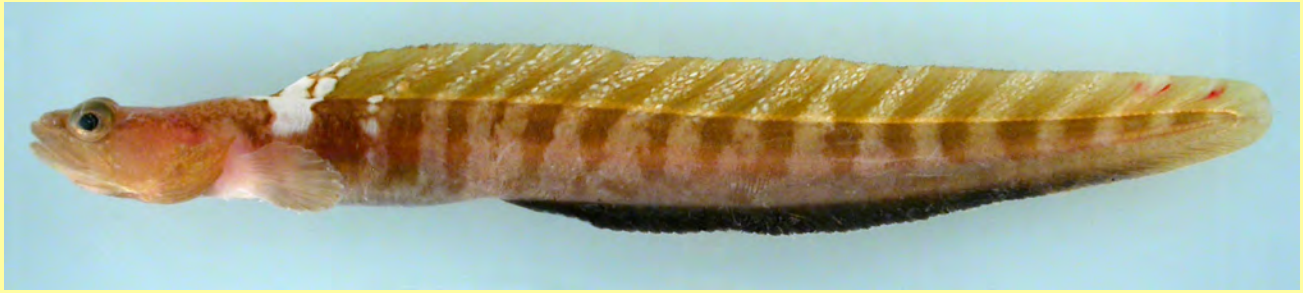
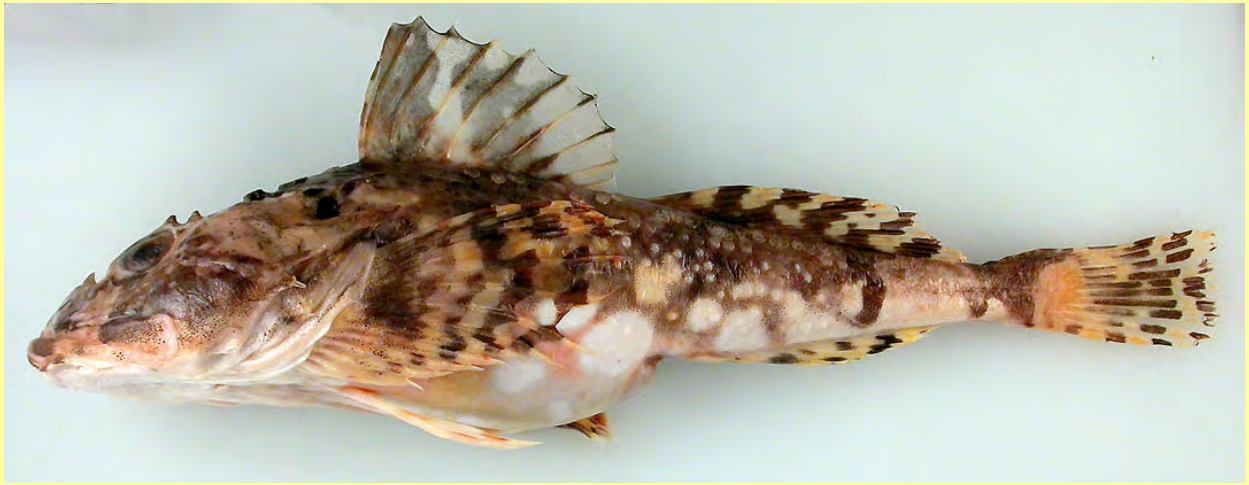
Lowell Wakefield Symposium

Anchorage, Alaska
27 March 2013



The RUSALCA mission and detection of change in the diversity and distribution of fishes



Presentation by
Catherine W. Mecklenburg
T. Anthony Mecklenburg

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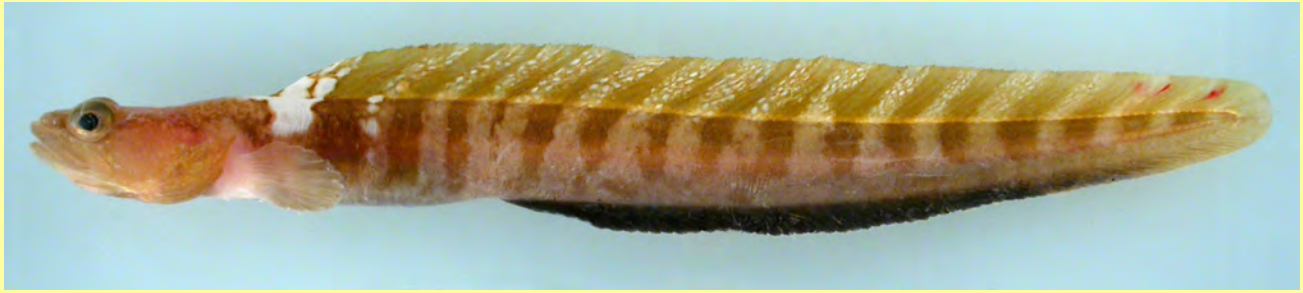
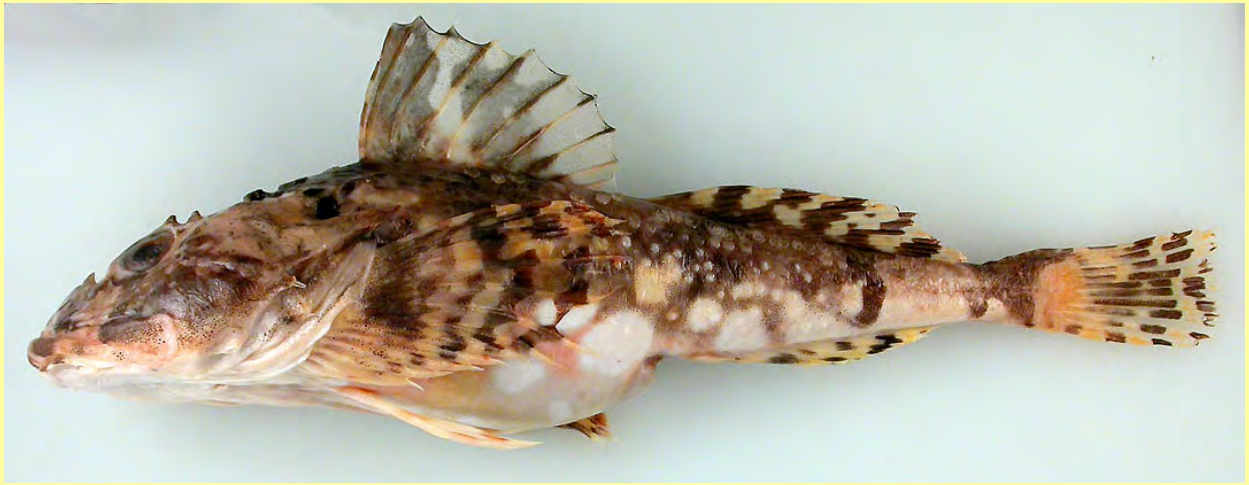


The RUSALCA mission and detection of change in the diversity and distribution of fishes



Presentation by
Catherine W. Mecklenburg
T. Anthony Mecklenburg

RUSSIAN–AMERICAN LONG-TERM CENSUS OF THE ARCTIC

(RUSALCA)

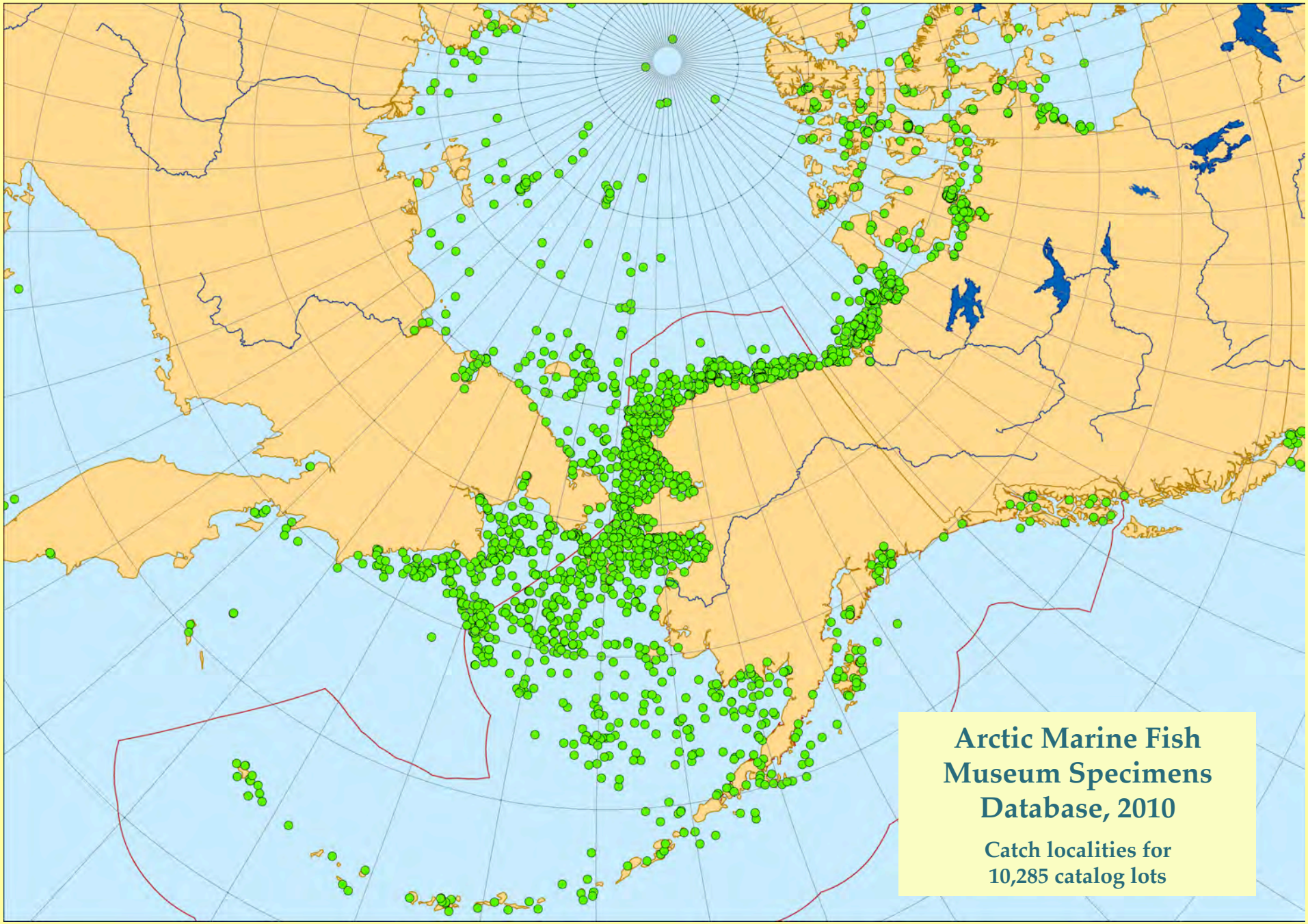
Cooperative program, started in 2003:

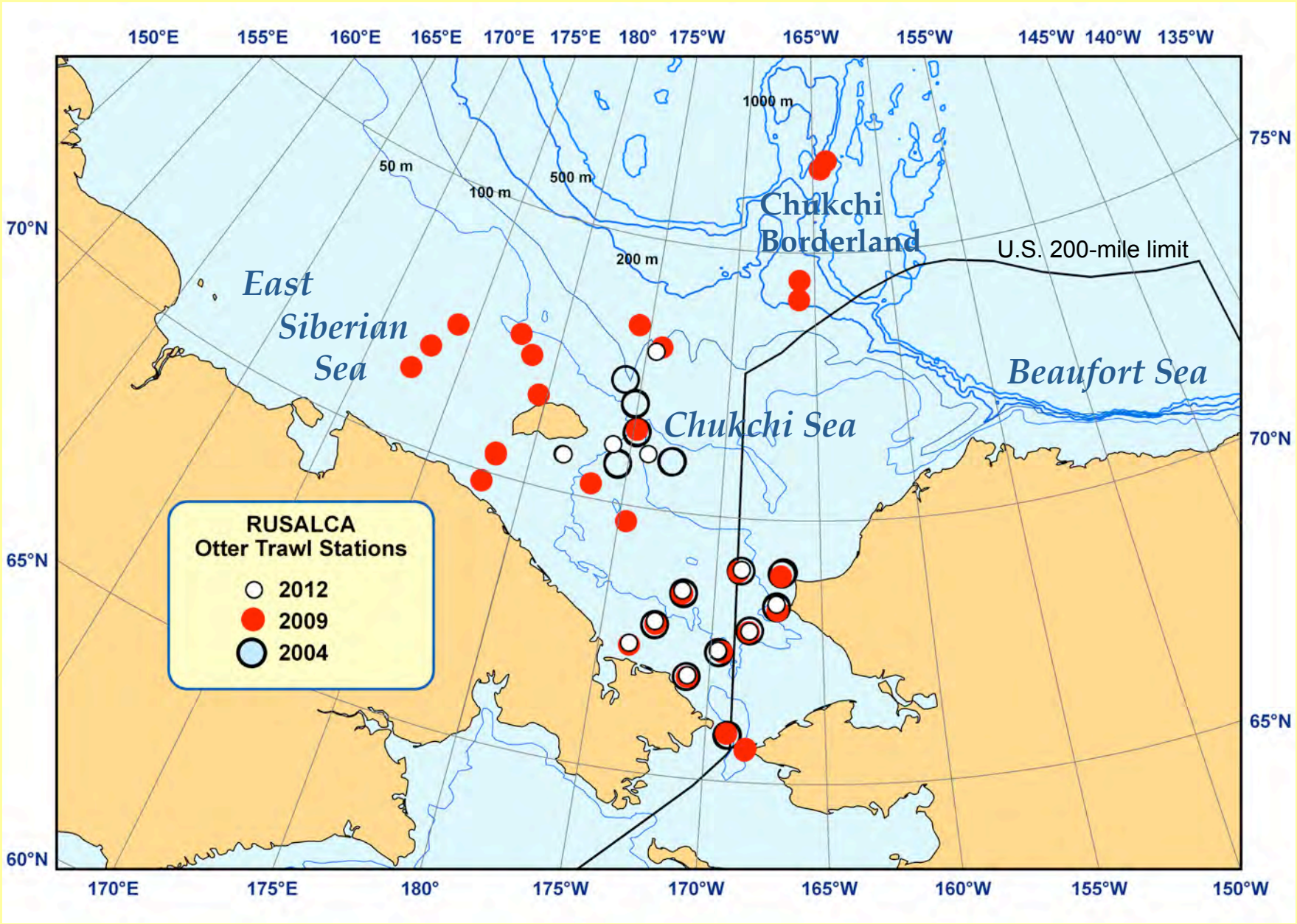
National Oceanic & Atmospheric Administration

& Russian Academy of Sciences

Objectives

- Document the state of the Arctic climate and marine life
  — particularly in regions of projected rapid change.
- Detect change in Arctic climate and marine life.


Arctic Marine Fish
Museum Specimens
Database, 2010
Catch localities for
10,285 catalog lots



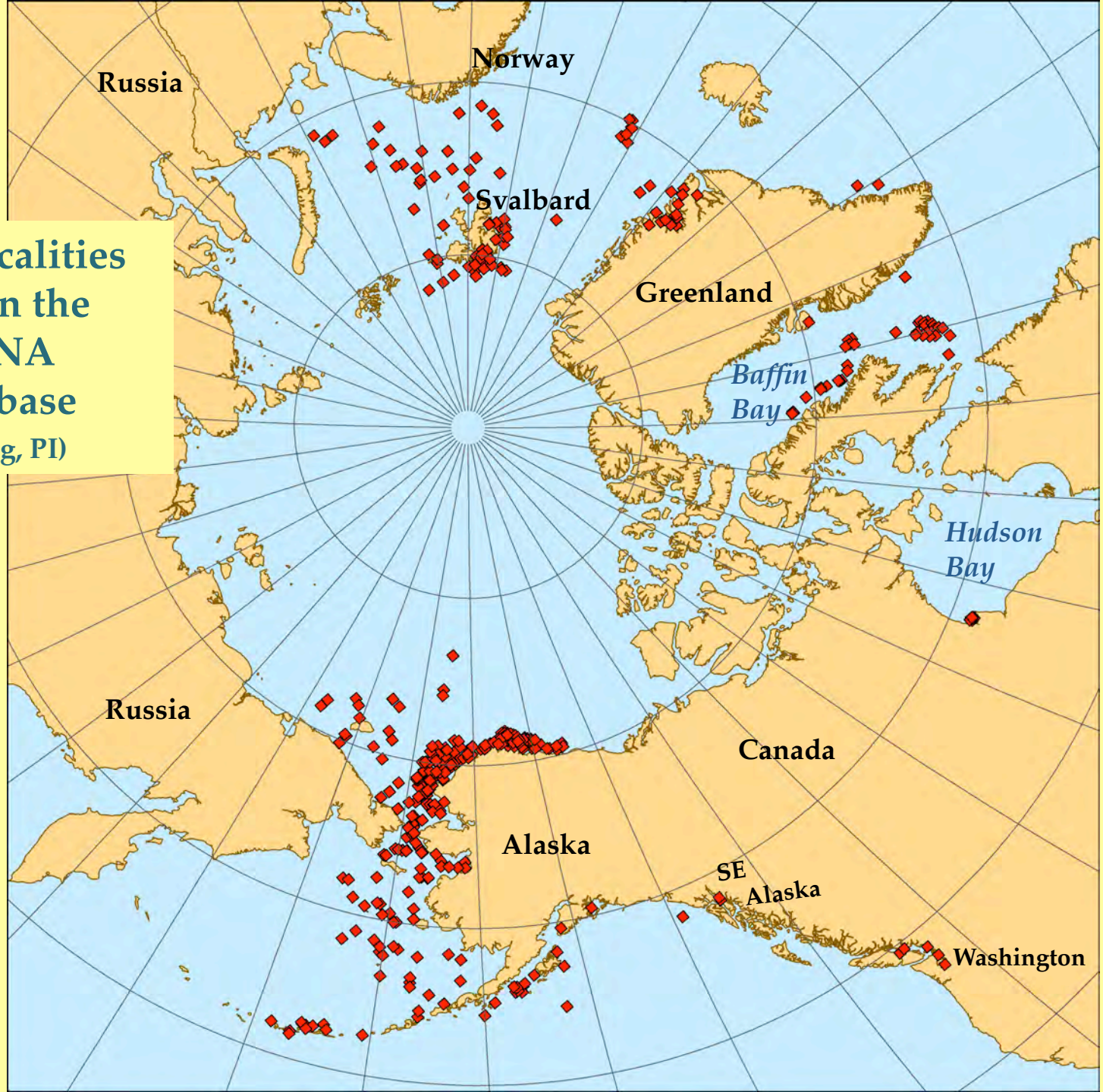
Otter trawl stations, RUSALCA 2004, 2009, 2012

Collection localities for samples in the Arctic fish DNA barcode database

(C.W. Mecklenburg, PI)

1, 649 CO1 sequences (barcodes)

~200 species



Biodiversity of Arctic Marine Fishes: Taxonomy and Zoogeography

(Marine Biodiversity 41(1):109–140 + Online Resources 1–5)

- **Catherine W. Mecklenburg**, Research Associate, California Academy of Sciences, San Francisco; Private Consultant, Point Stephens Research, Auke Bay, Alaska

- **Peter R. Møller**, Head of Vertebrate Zoology and Curator of Fishes, Natural History Museum of Denmark, University of Copenhagen

- **Dirk Steinke**, Lead Scientist, Barcoding of Marine Life, Biodiversity Institute of Ontario, University of Guelph, Ontario, Canada

Mar Biodiv (2011) 41:109–140
DOI 10.1007/s12526-010-0070-z

SENCKENBERG

ARCTIC OCEAN DIVERSITY SYNTHESIS

Biodiversity of arctic marine fishes: taxonomy and zoogeography

Catherine W. Mecklenburg · Peter Rask Møller · Dirk Steinke

Received: 3 June 2010 / Revised: 23 September 2010 / Accepted: 1 November 2010 / Published online: 1 December 2010

Abstract Taxonomic and distributional information on each fish species found in arctic marine waters is reviewed, and a list of families and species with commentary on distributional records is presented. The list incorporates results from examination of museum collections of arctic marine fishes dating back to the 1830s. It also incorporates results from DNA barcoding, used to complement morphological characters in evaluating problematic taxa and to assist in identification of specimens collected in recent expeditions. Barcoding results are depicted in a neighbor-joining tree of 880 *CO1* (cytochrome *c* oxidase 1 gene) sequences distributed among 165 species from the arctic region and adjacent waters, and discussed in the family reviews. Using our definition of the arctic region, we count 242 species with documented presence, if 12 species that likely are synonyms are excluded. The 242 species are distributed among 45 families.

Six families in Cottoidei with 72 species and five Zoarcoidei with 55 species account for more than (52.5%) the species. This study produced *CO1* sequences 106 of the 242 species. Sequence variability in the barc region permits discrimination of all species. The aver sequence variation within species was 0.3% (range 0–3.5 while the average genetic distance between congeners 4.7% (range 3.7–13.3%). The *CO1* sequences supp taxonomic separation of some species, such as *Osme dentex* and *O. mordax* and *Liparis bathyarcticus* and *gibbus;* and synonymy of others, like *Myoxocepha verrucosus* in *M. scorpius* and *Gymnelus knipowitschi G. hemifasciatus*. They sometimes revealed the presence additional species that were not entirely expected, such as unidentified species of *Ammodytes* in the western Gulf Alaska, most likely *A. personatus;* and an unidentified *Ice* species of the *I. spatula* complex with populations in western Gulf of Alaska and the northern Bering and Chuk Seas which could be a new species or a species in synony Reviewing distribution, we found that for 24 species patterns assigned by authors understated historical prese in the arctic region, and for 12 species they oversta presence. For instance, *Hippoglossoides robustus* is coun as an arctic–boreal species rather than predominantly bor and *Artediellus uncinatus* as predominantly arctic rather t predominantly boreal. Species with arctic, predominan arctic, or arctic–boreal distributions composed 41% of 242 species in the region, and predominantly boreal, bor and widely distributed species composed 59%. For so continental shelf species, such as the primarily amphibor *Eumesogrammus praecisus* and *Leptoclinus macula* distributions appear to reflect changes, including reentry i Arctic seas and reestablishment of continuous ranges, that zoogeographers believe have been going on since the end of land bridge and glacial times.

This article belongs to the special issue "Arctic Ocean Diversity Synthesis"

Electronic supplementary material The online version of this article (doi:10.1007/s12526-010-0070-z) contains supplementary material, which is available to authorized users

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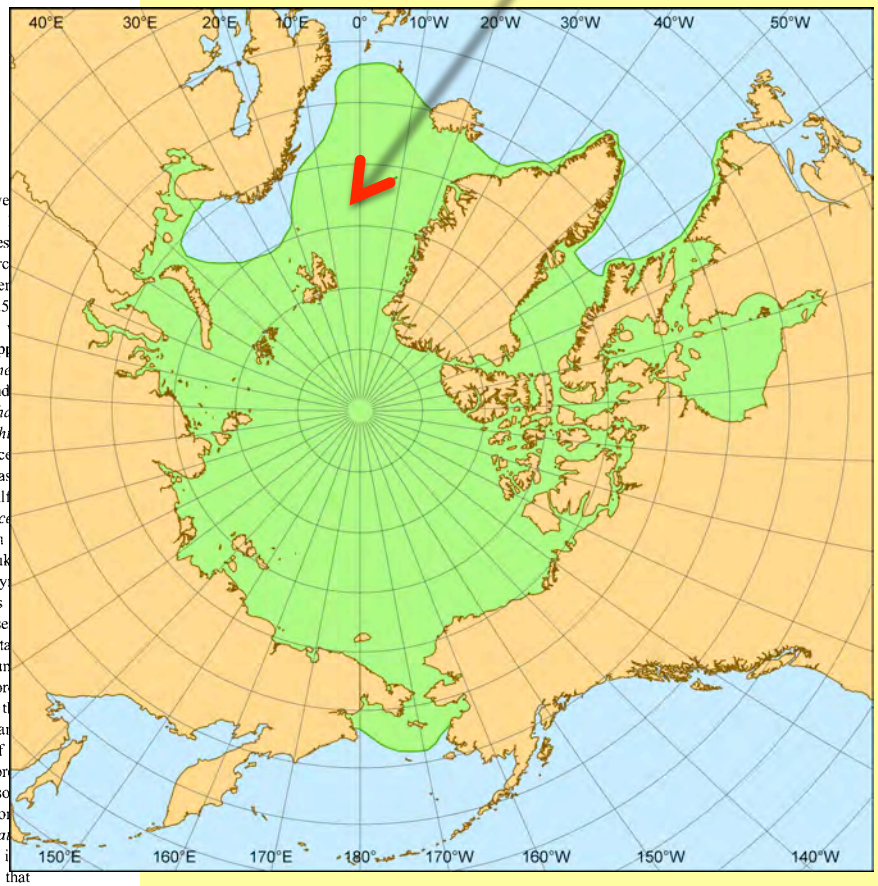
Arctic Region (green)



Mecklenburg, Møller, Steinke. 2011. Marine Biodiversity 41(1):109–140 + Online Resources 1–5

Head spines large, typically doubled or wedge-like

Northern Bering Sea

Myoxocephalus scorpius
Shorthorn Sculpin

Head spines absent or small and single

Southeastern Gulf of Alaska

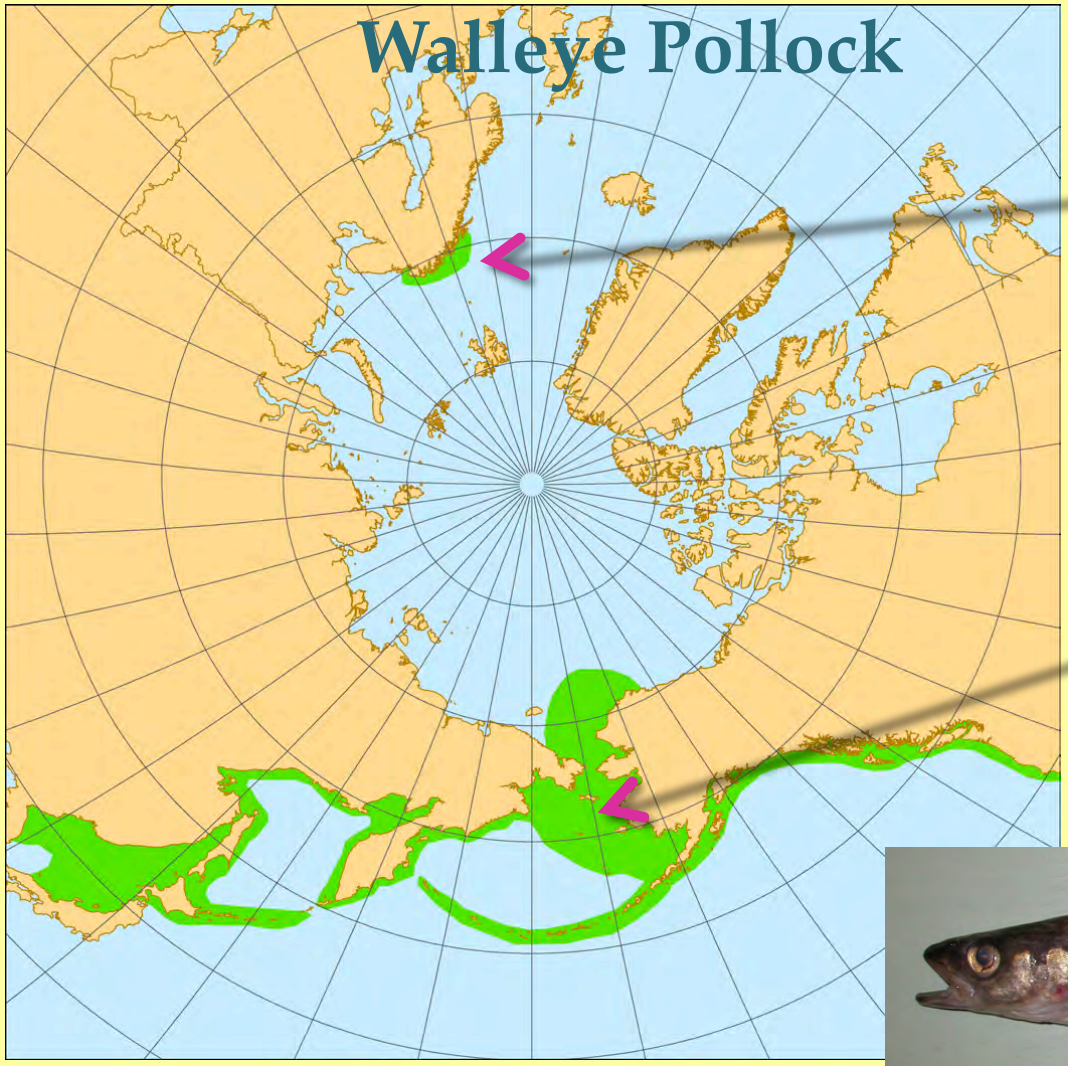
Myoxocephalus scorpius

Shorthorn Sculpin

arctic–boreal,
circumpolar

Geographic
distribution

Gadus chalcogrammus Pallas, 1814



Theragra finnmarchica

Norway Pollock

(Koefoed 1956)

Theragra chalcogramma

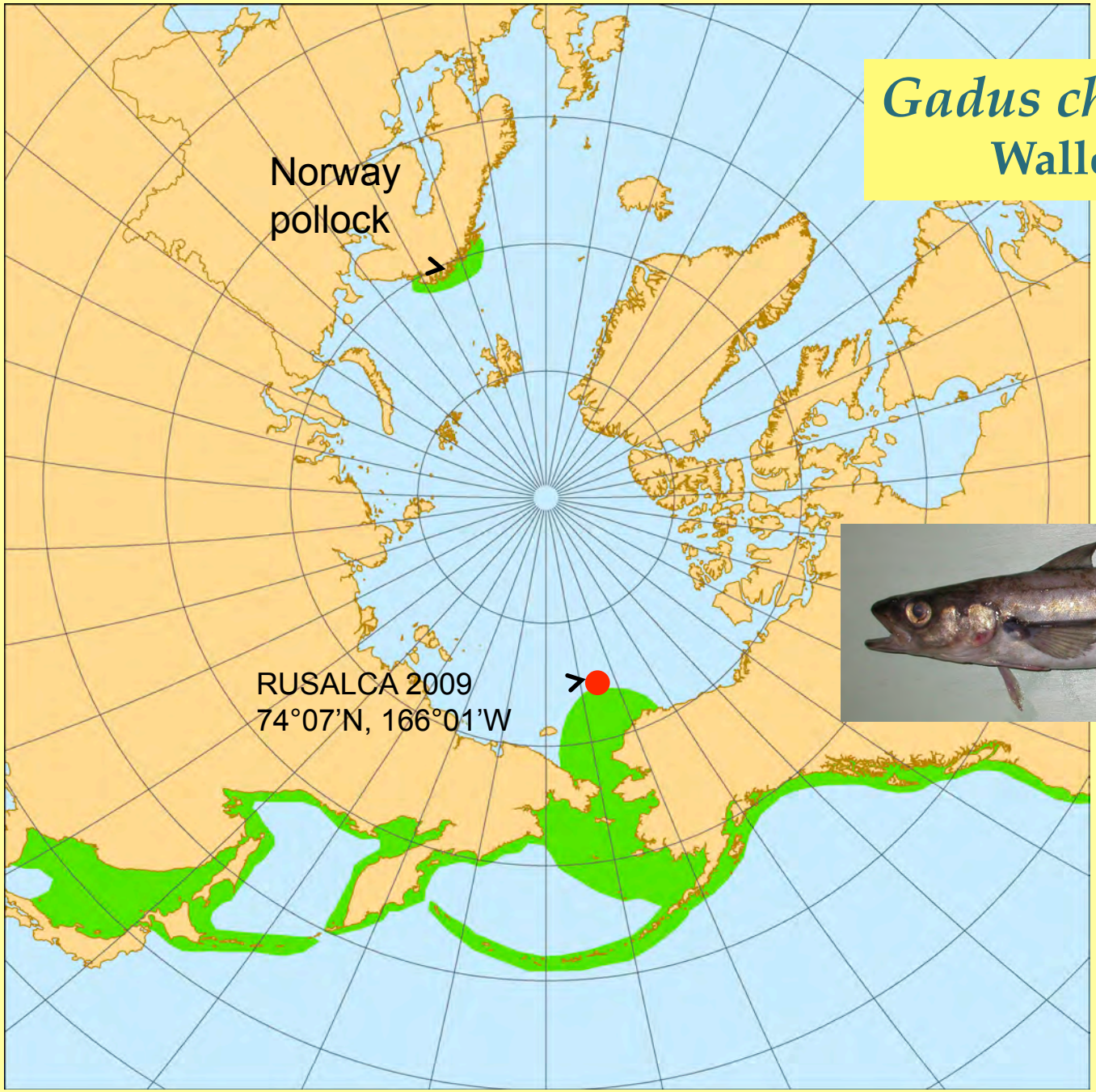
Walleye Pollock

(Pallas 1814)

Norway Pollock and Walleye Pollock are the same species

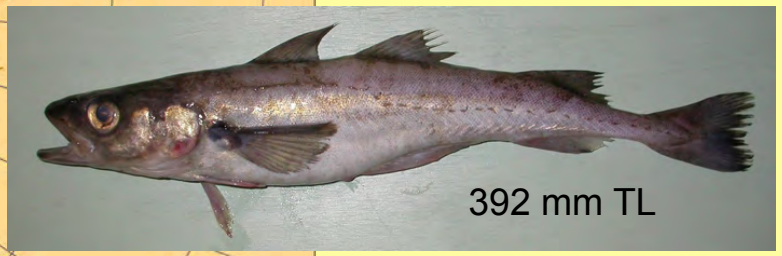
(e.g., Ursvik et al. 2007, Byrkjedal et al. 2008)

Gadus chalcogrammus
Walleye Pollock

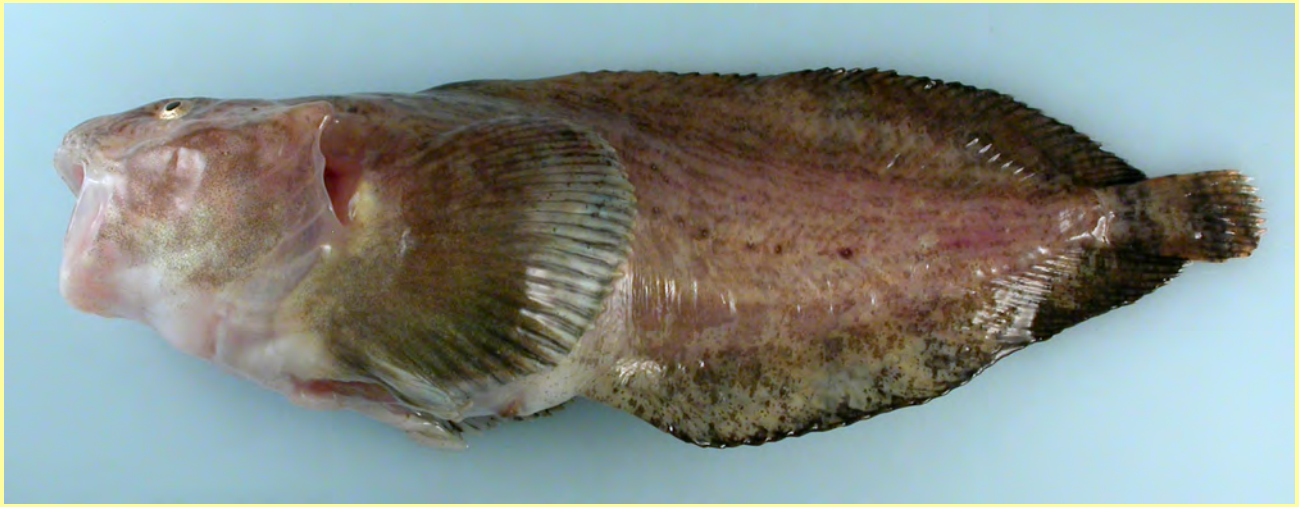


Chukchi Borderland:
1 at 365–370 m
(74°07' N, 166°01'W)

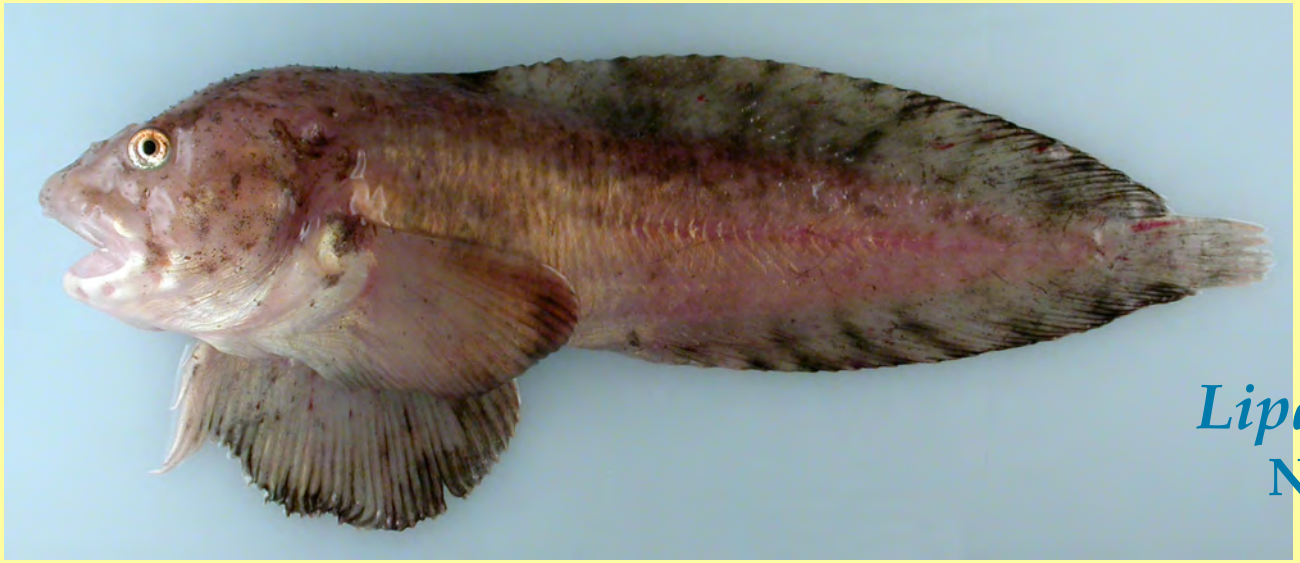
Overall depth range:
Surface to 1,200 m
Demersal & pelagic



predominantly
boreal Pacific;
also North Atlantic

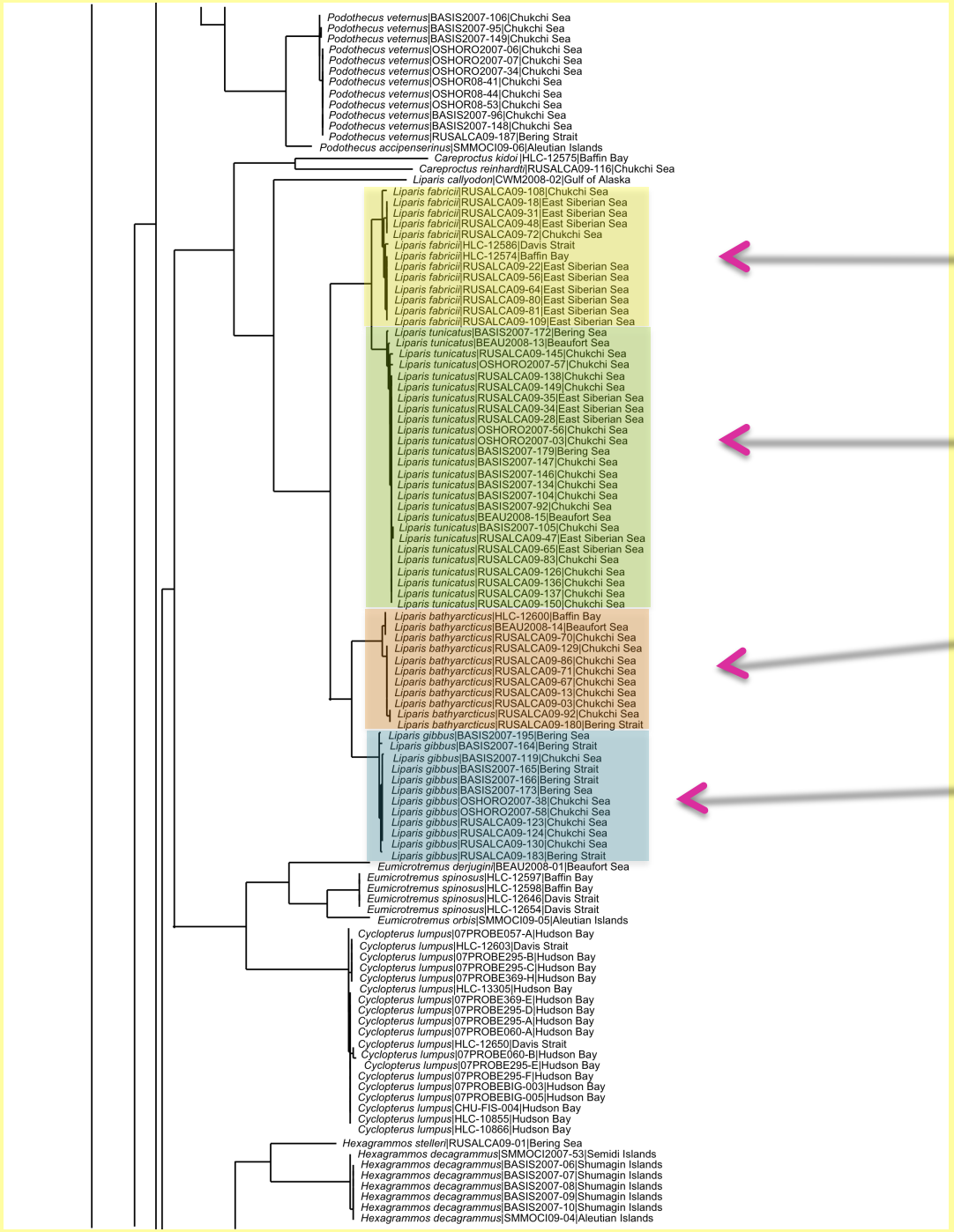


Liparis gibbus
Variegated Snailfish



Liparis bathyarcticus
Nebulous Snailfish

Very close in appearance, yet they are different species
(Chernova 2008)



Liparis fabricii
Gelatinous Seasnail

Liparis tunicatus
Kelp Snailfish

Liparis bathyarcticus
Nebulous Snailfish

Liparis gibbus
Variegated Snailfish

DNA sequences (barcodes) indicate 4 distinct species of *Liparis* are present in the Chukchi and Beaufort Seas

Myoxocephalus stelleri

Frog Sculpin

Hippoglossoides robustus
Bering Flounder

East Siberian Sea
RUSALCA 2009

Eggs at
Long Strait
1934

Buchan Bay, 1965
Bathurst Inlet,1975

arctic–boreal
Pacific

Hippoglossoides robustus = *H. elassodon*

Flathead Sole

(Kartavtsev et al. 2007

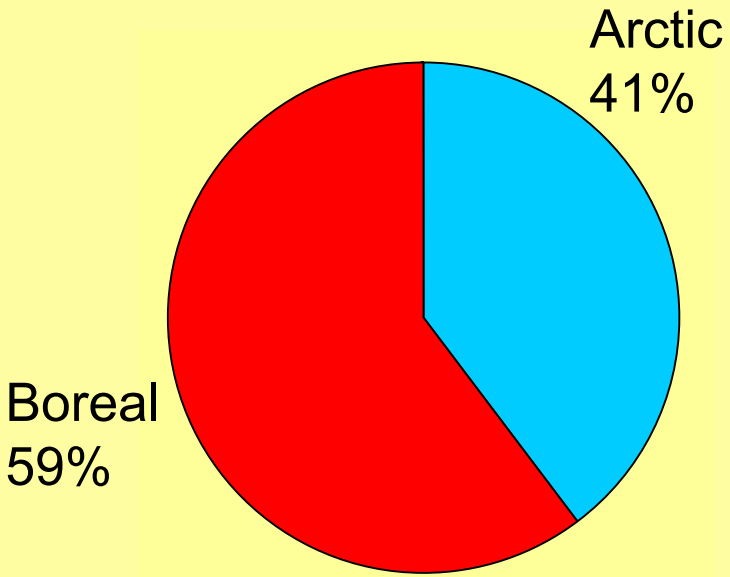
arctic–boreal Pacific

Hippoglossoides robustus = *H. elassodon*

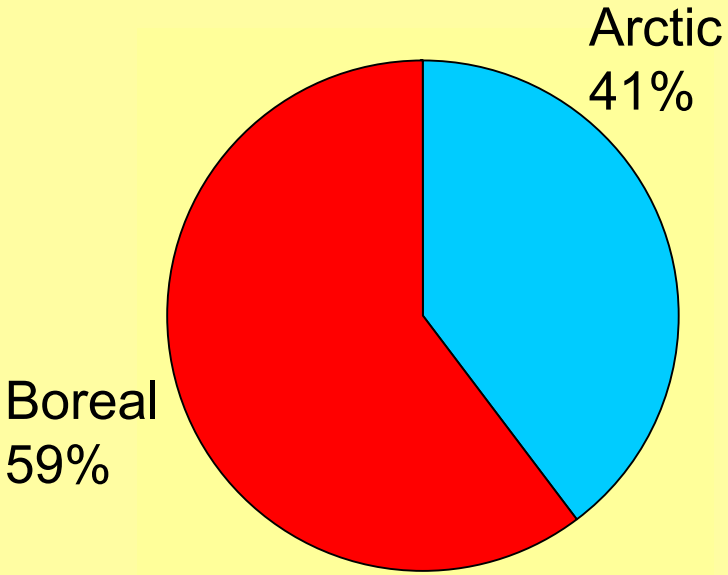
Flathead Sole

(Kartavtsev et al. 2007

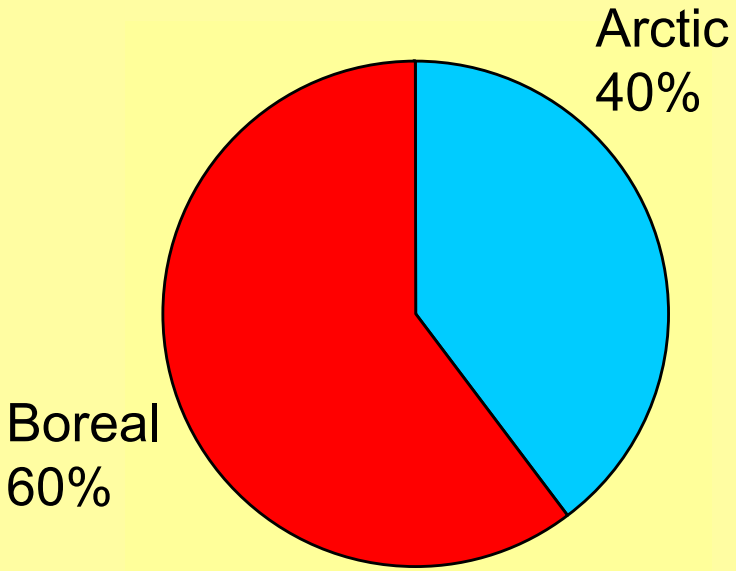
arctic–boreal Pacific



Fish species in **Arctic Region**
(n = 242 species)

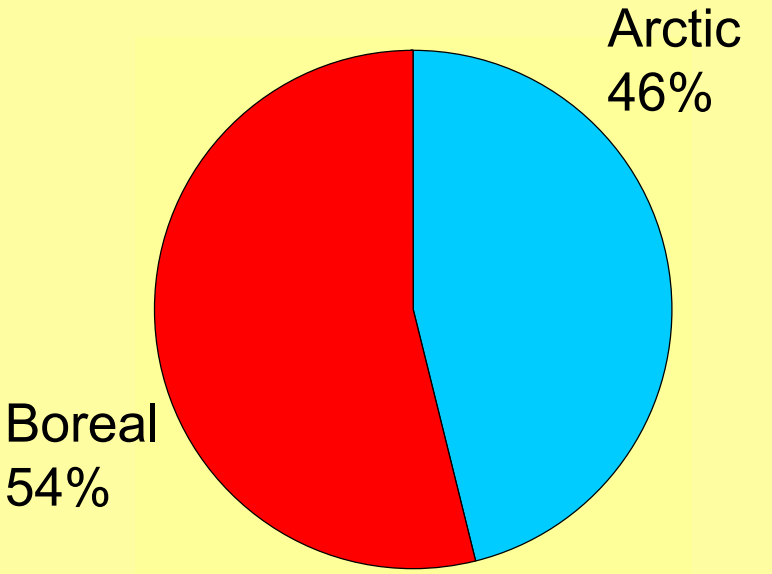


Fish species in **Arctic Region**

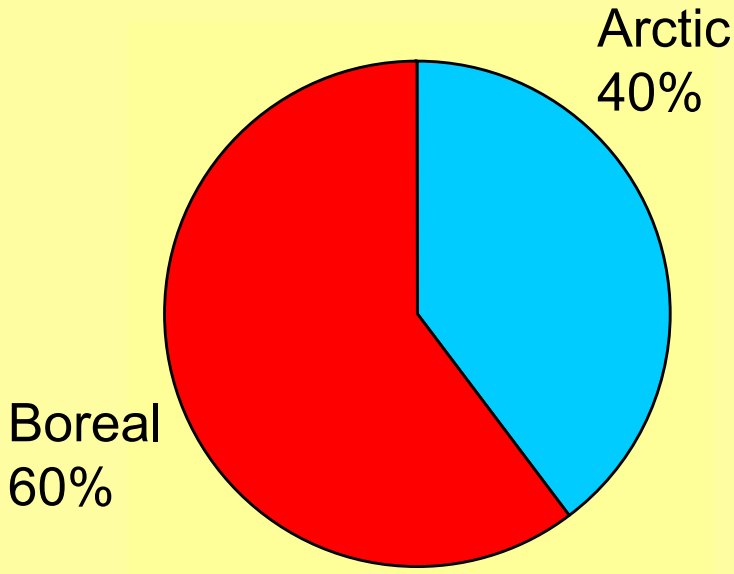


Fish species in **Chukchi Sea**

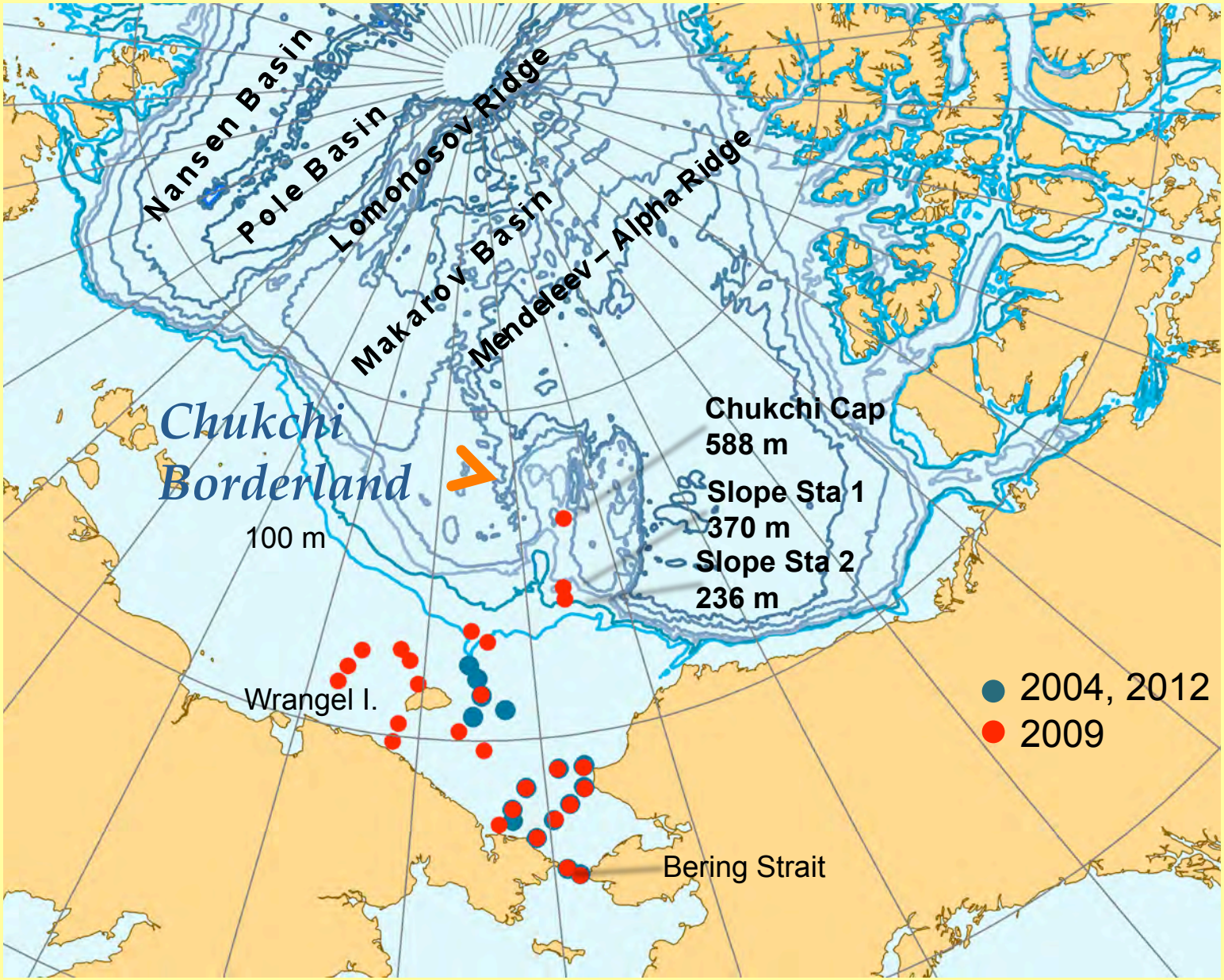
Marine fish species in the Chukchi Sea



1939
(Andriashev 1939)



2011
(Mecklenburg, Møller, Steinke 2011)



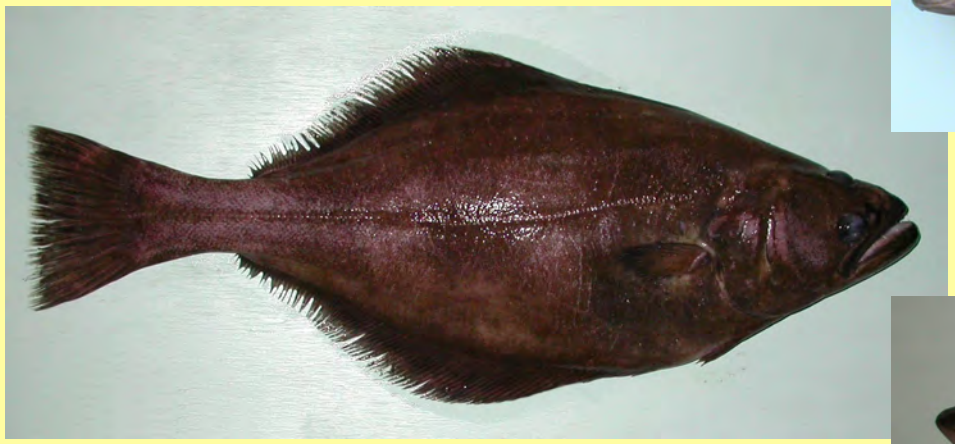
RUSALCA Bottom Trawl Stations & Chukchi Borderland

Leptoclinus maculatus
Daubed Shanny

Arctogadus glacialis
Polar Cod

Liparis fabricii
Gelatinous Seasnail

Boreogadus saida
Arctic Cod



Reinhardtius hippoglossoides
Greenland Halibut

Gadus chalcogrammus
Walleye Pollock

Six species collected in the Chukchi Borderland are also found on the continental shelf

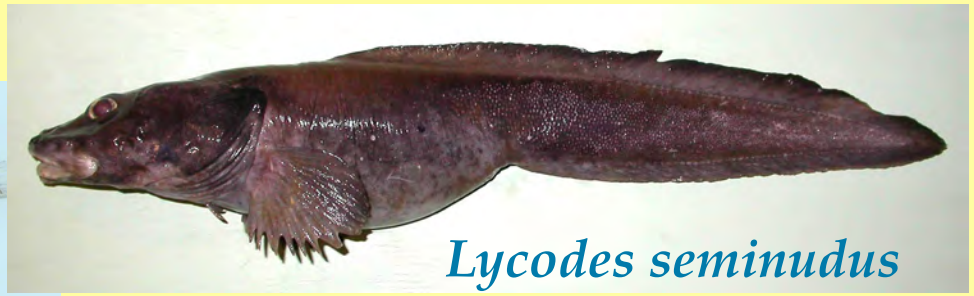
Artediellus atlanticus
Atlantic Hookear Sculpin

Careproctus reinhardti
Sea Tadpole

Lycodes adolfi
Adolf's Eelpout

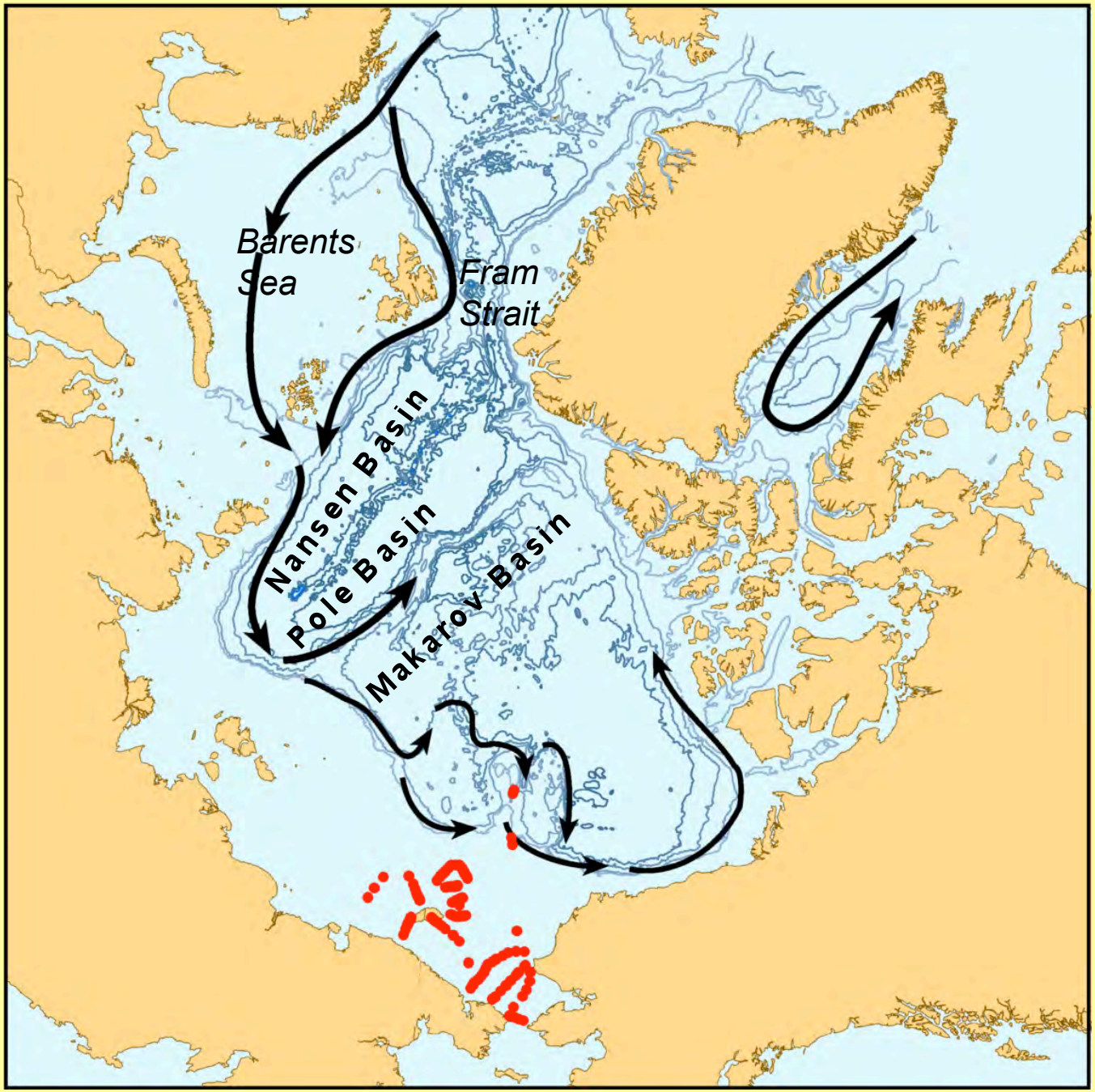
Cottunculus microps
Polar Sculpin

Triglops nybelini
Bigeye Sculpin



Lycodes seminudus
Longear Eelpout

Six species were found only in the Chukchi Borderland

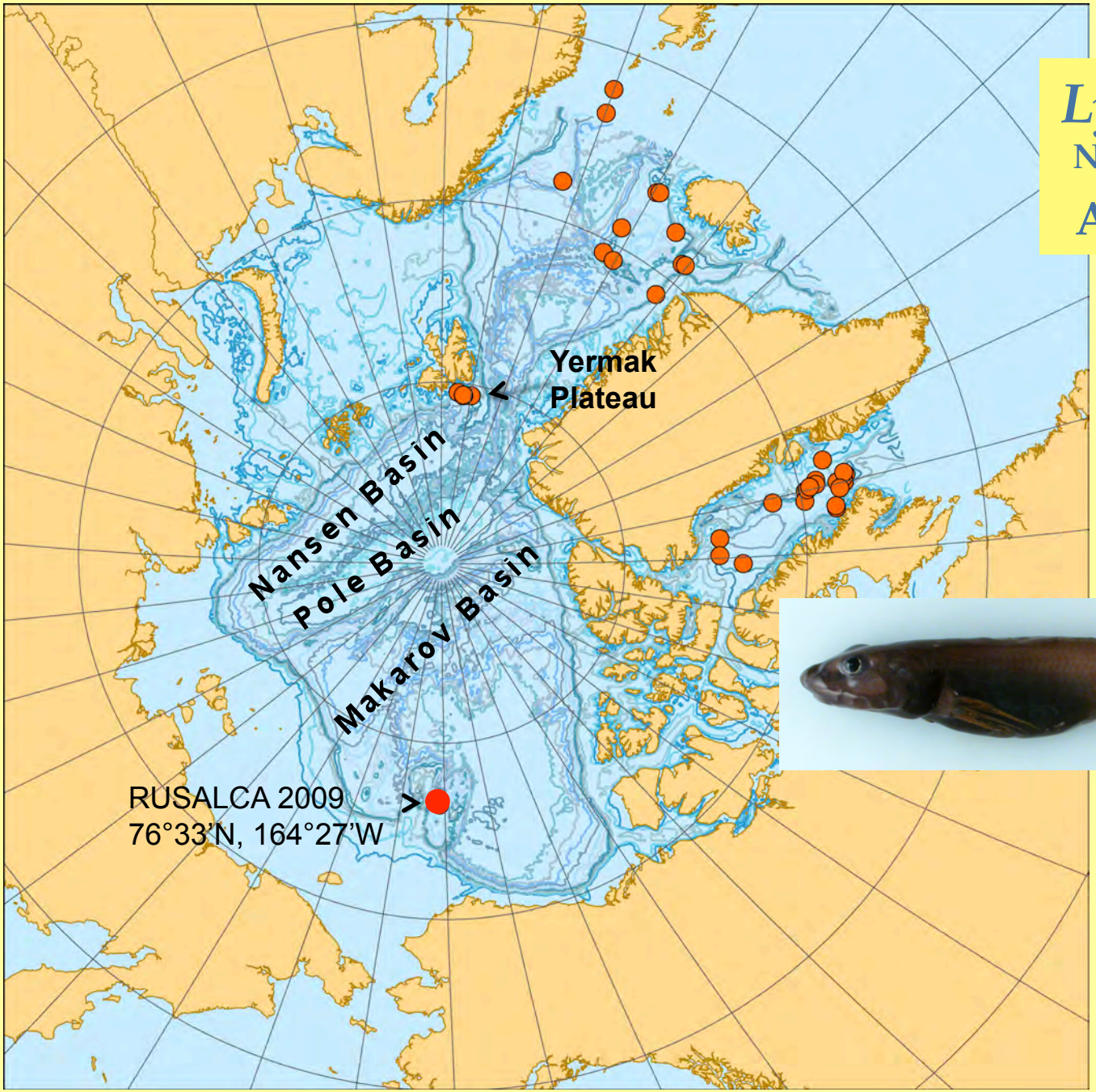


Atlantic Water circulation in the Arctic, 200–800 m

Lycodes adolfi

Nielsen & Fosså, 1993

Adolf's Eelpout



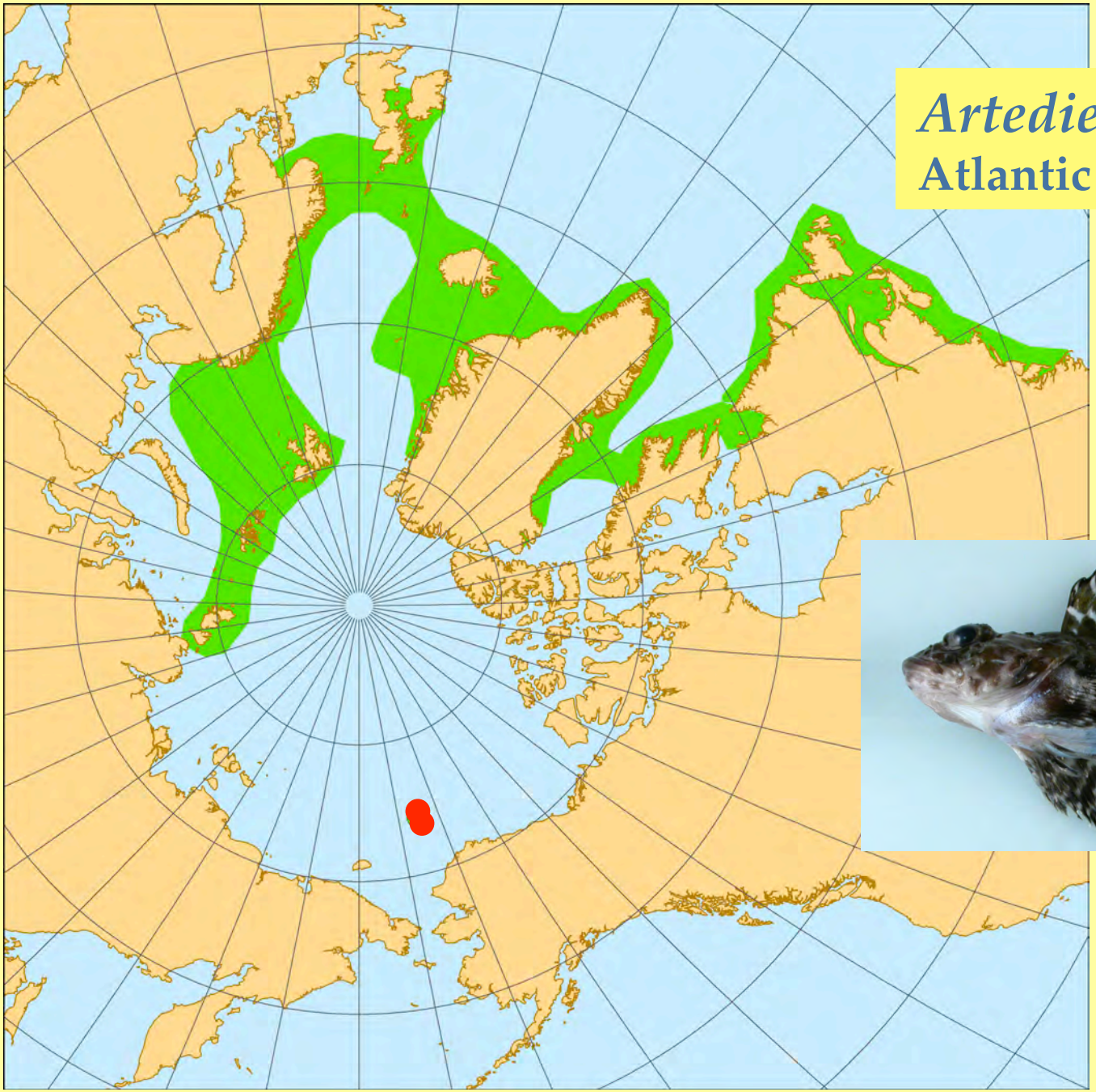
Chukchi Borderland:
4 at 580–588 m

Overall depth range:
386–1,880 m

Benthic

arctic, mainly Atlantic, probably circumpolar

Artediellus atlanticus
Atlantic Hookear Sculpin



Chukchi Borderland:
5 at 227–236 m
2 at 365–370 m

Overall known depth range:
11–1,366 m
Benthic

arctic–boreal,
mainly Atlantic,
possibly
circumpolar

Pacific-Arctic Marine Fishes

A distributional atlas and identification guide to the fishes of the RUSALCA study area

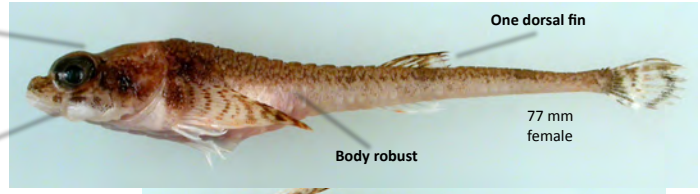
(northern Bering Sea, East Siberian, Chukchi, and Beaufort Seas, and the adjacent deep waters of the Arctic Ocean)

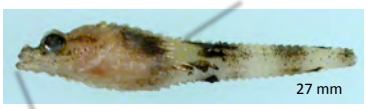
Mecklenburg and others

In preparation

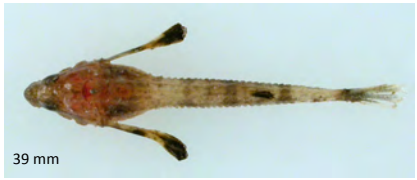
Family: Agonidae — Poachers

Aspidophoroides olrikii Arctic alligatorfish





- Reaches about 10 cm in length.
- The relatively large head and short, robust body reliably distinguish this species from alligatorfish *Aspidophoroides monopterygius*.



Photographs:
77 mm female: UAM 5833, NE Chukchi Sea, barcode OSHOR08-56
69 mm male: UAM 6304, W Beaufort Sea, barcode BEAU2011-116
54 mm male: UAM 5727, NE Chukchi Sea, barcode ID OSHOR08-38
74–77 mm males & female: PSR 842, NE Bering Sea, 2006
39 mm: UAM 5873, NE Chukchi Sea, 2007
27 mm (tail broken off): UAM 6373, W Beaufort Sea, barcode BEAU2011-83
All by C. W. Mecklenburg

Agonidae — Poachers

Aspidophoroides olrikii Lütken, 1877 Arctic alligatorfish

French name: poisson-alligator arctique
Norwegian name: arktisk panserulke
Russian name: [name in cyrillic to be inserted]
(Iedovitomorskaya lisitchka)

Zoogeography: Predominantly arctic.

Distribution: Nearly circumpolar, from south-eastern Barents Sea and White Sea eastward to west Greenland, southward in the Atlantic to the Newfoundland banks and in the Pacific to the southern Bering Sea and Gulf of Alaska.

Records from the southern Bering Sea east of the Pribilof Islands (UW 116517) and the Gulf of Alaska at Prince William Sound (UAM 1171) are exceptional (dots on the map). Other records occur southward in the Bering Sea only to the vicinity of St. Matthew Island and west of Nunivak Island.

Not known from the Canadian high Arctic archipelago, northern Baffin Bay, east Greenland to the Norwegian Sea and northern Barents Sea (Mecklenburg et al. 2011). In bottom trawl surveys of the Barents Sea in 2004–2009, was found only in the eastern part near Novaya Zemlya (Wienerroither et al. 2011). The Atlantic Reference Centre has records of *A. olrikii* as far south as Georges Bank off the Gulf of Maine (ARC 186059).

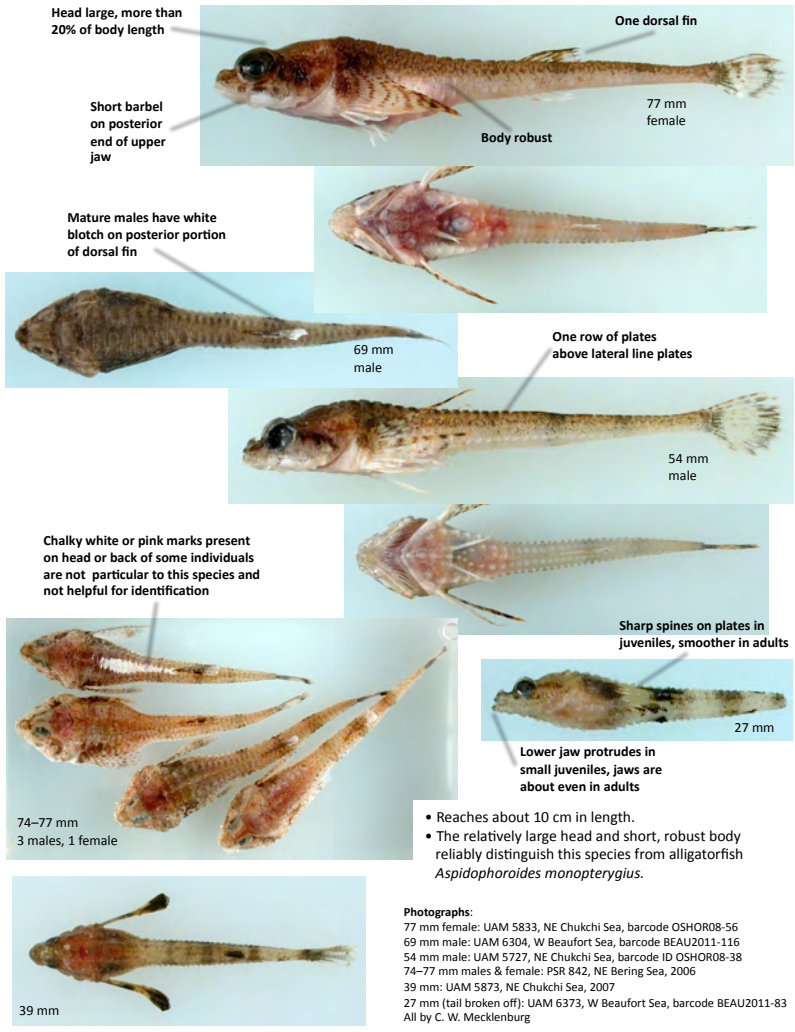
Habitat: Benthic, at depths of 3–520 m on mud, sand, gravel, and rock substrates. Usually taken in waters less than 100 m deep. Greatest depth of capture in RUSALCA bottom trawls was 83 m in the East Siberian Sea northwest of Wrangel Island (Appends. D, E). Reported to 400 m in the Beaufort Sea off Alaska (Frost and Lowry 1983), 248 m in Franklin Bay east of Cape Bathurst (CMNFI 1977-0975.5), 200–300 m in the Barents Sea and 520 m in the Kara Sea (Andriashev 1986). The Prince William Sound record (UAM 1171) comprises 3 specimens taken in Port Wells, a fjord, at a depth of 420 m. The minimum depth of 3 m is from a specimen (USNM 111624) caught in a trap on the Chukchi Sea side of Point Barrow. Reported to occur on substrates of mud, sand, stones, and rocks in various mixtures (Backus 1957, Andriashev 1986); found on mud, muddy sand, muddy gravel, and gravel by the RUSALCA (Appends. D, E).

Reported to prefer temperatures below 0°C, up to 2–3°C off western Greenland and 7.5°C in the White Sea; and salinities of 33–35 units, except relatively freshened, to 23–28 units in the East Siberian, Kara, and White Seas (Andriashev 1954, 1986). The lowest temperature reported was –1.85°C off Labrador (Backus 1957). In 2004, taken in RUSALCA otter trawls at –1.7°C and salinity of 33.32 in the western Chukchi Sea northeast of Wrangel Island to 7.9°C and salinity of 31.30 off Cape Lisburne in the eastern Chukchi Sea (Mecklenburg et al. 2007). Lowest salinities encountered for *A. olrikii* in RUSALCA sampling were off the Russian coast in 2009: 25.79 in Long Strait and 28.67 off Cape Serdste Kamen'; temperature at both stations was 3.7°C (Appends. D, E).

Identifying features: Brownish to greenish brown on back and upper sides, fading to white below; three darker saddle bands or blotches and dark band around base of caudal fin; dorsal fin blackish; anal and pelvic fins white; caudal fin blackish brown with white area in center and white along margin. Males have chalky white blotch on posterior area of dorsal fin. Dark bands are more distinct in juveniles. **Body elongate and robust,** greatest depth more than 12% of standard length. **Head broad, large,** head length more than 20% of standard length. **Mouth terminal.** Nasal spine (paired) present, nearly indiscernible to well developed. **Short barbel on posterior end of maxilla. One dorsal fin** (the first is absent), with 5–7 rays, opposite anal fin with 5–7 rays. Plates on body and top of head flat, without spines or keels; supralateral row of plates absent, leaving **one row of plates above lateral line**; 40 or fewer plates in lateral line row; single row of plates along midline of breast.

Family: Agonidae — Poachers

Aspidophoroides olrikii Arctic alligatorfish



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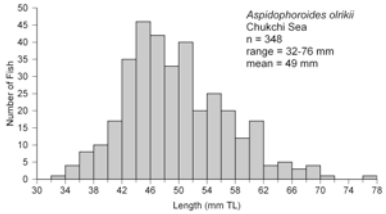
All by C. W. Mecklenburg

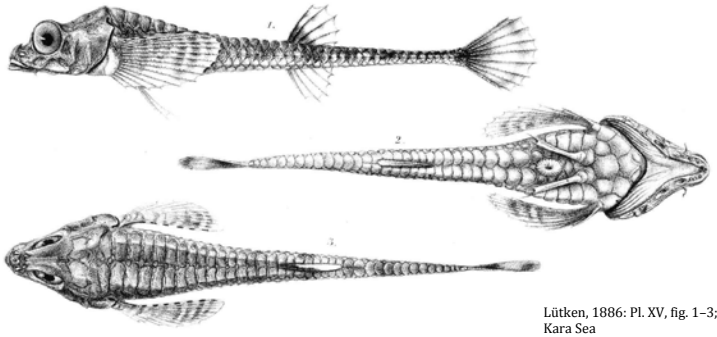
Small juveniles (about 40 mm or less) differ from the adults by having pectoral fins with a narrow blackish band in the middle and broad blackish distal portion, spinelike keels on the plates, a projecting lower jaw, and the anus situated farther posteriorly.

Adults reach at least 100 mm TL in the Barents Sea (Wienerroither et al. 2011). The largest *A. olrikii* measured in UAM 1973 and RUSALCA 2004–12 bottom trawl catches in the Chukchi Sea was 76 mm, and the mean length was 49 mm (see chart). In the Barents Sea in 2004–08 the mean was 64 mm (Wienerroither et al. 2011). In the Gulf of St. Lawrence in 2004–08, the largest was 83 mm and the mean was 71 mm (Nozères et al. 2010). The relatively small average size of *A. olrikii* in the Pacific-Arctic could be an artifact of net mesh size or other gear differences, or there could be populational differences in size.



Relative abundance in Pacific-Arctic: The most numerous poacher in bottom trawl surveys of the Chukchi and Beaufort Seas, where this species has ranked 5–12th in abundance by number of fish caught (e.g., Frost and Lowry 1983, Mecklenburg et al. 2007; Appendix F).

Uncommon or rare in subarctic waters. In the Bering Sea, rare south of St. Matthew and Nunivak Islands (Mecklenburg et al. 2011). In the Gulf of St. Lawrence, was found at only 3% of stations sampled in 2004–2008 (Nozères et al. 2010), compared to 35–75% of stations sampled in the Chukchi Sea by the UAM 1973 and RUSALCA 2004, 2009, and 2012 bottom trawls.



Lütken, 1886: Pl. XV, fig. 1–3; Kara Sea

Taxonomy: Considered by some taxonomists to represent a separate genus *Ulcina* (e.g., Cramer 1896, Jordan et al. 1930, Kanayama 1991), this species is more appropriately classified in its original genus, *Aspidophoroides* (Mecklenburg et al. 2011). The close genetic similarity of *A. olrikii* to *A. monopterygius* may be seen in the barcode identification tree (Appendix B). The two species differ by a genetic distance of only 1.4%.

Aspidophoroides guentherii Bean, 1885 was described as a new species from Alaska but was later recognized (Rendahl 1931) from further study of the morphology to be the same as *A. olrikii* from Greenland and other Atlantic localities. The barcode database includes barcodes of *A. olrikii* from the Barents Sea and they are the same as those from the northern Bering, East Siberian, Chukchi, and Beaufort Seas, together exhibiting very low intraspecific variation (0.0%)

Pacific-Arctic Marine Fishes, DRAFT, CWM, 16 March 2013

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