Checklist of the parasites of European eel *Anguilla anguilla* (Linnaeus, 1758) (Anguillidae) in Poland

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Abstract

The present paper lists all parasite species of the European eel *Anguilla anguilla* (Linnaeus, 1758), recorded in Poland, in both its saltwater and freshwater habitats. The list has been drawn up, based on data acquired since 1844. The majority of included parasite species are presented with fish infection parameters together with data on their developmental stages and occupied microhabitats, localities and dates of collection of the eels themselves. The database includes 62 parasite taxa (including 50 species, nine identified to the genus level and three to higher taxa), representing at least 47 genera and 39 families. The most frequently-noted parasites of the European eel are the cestode *Bothriocephalus claviceps*, the nematodes *Anguillicoloides crassus*, *Camallanus lacustris* and *Raphidascaris acus* and the acanthocephalan *Acanthocephalus lucii*. Four alien species have been noted from this host: *A. crassus*, the monogeneans *Pseudodactylogyrus anguillae* and *Pseudodactylogyrus bini* and the acanthocephalan *Paratenuisentis ambiguus*. The present list includes both new host records and earlier records not included in previous lists of parasites of eels.

Keywords

biodiversity, eel, fish, parasite, species distribution
Introduction

The European eel *Anguilla anguilla* (Linnaeus, 1758) is a species of fish with a wide distribution in European waters and one with both very high environmental and economic value. Therefore, there is a pressing need to understand the real and potential threats for eel populations, including such death hazards as parasitoses and their secondary consequences. Since the end of the 20th Century, eel populations have decreased by over 99% due to various factors, such as increased water pollution, climate change, overfishing and dam construction and the species is at risk of extinction. It is currently subject to protection by various forms of conservation, including the Washington Convention (CITES) and is listed as critically endangered by the IUCN Red List of Threatened Species (Dekker 2003, Stone 2003, Freyhof and Kottelat 2010). One significant factor in this decline was the appearance of the nematode *Anguillicoloides crassus*: an alien, invasive parasite which inhabits the swim bladders of eels, resulting in sickness and the disturbance of various vital functions that may prevent the eels from reaching their spawning area and reproducing (Moriarty and Dekker 1997, Lefebvre et al. 2002, Dekker 2003, Kirk 2003, Stone 2003, van Ginneken and Maes 2005). *Anguillicoloides crassus* was probably introduced from Taiwan, where it was associated with its specific host, the Japanese eel; since its introduction, it has spread rapidly throughout the European eel population (Taraschewski et al. 1987, Moravec 1992, Molnár et al. 1993, Münderle et al. 2006).

A comprehensive analysis of the European eel parasite fauna is complicated by its wide geographical distribution and by the poor understanding of the complex biology of the eel. It is therefore often difficult to draw firm conclusions on the infection routes with parasites or participation of the eel in their life cycles. Eel leptocephalus larvae migrate across the Atlantic Ocean to the coasts of Europe; then they metamorphose into glass eel (montée) and move to rivers and lakes, where they mature. Finally, they take part in catadromous migration to the spawning area in the Sargasso Sea (van Ginneken and Maes 2005). Thus, they inhabit different environmental conditions at different stages of ontogenesis; in addition, during the course of their migrations, they may accumulate parasites originating from different areas and further disseminate them. Parasite accumulation is also supported by their longevity and predatory lifestyle, the oldest known specimen in the wild being 85 years old (Dekker et al. 1998). The eel may constitute a significant link in the life cycles of parasites and their distribution in the environment; however, some differences may be attributed to local factors.

Therefore, there is a clear need to better understand the parasite fauna of European eels, its species composition, structural changes and infection level, both on the global and regional scales. Constant parasitological monitoring in all distribution areas would provide a clearer picture of the formation of parasite assemblages across the different parts of the distribution of the eel; it would also allow observation of changes in the parasite ranges and hence, any associated threats. However, being rather local in nature, data on the eel parasite fauna are scattered across a range of publications and reports; in addition, collective analyses are often further complicated by variations in sources or language barrier. Thus far, three checklists of eel parasites have been published concerning various
species of Anguilla: two of them are from Japan, the second being a revised and updated checklist, while the other concerns the parasites found in A. anguilla in Europe and North Africa (Nagasawa et al. 2007, Jakob et al. 2016, Nagasawa and Hirotaka 2017). Out of necessity, the latter list is restricted to available sources from selected countries. Its aim was to provide an overview of the parasite fauna acting as the reference point to future analyses of trends in changes in biodiversity. However, this work did not provide a full picture of the data from Poland, as it included only seven original studies; in contrast, the present checklist includes 59.

Therefore, the objective of this study was to provide a complete, verified list of parasitic Protista and Metazoa found, thus far, in the European eel in Poland.

Material and methods

The checklist has been drawn up primarily on the basis of published data (55 items) from the area of Poland, including data from the period 1844-2016. It also includes our own unpublished data, marked in the table as "this study", together with examples of data from conference abstracts regarding the occurrence of A. crassus or the presence of new records from Poland.

For the majority of species, additional data have been provided if included in the source publications: infection parameters such as prevalence (P), mean intensity, intensity range and abundance, as well as the developmental stages of the parasites and their microhabitats. The infection parameters were calculated, based on data included in original studies by means of unification, where possible. Information on dates of fish collection, as well as the geographical location (with GPS coordinates in the Suppl. material 1), have been also included.

The species were arranged in taxonomic and then alphabetical order. The Protista taxonomy follows Lom and Dyková (1992); for Trematoda, Gibson et al. (2002) and Jones et al. (2005); for Nematoda, Moravec (2013) and Nadler et al. (2005); for Cestoda, Kahlil et al. (1994); for Acanthocephala, Amin (2013); the taxonomy for Myxozoa, Monogenea, Arthropoda, Annelida and Mollusca follows the WORMS database (WoRMS Editorial Board 2020). As some taxa have been subject to revision over the years, valid and verified species names were used in the list. For instance, Szidat (1944) considered Sphaerostomum bramae (Müller, 1776), a trematode from the study of Markowski (1933) as Plagioporus angulatus. Furthermore, Spironucleus mobilis Wierzbicka & Einszporn-Orecka, 1986 is currently a synonym of Spironucleus anguilae (Lom and Dyková 1992), Trichophrya piscium Buetschli, 1889 is Capriniana piscium (Svobodová et al. 2009), Sphaerospora sphaerocapsularae Wierzbicka 1986 is now Ortholinea sphaerocapsularae (Sitjà-Bobadilla and Alvarez-Pellitero 1994), Sphaerospora anguilae Wierzbicka, 1986 is a synonym of S. gilsoni (Wierzbicka 1994), Ascaris labiata Rudolphi, 1809 is Raphidascaris acus, Anguillicola crassus Kuwahara, Niimi & Itagaki, 1974 is currently known as Anguillicoloides crassus (Moravec 2006) and Contracaecum aduncum (Rudolphi, 1802) is Hysterothylacium aduncum. Bielecki et al. (2011) believe that Cystobranchus respirans
(Troschel, 1850) is *Piscicola respirans*. In addition, it is known that "*Diplostomum spathaceum*" includes more than one species; there are several species of *Diplostomum* difficult to identify without using molecular methods (Niewiadomska 2003, Georgieva et al. 2013). Likewise, there is a possibility of wrong species identification in the case of *Pomphorhynchus laevis*, due to morphological similarity to *P. tereticollis* which occurs sympatrically (Špakulová et al. 2011, Hohenadler et al. 2018).

**Results and Discussion**

A total of 62 taxa have been recorded from the European eel in Poland, of which 11 are Protista (eight species and three identified at the genus level), including five Ciliophora (one identified at the genus level as *Apiosoma*) and two Apicomplexa. Of the 51 representatives of Metazoa (42 identified as species, six to genus level, three to higher taxa), six were Myxozoa, nine Trematoda, five Monogenea (one identified at the genus level – *Dactylogyrus* and one as Monogenea), five Cestoda (one identified as Cestoda gen. sp. *Pseudophyllidearum* larvae), ten Nematoda, eight Acanthocephala, two Annelida, three Arthropoda, one Mollusca (identified as *Unionidae*). In addition to the species mentioned in Table 1, further data on the occurrence of *Acanthocephalus clavula* and *Corynosoma semerme* in the European eel were given in overview studies on the parasites of the Polish ichthyofauna (Pojmańska et al. 2007, Popiołek 2016); however, this information was not included in the analysed original studies.

| Parasite life stage | Microhabitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|--------------|-------|------------------------|-----------|----------|--------------------------|------------|
| METAMONADA          |              |       |                        |           |          |                          |            |
| Family Hexamitidae  |              |       |                        |           |          |                          |            |
| *Spironucleus anguillae* Einszporn-Oreka, 1979 |              |       |                        |           |          |                          |            |
| 1 - intestine        | 1.9 (±)-(++) | -     | -                      | Szczecin Lagoon | 1982-83 | Wierzbiicka and Einszporn-Oreka 1986, Wierzbiicka and Orecka-Grabda 1994 |  |
| Parasite life stage | Microhabitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|--------------|-------|------------------------|-----------|----------|--------------------------|------------|
| - intestine         |              | 4.2   | (++)                   | -         | Oder mouth | 1982-83                  | Wierzbicka and Einszporn-Orecka 1986, Wierzbicka and Orecka-Grabda 1994 |

EUGLENOZOA

**Family Trypanosomatidae**

*Trypanosoma granulosum* Laveran & Mesnil, 1909

| Trypanosoma granulosum | Laveran & Mesnil, 1909 |
|------------------------|------------------------|
| trypomastigote         | blood                  | 24                 | (0.2-16.0) 4 | -         | Lake Siecino            | 1970-73 | Orecka-Grabda and Wierzbicka 1996 |
| trypomastigote         | blood                  | 68                 | (2.2-16.2) 4 | -         | Lake Dąbie              | 1970-73 | Orecka-Grabda and Wierzbicka 1996 |
| -                      | blood                  | -                  | -           | -         | Szczecin Lagoon, Lake Dąbie | 1970-73 | Orecka-Grabda 1986 |
| -                      |                        | 5                  | 46.9 3      | (-)(++)   | Szczecin Lagoon          | 1982-83 | Wierzbicka and Orecka-Grabda 1994 |
| -                      |                        | 5                  | 95.8        | (-)(++)   | Oder mouth               | 1982-83 | Wierzbicka and Orecka-Grabda 1994 |
| -                      |                        |                    | 50-60       | -         | Lake Śniardwy             | 1989     | Własow et al. 1991 |
| -                      |                        |                    | 50          | -         | Lake Mamry               | 1990     | Własow et al. 1991 |
| - blood                | 100                    | variable           | -           | -         | River Rega               | 2001-02 | Rząd et al. 2007 |

Trypanosoma sp.

| Trypanosoma sp. |
|------------------|
| blood            | 24               | -                 | -           | -         | Lake Insko               | 1993     | Rząd and Pilecka-Rapacz 2002 |

CILIOPHORA

**Family Epistylididae**

*Apiosoma* sp.

| Apiosoma sp. |
|--------------|
| -            | 6               | -                 | -           | -         | Lake Dąbrowa Wielka      | 1990-91 | Własow et al. 1991 |

**Family Ichthyophthiridae**

*Ichthyophthirius multifiliis* (Fouquet, 1876)

| Ichthyophthirius multifiliis |
|------------------------------|
| gills, skin                  | -                              | -                 | -           | -         | River Darłówka           | -        | Grabda 1971 |
| Parasite life stage | Microhabitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|-------------|-------|------------------------|-----------|----------|--------------------------|------------|
| -                   | gills       | 3.1   | (+)                    | -         | Szczecin Lagoon          | 1982-83     | Wierzbicka and Orecka-Grabda 1994 |
| **Family Trichodinidae** |             |       |                        |           |          |                          |            |
| *Trichodina jadranica* Raabe, 1958 |             |       |                        |           |          |                          |            |
| -                   | gills       | 68.6  | (+)-(++++)             | -         | Szczecin Lagoon          | 1982-83     | Wierzbicka and Orecka-Grabda 1994 |
| -                   | gills       | 66.7  | (+)                    | -         | Oder mouth               | 1982-83     | Wierzbicka and Orecka-Grabda 1994 |
| **Trichodina sp.** |             |       |                        |           |          |                          |            |
| -                   | -           | 30    | -                      | -         | Lake Niegocin            | 1989        | Własow et al. 1991 |
| -                   | -           | 8     | -                      | -         | Lake Mamry               | 1990        | Własow et al. 1991 |
| -                   | -           | 6     | -                      | -         | Lake Dąbrowa Wielka      | 1990-91     | Własow et al. 1991 |
| *Trichodinella epizootica* (Raabe, 1950) |             |       |                        |           |          |                          |            |
| -                   | gills       | 62.9  | (+)-(+++                  | -         | Szczecin Lagoon          | 1982-83     | Wierzbicka and Orecka-Grabda 1994 |
| -                   | gills       | 41.7  | (+)-(+++                  | -         | Oder mouth               | 1982-83     | Wierzbicka and Orecka-Grabda 1994 |
| -                   | -           | 3.3   | 1-4 (2.5)              | -         | Vistula Lagoon          | 2005        | Rolbiecki and Rokicki 2006 |
| **Family Trichophryidae** |             |       |                        |           |          |                          |            |
| *Capriniana piscium* (Bütschli, 1889) |             |       |                        |           |          |                          |            |
| -                   | gills       | 4.2   | (+++)                  | -         | Oder mouth               | 1982-83     | Wierzbicka and Orecka-Grabda 1994 |
| **APICOMPLEXA** |             |       |                        |           |          |                          |            |
| **Family Eimeriidae** |             |       |                        |           |          |                          |            |
| *Eimeria anguillae* Léger & Hollande, 1922 |             |       |                        |           |          |                          |            |
| oocyst              | intestine   | 11.9  | (+)-(++++)             | -         | Szczecin Lagoon          | 1982-83     | Wierzbicka and Orecka-Grabda 1994 |
| oocyst              | intestine   | 20.8  | (+)-(+++                  | -         | Oder mouth               | 1982-83     | Wierzbicka and Orecka-Grabda 1994 |
| **Family uncertain** |             |       |                        |           |          |                          |            |
| Parasite life stage | Micro habitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|---------------|-------|------------------------|-----------|----------|--------------------------|------------|
| Rhabdospora thelohani Laguessé, 1895 |
| -                  | -             | 20    | -                      | -         | Lake Niegocin          | 1989        | Wíasow et al. 1991      |
| -                  | -             | 50-60 | -                      | -         | Lake Śniardwy          | 1989        | Wíasow et al. 1991      |
| -                  | -             | 17    | -                      | -         | Lake Mamry             | 1990        | Wíasow et al. 1991      |
| -                  | -             | 49    | -                      | -         | Lake Dąbrowa Wielka    | 1990-91     | Wíasow et al. 1991      |

**MYXOZOA**

**Family Myxidiidae**

*Myxidium giardi* Cépède, 1906

| Spores                          | Ub     | 79.9 3 | (++)-((++) | -       | Szczecin Lagoon | 1982-83 | Wierzbicka and Orecka-Grabda 1994 |
|---------------------------------|--------|--------|-------------|---------|----------------|---------|------------------------------|
| Spores                          | Ub     | 100    | (++)-(++++) | -       | Oder mouth     | 1982-83 | Wierzbicka and Orecka-Grabda 1994 |
| Gills                           | -      | 20     | (++)-(++)   | -       | Lake Miedwie   | 1997-99 | Sobecka and Piasecki 2002    |
| -                               | -      | 21.1   | (++)-(++)   | -       | Vistula Lagoon | 2005    | Rolbiecki and Rokicki 2006   |

*Zschokkella stettinensis* Wierzbicka, 1987

| Spores                          | Ub     | 48.65  | (++)-(++)   | -       | Szczecin Lagoon, Lake Dąbie | 1983, 1985 | Wierzbicka 1987 |
|---------------------------------|--------|--------|-------------|---------|------------------------------|-----------|----------------|
| -                               | Ub     | 11.3 3 | (++)-(++)   | -       | Szczecin Lagoon             | 1982-83   | Wierzbicka and Orecka-Grabda 1994 |
| -                               | Ub     | 50.0   | (++)-(++)   | -       | Oder mouth                  | 1982-83   | Wierzbicka and Orecka-Grabda 1994 |

**Family Myxobolidae**

*Henneguya psorospermica* Thélohan, 1895

| -                               | -      | 6      | -           | -       | Lake Dąbrowa Wielka         | 1990-91   | Wíasow et al. 1991       |

*Myxobolus portucalensis* Saraiva & Molnar, 1990

| Pl. Spores                      | Ub     | 16.9   | (++)-(++)   | -       | Szczecin Lagoon             | 1982-83   | Wierzbicka and Orecka-Grabda 1996 |

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**Checklist of the parasites of European eel Anguilla anguilla (Linnaeus, ...**
| Parasite life stage | Micro habitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|--------------|-------|------------------------|-----------|----------|--------------------------|------------|
| pl, spores          | 8            | 29.2  | (+)-(++)               | -         | Skolwiński Canal         | 1982-83     | Wierzbicka and Orecka-Grabda 1996 |
| pl, spores          | 8            | 38.5  | (+)-(++)               | -         | Lake Dąbie               | 1985        | Wierzbicka and Orecka-Grabda 1996 |

**Family Ortholineidae**

*Ortholinea sphaerocapsularae* (Wierzbicka, 1986)

| Time period | Locality | References |
|-------------|----------|------------|
| pl, spores  | ub       | 7.69 (+)   | Lake Dąbie 1985 Wierzbicka 1986b |

**Family Sphaerosporidae**

*Sphaerospora gilsoni* (Debaisieux, 1925)

| Time period | Locality | References |
|-------------|----------|------------|
| pl, spores  | ub       | 13.2 (+)   | Szczecin Lagoon 1982-83 Wierzbicka and Orecka-Grabda 1994 |

**PLATYHELMINTHES: TREMATODA**

**Family Allocreadiidae**

*Bunodera luciopercae* (Müller, 1776)

| Time period | Locality | References |
|-------------|----------|------------|
| A           | -        | 1.1        | Vistula Lagoon 2005 Rolbiecki and Rokicki 2006 |

**Family Azygiidae**

*Azygia lucii* (Müller, 1776)

| Time period | Locality | References |
|-------------|----------|------------|
| -           | stomach  | 0.63 (+)   | Szczecin Lagoon 1982-83 Orecka-Grabda and Wierzbicka 1994 |

**Family Deropristidae**

*Deropristis inflata* (Molin, 1859)

| Time period | Locality | References |
|-------------|----------|------------|
| A           | intestine| 18.5 (+)   | Baltic Sea (n. Chłapowo), Puck Bay 1930-31 Markowski 1933 |
| -           | intestine| 17.6 (+)   | Gulf of Gdańsk 1967-71 Rokicki 1975 |
| -           | -        | 3 (+)      | Lake Dąbie 1971 Seyda 1973 |
| -           | intestine| 3.8 (+)    | Szczecin Lagoon 1982-83 Orecka-Grabda and Wierzbicka 1994 |
| Parasite life stage | Micro habitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|--------------|-------|------------------------|-----------|----------|-------------------------|------------|
| A                   | intestine    | 1.43  | 2-4                    | 0.042     | Dead Vistula | 1982-90                | Sułgostowska 1993 |
| A                   | intestine    | 12.17 | 1-600                  | 2.190     | Gulf of Gdańsk | 1982-90                | Sułgostowska 1993 |
| A                   | intestine    | 42.15 | 1-200                  | 16.016    | Baltic Sea (n. Władysławowo) | 1982-90                | Sułgostowska 1993 |
| -                   | intestine    | 1.14  | 2 (2.00)               | 0.02      | Lake Łębsko | 2000-06                | Morozińska-Gogol 2011 |
| -                   | -            | 0.4   | 1 (1)                  | 0.002     | Vistula Lagoon | 2001-02                | Bystydzieńska et al. 2005 |
| -                   | -            | 0.7   | 1 (1)                  | 0.007     | Puck Bay | 2002                   | Bystydzieńska et al. 2005 |
| A                   | -            | 2.2   | 2-6 (3)                | 0.09      | Vistula Lagoon | 2005                   | Rolbiecki and Rokicki 2006 |

**Family Diplostomidae**

*Diplostomum spathaceum* s. l. (Rudolphi, 1819)

| -       | 10   | 1 (1) | 0.10 | Oder (n. Stolczyn) | 1971 | Seyda 1973 |
| -       | 31   | 1-4 (1.6) | 0.50 | Szczecin Lagoon | 1971 | Seyda 1973 |
| -       | 6    | 1 (1) | 0.10 | Lake Dąbie | 1971 | Seyda 1973 |

*Diplostomum* spp.

| -       | 9.1  | 2 (2.0) | 0.2 | Lake Dgal Wielki | 1979-84 | Grabda-Kazubska et al. 1987 |
| -       | 6    | -      | -  | Lake Mamry | 1990 | Własow et al. 1991 |
| -       | 19   | -      | -  | Lake Dąbrowa Wielka | 1990-91 | Własow et al. 1991 |
| eyes    | 3.41 | 1-3 (3.67) | 0.13 | Lake Łębsko | 2000-06 | Morozińska-Gogol 2007, Morozińska-Gogol 2011 |
| eyes    | 51.1 | 1-88 (6.8) | -  | Puck Bay | 2002 | Bystydzieńska et al. 2005 |
| -       | 8.9  | 1-2 (1.4) | -  | Vistula Lagoon | 2005 | Rolbiecki and Rokicki 2006 |
| eye lens| 14.3 | 6 (6.0) | 0.85 | Rzeka Łeba | 2014-15 | This study |

*Tylodelphys clavata* (Nordmann, 1832)

| -       | 3    | 1 (1) | 0.03 | Szczecin Lagoon | 1971 | Seyda 1973 |
| Parasite life stage | Microhabitat            | P [%] | Intensity range (mean) | Abundance | Locality          | Material collection year | References                        |
|---------------------|-------------------------|-------|------------------------|-----------|-------------------|---------------------------|-----------------------------------|
| met                 | vitreous humour         | 3     | 1 (1)                  | 0.03 ³    | Lake Dąbie        | 1971                      | Seyda 1973                       |
|                     |                         |       |                        |           |                   |                           |                                   |
| Family Hemiuridae   |                         |       |                        |           |                   |                           |                                   |
| *Brachyphallus crenatus* (Rudolphi, 1802) |                     |       |                        |           |                   |                           |                                   |
| -                   | -                       | 5.9 ³ | 9                      | 0.53 ³    | Gulf of Gdańsk    | 1967-71                   | Rokicki 1975                    |
| -                   | -                       | 0.2   | 1 (1)                  | 0.002 ³   | Vistula Lagoon    | 2001-02                   | Bystydzieńska et al. 2005        |
| Family Opecoelidae  |                         |       |                        |           |                   |                           |                                   |
| *Plagioporus angulatus* (Dujardin, 1845) |                     |       |                        |           |                   |                           |                                   |
| A                   | intestine               | 7.4 ³ | 1-3 (2)                | 0.15 ³    | Baltic Sea (n. Chłapowo) | 1930-31                   | Markowski 1933                  |
| Family Strigeidae   |                         |       |                        |           |                   |                           |                                   |
| *Ichthyocotylurus platycephalus* (Creplin, 1825) |                     |       |                        |           |                   |                           |                                   |
| met                 | stomach                 | 0.63 ³| 3 (3)                  | 0.02 ³    | Szczecin Lagoon   | 1982-83                   | Orecka-Grabda and Wierzbicka 1994 |
| met                 | -                       | 2.2   | 3 (3)                  | 0.07 ³    | Vistula Lagoon    | 2005                      | Rolbiecki and Rokicki 2006       |

**PLATYHELMINTHES: MONOGENEA**

**Family Dactylogyridae**

*Dactylogyrus* sp.

- gills 30 (1) - Lake Miedwie 1997-99 Sobecka and Piasecki 2002

**Family Pseudodactylogyridae**

*Pseudodactylogyrus anguilae* (Yin & Sproston, 1948)

- gills - - 3.46 ³ Lake Strażyn - Dzika et al. 1995
- gills 90 (11.6) 10.4 Lake Dębno 1994-95 Dzika 1999
- gills 1.13 (1.82-9.25) 0.14-4.78 Rivers Radew, Rega, Więprza 1999-2003 Sobeka and Pilecka-Rapacz 2003
- gills 100 ³ 6-16 (11) 11.0 ³ Puck Bay 2002 Bystydzieńska et al. 2005

*Pseudodactylogyrus bini* Kikuchi, 1929

- gills - - 2.07 ³ Lake Strażyn - Dzika et al. 1995
- gills 71 (18.1) 16.2 Lake Dębno 1994-95 Dzika 1999
| Parasite life stage | Micro habitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|--------------|-------|------------------------|-----------|----------|--------------------------|------------|
| -                   | gills        | 11    | (0.73-3.5)             | 0.12-1.95 | River Radew, Rega, Wieprza | 1999-2003   | Sobecka and Pielecka-Rapacz 2003 |
| *Pseudodactylogyrus* sp. |
| -                   | gills        | 1.9³  | 1 (1)                  | 0.02³     | Szczecin Lagoon | 1982-83     | Orecka-Grabda and Wierzbicka 1994 |
| Monogenea n. det.  |
| -                   | -            | 17    | -                      | -         | Lake Dąbrowa Wielka | 1990-91     | Własow et al. 1991 |
| PLATYHELMinTHES: CESTODA |
| Family *Bothrioccephalidae* |
| *Bothrioccephalus claviceps* (Goeze, 1782) |
| A                   | intestine    | 22.2³ | 2-3 (2.5³)             | 0.55³     | Baltic Sea (n. Chłapowo), Puck Bay | 1930-31     | Markowski 1933 |
| A                   | -            | -     | -                      | -         | Lake Gołdapiwo, Lake Mamry | 1954-58     | Jarecka 1959 |
| A                   | intestine    | 8.3³  | 1 (1)                  | 0.08³     | Puck Bay | 1959         | Sołyński 1964 |
| -                   | -            | 25    | 1-11 (4.2³)            | 1.05³     | Oder (n. Stolczyn) | 1971         | Seyda 1973 |
| -                   | -            | 37    | 1-14 (4.9³)            | 1.84³     | Szczecin Lagoon | 1971         | Seyda 1973 |
| -                   | -            | 23    | 2-13 (3.7³)            | 0.84³     | Lake Dąbie | 1971         | Seyda 1973 |
| -                   | -            | 9.1   | 3³ (3³)                | 0.27      | Lake Dgal Wielki | 1979-84     | Grabda-Kazubesa et al. 1987 |
| -                   | intestine    | 35.2³ | 1-5 (1.1³)             | 0.40³     | Szczecin Lagoon | 1982-83     | Orecka-Grabda and Wierzbicka 1994 |
| -                   | intestine    | 29.2  | 1-3 (1.4³)             | 0.42³     | Skołwiński Canal | 1982-83     | Orecka-Grabda and Wierzbicka 1994 |
| immature, A         | intestine    | 10.00 | 1-35                   | 0.807     | Dead Vistula | 1982-90     | Suľgostowska 1993 |
| immature, A         | intestine    | 8.36  | 1-10                   | 0.183     | Gulf of Gdańsk | 1982-90     | Suľgostowska 1993 |
| immature, A         | intestine    | 11.57 | 1-18                   | 0.371     | Baltic Sea (n. Władysławowo) | 1982-90     | Suľgostowska 1993 |
| -                   | -            | 6     | -                      | -         | Lake Dąbrowa Wielka | 1990-91     | Własow et al. 1991 |
| -                   | intestine    | 12.5  | 1-6 (2.27)             | 0.28      | Lake Łębsko | 2000-06     | Morozińska-Gogol 2011 |
| Parasite life stage | Micro habitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|---------------|-------|------------------------|-----------|----------|--------------------------|------------|
| -                   | -             | 0.8   | 1-2 (1.5)              | -         | Vistula Lagoon          | 2001-02     | Bystydzieńska et al. 2005 |
| -                   | -             | 30.1  | 1-11 (2.8)             | -         | Puck Bay               | 2002        | Bystydzieńska et al. 2005 |
| A intestine         | 15.2          | 1-14 (3.4) | 0.52                  | Lake Wdzydze | 2004             | This study |
| A -                | 18.9          | 1-3 (1.3) | -                     | Vistula Lagoon | 2005             | Rolbiecki and Rokicki 2006 |

**Family Proteocephalidae**

*Proteocephalus macrocephalus* (Creplin, 1825)

- Intestine 22.2³ 1-20 (5.0³) 1.10³ Baltic Sea (n. Chłapowo), Puck Bay 1930-31 Markowski 1933
- Plerocercoid intestine 8.3³ 1 (1) 0.08³ Puck Bay 1959 Sołtyńska 1964
- Intestine 4.1³ 1-19 - Gulf of Gdańsk 1967-71 Rokicki 1975
- - 10 1-3 (2.0³) 0.20³ Oder (n. Stolczyn) 1971 Seyda 1973
- - 22 1-10 (2.9³) 0.62³ Szczecin Lagoon 1971 Seyda 1973
- - 26 1-4 (4.5³) 1.16³ Lake Dąbie 1971 Seyda 1973
- Intestine 39.0³ 1-33 (3.3³) 1.30³ Szczecin Lagoon 1982-83 Orecka-Grabda and Wierzbicka 1994
- Intestine 16.7 1-2 (1.5³) 1.50³ Skołwiński Canal 1982-83 Orecka-Grabda and Wierzbicka 1994
- Intestine 15.7 1-5 0.300 Dead Vistula 1982-90 Sulgostowska 1993
- Intestine 10.1 1-25 0.253 Gulf of Gdańsk 1982-90 Sulgostowska 1993
- Intestine 24.7 1-12 0.743 Baltic Sea (n. Władysławowo) 1982-90 Sulgostowska 1993
- Intestine 27.2 1-15 (3.75) 1.02 Lake Łebsko 2000-06 Morozińska-Gogol 2011
- - 8.4 1-22 (3.8) - Vistula Lagoon 2001-02 Bystydzieńska et al. 2005
- - 23.3 1-42 (4.8) - Puck Bay 2002 Bystydzieńska et al. 2005
- Intestine 31.1 1-5 (2.5) - Vistula Lagoon 2005 Rolbiecki and Rokicki 2006
- Intestine 20.0³ 2 (2.0) 0.40 River Szkarpawa 2014-16 This study

*Proteocephalus* sp.
| Parasite life stage | Micro habitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|--------------|-------|------------------------|-----------|----------|--------------------------|------------|
| juvenile            |              | 16.7  | 1-6 (2.2)              |           | Vistula Lagoon           | 2005        | Rolsiecki and Rokicki 2006 |

**Family Triaenophoridae**

*Trienophorus nodulosus* (Pallas, 1781)

- intestine 20.0 \(^{3}\) \(^{9}\) 1 0.203 Vistula (n. Warszawa) 1924-25 Dąbrowska 1970

**Family n. det.**

Cestoda gen. sp. Pseudophyllidarum larvae

L intestine 8.3 \(^{3}\) 1 (1) 0.08 \(^{3}\) Puck Bay 1959 Sołtyńska 1964

**NEMATODA**

**Family Anguillicolidae**

*Anguillicoloides crassus* (Kuwahara, Niimi & Itagaki, 1974)

- sb 75 - - Vistula Lagoon 1988 Grawiński 1994
- sb 80 - - Lakes Przywlożcze, Skape, Wielewicke 1989 Grawiński 1994
- - 68.3 1-25 - Vistula Lagoon 1988-90 Rolbiecki et al. 1996
- - 2.7 \(^{3}\) 1-2 - Lake Niegocin 1989 Własow et al. 1991
- - 70.0 \(^{3}\) 5-25 - Goczałkowick Reservoir 1989-90 Własow et al. 1991
- - 2.7 \(^{3}\) 2-33 - Lake Mamry 1990 Własow et al. 1991
- - - - - 12 - Własow 1991
L2-L4, pA, A sb 78.3 1-204600 - Lake Strażyn 1993 Własow et al. 1991
L2-L4, pA, A sb 25 1-102 - reservoir near the village of Gaj 1993 Własow et al. 1991
- - 100 15-20 - Vistula Lagoon 1993 Grawiński 1994
L, A sb 78.7 1-15 - Lake Ińsko 1993 Orecka et al. 1995
- sb 88.7 1-15 - Lake Ińsko 1993 Rząd and Pilecka-Rapacz 2002
juvenile, F sb 23.4 \(^{3}\) 0-36 - Szczecin Lagoon 1993-94 Garbacik-Wesolowska et al. 1994
| Parasite life stage | Microhabitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|--------------|-------|------------------------|-----------|----------|-------------------------|------------|
| juvenile, F         | sb           | 69.0  | 0-22                   | -         | Lake Łętowskie | 1994 | Garbacik-Wesołowska et al. 1994 |
| juvenile, F         | sb           | 23.1  | 0-10                   | -         | Pomeranian Bay | 1994 | Garbacik-Wesołowska et al. 1994 |
| L                   | sb           | 70    | 1-35                   | -         | Szczecin Lagoon | 1994-96 | Rząd and Pilecka-Rapacz 2001 |
| -                   | sb           | 37.5  | 3-8 (5.0)              | -         | Dead Vistula | 1996 | Rolbiecki and Rokicki 2005 |
| -                   | sb           | 37.5  | 5-16 (7.3)             | -         | Lake Drużno | 1997 | Rolbiecki and Rokicki 2005 |
| e, L4, pA, A intestine | sb           | 41.9  | (3.0)                  | -         | Gulf of Gdańsk | 1997-98 | Rolbiecki et al. 2000 |
| -                   | sb           | 100   | 3-44 (8.2)             | 6.7       | Lake Miedwie | 1997-99 | Sobeka and Piascicki 2002 |
| L3, L4, A           | sb           | 33.3  | 1-7                    | -         | River Wieprza (near Darłowo) | 1999 | Pilecka-Rapacz 2001 |
| L3, L4, A           | sb           | 40    | 1-10                   | -         | River Rega (near Trzebiatów) | 1999 | Pilecka-Rapacz 2001 |
| -                   | sb           | 59.1  | 1-11 (1.7)             | -         | River Rega (Lake Rejowice) | 1999-2003 | Pilecka-Rapacz and Sobeka 2004 |
| -                   | sb           | 41.7  | 1-8 (1.3)              | -         | River Wieprza (near Darłowo) | 1999-2001 | Pilecka-Rapacz and Sobeka 2004 |
| -                   | sb           | 65.6  | 1-12 (2.1)             | -         | River Radew | 2000-01 | Pilecka-Rapacz and Sobeka 2004 |
| A, L                | sb           | 68.18 | 1-27 (5.82)            | 3.97      | Lake Łębsko | 2000-06 | Morozińska-Gogol 2005, Morozińska-Gogol 2007, Morozińska-Gogol 2009, Morozińska-Gogol 2011 |
| -                   | sb           | 66.7  | 11-24 (17.5)           | -         | Lake Bukowo | 2000-07 | Morozińska-Gogol 2009 |
| -                   | sb           | 100   | 5-11 (8.0)             | -         | Lake Kopan | 2000-07 | Morozińska-Gogol 2009 |
| -                   |              | 73    | 1-58 (10)              | -         | Vistula Lagoon | 2001-02 | Bystydzińska et al. 2005 |
| L4, L5, A           | sb           | 75.9  | 1-11 (3.2)             | -         | River Rega | 2001-02 | Rząd et al. 2007 |
| Parasite life stage | Microhabitat | P (%) | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|--------------|-------|------------------------|-----------|----------|--------------------------|------------|
| -                   | -            | 74.4  | 1-62 (8.3)              | -         | Puck Bay | 2002                     | Bystydzieńska et al. 2005 |
| L2-L4, A, e         | sb           | 79.3  | 1-46 (7.2)              | 5.7       | Lake Wdzydze | 2002-05                  | Rolbiecki 2008 |
| -                   | sb           | 100.9 | 6-18 (12)               | -         | Lake Raduńskie Dolne, Lake Raduńskie Górne | 2004        | Rolbiecki and Rokicki 2005 |
| -                   | sb           | 58.3  | 2-12 (6.0)              | -         | Dead Vistula | 2004                    | Rolbiecki and Rokicki 2005 |
| L3, L4, A, e        | sb           | 67.8  | 1-37 (4.2)              |           | Vistula Lagoon | 2005                    | Rolbiecki and Rokicki 2006 |
| L2, L4, A, e        | sb           | 65.2  | 1-20 (5.5)              | 3.6³      | Lake Ostrzyckie | 2005-07                  | Rolbiecki 2011 |
| -                   | -            | -     | -                      | -         | Lake Kuc       | 2006-07                  | Jeżewski et al. 2007 |
| L2, A, e            | sb           | 50.0  | 1-12 (3.8)              | 1.9³      | Lake Żarnowieckie | 2006-08                 | Rolbiecki 2011 |
| L2, A, e            | sb           | 40.0  | 2-3 (3.0)               | 1.2³      | Lake Raduńskie Dolne, Lake Raduńskie Górne | 2006-08      | Rolbiecki 2011 |
| L4, A               | sb           | 28.6³ | 4-6 (5.0)               | 1.4³      | Vistula (near Tczew) | 2007                    | Rolbiecki 2011 |
| L3, A               | sb, intestine wall | 100.9 | 3-6                     | 4.5³      | Lake Żarnowieckie | 2007                    | Rolbiecki 2011 |
| pA, A               | sb           | 92.9  | 1-49 (10.8)             | -         | Szczecin Lagoon | -                      | Popielarczyk et al. 2012 |
| pA, A               | sb           | 64.7  | 1-5 (1.9)               | -         | Lake Dąbie      | -                      | Popielarczyk et al. 2012 |
| pA, A               | sb           | 64.2  | 3-62 (18.5)             | -         | Lake Bukowo    | -                      | Popielarczyk et al. 2012 |
| pA, A               | sb           | 100.9 | 1-50 (13.6)             | -         | Lake Łębsko    | -                      | Popielarczyk et al. 2012 |
| pA, A               | sb           | 80.0³ | 3-16 (8.0)              | -         | Lake Gardno    | -                      | Popielarczyk et al. 2012 |
| pA, A               | sb           | 85.7  | 1-23 (7.2)              | -         | Lake Resko     | -                      | Popielarczyk et al. 2012 |
| pA, A               | sb           | 76.9  | 1-55 (11.6)             | -         | Lake Jamno     | -                      | Popielarczyk et al. 2012 |
| pA                  | sb           | 50.0  | 1-7 (3.2)               | -         | Oder           | -                      | Popielarczyk et al. 2012 |
| pA, A               | sb           | 71.4  | 1-6 (3.4)               | -         | Vistula        | -                      | Popielarczyk et al. 2012 |
| Parasite life stage | Microhabitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|--------------|-------|------------------------|-----------|----------|--------------------------|------------|
| pA                  | sb           | 62.5  | 1-4 (1.7)              | -         | River Węgora -             | -           | Popielarczyk et al. 2012 |
| pA, A               | sb           | 66.7  | 1-7 (2.6)              | -         | River Drwęca                | -           | Popielarczyk et al. 2012 |
| A                   | sb           | 100   | 7 (7.0)                | 7.0       | River Piaśnica              | 2014-16     | This study                 |
| A, L4               | sb           | 40.0  | 6-9 (7.5)              | 3.0       | River Szkarpa               | 2014-16     | This study                 |
| A                   | sb           | 42.9  | 2-4 (3.0)              | 1.28      | Lake Sarbsko                | 2016        | This study                 |

**Family Camallanididae**

*Camallanus lacustris* (Zoega, 1776)

| -                  | intestine    | 20.0  | 1 (1.0)                | 0.20      | Vistula (near Warszawa)     | 1924-25     | Dąbrowska 1970             |
| -                  | intestine    | 100   | 87 (87.0)              | 87.0      | Lake Wdzydze                | 1958        | Grabda et al. 1961         |
| -                  | intestine    | -     | -                      | -         | Lake Gardno, River Nogat   | -           | Grabda 1971                |
|                    | -            | 15    | 1-4 (2.7)              | 0.40      | Oder (near Stołczyn)        | 1971        | Seyda 1973                 |
|                    | -            | 3     | 12 (12)                | 0.39      | Lake Dąbie                  | 1971        | Seyda 1973                 |
|                    | -            | 45.5  | (4.2)                  | 1.9       | Lake Dgal Wielki           | 1979-84     | Grabda-Kazubska et al. 1987|
| A                  | intestine    | 3.1   | 1-7 (3.4)              | 0.11      | Szczecin Lagoon             | 1982-83     | Orecka-Grabda and Wierzbicka1994|
| L4, A              | intestine    | 5.00  | 1-3                    | 0.057     | Dead Vistula                | 1982-90     | Sulgostowska 1993          |
| L4, A              | intestine    | 2.93  | 1-20                   | 0.152     | Gulf of Gdańsk             | 1982-90     | Sulgostowska 1993          |
| -                  | -            | 7     | -                      | -         | Lake Dabrowa Wielka        | 1990-91     | Własow et al. 1991         |
| -                  | intestine    | -     | -                      | -         | Lake Insko                  | 1993        | Rząd and Pilecka-Rapacz 2002|
| -                  | intestine    | 10    | 1 (1)                  | -         | Lake Miedwie                | 1997-99     | Sobecka and Piascki 2002   |
| -                  | intestine    | 3.41  | 1-2 (1.67)             | 0.06      | Lake Łębsko                 | 2000-06     | Morozińska-Gogol 2011      |
| -                  | -            | 3.8   | 1-7 (2.0)              | -         | Puck Bay                    | 2002        | Bystydzieńska et al. 2005  |
| Parasite life stage | Microhabitat | P [%] | Intensity range (mean) | Abundance | Locality          | Material collection year | References                     |
|--------------------|--------------|-------|------------------------|-----------|-------------------|--------------------------|-------------------------------|
| A                  | stomach      | 2.2   | 2                      | 0.04      | Lake Wdzydze      | 2004                     | This study                     |
| A                  | -            | 2.2   | 2 (2)                  | 0.04³     | Vistula Lagoon    | 2005                     | Rolbiecki and Rokicki 2006    |
| A                  | intestine    | 25.0⁹ | 7 (7.0)                | 1.75      | Lake Kłodno       | 2015                     | This study                     |
| Camallanus truncatus (Rudolphi, 1814) | - | -    | 3                      | 1 (1)     | Szczecin Lagoon  | 1971                     | Seyda 1973                     |
|                    | L4           | 0.29  | 1-3                    | 0.005     | Gulf of Gdańsk    | 1982-90                  | Sulgostowska 1993             |
| A                  | intestine    | 2.2   | 2-4 (3)                | 0.073     | Vistula Lagoon    | 2005                     | Rolbiecki and Rokicki 2006    |
| A                  | intestine    | 10.0⁹ | 4 (4.0)                | 0.40      | Lake Choczewskie  | 2008-15                  | This study                     |
| A                  | intestine    | 25.0⁹ | 1 (1.0)                | 0.25      | Lake Kłodno       | 2015                     | This study                     |
| A                  | intestine    | 20.0⁹ | 1 (1.0)                | 0.20      | Lake Dargin       | 2015                     | This study                     |
| Family Cystidicolidae |              |       |                        |           |                   |                          |                               |
| Cystidicola faronias Fischer, 1798 | - | -    | 0.7                    | 7 (7)     | Puck Bay          | 2002                     | Bystydieńska et al. 2005       |
| Spinitectus inermis (Zeder, 1800) | F | intestine | 3.7³      | 3 (3)     | 0.11³            | Baltic Sea (near Chłapowo), Puck Bay | 1930-31 | Markowski 1933 |
| A, L               | intestine    | 3.3   | 1-5 (3.0³)             | 0.10³     | River Wieprza (near Darłowo) | 1999, 2001 | Plelecka-Rapacz and Sobeka 2004 |
| A, L               | intestine    | 6.1   | 1-10 (3.4³)            | 0.21³     | River Rega (Lake Rejowice) | 1999-2003 | Plelecka-Rapacz and Sobeka 2004 |
| A, L               | intestine    | 10.9  | 1-6 (2.3³)             | 0.25³     | River Radew       | 2000-01                  | Plelecka-Rapacz and Sobeka 2004 |
| Family Daniconematidae |              |       |                        |           |                   |                          |                               |
| Daniconema anguillae Moravec & Keie, 1987 | - | gills | 1.9³      | 1 (1.0)     | 0.02³             | Lake Dąbrowa Wielka     | 1990-91 | Własow et al. 1991 |
| F                  | sb wall      | -     | 1                      | -         | Reservoir near village Gaj | 1993     | Własow et al. 1991 |
| Family Dioctophymatidae |              |       |                        |           |                   |                          |                               |
| Eustrongylides excisus Jägerskiöld, 1909 | - |       |                        |           |                   |                          |                               |
| Parasite life stage | Microhabitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|--------------|-------|------------------------|-----------|----------|--------------------------|------------|
| L intestine wall    | 3            | 3     | 0.09 \(^3\)            | Szczecin Lagoon | 1971 | Seyda 1973 |
| L stomach, body cavity | 2.5 \(^3\) | 1-3 (2.2 \(^3\)) | 0.06 \(^3\) | Szczecin Lagoon | 1982-83 | Orecka-Grabda and Wierzbicka 1994 |

**Family Raphidascarididae**

*Hysterothyacium aduncum* (Rudolphi, 1802)

- intestine 33.3 \(^{3,6}\) 1 (1.0) 0.33 \(^3\) River Gnina - Grabda 1971
- - 0.2 1 (1) 0.002 \(^3\) Vistula Lagoon 2001-02 Bystydzierska et al. 2005
- - 0.7 1 (1) 0.01 \(^3\) Puck Bay 2002 Bystydzierska et al. 2005
A - 2.2 1-2 (1.5) 0.03 \(^3\) Vistula Lagoon 2005 Rolbiecki and Rokicki 2006

*Raphidascaris acus* (Bloch, 1779)

- intestine 20.0 \(^{3,6}\) 1 (1) 0.20 \(^3\) Vistula (near Warszawa) 1924-25 Dąbrowska 1970
- intestine 3.7 \(^3\) 1 (1) 0.04 \(^3\) Baltic Sea (near Chłapowo), Puck Bay 1930-31 Markowski 1933
- intestine 100 \(^{3,6}\) 1 (1.0) 1.00 \(^3\) Lake Družno 1951 Kozicka 1959
- intestine - - - River Gnina, Lake Blanki - Grabda 1971
- - 10 1-2 (1.5 \(^3\)) 0.15 \(^3\) Oder (near Sotłczyn) 1971 Seyda 1973
- - 6 3-4 (3.5 \(^3\)) 0.22 \(^3\) Szczecin Lagoon 1971 Seyda 1973
- - 13 1-6 (2.5 \(^3\)) 0.32 \(^3\) Lake Dąbie 1971 Seyda 1973
A - 9.1 1 \(^3\) (1 \(^3\)) 0.09 Lake Dgal Wielki 1979-84 Grabda-Kazubska et al. 1987
A intestine 2.5 \(^3\) 1-6 (4.0 \(^3\)) 0.10 \(^3\) Szczecin Lagoon 1982-83 Orecka-Grabda and Wierzbicka 1994
- - 4.2 2 (2) 0.08 Skolwiński Canal 1982-83 Orecka-Grabda and Wierzbicka 1994
L4, A intestine 24.28 1-26 0.900 Dead Vistula 1982-90 Sulgostowska 1993
L4, A intestine 19.06 1-68 1.067 Gulf of Gdańsk 1982-90 Sulgostowska 1993
L4, A intestine 9.09 1-2 0.107 Baltic Sea (near Władysławowo) 1982-90 Sulgostowska 1993
| Parasite life stage | Microhabitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|--------------------|--------------|-------|------------------------|-----------|----------|--------------------------|------------|
| -                  | intestine    | -     | -                      | -         | Lake Ińsko | 1993                     | Rząd and Pilecka-Rapacz 2002 |
| L                  | intestine    | 0.4 3 | 1 (1.0)                | 0.003 3   | Rivers Rega (Lake Rejowice), Radew, Wieprza (near Darłowo) | 1999-2003 | Pilecka-Rapacz and Sobecka 2004 |
| -                  | intestine    | 1.14  | 1 (1.00)               | 0.01      | Lake Łebsko | 2000-06                 | Morozińska-Gogol 2011 |
| -                  | -            | 56.1  | 1-92 (5.6)             | -         | Vistula Lagoon | 2001-02                 | Bystydzięńska et al. 2005 |
| -                  | -            | 4.5   | 1-12 (5)               | -         | Puck Bay | 2002 | Bystydzięńska et al. 2005 |
| A                  | intestine    | 2.2   | 2 (1.0)                | 0.02      | Lake Wdzydze | 2004 | This study |

**Family Quimperiidae**

*Paraquimperia tenerima* (von Linstow, 1878)

| L | intestine | 0.4 | 1 | 0.0033 | Rivers Rega (Lake Rejowice), Radew, Wieprza (near Darłowo) | 1999-2003 | Pilecka-Rapacz and Sobecka 2004 |

**ACANTHOCEPHALA**

**Family Echinorhynchidae**

*Acanthocephalus anguillae* (Müller, 1780)

| - | intestine | 20.0 3,9 | 1 (1) | 0.20 3 | Vistula (near Warszawa) | 1924-25 | Dąbrowska 1970 |
| - | intestine | 55.5 3,9 | 1-7   | -      | Potok Oliwski | - | Grabda 1971 |
| - | intestine | 33.3 3,9 | 8     | 2.67 3 | River Łupawa | - | Grabda 1971 |
| - | intestine | 36.4 3   | 1-9   | -      | Vistula (near Tczew) | - | Grabda 1971 |
| - | intestine | 40.0 3,9 | 1     | 0.40 3 | River Nogat (near Malbork) | - | Grabda 1971 |
| - | intestine | -       | -     | -      | Lake Probark | - | Grabda 1971 |
| - | -         | 35 3    | 1-37 (9.1 3) | 3.20 3 | Oder (near Stolczyn) | 1971 | Seyda 1973 |
| - | -         | 29 3    | 1-74 (11.1 3) | 3.23 3 | Lake Dąbie | 1971 | Seyda 1973 |
| - | intestine | 2.5 3   | 1-2 (1.2 3) | 0.03 3 | Szczecin Lagoon | 1982-83 | Orecka-Grabda and Wierzbicka 1994 |
| - | intestine | 4.2     | 17 (17) | 0.71   | Skołwiński Canal | 1982-83 | Orecka-Grabda and Wierzbicka 1994 |
| Parasite life stage | Microhabitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|-------------|-------|------------------------|-----------|----------|-------------------------|------------|
| A                   | intestine   | 4.29  | 1-9                    | 0.157     | Dead Vistula        | 1982-90    | Sulgostowska 1993        |
| A                   | intestine   | 1.61  | 1-23                   | 0.061     | Gulf of Gdańsk      | 1982-90    | Sulgostowska 1993        |
| -                   | intestine   | 43.4  | -                      | -         | Lake Inisko         | 1993       | Rząd and Pliecka-Rapacz 2002 |
| -                   | intestine   | 7.95  | 1-21 (6.57)            | 0.52      | Lake Łebsko         | 2000-06    | Morozinska-Gogol 2011    |
| -                   | -           | 0.6   | 1-8 (3.3)              | -         | Vistula Lagoon      | 2001-02    | Bystydzieniska et al. 2005 |
| -                   | -           | 1.5   | 1 (1)                  | 0.01      | Puck Bay            | 2002       | Bystydzieniska et al. 2005 |
| **Acanthocephalus lucii (Müller, 1776)** |
| -                   | intestine   | 100   | 2 (2.0)                | 2.00      | Lake Druzno         | 1951       | Styczyńska 1958          |
| -                   | intestine   | 100   | 2 (2.0)                | 2.00      | Lake Druzno         | 1951       | Kozicka 1959             |
| -                   | intestine   | 100   | 7 (7.0³)               | 7.00      | Lake Wdzydze        | 1958       | Grabda et al. 1961       |
| -                   | intestine   | -     | -                      | -         | Vistula mouth, River Łupawa, River Dadaj, Lake Dąbrówka Wielka | - | Grabda 1971 |
| -                   | -           | 15    | 2-8 (4.0³)             | 0.60      | Oder (near Stołczyn) | 1971       | Seyda 1973               |
| -                   | -           | 3     | 1 (1)                  | 0.03      | Szczecin Lagoon     | 1971       | Seyda 1973               |
| -                   | -           | 10    | 1 (1)                  | 0.10      | Lake Dąbie          | 1971       | Seyda 1973               |
| -                   | intestine   | 5.0-16.7 | 1-7 (2.4³)            | 0.25      | Szczecin Lagoon  | 1982-83    | Orecka-Grabda and Wierzbicka 1994 |
| -                   | intestine   | 16.7  | 1-11 (3.8³)            | 0.62      | Skolwinski Canal    | 1982-83    | Orecka-Grabda and Wierzbicka 1994 |
| A                   | -           | 3.57  | 1-5                    | 0.092     | Dead Vistula        | 1982-90    | Sulgostowska 1993        |
| A                   | -           | 0.88  | 1-7                    | 0.024     | Gulf of Gdańsk      | 1982-90    | Sulgostowska 1993        |
| -                   | -           | 6     | -                      | -         | Lake Śniardwy       | 1989       | Własow et al. 1991       |
| -                   | -           | 6     | -                      | -         | Lake Mamry          | 1990       | Własow et al. 1991       |
| -                   | -           | 6     | -                      | -         | Lake Dąbrówka Wielka | 1990-91 | Własow et al. 1991       |
### Parasite life stage

| Micro habitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------|-------|------------------------|-----------|----------|--------------------------|------------|
| -             | -     | 0.2                    | 14 (14)   | 0.03     | Vistula Lagoon           | 2001-02    | Bystydzieńska et al. 2005 |
| - intestine   | 15.91 | 1-80 (14.14)           | 2.41      | Lake Łębsko | 2000-06                 | Morozińska-Gogol 2011 |
| -             | 0.7   | 14 (14)                | 0.11      | Puck Bay | 2002                    | Bystydzieńska et al. 2005 |
| A intestine   | 28.3  | 1-8 (2.6)              | 0.74      | Lake Wdzydze | 2004                | This study |
| A             | 1.1   | 1                      | 0.01      | Vistula Lagoon | 2005            | Rolbiecki and Rokicki 2006 |

**Echinorhynchus gadi** Zoega in Müller, 1776

| -             | 0.73  | 1-4                    | 0.014     | Gulf of Gdańsk | 1982-90  | Sulgostowska 1993 |
| -             | 0.2   | 1 (1)                  | 0.002     | Vistula Lagoon | 2001-02   | Bystydzieńska et al. 2005 |
| -             | 3     | 1-10 (3.2)             | -         | Puck Bay | 2002  | Bystydzieńska et al. 2005 |

**Echinorhynchus truttae** (Schrank, 1788)

| - intestine   | 33.3  | 3 (3.0)                | 1.00      | River Łupawa | -            | Grabda 1971 |
| - intestine   | 11.1  | 1 (1.0)                | 0.11      | Potok Oliwski | -            | Grabda 1971 |
| - intestine   | 3.41  | 2-21 (8.67)            | 0.30      | Lake Łębsko | 2000-06     | Morozińska-Gogol 2011 |

**Family Neoechinorhynchidae**

**Neoechinorhynchus rutili** (Müller, 1780)

| - intestine   | 5.9   | 2                      | 0.12      | Gulf of Gdańsk | 1967-71  | Rokicki 1975 |
| - intestine   | 2.27  | 1-2 (1.5)              | 0.03      | Lake Łębsko | 2000-06     | Morozińska-Gogol 2011 |

**Family Polymorphidae**

**Corynosoma strumosum** (Rudolphi, 1802)

| cystacanth    | 1.1   | 1 (1)                  | 0.01      | Vistula Lagoon | 2005       | Rolbiecki and Rokicki 2006 |

**Family Pomphorhynchidae**

**Pomphorhynchus laevis** (Zoega in Müller, 1776)

| A intestine   | 14.8  | 1-37 (10.8)            | 1.59      | Baltic Sea (near Chłapowo), Puck Bay | 1930-31  | Markowski 1933 |
| -             | 3     | 1 (1)                  | 0.03      | Lake Dąbie | 1971      | Seyda 1973 |
| A intestine   | 0.44  | 1-2                    | 0.005     | Gulf of Gdańsk | 1982-90    | Sulgostowska 1993 |
| A             | 1.65  | 1-3                    | 0.033     | Baltic Sea | 1982-90    | Sulgostowska 1993 |
| Parasite life stage | Microhabitats | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|--------------|-------|------------------------|-----------|----------|--------------------------|------------|
| -                   | -            | 6     | 1-10 (2.8)             | -         | Puck Bay | 2002                     | Bystydgieńska et al. 2005 |
| -                   | intestine    | 3.41  | 1-2 (1.3)              | 0.05      | Lake Łębsko | 2000-06                 | Morozińska-Gogol 2011 |

**Family Tenuisentidae**

*Paratenuisentis ambiguus Van Cleave, 1923*

|        | Locality | Material collection year | References |
|--------|----------|--------------------------|------------|
| intestine | 6.82     | 1-163 (28.17)            | 1.92       | Lake Łębsko | 2000-06 | Morozińska-Gogol (2008), Morozińska-Gogol (2011), Morozińska-Gogol (2009) |

**MOLLUSCA: BIVALVIA**

**Family Unionidae**

|        | Locality | Material collection year | References |
|--------|----------|--------------------------|------------|
| glochidium | 9.1     | 1 3 (1 3)                | 1.09       | Lake Dgal Wielki | 1979-84 | Grabda-Kazubska et al. 1987 |
| glochidium | 1.14    | 21 (21)                  | 0.24       | Lake Łębsko | 2000-06 | Morozińska-Gogol 2011 |
| glochidium | gills  | 33.39                   | 2.0        | River Słupia | 2015-16 | This study |

**ANNELIDA: CLITELLATA**

**Family Piscicolidae**

*Piscicola geometra* (Linnaeus, 1761)

|        | Locality | Material collection year | References |
|--------|----------|--------------------------|------------|
| -      | -        | 1.1                      | 0.01 3     | Vistula Lagoon | 2005 | Rolbiecki and Rokicki 2006 |

*Piscicola respirans* Troschel, 1850

| -      | -        | -                        | -          | River Dunajec with tributaries | - | Słtowski 1937 |

**ARTHROPODA: BRANCHIURA**

**Family Argulidae**

*Argulus foliaceus* (Linnaeus, 1758)

|        | Locality | Material collection year | References |
|--------|----------|--------------------------|------------|
| -      | gills    | 1.9 3                    | 1 (1) 0.02 3 | Szczecin Lagoon | 1982-83 | Orecka-Grabda and Wierzbicka 1994 |

**ARTHROPODA: COPEPODA**

**Family Ergasilidae**

*Ergasilus gibbus* Nordmann, 1832

|        | Locality | Material collection year | References |
|--------|----------|--------------------------|------------|
| -      | gills    | -                        | -          | Vistula Lagoon | - | Zaddach 1844 |
| A      | gills    | 28.5                     | -          | Vistula Lagoon | 1908 | Wegener 1909 |
| Parasite life stage | Micro habitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References |
|---------------------|--------------|-------|------------------------|-----------|----------|--------------------------|------------|
| -                   | -            | 16.6  | (1.4)                  | 0.23 ³    | Lake Dąbie | 1955 | Kozikowska 1957         |
| -                   | gills        | 38.3  | 1-51 (8.5)             | 3.21 ³    | Vistula Lagoon | 1959 | Grabda 1962            |
| -                   | -            | -     | -                      | -         | Puck Bay   | 1959 | Grabda 1962            |
| -                   | gills        | 27.6  | up to 4 (2.3)          | -         | Puck Bay   | 1959 | Kozikowska 1965         |
| -                   | gills        | 75.0 ³⁹ | up to 75              | -         | Vistula (near Świbno) | 1961-63 | Grabda 1972            |
| -                   | -            | -     | -                      | -         | Vistula mouth | - | Grabda 1967            |
| -                   | gills        | 1.9 ³ | 1-4 (3.0³)             | 0.06 ³    | Szczecin Lagoon | 1982-83 | Orecka-Grabda and Wierzbińska 1994 |

_Ergasilus sieboldi_ von Nordmann, 1832

| -           | gills | 38.3 | 1-12 (3.2) | 1.25 ³ | Vistula Lagoon | 1959 | Grabda 1962         |
| -           | -     | -    | -          | -      | Lake Dąbrowa Wielka | - | Grabda 1962         |
| -           | -     | 45.5 | (4.4³)     | 2.0    | Lake Dgal Wielki | 1979-84 | Grabda-Kazubska et al. 1987 |
| -           | gills | 52.2³ | 1-16 (3.4³) | 1.79³ | Szczecin Lagoon | 1982-83 | Orecka-Grabda and Wierzbińska 1994 |
| -           | gills | 33.3 | 1-4 (2.2³) | 0.75   | Skołwiński Canal | 1982-83 | Orecka-Grabda and Wierzbińska 1994 |
| -           | -     | 6    | -          | -      | Lake Śniardwy | 1989 | Wlasow et al. 1991   |
| -           | gills | 10.23 | 1-23 (7.67) | 0.78   | Lake Łębsko | 2000-06 | Morozińska-Gogol 2007, Morozińska-Gogol 2011 |
| -           | -     | 9    | 1-4 (2.3) | 0.20³  | Vistula Lagoon | 2005 | Rolbiecki and Rokicki 2006 |

A

| gills | 100³⁹ | (3.0³) | 1.50³ | Lake Zamowieckie | 2007 | Rolbiecki 2011         |
| gills | 10.0³⁹ | 3 (3.0) | 0.30  | Lake Choczewskie | 2008-15 | This study         |
| gills | 20.0³⁹ | 7 (7.0) | 1.40  | River Parsęta | 2014-16 | This study         |
| gills | 20.0³⁹ | 5 (5.0) | 1.00  | Lake Jasień | 2015 | This study         |
| gills | 28.6³⁹ | 2-3 (2.5) | 0.71  | Lake Sarbsko | 2016 | This study         |

_Ergasilus sp._
Parasite life stage | Microhabitat | P [%] | Intensity range (mean) | Abundance | Locality | Material collection year | References
---|---|---|---|---|---|---|---
- | gills | 10 | (2) | - | Lake Miedwie | 1997-99 | Sobecka and Piasecki 2002

1 blood, liver, spleen, kidney, skin, necrotic muscles;
2 single to numerous in spleen, single to very numerous in blood, liver, kidney; very numerous in skin;
3 parameter was calculated on the basis of data from publication;
4 parasite number in smear area 20 x 25 mm;
5 blood, kidney, liver, urinary bladder, gills;
6 rare or sporadic;
7 gills, kidney, intestine, urinary bladder, liver, gall bladder, spleen, skin;
8 fins, gills, urinary bladder, kidney, liver, intestine;
9 calculated from less than ten individuals;
10 questionable microhabitat;
11 unspecified, the authors provided a value for several reservoirs;
12 together Szczecin Lagoon, Vistula Lagoon, Goczałkowicki Reservoir, Lake Charzykowskie, Lake Niegocin, Lake Mamry.

For comparison, the list of European eel parasites (data until 2009) from 30 countries in Europe and North Africa specifies 161 parasitic taxa (129 identified to species), of which 146 were metazoans and 15 were Protista (Jakob et al. 2016): *Epieimeria anguillae* and *Eimeria anguillae*, which were listed as two distinct species, are now considered to be the same taxon in the genus *Eimeria*, according to Benajiba et al. (1994). Similarly to the Polish study, digenetic trematodes (39 species) and nematodes (38 species) formed the most species-rich groups.

Twenty six parasite species, included in the present list, are also present in Jakob et al. (2016). However, that list does not include many parasite species and localities from Poland and does not reflect the actual distribution of the parasites. For example, Poland was not given as the area of occurrence for 23 parasite species (*Trypanosoma granulosum*, *Apiosoma* sp., *Ichthyophthirius multifiliis*, *Trichodina jadranica*, *Trichodinella epizootica*, *Capriniana piscium*, *Rhabdospora thelohani*, *Henneguya psorospermica*, *Myxobolus portucaleensis*, *Myxidium giardi*, *Zschokkella stettinensis*, *Ortholinea sphaerocapsularae*, *Bunodera lucioperae*, *Dactylogyrus* sp., *Triaenophorus nodulosus*, *Cystidcola farionis*, *Spinitectus inermis*, *Hysterothyacium aduncum*, *Paraquimperia tenerrima*, *Corynosoma strumosum*, *Echinorhynchus gadi*, *Echinorhynchus truttae* and *Paratenuisentis ambiguus*) in Jakob et al. (2016). In addition, a number of groups and species, included in the present list, were absent from Jakob et al. (2016). For instance, the group of protists from Poland has now been expanded to include *Capriniana piscium* and *Ortholinea sphaerocapsularae* and a representative of *Apiosoma* without species identification. *Rhabdospora thelohani* is also mentioned; however, considerable controversy exists as to whether this species is indeed a representative of apicomplexan parasites or a host “rodlet cell” (Davies and Ball 1993). In addition, amongst the Metazoa, the new list has been enriched with the addition of *Henneguya psorospermica*, *Cystidicola farionis* and an unidentified *Dactylogyrus* species for Poland, as well as unidentified cestodes found by Soltyńska (1964). The present list includes a number of new localities for eel parasites, previously unpublished (marked in Table 1 as "this study"
In comparison, only nine species of parasites were recorded for European eels in Japan, as well as seven taxa identified at genus level and an unidentified Monogenea. However, these eels also included parasites, thus far unknown from the European A. anguilla (Cryptobia spp., Ichthyobodo spp., Gyrodactylus anguillae, Lernaea cyprinacea) (Nagasawa et al. 2007, Nagasawa and Hirotaka 2017). This confirms the possibility that regional differences may exist, not only with regard to the level of infection, but also in the composition and species diversity of the parasite fauna.

Within the parasitofauna of eel, the greatest repeatability between different distribution areas is exhibited by the parasites specific to the genus Anguilla (e.g. the nematode A. crassus, the cestodes Bothriocephalus claviceps and Proteocephalus macrocephalus or the trematode Deropristis inflata), but also certain widely-distributed species with large ranges of hosts, such as the trematode Diplostomum spathaceum s. l., the leech Piscicola geometra or the copepod Ergasilus sieboldi. It is in this area that the number of records of alien and invasive parasites increases for the European eel; for example, A. crassus, which was introduced to Europe in 1982 and recorded in Poland in 1988 (Koops and Hartmann 1989, Własow 1991, Bystydzińska et al. 2005) or Pseudodactylogyrus anguilla and P. bini, recorded in Poland in 1995 by Dzika et al. (1995). It is also important to note the presence of a new, potentially invasive species, the acanthocephalan Paratenuisentis ambiguus, originally a parasite of Anguilla rostrata (Lesueur, 1817), which was first recorded in a European eel from Europe in 1980 and later in Poland by Morozińska-Gogol (2008).

The dispersal of parasites, their increased prevalence and level of infection are linked not only to the life history of eels and their migrations. Parasite infection in local eel populations can also transmitted through stocking material. For instance, protozoan Trichodina fultoni (100% infection) was found in rearing glass eel imported to Poland from France in 1971 (Markiewicz and Migala 1980). In addition, the monogenean P. anguillae and the nematode A. crassus were found in eels originating from the stocking material for the Vistula Lagoon in 2006 (Rolbiecki et al. 2008). What is more, of the eels originating from farming facilities located in the Warmian-Masurian Voivodeship (northeast Poland) and studied in the period 2010-2014, 77.2% were found to have Pseudodactylogyrus spp.; Trichodina spp. and I. multifiliis were typical parasites at the early rearing stage (Terech-Majewska et al. 2016).

With their resources already being considerably depleted and the growing number threats to eel populations, there has been a growing interest in their parasitic fauna; this growth has been accompanied by a greater need to carry out regular monitoring of parasitological threats, especially actual or potentially pathogenic species, including alien and invasive species. However, such data have to be constantly supplemented and verified with new records of parasites in different parts of distribution of this host. As such research would be complicated by the degree of data scatter, the best solution would be to create a web-based database, supplemented and coordinated by scientific centres from different countries.
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Supplementary material

Suppl. material 1: GPS coordinates of collection sites  

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