

Identification of Larvae of Three Arctic Species of *Limanda* (Family Pleuronectidae)

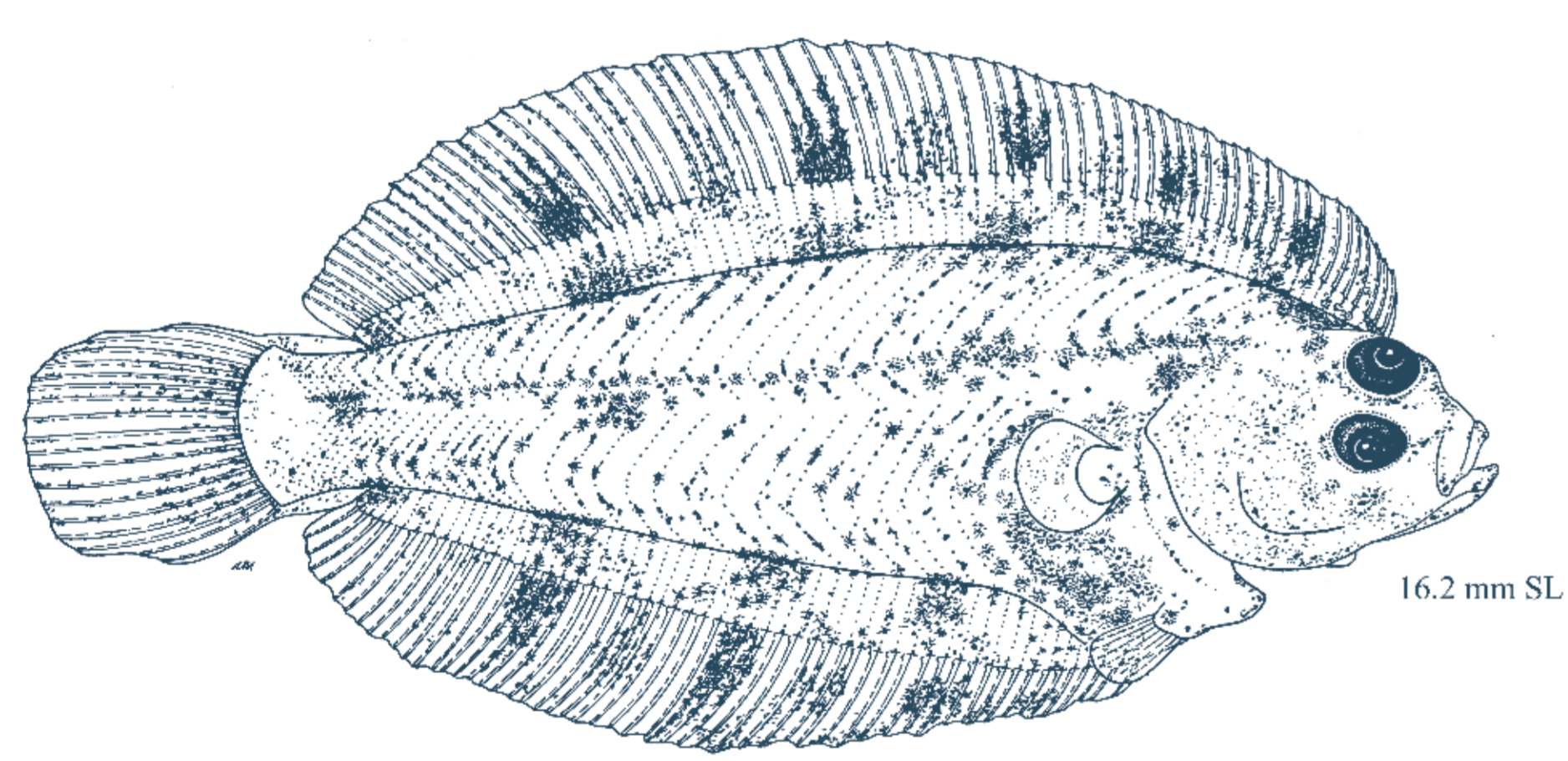
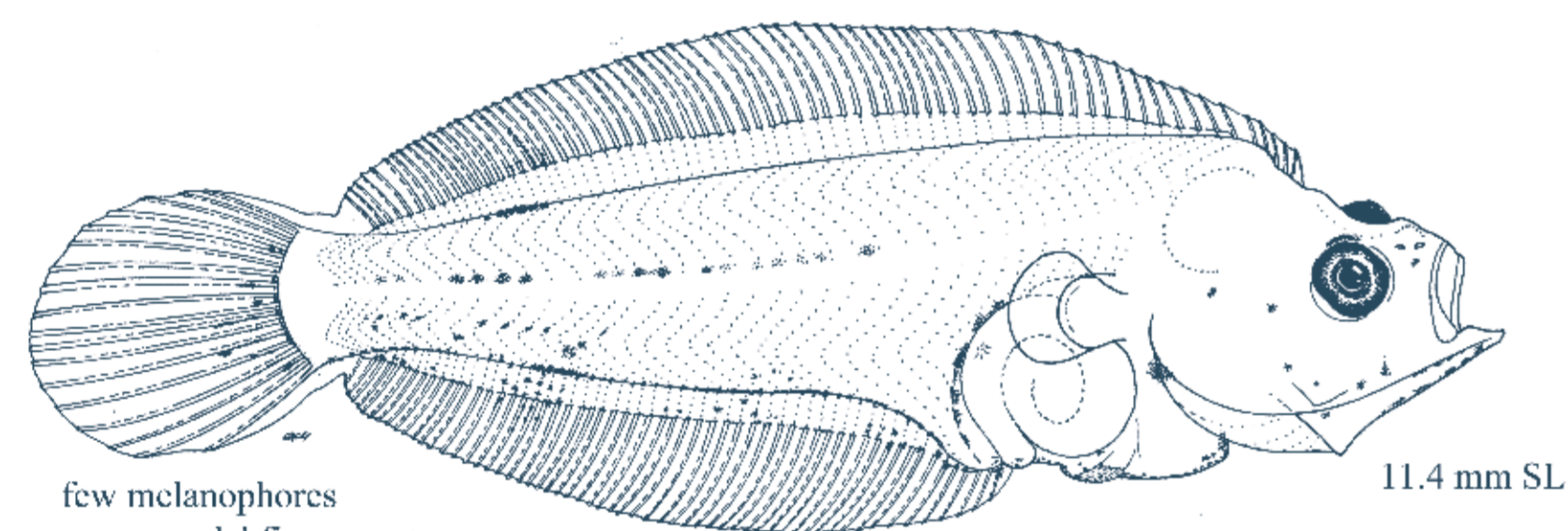
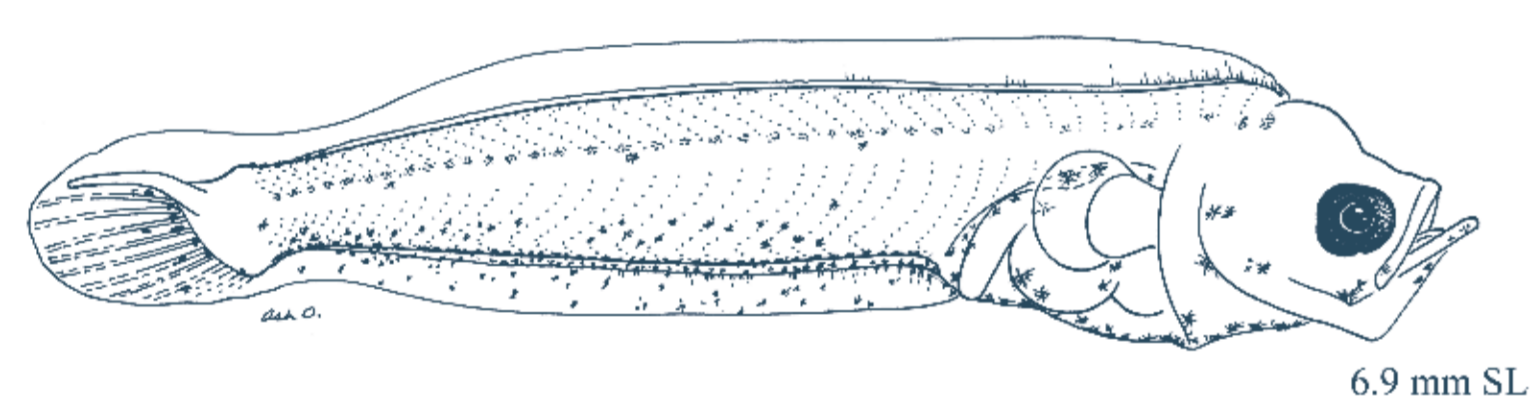
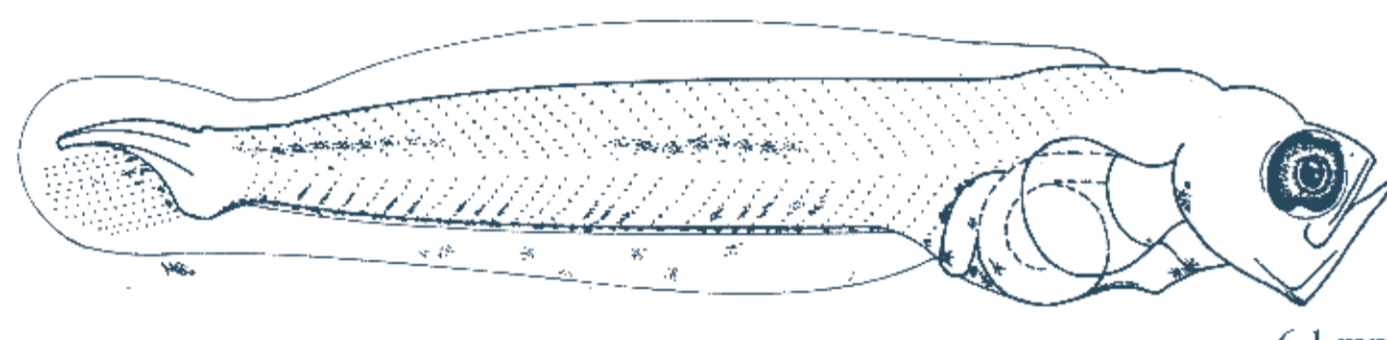
Introduction

Interest in assessment of Arctic ecosystems has increased recently as the result of climate change; in particular, diminished sea ice coverage and concentration. Increased potential for oil and gas development and expanded transportation routes are other notable economic considerations. A goal of several scientific programs including the Arctic Ecosystem Integrated Survey (Arctic EIS); Chukchi Acoustics, Oceanography, and Zooplankton (CHAOZ); and Russian-American-Long-Term Census of the Arctic (RUSALCA) is to assess the abundance and distribution of ichthyoplankton in Arctic ecosystems. Central to the success of these programs is the ability to identify organisms at all life stages. Identification of all life stages of fishes is necessary for baseline assessments of population structure and abundance and to understand life history processes.

The Recruitment Processes Program at the Alaska Fisheries Science Center has begun work on an identification guide of early life stages of fish found in Arctic waters. The first family addressed will be the Pleuronectidae (right-eyed flounders). Mecklenburg et al. (2011) reported 10 species from the Arctic Ocean seas and adjacent boreal waters. Of these, members of the genus *Limanda* in the northern Bering, Chukchi, and Beaufort seas are among the most abundant species collected and are the focus of this study. Three species are known in the Arctic: *Limanda aspera* (Yellowfin Sole), *L. proboscidea* (Longhead Dab), and *L. sakhalinensis* (Sakhalin Sole).

Limanda aspera

Limanda aspera were previously known from the description and illustrations of a developmental series presented in Pertseva-Ostroumova (1961). However, some discrepancies were noted in the pigmentation between the material we compiled and that depicted in Pertseva-Ostroumova's series. Reproductions of those illustrations were of generally poor quality, therefore a new developmental series was illustrated.



Distinguishing Characters:

EARLY-STAGE LARVAE

- Slash-like hypaxial melanophores
- Pigment on anal fin

LATE-STAGE LARVAE

- Few melanophores on caudal fin
- Small size at transformation (≤16.2 mm SL)

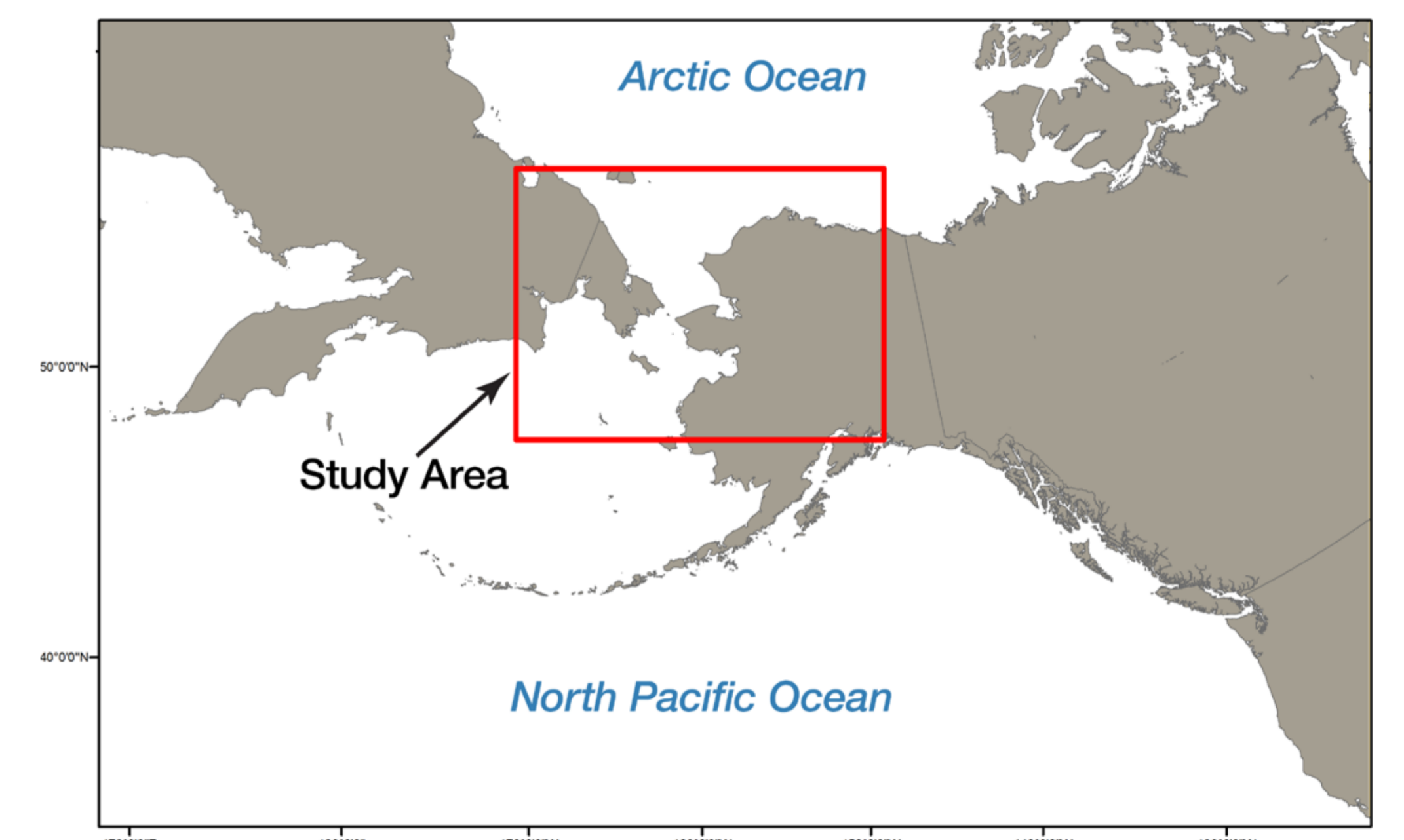
Methods

The study area is in the North Pacific Ocean, defined with a southern boundary in the Bering Sea at latitude 62°N and extending northward into the Chukchi and Beaufort seas, which at present is the northern limit of our sampling. This area is well within the boundary of the Arctic marine ichthyofaunal region as defined by Mecklenburg et al. (2011). Larvae were collected during 12 cruises from 2004 to 2013 with a 60-cm bongo sampler and 1-m Tucker sled trawl; bottom depth at most stations was 10–50 m. Morphometric measurements were taken on the right side of up to 50 larvae of each species, when possible; body depth is defined as the vertical distance from dorsal to ventral body margin at the center of the anus. Selected specimens were cleared and differentially stained to count meristic structures and follow sequence of fin development.

Cleared and stained transformation-stage larva of *Limanda proboscidea* (36.0 mm SL). Photo by Karna McKinney.

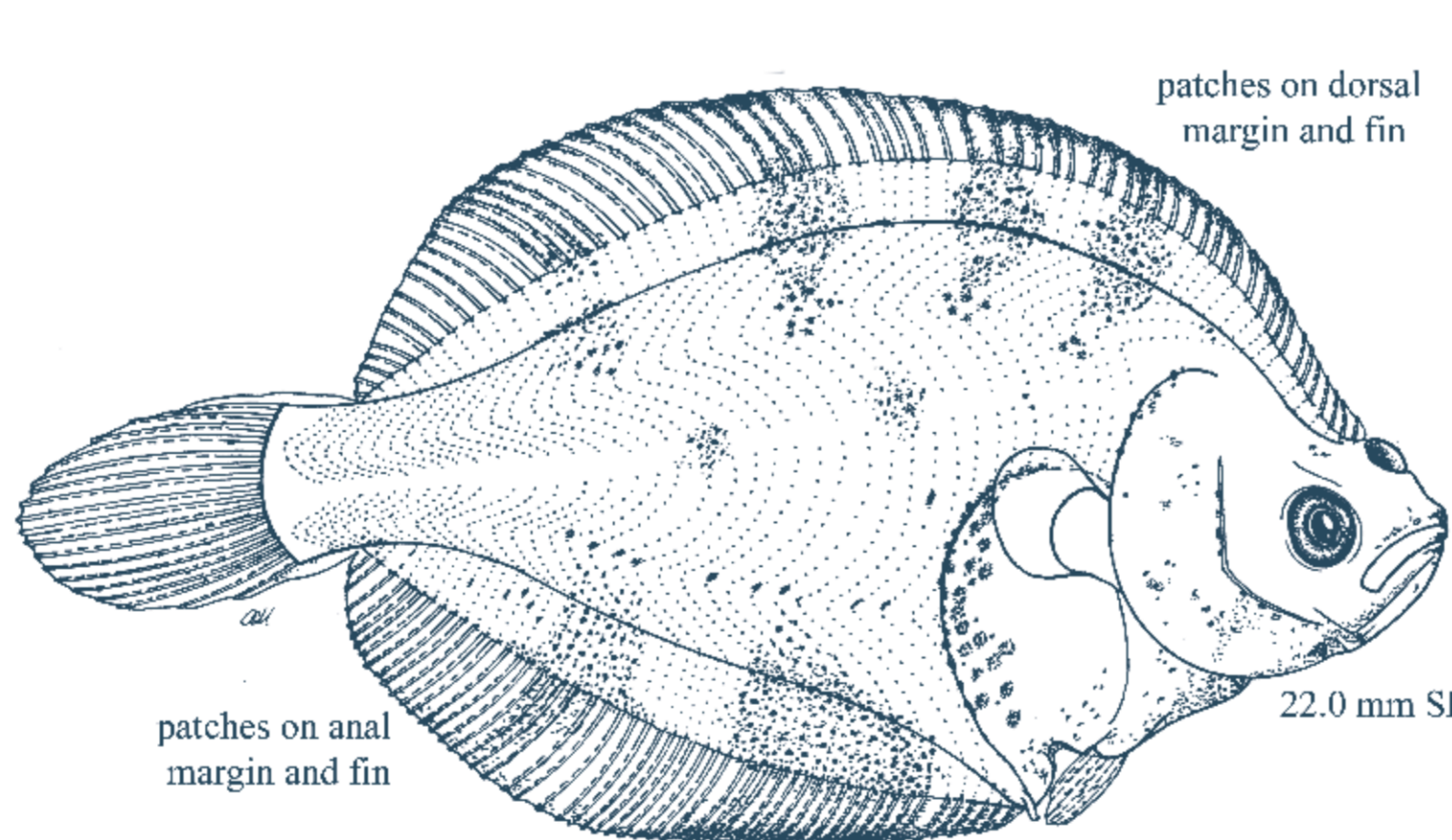
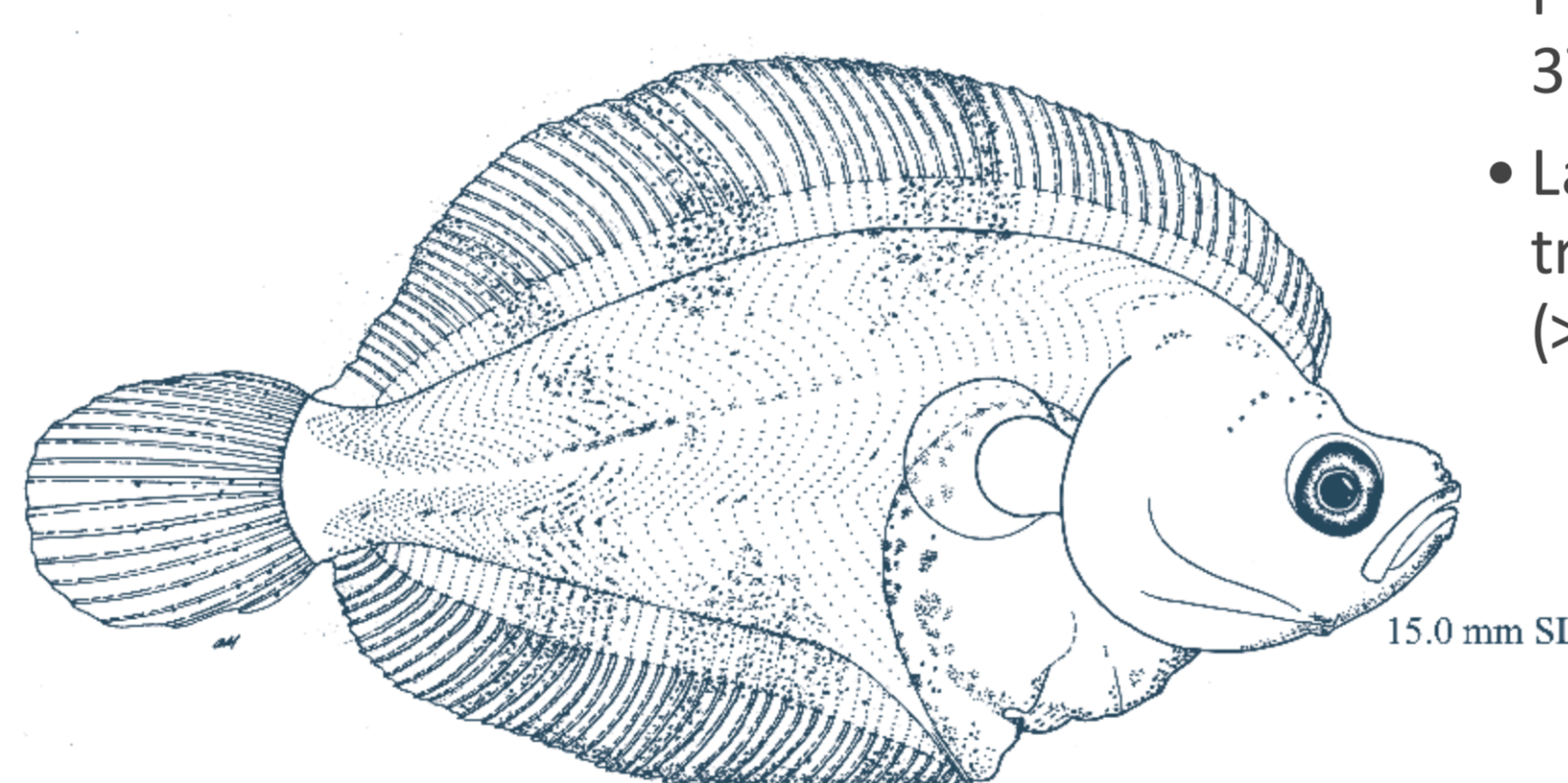
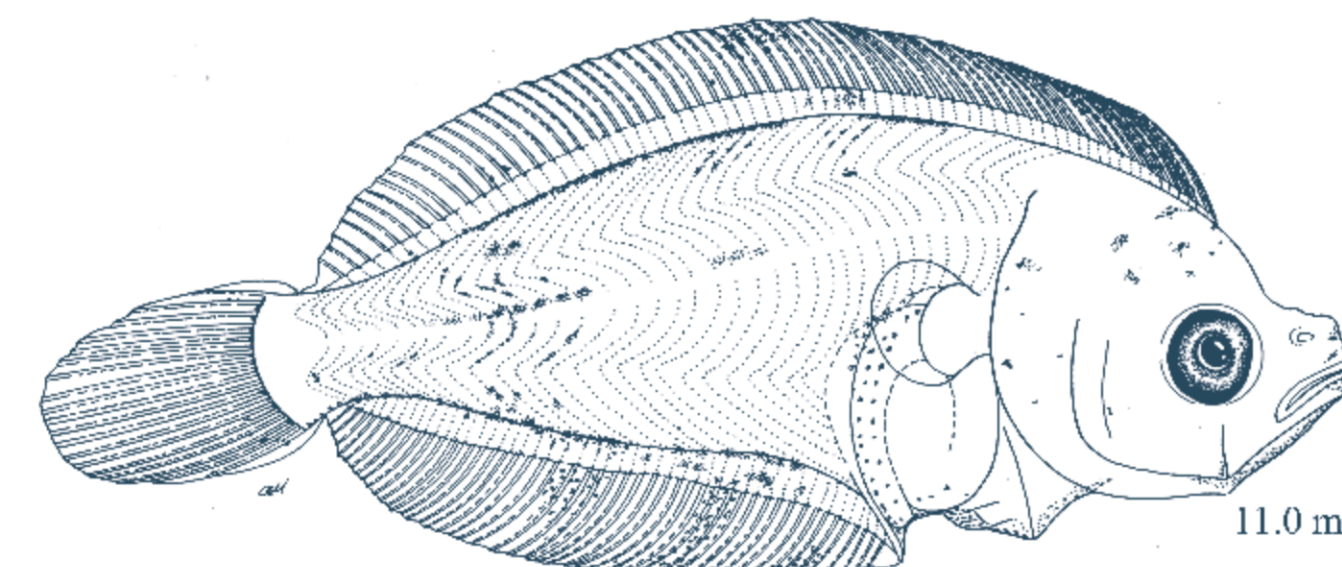
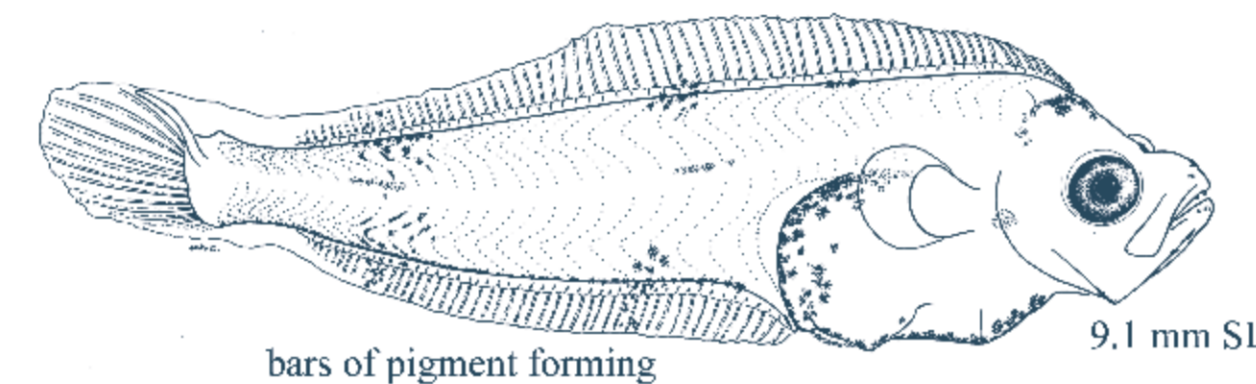
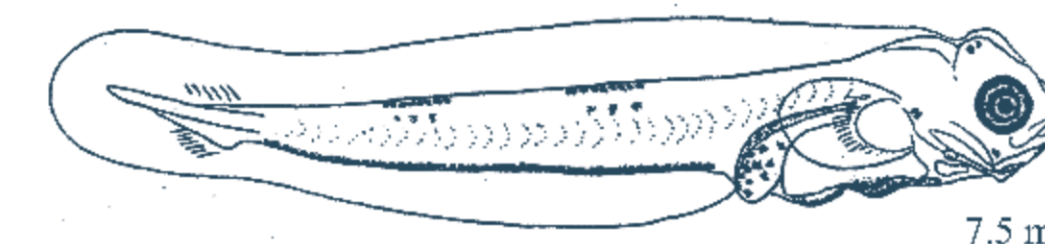
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Limanda proboscidea

Preflexion and early flexion-stage larvae of *Limanda proboscidea* were initially identified using the characters and illustrations in Grigor'ev (2004). Late flexion and postflexion stage larvae were originally thought to be Arctic Flounder (*Pleuronectes glacialis*). However, counts of anal-fin rays were determined to be too high for that species (45–58 *L. proboscidea* vs. 33–46 *P. glacialis*) and a DNA barcode match further verified the identifications as *L. proboscidea* (C. W. Mecklenburg, pers. comm.).



Distinguishing Characters:

EARLY-STAGE LARVAE

- Pigment along dorsal margin of body
- Two "bars" of pigment on postanal body
- Deepest body depth: Flexion stage = 24.0% BD/SL

LATE-STAGE LARVAE

- Patches along dorsal and anal margins and fins
- Deepest body depth: Postflexion stage = 37.8% BD/SL
- Large size at transformation (>35.1 mm SL)

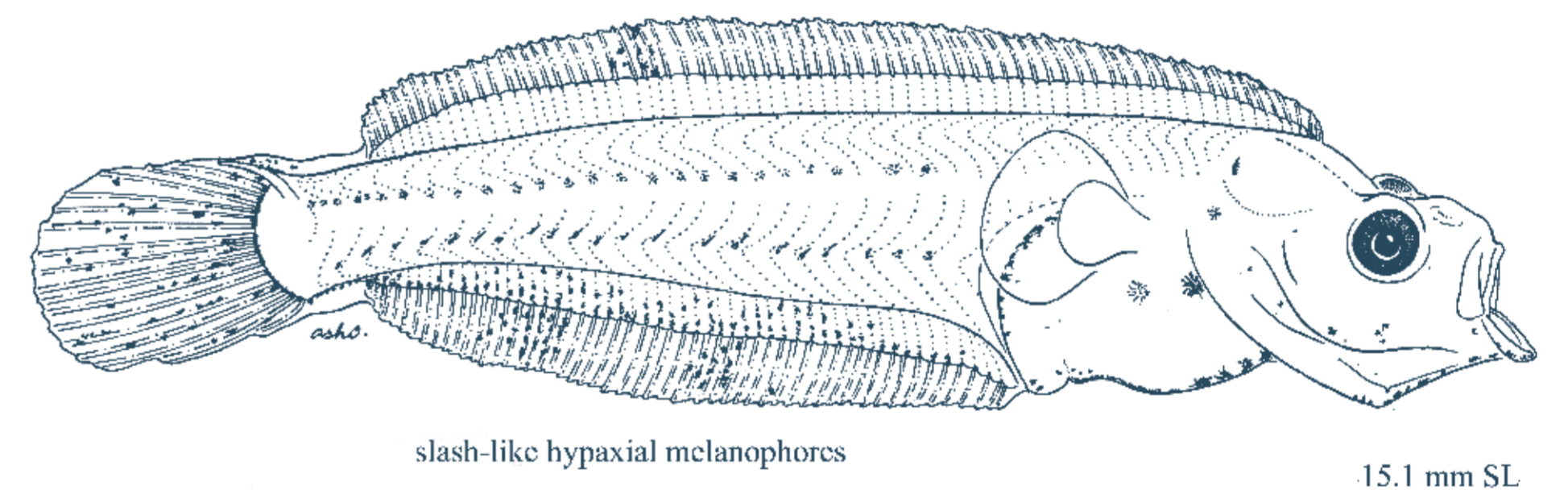
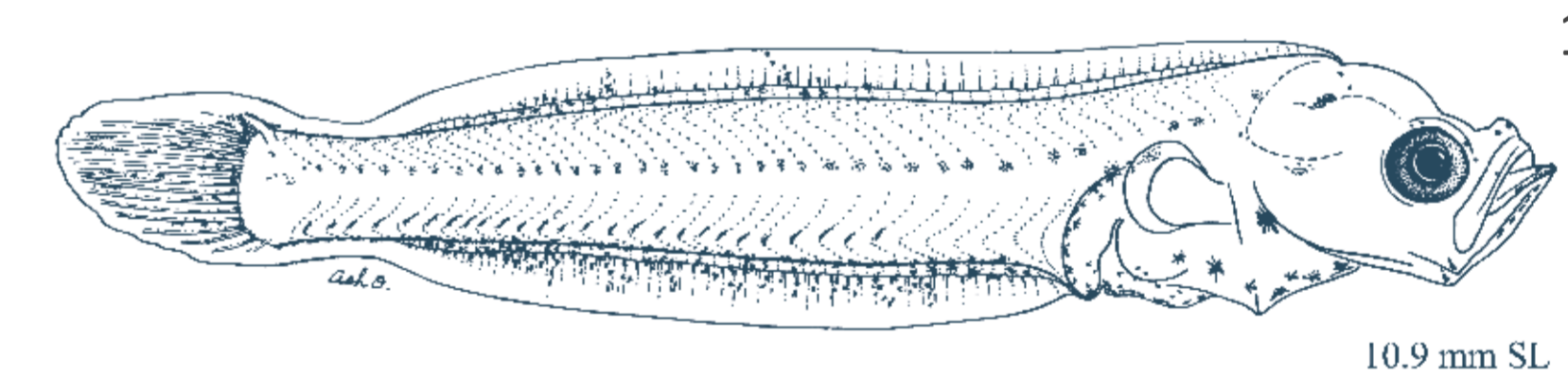
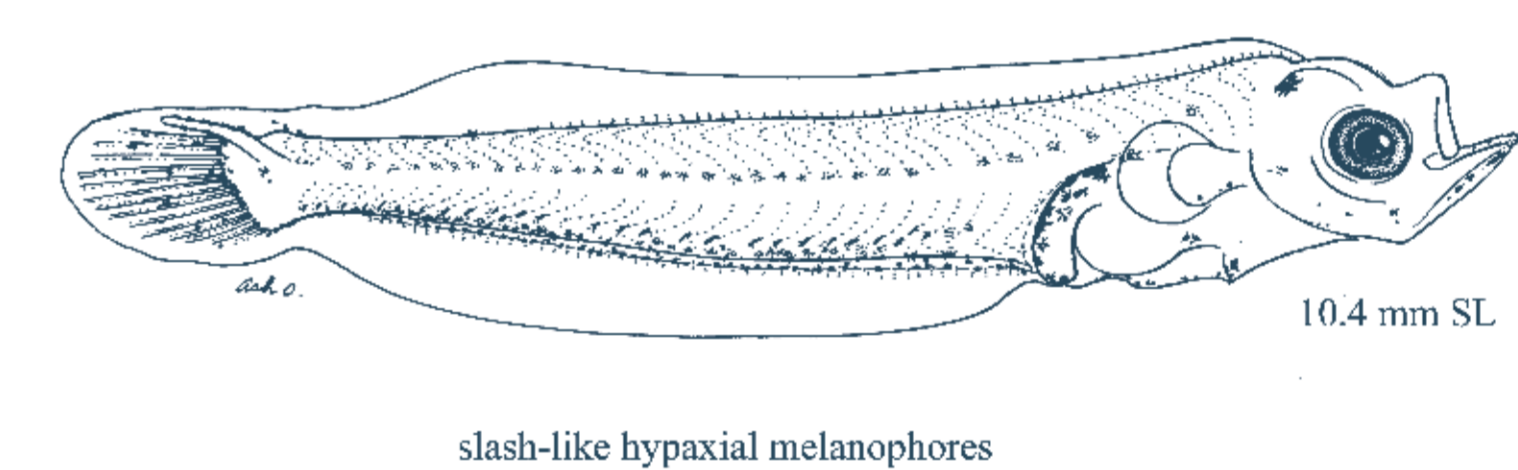
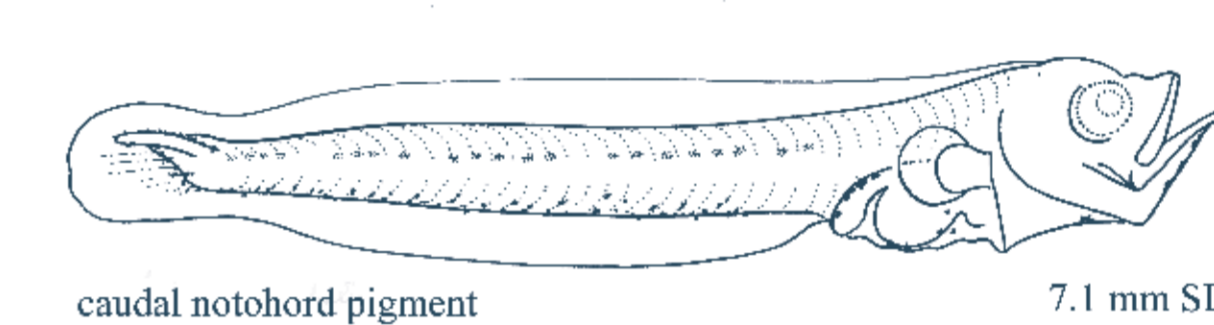
Distinguishing Characters:

EARLY-STAGE LARVAE

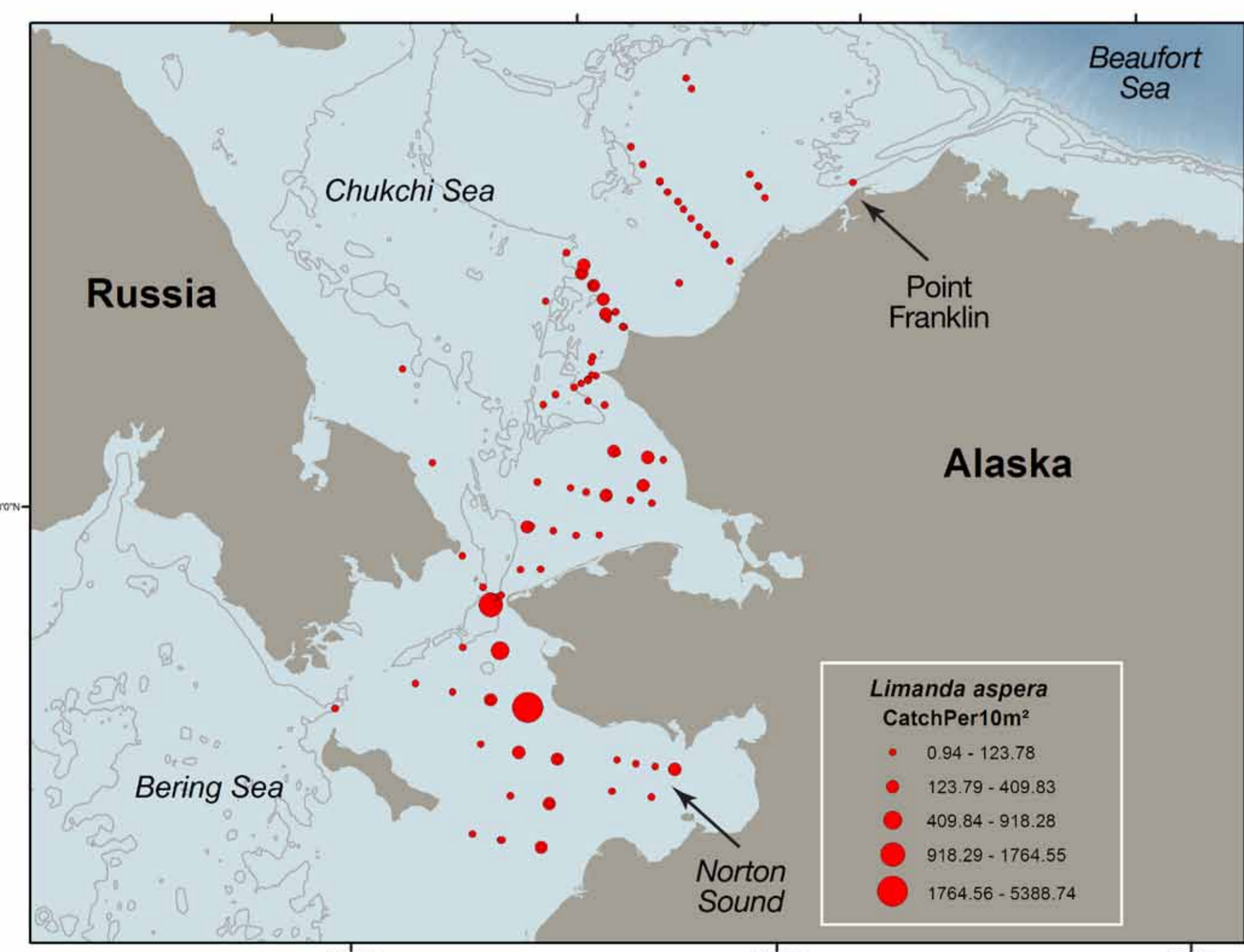
- Slash-like hypaxial melanophores
- Pigment around notochord tip and on caudal margin
- Most slender body: Flexion stage = 16.9% BD/SL

LATE-STAGE LARVAE

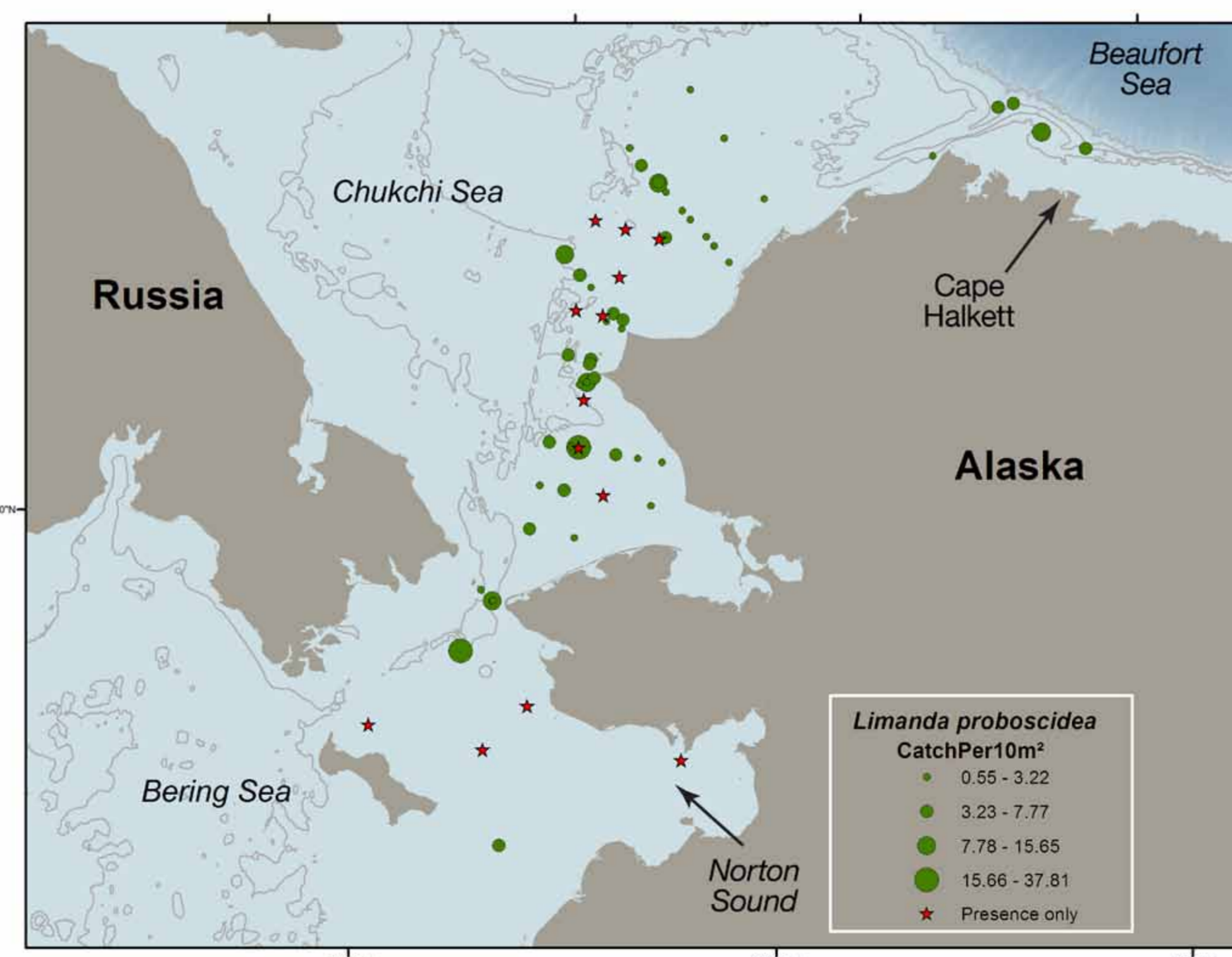
- Slash-like hypaxial melanophores
- Pigment along edge of caudal margin
- Most slender body: Postflexion stage = 19.9% BD/SL



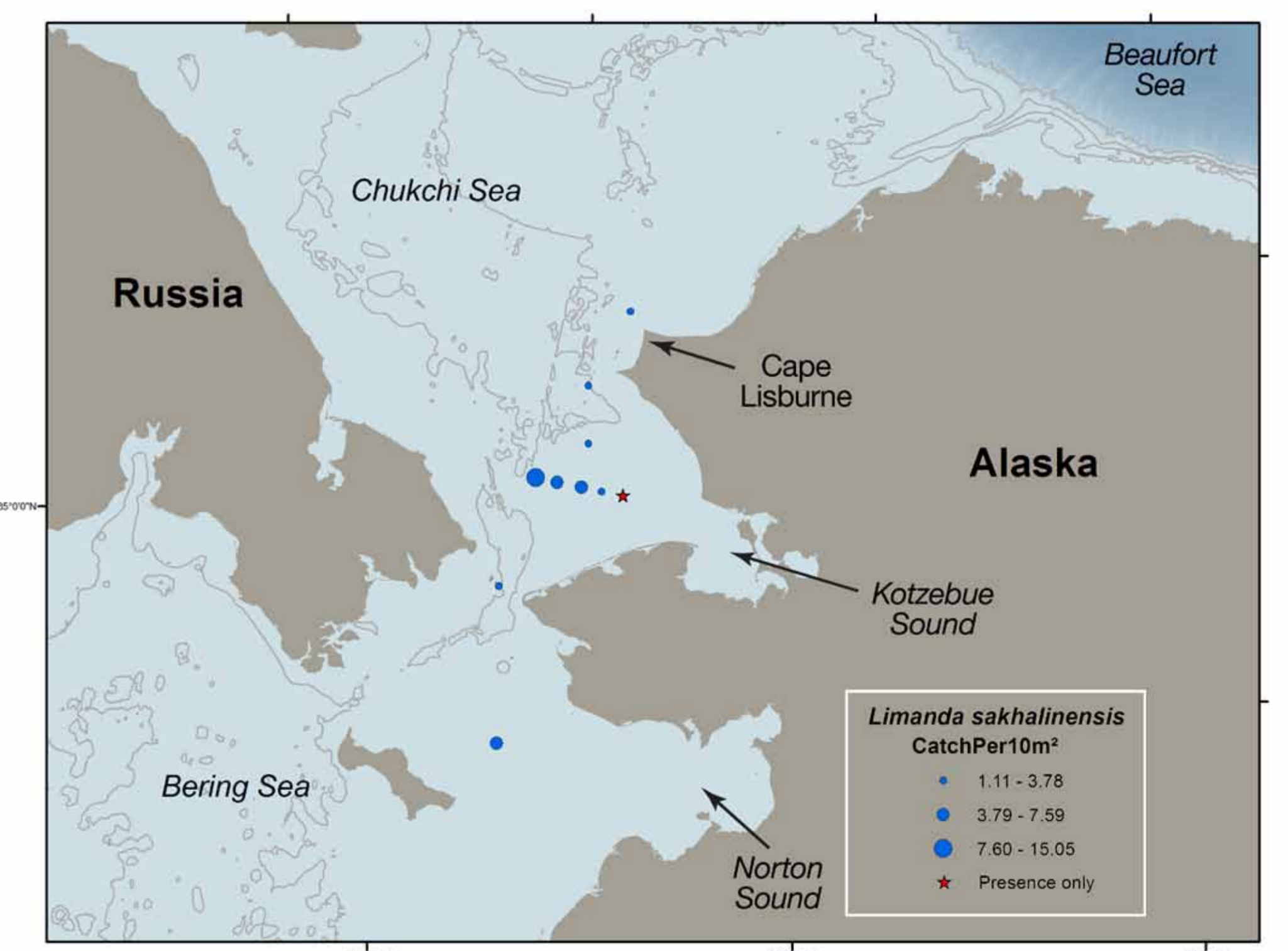
Larval illustrations by Ashlee Overdick



Although *Limanda aspera* larvae are found as far south as Kodiak Island in the Gulf of Alaska, Arctic specimens are found from Norton Sound to Point Franklin. It is the most commonly occurring of the *Limanda* species and by far the most abundant; in areas of highest abundance, catches are more than 100 times greater than either of the other two species.



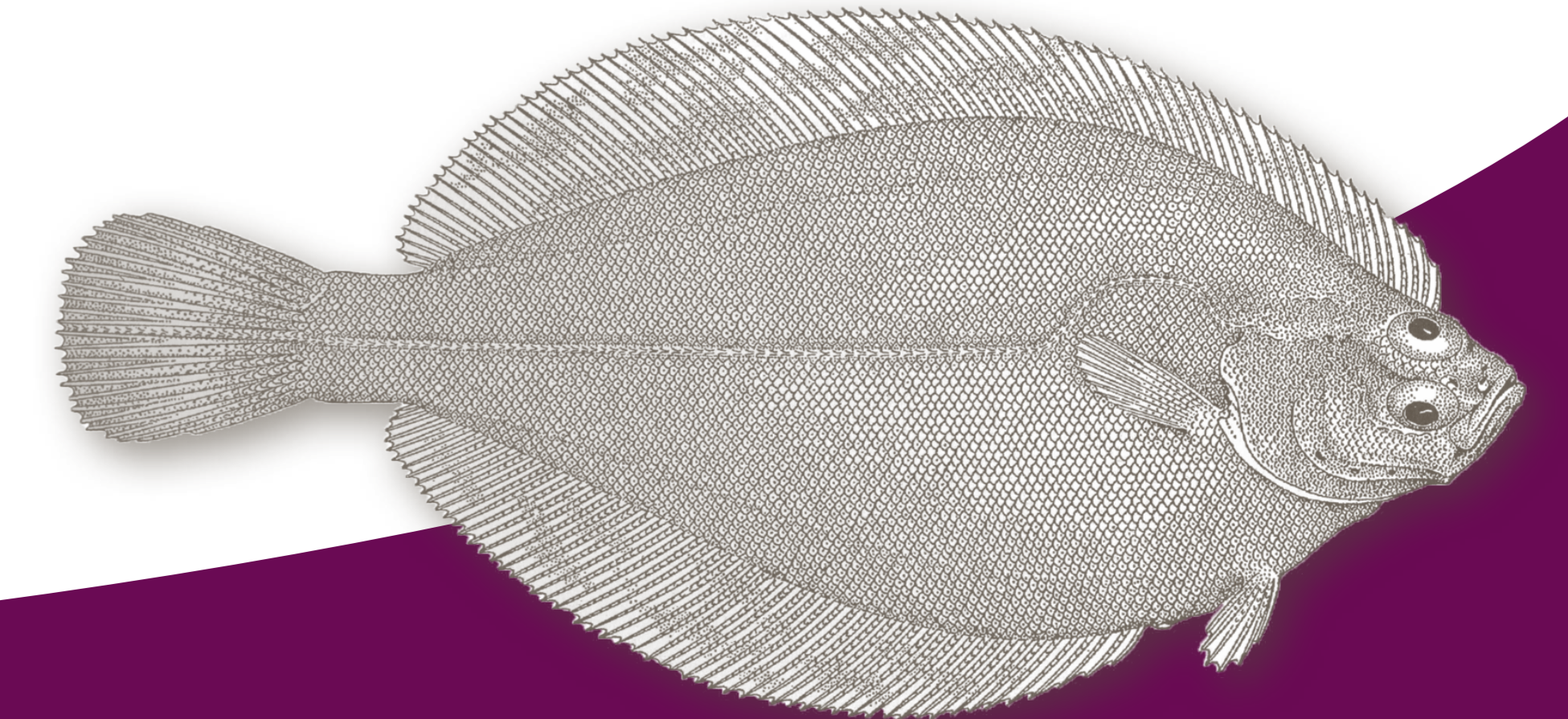
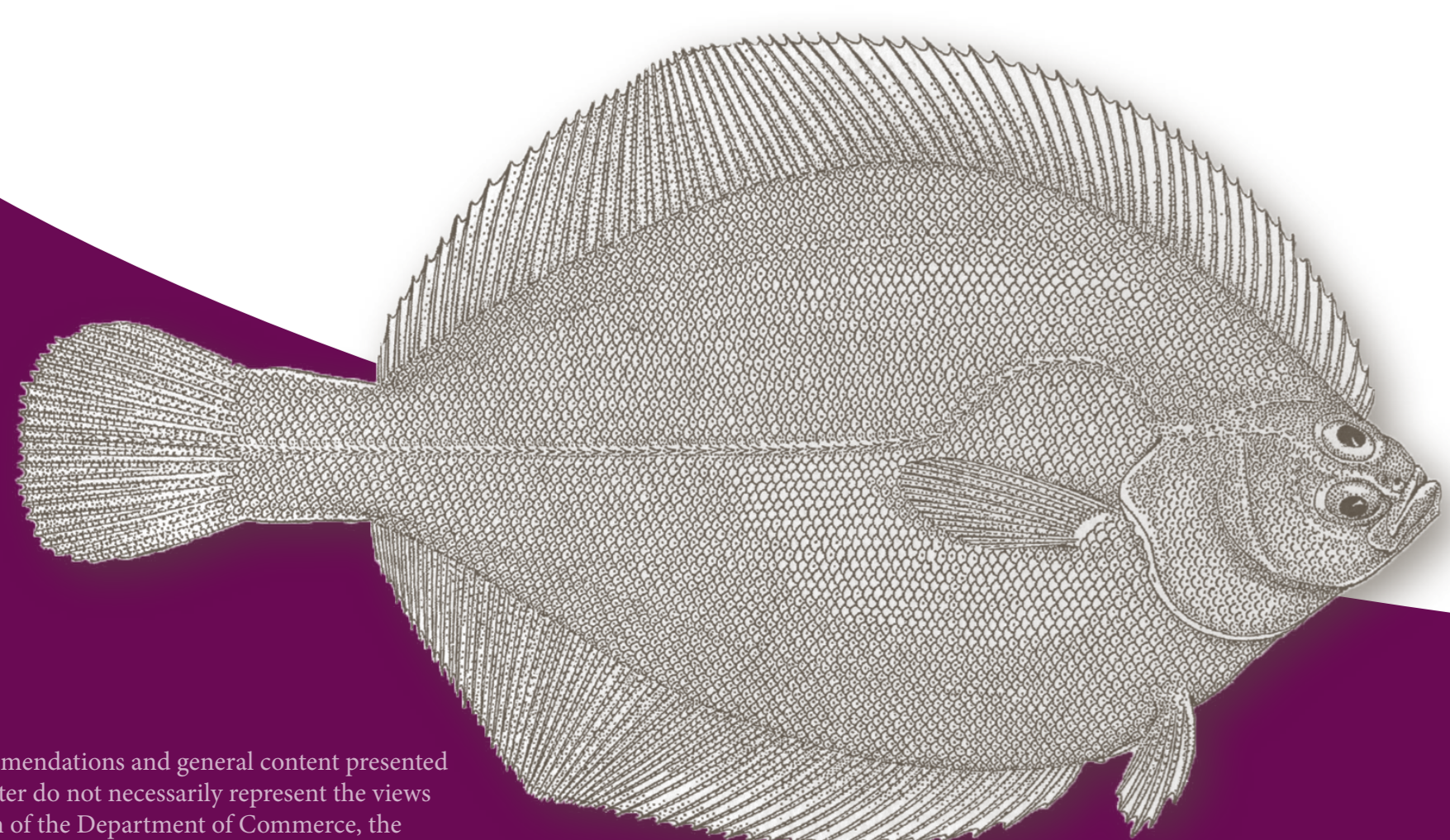
Limanda proboscidea larvae have the widest Arctic distribution of the *Limanda* species; they are found just south of Norton Sound to the area off Cape Halkett in the Beaufort Sea.



Limanda sakhalinensis larvae are uncommon within the Arctic area; at the present time we have collected only 16 specimens. Found from outside Norton Sound to Cape Lisburne, most larvae have been collected outside Kotzebue Sound.

REFERENCES

- Grigor'ev, S.S. 2004. Description of the longhead dab *Limanda proboscidea* (Pleuronectidae) larvae from the Sea of Okhotsk. *Journal of Ichthyology* 44:152-157.
- Mecklenburg, C. W., T. A. Mecklenburg, and L. K. Thorsteinson. 2002. *Fishes of Alaska*, 1037 p. American Fisheries Society, Bethesda, MD.
- Mecklenburg, C.W., P.R. Møller, and D. Steinke. 2011. Biodiversity of Arctic marine fishes: taxonomy and zoogeography. *Marine Biodiversity* 41:109-140.
- Pertseva-Ostroumova, T.A. 1961. The reproduction and development of far-eastern flounders. *Tr. Inst. Okeanol. Akad. Nauk. SSSR*, 484 p.



Adult illustrations: Mecklenburg et al. 2002