Preliminary report on fish diversity at the Prince Gustav Channel, the northern part of the James Ross Island, Antarctica

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Abstract
Notothenioid fish were collected in the coastal part of the James Ross Island (Antarctica) mainly during Austral summer in 2012. In this paper, we report the list of species records and their basic biometric measurements as a reaction to missing ichthyofaunal investigation of this particular area. Collected fishes belong to the families Nototheniidae (*Trematomus bernacchii* Boulenger, 1902; *T. eulepidotus* Regan, 1914; *T. newnesi* Boulenger, 1902; *Gobionotothen gibberifrons* (Lönnberg, 1905); *Notothenia coriiceps* Richardson, 1844) and Bathydraconidae (*Gymnodraco acuticeps* Boulenger, 1902).

Key words: Notothenioid fish, Weddell Sea, Prince Gustav Channel

Introduction

Antarctica, the most remote continent surrounded by Southern Polar Ocean is bounded by Circum Antarctic Current (CAC). This mass of circulating water prevents the species migration northward and vice versa. The isolation of Antarctic continent is derived from the Gondwana breakage, which created CAC by opening of Drake passage in Miocene (Livermore et al. 2005). The Southern ocean waters, south of the Convergence are colder and thermally more stable than those in the north. Therefore, surface currents on both sides of the Convergence flow generally northward, away from Antarctica (DeWitt 1971). It represents an approximate northern boundary for the Antarctic Ocean as a natural biogeographic province (East-man et Grande 1989). As a reaction to the cooling from Oligocene, the Antarctic shelf became poor environment (Clarke et Crame 2010). Most of the fauna became extinct, or underwent bottleneck effect, due to iceberg scouring of the benthos (Thatje et al. 2005), freezing temperatures and seasonal food availability.

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Notothenioids evolved a unique adaptations to the cold at morphological, physiological and biochemical levels that allowed them to survive subzero temperatures (Eastman et Grande 1989, Matschiner et al. 2011, Ingram et Mahler 2011, Patarnello et al. 2011). Therefore, they are the most abundant and diverse taxa with remarkable degree of endemism (Eastman et Sidell 2002, Verde et al. 2003, Sidell et O'Brien 2006). The prominent adaptation, causing remarkable adaptive radiation, was the gain of antifreeze glycolproteins in their body tissue, which decreased the freezing point (Cheng et Detrich 2007). Notothenioids derived from benthic ancestors and although lacking the swim bladder, they inhabit different bathymetry and evolved different life histories (benthic, pelagic and even cryopelagic) (Eastman et Eakin 2000) with polyphyletic origin (Rutschmann et al. 2011). The recent Southern Ocean fish fauna is taxonomically limited, highly endemic and dominated by the fishes of the suborder Notothenioidei not just by species number but also by abundance and biomass (Eastman et McCune 2000, Eastman 2005). No other oceanic ecosystem is so dominated by a single taxonomic group of fish (Clarke and Johnston, 1996). Eastman et Eakin (2000) mentioned that since the publication of Fishes of the Southern Ocean (by Gon et Heemstra in 1990), 11 new notothenioid species have been described and seven others placed in synonymy. The previous decades were an active time in the discoveries of new species of notothenioids.

Knowledge of species diversity is essential for understanding the structure, evolution and management of the Antarctic marine ecosystem (Eastman et Eakin 2000). The suborder Notothenioidei includes eight families with 43 genera and 122 species according to Eastman et Eakin (2000). Moreover, Eastman (2005) describes notothenioids as the most specialised taxa except of liparids and zoarcids, which account together for 88% of species diversity of the Antarctic fish fauna and states existence of eight notothenioid families (five of them are primarily Antarctic). The families include a total of 44 genera and 129 species, 101 Antarctic and 28 non-Antarctic. The 101 Antarctic species make up 45% of the benthic species diversity in the Antarctic region (Eastman 2005). The author enumerated in total 131 species (104 Antarctic and 27 non-Antarctic) and 44 genera in his not-yet-published Notothenioid classification list of species from 2010. He gained data from the electronic Catalog of Fishes by Eschmeyer et Fricke (2009). However, there are still some uncounted new species (*e. g.* Shandikov 2011) in the last version of the Catalog of Fishes by Eschmeyer (2012). Damerau et al. (2012) state similarly to Eastman (2005), that notothenioids consist of 131 species from 8 families, with 104 species. Out of 5 of these families is endemic in High-Antarctic region.

Our research was held in the northwestern Weddell Sea in the Prince Gustav Channel (PGC) in the region of the eastern Antarctic Peninsula margin. PGC is situated on the eastern coast of the Graham Land, between the James Ross Island and the Trinity Peninsula and is about 160 kilometers (100 miles) long and from 8 to 16 km wide (Reece 1950). Since 1995, the PGC has been free of ice (Correll 1998) during austral summer season.

Data of fish species composition in this area have not been revised yet. The aim of this paper is to fill the gap and create a pilot study of the James Ross Island and PGC nototheniods fish, their species list, respectively.

Material and Methods

Field investigations were carried out during the Czech expedition Antarctica 2011-2012 from January to March. Some fishes were caught in previous seasons with rods. Fifteen specimens of 5 notothenioid fishes (Perciformes, Notothenioidei) were examined for parasites during the expedition in 2011-2012. They were caught in several sites in the Prince Gustav Channel (63° 47' 58.37" S, 57° 55' 12.35" W; depth about 30 m), in front of Johann Gregor Mendel station on the James Ross Island. Fish were collected with the use of gillnet.

Fish nomenclature is in concordance with FishBase (Froese et Pauly 2012). Biometric measurements were done in millimetres (mm), weight in grams (g). Gonadosomatic index (GSI, %) was calculated as gonad weight divided by total weight multiplied by hundred.

Results and Discussion

A total of 6 fish species (Figs. 1 – 11) belonging to two families were collected during two Czech Antarctic expeditions and are listed in Table 1 with their biometric characteristics. All found species are mainly epibenthic, foraging mainly in benthos. *Trematomus eulepidotus* and *T. newnesi* have a pelagic lifestyle (Kock 1992, Eastman 1993, Near et al. 2009, Rutschmann et al. 2011). In Notothenioids, parental care of hatched eggs is not rare (Kock et al. 2006). Between populations, gene flow is mediated by CAC (Van de Putte et al. 2012; Matschiner et al. 2009). They were captured in the depth ranging from 20 to 30 m.

The measurements presented here came from 15 fish caught in 2012. Previous catching were tentative only and revealed one species not obtained in the next season (*see* below). *Gobionotothen gibberifrons* (Lönnberg, 1905) constituted 39% of weight of the specimens collected. *Notothenia coriiceps* Richardson, 1844; *Trematomus bernacchi* Boulenger, 1902; *T. eulepidotus* Regan, 1914 and *T. newnesi* Boulenger, 1902 accounted 35%, 13%, 11% and 2% of total biomass respectively. The family Nototheniidae was represented by the highest number of species. Only single species and specimen from Bathydraconidae (*Gymnodraco acuticeps* Boulenger, 1902) was recorded (the expedition in 2010-11, exclusively). *Gobionotothen gibberifrons* and *T. eulepidotus* were the most abundant species. *Notothenia coriiceps* and *T. newnesi* were represented only by one specimen in 2012. Their stomachs contained mainly krill, polychaeta, mussels and algae. The krill was the main component of nourishment, because the main spawning season of Antarctic krill is from January to March (Ross et Quetin 1986). Further detailed study of the trophic ecology and structure of coastal Antarctic fish communities would be conducted because it is needed to deepen an understanding of structural and functional aspects of these communities as mentioned by Targett (1981). The most of studies of Antarctic fishes come mainly from the Ross Sea and from the islands of the Scotia Arc. The studies done in the Weddel Sea area are scarce (*e. g.* Kock et al. 1984, Hubold 1985, Ekau 1990, Brenner et al. 2001, Artigues et al. 2003, Van der Molen et Matallanas 2003, Lombarte et al. 2003). Investigations of the James Ross Island or Prince Gustav Channel are completely missing.

Remarks to the records

Nototheniidae (Cod icefishes)
***Gobionotothen gibberifrons* (Lönnberg , 1905)**
syn.: *Notothenia gibberifrons* Lönnberg, 1905; *Notothenia vaillanti* Regan, 1913

Figs. 7, 8

Gobionotothen giberifrons is a sedentary, benthic species feeding on infauna and engibenthic animals (Gon et Heemstra 1990, Matschiner et al. 2009). It inhabits even seasonal packed ice. Mainly juveniles and part of the adult population occur in the inshore waters 15–30m deep. Adults occur in offshore, deeper waters, at the depths down to 450 m (Casaux et al. 1990, Kulesz 1994, Barrera-Oro 2002). We found mainly krill, bivalves and polychaetes in their stomachs. *Gobionotothen gibberifrons* is known from all the islands of the Scotia Arc, the northern part of the Antarctic Peninsula and the South Atlantic, near to the south Shetlands and the Heard Island (Bykov 1983, Gon et Heemstra 1990).

***Notothenia coriiceps* Richardson, 1844**
syn.: *Notothenia coriiceps neglecta* (non Nybelin, 1951); *Notothenia neglecta* (non Nybelin, 1951)

Figs. 9, 10

Notothenia coriiceps is a demersal, shallow-water benthic species (Gon et Heemstra 1990). One of the most abundant Antarctic coastal fishes distributed probably circum-Antarctic on the continental shelf, known from the western Ross Sea, Balleny Islands, Adélie Land, Antarctic Peninsula and associated islands (islands of the Scotia Arc, to South Georgia, the Weddell Sea, the Bouvet and the sub-Antarctic islands of the Indian Ocean sector- (Everson 1970 and 1977, Fischer et Hureau 1985, Gon et Heemstra 1990) in the depths down to 450–550 m according to (Kock 1989, Tiedke et Kock 1989, Gon et Heemstra 1990, Barrera-Oro et Casaux 2008, Jones et Kock 2006, Kock et al. 2007). Feeding strategies and behavior were studied by Fanta et Meyer (1998). *Notothenia coriiceps* is primarily a benthic predator. Its, main prey are amphipods, isopods and moluscs (Hureau 1970, Richardson 1975, Burchett et al 1983). Except from krill, we found also macroalgae in its stomach as was already mentioned by Gon et Heemstra (1990).

***Trematomus bernacchii* Boulenger, 1902**
syn.: *Notothenia bernacchii* (Boulenger, 1902); *Pagothenia bernacchii* (Boulenger, 1902); *Pseudotrematomus bernacchii* (Boulenger, 1902); *Trematomus bernachii* Boulenger, 1902

Figs. 1, 2

Benthic species, found in seafloors (Froese et Pauly 2012). It is a common representative of shallow-water fish communities in the High-Antarctic Zone (Hureau 1994), resides probably circum-Antarctic and offshore islands (Peter Island, South Shetland, Elephant and South Orkney islands) (Gon et Heemstra 1990). We found mainly krill in its stomachs. Vacchi et al. (2000) describes a hunt-and-peck strategy of this species,

employed to capture prey such as polychaetes and bivalves. Hureau (1970) mentioned that it may feed on polychaetes, gastropods, isopods, amphipods and few algae. The detailed dietary diversity is provided by La Mesa et al (2004).

***Trematomus eulepidotus* Regan, 1914**

syn. *Pseudotrematomus eulepidotus* (Regan, 1914)

Figs. 3, 4

This is a bentho-pelagic (Fischer et Hureau 1985, Gon et Heemstra 1990) or epibenthic (Eastman 1993) species with pelagic feeding (Klingenberg et Ekau 1996), it can rest in glass sponges (Gutt et Ekau 1996). Distributed circum-Antarctic in nearshore and continental shelf and nearby islands, including the South Orkneys (Froese et Pauly 2012). Schwarzbach (1988), Gon et Heemstra (1990) and Kailola et al. (1993) mention that they feed on salps, nudibranchs, amphipods, copepods, polychaetes, krill, crustaceans, chaetognaths, and fish.

***Trematomus newnesi* Boulenger, 1902**

Figs. 5, 6

Trematomus newnesi sometimes foraging on bottom, otherwise in water collumn, feeds preferently on plankton. It is even cryopelagic (Andriashev 1970). It occupies various habitats, such as benthos, the water column beneath ice or free from ice and the surface in conjunction with algae banks, they can perform vertical migration (DeWitt 1971, Fischer et Hureau 1985). Distribution probably circum-Antarctic, it is known from East Antarctica, Weddell Sea, west coast of the Antarctic Peninsula, the South Shetland Islands, the Elephant Island, the South Orkney Islands, the Mac Robertson, the George V, the Queen Mary, the Adelie Coasts, the Davis Sea and the Ross Sea (Tiedke et Kock 1989, Froese et Pauly 2012). Along the Antarctic Peninsula, especially juveniles often feed in the water column or at the undersurface of ice (Gon et Heemstra 1990). Its prey are mainly euphausiids and amphipods, less frequently polychaetes, gastropods and isopods (Daniels 1982). It feeds preferently on plankton (Vacchi et La Mesa 1995).

Bathydraconidae (Antarctic dragonfishes)

***Gymnodraco acuticeps* Boulenger, 1902**

syn.: *Gymnodraco victori* Hureau, 1963

Fig. 11

Gymnodraco acuticeps was caught in the season of 2010-11, therefore not measured. Demersal circum-Antarctic notothenioid, generally found in relatively shallow water, in contact with anchor ice (Bargelloni et al. 1998, Froese et Pauly 2012). Probably circum-Antarctic, found along the Antarctic Peninsula, the South Shetland Islands and the Antarctic continental shelf (Froese et Pauly 2012). They are active ambush predators feeding on a variety of organisms including fish, fish eggs, amphipods and polychaetes (Gon et Heemstra 1990, Bargelloni et al. 1998, Evans et al. 2005).

Plate 1. Photos of five species of Notothenioid fish caught in season 2011-12. Figs. 1, 2 - *Trematomus bernacchii* Boulenger, 1902; Figs. 3, 4 - *T. eulepidotus* Regan, 1914; Figs. 5, 6 - *T. newnesi* Boulenger, 1902; Figs. 7, 8 - *Gobionotothen gibberifrons* (Lönnberg, 1905); Figs. 9, 10 - *Notothenia coriiceps* Richardson, 1844 (Photos 2–6 and 8–10 by Jitka Míková).

Fig 11. Photo of Bathydraconidae fish caught in season 2010-11: *Gymnodraco acuticeps* Boulenger, 1902 (Photo by Kamil Láska).

Species	Common name	n	WT	GSI	L_S	L_T	Food compostion
Gobionotothen gibberifrons	Humped rockcod	5	59–294	1.5 (1F) 1.2 (1M)	170–284	250–331	krill bivalves polychaetes
Notothenia coriiceps	Black rockcod or Bullhead notothen	1	871	6.8 (1F)	344	395	krill macroalgae
Trematomus bernacchii	Emerald rockcod	3	28–170	2.8 (1F) 0.8 (1M)	120–204	140–230	krill
Trematomus eulepidotus	Blunt scalyhead	4	37–100	5.3–7.4 (3F) 0.6 (1M)	125–190	142–212	krill
Trematomus newnesi	Dusky rockcod	1	44	-	145	165	krill
Gymnodraco acuticeps	Ploughfish	1	-	-	-	-	-

Table 1. Information on fish species used in this study. *Table legend*: n – number of measured fish; WT – weight (g); GSI – gonadosomatic index in % (with sample number and indication of sex in parentheses, M – male, F – female); LS – standard length (mm); LT – total length (mm).

Conclusion

To monitor the species composition and also the diet of species, we started the investigation of fish in austral summer 2012. Six notothenioid fish species were caught (*Trematomus bernacchii*, *T. eulepidotus*, *T. newnesi*, *Gobionotothen gibberifrons*, *Notothenia coriiceps* and *Gymnodraco acuticeps*). Summer polar waters are rich in nutrition, which allows to develop trophic structures, where primary consumers, *e. g. Euphasia* sp. play a key role. Krill is the prominent nourishment for most of Antarctic marine organisms. Also notothenioids prefer krill, if available, as highly nutritious source. It can be the reason why we observed mostly krill in their stomachs. Besides krill, molluscs, polychaetes and algae were found in stomach. We emphasize the necessity of conducting further ichthyofaunal investigations as this will allow and help to monitor the status of the Prince Gustav Channel ecosystem. Eastman (2005) states that knowledge of species composition in an area or ecosystem is a fundamental prerequisite for subsequent work in evolutionary biology, ecology, biogeography and conservation.

Because the James Ross Island fishery has not yet been studied, we started with monitoring and arranging the equipment for next season work. Next austral summer, we want to proceed and watch the habitat and behavior of coastal fish up to 50-60 m using underwater camera. It is necessary to observe the shelf habitat to understand the species composition and explain the species life history. We want to pay closer attention to stomach content to prove the species food preferences.

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