.1977, det. E. Dumnicka.

Several factors make it difficult to come up with an exact number of Polish stygobionts. First, among species found only once many years ago, a few probably were not correctly determined (e.g., *Niphargus puteanus*) or exactly determined (*N.* cf. *inopinatus* and *Dendrocoelum* cf. *carphaticum*) (Table 1). Second, the taxonomic position of some species from various groups is not clear due to numerous subsequent taxonomic revisions. For example *Enchytraeus polonicus* (Oligochaeta) is treated by Schmelz and Collado (2010) as a cave population (with an additional pair of spermathecae) of a very common species *E. buchholzi*. Two forms of *Synurella ambulans* (*S. ambulans* f. *subterranea* and *S. ambulans* f. *tenebrarum*) were considered in Polish literature as stygobionts. Now, these forms are not listed in Fauna Europea, while in WoRMS (http://

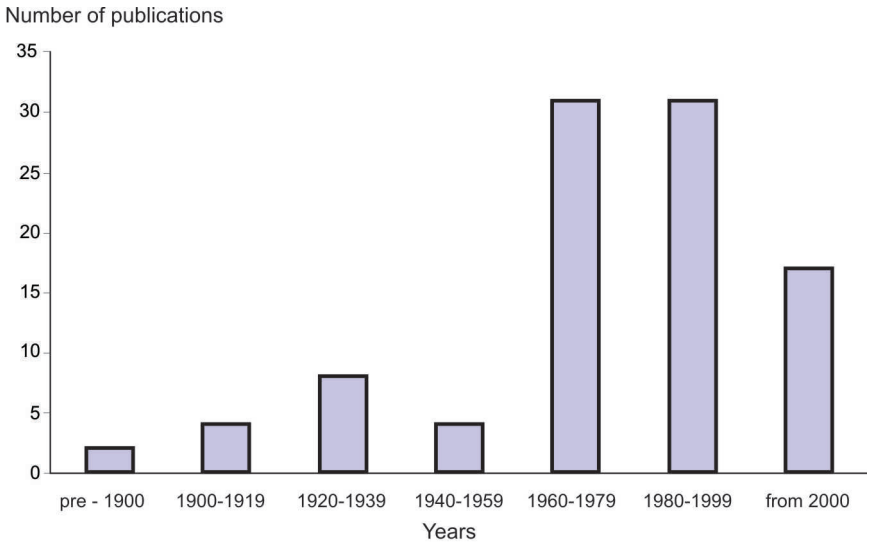

Figure 1. Number of publications concerning subterranean aquatic fauna of Poland through time.

www.marinespecies.org/) *S. ambulans* f. *tenebrarum* is elevated to the species level (as *S. tenebrarum*). This species is listed in the Table 1. Moreover, two species of Hydrachnidia (*Aturus petrophilus* Biesiadka 1979 and *Kongsbergia wroblewskii* Biesiadka 1997) are *nomen nudum* (Biesiadka pers. com.), though the first species is included in the list of Hydrachnidia in Fauna Europea.

In some cases, so-called local stygobionts were included in the checklist (Table 1). For example, *Rhyacodrilus subterraneus* is found exclusively in subterranean waters in Poland, it is known from surface waters in northern Europe (Dumnicka 2014). Three species of Hydrachnidia known exclusively from interstitial waters in Poland are considered stygobionts (Bogdanowicz et al. 2008).

Stygobiontic species in particular taxonomic groups

Approximately eighty stygobiontic species (Table 1) are known from aquatic subterranean environments in Poland, documented in various regions of the country (Fig. 2). The detailed localities of many stygobiontic species are given in publications but for some species only the range of their occurrence was published, with no specific localities.

Turbellaria seems to be the most poorly known group of invertebrates in Poland, due in part to a lack of researchers specializing in this group. There is a record of stygobiontic *Dendrocoelum* that has not yet been verified.

The phyllum Annelida is represented by only one stygobiontic species of Polychaeta (*Troglochaetus beranecki*). It is known only from Radochowska and Rogóżka caves (Table 1; entry no. 84), but has not been found since the original report, despite intensive sampling in the Radochowska cave and in interstitial waters of nearby streams and

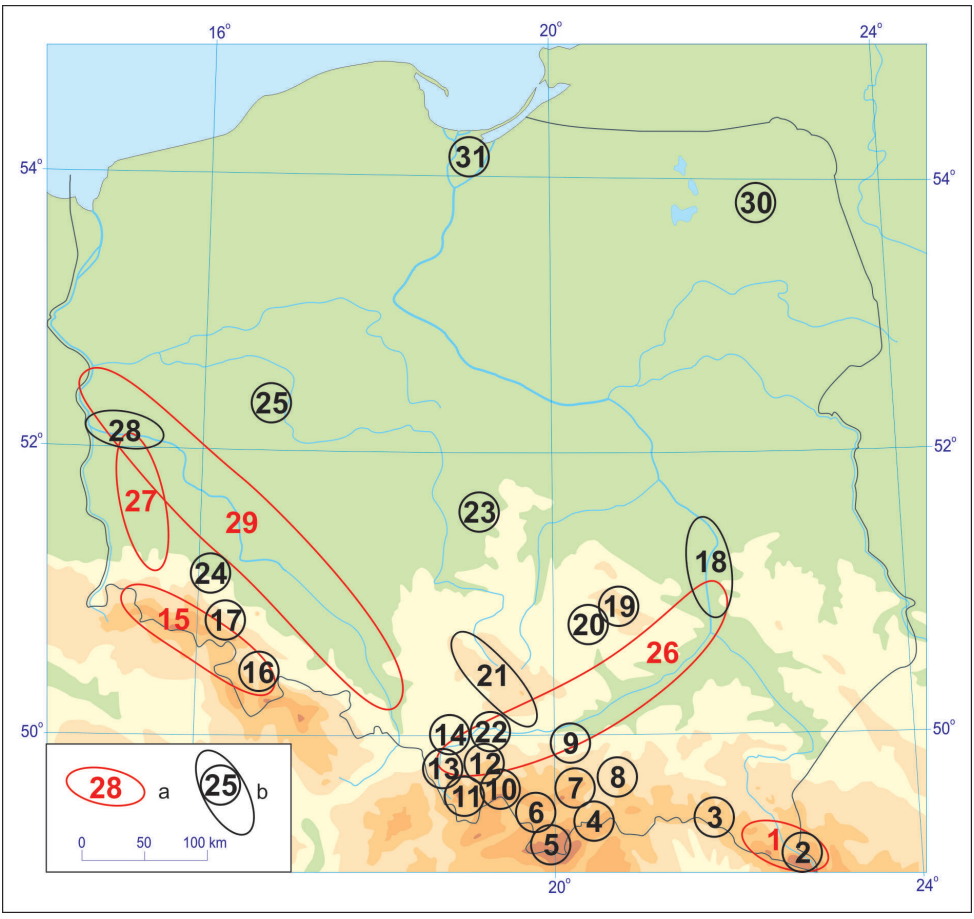

Figure 2. Regions of Poland studied by various authors: **1** Beskid Wschodni Mts. **2** Bieszczady Mts. **3** Beskid Niski Mts. **4** Pieniny Mts. **5** Tatra Mts. **6** Orava-Podhale Depression **7** Gorce Mts. **8** Beskid Wyspowy Mts. **9** Wieliczka Foothill **10** Range of Babia Góra **11** Beskid Żywiecki Mts. **12** Beskid Mały Mts. **13** Beskid Śląski Mts. **14** Silesian Foothill **15** Sudety Mts. **16** Kłodzko Basin **17** Wałbrzych Mts. **18** Małopolska Gap of the Vistula **19** Świętokrzyskie Mts. **20** Jędrzejów Plateau **21** Kraków- Częstochowa Upland **22** Oświęcim Basin **23** Łask Upland **24** Legnica Plain **25** Poznań Lakeland **26** Vistula catchment up to Kazimierz Dolny town **27** Bóbr River catchment **28** Central Oder Valley **29** Oder catchment up to the outlet of the Warta River **30** Ełk Lakeland **31** Vistula Fen Country. **a** area of species occurrence without exact localization given **b** geographical regions with detailed localization of species provided.

springs (Table 1; entry no. 20, 38, 89). At least ten stygobiontic Oligochaeta species occur in Poland, with representatives in habitats of all types. Their list and detailed distribution was recently provided (Dumnicka 2014). Moreover, juvenile specimens of *Trichodrilus* were found in materials collected by Skalski (Table 1).

Crustacea, which usually dominate in subterranean waters of south-western Europe (Danielopol et al. 2000, Deharveng et al. 2009, Sket 1999), are represented in Poland by only 24 species (Fig. 3).

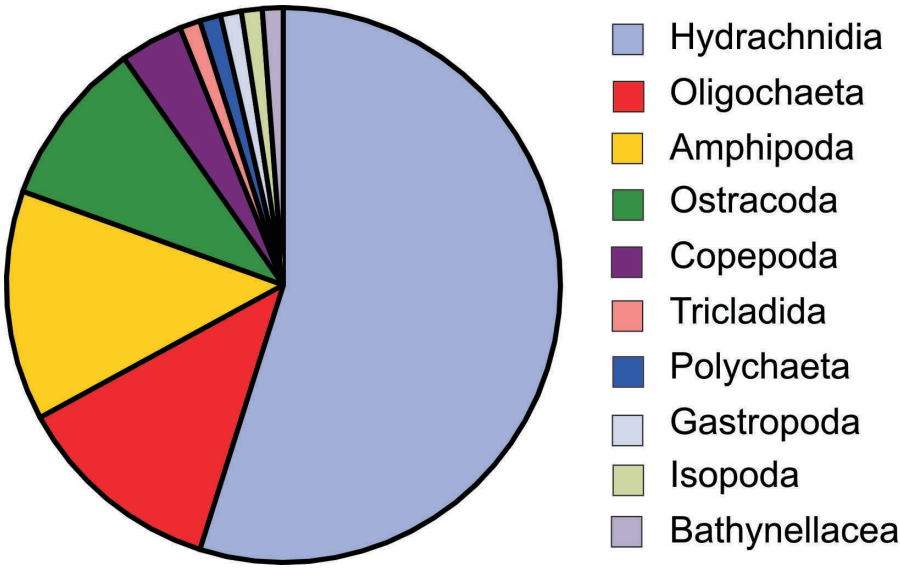

Figure 3. Percentage share of stygobiontic species from particular taxonomic groups.

Among the Amphipoda, eleven stygobiontic species have been reported, six of them belong to genus *Niphargus*. Of these, identification of *N. puteanus* (Table 1; entry no. 65) was contested by Skalski (Table 1; entry no. 77). The occurrence of two other *Niphargus* species (*Niphargus* ? *aquilex* and *N. inopinatus*) in Poland has not been confirmed in the last 100 years. For *N. inopinatus*, it is possible that the species occurs in the Polish part of the Tatra Mountains, because it was confirmed in the southern part of this mountain range, in Slovakia (http://www.zoo.sav.sk/voda_pdf/voda_pdf.htm). The most common *Niphargus* in all studied habitats is *N. tatrensis*, which is sporadically found in surface waters also (Fig. 4). This species has been repeatedly observed in some caves, especially in Tatra Mountains. Additionally, it has been recorded from piezometer samples taken in Carpathic effluents of the Vistula. However, *Niphargus tatrensis* has patchy distribution because it has not been recorded from the many sampled wells in a large area in south-eastern Poland (Table 1; entry no. 76). The only stygobiontic subspecies from genus *Gammarus* shows morphological features typical for stygobiontic species such as the absence of eyes and slender antenna and pereiopods (Table 1; entry no. 41).

The remaining orders of Malacostraca: Bathynellacea and Isopoda are each represented by one species (*Bathynella natans* and *Proasellus slavus*, respectively) (Table 1), and are rarely found in interstitial waters. Both species have also been recorded from wells.

None of the eight stygobiontic species of ostracods known from Poland have been recorded from cave waters. Instead, stygobiontic Ostracoda have been collected most frequently from wells and interstitial waters (Table 1). Two species have wide distribution (*Fabaeformiscandona wegelini*, *Pseudocandona eremita*) while the remaining have been stated only in southern Poland. Stygobiontic Copepoda have been poorly studied

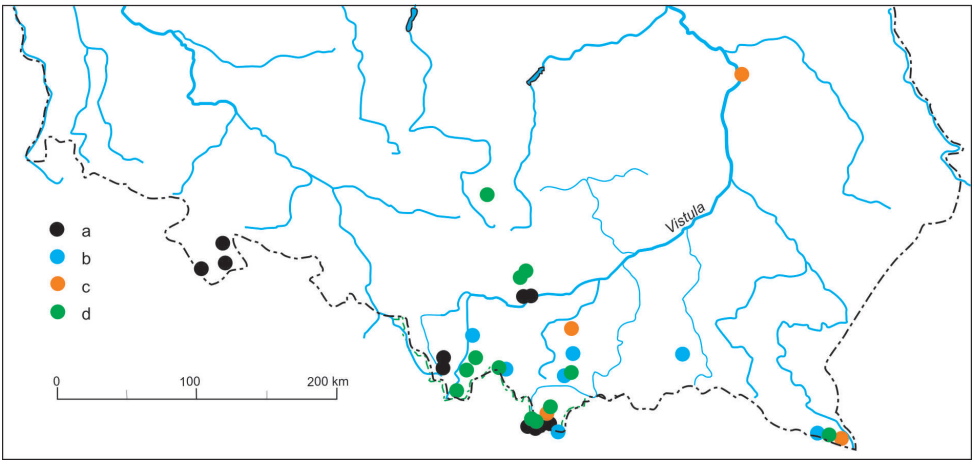

Figure 4. Distribution of *Niphargus tatrensis* in various habitats in Poland; **a** caves **b** surface waters **c** wells **d** springs.

in Poland, with only three species reported in subterranean waters. There is no published data on Harpacticoida, which is likely due to their occurrence predominantly in interstitial and epikarstic waters.

Mites, represented by Hydrachnidia (43 species) and Halacaroidea (two species) constitute over 50% of all stygobiontic species in Poland (Fig. 3). They inhabit almost exclusively (42 species) interstitial waters, but a few species have been reported from wells and surface waters. *Wandesia thori*, considered a stygobiontic species (Bogdanowicz et al. 2008, Botosaneanu 1986) was described from bottom samples collected in streams from the Tatra Mountains (Table 1; entry no. 67) and yet it has also been reported in a spring and two spring brooks in Gorce Mountains (Table 1; entry no. 68).

A species of Hydrobiidae (Gastropoda), *Falniowskia neglectissima*, has been described from wet litter covering the ground (Table 1; entry no. 34) and it is treated as a stygobiont living in the hypothelminorheic habitat (Culver and Pipan 2011).

Our review indicates that 14 endemic species (including two *nomen nudum*) have been described from Poland: three Oligochaeta, five Crustacea, five Hydrachnidia and one Gastropoda. Some of these have broad distributions, such as *Enchytraeus dominicae* (Table 1), while most of the 14 endemics described from the country are known from only one region.

Species richness in particular habitats

Of all the groundwater habitats, cave waters have been the most intensively investigated in Poland, yet the number of records of stygobiontic species from Polish caves is relatively low (Fig. 5), a pattern also observed in Slovakia (Kováč et al. 2014). In many caves of Poland, no stygobiontic species have been found (Table 1; entry no.

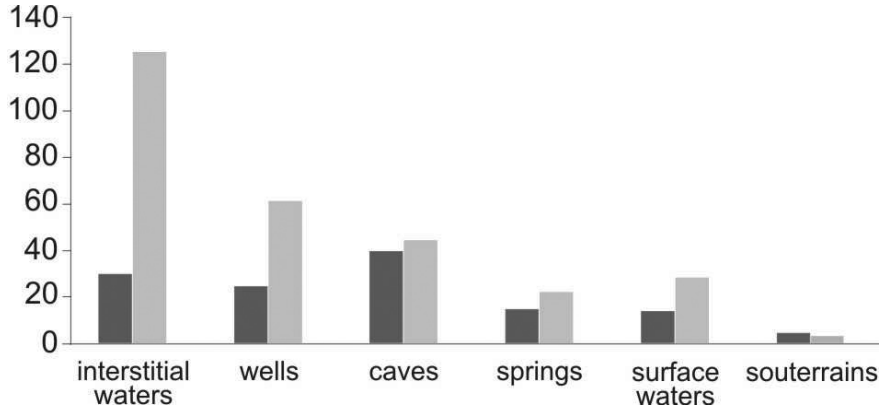

Figure 5. Number of studies performed in particular habitats (dark bar) and number of records of stygobiontic species found in them (light bar).

32), and in some cases aquatic fauna appeared to be totally absent (Kur et al. 2016). In contrast, interstitial waters of Poland contain numerous stygobiontic species, especially Hydrachnidia. Records of subterranean fauna collected from wells are relatively numerous, although this habitat seldom has been studied.

Conclusions

1. In Poland, the stygobiontic fauna proved to be unexpectedly rich in comparison to that of Belgium (Martin et al. 2009), while the more intensively studied subterranean waters of Germany have revealed a greater number of species (Hahn and Fuchs 2009). The comparison of richness of stygobiontic fauna with that stated in other neighboring countries is difficult. In Slovakia some invertebrate groups have barely been investigated in the subterranean habitat e.g. Hydrachnidia, whereas other groups such as Copepoda have been studied in more detail (Košel 2009, Juberthie et al. 2001, http://www.zoo.sav.sk/voda_pdf/voda_pdf.htm). The situation is similar in the Czech Republic, where Harpacticoida were intensively studied by Štěrba (1964, 1965, 1968) and a list of stygobionts was prepared by Bosák et al. (2001). In adjacent countries across the eastern border of Poland such studies are limited.
2. More intensive studies of stygobiontic species in Poland's interstitial waters and wells are needed because these habitats are threatened by river regulations and abandonment of wells use. In addition, some regions of Poland have been poorly studied with regard to the stygobiontic fauna, especially in northern part of the country (see Fig. 2), and more effort should be dedicated to investigating these understudied regions.
3. Due to the decline in the number of active taxonomists in recent years, the status of some stygobiontic species remains unclear. Additional societal support for taxonomic research is needed so that various groups in need of revision can be studied.

Acknowledgements

The authors would like to thank prof. Krzysztof Jażdżewski and dr Roland Dobosz for making possible access to late dr Andrzej Skalski scientific collection. We are grateful to dr Alicja Konopacka for permitting to use her unpublished data on Crustacea collected in wells situated in Grabia River valley. We thank anonymous reviewers for their valuable comments and Silviu Bercea for the English correction of the manuscript.

References

Anker A (2008) A worldwide review of stygobiotic and stygophilic shrimps of the family Alpheidae (Crustacea, Decapoda, Caridea). Subterranean Biology 6: 1–16.

Artheau M, Giani N (2006) A checklist of the groundfreshwater Oligochaeta and Polychaeta in France: an overview. Bulletin de l`Institut Royal des Sciences Naturelles de Belgique 76: 229–255.

Bogdanowicz W, Chudzicka E, Pilipiuk I, Skibińska E (2004) Fauna of Poland. Characteristics and checklist of species. Volume I, Muzeum i Instytut Zoologii PAN, Warszawa, 509 pp. [In Polish]

Bogdanowicz W, Chudzicka E, Pilipiuk I, Skibińska E (2008) Fauna of Poland. Characteristics and checklist of species. Volume III, Muzeum i Instytut Zoologii PAN, Warszawa, 603 pp. [In Polish]

Bosák P, Vasátko J, Cílek V, Dumnicka E, Hanuláková D, Horácek I, Jeník J, Kopecky I, Marvanová L, Mlejnek R, Růžička J, Zacharda M (2001) Czech Republik. In: Juberthie Ch, Decu V (Eds) Encyclopaedia Biospeleologica Tome III. Société Internationale de Biospéologie, Moulis-Bucarest, 1405–1426.

Botosaneanu L [Ed.] (1986) Stygofauna mundi. Leiden Brill EJ, Backhuys W, 740 pp.

Culver DC, Pipan T (2011) Redefining the extent of the aquatic subterranean biotope – shallow subterranean habitats. Ecohydrology 4: 721–730. https://doi.org/10.1002/eco.243

Danielopol DL, Pospisil P, Rouch R (2000) Biodiversity in groundwater: a large-scale view. Trends in Ecology & Evolution 15: 223–224. https://doi.org/10.1016/S0169-5347(00)01868-1

Deharveng L, Stoch F, Gibert J, Bedos A, Galassi D, Zagmajster M, Brancelj A, Camacho A, Fiers F, Martin P, Giani N, Magniez G, Marmonier P (2009) Groundwater biodiversity in Europe. Freshwater Biology 54: 709–726. https://doi.org/10.1111/j.1365-2427.2008.01972.x

Dumnicka E (2014) Stygobitic oligochaetes (Annelida, Clitellata) in Poland with remarks on their distribution in Central Europe. Subterranean Biology 14: 15–24. https://doi.org/10.3897/subtbiol.14.7700

Gibert J, Danielopol DL, Stanford JA (1994) Groundwater ecology. Academic Press, Inc., 571 pp.

Gunn J [Ed.] (2004) Encyclopedia of Caves and Karst Science. Taylor & Francis Books, 939 pp.

Gutjahr S, Schmidt SI, Hahn HJ (2014) A proposal for a groundwater habitat classification at local scale. Subterranean Biology 14: 25–49. https://doi.org/10.3897/subtbiol.14.5924

Hahn HJ, Fuchs A (2009) Distribution patterns of groundwater communities across aquifer types in south-western Germany. Freshwater Biology 54: 848–860. https://doi.org/10.1111/j.1365-2427.2008.02132.x

Juberthie Ch, Decu V, Košel V, Kovác K, Uhrin M (2001) Slovakia. In Juberthie Ch, Decu V (Eds) Encyclopaedia Biospeleologica Tome III. Société Internationale de Biospéologie, Moulis-Bucarest, 1445–1456.

Kováč L, Elhottová D, Mock D, Nováková A, Krištůfek V, Chroňáková A, Lukešová A, Mulec J, Košel V, Papáč V, Luptáčik P, Uhrin M, Višňovská Z, Hudec I, Gaál L, Bella P (2014) The cave biota of Slovakia. State Nature Conservancy SR, Slovak Caves Administration, Liptovský Mikuláš, 192 pp.

Kur J, Radwański JM, Mioduchowska M (2016) Investigation of the fauna in the Szmaragdowa/Szeptunów Cave in Poland: an example of short time colonization process. Acta Zoologica Cracoviensia 59: 153–162. https://doi.org/10.3409/azc.59_2.153

Martínez-Ansemil E, Giacomazzi F, Sambugar B (2016) Groundwater oligochaetes (Annelida: Clitellata) of the Dinaric region (South–East Europe). Biologia 71: 24–30. https://doi.org/10.1515/biolog-2016-0009

Reboleira ASPS, Gonçalves F, Oromí P (2012 (2013)). Literature survey, bibliographic analysis and a taxonomic catalogue of subterranean fauna from Portugal. Subterranean Biology 10: 51–60. https://doi.org/10.3897/subtbiol.10.4025

Schmelz RM, Collado R (2010) A guide to European terresstrial and freshwater species of Enchytraeidae (Oligochaeta). Soil organisms 82: 1–176.

Skalski AW (1981) Appendix. Checklist and distribution of troglobites, stygobites and species known in Poland from subterranean life zone only. V Rocznik Muzeum Okręgowego w Częstochowie, Przyroda 2: 109–112. [In Polish]

Sket B (1999) The nature of biodiversity in hypogean waters and how it is endangered. Biodiversity and conservation 8: 1319–1338. https://doi.org/10.1023/A:1008916601121

Strouhal H, Vornatscher J (1975) Katalog der rezenten Höhlentiere Österreichs. Annalen des Naturhistorischen Museums in Wien 79: 401–542.

Štěrba O (1964) Plazivky (Copepoda, Harpacticoida) Moravy a Slezska, část I.Acta Universitatis Palackianae Olomucensis Facultas Rerum Naturalium 16: 203–321.

Štěrba O (1965) Plazivky (Copepoda, Harpacticoida) Moravy a Slezska, část II. Acta Universitatis Palackianae Olomucensis Facultas Rerum Naturalium 16: 203–313.

Štěrba O (1968) Příspěvek k poznání klanonožců (Crustacea, Copepoda), zvláště plazivek (Harpacticoida) z Čech. Acta Universitatis Palackianae Olomucensis Facultas Rerum Naturalium 16: 211–232.

Thienemann A (1926) Die Binnengewässer Bd. 1. Die Binnengewässer Mitteleuropas: Eine limnologische Einführung. E. Schweizerbart, Stuttgart, 255 pp.

Fauna Europaea (2017) Fauna Europaea (http://www.faunaeur.org)

Vodné Bezstavovce (Makroevertebráta) Slovenska (2017) Vodné Bezstavovce (Makroevertebráta) Slovenska http://www.zoo.sav.sk/voda_pdf/voda_pdf.htm

WoRMS (2017) WoRMS. http://www.marinespecies.org

Bibliographic list

Papers concerning invertebrate species found in subterranean waters (papers listing stygophiles or stygoxenes exclusively were included).

1. Baltanás A, Namiotko T, Danielopol DL (2000) Biogeography and disparity within the genus *Cryptocandona* (Crustacea, Ostracoda). Vie et Milieu – Life and Environment 50: 297–310.
2. Biesiadka E (1972) Sur quelques Hydracariens nouveaux recueillis en Pologne. Bulletin de Académie Polonaise des Sciences. Série des sciences biologiques, Cl. II 20: 249–256.
3. Biesiadka E (1973) Nowe i rzadsze w faunie Polski gatunki wodopójek (*Hydracarina*). Fragmenta faunistica 18: 437–490.
4. Biesiadka E (1974) *Hydracarina* of the River Raba and some of its tributaries. Acta hydrobiologica 16: 31–50.
5. Biesiadka E (1975) Materiały do znajomości wodopójek (Hydracarina) wód podziemnych Polski, z opisem czterech nowych gatunków. Fragmenta faunistica 20: 75–113. [In Polish]
6. Biesiadka E (1979) Wodopójki (Hydracarina) Pienin. Fragmenta faunistica 24: 97–173.
7. Biesiadka E (1997) Halacaroidea, Hydrachnidia. In: Razowski J (Ed) Wykaz zwierząt Polski T. IV. Wyd. Instytut Systematyki i Ewolucji Zwierząt PAN: 229–239. [In Polish]
8. Biesiadka E, Cichocka M (1993) Środowiskowe rozmieszczenie wodopójek (Hydracarina) w Karkonoszach. In: Sarosiek J (Ed) Geoekologiczne Problemy Karkonoszy II. Ekologia roślin i zwierząt. Wyd. Uniwersytet Wrocław 275–283.
9. Biesiadka E, Kowalik W (1973) Wyniki wstępnych badań nad wodopójkami (Hydracarina) Bieszczadów Zachodnich. IX Zjazd Hydrobiologów Polskich w Poznaniu 3–8 września 1973. Streszczenia Referatów: 72.
10. Chaniecka K, Wiedeńska J (2006) Młaki – siedliska wyjątkowe. Wyniki badań fauny bezkręgowców w Gorczańskim Parku Narodowym. Ochrona Beskidów Zachodnich 1: 139–155.
11. Chodorowska W, Chodorowski A (1960) Ugrupowania fauny wodnej w jaskiniach tatrzańskich. Speleologia II (1): 57–62.
12. Czaja M (1999) Widłonogi Copepoda Cyclopoida Ojcowskiego Parku Narodowego. Msc Thesis, Gdańsk University, pp. 45.
13. Demel K (1918) Fauna jaskiń Ojcowskich. Sprawozdania z posiedzeń Towarzystwa Naukowego Warszawskiego. Wydział nauk matematycznych i przyrodniczych 11: 623–659.
14. Dumnicka E (1976) *Enchytraeus dominicae* sp. n. – a new species of Enchytraeidae (Oligochaeta) from Poland. Acta hydrobiologica 18: 421–424.
15. Dumnicka E (1977a) Annual changes of oligochaete fauna in a cave of the Kraków–Częstochowa Upland. Proc. 7th Int. Speleol. Congress, Sheffield, England: 163–165.
16. Dumnicka E (1977b) Oligochaeta from caves in the Tatra Mts with references to anomalies in their structure. Proc. 7th Int. Speleol. Congress, Sheffield, England: 160–163.
17. Dumnicka E (1981) Skąposzczety (Oligochaeta) jaskiń południowej Polski. V Rocznik Muzeum Okręgowego w Częstochowie, Przyroda 2: 15–22.

18. Dumnicka E (1995) Fauna inhabiting water bodies and experimental containers used for plants decomposition study in a cave. Mémoires de Biospéologie 22: 17–20.
19. Dumnicka E (1996) Aquatic Oligochaeta and Aphanoneura from the souterrains of Central Europe with description of a new *Enchytraeus* species. Mémoires de Biospéologie 23: 167–171.
20. Dumnicka E (2000) Studies on Oligochaeta taxocens in streams, interstitial and cave waters of southern Poland with remarks on Aphanoneura and Polychaeta distribution. Acta zoologica cracoviensia 43: 339–392.
21. Dumnicka E (2003) Observations on the distribution of aquatic fauna in Tatra Mountain caves. Subterranean Biology 1: 49–55.
22. Dumnicka E (2005) Stygofauna associated with springfauna in southern Poland. Subterranean Biology 3: 29–36.
23. Dumnicka E (2009a) Diversity of oligochaete fauna inhabiting epigean and hypogean sectors of a stream flowing through a non–karstic cave in Beskidy Mts. (Poland). Subterranean Biology 7: 41–46.
24. Dumnicka E (2009b) New for Poland tubificid (Oligochaeta) species from karstic springs. Polish Journal of Ecology 57: 395–401.
25. Dumnicka E, Chabrowska A, Szokalski M (2015) Fauna denna wypływu z jaskini Szczelina w Lelowie. Materiały 49. Sympozjum Speleol. Załęcze Wielkie 22–25.10.2015, 81–82.
26. Dumnicka E, Galas J (1997) The relationship between Oligochaeta, particulate organic matter and environmental conditions in epigean and hypogean parts of a mountain stream in Poland. Mémoires de Biospéologie 24: 9–14.
27. Dumnicka E, Galas J, Karlikowska J, Sznober N (2015) Temporary co–existence of aquatic and terrestrial invertebrates in shallow periodically flooded and frozen cave. Biologia 70: 1201–1209. Https://doi.org/10.1515/biolog-2015-0142
28. Dumnicka E, Galas J, Krodkiewska M (2017) Pattern of benthic fauna distribution in wells: the role of anthropogenic impact and geology. Vadose Zone Journal 16(5): 1–9. https://doi.org/10.2136/vzj2016.07.0057
29. Dumnicka E, Koszałka J (2005) The effect of draught on Oligochaeta communities in small woodland streams. Biologia 60: 143–150.
30. Dumnicka E, Wojtan K (1989) L` influence du milieu et des paramètre physico–chimiques de l`eau sur les peuplements des oligochètes et la variabilité des populations de *Propappus volki* (Enchytraeidae) dans la grotte Wodna (Tatras Montagnes, Pologne). Mémoires de Biospéologie 16: 225–232.
31. Dumnicka E, Wojtan K (1990) Differences between cave water ecological systems in the Kraków – Częstochowa Upland. Stygologia 5: 241–247.
32. Dumnicka E, Wojtan K (1993) Invertebrates (with special regard to Oligochaeta) of the semi–underground water bodies in the gypsum caves. Mémoires de Biospéologie 20: 63–67.
33. Dumnicka E, Wojtan K (1994) Faune aquatique de la grotte Chelosiowa Jama (Montagnes Świętokrzyskie, Pologne Centrale). Mémoires de Biospéologie 21: 53–56.
34. Falniowski A, Šteffek J (1989) A new species of Bythiospeum (Prosobranchia: Hydrobioidea: Moitessieriidae) from Southern Poland. Folia Malacologica 3: 95–101.

35. Gadzińska E (1974) *Cernosvitoviella parviseta* sp. n. – a new species of Enchytraeidae (Oligochaeta) from the Polish Tatra Mountains. Bulletin de Académie Polonaise des Sciences. Série des sciences biologiques, Cl. II. 22: 403–406.
36. Grochowski M (1904) O rodzaju Studniczka (Niphargus). Kosmos 29: 266–301.
37. Haeckel von K (1907) Niphargus aquilex im Odergebiet. Zoologischer Anzeiger 32: 430–431.
38. Hajduk Z, Ogorzałek A (1978) *Niphargellus arndti* (Schellenberg, 1933) z jaskini Kontaktowej koło Kletna. Acta Universitatis Wratislaviensis, 3. Studia Geograficzne 24: 155–157.
39. Jakubisiak S (1931) Materjały do fauny skorupiaków widłonogich (Copepoda) z rodziny *Harpacticidae* w Poznańskiem i na Pomorzu. Sprawozdanie Komisji Fizjograficznej PAU 65: 31–65.
40. Jaworowski A (1893) Fauna studzienna miast Krakowa i Lwowa. Sprawozdanie Komisyi Fizyograficznej AU 28: 29–48.
41. Karaman GS, Pinkster S (1977) 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.
42. Kasprzak K (1973a) Notatki o faunie skąposzczetów (Oligochaeta) Polski, I. Fragmenta faunistica 18: 405–434.
43. Kasprzak K (1973b) Notatki o faunie skąposzczetów (Oligochaeta) Polski, II. Fragmenta faunistica 19: 1–19.
44. Kasprzak K (1973c) Skąposzczety (Oligochaeta) wód interstycjalnych. Przegląd Zoologiczny 17: 41–44.
45. Kasprzak K (1975) Skąposzczety (Oligochaeta) osadów aluwialnych rzek. Prace Komisji Naukowych PTG. III/16: 173–185.
46. Kasprzak K (1979 a) Skąposzczety (Oligochaeta) Pienin. I. Wazonkowce (Enchytraeidae). Fragmenta faunistica 24: 7–56.
47. Kasprzak K (1979b) Skąposzczety (Oligochaeta) Pienin. Naididae, Tubificidae, Haplotaxidae, Lumbriculidae, Branchiobdellidae. Fragmenta faunistica 24: 57–80.
48. Kasprzak K (1981) Nowe dane o faunie skąposzczetów Oligochaeta w Tatrzańskim Parku Narodowym oraz w Bieszczadach. Chrońmy Przyrodę Ojczystą 37: 72–75.
49. Kasprzak K, Zajonc I (1980) Skąposzczety (Oligochaeta) Tatr. Przegląd Zoologiczny 24: 189–199.
50. Kolasa J (1974) Badania nad wirkami (*Turbellaria*) źródeł ze szczególnym uwzględnieniem okolic Poznania. Badania Fizjograficzne nad Polską Zachodnią. Seria B - Biologia 26: 7–31.
51. Kolasa J (1977) Systematical studies on freshwater *Microturbellaria*. *Limnoruanis romanae* gen. nov., sp. nov. Bulletin de Académie Polonaise des Sciences. Série des sciences biologiques, Cl. II. 25: 331–334.
52. Kolasa J (1981) Stan znajomości wirków (*Turbellaria*) wód podziemnych Polski. V. Rocznik. Muzeum Okręgowego w Częstochowie, Przyroda 2: 31–37.
53. Konopacka A, Jażdżewski K (1996) Groundwater crustaceans of the wells in the Grabia river system (Central Poland). 2nd European Crustacean Conference Liège (Belgium), Sept.2–6, 1996. Abstracts, 47.
54. Konopacka A, Sobocińska V (1992) Uwagi na temat występowania skorupiaka *Synurella ambulans* (Müll.) (Amphipoda, Crangonyctidae) w Polsce. Przegląd Zoologiczny 36: 123–131.

55. Kowalski K (1953) Jaskinie Polski T. II. Państwowe Muzeum Archeologiczne, Warszawa 186 pp.
56. Krzanowski W, Fiedor E, Kuflikowski T (1965) Fauna denna kamienisto–prądowych siedlisk dolnych odcinków Białego Dunajca, Rogoźnika i Lepietnicy. Zeszyty Naukowe UJ 103, Prace Zoologiczne 9: 43–60.
57. Kur J (2012) Zmienność populacyjna widłonogów Copepoda w wodach podziemnych Południowej Polski. Praca doktorska, IOP, 127 pp.
58. Lorenc MW, Chlebicki A, Szumska E (2003) Mieszkańcy dawnych wyrobisk kopalni złota w Złotym Stoku. Materiały 37. Sympozjum. Speleologicznego Wojcieszów 24–26.10.2003: 48–49.
59. Michalska B, Pukowski J, Wilga M (1999) Jaskinia Mokra – nowe stanowisko *Niphargus tatrensis* Wrześniowski 1888 w Beskidach Zachodnich. Materiały 33. Sympozjum Speleologicznego, Jeziorowice 22–24 X. 1999: 69.
60. Micherdziński W (1956) Taksonomia i ekologia *Niphargus tatrensis* Wrześniowski 1888 (Amphipoda). Annales Zoologici 16: 81–134.
61. Micherdziński W (1959) Kiełże rodzaju *Gammarus* Fabricius (Amphipoda) w wodach Polski. Acta zoologica cracoviensia 4: 527–637.
62. Moszyński A, Moszyńska M (1957) Skąposzczety (Oligochaeta) Polski i niektórych krajów sąsiednich . Poznańskie Towarzystwo Przyjaciół Nauk, Wydział Matematyczno - Przyrodniczy. Prace Komisji Biologicznej. 18: 202 pp.
63. Moszyński A (1936) Die Höhlenfauna des Glatzer Schneeberges. 9. Ein neuer Vertreter der Gattung Trichodrilus Clap. (Trichodrilus spelaeus nov. spec.) aus dem Stollen in Neu–Klessengrund. Beiträge zur Biologie des Glatzer Schneeberges 2: 214–216.
64. Namiotko T (1990) Freshwater Ostracoda (Crustacea) of Żuławy Wiślane (Vistula Fen Country, Northern Poland). Acta zoologica cracoviensia 33: 459–484.
65. Pax F (1921) Die Tierwelt Schlesiens. Jena, VIII 324 pp.
66. Pax F, Maschke K (1935) Die Höhlenfauna des Glatzer Schneeberges. 1. Die rezente Metazooenfauna. Beiträge zur Biologie des Glatzer Schneeberges 1: 4–72.
67. Pešić V, Chaniecka K (2006) Water mites (Acari: Hydrachnidia) from spring areas of the Gorce National Park in Poland. Lauterbornia 56: 49–59.
68. Schechtel E (1912 (1913)) Eine neue Hydrachniden–Gattung aus der polnischen Tatra, *Wandesia* n.g. Bulletin international de l' Académie des Sciences de Cracovie. Classe des sciences Mathématiques et Naturelles. Série B, Sciences naturelles: 463–468.
69. Schellenberg A (1932) Deutsche subterrane Amphipoden. Zoologischer Anzeiger 99: 311–323.
70. Schellenberg A (1933) Weitere deutsche und ausländische Niphargiden. Zoologischer Anzeiger 102: 22–33.
71. Schellenberg A (1935) Die Höhlenfauna des Glatzer Schneeberges. 2. Höchlenamphipoden des Glatzer Schneeberges. Beiträge zur Biologie des Glatzer Schneeberges 1: 72–75.
72. Skalski A (1967) Characteristics of the recent fauna from the Szczelina Chochołowska cave in the Tatra Mts. Prace Muzeum Ziemi 11: 288–290.
73. Skalski AW (1970) The hypogeous gammarids in Poland (Crustacea, Amphipoda, Gammaridae). Acta hydrobiologica 12: 431–437.

74. Skalski AW (1972) Distribution des Amphipodes souterrains en Pologne, avec notes sur la variabilité du *Niphargus tatrensis* Wrześniowski. Actes du I[er] Colloque International sur le genre *Niphargus*. Verona, 15–19 Aprile 1969: 47–53.
75. Skalski AW (1978) Studniczek tatrzański, *Niphargus tatrensis* Wrześniowski, 1888 (Amphipoda) na Wyżynie Krakowsko–Częstochowskiej. Przegląd Zoologiczny 22: 40.
76. Skalski AW (1980) Studniczek lwowski, *Niphargus leopoliensis* Jaworowski, 1893 (Amphipoda) w Polsce. Przegląd Zoologiczny 24: 97–101.
77. Skalski AW (1981a) Podziemne obunogi (Amphipoda) Polski. V Rocznik Muzeum Okręgowego w Częstochowie, Przyroda 2: 61–83.
78. Skalski AW (1981b) Ośliczka *Asellus aquaticus* (L.) (Isopoda) w wodach podziemnych południowej Polski. V Rocznik Muzeum Okręgowego w Częstochowie, Przyroda 2: 85–88.
79. Skalski AW (1982) Groundwater fauna of the Małopolska Gap of the Vistula. Polskie Archiwum Hydrobiologii 29: 387–404.
80. Skalski AW (1996) Fauna podziemna Tatr stan poznania, problemy badawcze i zagrożenia. In: Kownacki A (Ed.) Przyroda Tatrzańskiego Parku Narodowego a Człowiek, T. II. Biologia, TPN, PTPNoZ, Oddział Kraków–Zakopane: 113–117.
81. Skalski A, Skalska B (1969) The recent fauna of the Polish Caves. Proc. 4[th] Int. Speleol. Congress, 4–5: 213–223.
82. Skalski AW, Sywula T (1987) A contribution to our knowledge of the underground Crangonyctidae (Amphipoda) of Poland. Rocznik Muzeum Okręgowego w Częstochowie, Przyroda 3: 59–68.
83. Skorupski M, Biesiadka E, Gabryś G, Gwiazdowicz DJ, Kaźmierski A, Magowski WŁ, Mąkol J, Olszanowski Z, Siuda K (2000) Roztocze (Acari) Bieszczadów. Monografie Bieszczadzkie 7: 67–100.
84. Stammer HJ (1936) Die Höhlenfauna des Glatzer Schneeberges. 8. Die Wasserfauna der Schneeberghöhlen. Beiträge zur Biologie des Glatzer Schneeberges 2: 199–214.
85. Sywula T (1974a) The ostracods (Ostracoda) of the River Raba and of certain aquatic environments connected with it. Acta hydrobiologica 16: 255–277.
86. Sywula T (1974b) Notes on Ostracoda. XIV. Interesting species from the basin of the River Raba (South Poland). Annales zoologici 32: 59–73.
87. Sywula T (1976) New species of Ostracoda (Crustacea) from subterranean waters of Poland. Bulletin de Académie Polonaise des Sciences. Série des sciences biologiques, Cl. II 24: 271–278.
88. Sywula T (1981) Małżoraczki (Ostracoda) wód podziemnych Polski. V Rocznik Muzeum Okręgowego w Częstochowie Przyroda 2: 89–96.
89. Sywula T (1989) Bathynella natans Vejdovsky, 1882 i Proasellus slavus (Remy, 1948) nowe dla Polski, podziemne skorupiaki. Przegląd Zoologiczny 33: 77–82.
90. Sywula T (2000) Skorupiaki (Crustacea) Bieszczadów (z wyjątkiem Malacostraca). Monografie Bieszczadzkie 7: 49–54.
91. Sywula T, Jędryczkowski WB (2000) Skorupiaki (Crustacea). In: Razowski J (Ed) Flora i fauna Pienin. Monografie Pienińskie 1: 107–110.
92. Tabacki A (1971) Widłonogi (Copepoda) rzeki Grabi. Zeszyty Naukowe Uniwersytetu Łódzkiego Nauki Matematyczno–Przyrodnicze Seria II 44: 31–52.

93. Tabacki AP (1980) Widłonogi (Copepoda) wód studziennych okolic Sulejowa koło Łodzi. Acta Universitatis Lodziensis Nauki Matematyczno–Przyrodnicze Seria II, 33: 123–128.
94. Wróblewski A, Sywula T (1997) Copepoda–Widłonogi. In: Razowski J (Ed.) Wykaz zwierząt Polski. T. IV: 158–164.
95. Wrześniowski A (1888) O trzech kiełżach podziemnych. Pamiętnik Fizjograficzny 8, III: 221–330 + 27 tablic i rysunków
96. Zawal A (1999) Nowe i rzadsze w faunie Polski gatunki wodopójek (*Hydracarina*) z masywu Babiej Góry. Przegląd Zoologiczny 43: 97–102.
97. Zieliński D (1998) Life cycle and altitude range of *Gammarus leopoliensis* Jażdżewski & Konopacka, 1989 (Amphipoda) in south–eastern Poland. Crustaceana 71:129–143.