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SHORT COMMUNICATION

Studies on endangered and rare non-commercial fish species recorded in the Pomeranian Bay (southern Baltic Sea) in 2010–2013

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Abstract This paper presents the results of studies on endangered and rare non-commercial fish species (*Spinachia spinachia*, *Nerophis ophidion*, *Syngnathus typhle*, *Agonus cataphractus*, *Pholis gunnellus*, *Enchelyopus cimbrius*, *Cyclopterus lumpus*) and one lamprey species (*Lampetra fluviatilis*), recorded as bycatch during monitoring surveys in 2010–2013 in the Pomeranian Bay. Two species were observed for the first time in the Pomeranian Bay: *A. cataphractus* and *E. cimbrius.* Descriptions of parasite fauna are provided for *C. lumpus* and *E. cimbrius*, which were infected with four pathogenic species from Neomonada, Digenea, Nematoda, and Acanthocephala. Almost all parasite species were new in the hosts examined.

Keywords Non-commercial species · Endangered fish · Parasite fauna · Pomeranian Bay · Southern Baltic

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Introduction

The Pomeranian Bay (ICES IIId, SD 24) is a large, shallow basin off the Polish and German coasts, no more than 30 m deep, a highly dynamic environment, one of most important ecological areas in the southwestern Baltic Sea. Salinity does not deviate from that prevailing in southern Baltic surface waters (~7 psu), and the effect of fresh water discharge from the Szczecin Lagoon is only noted in the inshore zone (Czugała and Woźniczka 2010). In the Pomeranian Bay, the monitoring surveys oriented to the endangered and non-commercial fish species have not been already performed. Especially, next to nothing is known on the littoral zone ichthyofauna structure (0–3 m of depth). Monitoring in the Polish sea areas is performed only for several commercial fish species, such as *Gadus morhua*, *Clupea harengus*, *Sprattus sprattus*, *Salmo salar,* and *Platichthys flesus*. Information concerning fish species that are caught sporadically or are commercially insignificant is not generally available (Psuty-Lipska and Garbacik-Wesołowska 1998). Therefore, assessment of the extent to which Baltic Sea species are endangered remains a highly problematic undertaking—excepting for those with economic significance—owing to the fact that lack of availability of either sufficient biological and ecological data or long-term observations of the various species that would allow patterns to be defined. The latter two decades of the 20th century saw a renewed focus on systematic and scientifically grounded descriptions of all fish species in the various Baltic Sea regions—not only from an economic standpoint, but also with a view to shedding light on their research on ecology and biodiversity. Most of this work was, and is still today, carried out in peripheral and shallow waters; since the mid-1990s, the BMB has been endeavoring to collect current research results and data with

regard to the occurrence, distribution, and the overall ecological status of fish species in the various Baltic Sea regions (Winkler et al. 2000).

The aim of the present paper was to fill a knowledge gap on the biodiversity status of the endangered and rare non-commercial fish species and one lamprey species, in the coastal zone of the Pomeranian Bay, that were recorded as the bycatch during monitoring surveys in 2010–2013, with some notes on their current conservation status in Poland, on the IUCN Red List and HELCOM Red List. Included are brief descriptions of the parasite fauna in two specimens of *C. lumpus*, and *E. cimbrius*; the other specimens were either preserved in alcohol or released live back into the water.

Materials and methods

The material to study was collected as the bycatch during monitoring surveys of the commercial fish species (with perch, herring and sprat trawls, 10–12 hauls every month (a total of 540), covering a continuous area of approximately 0.18 square km of the bottom in one haul) conducted by the research vessel SNB-AR-1, and the monitoring surveys of ichthyofauna structure (using the Nordic net, recommended by HELCOM, set up once a month) in the coastal zone of Pomeranian Bay in 2010–2013. The fish collected were measured and weighed. Basic metric and meristic measurements of taxonomical significance were taken of each specimen and were used to identify specimens to the species level. Parasitological examination focused on the skin, vitreous humor, eye lens, mouth and nasal cavities, gills, gonads, gastrointestinal tract, kidneys, swim bladder, urinary bladder, gall bladder, peritoneum, and muscles. The parasites found were prepared for species determination by viewing specimens that were immersed in glycerin or preserved in 70 % ethanol under transient light.

Results

The material collected was divided into two categories: native species strictly protected under Polish law and rare native species not protected under Polish law. They are characterized in Tables 1 and 2, respectively.

One *S. spinachia* specimen collected in this study (118.4 mm TL) was caught with a Nordic net, similarly like representatives of the family Syngnathidae. The total length of five *N. ophidion* specimens studied was from 83.2 to 152.1 mm. They were assigned to juvenile (to 120 mm TL) or subadult stage (to 150 mm TL). In four juveniles, the membranous pectoral fins were observed, while in one subadult specimen (152.1 mm TL) it was absent.

Table 1 Rare native fish species strictly protected under Polish law (Act of April 16, 2004, on nature conservation)

Species and its taxonomic affiliation	Locality and depth of capture	Date and method of capture, number of specimens	Length TL (mm), weight of fish (g)	Conservation status (IUCN* and HELCOM** Red Lists)
Gasterosteiformes: Gasterosteidae				
1. Sea stickleback *Spinachia spinachia* (L., 1758)	53°57′52.56″N, 14°29′57.48″E 2–4 m, on the rocky bottom	May 25/26, 2011 [1] (Nordic net, according to EN 14757:2005	118.4 mm; 4.35 g	NE* LC**
Syngnathiformes: Syngnathidae				
1. Straightnose pipefish *Nerophis ophidion* (L., 1758)	53°57′52.56″N, 14°29′57.48″E, 2–4 m on the rocky and sandy bottom	May 28/29, 2011 [1]; August 24, 2012 [2], Feb 16, 2013 [2]; Nordic net	152.1 mm, 0.296 g 98.2 mm, 0.095 g; 102.8 mm, 0.064 g 103.5 mm, 0.064 g; 83.2 mm, 0.065 g	NE* LC**
2. Broadnosed pipefish *Syngnathus typhle* L., 1758	53°58′3″N, 14°31′16″E; 0–2 m on the rocky bottom	June 20, 2013 [1] Nordic net	137.44 mm, 1.11 g ♂	NE* LC**
Petromyzontida (formerly: Agnatha), Petromyzontiformes: Petromyzontidae				
1. River lamprey *Lampetra fluviatilis* (L., 1758)	53°56′N, 14°18′E; trawling at 3–10 m of depth	Oct 17, 2012 [1] herring trawl (mesh size: 40 mm)	375 mm	LC* NT**

NE not evaluated, *LC* least concern, *NT* near threatened

* Conservation status according to the IUCN Red List

** Conservation status according to the Helcom Red List

Table 2 Rare indigenous fish species not protected under Polish law

Species and its taxonomic affiliation	Locality and depth of capture	Date, method of capture, number of specimens	Length TL (mm), weight of fish (g)	Conservation status (IUCN* and HELCOM** Red Lists)
Scorpaeniformes				
1. Cyclopteridae: lumpfish *Cyclopterus lumpus* L., 1758	53°55′N, 14°18′E; 54° 07′N, 14°21′E, 13 m	April 2010 [1] Dec 11, 2013 [1] herring trawl (mesh size: 40 mm)	427.6 mm, ♀ $W = 2210.5$ g; 241 mm	NE* NT**
2. Agonidae: hooknose *Agonus cataphractus* (L., 1758)	54°03′N 14°37′-38′E; 15 m, on the sandy bottom	April 11, 2011 [1] sprat trawl (mesh size: 20 mm)	145 mm	NE* LC**
Gadiformes: Lotidae				
1. Fourbeard rockling *Enchelyopus cimbrius* (L., 1766)	54°03′N, 14°45′E 10–12 m	March 1, 2011[1] perch trawl (mesh size: 60 mm)	278.7 mm, 91.6 g ♀	NE* NT**
Perciformes: Pholidae				
1. Rock gunnel *Pholis gunnellus* (L., 1758)	53°58′3″N, 14°29′57″E 1.5 m, on the rocky bottom	May 15, 2011 [1] June 20, 2013 [1] Nordic net	142.21 mm, 6.81 g 111.58 mm; 4.53 g	NE* LC**

NE not evaluated, *LC* least concern, *NT* near threatened

* Conservation status according to the IUCN Red List

** Conservation status according to the Helcom Red List

Syngnathus typhle specimen studied (137.44 mm TL) was a male with eggs in its brood pouch, which ranged in the diameter from 1.27 to 1.45 mm. One specimen of river lamprey, *L. fluviatilis*, was caught in October 2012 with a herring trawl, but since it was alive and in good condition, it was released back into water, after basic measurements (Table 1).

Of two specimens of lumpfish, *C. lumpus*, caught, one (241 mm of TL) was alive and released back into the sea, while the second one, which was a female ready for spawning that was caught in April (427.6 mm TL), was examined. The absolute fecundity of the *C. lumpus* specimen examined was amounted to 85,870 eggs. The lumpfish examined hosted parasites from three higher taxa: Neomonada (one species), Digenea (one species), and Nematoda (two species). The most numerous were nematodes (Secernentea: Anisakidae). Two larvae L3 of *Contracaecum osculatum* (Rudolphi 1802) were found in the stomach and one in the anterior part of the intestine of the lumpfish. One *Raphidascaris acus* (Bloch 1779) nematode was also found in the pyloric appendages; this parasite had not yet been recorded in this host. One *Podocotyle reflexa* (Creplin 1825) Odhner 1905 (Allocreadioidea: Opecoelidae) digenean was noted in the stomach, and numerous spores of Neomonada (Mesomycetozoea). *Ichthyophonus hoferi* Plehn and Mulsow 1911 were found on the inner surface of the walls of the gallbladder and in its contents. The specimen size and its parasite fauna may indicate that it probably entered the Pomeranian Bay from the western Baltic or North Sea.

The hooknose, *A. cataphractus* collected (145 mm TL), was alive and was released back into the sea, after basic measurements. One female specimen of fourbeard rockling, *E. cimbrius* (278.7 mm TL), was caught with a perch trawl. In the stomach partially digested *Mysis mixta* was noted. The fish examined hosted one species of parasite from one higher taxon: Acanthocephala. A female *Echinorhynchus gadi* Zoega in Müller (1776) (Palaeacanthocephala: Echinorhynchidae) acanthocephalan was noted in the posterior part of the intestine of the fourbeard rockling. There was the only parasite recorded in this host species, and it has not been noted previously in this host.

Two specimens of *P. gunnellus* (142.21 and 111.58 mm TL) were caught with a Nordic net (Table 2).

Discussion

The ichthyofauna in the Pomeranian Bay comprises over 40 species: *C. harengus* (up to 93 % of the fish mass caught), flatfish, *S. lucioperca*, *Perca fluviatilis,* and *Anguilla anguilla* (Garbacik-Wesołowska and Boberski 2000). During monitoring catches in the area Dudko (2008)

reported the occurrence of 22 fish species, with *P. flesus* and *P. fluviatilis* predominate in the catches (at 42 and 29 %, respectively). However, a precise description of the quantitative relationships among the species, especially with respect to non-commercial species, is lacking. Only experimental catches conducted with less selective gears permit collecting data regarding the biodiversity of ichthyofauna communities (Psuty-Lipska and Garbacik-Wesołowska 1998).

Most of the species protected under the Polish law studied in this paper lives in the sensitive habitats—meadows of macrophytes—*Zostera* and *Fucus* spp. stands, which have declined or deteriorated within the HELCOM area. It is plausible that the population of the species has also declined together with habitat changes. However, these changes occurred in most areas several decades ago, and the current situation is stable, if not improved. *Spinachia spinachia* occurrence in the area was noted by Garbacik-Wesołowska and Boberski (2000) in 1978–1997, but no recent observations have been reported in Polish waters. Similarly, like most species of Syngnathidae family, *S. typhle* and *N. ophidion* distribution and abundance are not monitored well with standardized monitoring fishing nets. *Syngnathus typhle* occur mainly in shallow waters or in soft and sandy bottoms to depths of 20 m (Kullander et al. 2012). In Polish waters, it is disappearing because benthic algae are disappearing and three-spined stickleback predation pressure is increasing (Horackiewicz and Skóra 1998). However, there are indications that the abundance of this species has been increasing in Polish coastal areas since 2003 (van Damme and Couperus 2008). The specimen caught in the present study was identified as male, with the mean egg diameter (1.39), smaller than given in Dawson (1986)—ca 2 mm. *Nerophis ophidion* inhabits coastal zones from depths of 2 to 15 m. Occurrence in the area has been noted sporadically: Three specimens were recorded in experimental catches conducted by Psuty-Lipska and Garbacik-Wesołowska (1998) in 1994, and it was also confirmed by Garbacik-Wesołowska and Boberski (2000) in 1978–1998, but no recent observations have been reported in Polish waters. These species are assessed in the HELCOM Red List project with a preliminarily suggested category of LC.

The anadromous river lamprey is distributed throughout the HELCOM area including adjacent rivers and streams. In Poland, spawning probably takes place in some Pomeranian rivers and lakes as well as in estuaries and coastal areas linked with the Oder and Vistula basins; however, knowledge of this species is lacking. In Germany, this species is considered critically endangered. Past, current, and future threats include migration barriers, eutrophication, and fishing (HELCOM 2013). *Lampetra fluviatilis* and a second anadromous species, *Petromyzon marinus,* are listed in Annex II of the UE Habitats Directive as species of community interest, the conservation of which requires the designation of SAC, in Appendix III of the Bern Convention, and national Red Data Books throughout the southern Baltic Sea region. Thiel et al. (2009) report single records of the catches in the Szczecin Lagoon in 2004. Sobecka et al. (2010) studied lampreys caught in Lake Dąbie during the fall spawning migration from the Pomeranian Bay in 2001 and in the same months in 2005. *Petromyzon marinus*, a rarity in the Baltic Sea, is not known to spawn in it (Winkler et al. 2000). However, in May 1989, a live female (89.0 cm TL) was caught by a fisher in a net in the Oder River over 70 km inland from the Pomeranian Bay and dissection revealed it was carrying mature eggs (authors' unpublished data).

Cyclopterus lumpus inhabits rocky bottoms, but also occurs among floating seaweed (Möller Christensen 1977). A rare in the Baltic, and fisheries and bycatch pose a threat to it. In the Arkona Sea, the ICES Baltic International Bottom Trawl Survey indicated a 60–70 % decline the last 20 years. Its occurrence in the Pomeranian Bay has been noted very rarely; Psuty-Lipska and Garbacik-Wesołowska (1998) and Garbacik-Wesołowska and Boberski (2000) both noted one specimen in experimental catches in 1994 and four specimens in those in 1995. Its occurrence in the area was observed sporadically by Grygiel and Trella (2007). Dudko (2008) recorded one specimen in 2007 and two specimens in 2008 during monitoring catches, but none was noted in the 2009–2013 period. It reproduced in the area, as is indicated by observations of juveniles measuring 40–50 mm in length in the coastal waters in August 2002 (54°3′N, 14°56′E) (author's observations, unpublished). This species usually reaches lengths of 30 cm, but sometimes much larger specimens are caught, which probably enter the Baltic from the North Sea (Lampart-Kałużniacka et al. 2009). *Agonus cataphractus* remain on the German Red List (LC status), and it was assessed to be included on the HELCOM Red List in 2013. In the present study, it was identified in the Pomeranian Bay for the first time.

Also, this study reports the first documented record of *E. cimbrius* occurrence in the area. German trawl surveys in the Arkona Basin and the Belt Seas show no decreasing trend, while Swedish trawl survey data show a decreasing trend since 2001 in the same area. Current threats are unknown, and future threats are determined to be bycatch (Thiel et al. 2013). For example, in March 2014, four specimens (199–211 mm TL) were caught unintentionally in a cod trawl in the eastern part of Polish coast (55°13′N, 17°17′E).

Pholis gunnellus is assessed in the HELCOM Red List project. It was recorded sporadically in Polish zone by Garbacik-Wesołowska and Boberski (2000). Grygiel and Trella (2007) confirm its very rare occurrence during

bottom research catches conducted in the 1976–2004 period, but no recent observations have been reported in Polish waters.

In the fishes examined, the most numerous were the nematodes (found only in the lumpfish). The larvae of *C. osculatum* were observed in this host from the Gulf of Gdańsk (Rolbiecki and Rokicki 2008). Marine mammals are the definitive hosts, while planktonic copepods are the first intermediate hosts. *Raphidascaris acus*, a parasite of freshwater fish, is also frequent in estuaries. The definitive hosts are freshwater fish, and larvae are found in aquatic invertebrates (Smith 1984). The digenetic trematode found in the stomach is a parasite recorded in the saline waters of the North Sea, the Danish straits, and the western Baltic Sea, where its definitive host is mainly cod (Gibson 2001). The type host of *P. reflexa* is the lumpfish (noted here for the first time), and the type locality is the western Baltic Sea off the coast of eastern Germany. The gastropod mollusks (*Buccinum undatum*, *Neptunea antiqua*), the intermediate hosts of this digenean species, do not inhabit this part of the Baltic Sea (Koie 1981). Further studies are needed to determine whether the lumpfish studied was infected in water with a higher salinity, or whether *P. reflexa* colonized another intermediate host species that can inhabit waters of lower salinity. Another possible explanation is the occurrence in its life cycle of a paratenic host, one in which the parasite does not develop but utilizes only for transport. This could be a different fish species that is more mobile than the lumpfish, is smaller, and can be eaten. Fish are infected with *I. hoferi* recorded (the Class Mesomycetozoea, a group of microorganisms residing between the fungi and animals), when they feed on food containing viable spores of the pathogen (Lauckner 1984). The acanthocephalan *E. gadi* is one of the most widespread species in North European marine fish, and it is the predominant parasite in Baltic cod, which is its final host (Sobecka et al. 2011). Amphipods are its intermediate host and *E. cimbrius* also feeds on them; however, its infection has not yet been recorded. All the parasites found are generalists and are reported in many fish species in the Pomeranian Bay (Sobecka and Słomińska 2007). They colonized new accidental hosts making them part of their life cycle (Rohde 2005).

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