Stable isotopic comparison between otoliths of chum salmon and sockeye salmon

Yongwen Gao, PhD
Makah Fisheries Management
E-mail: gaoy@olypen.com

Chum salmon in China

- The only salmon species (*Oncorhynchus keta*) in northeast China
- All estuaries are located in Russia or N Korea
- Few studies conducted because no biological observations available for salmon life history and population structure

Stable isotope analysis

In otoliths, we analyze aragonite powder samples:

$$CaCO_3 \Rightarrow CO_2$$

$$\Rightarrow \delta^{13}C + \delta^{18}O \text{ (from mass spectrometer)}$$

$\delta^{13}C$: *Food, metabolic sources; dietary shifts; trophic-level changes*

$\delta^{18}O$: *Water conditions (T; Salinity; chemical composition)*

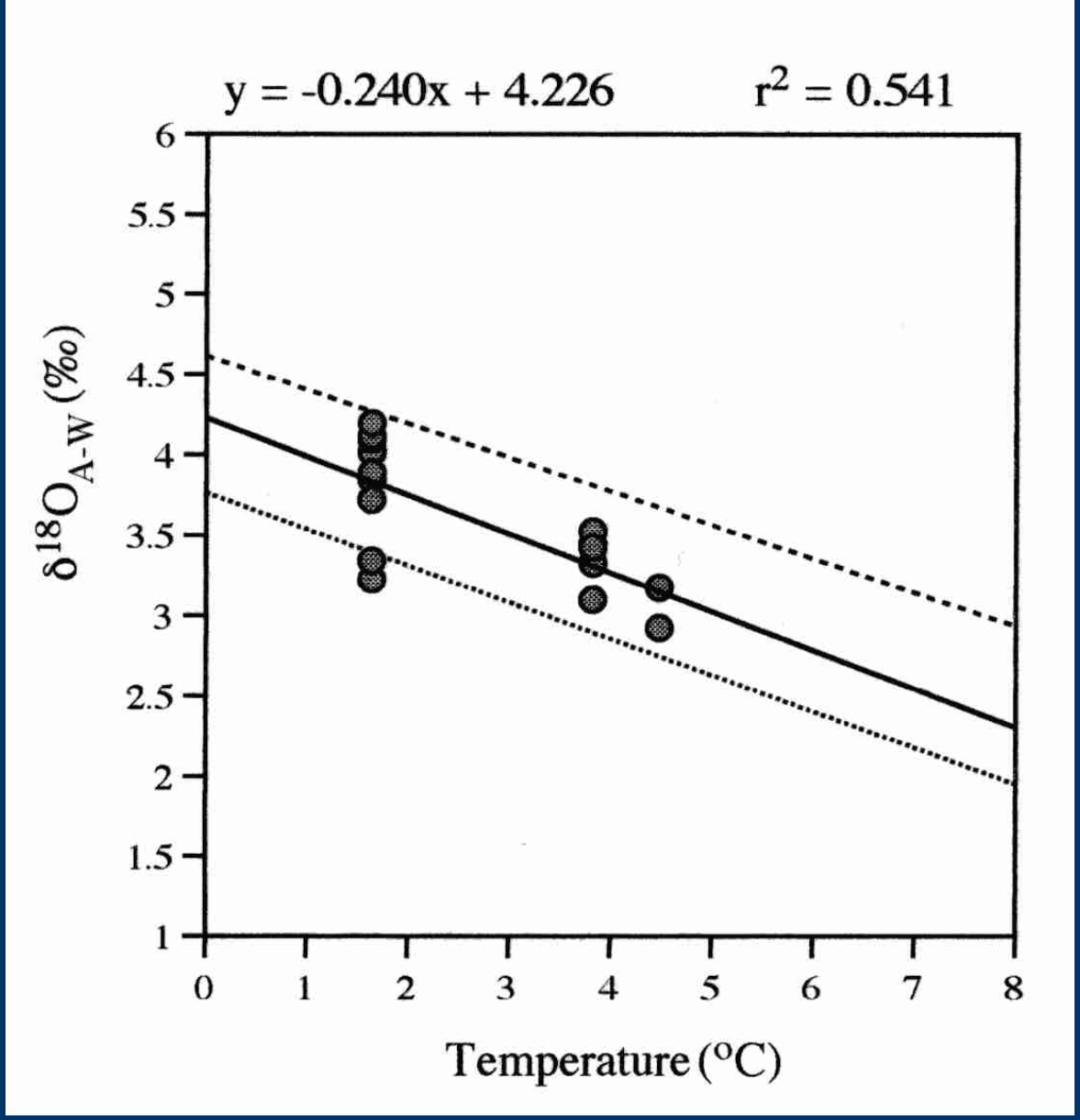
$\delta^{18}O$ versus $\delta^{13}C$

- **Initially documented** by *Keith & Weber (1965)*
- May show **kinetic and metabolic effects** in rapid-growth carbonate skeletons (*McConnaughey, 1989a;1989b*)
- Can be used as a "**Habitat Index**" in fish otolith studies (*Gao & Beamish, 1999*)

The principle of using stable isotopic composition in fish otoliths

- Otoliths are *formed in, or very close to, oxygen isotopic equilibrium with the ambient seawater*, so the isotopic fractionation between carbonate mineral and water phase is temperature dependent:

$$10^3 \ln\alpha = A + B/T^2$$



Oxygen isotopic temperature scale of Atlantic cod from opaque otolith zones and the summer survey data *(Gao, 2002)*

Microsampling methods

- Micro-miller

  -at 20-40 μm interval

- DM-2800

  -for seasonal growth zones

- Dremel

  -for annual growth zones

(e.g., Patterson et al., 1993; Dettman & Lohmann, 1995; Gao, 1999)

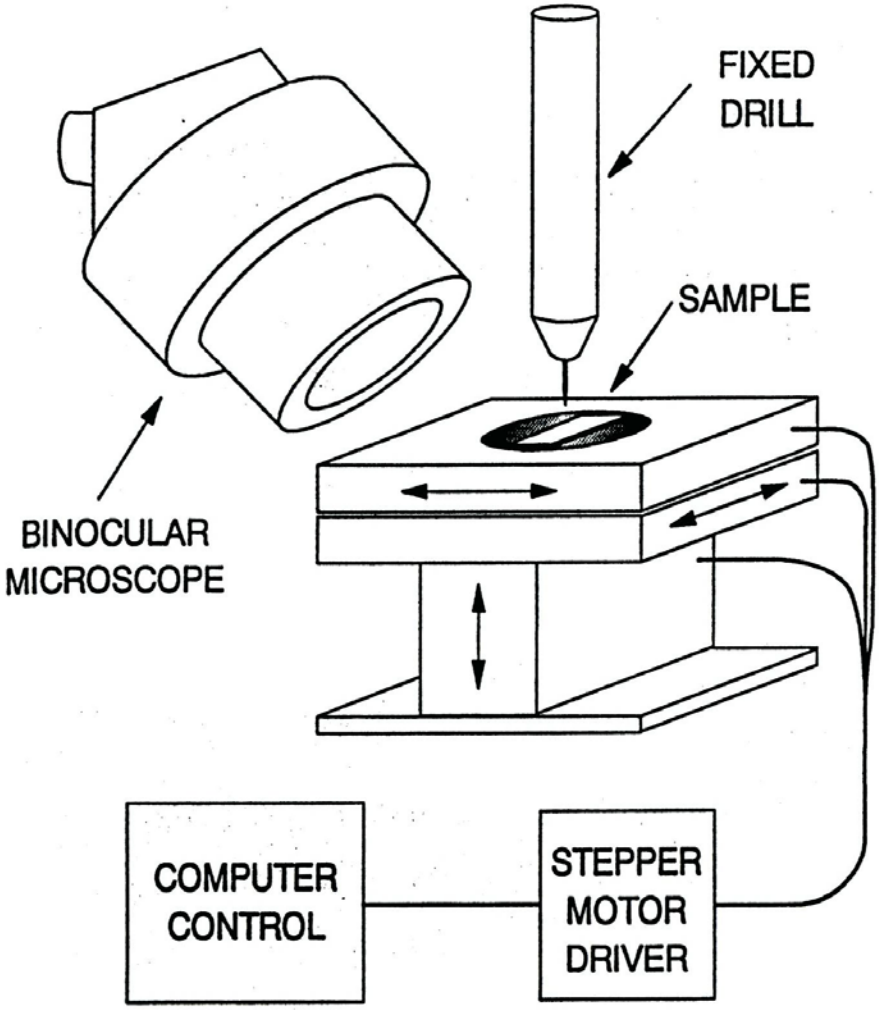


FIG. 1.—Microdrill assembly.

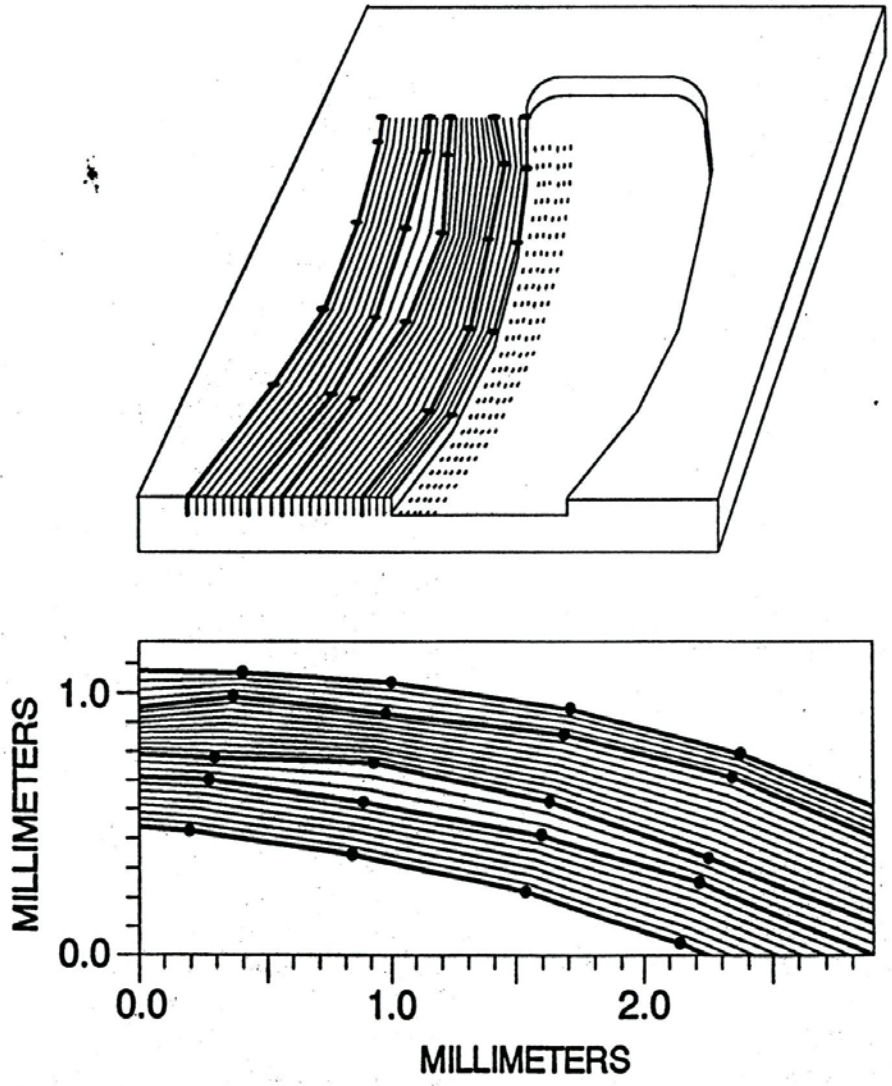
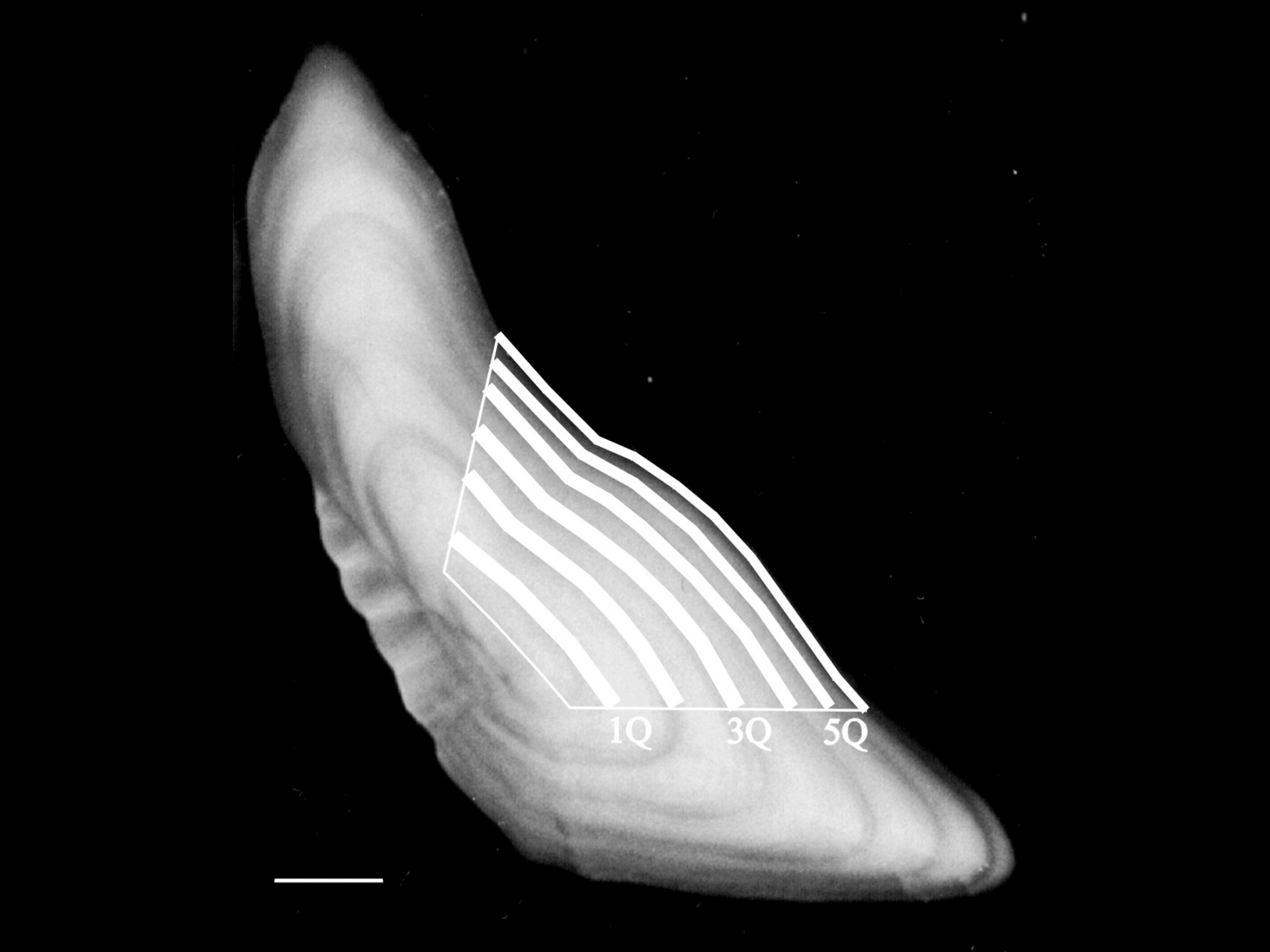


FIG. 2.—Part of the drill-path map for the bivalve in Figure 3. Heavy lines are digitized curves, which follow visible growth bands on a photo enlargement of the thick section. Fine lines are interpolated curves, which maintain equal spacing between any two adjacent digitized curves. Note how the interpolated curves respond to variations in growth rate at any point along a curve. Dimensions are taken from the thick section.

D. L. Dettman & K. C. Lohmann, 1994


1Q
3Q
5Q

A blind-test project

- ***Eighty-four otoliths*** were collected from Areas A, B, and C
- ***Two aragonite powder samples were taken*** from each otolith: one from the nucleus, the other from the 2nd summer rings
- ***Three representative otoliths*** for annual analysis

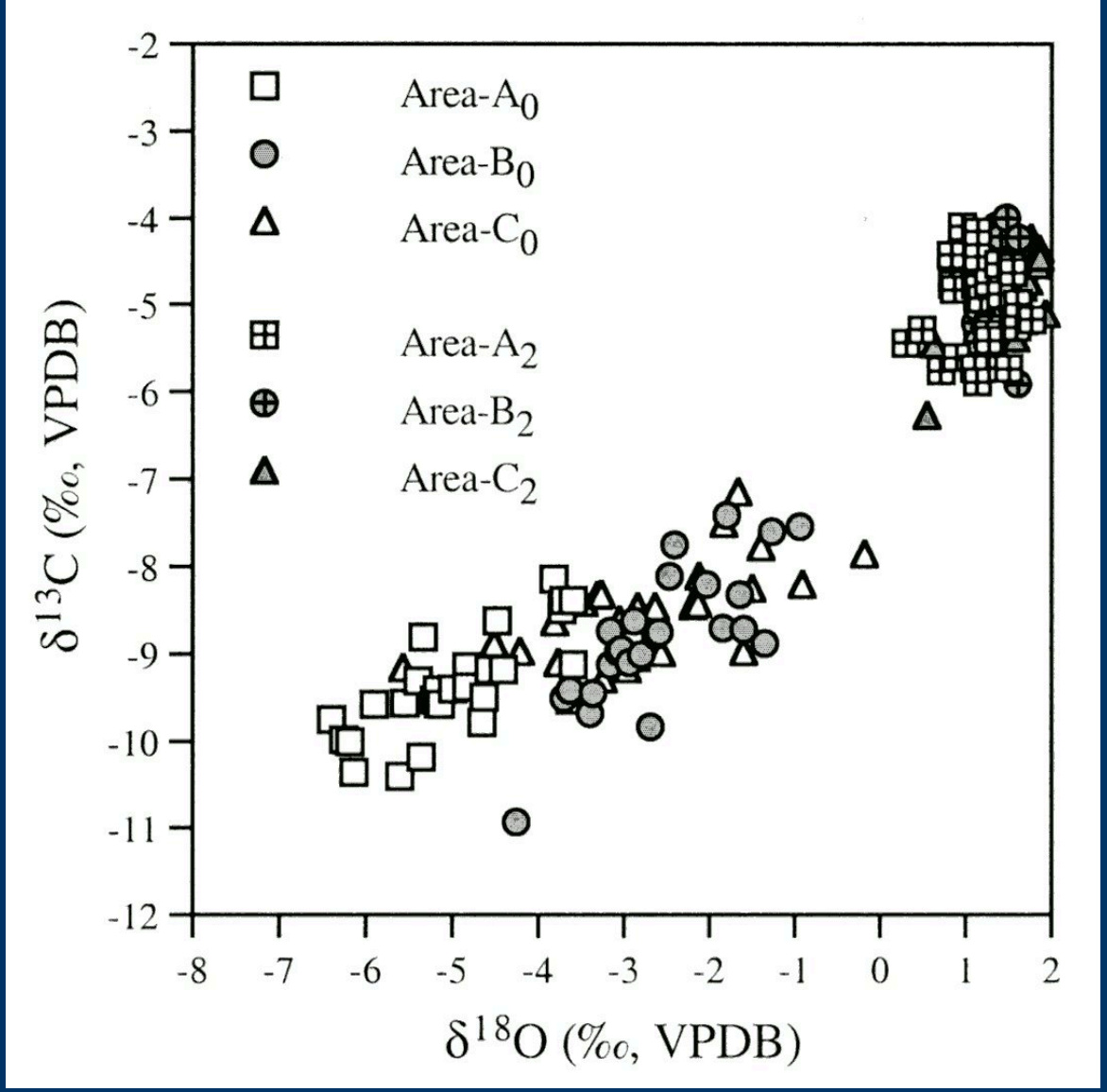


Fig. 1 The isotopic data of chum salmon otoliths from the nuclei and the 2nd summer otolith rings, showing a two-stage (freshwater and marine) life history for chum salmon in northeast China.

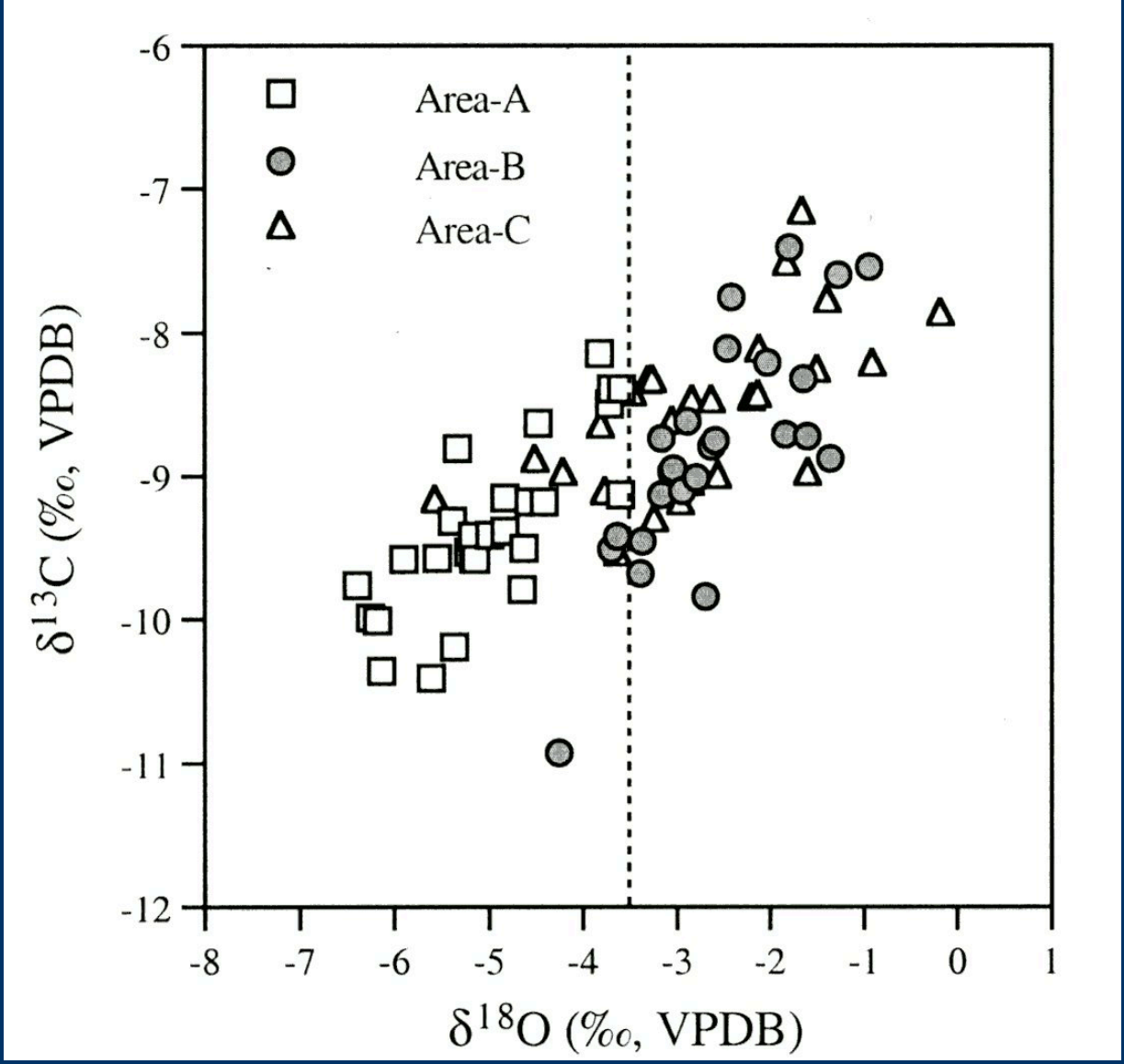


Fig. 2 The isotopic data from the nuclei of otolith samples among three areas, showing two chum spawning stocks or populations in this study.

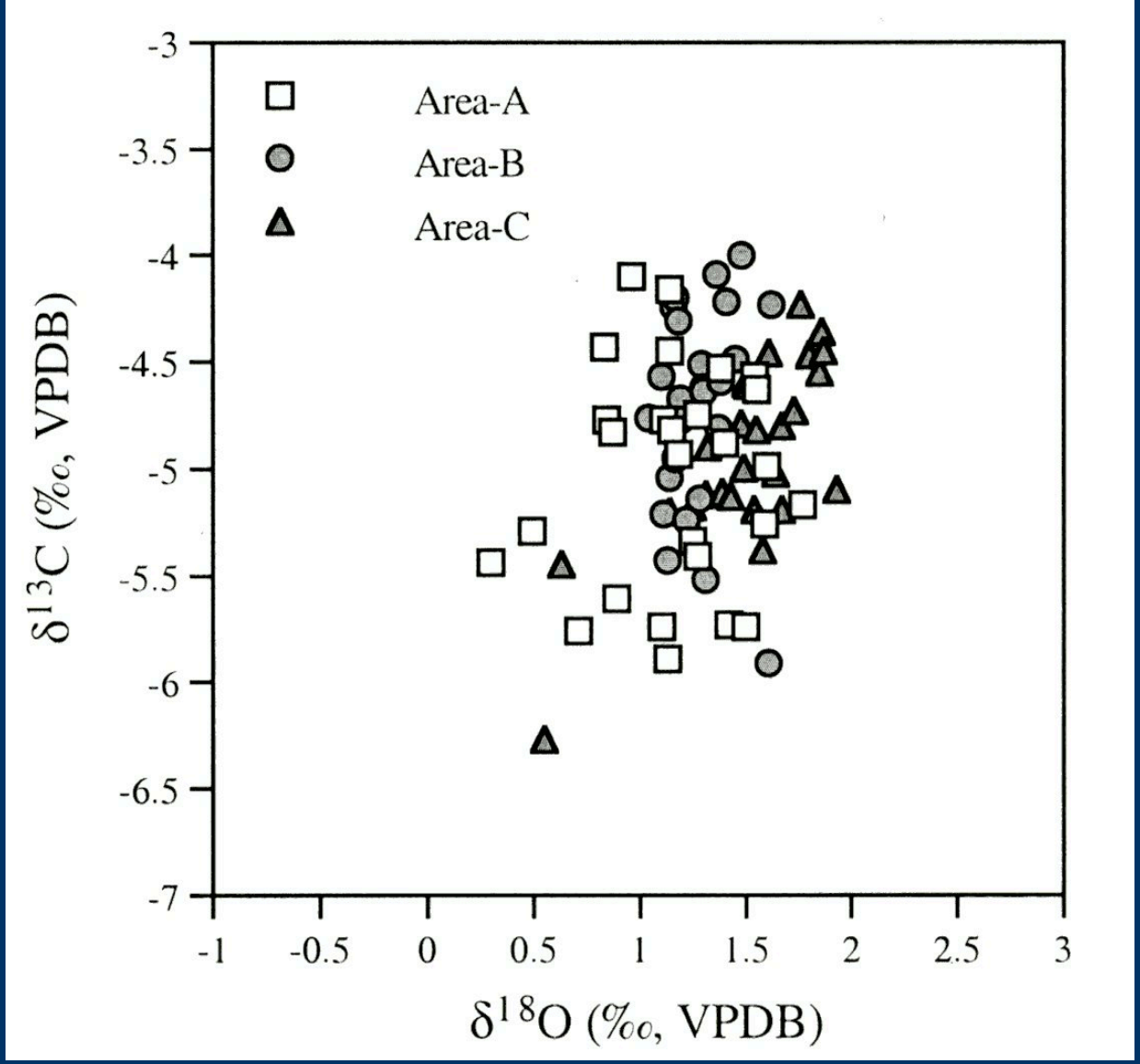


Fig. 3 The isotopic data from the 2nd summer otolith rings, indicating that after the ocean entry, all sampled chum salmon were lived in a similar habitat area.

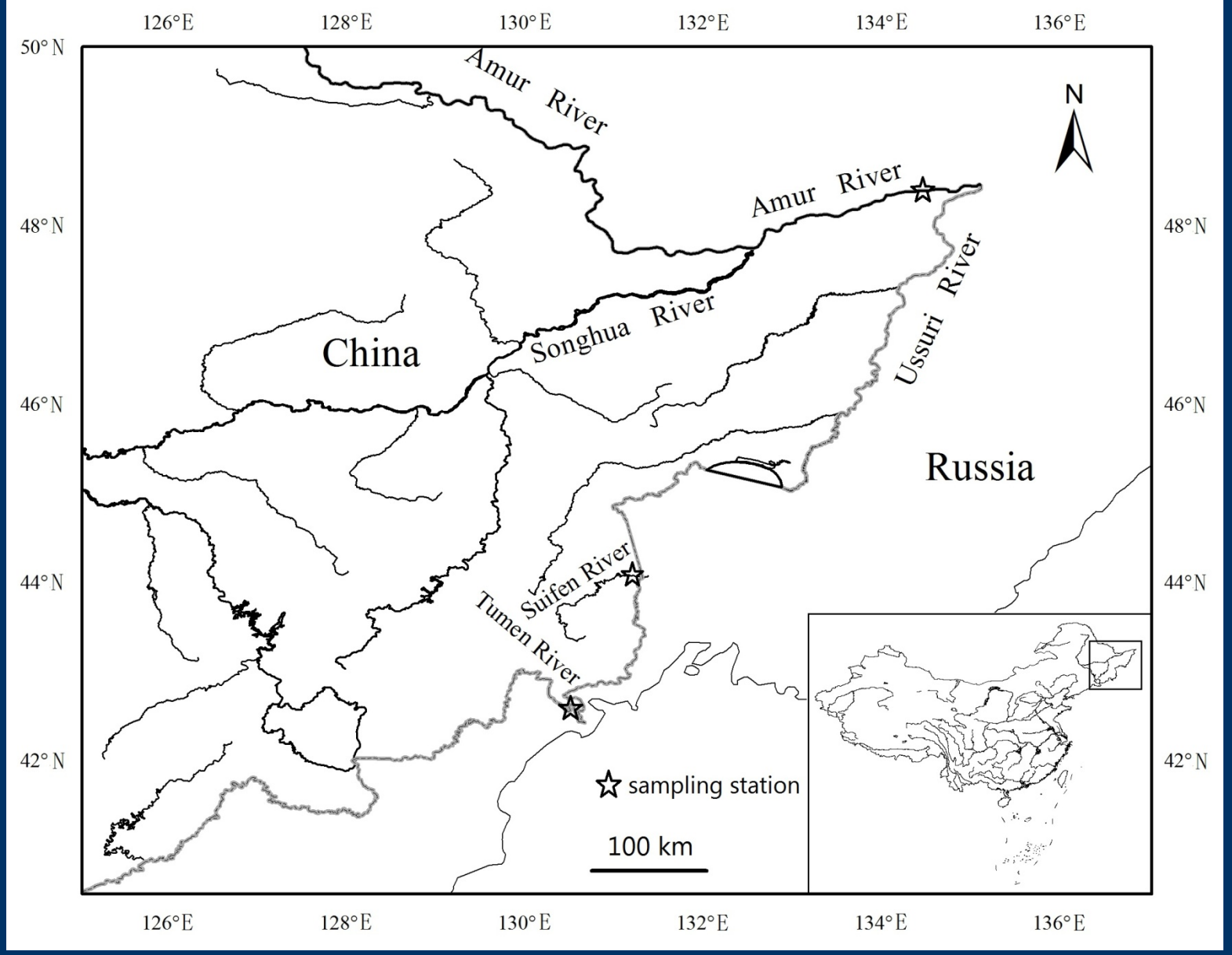


Fig. 4 Location map showing the otolith sampling stations in northeast China. Areas A, B, and C represent the Amur River, the Tumen River, and the Suifen River, respectively.

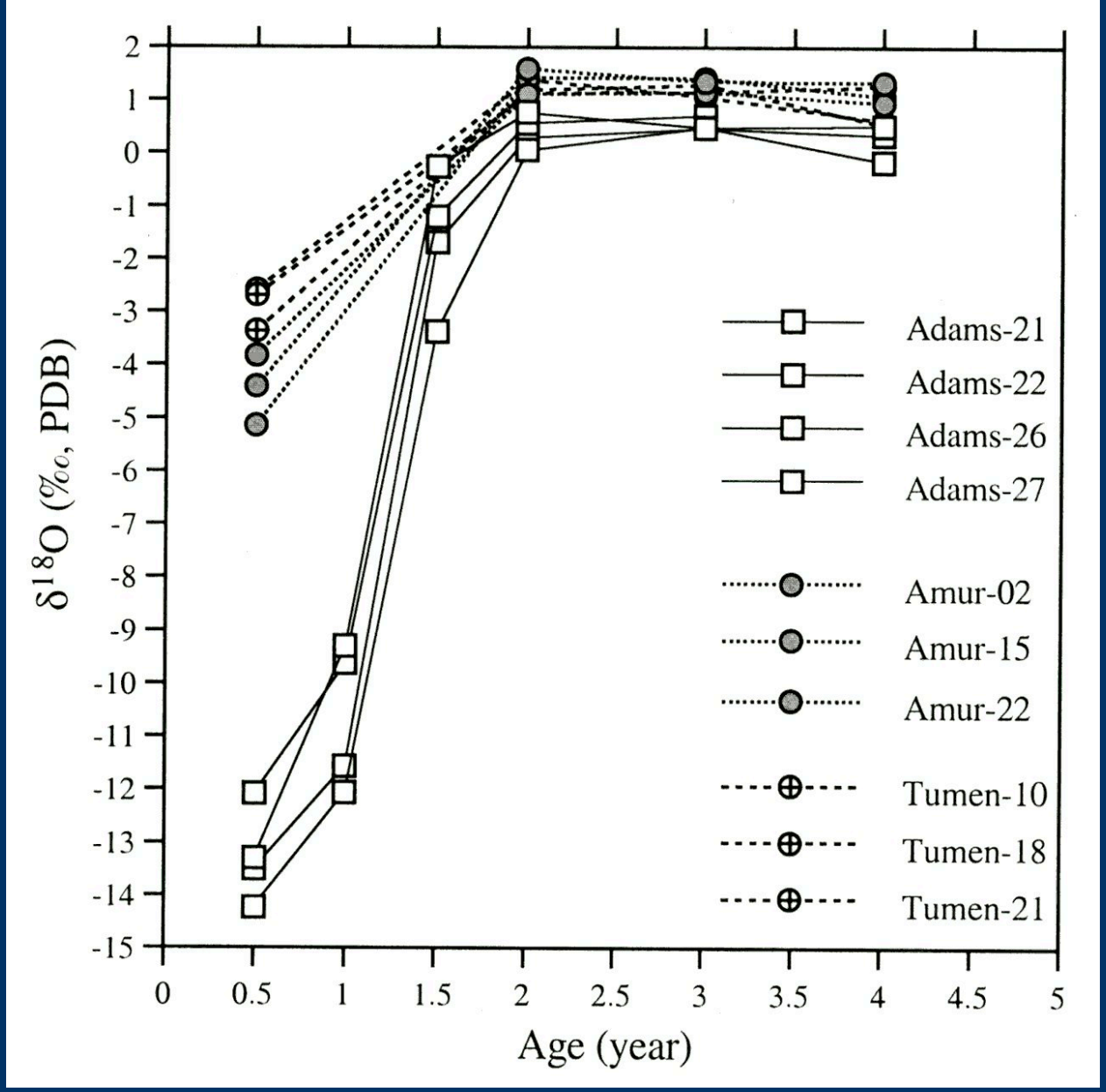


Fig. 5 The $\delta^{18}O$ variations of individual otolith samples from chum salmon and the Adams River sockeye salmon, showing annual changes and the full life history.

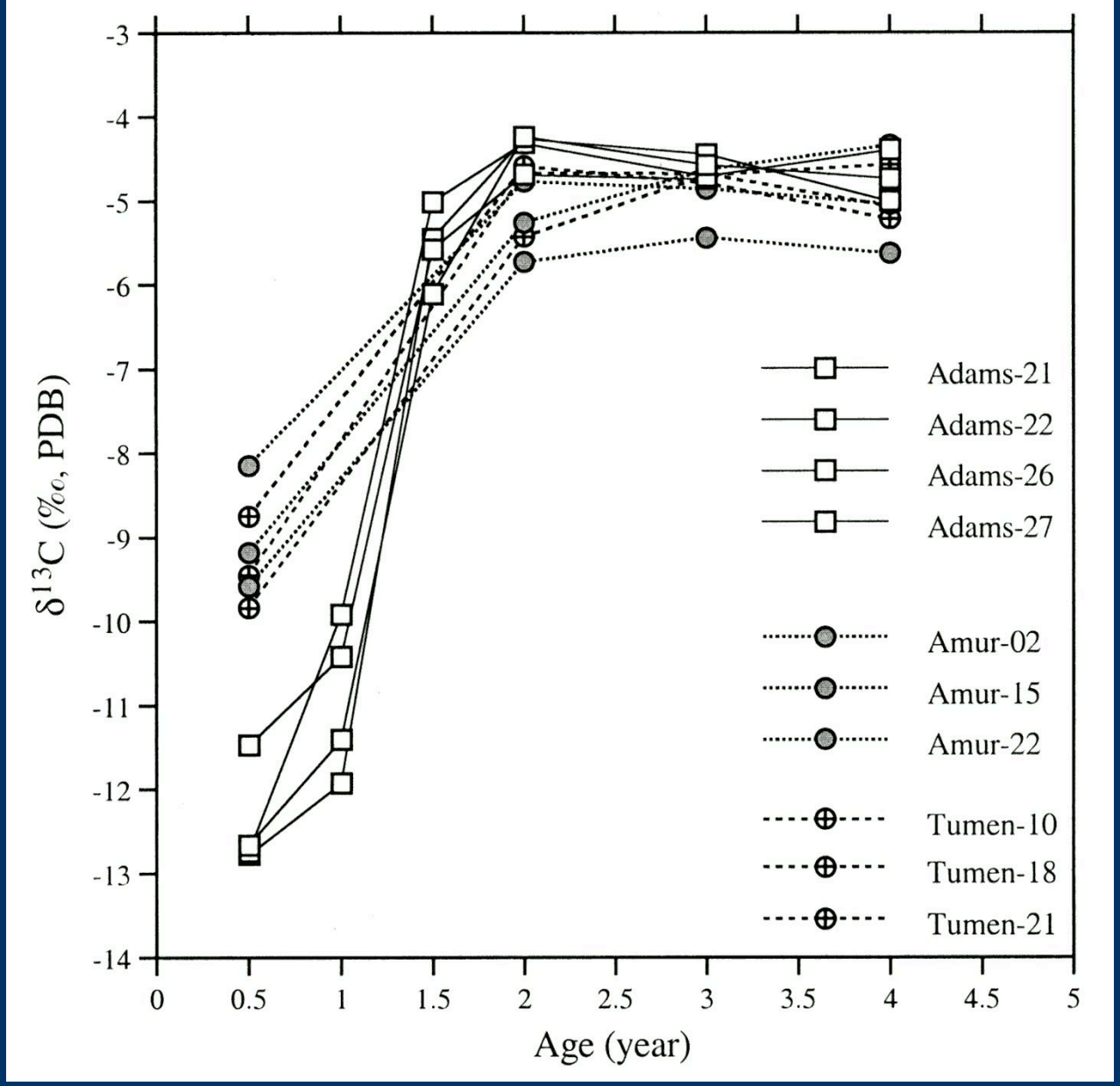


Fig. 6 The $\delta^{13}C$ variations of individual otolith samples from chum salmon and the Adams River sockeye salmon, showing annual changes and the full life history.

Brief conclusions

- *Two spawning stocks or populations* had been identified;
- The chum salmon in northeast China had the *same life history as other salmon populations;*
- Stable isotope ratios can be used as *a natural tag* in fish life history and population studies.

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Thank you!