

An updated species list for notothenioid fish (Perciformes; Notothenioidei), with comments on Antarctic species

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Abstract

Perciform fish of the suborder Notothenioidei dominate the cold shelf waters surrounding the Antarctic continent. The past decade has been an active period in the taxonomy and systematics of this group. Since publication of *Fishes of the Southern Ocean* in 1990, 11 new notothenioid species have been described and seven others placed in synonymy. The suborder currently includes eight families with 43 genera and 122 species. Ninety-six species inhabit Antarctic waters and 26 are non-Antarctic. A list of species with authorities and dates is provided. There are brief comments on species placed in synonymy, collection localities for new species and intraspecific variation.

Kurzfassung

Aktualisierte Artenliste notothenioider Fische (Perciformes, Notothenioidei) unter besonderer Berücksichtigung der antarktischen Spezies

Perciforme Fische der Unterordnung Notothenioidei dominieren im kalten Schelfwasser rund um den Antarktischen Kontinent. In den vergangenen zehn Jahren wurde die Taxonomie und Systematik dieser Fischgruppe intensiv untersucht. Seit der zusammenfassenden Veröffentlichung „Fishes of the Southern Ocean“ im Jahr 1990 wurden elf neue Notothenioidenarten beschrieben und sieben weitere zu Synonymen erklärt. Dadurch umfasst die Unterordnung derzeit acht Familien mit 43 Genera und 122 Arten. 96 Arten sind Bewohner der antarktischen Gewässer und 26 leben ausserhalb der Antarktis. Der Beitrag präsentiert eine vollständige Liste der gültigen Arten und ihrer Beschreiber. Die Synonyme werden kurz erläutert und die Fundorte sowie die intraspezifischen Variationen der neuen Arten werden vorgestellt.

Introduction

Fish of the perciform suborder Notothenioidei dominate the cold shelf waters surrounding the Antarctic continent. Although lacking a swimbladder, they have undergone a depth-related diversification to fill a variety of water column niches. Notothenioids

have become subjects for expanding research efforts in evolutionary and fish biology. As the only known example of an adaptive radiation of marine fish, the notothenioid diversification is being studied at the ecosystem, organismal, organ system and molecular levels of organisation (Kock 1992; Eastman 1993; Miller 1993; Eastman and Clarke 1998; Klingenberg and Ekau 1996; Chen *et al.* 1997a, 1997b; Cheng 1998; di Prisco 1998; Ozouf-Costaz *et al.* 1997; Pisano *et al.* 1998).

The past decade has been an active period in the discovery of new species of notothenioids. Knowledge of species diversity is essential for understanding the structure, evolution and management of the Antarctic marine ecosystem. As the major fish resource in the Southern Ocean, notothenioids are under increasing pressure from commercial fishing (Kock 1994). *Fishes of the Southern Ocean* (Gon and Heemstra 1990) is an excellent taxonomic and distributional survey of the fauna. Since publication of this volume, however, the number of species has changed and the number of families, their nomenclature and their sequencing now differ from the standard reference for fish taxonomy (Nelson 1994). Since one of the goals of systematic ichthyology is to provide a stable system of nomenclature for taxa, this is an opportune time to update species number and nomenclature for notothenioids. This list will also provide a convenient reference for the increasing number of workers in Antarctic fish biology.

It is also noteworthy that much research on phyletic relationships of notothenioids has appeared recently (Bargelloni *et al.* 1994, 1997; Bargelloni and Lecointre 1998; Ritchie *et al.* 1996, 1997; Lecointre *et al.* 1997; Chen *et al.* 1998). This work has utilised DNA sequence data from mitochondrial and nuclear genes. Molecular phylogenetics has provided answers to some questions while also opening additional avenues for research. For example, the traditional Bovichtidae was found to be paraphyletic and the newly defined Bovichtidae (*Bovichtus* and *Cottoperca*) appears no more closely related to other notothenioids than are several non-notothenioid outgroups (Lecointre *et al.* 1997). Furthermore, it is likely that the families Nototheniidae and Bathydraconidae are paraphyletic and that three of four nototheniid subfamilies are not natural groups (Bargelloni *et al.* 1994; Bargelloni and Lecointre 1998; Ritchie *et al.* 1997).

Methods and presentation

Table 1 is a summary of extant notothenioid species. The arrangement is phylogenetic for families based on Lecointre *et al.* (1997) and alphabetical for genera within families and for species within genera. Family names and realignments are from Balushkin (1992). We follow the rationale of Gon (1990a) rather than Nelson (1994) for the spelling of Bovichtidae. We follow DeWitt *et al.* (1990) rather than Balushkin (1992) for the spelling of the stem-genus portion of Eleginopidae. An asterisk (*) indicates non-Antarctic species. The Antarctic species include those from *Fishes of the Southern Ocean* (Gon and Heemstra 1990) plus those described since publication of this volume. Species names of the latter are preceded by a dagger (†) and the full citations to authorities are found in the references. Species placed in synonymy since 1990 are underlined in the list but not counted. These are briefly discussed below.

Discussion

Number of species

As outlined in Table 1, the suborder Notothenioidei includes 43 genera with 122 species, 96 Antarctic and 26 non-Antarctic. In 1990 there were 93 Antarctic species listed in *Fishes of the Southern Ocean* plus an additional 25 non-Antarctic species for a total of 118. The seeming addition of only four species is artefactual and disguises a period of considerable activity in notothenioid taxonomy. While 11 new species were described, seven other species were placed in synonymy for a net gain of four. One of the new species was placed in a new genus (*Acanthodraco*). Furthermore, the monotypic genera *Pseudaphritis* and *Eleginops* were removed from the Bovichtidae and Nototheniidae and reassigned to the families Pseudaphritidae and Eleginopidae, respectively (Balushkin 1992).

It should also be mentioned that another approach to notothenioid taxonomy recognises more genera and species, approximately 47 and 130, respectively (Balushkin 1992, 1997). The difference in taxonomic approach between splitting and lumping accounts for the disparity between Balushkin's count and that of DeWitt *et al.* (1990) which serves as the basis for the list in Table 1. Differences between Balushkin's classification and that presented Table 1 are confined primarily to the families Nototheniidae and Channichthyidae.

Species placed in synonymy

On the basis of data derived from enzyme electrophoresis, Schneppenheim *et al.* (1994) decided that the morphologically and meristically overlapping species of the *Lepidonotothen squamifrons* group (*L. squamifrons*, *L. kempfi* and *L. macrophthalma*) are just one species — *L. squamifrons* (Günther, 1880). *Lepidonotothen kempfi* and *L. macrophthalma* were therefore placed in synonymy.

Within the Artedidraconidae, the genus *Pogonophryne* has presented a considerable taxonomic challenge. Typical meristic characters poorly separate the species, and in some species there is ontogenetic variation in the barbel, a key taxonomic character. Recently progress has been made in recognising intraspecific variation and in identifying natural groups within the genus. As a result of this work, five species of *Pogonophryne* were placed in synonymy (Balushkin and Eakin 1998).

Likely sites for discovery of new species

Collecting in accessible and presumably well-studied areas of the Antarctic shelf still offers the possibility of increasing our knowledge of species diversity. For example, recent bottom trawling in the Ross Sea yielded 979 specimens including two new artedidraconid species as well as a new colour morph of a known species (Eakin and Eastman 1998; Eastman and Eakin 1999). These species were taken in shallow water (100—300 m) on the tops of banks or in the vicinity of sponge beds.

Other complexities in the delimitation of species

Although widespread among some species of boreal lacustrine fish, the phenomenon of phenotypic plasticity or morphism has only recently been recognised in notothenioids. The circum-Antarctic nototheniid *Trematomus newnesi* exists as two morphs in the Ross

Sea, the typical morph and a large mouth/broad headed morph (Eastman and DeVries 1997). In addition, the artedidraconid *Artedidraaco shackletoni* has a distinctive spotted colour morph in addition to the common barred morph (Eastman and Eakin 1999). An alternate interpretation of these morphs is that they are cryptic or sibling species, however this hypothesis cannot be tested without data on genetic diversification. In the only case where genetic information has been obtained, mitochondrial DNA sequences of the 12S and 16S ribosomal regions indicated that the brown and white blotch colour morphs of *Trematomus bernacchii* were not genetically different (Bernardi and Goswami 1997). As these mitochondrial regions are conserved, it is possible genetic differences could have accumulated in more variable regions (Bernardi and Goswami 1997). Finally, polymorphism in chromosome number and morphology has been discovered in several widely distributed nototheniids including *Trematomus eulepidotus* and *T. hansonii* (Ozouf-Costaz *et al.* 1997; Pisano *et al.* 1998). Although the systematic significance of these findings is not clear, intraspecific chromosomal rearrangement may be an initial stage in the attainment of reproductive isolation or it may appear incidentally before or after species formation (Ozouf-Costaz *et al.* 1997).

Table 1: List of notothenioid species. Bovichtids from Gon (1990a) with non-Antarctic species from Hardy (1988) and Balushkin (1992); pseudaphritids and eleginopids from Balushkin (1992); nototheniids from DeWitt *et al.* (1990) with non-Antarctic species from DeWitt (1966, 1970); harpagiferids from Hureau (1990); artedidraconids from Eakin (1990) with revision of *Pogonophryne* following Balushkin and Eakin (1998); bathydraconids from Gon (1990b) and channichthyids from Iwami and Kock (1990). Asterisk (*) indicates non-Antarctic species. Dagger (†) precedes names of species described after publication of *Fishes of the Southern Ocean* (Gon and Heemstra 1990). Species placed in synonymy since 1990 are underlined in the list but not counted.

Family and species
Bovichtidae
<i>Bovichtus</i>
<i>angustifrons</i> Regan, 1913*
<i>argentinus</i> MacDonagh, 1931*
<i>chilensis</i> Regan, 1913*
<i>diacanthus</i> (Carmichael, 1818)*
<i>elongatus</i> Hureau and Tomo, 1977
<i>oculus</i> Hardy, 1988*
<i>psychrolutes</i> Günther, 1860*
<i>variegatus</i> Richardson, 1846*
<i>veneris</i> Sauvage, 1879*
<i>Cottoperca gobio</i> (Günther, 1861)*
Pseudaphritidae
<i>Pseudaphritis urvillii</i> (Valenciennes in Cuvier and Valenciennes, 1832)*
Eleginopidae
<i>Eleginops maclovinus</i> (Cuvier in Cuvier and Valenciennes, 1830)*

Notothenoid species list

Nototheniidae

- Aethotaxis mitopteryx* DeWitt, 1962
Cryotheria peninsulae Daniels, 1981
Dissostichus
 eleginoides Smitt, 1898
 mawsoni Norman, 1937
Gobionotothen
 acuta (Günther, 1880)
 †*barsukovi* Balushkin, 1991
 gibberifrons (Lönnberg, 1905)
 marionensis (Günther, 1880)
Gvozdarus svetovidovi Balushkin, 1989
Lepidonotothen
 kempi (Norman, 1937)
 larseni (Lönnberg, 1905)
 macrophthalma (Norman, 1937)*
 mizops (Günther, 1880)
 nudifrons (Lönnberg, 1905)
 squamifrons (Günther, 1880)
Notothenia
 angustata Hutton, 1875*
 coriiceps Richardson, 1844
 cyanobrancha Richardson, 1844
 microlepidota Hutton, 1875*
 rossii Richardson, 1844
Pagothenia
 borchgrevinki (Boulenger, 1902)
 brachysoma (Pappenheim, 1912)
Paranotothenia
 †*dewitti* Balushkin, 1990
 magellanica (Forster in Bloch and Schneider, 1801)
Patagonotothen
 brevicauda (Lönnberg, 1905)*
 canina (Smitt, 1897)*
 cornucola (Richardson, 1844)*
 elegans (Günther, 1880)*
 guntheri (Norman, 1937)
 jordani (Thompson, 1916)*
 †*krefftii* Balushkin and Stehmann, 1993*
 longipes (Steindachner, 1876)*
 ramsayi (Regan, 1913)*
 sima (Richardson, 1844)*
 squamiceps (Peters, 1876)*
 tessellata (Richardson, 1845)*
 †*thompsoni* Balushkin, 1993*
 wiltoni (Regan, 1913) *
Pleuragramma antarcticum Boulenger, 1902
Trematomus
 bernacchii Boulenger, 1902
 eulepidotus Regan, 1914
 hansoni Boulenger, 1902
 lepidorhinus (Pappenheim, 1911)

loennbergii Regan, 1913
newnesi Boulenger, 1902
nicolai (Boulenger, 1902)
pennellii Regan, 1914
scotti (Boulenger, 1907)
tokarevi Andriashev, 1978
vicarius Lönnberg, 1905

Harpagiferidae

Harpagifer

antarcticus Nybelin, 1947
bispinis (Schneider in Bloch and Schneider, 1801)
georgianus Nybelin, 1947
kerquelenensis Nybelin, 1947
palliolatus Richardson, 1845
spinus Hureau, Louis, Tomo and Ozouf, 1980

Artedidraconidae

Artedidraco

†*glareobarbatus* Eastman and Eakin, 1999
loennbergi Roule, 1913
mirus Lönnberg, 1905
orianae Regan, 1914
shackletoni Waite, 1911
skottsbergi Lönnberg, 1905

Dolloidraco longedorsalis Roule, 1913

Histiodraco velifer (Regan, 1914)

Pogonophryne

albipinna Eakin, 1981
barsukovi Andriashev, 1967
†*cerebropogon* Eakin and Eastman, 1998
curtilemma Balushkin, 1988
dewitti Eakin, 1988
dolichobranchiata Andriashev, 1967
†*eakini* Balushkin, 1999
†*fusca* Balushkin and Eakin, 1998
immaculata Eakin, 1981
lanceobarbata Eakin, 1987
macropogon Eakin, 1981
marmorata Norman, 1938
mentella Andriashev, 1967
†*orangiensis* Eakin and Balushkin, 1998
orcadensis Tomo, 1981
permitini Andriashev, 1967
phyllopogon Andriashev, 1967
platypogon Eakin, 1988
scotti Regan, 1914
†*squamibarbata* Eakin and Balushkin, 2000
velifera Eakin, 1981
ventrimaculata Eakin, 1987

Bathydraconidae

†*Acanthodraco dewitti* Skóra, 1995

Notothenoid speceis list

Akarotaxis nudiceps (Waite, 1916)
Bathyraco
 antarcticus Günther, 1878
 joannae DeWitt, 1985
 macrolepis Boulenger, 1907
 marri Norman, 1938
 scotiae Dollo, 1906
Cygnodraco mawsoni Waite, 1916
Gerlachea australis Dollo, 1900
Gymnodraco acuticeps Boulenger, 1902
Parachaenichthyscharcoti (Vaillant, 1906)
georgianus (Fischer, 1885)
Prionodraco evansii Regan, 1914
Psilodraco breviceps Norman, 1937
Racovitzia glacialis Dollo, 1900
Vomeridens infuscipinnis (DeWitt, 1964)

Channichthyidae

Chaenocephalus aceratus (Lönnberg, 1906)
Chaenodraco wilsoni Regan, 1914
Champscephalus
 esox (Günther, 1861)
 gunnari Lönnberg, 1905
Channichthys rhinoceratus Richardson, 1844
Chionobathyscus dewitti Andriashev and Neelov, 1978
Chionodraco
 hamatus (Lönnberg, 1905)
 myersi DeWitt and Tyler, 1960
 rastrospinosus DeWitt and Hureau, 1979
Cryodraco antarcticus Dollo, 1900
Dacodraco hunteri Waite, 1916
Neopagetopsis ionah Nybelin, 1947
Pagetopsis
 macropterus (Boulenger, 1907)
 maculatus Barsukov and Permitin, 1958
Pseudochaenichthys georgianus Norman, 1937

References

- Balushkin, A. V., 1990: Review of blue notothenias of the genus *Paranotothenia* Balushkin (Nototheniidae) with description of a new species. *J. Ichthyol.* 30(6): 132—147.
- Balushkin, A. V., 1991: Review of green notothenias, *Gobionotothen*, Balushkin (Nototheniidae) of the Antarctic and Subantarctic. *J. Ichthyol.* 31(8): 42—55.
- Balushkin, A. V., 1992: Classification, phylogenetic relationships, and origins of the families of the suborder Notothenioidei (Perciformes). *J. Ichthyol.* 32(7): 90—110.
- Balushkin, A. V., 1993: *Patagonotothen thompsoni* sp. n., a new Patagonian notothen from the Strait of Magellan, South America (Pisces, Perciformes, Nototheniidae). *Arch. FischWiss.* 41(3): 223—229.

- Balushkin, A. V., 1997: Morphology, classification, and evolution of notothenioid fishes of the Southern Ocean (in Russian). Doctor of Science (Biol.) Dissertation. St. Petersburg: Zoological Institute, Russian Academy of Sciences. 52 pp.
- Balushkin, A. V., 1999: *Pogonophryne eakini* sp. nova (Artedidraconidae, Notothenioidei, Perciformes): A new species of plunderfish from the Antarctic. J. Ichthyol. 39(9): 799-802.
- Balushkin, A. V.; Eakin, R., 1998: A new toad plunderfish *Pogonophryne fusca* sp. nova (Fam. Artedidraconidae: Notothenioidei) with notes on species composition and species groups in the genus *Pogonophryne* Regan. J. Ichthyol. 38(8): 574—579.
- Balushkin, A. V.; Stehmann, M., 1993: Results of the research cruises of FRV 'Walther Herwig' to South America. LXXII. *Patagonotothen krefftii* sp. n., a new Patagonian notothen from Burdwood Bank, Western South Atlantic (Pisces, Perciformes, Nototheniidae). Arch. FischWiss. 41(3): 211—221.
- Bargelloni, L.; Lecointre, G., 1998: Four years in notothenioid systematics: A molecular perspective. In: di Prisco, G.; Pisano, E.; Clarke, A. (eds): Fishes of Antarctica: a biological overview. Milan: Springer-Verlag Italia, p. 259—273.
- Bargelloni, L.; Ritchie, P. A.; Patarnello, T.; Battaglia, B.; Lambert, D. M.; Meyer, A., 1994: Molecular evolution at subzero temperatures: mitochondrial and nuclear phylogenies of fishes from Antarctica (suborder Notothenioidei), and the evolution of antifreeze glycopeptides. Mol. Biol. Evol. 11(6): 854—863.
- Bargelloni, L.; Patarnello, T.; Ritchie, P. A.; Battaglia, B.; Meyer, A., 1997: Molecular phylogeny and evolution of notothenioid fish based on partial sequences of 12S and 16S ribosomal RNA mitochondrial genes. In: Battaglia, B.; Valencia, J.; Walton, D. W. H. (eds): Antarctic communities: species, structure and survival. Cambridge: Cambridge University Press, p. 45—50.
- Bernardi, G.; Goswami, U., 1997: Molecular evidence for cryptic species among the Antarctic fish *Trematomus bernacchii* and *Trematomus hansonii*. Antarct. Sci. 9(4): 381—385.
- Chen, L.; DeVries, A. L.; Cheng, C. -H. C., 1997a: Evolution of antifreeze glycoprotein gene from a trypsinogen gene in Antarctic notothenioid fish. Proc. Natl. Acad. Sci. USA 94(8): 3811—3816.
- Chen, L.; DeVries, A. L.; Cheng, C. -H. C., 1997b: Convergent evolution of antifreeze glycoproteins in Antarctic notothenioid fish and Arctic cod. Proc. Nat. Acad. Sci. USA 94(8): 3817—3822.
- Chen W. -J.; Bonillo, C.; Lecointre, G., 1998: Phylogeny of the Channichthyidae (Notothenioidei, Teleostei) based on two mitochondrial genes. In: di Prisco, G.; Pisano, E.; Clarke, A. (eds): Fishes of Antarctica: a biological overview. Milan: Springer-Verlag Italia, p. 287—298.
- Cheng, C. -H. C., 1998: Origin and mechanism of evolution of antifreeze glycoproteins in polar fishes. In: di Prisco, G.; Pisano, E.; Clarke, A. (eds): Fishes of Antarctica: a biological overview. Milan: Springer-Verlag Italia, p. 311—328.
- DeWitt, H. H., 1966: A revision of the Antarctic and southern genus *Notothenia* (Pisces, Nototheniidae). Ph. D. Dissertation. Palo Alto, California: Stanford University. 469 pp.
- DeWitt, H. H., 1970: A revision of the fishes of the genus *Notothenia* from the New Zealand region, including Macquarie Island. Proc. Calif. Acad. Sci. 38(16): 299—340.
- DeWitt, H. H.; Heemstra, P. C.; Gon, O., 1990: Nototheniidae. In: Gon, O.; Heemstra, P. C. (eds): Fishes of the Southern Ocean. Grahamstown, South Africa: J. L. B. Smith Institute of Ichthyology, p. 279—331.
- di Prisco, G., 1998: Molecular adaptations of Antarctic fish hemoglobins. In: di Prisco, G.; Pisano, E.; Clarke, A. (eds): Fishes of Antarctica: a biological overview. Milan: Springer-Verlag Italia, p. 339—353.
- Eakin, R. R., 1990: Artedidraconidae. In: Gon, O.; Heemstra, P. C. (eds): Fishes of the Southern Ocean. Grahamstown, South Africa: J. L. B. Smith Institute of Ichthyology, p. 332—356.

- Eakin, R. R.; Balushkin, A. V., 1998: A new species of toadlike plunderfish *Pogonophryne orangiensis* sp. nova (Artedidraconidae, Notothenioidi) from the Weddell Sea, Antarctica. *J. Ichthyol.* 38(9): 800—803.
- Eakin, R. R.; Balushkin, A. V., 2000: A new species of *Pogonophryne* (Pisces: Perciformes: Artedidraconidae) from East Antarctica. *Proc. Biol. Soc. Wash.* 113(1): 264-268.
- Eakin, R. R.; Eastman, J. T., 1998: New species of *Pogonophryne* (Pisces, Artedidraconidae) from the Ross Sea, Antarctica. *Copeia* 1998(4): 1005—1009.
- Eastman, J. T., 1993: Antarctic fish biology: evolution in a unique environment. San Diego: Academic Press. 322 pp.
- Eastman, J. T.; Clarke, A., 1998: A comparison of adaptive radiations of Antarctic fish with those of nonAntarctic fish. In: di Prisco, G.; Pisano, E.; Clarke, A. (eds): *Fishes of Antarctica: a biological overview*. Milan: Springer-Verlag Italia, p. 3—26.
- Eastman, J. T.; DeVries, A. L., 1997: Biology and phenotypic plasticity of the Antarctic nototheniid fish *Trematomus newnesi* in McMurdo Sound. *Antarct. Sci.* 9(1): 27—35.
- Eastman, J. T.; Eakin, R. R., 1999: Fishes of the genus *Artedidraco* (Pisces, Artedidraconidae) from the Ross Sea, Antarctica, with the description of a new species and a colour morph. *Antarct. Sci.* 11(1): 13—22.
- Gon, O., 1990a: Bovichtidae. In: Gon, O.; Heemstra, P. C. (eds): *Fishes of the Southern Ocean*. Grahamstown, South Africa: J. L. B. Smith Institute of Ichthyology, p. 277—278.
- Gon, O., 1990b: Bathydraconidae. In: Gon, O.; Heemstra, P. C. (eds): *Fishes of the Southern Ocean*. Grahamstown, South Africa: J. L. B. Smith Institute of Ichthyology, p. 364—380.
- Gon, O.; Heemstra, P. C. (eds), 1990: *Fishes of the Southern Ocean*. Grahamstown, South Africa: J. L. B. Smith Institute of Ichthyology. 462 pp.
- Hardy, G. S., 1988: A revision of *Bovichtus* Cuvier, 1831 (Pisces: Bovichthyidae) from Australasia, with description of a new deepwater species from the New Zealand Subantarctic. *J. Nat. Hist.* 22(6): 1639—1655.
- Hureau, J. -C., 1990: Harpagiferidae. In: Gon, O.; Heemstra, P. C. (eds): *Fishes of the Southern Ocean*. Grahamstown, South Africa: J. L. B. Smith Institute of Ichthyology, p. 357—363.
- Iwami, T.; Kock, K. -H., 1990: Channichthyidae. In: Gon, O.; Heemstra, P. C. (eds): *Fishes of the Southern Ocean*. Grahamstown, South Africa: J. L. B. Smith Institute of Ichthyology, p. 381—399.
- Klingenberg, C. P.; Ekau, W., 1996: A combined morphometric and phylogenetic analysis of an ecomorphological trend: pelagization in Antarctic fishes (Perciformes: Nototheniidae). *Biol. J. Linn. Soc.* 59(2): 143—177.
- Kock, K. -H., 1992: Antarctic fish and fisheries. Studies in polar research. Cambridge: Cambridge University Press. 359 pp.
- Kock, K. -H., 1994: Fishing and conservation in southern waters. *Polar Rec.* 30(172): 3—22.
- Lecointre, G.; Bonillo, C.; Ozouf-Costaz, C.; Hureau, J. -C., 1997: Molecular evidence for the origins of Antarctic fishes: paraphyly of the Bovichtidae and no indication for the monophyly of the Notothenioidi (Teleostei). *Polar Biol.* 18(3): 193—208.
- Miller, R. G., 1993: History and atlas of the fishes of the Antarctic Ocean. Carson City, Nevada: Foresta Institute for Ocean and Mountain Studies. 792 pp.
- Nelson, J. S., 1994: *Fishes of the world* (3rd ed.). New York: John Wiley & Sons. 600 pp.
- Ozouf-Costaz, C.; Pisano, E.; Thaeron, C.; Hureau, J. -C., 1997: Antarctic fish chromosome banding: significance for evolutionary studies. *Cybiurn* 21(4): 399—409.
- Pisano, E.; Ozouf-Costaz, C.; Prirodina, V., 1998: Chromosome diversification in Antarctic fish (Notothenioidi). In: di Prisco, G.; Pisano, E.; Clarke, A. (eds): *Fishes of Antarctica: a biological overview*. Milan: Springer-Verlag Italia, p. 275—285.
- Ritchie, P. A.; Bargelloni, L.; Meyer, A.; Taylor, J. A.; Macdonald, J. A.; Lambert, D. M., 1996: Mitochondrial phylogeny of trematomid fishes (Nototheniidae, Perciformes) and the evolution of Antarctic fish. *Mol. Phylogen. Evol.* 5(2): 383—390.
- Ritchie, P.; Lavoué, S.; Lecointre, G., 1997: Molecular phylogenetics and the evolution of Antarctic notothenioid fishes. *Comp. Biochem. Physiol.* 118A(4): 1009—1025.

J. T. Eastman; R. R. Eakin

- Schneppenheim, R.; Kock, K. -H.; Duhamel, G.; Janssen, G., 1994: On the taxonomy of the *Lepidonotothen squamifrons* group (Pisces, Perciformes, Notothenioidei). Arch. Fish. Mar. Res. 42(2): 137—148.
- Skóra, K. E., 1995: *Acanthodraco dewitti* gen. et sp. n. (Pisces, Bathydraconidae) from Admiralty Bay (King George Island, South Shetland Islands, Antarctica). Arch. Fish. Mar. Res. 42(3): 283—289.

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