UNDERWATER FIELD GUIDE TO ROSS ISLAND & MCMURDO SOUND, ANTARCTICA, VOLUME 6: CHORDATA

salps, ascidians, tunicates, fish, penguins, marine mammals

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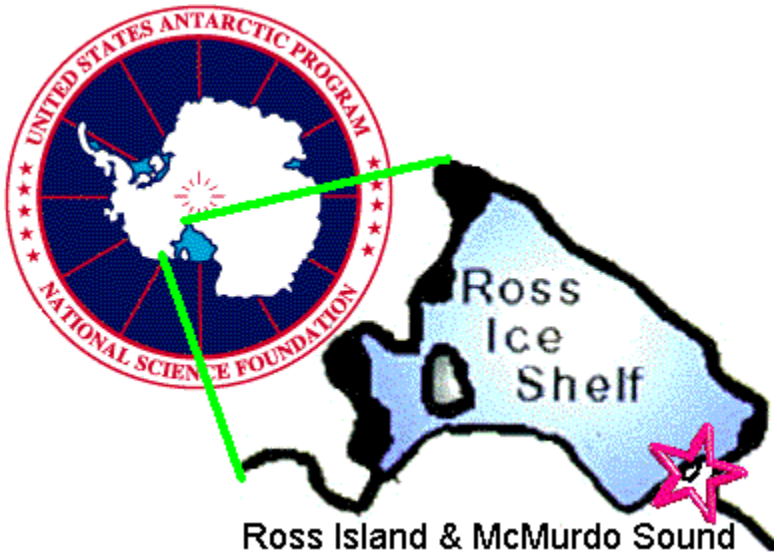
Photographs: Steve Alexander, Bill Baker, Jeffrey Bozanic, Peter Brueggeman, Paul Cziko, Paul Dayton, Julian Gutt, Shawn Harper, Adam G Marsh, Bruce A Miller, Hans Peter Reinthaler, Rob Robbins, M Dale Stokes & Norbert Wu



The National Science Foundation's Office of Polar Programs sponsored Norbert Wu on an Artist's and Writer's Grant project, in which Peter Brueggeman participated. One outcome from Wu's endeavor is this Field Guide, which builds upon principal photography by Norbert Wu, with photos from other photographers, who are credited on their photographs and above. This Field Guide aims to facilitate underwater/topside field identification from visual characters. Most organisms were identified from photographs with no specimen collection, so there can be uncertainty with these identifications.

Keywords: Antarctica, Antarctic, Ross Island, McMurdo Sound, field guide, salp, ascidian, tunicate, fish, penguin, marine mammals, whale, seal

aggregate salp *Ihlea racovitzai*

ascidian *Aplidium* sp., possibly *Aplidium vastum*

ascidian *Cnemidocarpa verrucosa*

ascidian, probably *Didemnum biglans*

ascidian *Distaplia cylindrica*

mushroom ascidian *Sycozoa gaimardi*

ascidian *Synoicum adareanum*

ascidian, possibly *Agnezia biscoei*

stalked ascidian, possibly *Pyura bouvetensis*

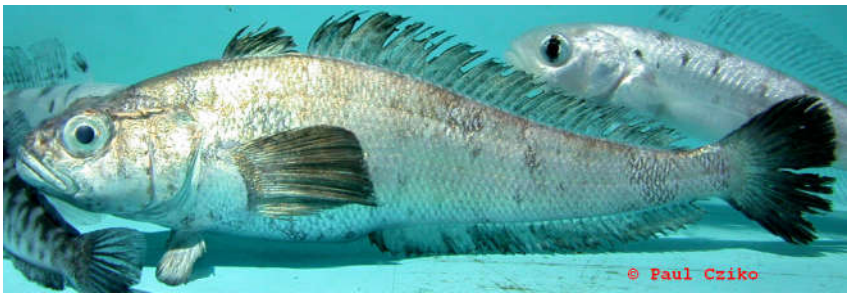
lightbulb ascidian, possibly *Tylobranchion speciosum*

naked dragonfish *Gymnodraco acuticeps*

plunderfish *Histiodraco velifer*

eelpout *Lycodichthys dearborni*

Pagetopsis macropterus



Trematomus amphitreta

Bald notothen *Trematomus borchgrevinki*

Emerald notothen *Trematomus bernacchii*

Striped notothen *Trematomus hansoni*

deepwater notothen *Trematomus loennbergii*

Dusky notothen *Trematomus newnesi*

Spotted notothen *Trematomus nicolai*

Sharp-spined notothen *Trematomus pennellii*

DeVries' paraliparis *Paraliparis devriesi*

Antarctic toothfish *Dissostichus mawsoni*

skate *Bathyraja* sp.

Antarctic silverfish *Pleuragramma antarctica*

Hagfish, family Myxinidae

Adelie penguin *Pygoscelis adeliae*

Emperor penguin *Aptenodytes forsteri*

Weddell seal *Leptonychotes weddellii*

Leopard seal *Hydrurga leptonyx*

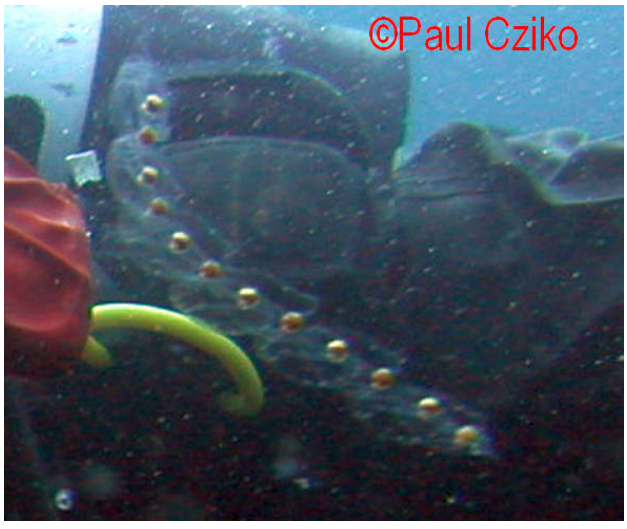
crabeater seal *Lobodon carcinophaga*

killer whale or orca *Orcinus orca*

Antarctic minke whale *Balaenoptera bonaerensis*

November 2021: taxonomic names checked in Zoological Record and World Register of Marine Species.

aggregate salp *Ihlea racovitzai*



Ihlea racovitzai is found in high-latitude ice-edge areas, and south of the Antarctic convergence [1,4]. Two species of salp are found in Antarctica, and the other species *Salpa thompsoni* is found in ice-free areas [1,4]. *Ihlea racovitzai* occurs by preference in waters colder than 0 degree C, and avoids areas with warmer water influence [1]. Asexually reproducing solitary salps bud to form aggregate salps in chains, which then sexually reproduce to produce solitary salps. *Ihlea racovitzai* aggregate salps reproduce sexually in the fall, and solitary salps dominate during the winter [1]. Predators of *Ihlea racovitzai* include the Adelie penguin, and the New Zealand scampi lobster *Metanephrops challengeri* [2,3,5].

References: 1: Polar Biology 36:807-817, 2013; **2:** Frontiers in Ecology and the Environment 15(8):437-441, 2017; **3:** Marine Biology 163(5):108, 2016; **4:** A Guide to the Pelagic Tunicates of the Southern Ocean and Adjacent Waters. David O'Sullivan. ANARE Research Notes 8. Australia Department of Science and Technology, Antarctic Division, 1983; **5:** PeerJ 6:e5641 https://doi.org/10.7717/peerj.5641

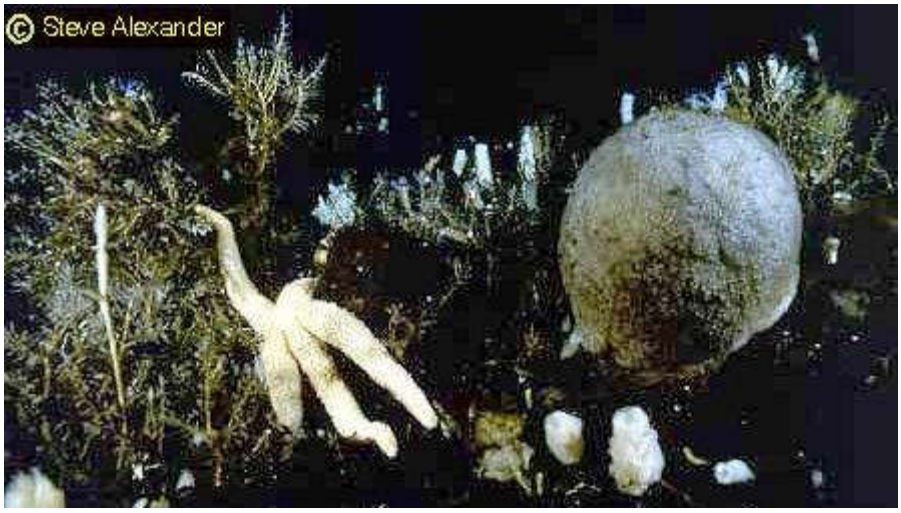
ascidian *Aplidium* sp., possibly *A. vastum*

This ascidian *Aplidium* sp. is a colonial ascidian in the family Polyclinidae and could be *Aplidium vastum* [2].

Aplidium vastum is found throughout Antarctica and the Antarctic Peninsula from 75 to 300 meters depth [1,3,5,6].

Aplidium vastum colonies are massive, spherical or egg-shaped, from six to twenty centimeters in diameter [1,4].

The spherical colonies of *Aplidium vastum* have zooids opening all around the surface and their test (covering) may be impregnated with sand [1,4].



This photo of the *Aplidium* sp. colony above shows its size relative to other organisms.

References: 1: Antarctic Ascidiacea; Monographic Account of the Known Species Based on Specimens Collected under U.S. Government Auspices, 1947-1965. Kott, Patricia. Washington, DC: American Geophysical Union, 1969. Antarctic Research Series. Volume 13; **2:** Patricia (Kott) Mather, personal communication, 1999; **3:** Memoires du Museum National d'Histoire Naturelle. Nouvelle Serie. Serie A, Zoologie 125:1-168, plates, 1983; **4:** Bulletin du Museum National d'Histoire Naturelle. 3e Serie. Number 510. Zoologie 351:3-18, 1978; **5:** Polar Research 28:403-414, 2009; **6:** Advances in Polar Science 26(1):8-23, 2015

ascidian *Cnemidocarpa verrucosa*

Cnemidocarpa verrucosa is found throughout Antarctica and the Antarctic Peninsula, South Shetland Islands, South Orkney Islands, South Sandwich Islands, South Georgia Island, Kerguelen Island, Bouvet Island, Crozet Island, Falkland Islands, Magellanic Chile, and Tierra del Fuego from 2 to 5,845 meters depth [2,7,8,10,14,15,16,17].

The body shape of *Cnemidocarpa verrucosa* may be cylindrical, ovate, or barrel shaped [2]. *C. verrucosa* has a thin, tough, flexible, opaque body covering (test) whose surface may be smooth or roughened by furrows, wrinkles, and conical or low wart-like papillae [2]. The test of ascidians is an acellular covering secreted by the epidermis; it is largely made of tunicin, a substance allied to plant cellulose and the only cellulose-like substance to occur in the animal kingdom [6]. The body wall of *C. verrucosa* is thin and adheres closely to the test [2]. *C. verrucosa* may have a short stalk with larger specimens having an expanded jelly-like plate at the stalk's base [2,18].

Cnemidocarpa verrucosa lives at least four years and can be quite large; maximum size has been described as up to twenty centimeters in diameter or as eighteen centimeters long and nine centimeters in diameter [1,2,9,10]. The larger incurrent branchial siphon of *C. verrucosa* is curved over with its flared opening facing downward; the smaller excurrent atrial siphon faces upward from the body [2].

Cnemidocarpa verrucosa color varies among specimens and with age: white, white with a rosy and yellow tinge, bright yellow (a predator *Marseniopsis mollis* is bright yellow), yellowish-brown, orange, brown, or gray and it can be bright yellow around its apertures [2,10].

Cnemidocarpa verrucosa feeds on diatoms, nanoplankton, bacteria, and detritus [13].

Cnemidocarpa verrucosa is the largest and most abundant Styelidae ascidian in the Antarctic Ocean [9]. *C. verrucosa* is oftentimes attached to cobblestones or boulders and may be clustered with several others of its species; one study site had a *C. verrucosa* population density of 0.4 individuals per square meter at 20 - 30 meters depth [1].

Cnemidocarpa verrucosa released gametes for external fertilization in the laboratory in November, and their planktonic larvae appear to be yolk-feeders [1].

The bright yellow prosobranch mollusc *Marseniopsis mollis* is the primary predator of *Cnemidocarpa verrucosa*; no seastars or fish have been observed eating *C. verrucosa* [3,4]. *Marseniopsis mollis* is shell-less and appears to be protected from predation itself by a chemical, homarine, which deters feeding [3]. *Marseniopsis mollis* appears to obtain its defensive chemical homarine from bryozoans and hydroids growing on the surface of *C. verrucosa* [3]. *Marseniopsis mollis* has been observed drilling into the tunic of *C. verrucosa* to deposit its eggs [4].

The gastropod *Phyline antarctica* also deposits its eggs in the tunic of *Cnemidocarpa verrucosa* [12].

Younger *Cnemidocarpa verrucosa* are almost cylindrical, attached by their posterior, and are covered with characteristic pointed test protuberances [2,5,9].

Taxonomic Note: Genetic analysis suggests the existence of at least two species within *Cnemidocarpa verrucosa*; the presence of an expanded basal disk or plate at the base of the tunicate's stalk in one of the genotypes could be a diagnostic morphological trait to differentiate the species [18]**.**

References: 1: Journal of Experimental Marine Biology and Ecology 147(2):163-175, 1991; **2:** Antarctic Ascidiacea; Monographic Account of the Known Species Based on Specimens Collected under U.S. Government Auspices, 1947-1965. Kott, Patricia. Washington, DC: American Geophysical Union, 1969. Antarctic Research Series. Volume 13; **3:** Antarctic Journal of the United States 29(5):151-153, 1994; **4:** Ecological Monographs 44(1):105-128, 1974; **5:** Further Zoological Results of the Swedish Antarctic Expedition 1901-1903. Volume 4, Number 4. Ascidiacea Part 2. A Arnback-Christie-Linde. Stockholm: PA Norstedt and Soner, 1950; **6:** Patricia (Kott) Mather, personal communication, 1999; **7:** Biology of the Antarctic Seas 4:11-82, 1971. Antarctic Research Series 17; **8:** Memoires du Museum National d'Histoire Naturelle. Nouvelle Serie. Serie A, Zoologie 125:1-168, plates, 1983; **9:** Bulletin du Museum National d'Histoire Naturelle. 4e Serie. Section A, Zoologie, Biologie et Ecologie Animales 16(1):13-37, 1994; **10:** Tethys 5(4):611-628, 1974; **11:** Polar Biology 20(4):229-247, 1998; **12:** Berichte zur Polarforschung, Reports on Polar Research 286, 1998; **13:** Polar Biology 25:58-64, 2002; **14:** Zootaxa 2817:1-54, 2011; **15:** Polar Research 28:403-414, 2009; **16:** Advances in Polar Science 26(1):8-23, 2015; **17:** Management of Biological Invasions 7(1):77-86, 2016; **18:** Ecology and Evolution 10(15):8127-8143, 2020

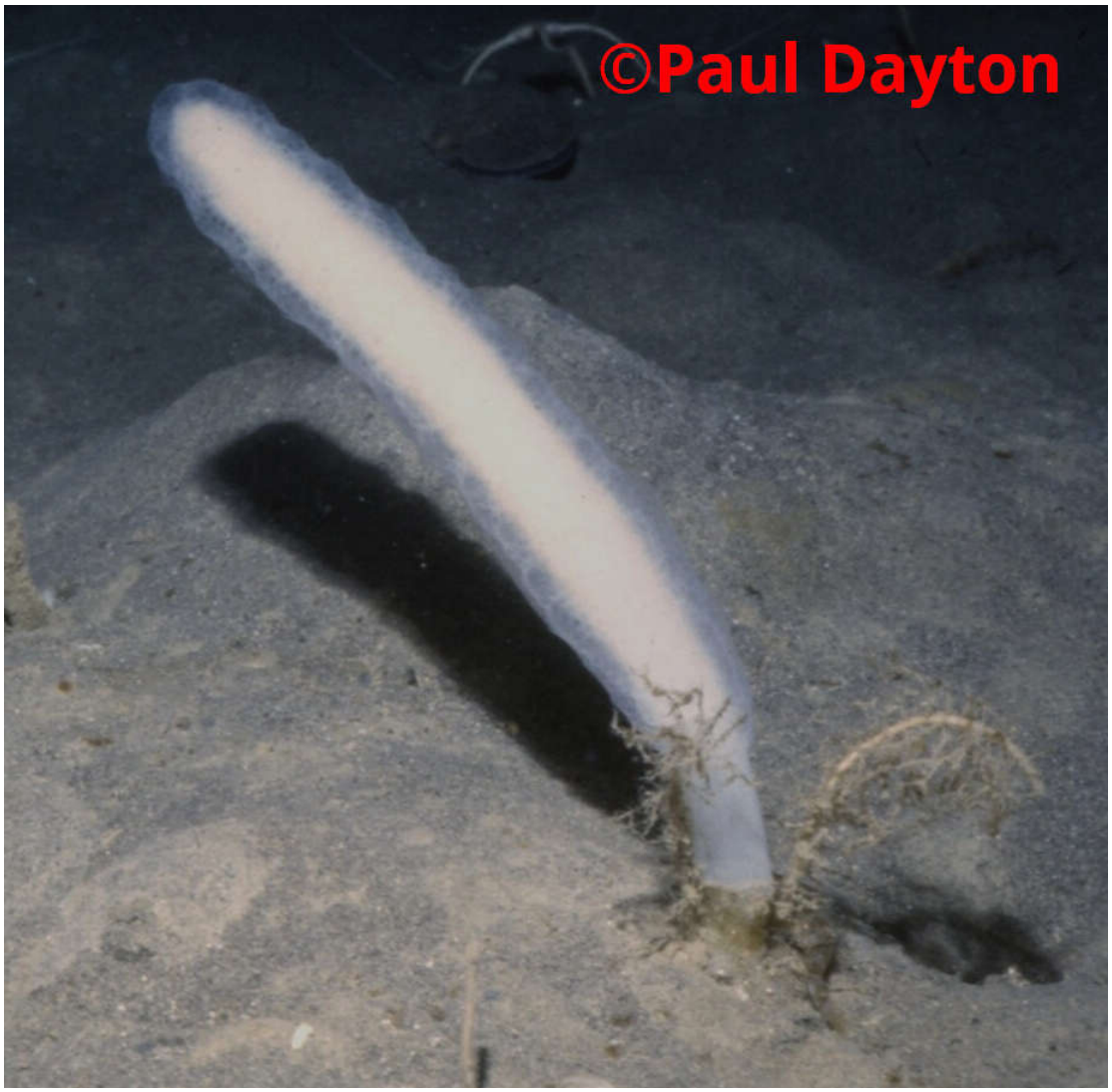
ascidian, probably *Didemnum biglans*

Didemnum biglans is found in Antarctica, the Antarctic Peninsula, and the South Shetland Islands, South Orkney Islands, South Georgia Island, and southern Chile, from 2 to 3,495 meters depth [2,3].

The *biglans* and *studeri* species of *Didemnum* are reported as problematic to identify, both being thin, encrusting, and white colored [1,4].

References: 1: Advances in Polar Science 26(1):8-23, 2015; **2:** Marine Wildlife, King George Island, Antarctica, Identification Guide. Dirk Schories & Gesche Kohlberg, eds. Rostock, Germany: Dirk Schories Publications, 2016; **3:** Antarctic Ascidiacea. Patricia Kott, ed. American Geophysical Union, 1969; **4:** Advances in Polar Science 26(1):8-23, 2015

ascidian *Distaplia cylindrica*



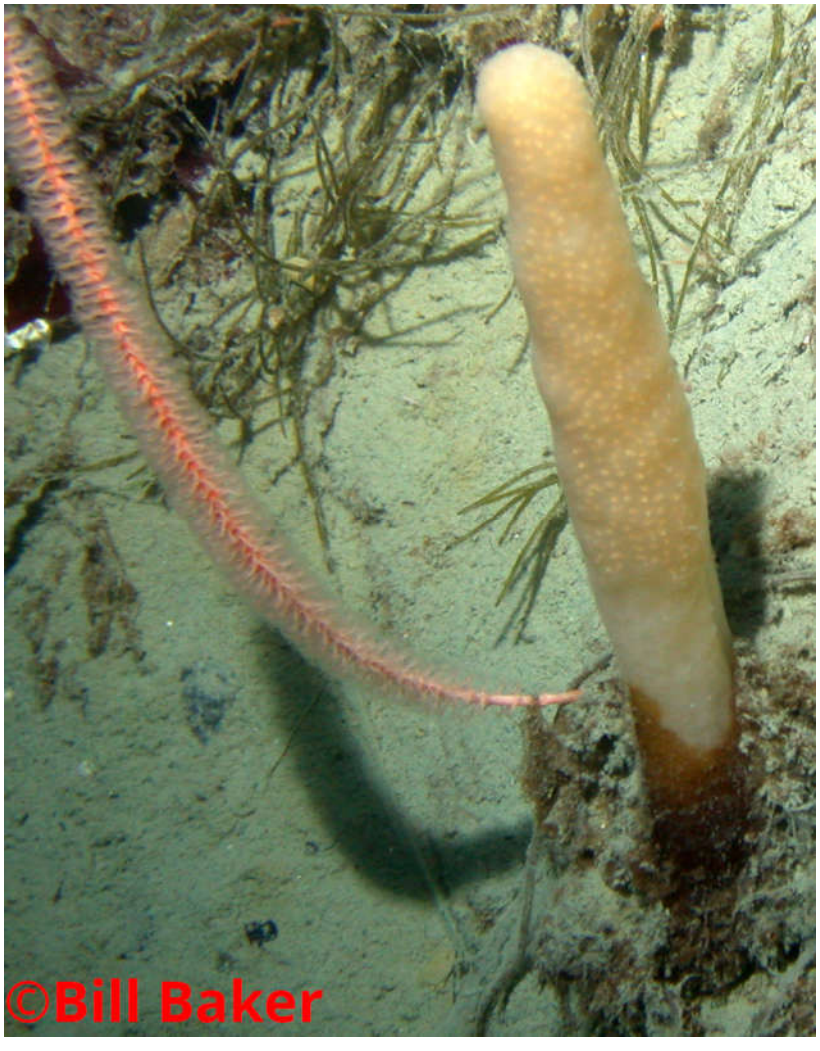
Distaplia cylindrica is found throughout Antarctica and the Antarctic Peninsula, South Shetland Islands, South Orkney Islands, South Sandwich Islands, South Georgia Island, Strait of Magellan, and Tierra del Fuego from 0 to 786 meters depth [1,2,3,5,8].

Distaplia cylindrica is stalked with a cylindrical or tapering head up to 700 cm long (7 meters) [2,3,9].

A *Distaplia cylindrica* colony is up to 8 cm in diameter at its widest end near the stalk [3].

Color of *Distaplia cylindrica* is milky-white to yellowish-white to pale pink [2,3,4].

The youngest *Distaplia cylindrica* colonies are usually a simple clavate form [2,3].



This *Distaplia cylindrica* colony is near Palmer Station [6].

Large *Distaplia cylindrica* colonies are up to seven meters long and are slender and flexible [2,3]. These photos of a long *Distaplia cylindrica* colony were taken at Trinity Island in the Antarctic Peninsula [7].

Distaplia cylindrica grows attached to the substrate, and colonies can break loose and float near the surface [2]. Free-floating *Distaplia cylindrica* colonies can live for a time and have been observed to move with slow undulations; the zooids in such unattached colonies are usually in poor condition [2].

References: 1: Smithsonian National Museum of Natural History, Antarctic Invertebrates invertebrates.si.edu; **2:** The North and South American ascidians. Bulletin of the American Museum of Natural History 84: 143-144, 1945; **3:** Antarctic Ascidiacea; Monographic Account of the Known Species Based on Specimens Collected under U.S. Government Auspices, 1947-1965. Kott, Patricia. Washington, DC: American Geophysical Union, 1969. Antarctic Research Series. Volume 13. pp. 29-32; **4:** Antarctic Science 10(2):147-152, 1998; **5:** Zootaxa 2817:1-54, 2011; **6:** Bill Baker, personal communication, 2016; **7:** Hans Peter Reinthaler, personal communication, 2016; **8:** Polar Research 28:403-414, 2009; **9:** Ecological Applications 29(1), 2019, e01823

mushroom ascidian *Sycozoa gaimardi*

Sycozoa gaimardi is found throughout Antarctica and the Antarctic Peninsula, South Shetland Islands, South Georgia Island, Kerguelen Island, Falkland Islands, Strait of Magellan, and Tierra del Fuego, from 5 to 238 meters depth [1,2,3,4,7,8].

Colonies are easily recognizable, resembling small, slender-stem mushrooms with a convex dome-shaped head of transparent closely placed zooids [3,4].

The head is usually not over 12 mm in diameter, and the stalk is usually not much over 25 mm long, but may reach 40 mm [3,4]. The stalk is thickest at the upper end where it joins the head, and does not branch [3,4].

Color in general is yellow; colonies are either male or female [3,4].

This *Sycozoa gaimardi* ascidian was photographed near Palmer Station [5].

Sycozoa gaimardi may be attached directly to the bottom or may be an epibiont living attached to other ascidians including *Cnemidocarpa verrucosa* [6].

References: 1: aqua, Journal of Ichthyology and Aquatic Biology 7(3):89-96, 2003; **2:** Smithsonian National Museum of Natural History, Antarctic Invertebrates invertebrates.si.edu; **3:** The North and South American ascidians. Bulletin of the American Museum of Natural History 84: 150-151, 1945; **4:** Antarctic Ascidiacea; Monographic Account of the Known Species Based on Specimens Collected under U.S. Government Auspices, 1947-1965. Kott, Patricia. Washington, DC: American Geophysical Union, 1969. Antarctic Research Series. Volume 13. pp. 28-29; **5:** Bill Baker, personal communication, 2016; **6:** Antarctic Science 10(2):147-152, 1998; **7:** Polar Research 28:403-414, 2009; **8:** Advances in Polar Science 26(1):8-23, 2015

ascidian *Synoicum adareanum*

Synoicum adareanum is found throughout Antarctica and the Antarctic Peninsula, Kerguelen Island, South Shetland Islands, South Orkney Islands, South Sandwich Islands, and South Georgia Island, from 15 to 866 meters depth [1,2,3,4,6,8,9].

Synoicum adareanum colonies consist of large rounded or club-shaped heads with the bottom stalk-like half being wrinkled and leathery and only slightly narrower than the head [1]. *S. adareanum* colonies can be up to eighteen centimeters high with a diameter of twelve centimeters [1].

These yellow lamellarian gastropods *Marseniopsis mollis* could be feeding on *Synoicum adareanum*, or could have just mated and are laying eggs. The holes on *Synoicum adareanum* could be from lamellarian feeding.

Synoicum adareanum has been described as orange or ochre colored when alive; sand may be embedded into the test which affects color [1,5,6,10].

Synoicum adareanum is shown here near Palmer Station [7].

Synoicum adareanum colonies may be a single head or up to six heads arising from a single stalk [1,3,5]. The test (body covering) of *S. adareanum* has been described as firm and cartilaginous or leathery and wrinkled and is semitransparent to glossy [1,5]. The head of a *S. adareanum* colony is smooth and less firm than the stalk [1].

Zooids are large (twelve to twenty millimeters) and arranged in circular rosette systems of six to ten zooids around a conspicuous common cloaca; these systems are evenly distributed over the colonial head [1,5]. One to eight embryos were present in brood pouches in the test of a large specimen [1].

Synoicum adareanum is shown here near Palmer Station [7].

Taxonomic Note: Sometimes misspelled *Synoicium*.

References: 1: Antarctic Ascidiacea; Monographic Account of the Known Species Based on Specimens Collected under U.S. Government Auspices, 1947-1965. Kott, Patricia. Washington, DC: American Geophysical Union, 1969. Antarctic Research Series. Volume 13; **2:** Patricia (Kott) Mather, personal communication, 1999; **3:** Biology of the Antarctic Seas 4:11-82, 1971. Antarctic Research Series 17; **4:** Memoires du Museum National d'Histoire Naturelle. Nouvelle Serie. Serie A, Zoologie 125:1-168, plates, 1983; **5:** Bulletin du Museum National d'Histoire Naturelle. 4e Serie. Section A, Zoologie, Biologie et Ecologie Animales 16(1):13-37, 1994; **6:** Tethys 5(4):611-628, 1974; **7:** Bill Baker, personal communication, 2016; **8:** Zootaxa 2817:1-54, 2011; **9:** Polar Research 28:403-414, 2009; **10:** Antarctic Science 10(2):147-152, 1998

ascidian, possibly *Agnezia biscoei*

Agnezia biscoei is found in Antarctica and the Antarctic Peninsula, the South Shetland Islands, and South Orkney Islands, at depths down to 200+ meters [1,2,3]. *Agnezia biscoei* is a solitary oval-shaped ascidian, up to 4 centimeters in greatest dimension, with its body covered in sand or gravel [1,2]. Positive identification is accomplished with dissection, since it lacks external features to separate it from other sand-covered ascidians [1].

Taxonomic Note: In the original description of this species, its genus was spelled *Agnesia* [4]. The names of the genus *Agnesia* [Michaelsen 1898] and the family Agnesidae [Huntsman 1912] were changed in 1991 to *Agnezia* nom. nov. and Agneziidae nom. nov. because the gastropod genus *Agnesia* [Koninck 1883] and its family Agnesiidae had taxonomic priority [5,6].

References: 1: Marine Wildlife, King George Island, Antarctica, Identification Guide. Dirk Schories & Gesche Kohlberg, eds. Rostock, Germany: Dirk Schories Publications, 2016; **2:** Advances in Polar Science 26(1):8-23, 2015; **3:** Scientia Marina 69(Suppl. 2):215-223, 2005; **4:** Mémoires du Museum National d'Histoire Naturelle. Serie A Zoologie 125:1-168, 1983; **5:** Mémoires du Museum National d'Histoire Naturelle. Serie A Zoologie 151:357-448, 1991; **6:** Invertebrate Biology 116(3):262-276, 1997

stalked ascidian, possibly *Pyura bouvetensis*

This stalked ascidian was seen at Salmon Bay, and looks like *Pyura bouvetensis* [1,2].

Pyura bouvetensis is found in Antarctica and the Antarctic Peninsula, South Shetland Islands, South Orkney Islands, and South Georgia Island, at depths from 21 to 2,350 meters [3,4,5].

The body of *Pyura bouvetensis* is oval shaped up to 5 centimeters long, and supported by a stalk two to ten times the length of the body [3]. Color of *P. bouvetensis* varies from milky white to light brown [3].

References: 1: Ecological Applications 29(1):e01823, 2019; **2:** Polar Biology 39:863-879, 2016; **3:** Marine Wildlife, King George Island, Antarctica, Identification Guide. Dirk Schories & Gesche Kohlberg, eds. Rostock, Germany: Dirk Schories Publications, 2016; **4:** Polar Biology 39:863–879, 2016; **5:** Antarctic Science 10(2):147-152, 1998

lightbulb ascidian, possibly *Tylobranchion speciosum*

Tylobranchion speciosum is found in Antarctica and the Antarctic Peninsula, South Shetland Islands, South Orkney Islands, South Georgia Island, and the Magellan region, at depths from 15 to 2,897 meters [2]. *T. speciosum* is colonial, having pillar or wedge-shaped colonies up to 9 centimeters long, which can be flattened laterally and narrow to the base, often with a small area of attachment [2]. The tunic color of *T. speciosum* is whitish milky to translucent [2].

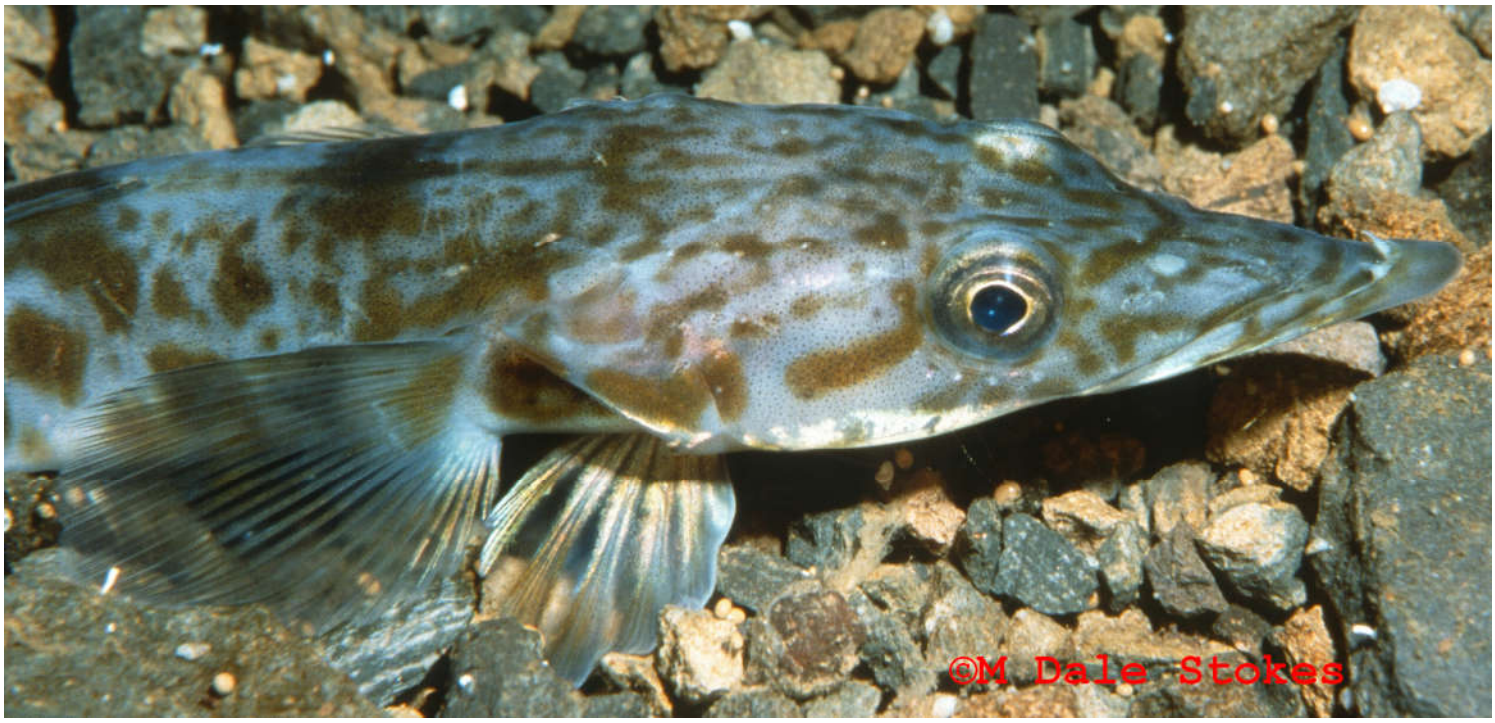
Specimen at left is about four centimeters high and photographed at 21 meters depth at McMurdo intake jetty [1].

References: 1: Rob Robbins, personal communication, 2005; **2:** Marine Wildlife, King George Island, Antarctica, Identification Guide. Dirk Schories & Gesche Kohlberg, eds. Rostock, Germany: Dirk Schories Publications, 2016

Naked dragonfish *Gymnodraco acuticeps*

Gymnodraco acuticeps occurs throughout Antarctica and the South Shetland Islands, at depths from 0 to 1,000 meters (usually found in the first 50 meters) [1,4,6].

Gymnodraco acuticeps can grow up to 42 centimeters in length, and spawning occurs in September, with egg hatching in spring [1,5].



Gymnodraco acuticeps eats other fish (including *Pleuragramma antarctica*, *Trematomus borchgrevinki*, and *Trematomus nicolai*), amphipods, fish eggs, polychaetes, and krill [1,2].

Predators of *Gymnodraco acuticeps* include the Antarctic toothfish *Dissostichus mawsoni* [7].

Dragonfishes are a small, diverse group of Antarctic fishes living at great depths near the Antarctic continent with some species adapted to living under the ice [3].

These are eggs of *Gymnodraco acuticeps*.

Recently hatched *Gymnodraco acuticeps*.

References: 1: Fishes of the Southern Ocean. O Gon & PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **2:** Polar Biology 4:155-160, 1985; **3:** FAO Species Identification Sheets for Fishery Purposes: Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area). W Fischer & JC Hureau, eds. Rome: Food and Agriculture Organization of the United Nations, 1985; **4:** Antarctic Science 11(3):293-304, 1999; **5:** Ross Sea Ecology: Italiantartide Expeditions (1987-1995). FM Faranda, L Guglielmo, A Ianora, eds. Berlin: Springer, 2000. pp. 457-468; **6:** Polar Biology 40:2077-2095, 2017; **7:** CCAMLR Science 22:29–44, 2015

Plunderfish *Histiodraco velifer*

Histiodraco velifer is found in Antarctica, at depths from 210 to 667 meters [1]. Here it was photographed at scuba diving depth.

Histiodraco velifer is up to 21.8 centimeters in length [3].

Antarctic plunderfish have a mental or chin barbel that is used as lure or tactile organ [2].

The Antarctic plunderfish family comprises several genera and species endemic to Antarctic waters and are sedentary members of the benthic fish fauna in the Southern Ocean continental shelf and slope habitats [1,2].

References: 1: Fishes of the Southern Ocean. O Gon and PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **2:** Antarctic Science 22(6):805–814, 2010; **3:** Polar Biology 42:1131-1145, 2019

eelpout *Lycodichthys dearborni*

Lycodichthys dearborni has been collected in the Ross Sea at depths from 466 to 600 meters [1,3,4,5]. *L. dearborni* has been collected at lengths up to 23 centimeters [1,3,4].

Body color of *Lycodichthys dearborni* is light or yellowish with brown mottling; largest specimens are mostly uniform dark brown with the head and nape darker [3,4]. Body color of *L. dearborni* has also been described as brownish to pale yellowish brown with a dark back and lighter sides with a small light fleck under each dark scale [1].

Pectoral fins of *Lycodichthys dearborni* are yellowish with light brown mottling when young, which fades in larger specimens [3,4]. Smaller specimens have a dark brown dorsal surface of head, body, and tail which breaks up into blotches on cheeks, abdomen, and tail [4].

The eelpout family (Zoarcidae) of fishes are usually benthic slope dwellers and are found around the world; benthic forms are usually sexually dimorphic [2]. Benthic eelpouts like *Lycodichthys dearborni* feed on polychaetes, bivalves, and gastropods [3].

The species name *dearborni* honors John Dearborn who collected the first specimens.

References: 1: History and Atlas of the Fishes of the Antarctic Ocean. RG Miller. Carson City, Nevada: Foresta Institute for Ocean and Mountain Studies, 1993. pp. 652-653; **2:** FAO Species Identification Sheets for Fishery Purposes: Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area) / W Fischer & JC Hureau, eds. Rome: Food and Agriculture Organization of the United Nations, 1985; **3:** Fishes of the Southern Ocean. O Gon and PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **4:** Biology of the Antarctic Seas 19:59-113, 1988. Antarctic Research Series Volume 47; **5:** Antarctic Science 11(3):293-304, 1999

Pagetopsis macropterus

Pagetopsis macropterus is found in Antarctica the Antarctic Peninsula, and the South Shetland Islands, at depths from 5 to 752 meters [1,3].

Pagetopsis macropterus is up to 33 centimeters in length [2,3].

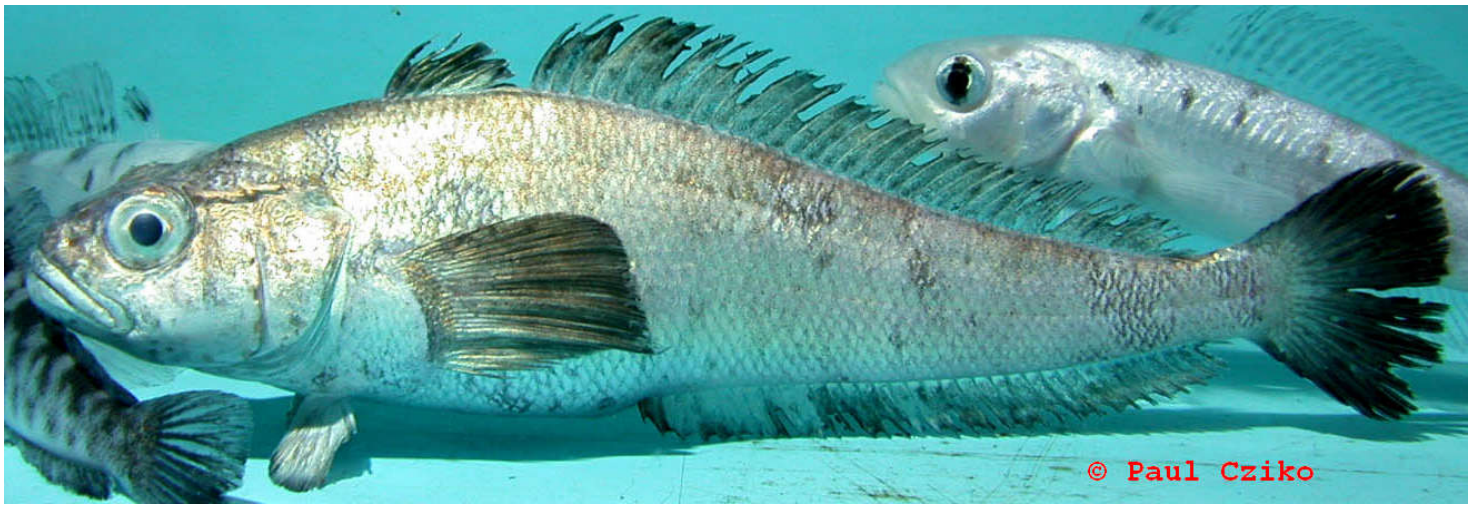
Pagetopsis macropterus has a greyish-green body with a whitish ventral side [3]. *P. macropterus* has fifteen narrow dark cross-bars on the side of its body, with a lighter area in center, and its cheeks have dark stripes [3]. First dorsal and pelvic fins of *P. macropterus* are black; the pelvic fins lack oblique stripes; other fins are pale [3].

Pagetopsis macropterus post-larvae and juveniles feed on krill and fish larvae, and adults feed on fish, such as *Pleuragramma antarctica* and *Notothenia nudifrons* [3].

Pagetopsis macropterus has been often found in the stomachs of Weddell seals [3].

References: 1: Polar Biology 40:2077-2095, 2017; **2:** Polar Biology 42:1131-1145, 2019; **3:** Fishes of the Southern Ocean. O Gon and PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990

Trematomus amphitreta



A female *Trematomus amphitreta* was collected in 20 meters depth at McMurdo Station saltwater intake jetty, at 30.3 centimeters in length [1].

The body of *Trematomus amphitreta* is bronze-colored with silver undertones and iridescence [1].

Taxonomic Note: Genus changed from *Cryothenia* to *Trematomus* [2,3,4].

References: 1: Copeia 2006(4):752-759; **2:** Molecular Phylogenetics and Evolution 47:832-840, 2008; **3:** Molecular Genetics and Evolution 65:87-101, 2012; **4:** Molecular Phylogenetics and Evolution 65:87-101, 2012

Bald notothen or bald rockcod *Trematomus borchgrevinki*

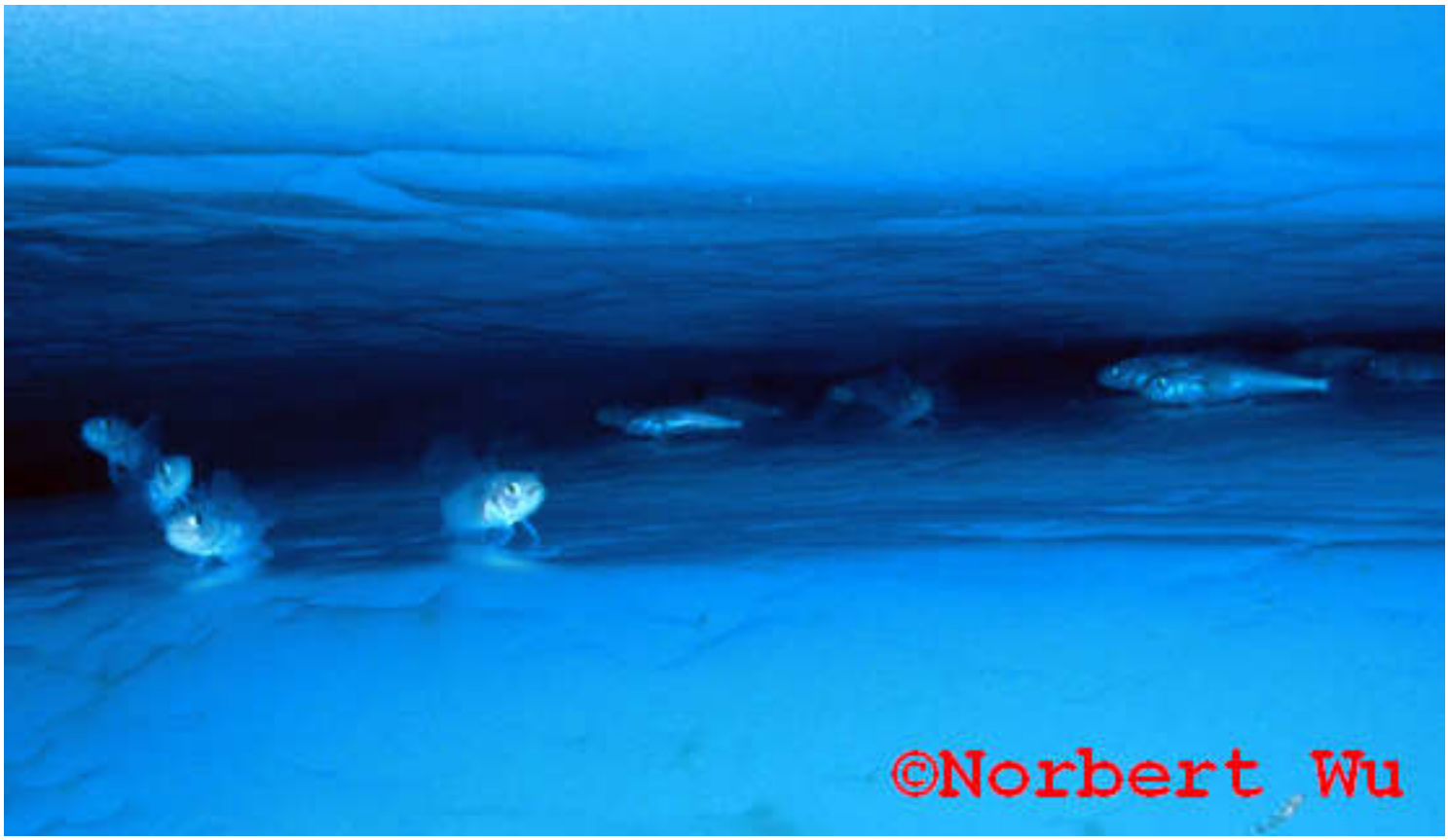
Trematomus borchgrevinki is found throughout Antarctica, the Antarctic Peninsula, South Orkney Islands, and South Shetland Islands from 0 to 695 meters depth [8,11,13]. *T. borchgrevinki* is a commonly seen fish associated with the sea ice along the Antarctic shore and has been observed clinging to the underside of thick ice shelves [8,16]. *T. borchgrevinki* can grow up to 28 centimeters in length [8].

Trematomus borchgrevinki collected under the sea ice are pale all over in coloration while those collected in association with the bottom are a dark phase with a dark olive-brown spotted pattern above and silver-white below [9]. Color has also been recorded as yellowish with dark spots or irregular crossbars and dorsal and caudal fins with a series of spots but caudal fin without transverse bands [11].

Trematomus borchgrevinki lives in the upper six meters of water swimming beneath the sea ice undersurface and entering it to feed and take refuge where it is well-camouflaged by special adaptations in its body coloration. A silvery protective layer beneath the skin masks dark-colored internal organs (i.e. liver) from appearing on its lightly colored body; the iris and choroid of the eye are similarly masked to avoid their brown or black color [3,6].

The undersurface of sea ice is a feeding and refuge site for many organisms with a profusion of amphipods, euphausiids, and fish including *Trematomus borchgrevinki*. *T. borchgrevinki* is well adapted as a hunter; its lateral line sensory system can detect prey by recognizing the low vibration frequencies emitted by swimming crustaceans like *Pseudorchomene plebs*, *Euphausia crystallorophias*, and *Euchaeta antarctica* [17]. *T. borchgrevinki* eats the free-swimming shelled pteropod mollusc *Limacina rangii*, ice krill *Euphausia crystallorophias*, copepods (including the calanoid copepod *Euchaeta antarctica*), decapod crustacean larvae, chaetognaths, amphipods (including the medusa-hitchhiking hyperiid amphipod *Hyperiella dilatata*, *Pseudorchomene plebs* and *Epimiriella macronyx*), and juvenile fish (including *Pleuragramma antarctica*, a key species in the food web) [2,3,6,10,11,12].

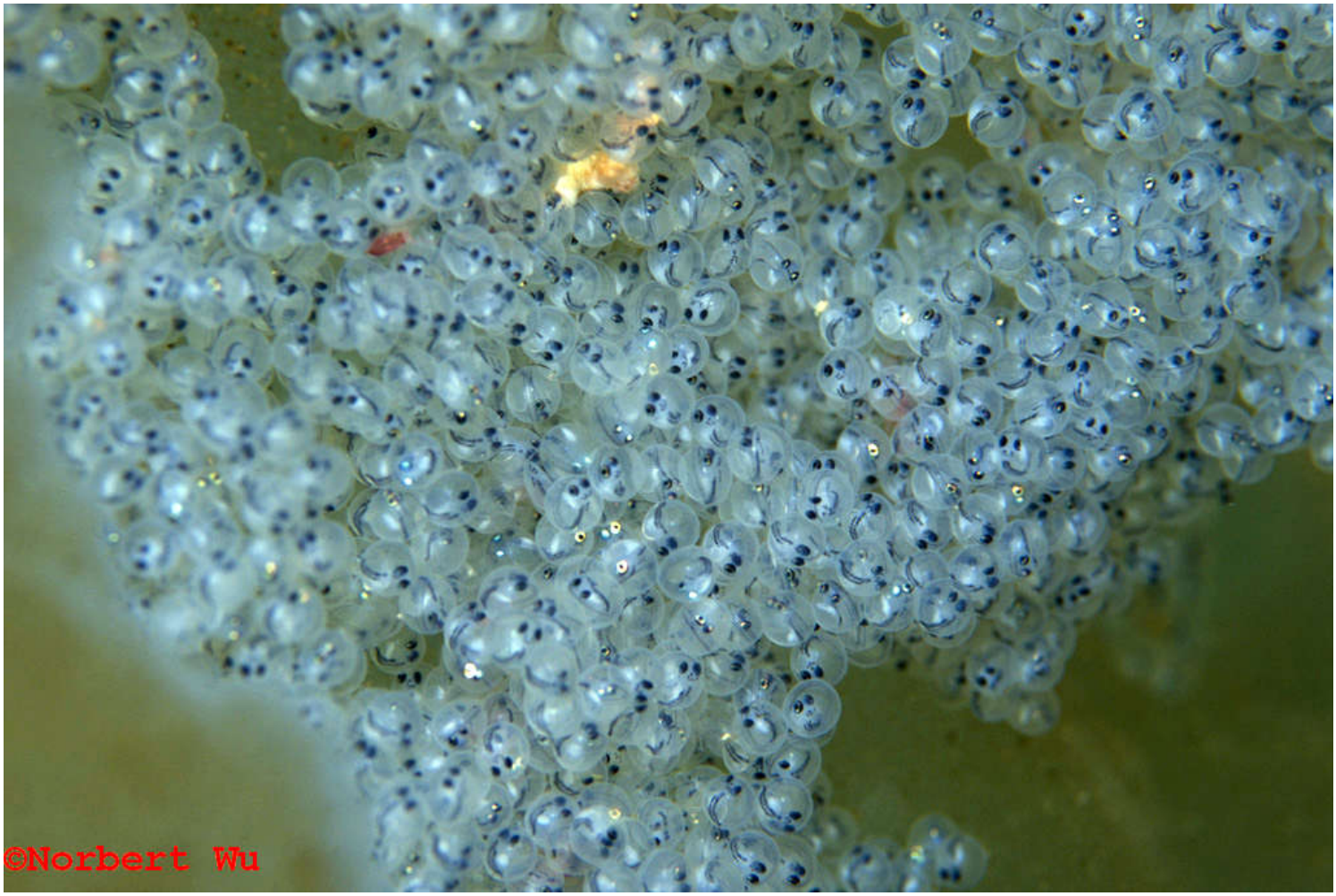
Trematomus borchgrevinki is eaten by emperor penguins and other predators [4].



Here *Trematomus borchgrevinki* is seen in a crack on a grounded iceberg just south of Cape Evans on Ross Island. Termed cryopelagic for its lifestyle preference, *T. borchgrevinki* is ideally suited for its close association with sea ice. Living in such close association with sea ice crystals is a physiological challenge; you couldn't pick a colder place to live and risk freezing. *Trematomus borchgrevinki*, *Pleuragramma antarctica* and *Pagothenia brachysoma* are among the most southern fish [11].

Antarctic fish like *T. borchgrevinki* are well-adapted to the extremely low and stable temperatures of McMurdo Sound where seawater has a nearly constant mean annual temperature of -1.86 degrees Celsius (28.65 degrees Fahrenheit) and temperature doesn't vary much with depth or season -- 0.2 degrees Celsius (0.36 degrees Fahrenheit) [5]. The flip side is that *T. borchgrevinki* and some other cold-adapted Antarctic fish die of heat at approximately 6 degrees Celsius (42.8 degrees Fahrenheit) which is the lowest known heat death temperature of any animal [7].

Trematomus borchgrevinki is protected from freezing by glycopeptide antifreeze compounds in its body fluids, that bind to emerging ice crystals and prevent their growth [1,15]. These antifreeze compounds are being commercially marketed for product development [14].



Trematomus borchgrevinki eggs located in a hole in a grounded iceberg south of Cape Evans being protected by a parent fish.

The species name *borchgrevinki* honors Carsten Egeberg Borchgrevink, the Norwegian commander of the British Southern Cross Antarctic Expedition of 1898-1900 which established the first wintering-over base on the Antarctic continent, and which first collected this fish.

Taxonomic Note: Genus was changed from *Pagothenia* to *Trematomus* [18,19,20].

References: 1: Science 172:1152-1155, 1971; **2:** Antarctic Fish Biology. JT Eastman. San Diego: Academic Press, 1993; **3:** Polar Biology 4:155-160, 1985; **4:** The Penguins, Spheniscidae. TD Williams. Oxford: Oxford University Press, 1995. pp.152- 160; **5:** Antarctic Research Series 5, Biology of the Antarctic Seas II. GA Llano, ed. Washington DC: American Geophysical Union, pp1-37; **6:** Polar Biology 4:45- 52, 1985; **7:** Science 156(3772):257-258, 1967; **8:** Fishes of the Southern Ocean. O Gon and PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **9:** Hydrobiologia 165:161- 167, 1988; **10:** Polar Biology 8:41-48, 1987; **11:** FAO Species Identification Sheets for Fishery Purposes: Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area). W Fischer & JC Hureau, eds. Rome: Food and Agriculture Organization of the United Nations, 1985; **12:** Polar Biology 8(1):49-54, 1987; **13:** Tethys 6(3):631-653, 1974; **14:** www.afprotein.com; **15:** Water and Life: Comparative Analysis of Water Relationships at the Organismic, Cellular, and Molecular Levels. GN Somero, CB Osmond, CL Bolis, eds. New York: Springer-Verlag, 1992. pp. 301-315; **16:** Polar Biology 25(4):320-322, 2002; **17:** Science 235(4785):195-196, 1987; **18:** Molecular Genetics and Evolution 65:87-101, 2012; **19:** Marine Genomics 8:49-58, 2012; **20:** Molecular Phylogenetics and Evolution 47:832-840, 2008

Emerald notothen or emerald rockcod *Trematomus bernacchii*

Trematomus bernacchii is found throughout Antarctica, the Antarctic Peninsula, South Shetland Islands, South Orkney Islands and Peter I Island, from the shore to 695 meters depth [8,13]. *T. bernacchii* is commonly found within the first 200 meters of depth, but it can be found down to 700 meters [1].

Trematomus bernacchii has been observed taking refuge within volcano sponges with their heads sticking out [2].

Trematomus bernacchii has two morphs, with or without a white blotch spreading out on the nape, behind the eyes, and before the pectoral fins [11,12].

Trematomus bernacchii has black or dark brown blotches over a pale brown or pink-brown body that is darker dorsally; its dorsal and anal fins are uniformly light brown [8]. The pectoral fins of *T. bernacchii* are dark with numerous light spots and it has three green spots on the upper part of the pectoral fin base [8].

In deeper water, *Trematomus bernacchii* can be less pigmented and more pinkish-brown in coloration as shown here [9].

Trematomus bernacchii females can be up to 35 centimeters long, and males up to 28 centimeters long; females live up to 21 years, and males up to 16 years [1,19].

Trematomus bernacchii lives on the seafloor (benthic) and is primarily a benthic feeder, eating sedentary and moving prey, by ambush or hunt- and-peck feeding [1,2,3,4,7,8,10,14].

Trematomus bernacchii has a varied diet: algae; testate amoeba *Gromia*; crustaceans (including euphausiid krill, mysids, copepods, pycnogonids, tanaids, cumaceans, ostracods, isopods, amphipods, shrimp); nemerteans; sipunculids; priapulids; nematodes; oligochaetes; pterobranchs; polychaetes; hydroids; soft coral (including *Clavularia*); medusae; anemone *Edwardsia meridionalis*; echinoderms (holothurians, brittle stars, sea urchin *Sterechinus neumayeri*); bivalves; gastropods; tunicates; thaliaceans; fish; and fish eggs [1,2,3,4,7,8,10,14,16,17,18,19,23].

Spawning takes place in December-January in McMurdo Sound and in October-November in other reported areas [1]. *Trematomus bernacchii* deposits its eggs on the seafloor (demersal) or within rossellid volcano sponges; parental guarding of the egg mass within volcano sponges has been observed [2]. Hatching may occur towards the end of summer or early autumn [1].

Antarctic fish like *Trematomus bernacchii* are well-adapted to the extremely low and stable temperatures of McMurdo Sound where seawater has a nearly constant mean annual temperature of -1.86 degrees Celsius (28.65 degrees Fahrenheit) and temperature doesn't vary much with depth or season -- 0.2 degrees Celsius (0.36 degrees Fahrenheit) [5].

The flip side is that *Trematomus bernacchii* and some other cold-adapted Antarctic fish die of heat at approximately 6 degrees Celsius (42.8 degrees Fahrenheit) which is the lowest known heat death temperature of any animal [6]. This freezing resistance is accomplished with special antifreeze glycopeptides in its body fluids, that bind to emerging ice crystals and prevent their growth; these antifreeze compounds are being commercially marketed for product development [15,20].

The species name *bernacchii* honors L.O. Bernacchi, an Australian physicist-meteorologist who collected on the Southern Cross Expedition and who also served on Scott's 1901 expedition.

Taxonomic Note: In 1982, Balushkin split the *Trematomus* species into two genera, *Trematomus* and *Pseudotrematomus*, with the species *T. newnesi* retained in *Trematomus*, and all other species placed in *Pseudotrematomus* [22]. Balushkin based division on pectoral fin morphology [22]. The *bernacchii* species was later placed in *Pagothenia* based on morphological characters; however molecular studies don't support this so it reverted to its older genus *Trematomus* [21,24].

References: 1: Fishes of the Southern Ocean. O Gon and PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **2:** Copeia 1980(1):171-173; **3:** Polar Biology 4:155-160, 1985; **4:** Polar Biology 13(6):429-431, 1993; **5:** Antarctic Research Series 5, Biology of the Antarctic Seas II. GA Llano, ed. Washington DC: American Geophysical Union, pp1-37; **6:** Science 156:257-258, 1967; **7:** Antarctic Science 6(1):61-65, 1994; **8:** FAO Species Identification Sheets for Fishery Purposes: Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area) / W Fischer & JC Hureau, eds. Rome : Food and Agriculture Organization of the United Nations, 1985; **9:** Art De Vries, personal communication, 1998; **10:** Bulletin de l'Institut Oceanographique 66(1368), 1966; **11:** Biochemical Systematics and Ecology 20(3):233-241, 1992; **12:** Antarctic Science 9(4):381-385, 1997; **13:** Tethys 6(3):631-653, 1974; **14:** Antarctic Science 12(1):64-68, 2000;**15:** www.afprotein.com; **16:** Ophelia 24(3):155- 175, 1985; **17:** Polar Biology 13:291-296, 1993; **18:** Ross Sea Ecology: Italiantartide Expeditions (1987-1995). FM Faranda, L Guglielmo, A Ianora, eds. Berlin: Springer, 2000. pp. 551-561; **19:** Ross Sea Ecology: Italiantartide Expeditions (1987-1995). FM Faranda, L Guglielmo, A Ianora, eds. Berlin: Springer, 2000. pp. 457-468; **20:** Water and Life: Comparative Analysis of Water Relationships at the Organismic, Cellular, and Molecular Levels. GN Somero, CB Osmond, CL Bolis, eds. New York: Springer-Verlag, 1992. pp. 301-315; **21:** Molecular Genetics and Evolution 65:87-101, 2012; **22:** Biologiia Shel'fovykh zon Mirovogo Okeana : tezisy dokladov Vtoroi vsesoiuznoi konferentsii po morskoi biologii, Vladivostok, sentiabr' 1982 g. AI Kafanov & TS Veniaminson, eds. Vladivostok: DVNTS AN SSSR, 1982. Volume 2, pp. 9-10; **23:** Polar Biology 27(11):721-728, 2004; **24:** Copeia 4:819-833, 1962

Striped notothen / striped rockcod / green rockcod *Trematomus hansoni*

Trematomus hansoni is found throughout Antarctica, the Antarctic Peninsula, South Shetland Islands, South Orkney Islands, and South Georgia Island, at depths from 0 to 640 meters [1,3,6,8,12]. *T. hansoni* is colored greenish-grey with large black crossbars; its head is bluish mauve at the lower part [6]. The dorsal and anal fins of *T. hansoni* have greyish-green rays and black membrane and the caudal fin has dark transverse narrow bands with a clear membrane [6]. The pectoral fins of *T. hansoni* have light and grey bands with a dark membrane between the four last rays; its pelvic fins are punctuated with black spots on the rays [6]. *T. hansoni* can reach 45.5 centimeters in length [1,6,13,17].

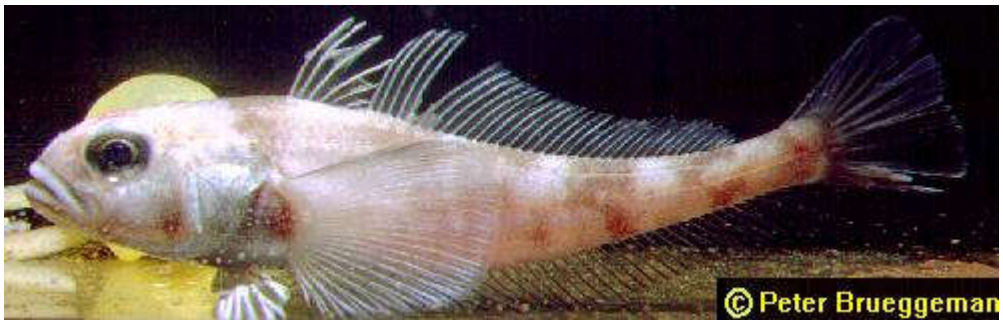
Depending on location, *Trematomus hansoni* becomes sexually mature and spawns in December - February; eggs probably hatch in winter [1,6,12,13]. Antarctic fish like *Trematomus hansoni* are well-adapted to the extremely low and stable temperatures of McMurdo Sound where seawater has a nearly constant mean annual temperature of - 1.86 degrees Celsius (28.65 degrees Fahrenheit) and temperature doesn't vary much with depth or season -- 0.2 degrees Celsius (0.36 degrees Fahrenheit) [5]. The flip side is that *T. hansoni* and some other cold- adapted Antarctic fish die of heat at approximately 6 degrees Celsius (42.8 degrees Fahrenheit) which is the lowest known heat death temperature of any animal [4]. This freezing resistance is accomplished with special antifreeze glycopeptides in its body fluids, that bind to emerging ice crystals and prevent their growth; these antifreeze compounds are being commercially marketed for product development [9,14].

Trematomus hansoni eats juvenile fish, fish eggs, algae, polychaetes (including *Harmothoe spinosa*, *Haploscoloplos kerguelensis*, *Spiophanes tcherniai*, *Gyptis* sp., *Capitella* sp.), krill, mysids, isopods (including *Austrosignum glaciale*, *Antarcturus* sp.), amphipods (including *Monoculodes scabriculosus*, *Heterophoxus videns*, *Hyperiella* sp.), tanaid *Nototanais dimorphus*, shrimp (*Chorismus antarcticus*, *Notocrangon antarcticus*), copepods, nemerteans, crinoids, holothurians, anemones (including *Edwardsia meridionalis*), medusae, pycnogonids, pterobranchs, and gastropods (including *Neobuccinum eatoni*, *Marseniopsis mollis*) [1,3,6,7,10,11,12,13]. *T. hansoni* tends to take more prey from the water column than other primarily benthic feeding fish like *T. pennelli* or *T. bernacchii* [2].

The species name *hansoni* honors Nicolai Hanson, the biologist of the Southern Cross Expedition.

Taxonomic Note: Sometimes reported with the genus *Pagothenia*. In 1982, Balushkin split the *Trematomus* species into two genera, *Trematomus* and *Pseudotrematomus*, with the species *T. newnesi* retained in *Trematomus*, and all other species placed in *Pseudotrematomus* [16]. Balushkin based division on pectoral fin morphology [16]. Molecular studies don't support this division, so all species are in the older name *Trematomus* [15].

References: 1: Fishes of the Southern Ocean. O Gon and PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **2:** Polar Biology 13(6):429-431, 1993; **3:** Polar Biology 17(1):62-68, 1997; **4:** Science 156:257-258, 1967; **5:** Antarctic Research Series 5, Biology of the Antarctic Seas II. GA Llano, ed. Washington DC : American Geophysical Union, pp.1-37; **6:** FAO Species Identification Sheets for Fishery Purposes : Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area) / W Fischer & JC Hureau, eds. Rome : Food and Agriculture Organization of the United Nations, 1985; **7:** Bulletin de l'Institut Oceanographique 66(1368), 1966; **8:** Tethys 6(3):631-653, 1974; **9:** www.afprotein.com; **10:** Ophelia 24(3):155-175, 1985; **11:** Ross Sea Ecology : Italiantartide Expeditions (1987-1995). FM Faranda, L Guglielmo, A Ianora, eds. Berlin: Springer, 2000. pp. 551-561; **12:** Antarctic Ecosystems: Models for Wider Ecological Understanding. W Davison, C Howard-Williams, P Broady, eds. Christchurch, NZ: New Zealand Natural Sciences, 2000. pp. 96-100; **13:** Ross Sea Ecology: Italiantartide Expeditions (1987-1995). FM Faranda, L Guglielmo, A Ianora, eds. Berlin: Springer, 2000. pp. 457-468; **14:** Water and Life: Comparative Analysis of Water Relationships at the Organismic, Cellular, and Molecular Levels. GN Somero, CB Osmond, CL Bolis, eds. New York: Springer-Verlag, 1992. pp. 301-315; **15:** Molecular Genetics and Evolution 65:87-101, 2012; **16:** Biologiia Shel'fovykh zon Mirovogo Okeana : tezisy dokladov Vtoroi vsesoiuznoi konferentsii po morskoi biologii, Vladivostok, sentiabr' 1982 g. AI Kafanov & TS Veniaminson, eds. Vladivostok: DVNTS AN SSSR, 1982. Volume 2, pp. 9-10; **17:** Polar Biology 42:1131-1145, 2019



deepwater notothen or scaly rockcod *Trematomus loennbergii*

Trematomus loennbergii is found throughout Antarctica and the Antarctic Peninsula at depths from 0 to 1,191 meters [1,2,3,4,12]. *T. loennbergii* is light brown or reddish and has four to five irregular crossbars from back to below mid-side [1,3,12].

Trematomus loennbergii can be up to 33 centimeters long, and is common up to twenty centimeters [1,3,7,12].

Trematomus loennbergii often leaves the bottom in order to feed on prey in the water column [1]. *T. loennbergii* feeds on algae, amphipods (including *Pseudorchomene plebs*, *Epimeria* spp., and *Eusirus perdentatus*), isopods, shrimp (*Chorismus antarcticus*, *Notocrangon antarcticus*), polychaetes (including *Barrukia cristata*), fish, and fish eggs [1,5,6,7].

Taxonomic Note: In 1982, Balushkin split the *Trematomus* species into two genera, *Trematomus* and *Pseudotrematomus*, with the species *T. newnesi* retained in *Trematomus*, and all other species placed in *Pseudotrematomus* [9]. Balushkin based division on pectoral fin morphology [9]. Molecular studies don't support this division, so all species are in the older name *Trematomus* [8].

References: 1: Fishes of the Southern Ocean. O Gon & PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **2:** Antarctic Science 11(3):293-304, 1999; **3:** FAO Species Identification Sheets for Fishery Purposes: Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area). W Fischer & JC Hureau, eds. Rome: Food and Agriculture Organization of the United Nations, 1985; **4:** Tethys 6(3):631-653, 1974; **5:** Polar Biology 17(1):62-68, 1997; **6:** Ross Sea Ecology: Italiantartide Expeditions (1987- 1995). FM Faranda, L Guglielmo, A Ianora, eds. Berlin: Springer, 2000. pp. 551- 561; **7:** Ross Sea Ecology: Italiantartide Expeditions (1987-1995). FM Faranda, L Guglielmo, A Ianora, eds. Berlin: Springer, 2000. pp. 457-468; **8:** Molecular Genetics and Evolution 65:87-101, 2012; **9:** Biologiia Shel'fovykh zon Mirovogo Okeana : tezisy dokladov Vtoroi vsesoiuznoi konferentsii po morskoi biologii, Vladivostok, sentiabr' 1982 g. AI Kafanov & TS Veniaminson, eds. Vladivostok: DVNTS AN SSSR, 1982. Volume 2, pp. 9-10; **10:** Fishes of the Ross Sea Region – A field guide to common species caught in the longline fishery. P.J. McMillan et al. New Zealand Aquatic Environment and Biodiversity Report No. 134. New Zealand Ministry for Primary Industries, 2015 https://www.ccamlr.org/en/document/publications/fishes-ross-sea-region-%E2%80%93-field-guide-common-species-caught-longline-fishery

Dusky notothen *Trematomus newnesi*

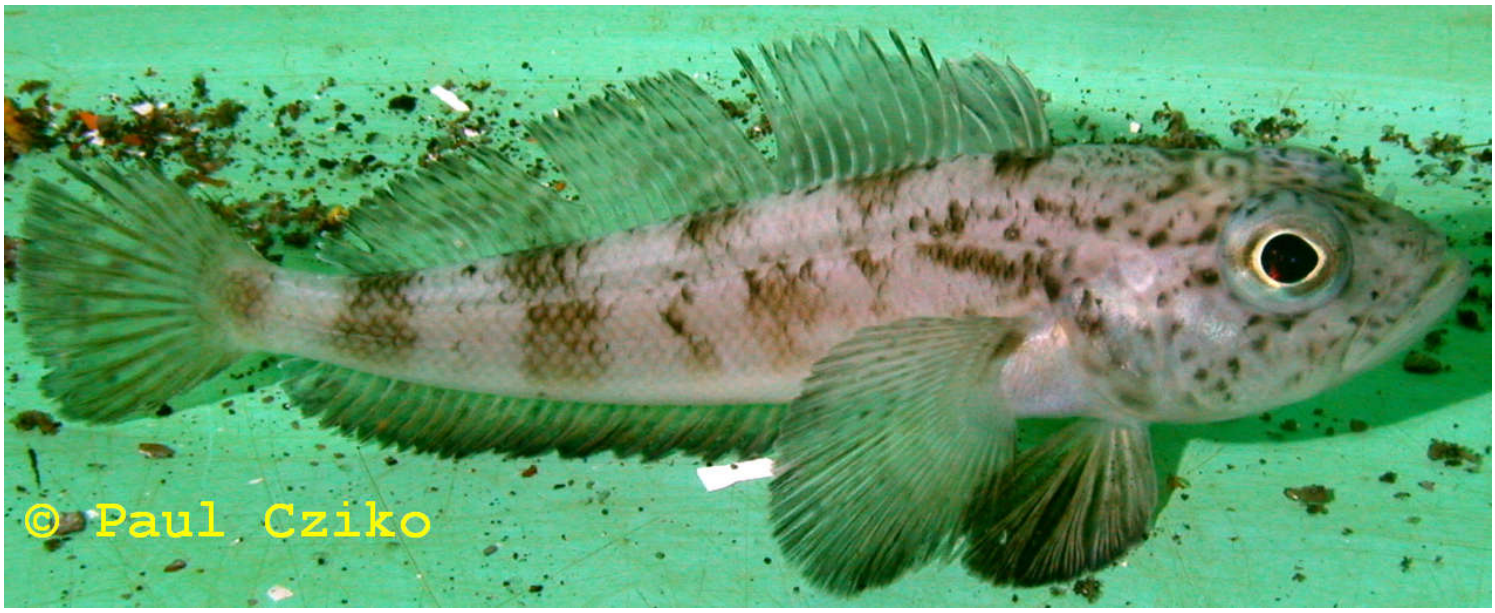
Trematomus newnesi is found in Antarctica, the Antarctic Peninsula, South Shetland Islands, and South Orkney Islands, at depths from 0 to 400 meters [1,4].

Trematomus newnesi is up to 24.9 centimeters in length [3]. The body and head of *T. newnesi* is brown to almost blackish, and paler below, with a blueish-black belly [4]. Some specimens of *T. newnesi* can have a pale horizontal line extending the scales of the middle lateral line [4]. The first dorsal fin of *T. newnesi* is dusky to blackish [4].

Trematomus newnesi is a benthic and midwater feeder, and feeds on euphausiids, amphipods, polychaetes, copepods, gastropods, isopods [4]. Predators of *Trematomus newnesi* include Weddell seals [2].

References: 1: Polar Biology 40:2077-2095, 2017; **2:** Polar Biology 41(5):1027-1031, 2018; **3:** Polar Biology 42:1131-1145, 2019; **4:** Fishes of the Southern Ocean. O Gon and PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990

Spotted notothen *Trematomus nicolai*



Trematomus nicolai is found in Antarctica and the South Shetland Islands, at depths from 0 to 460 meters [1,5,6]. *T. nicolai* is up to 36 centimeters in length [4]. *T. nicolai* feeds on amphipods, other fish, molluscan larvae, polychaetes and mysids [5].

Taxonomic Note: In 1982, Balushkin split the *Trematomus* species into two genera, *Trematomus* and *Pseudotrematomus*, with the species *T. newnesi* retained in *Trematomus*, and all other species placed in *Pseudotrematomus* [3]. Balushkin based division on pectoral fin morphology [3]. Molecular studies don't support this division, so all species are in the older name *Trematomus* [2].

References: 1: Polar Biology 40:2077-2095, 2017; **2:** Molecular Genetics and Evolution 65:87-101, 2012; **3:** Biologiia Shel'fovykh zon Mirovogo Okeana : tezisy dokladov Vtoroi vsesoiuznoi konferentsii po morskoi biologii, Vladivostok, sentiabr' 1982 g. AI Kafanov & TS Veniaminson, eds. Vladivostok: DVNTS AN SSSR, 1982. Volume 2, pp. 9-10; **4:** Polar Biology 42:1131-1145, 2019; **5:** Fishes of the Southern Ocean. O Gon & PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **6:** Acta Zoologica Bulgarica 73(1):71-76, 2021

Sharp-spined notothen *Trematomus pennellii*

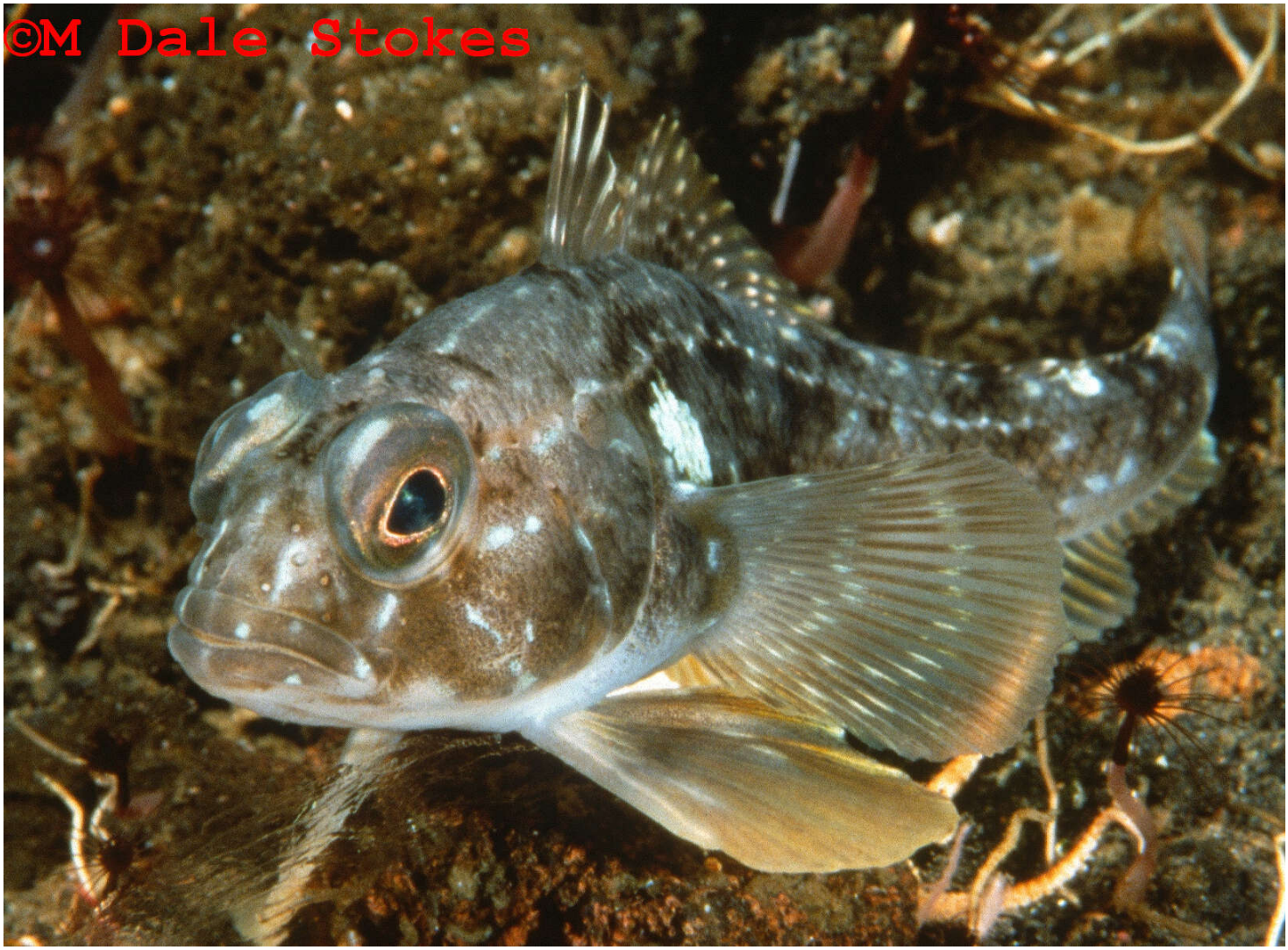
Trematomus pennellii is found in Antarctica, the Antarctic Peninsula, South Shetland Islands, and South Orkney Islands, at depths from the 0 to 732 meters [1].

Trematomus pennellii has distinctive white or pale blueish flecks and lines, and grows up to 25.5 centimeters long [1,3,7].

Trematomus pennellii lives on the seafloor (benthic) where it is primarily a benthic feeder eating fish eggs, polychaetes (particularly *Amithas membranifera*, *Barrukia cristata*, *Aglaophamus trissophyllus*, and including *Ophelina gymnopige*, *Scoloplos marginatus*), amphipods, pycnogonids/sea spiders, and molluscs [1,2,3].

Trematomus pennellii spawns in summer [1].

The species name *pennellii* honors Harry LL Pennell, Captain of the ship *Terra Nova* of Scott's British Antarctic Expedition of 1910.


©M Dale Stokes

Taxonomic Note: *T. centronotus* was synomized under *T. pennellii* in 1987 with some disagreement [4]. In 1982, Balushkin split the *Trematomus* species into two genera, *Trematomus* and *Pseudotrematomus*, with the species *T. newnesi* retained in *Trematomus*, and all other species placed in *Pseudotrematomus* [6]. Balushkin based division on pectoral fin morphology [6]. Molecular studies don't support this division, so all species are in the older name *Trematomus* [5].

References: 1: Fishes of the Southern Ocean. O Gon and PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **2:** Polar Biology 13(6):429-431, 1993; **3:** Ross Sea Ecology: Italiantartide Expeditions (1987-1995). FM Faranda, L Guglielmo, A Ianora, eds. Berlin: Springer, 2000. pp. 457-468; **4:** Journal of Ichthyology 27(4):56-62, 1987; **5:** Molecular Genetics and Evolution 65:87-101, 2012; **6:** Biologiia Shel'fovykh zon Mirovogo Okeana : tezisy dokladov Vtoroi vsesoiuznoi konferentsii po morskoi biologii, Vladivostok, sentiabr' 1982 g. AI Kafanov & TS Veniaminson, eds. Vladivostok: DVNTS AN SSSR, 1982. Volume 2, pp. 9-10; **7:** Fishes of the Ross Sea Region – A field guide to common species caught in the longline fishery. P.J. McMillan et al. New Zealand Aquatic Environment and Biodiversity Report No. 134. New Zealand Ministry for Primary Industries, 2015
https://www.ccamlr.org/en/document/publications/fishes-ross-sea-region-%E2%80%93-field-guide-common-species-caught-longline-fishery

DeVries' Paraliparis
Paraliparis devriesi

Paraliparis devriesi has been found in the Ross Sea at 500-900 meters depth, where it lives on the seafloor (epibenthic) [1,2,3,4].

Specimens of *Paraliparis devriesi* have been collected up to nineteen centimeters long [1,3].

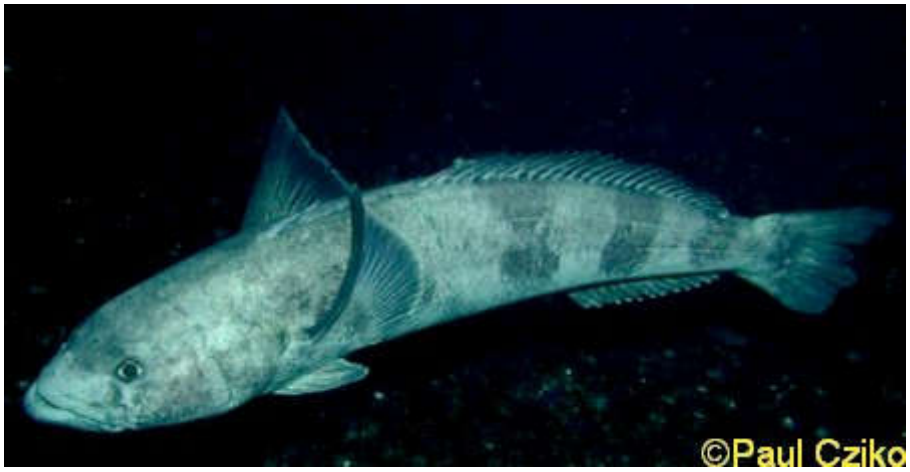
Paraliparis devriesi is pale pink or whitish with translucent skin, with color more intense in the snout and tail, has pale pinkish dorsal and anal fins, a blueish abdomen, and shows a black peritoneum visible through the body wall [3,4].

Spawing of *Paraliparis devriesi* probably occurs in summer [4].

Paraliparis devriesi lacks a swim bladder and maintains its neutral buoyancy through reduced skeletal ossification and a gelatinous subdermal material [2].

There are at least thirteen species of snailfish found in the Ross Sea [5].

References: 1: Review of the Snailfish Genus Paraliparis (Scorpaeniformes, Liparididae) of the Southern Ocean. AP Andriashev. Koenigstein: Koeltz Scientific Books, 1986; **2:** Journal of Morphology 220:85-101, 1994; **3:** Zootaxa 3285:1-120, 2012; **4:** Fishes of the Southern Ocean. O Gon and PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **5:** Fishes of the Ross Sea Region – A field guide to common species caught in the longline fishery. P.J. McMillan et al. New Zealand Aquatic Environment and Biodiversity Report No. 134. New Zealand Ministry for Primary Industries, 2015
https://www.ccamlr.org/en/document/publications/fishes-ross-sea-region-%E2%80%93-field-guide-common-species-caught-longline-fishery



Antarctic toothfish *Dissostichus mawsoni*

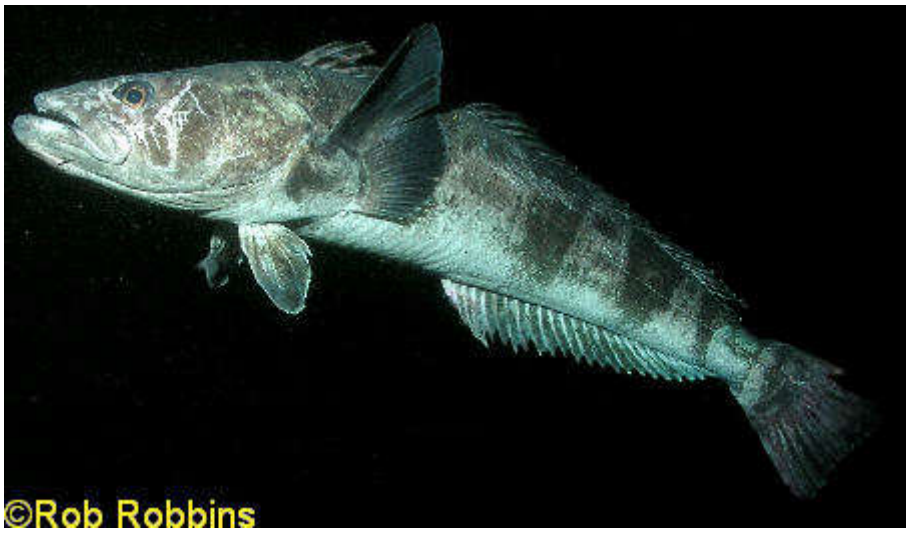
Dissostichus mawsoni is found throughout Antarctica from 12 to 2,210 meters depth [1,2,6]. *D. mawsoni* have been collected up to 210 centimeters long, and up to eighty kilograms in weight [1,2,8]. *D. mawsoni* is usually found near the bottom [2].

Dissostichus mawsoni is an opportunistic feeder, eating zooplankton and other pelagic invertebrates as juveniles, and shifting to various mid- to deep-water fish and squid by their third year [1]. The species of fish and crustaceans found in *D. mawsoni* stomachs in McMurdo Sound indicates that they feed deep and in the open sea, and close under the sea ice [1]. In the Ross Sea region, sub-adult *D. mawsoni* eat benthic fish and cephalopods, and eat more small prey than eaten by adults, including small fish and prawns [5]. One study determined that grenadiers were the most important fish and overall prey [5]. Icefish and eel cods were important fish prey on the continental slope, as well as the squid *Psychroteuthis glacialis* [5].

Prey items of *Dissostichus mawsoni* are diverse and include Macrouridae fish including Whitson's grenadier *Macrourus whitsoni* and rattails *Macrourus* spp., *Chionbathyscus dewitti*, Nototheniidae fish, spotted barracudina *Arctozenus risso*, the rays *Bathyraja maccaini* and *Bathyraja eatonii*, squid, the dragonfishes *Cygnodraco mawsoni* and *Gymnodraco acuticeps*, and sunken penguins and seabirds [7,9].

Predators of *D. mawsoni* include Weddell seals, sperm whales, and orcas [1,2,4].

Dissostichus mawsoni has no swim bladder, and relies on reduced calcification of its skeleton, and lipid production in adipose tissue cells, to maintain neutral buoyancy [2].



Dissostichus mawsoni is greyish in color, sometimes with large darker saddles dorsally, and scattered, irregular darker markings [2]. *D. mawsoni* is sexually mature at eight years of age and one meter in length [2]. A well-regulated and enforced commercial fishing for Antarctic toothfish would factor in their slow growth and long lifespan. Such fish cannot be harvested in great quantities, or it will be pushed towards extinction.

Dissostichus mawsoni is related to the Patagonian toothfish, or Chilean sea bass. Large, unreported catches from illegal fishing of Patagonian toothfish, or Chilean sea bass, has made effective fisheries management difficult, and it is being overfished in some areas [3]. Overfishing of long-lived fish pushes them towards extinction. A fate similar to that of the Patagonian toothfish, or Chilean sea bass, may await the Antarctic toothfish. Effective fisheries management in the remote waters of Antarctica is nearly impossible.

Dissostichus mawsoni is named after Douglas Mawson, the leader of early Australian Antarctic exploration.

References: 1: History and Atlas of the Fishes of the Antarctic Ocean. RG Miller. Carson City, Nev.: Foresta Institute for Ocean and Mountain Studies, 1993; **2:** Fishes of the Southern Ocean. O Gon & PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **3:** Fact Sheet, Joint U.S. Department of Commerce/U.S. Department of State. Washington, DC. March 26, 2002; **4:** Norbert Wu, personal communication, 2001; **5:** Antarctic Science 26(5):502-512, 2014; **6:** Polar Biology 40:2077-2095, 2017; **7:** CCAMLR Science 22:29–44, 2015; **8:** Polar Biology 42:1131-1145, 2019; **9:** Polar Biology 44(3):499-508, 2021

skate *Bathyraja* sp.

This photo was shot in a Crary Lab tank. Several *Bathyraja* species are found in the Ross Sea [7].

One species is Eaton's skate *Bathyraja eatonii*, found in Antarctica, Antarctic Peninsula, South Shetland Islands, South Orkney Islands, Kerguelen Island, and Heard Island, at depths from 15 to 1,100 meters [1,2,4,6]. *B. eatonii* can be over 120 centimeters in length [1,4]. The dorsal surface of *Bathyraja eatonii* is in shades from pale through dark ochre to greyish-brown, with its semi-transparent rostral triangle usually lighter [6]. It may show a patterning of dark and light spots or marbling [6]. *B. eatonii* can be distinguished from *B. maccaini* by the absence of thorns around its eyes [1]. One predator of *B. eatonii* is the sleeper shark *Somniosus* cf. *microcephalus* [3]. A predator on *Bathyraja eatonii* is the Antarctic toothfish *Dissostichus mawsoni* [5].

References: 1: FAO Species Identification Sheets for Fishery Purposes : Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area) / W Fischer & JC Hureau, eds. Rome : Food and Agriculture Organization of the United Nations, 1985; **2:** Antarctic Science 2(2):129-137, 1990; **3:** Deep Sea Research Part I 51:17-31, 2004; **4:** Fisheries Research 186(1):65-81, 2017; **5:** CCAMLR Science 22:29–44, 2015; **6:** Fishes of the Southern Ocean. O Gon & PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **7:** Fishes of the Ross Sea Region – A field guide to common species caught in the longline fishery. P.J. McMillan et al. New Zealand Aquatic Environment and Biodiversity Report No. 134. New Zealand Ministry for Primary Industries, 2015
https://www.ccamlr.org/en/document/publications/fishes-ross-sea-region-%E2%80%93-field-guide-common-species-caught-longline-fishery

Antarctic silverfish *Pleuragramma antarctica*

Pleuragramma antarctica is found in Antarctica, Antarctic Peninsula, South Shetland Islands, and South Orkney Islands, at depths from 0 to 1,000 meters [1,6,9,19,20]. *P. antarctica* is slow-growing with a maximum estimated age of 14 years, and maximum length of 27 centimeters [13,18].

Pleuragramma antarctica has an elongate silvery body, slightly darker on top, with a projecting lower jaw and slightly forked caudal fin; its dorsal, pectoral and caudal fins may be dark or dusky, and its anal and pelvic fins pale [20].

All developmental stages of *Pleuragramma antarctica* live throughout the water column, in both open water and pack ice, in the shelf waters around Antarctica [1,6,9]. An acoustic survey with trawling in the Ross Sea found adult *Pleuragramma antarctica* in layers at 100-400 meters depth, and were sometimes present close to the bottom; a weak layer at about 80 meters depth was associated with juveniles [12]. Spawning occurs in later winter [6].

Pleuragramma antarctica is the most abundant pelagic fish in the Ross Sea and is a keystone species in Antarctic coastal ecosystems [6]. *P. antarctica* is a prey species of Antarctic toothfish *Dissostichus mawsoni*, Weddell seals, Antarctic fur seals, Adelie penguins, flying birds, and most upper-trophic-level predators [2,3,5,7,8,10,11,20]. Along with krill, *P. antarctica* is a key mid-trophic level species in the Ross Sea, connecting primary production by photosynthetic organisms to upper trophic levels [4].

Pleuragramma antarctica eats copepods and euphausiids as main food items, and also eats other planktonic prey (amphipods, cladocerans, mysids, ostracods, polychaetes, siphonophores, thecosomes, chaetognaths) [20].

The unhappy fish in these photos came from the stomach of a freshly caught Antarctic toothfish *Dissostichus mawsoni*.

Taxonomic Note: Boulenger named it *Pleuragramma antarcticum* in 1902 [14]. Boulenger combined the words "pleur" ('side of body') with "agramma" ("absence of line") to create the compound genus name of *Pleuragramma* [15,17]. *Pleuragramma antarctica* lacks a lateral line, as can be seen. Agramma is feminine, and the root word Antarctic is an adjective, so the species names should the feminine *antarctica* and not the neuter *antarticum* [15,16].

References: 1: Polar Biology 40:2077-2095, 2017; **2:** Polar Biology 41(5):1027-1031, 2018; **3:** Marine Ecology Progress Series 601:239-251, 2018; **4:** Marine Ecology Progress Series 584:45-65, 2017; **5:** Polar Biology 40(2):471-475, 2017; **6:** Polar Biology 40(1):199-211, 2017; **7:** PLoS ONE 11(3):e0149090, 2016; **8:** Deep-Sea Research Part II Topical Studies in Oceanography 88(8):23-33, 2013; **9:** Fish and Fisheries 13(3):241-266, 2012; **10:** Annual Review of Marine Science 6:469-487, 2014; **11:** CCAMLR Science 20:21-36, 2013; **12:** Deep-Sea Research Part II Topical Studies in Oceanography 58(1-2):181-195, 2011; **13:** CCAMLR Science 18:75-86, 2011; **14:** Report on the collections of natural history made in the Antarctic regions during the voyage of the "Southern Cross." London: British Museum (Natural History), 1902. p. 187; **15:** Charlton T. Lewis & Charles Short, A Latin Dictionary, www.perseus.tufts.edu/hopper/text?doc=Perseus:text:1999.04.0059 ; **16:** International Code of Zoological Nomenclature, Article 31.2 Species-group Names, Agreement in Gender www.iczn.org/the-code/the-international-code-of-zoological-nomenclature/the-code-online/ ; **17:** Fricke, R., Eschmeyer, W. N. & Van der Laan, R. (eds) 2019. Eschmeyer's Catalog of Fishes: Genera, Species, References. Electronic version accessed 26 May 2019 researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp ; **18:** Polar Biology 42:1131-1145, 2019; **19:** Fishes of the Southern Ocean. O Gon & PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **20:** Polar Biology 42:2045–2054, 2019; **20:** Fishes of the Ross Sea Region – A field guide to common species caught in the longline fishery. P.J. McMillan et al. New Zealand Aquatic Environment and Biodiversity Report No. 134. New Zealand Ministry for Primary Industries, 2015 https://www.ccamlr.org/en/document/publications/fishes-ross-sea-region-%E2%80%93-field-guide-common-species-caught-longline-fishery

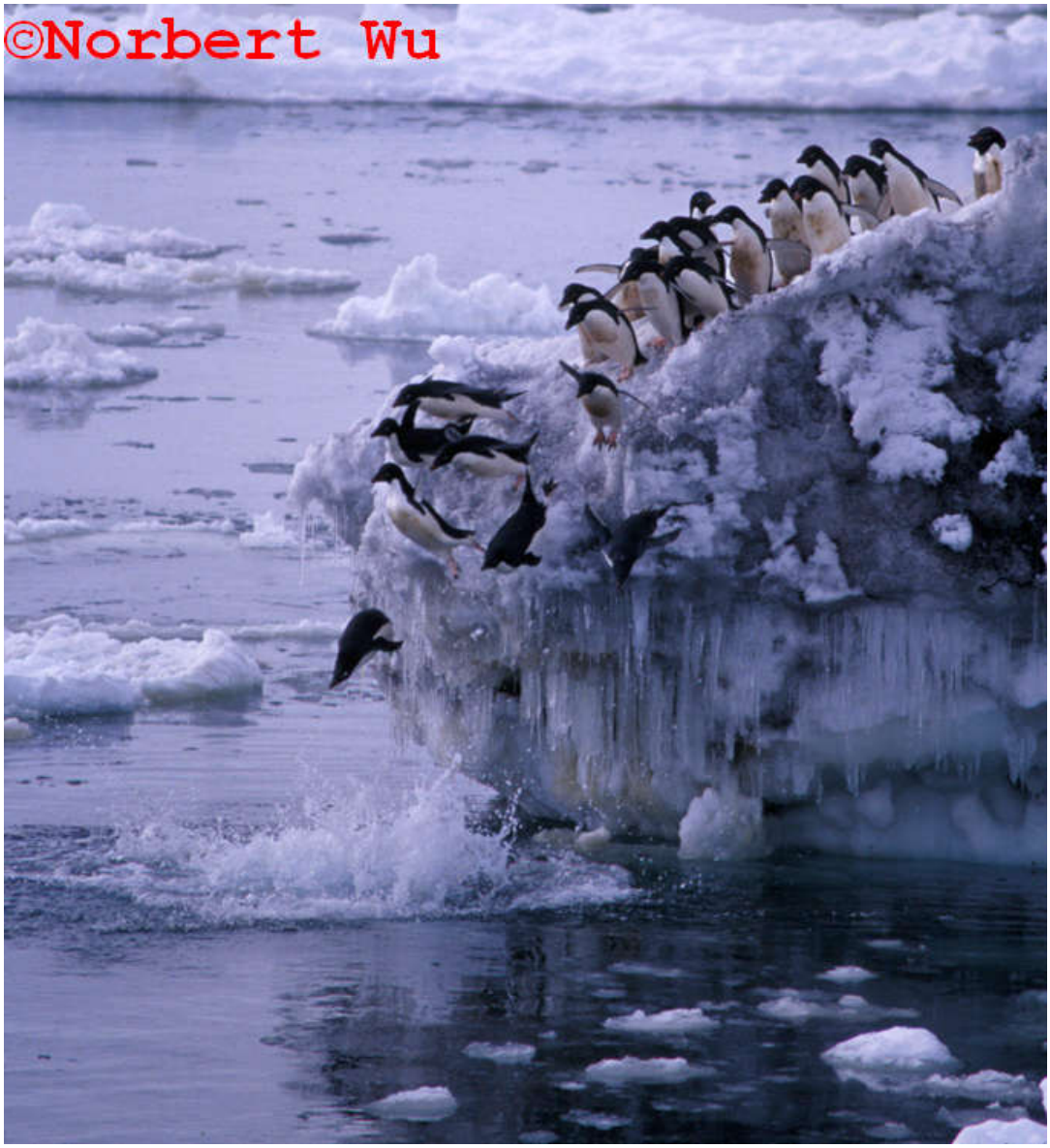
Hagfish, family Myxinidae

Photographed at 30 meters depth in Salmon Bay, this hagfish is burrowing down after a *Laternula ellipitica* clam which is releasing a white cloud of sperm, seen in this photo [1]. This small hagfish resembles the New Zealand slender hagfish *Neomyxine* spp. [1].

Within the Southern Ocean, a single specimen of *Myxine australis* has been collected at the South Shetland Islands, with *M. australis* being more frequent in Tierra del Fuego and the Magellan region of Chile, with a depth range of 10 to 105 meters [2,3]. *M. australis* has been collected farther north in Chile, Argentina, and southern Brazil [4,5]. Other *Myxine* species have been found in the straits of Magellan and further north [5].

References: 1: Antarctic Science 30(4):243-244, 2018; **2:** Fishes of the Southern Ocean. O Gon & PC Heemstra, eds. Grahamstown, South Africa: JLB Smith Institute of Ichthyology, 1990; **3:** PLoS ONE 13(1):e0189930, 2018; **4:** Mare Magnum 1(2):125-127, 2001; **5:** U.S. National Marine Fisheries Service Fishery Bulletin 93(3):530-550, 1995

Adelie penguin *Pygoscelis adeliae*



The Adelie penguin *Pygoscelis adeliae* occurs throughout Antarctica and the subantarctic islands, limited in distribution by shelf ice to the south and pack ice to the north (seldom found in open water).

The Ross Sea area has the largest estimated breeding population at 1 million pairs; the total estimated population is 2,610,000 breeding pairs and 10 million immature penguins.

Breeding colonies are found on rocky islands, peninsulas, beaches and scree slopes wherever ice-free and accessible from the ocean.

Adelie penguins eat mainly euphausids (over 70% of diet) as well as some fish and squid. They catch their prey by diving in pursuit at 10 to 40 meters depth with an average dive duration of 1.4 - 1.9 minutes; they can dive down to a maximum depth of 170 meters. The average swimming speed on an Adelie penguin is 2.2 - 4.6 kilometers per hour.

Adelie penguins return to their breeding colony from September to October with egg laying occurring in October to November. Shallow nests lined with pebbles are built by both parents. Two eggs are laid with peak egg laying from November 10 - 15. Eggs are incubated by alternating parents for 35 days. After egg laying, the female leaves to forage and the male sits on the egg. The egg will be left to die by the male if the female doesn't return from her first foraging trip in time to relieve the male. Peak egg hatching is December 10-15. After hatching, chicks are brooded in the nest for 22 days, guarded by a parent. Then the chicks leave the nest to form small creche groups while awaiting the return of parents from feeding forays.

When possible, skuas will attack and kill Adelie penguin eggs and chicks; 9% of the eggs were lost to predation in 1 year at Cape Bird. At the Cape Bird rookery where these pictures were taken during the egg incubation period, Adelie penguins make long foraging trips averaging 9-25 days in duration and up to 100 kilometers away. During the chick rearing period, they make much shorter trips in duration and distance. Chicks are fed by their parents every 1-2 days until they depart from the colony at 2 months of age. The chicks molt by early February and then leave. 60-70% of the mating pairs retain the same partner each year. Adelie penguins tend to be faithful to a specific nest site; males are 99% faithful to the nest site with females less so. Adelie penguins are most active between 4 am and 10 am. Those in the Ross Sea Area have an annual mortality of 20%. Predation on juvenile Adelie penguins by a Weddell seal has been observed [3].

References: 1: The Penguins, Spheniscidae. TD Williams. Oxford: Oxford University Press, 1995. pp.169-178; **2:** Penguin Biology. LS Davis & JT Darby. San Diego: Academic Press, 1990; **3:** Polar Biology 42(8):1621–1624, 2019

Emperor penguin *Aptenodytes forsteri*

The emperor penguin *Aptenodytes forsteri* is found throughout Antarctica within the limits of pack ice. Emperor penguins walk right up to the human visitor and trumpet their arrival. Their calls are used to recognize each other and form pairs for mating. An estimated 400,000 - 450,000 individual emperor penguins with 195,400 breeding pairs populate Antarctica; the Ross Sea area has half the total population of emperor penguins.

Emperor penguins mainly eat nototheniid fish, squid, and euphausid and amphipod crustaceans which they pursue to capture, diving down to 500 meters for a usual duration of twelve minutes. Emperor penguins can dive to almost 600 meters and stay underwater for twenty minutes on a shallow dive. Emperor penguins swim 2.4 - 3.4 meters per second during foraging (5.4 - 7.6 miles per hour) and have been measured at maximum speeds of 4.6 - 7.1 meters per second (10.3 - 15.9 miles per hour). A single foraging trip may involve travel up to 150 - 1,000 kilometers with travel speeds ranging from 1.5 - 2.5 kilometers per hour.

Emperor penguins breed on level, stable sea ice with only two colonies known on land. Cape Washington has a large breeding population of 20 - 25,000 pairs. Before breeding, males weigh more than females ranging from 35 - 40 kilograms and 28 - 32 kilograms respectively. Emperor penguins return to their breeding colonies in March through early April, oftentimes walking 50 - 120 kilometers over sea ice to get there. A single, large egg is laid in May through early June. Emperor penguin egg laying, incubation, and chick rearing takes place in the Antarctic winter; other penguin species do this in the Antarctic summer. Emperor penguins are very colonial, are not territorial, and are monogamous within that breeding season (but only 15% of the mating pairs retain the same partner the following year).

Male emperor penguins are responsible for egg incubation and they huddle closely in large groups for warmth during the two months of egg incubation. During their breeding fast, emperor penguin weight decreases by 35 - 40% in males and 20 - 25% in females; the males lose more weight since they incubate the egg. After egg hatching, both parents alternate chick brooding for its fifty-day period; one goes off to feed while the other. Chicks then form large creches until they depart from the colony in December through early January. When left alone while its parents are out feeding, the emperor penguin chick regularly calls for its parents who use that call to locate their chick.

Review: The Penguins, Spheniscidae. TD Williams. Oxford: Oxford University Press, 1995. pp.152-160; **Diving Physiology:** American Scientist 85: 530-539, 1997; **Swimming Speed:** Journal of Experimental Biology 165:161-180, 1992

Weddell seal *Leptonychotes weddellii*

The Weddell seal *Leptonychotes weddellii* commonly occurs on fast ice and nearshore pack ice along the Antarctic coast and Peninsula and in small populations in the South Shetland Islands, South Orkney Islands, and South Georgia Island [7,8,9,10]. Wandering Weddell seals have been sighted in the Falkland Islands, Argentina, Uruguay, Chile, Juan Fernandez Islands, Bouvet Island, Marion Island, Kerguelen Island, Heard Island, Macquarie Island, Auckland Islands, New Zealand, and southern Australia, [7,8,9,10].

The McMurdo diver will see them around sea ice cracks. The Weddell seal can be over three meters in length and 400 - 450 kilograms in weight. Its population is estimated at 800,000 individuals. Weddell seals move around the sea ice, are not gregarious, and are spaced apart when seen hauled out on the sea ice. Weddell seals are commonly found at 8 - 12 years of age with individuals 18 and 22 years old noted in the literature.

Half or more of the Weddell seal diet is fish (*Dissostichus mawsoni*, *Notothenia*, *Trematomus*, *Gymnodraco* including *G. acuticeps*, *Pleuragramma antarctica*, *Cryodraco antarcticus*, *Pagetopsis macropterus*) with the rest being cephalopods (squid and *Pareledone* octopus), krill, mysids, isopods, amphipods, and decapods [3,4]. Weddell seals hunt fish in the slushy platelet ice on the underside of the sea ice ceiling, by blowing out air to flush fish from their refuge; they hunt the Antarctic cod *Dissostichus mawsoni* in midwater by silhouetting it against the sea ice ceiling while remaining hidden from sight [12]. Predation on juvenile Adelie penguins by a Weddell seal has been observed [13].

Due to the Weddell seal's preference for fast sea ice, the impact of predators such as leopard seals upon the Weddell seal population is minimal.

The Weddell seal dives beneath stable contiguous sea ice and can store a large amount of oxygen in their bodies mostly in their blood and muscles. This enables them to stay underwater for a usual dive to 300-400 meters for fifteen minutes [5]. Weddell seals have been observed staying underwater for 82 minutes and diving down to 700 meters [5].

Weddell seals glide a lot in deep dives rather than swim continuously [2]. The lungs of the Weddell seal collapse during a dive from water pressure thus decreasing the seal's buoyancy on descent [2]. The Weddell seals' limited oxygen storage is thus conserved by taking advantage of this physical change during a deep dive and reducing the amount of swimming during deep dives looking for fish [2]. After several dives, they can be observed coughing up a foamy white lung surfactant [6]. Their underwater swimming speed is estimated at 4- 7 knots [5].

The Weddell seal keeps breathing and entry/exit ice holes open year-round using its teeth.

Shown here at Granite Harbor are Weddell seals and a hole along a sea ice crack that is being kept open by Weddell seals, for their use getting in and out of the water, as well as breathing while in the water.

The inner edges of the ice crack would ordinarily run straight, but the Weddell seals round out holes in the crack using their teeth.

The strong upper teeth of the Weddell seal project forward and are dragged from side to side on the edge of an ice hole to keep it open. These teeth may be critical to survival. As the seal ages and its teeth wear down, the seals may lose their ability to maintain breathing holes and die at an earlier age than other seals.

Weddell seals are restless when breathing at a hole when other seals are nearby. They peer down and if a hole fits only one seal, the seal will either dive as another seal comes up or reverse and face down to prevent the intruding seal from surfacing. Weddell seals adopt a head-down fighting posture with eyes looking forward, foreflippers extended and sometimes their jaw open. If a hole is large enough for two seals and the breathing seal refuses to leave, the arriving seal may surface with a fight usually ensuing.

It has been suggested that a Weddell seal does not defend an area to the complete exclusion of other seals but to the discouragement of other seals. An intruding seal may be physiologically forced to take a breath which would override territorial aggression.

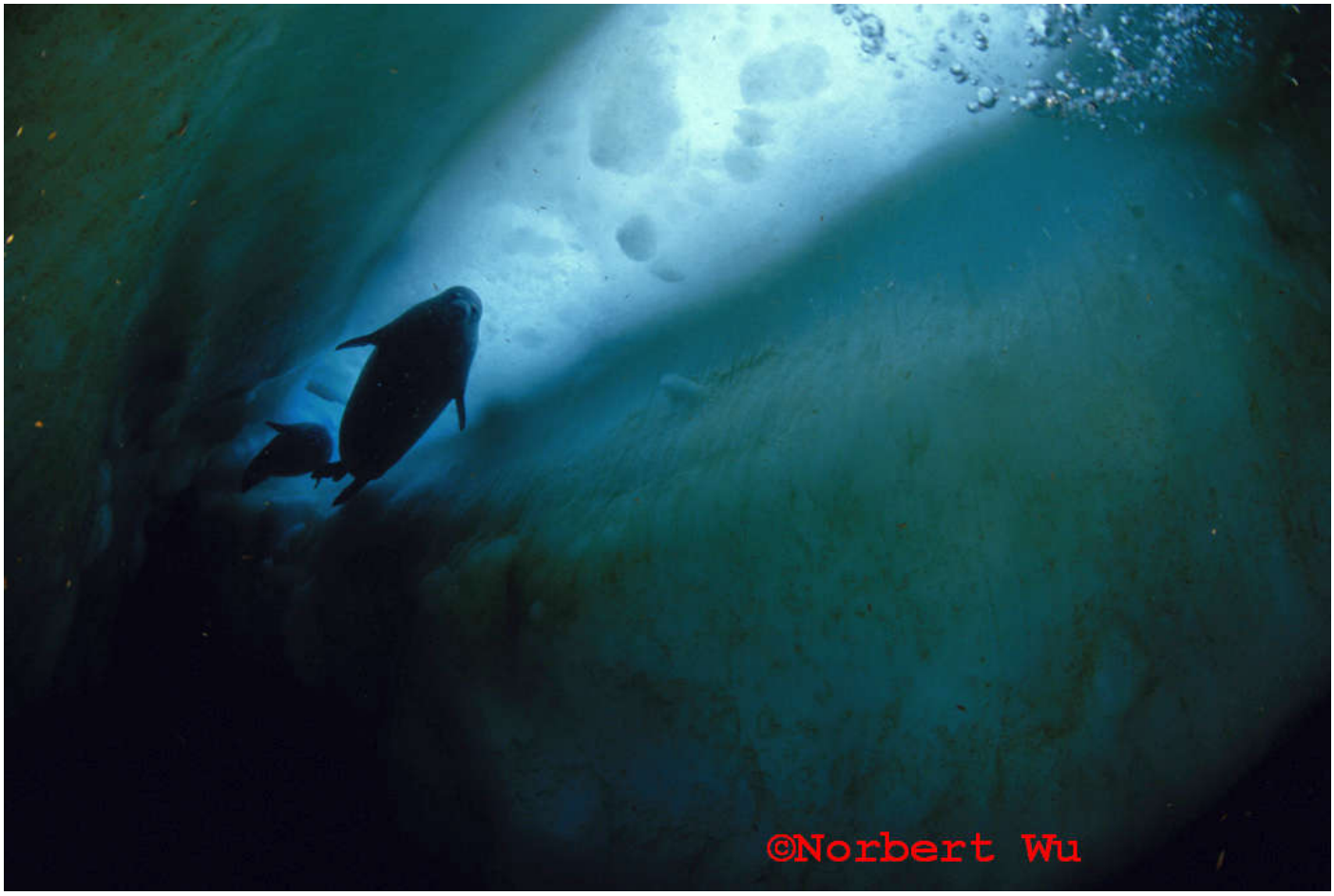
Here a Weddell seal mother and pup float in shallow water under a sea ice crack; their entry/exit/breathing holes are visible as bright lights above them. Breeding and pupping occur in the summer months. Breeding Weddell sea bulls set up under-ice territories of twenty meters diameter and tend to remain in the water where breeding takes place. Female Weddell seals move freely through the territories of the bulls. Subordinate males have their activity restricted by the dominant bull when moving through a territory. Females claim less well-defined territories, individually or jointly with other females. The mother gives birth to her newborn on the sea ice and stays with it for the first twelve days; after that, the mother will spend 30-40% of her time in the water while the pup remains on the sea ice.

The pup is born at 29 kilograms and gains 10-15 kilograms per week. By seven weeks of age, the pups can remain submerged for five minutes and dive down to 92 meters. The molting of the pup's fur is complete in thirty days. The pup nurses for 45 days and, when weaned, the pup weighs 113 kilograms.

Weddell seals have high juvenile survival due to a lack of predation in fast sea ice.

The Weddell seal vocalizes underwater and the diver is very aware of their presence though unseen. Their calls are an eerie underwater symphony.

Weddell seals produce a wide range of calls: lengthy buzzes descending from higher pitch to lower pitch called "trills", whistles, and chirps. Certain vocalizations are associated with aggressive displays and have been characterized as a trill, a rapid chi-chi-chi, an eeeyo, and a chirrup. A teeth clacking sound was observed as seals passed one another entering and leaving breathing holes. A trill is used by mature males to establish and mark their underwater territory; it is associated with tense situations. When a trill isn't heeded, a fight may ensue.



Here's a mother and pup. Weddell seals are highly vocal during the peak of breeding season at the Hutton Cliffs colony; researchers recorded almost twenty underwater calls per minute [1]. In mid-December when mating is almost over, the pups are being weaned, and adults dispersing, the underwater calls of Weddell seals at Hutton Cliffs decreased to two per minute [1]. Why? Their predators, leopard seals and killer whales, showed up at the fast ice edge about twenty kilometers away [1]. Weddell seals are no longer so isolated from their predators by distance from the fast ice edge since the edge shifts south as summer progresses [1]. Killer whales prowl the fast ice edge for prey and leopard seals can swim long distances under ice seeking out Weddell seals and their breathing holes [1]. Leopard seals and killer whales vocalize underwater and Weddell seals hear them [1]. Sounds are important for Weddell seals to communicate with their species, but they also need to avoid detection by predators [1]. Absence of sound from Weddell seals is an anti-predation strategy when the risk of predation by leopard seals and killer whales is increased [1].

Taxonomic Note: Species name *weddellii* can be misspelled in the literature with only one "i" [11].

Reviews: Handbook of Marine Mammals, Volume 2, Seals. SH Ridgway & RJ Harrison, eds. London: Academic Press, 1981, pp.275-296; Antarctic Research Series 70:287-301, 1996; **Sounds & Behavior:** Antarctic Journal of the United States 2:105-106, 1967; Biology of the Antarctic Seas III, Antarctic Research Series 11:227-261, 1967; **1:** Antarctic Journal of the United States 30(5):232-234, 1987; **2:** Science 288(5463):133-136, April 7 2000 **3:** Adaptations within Antarctic Ecosystems, Proceedings of the Third SCAR Symposium on Antarctic Biology. GA Llano, ed. Washington, DC: Smithsonian Institution, 1977. pp.749- 768; **4:** Journal of Mammalogy 46(1):37-43, 1965; **5:** American Scientist 85: 530-539, 1997; **6:** Peter Brueggeman, personal communication, 1997; **7:** Marine Mammals of the World: Systematics and Distribution. DW Rice. Lawrence, Kansas: Society for Marine Mammalogy, 1998; **8:** Handbook of Marine Mammals, Volume 2, Seals. SH Ridgway & RJ Harrison, eds. London: Academic Press, 1981, pp.275-296; **9:** Antarctic Research Series 70:287-301, 1996; **10:** FAO Species Identification Sheets for Fishery Purposes: Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area) / W Fischer & JC Hureau, eds. Rome: Food and Agriculture Organization of the United Nations, 1985; **11:** Marine Mammals of the World: Systematics and Distribution. DW Rice. Lawrence, Kansas: Society for Marine Mammalogy, 1998; **12:** Science 283:993-996, 12 February 1999; **13:** Polar Biology 42(8):1621–1624, 2019

Leopard seal *Hydrurga leptonyx*

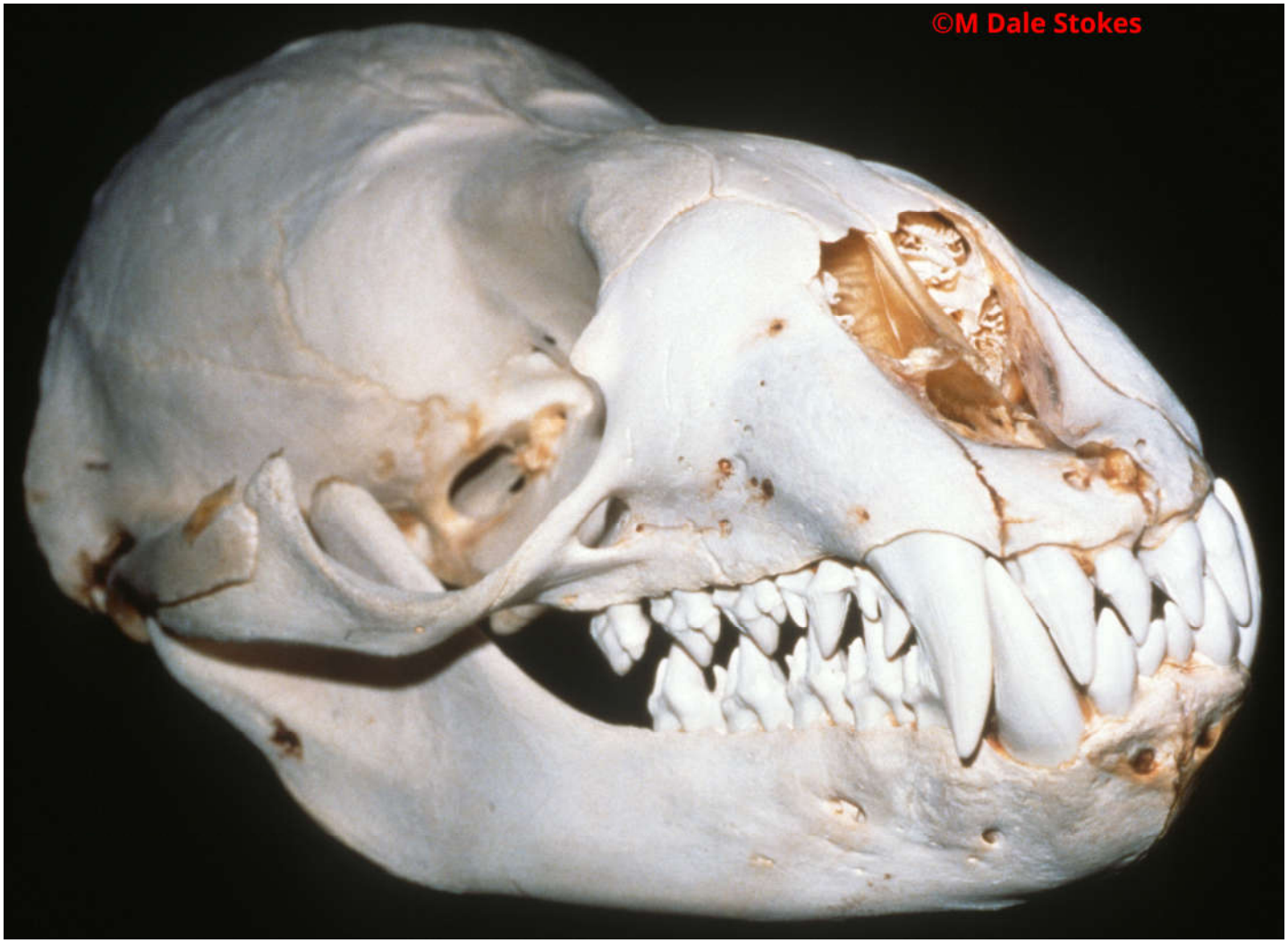
Leopard seals *Hydrurga leptonyx* are found in Antarctic pack ice (areas of concentration of drifting ice), along the Antarctic continent and the Antarctic Peninsula, South Shetland Islands, South Orkney Islands, South Sandwich Islands, South Georgia Island, Bouvet Island, Heard Island, and Macquarie Island. Wandering leopard seals have been sighted at Falkland Islands, the cape region of South Africa, Gough Island, South America from Tierra del Fuego in Chile to Brazil, Tristan da Cunha Island, Prince Edward Island, Crozet Island, Kerguelen Island, Amsterdam Island, St. Paul Island, New Zealand, southern Australia, Lord Howe Island, Auckland Islands, Snares Islands, Campbell Island, Rarotonga in the Cook Islands, and Juan Fernandez Islands.

Leopard seals are the largest of the Antarctic seals; built for speed, they are slender and can be just over three meters long. Leopard seals typically haul out on ice floes and breeding and pupping is assumed to occur on pack ice.

The diet of the leopard seal varies with season and location and includes benthic and pelagic fish, penguin adults and chicks, birds (petrels), seals (including crabeater seals, fur seals, elephant seals, and Weddell seals), cephalopods (squid and octopus), krill, fish, crustaceans, and seal and whale carcasses.

In McMurdo Sound, leopard seals are usually spotted on the prowl at the fast ice edge or penguin rookeries. The leopard seal is the only seal that regularly preys on warm- blooded animals.

Look at these incisor and canine teeth ! Leopard seals can be dramatic predators of penguins. Penguin chicks are awkward in the water and are easily taken; adult penguins are caught after pursuit or after falling back into the water after a missed leap out of the water. The leopard seal peels away the penguin skin by whipping the penguin back and forth while holding it between its incisor teeth. At Cape Crozier, scientists reported that six leopard seals killed an average of eight adult Adelie penguins each per day during a 100-day breeding season. They also reported that four seals killed fifteen Adelie penguin chicks per day each during two weeks of chick departure from the rookery. Penguins are a food resource of seasonal abundance for the leopard seal since penguins disperse from their rookeries after breeding/rearing their young.



Behind the leopard seal's long and sharply pointed incisor and canine teeth are interlocking cheek teeth or molars with three cusps, adapted for straining krill from the water. Krill is a large portion of the diet of the leopard seal. Krill might be eaten more by juvenile leopard seals and older, more experienced leopard seals might prey on penguins and seals.

Review: Handbook of Marine Mammals, Volume 2, Seals. SH Ridgway & RJ Harrison, eds. London: Academic Press, 1981, pp.261-274; FAO Species Identification Sheets for Fishery Purposes: Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area) / W Fischer & JC Hureau, eds. Rome: Food and Agriculture Organization of the United Nations, 1985. **Diet:** Adaptations within Antarctic Ecosystems, Proceedings of the Third SCAR Symposium on Antarctic Biology. GA Llano, ed. Washington, DC: Smithsonian Institution, 1977. pp.749-768; Polar Biology 27(12):729-734, 2004. **Distribution:** Marine Mammals of the World: Systematics and Distribution. DW Rice. Lawrence, Kansas: Society for Marine Mammalogy, 1998; Latin American Journal of Aquatic Mammals 2(1):51-54, 2003; Polar Biology 29(10):905-908, 2006.

Crabeater seal *Lobodon carcinophaga*

The crabeater seal *Lobodon carcinophaga* is found throughout Antarctica, usually in the pack ice [1,2]. Wandering crabeater seals have been sighted in the Falkland Islands, South Georgia Island, Bouvet Island, Heard Island, New Zealand, Tasmania and southern Australia, South Africa, Uruguay, Brazil, and Argentina [1,2,3].

Photographed here on fast ice near Cape Barne, crabeater seals, particularly young ones, come south into the Ross Sea and McMurdo Sound during summer months [2,4].

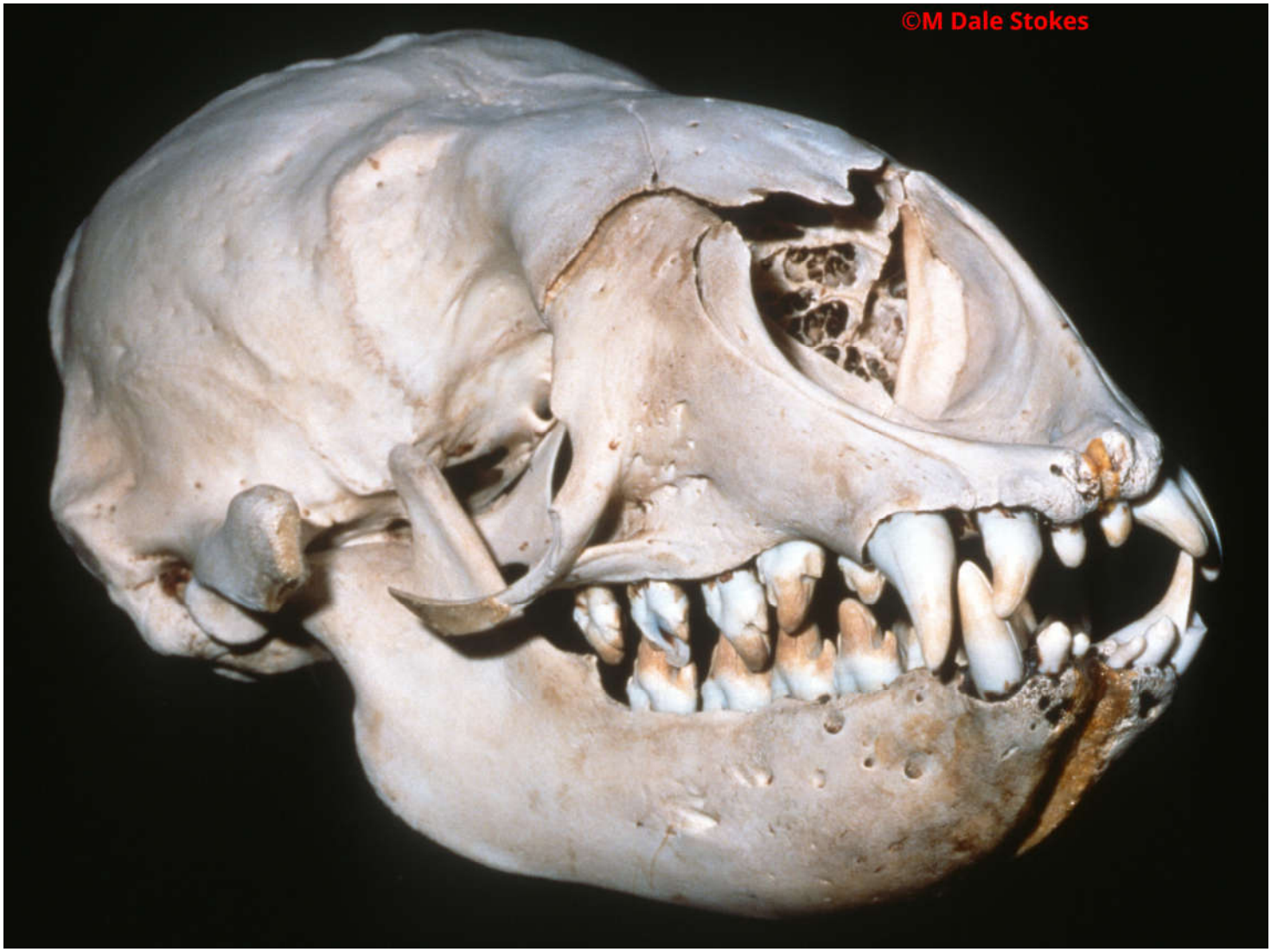
The crabeater seal is the most abundant seal in the world, with a population between fifteen and forty million (more than all other seals put together) [1].

The crabeater seal weighs up to 225 kilograms (496 pounds) and their length is up to 260 centimeters (8.5 feet) [1].

The color of the crabeater seal grades from blond on its ventral bottom side to darker brown on their dorsal top side [2]. The crabeater seal has characteristic net-like chocolate-brown markings and fleckings on its shoulders, sides and flanks [1].

When approached, crabeater seals do not roll onto their backs like Weddell seals; they open their mouths, bare their teeth, and snort [1,4].

The leopard seal is an important predator of young crabeater seals [1]. Killer whales have been observed creating waves to swamp an ice floe on which a crabeater seal is hauled out, thus knocking the seal into the water [5].



Compare this crabeater seal skull to the preceding leopard seal skull, with the predatory leopard seal's long and sharply pointed incisor and canine teeth. The crabeater seal’s incisor and canine teeth don’t look so ‘predatory’ .

The crabeater seal has ornate interlocking cheek teeth with four or five cusps, functioning as strainers to separate krill from seawater [1]. They’re more developed for straining krill from the water than the cheek teeth of the leopard

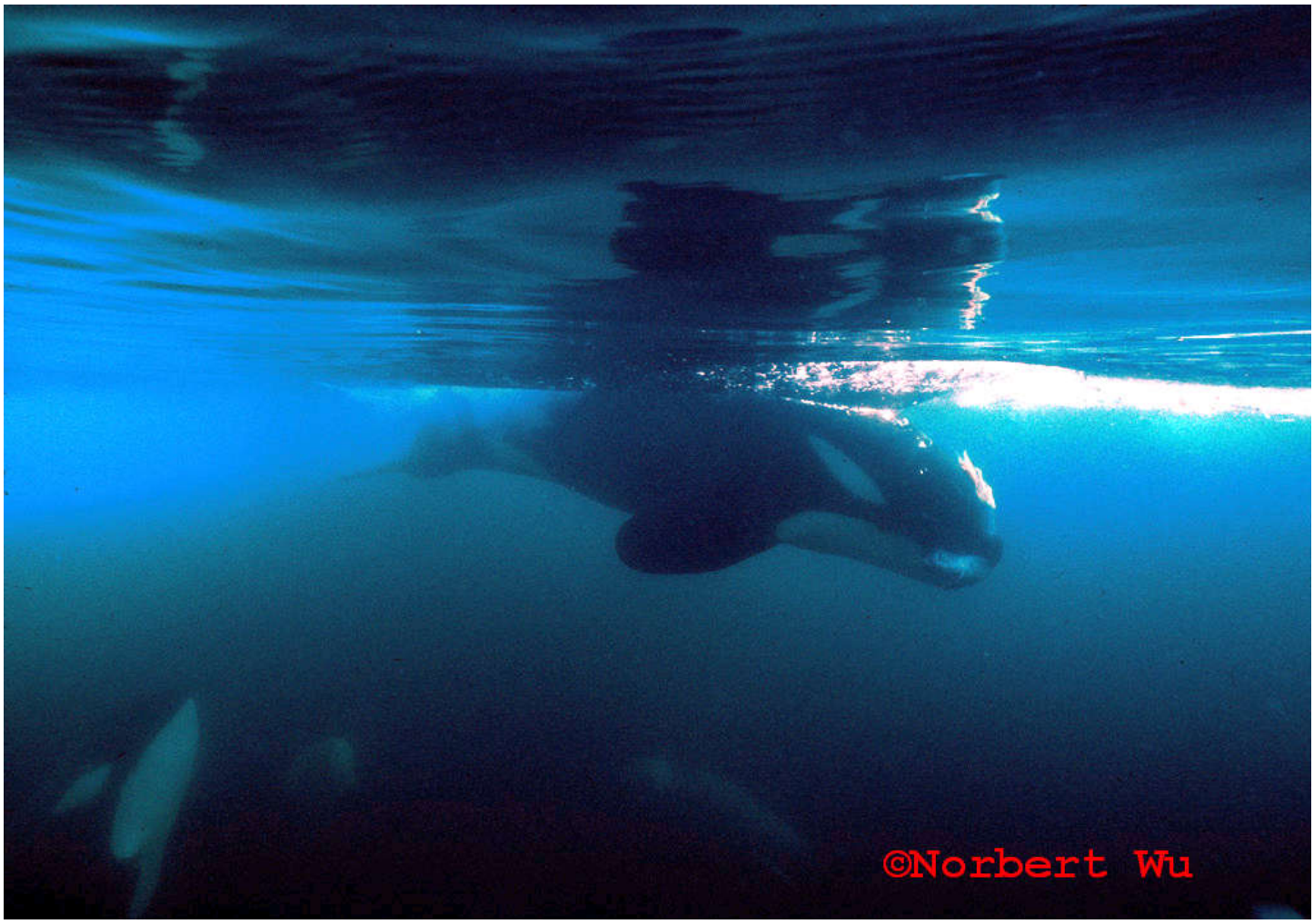
seal. The crabeater seal eats mostly Antarctic krill *Euphausia superba* and trivial amounts of fish, squid, and other invertebrates [1]. The crabeater seal is the major consumer of krill in the Southern Ocean [1].

Crabeater seals have been found dead and alive up well into the Dry Valleys near McMurdo Sound, where they can wander inland great distances [2,4]. Young crabeater seals disperse and spread out; they may become trapped by the autumn freezing sea ice in McMurdo Sound [4]. Trapped seals then have to escape over the ice surface to open water (if they can find the open water) [4]. Crabeater seals are more agile on land and ice than other Antarctic seals and thus can travel far from the open sea [4]. In addition to the Dry Valleys, dead crabeater seals have been found on the McMurdo Ice Shelf eleven kilometers west of Scott Base, 47 kilometers up the Ferrar Glacier at almost 1,100 meters altitude, and one kilometer inland on Cape Evans on the lower slopes of Mount Erebus [4].

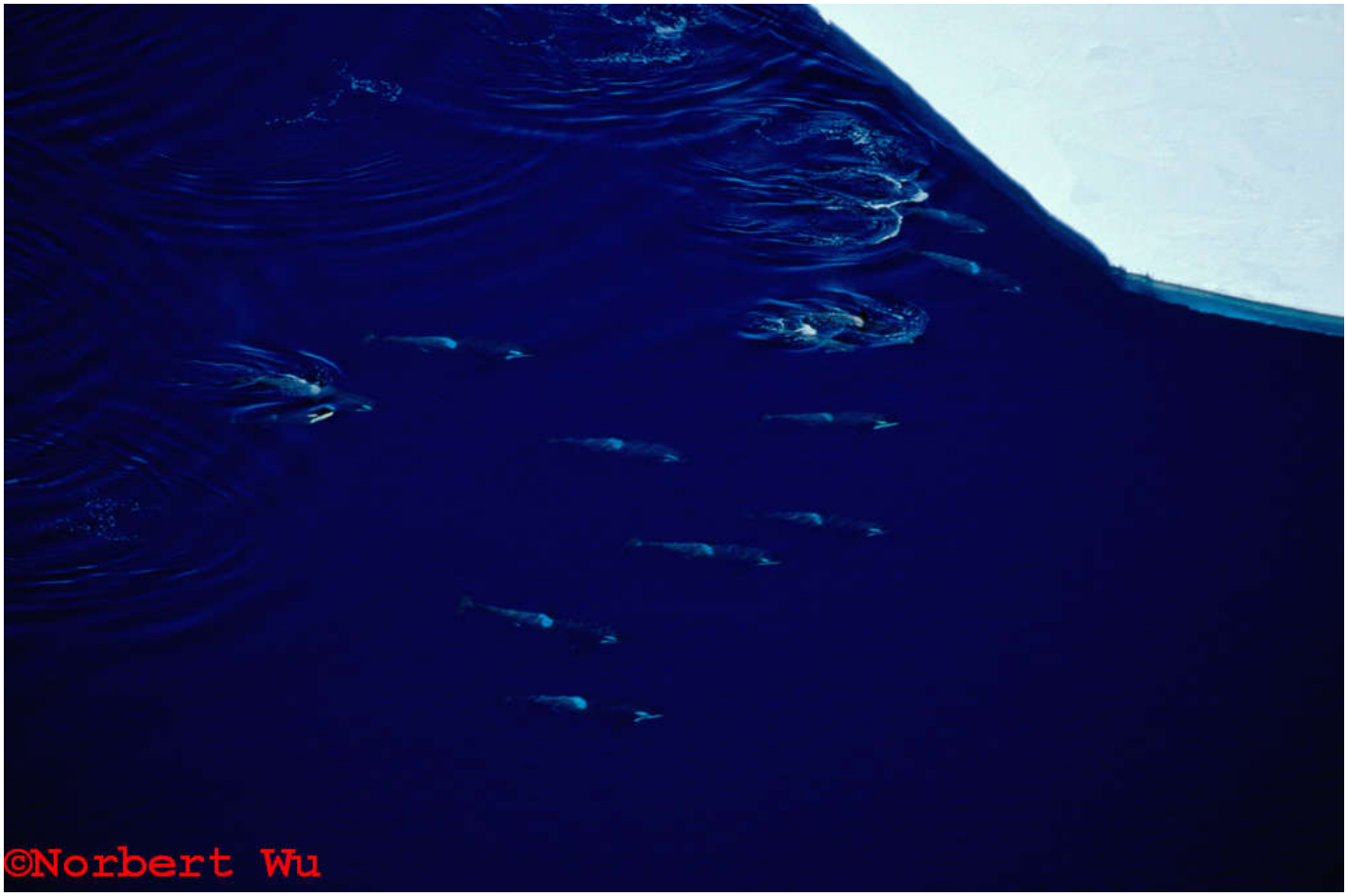
Taxonomic Note: The species is oftentimes improperly spelled with a masculine ending *carcinophagus*. The correct gender ending is *carcinophaga* since it is a noun in apposition and not an adjective, thus retaining its original feminine ending even though it is used with a masculine genus [3]. Put another way, the "feminine specific epithet (*carcinophaga*) was correctly used in combination with the feminine genus to which it was originally referred (*Phoca*). According to Article 31(b)(ii) of the International Commission on Zoological Nomenclature Code, *carcinophaga* retains its feminine ending despite now being used in combination with the masculine *Lobodon* (Rice 1998)" [6]. The Committee on Taxonomy of the Society for Marine Mammalogy has it listed as *carcinophaga* [7].

References: 1: FAO Species Identification Sheets for Fishery Purposes: Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area) / W Fischer & JC Hureau, eds. Rome: Food and Agriculture Organization of the United Nations, 1985; **2:** Handbook of Marine Mammals, Volume 2, Seals. SH Ridgway & RJ Harrison, eds. London: Academic Press, 1981, pp.221-235; **3:** Marine Mammals of the World : Systematics and Distribution. DW Rice. Lawrence, Kansas: Society for Marine Mammalogy, 1998; **4:** Journal of Mammalogy 52(1):175-180, 1971; **5:** Canadian Journal of Zoology 59(6):1185-1189, 1981; **6:** Mammalian Species 772:1-14, 2005; 7**:** Committee on Taxonomy. List of marine mammal species and subspecies. Society for Marine Mammalogy, https://www.marinemammalscience.org/species-information/list-marine-mammal-species-subspecies/ , Accessed on 2020-11-09

Killer whale or orca *Orcinus orca*



The killer whale or orca *Orcinus orca* is found throughout Antarctica and the Antarctic Peninsula and all parts of the Southern Ocean down to the Ross Sea [1,2].



The killer whale can be observed at the pack ice edge and sometimes in dense pack ice and under fast ice [1]. The killer whale usually travels in pods up to thirty individuals which may constitute a stable social structure [1].

The killer whale has a bulky body with a blunt, rounded head, a prominent triangular dorsal fin, and a black and white coloration including a grey saddle patch behind the dorsal fin, a white chin/throat, a broad white lobe reaching up and back beyond its navel, and a white oval patch above and behind its eye [1].

Male killer whales can be up to at least eight meters in length and females one meter shorter [1].

Adult killer whale males have the characteristic tall dorsal fin up to 1.8 meters tall as shown here [1]. In females and juvenile males, it is much smaller and has a concave trailing edge as shown in the top photo above [1].

Female killer whales reach sexual maturity in eight to ten years and males probably over sixteen years [1].

By mid- summer in McMurdo Sound, the plankton bloom reduces underwater visibility dramatically. A hunting mother and calf are seen in an opening lead of ice. Killer whale breeding occurs in autumn and the mother carries the developing baby for 13 to 16 months [1]. Killer whale calves nurse for twelve months and may remain with the mother for as long as ten years [1]. The killer whale preys on fish, cephalopods, and warm-blooded prey like penguins and seals; they have been observed dislodging prey from ice floes by tipping floes up and by swimming past, creating a wave to sweep prey off the floe [1,3]. The killer whale is a fast swimmer and can reach speeds of 46 kilometers/hour (29 miles/hr or 25 knots or 13 meters/sec) or more [1].

Taxonomic note: A supposed new species of dwarf or yellow killer whale was described from the ice edge in Antarctica's Indian Ocean sector [2]. Selecting fish rather than mammals as prey, further studies are needed to establish recognition as a separate species or subspecies [2].

References: 1: FAO Species Identification Sheets for Fishery Purposes: Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area). W Fischer & JC Hureau, eds. Rome: Food and Agriculture Organization of the United Nations, 1985; **2:** Marine Mammals of the World: Systematics and Distribution. DW Rice. Lawrence, Kansas: Society for Marine Mammalogy, 1998; **3:** Canadian Journal of Zoology 59(6):1185-1189, 1981

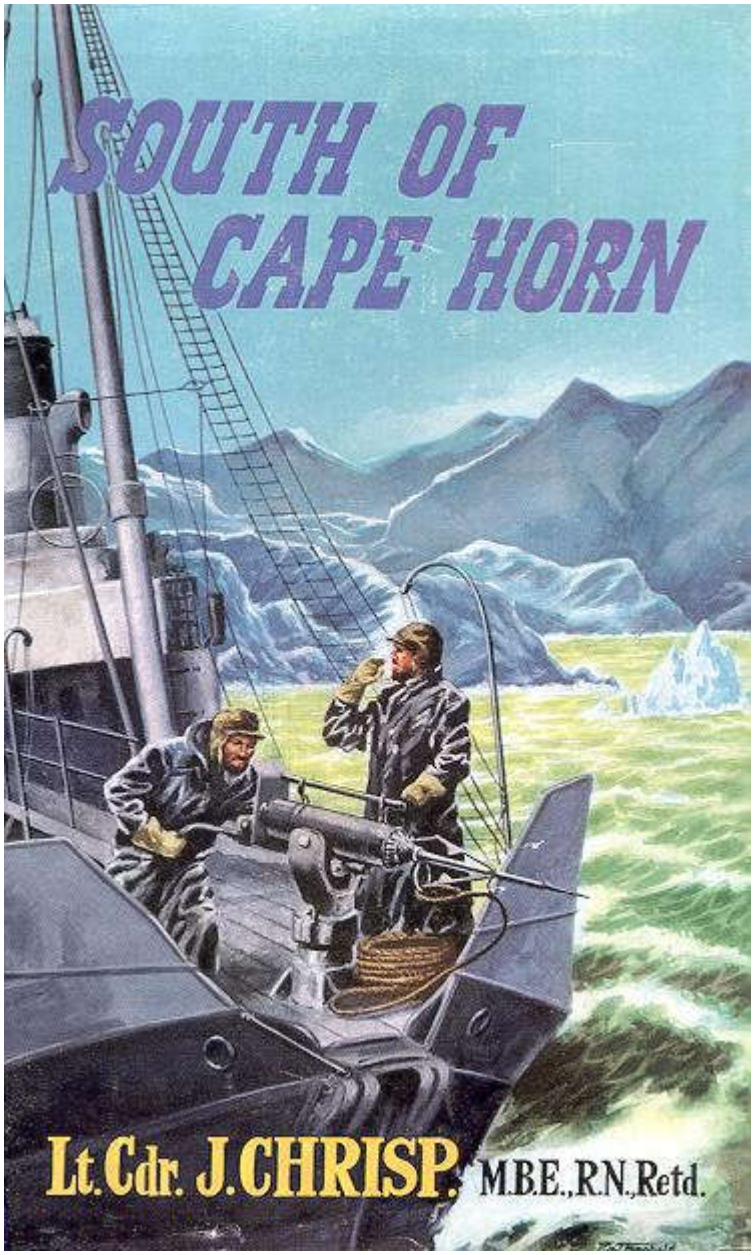
Antarctic minke whale *Balaenoptera bonaerensis*

The Antarctic minke whale *Balaenoptera bonaerensis* is found throughout Antarctica during summer [1,2]. During winter, Antarctic minke whales are found north to within seven degrees of the equator and south as far as the 35th parallel; they have also been sighted in Antarctica as well [1,2,4,5].

The Antarctic minke whale is usually sighted near the ice edge, either singly or in pairs [1]. The Antarctic minke whale ranges in length up to ten meters with an average length of eight meters; it is the smallest baleen whale in the Southern Ocean [1].

The Antarctic minke whale is dark grey on its back and white on its belly and beneath its flippers [1]. Most Antarctic minke whales have a white diagonal band on each flipper and there may be a pale chevron on its back behind the head or pale gray bracket marks above each flipper [1]. When the Antarctic minke whale surfaces, its dorsal fin appears simultaneously with the blow [1].

The blow of the Antarctic minke whale is small and low [1]. It breathes five to eight blows at intervals of less than one minute, and then dives up to twenty minutes [1]. The Antarctic minke whale feeds primarily on the Antarctic krill *Euphausia superba* and also on the euphausiid *Thysanoessa* spp. [1,3].



This book jacket illustrates harpoon gun whaling in the Southern Ocean.

Whaling in the Southern Ocean harvested some two million whales in the first half of the 20th century, with 28,000 blue whales killed in the 1930-1931 season alone [6].

Though whales in the Southern Ocean are now protected by the 1994 International Whaling Commission agreement for a Southern Ocean Whale Sanctuary, scientific research whaling continues under IWC rules, with Japan taking over 400 minke whales in the Southern Ocean each year in recent years [6,7]

Taxonomic Note: Bone features, genetic analysis, and external features confirm that the Antarctic minke whale is a separate species [2].

1: FAO Species Identification Sheets for Fishery Purposes: Southern Ocean (Fishing Areas 48, 58 and 88) (CCAMLR Convention Area) / W Fischer & JC Hureau, eds. Rome: Food and Agriculture Organization of the United Nations, 1985; **2:** Marine Mammals of the World: Systematics and Distribution. DW Rice. Lawrence, Kansas: Society for Marine Mammalogy, 1998; **3:** Polar Biology 11(7):479-487, 1991; **4:** Instituto Antartico Chileno. Serie Cientifica 44:91-98, 1994 ; **5:** International Whaling Commission Report 39:219-225, 1989; **6:** Whales, Dolphins and Porpoises. M Carwardine, ed. New York: Checkmark Books, 1999; **7:** Whaling. Whale and Dolphin Conservation Society. www.wdcs.org