Lipid metabolism of minke whale & pacific white-sided dolphin in Korean waters and implications for feeding ecology

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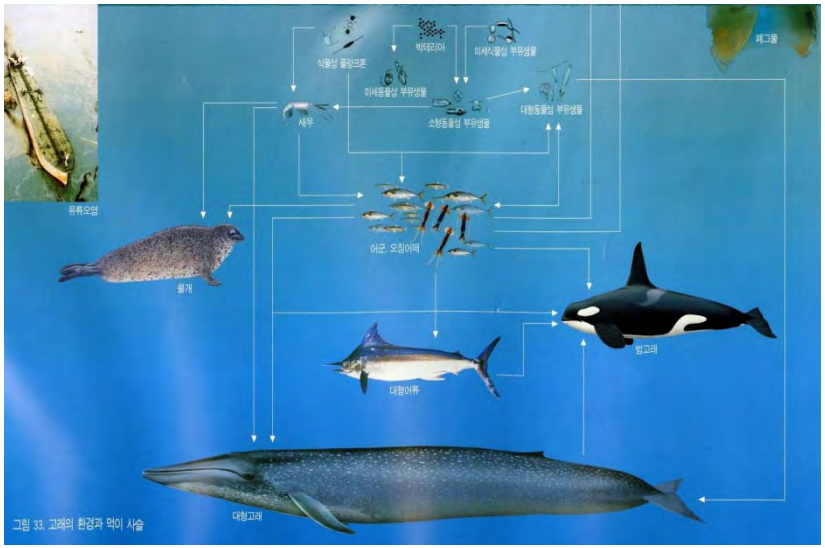
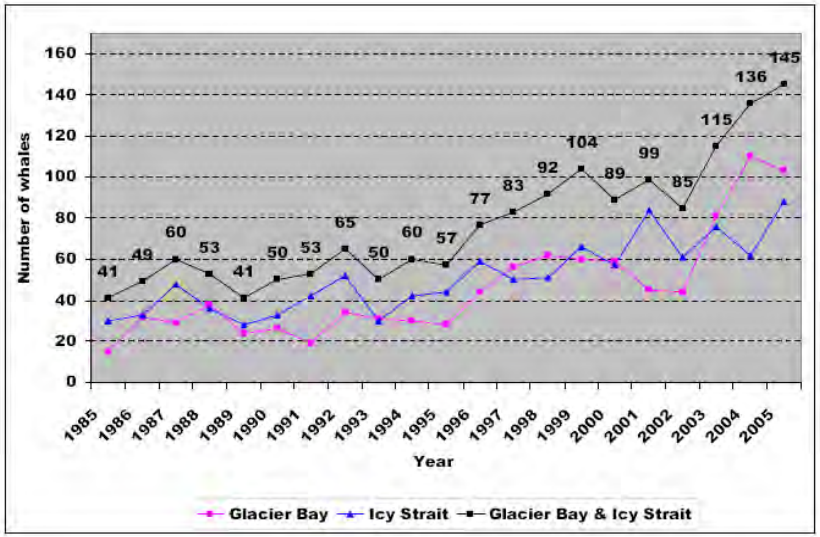
Backgrounds

- As you know the cetacean is the top predator in marine ecosystem.
- Before prohibition of whaling by IWC (1986), the number of whale significantly decreased and even some species were almost endangered to be extinct.
- Recently some species of cetaceans have been recovered and significantly increased their population.



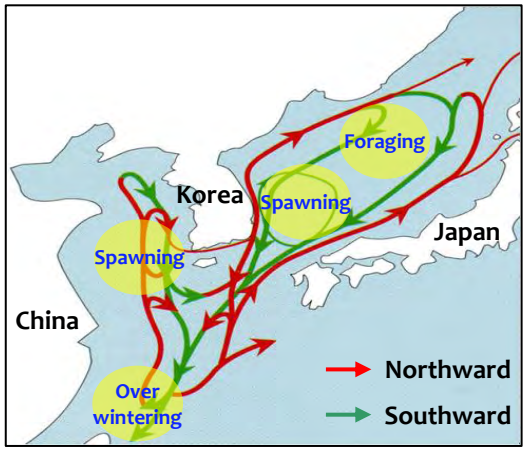


Number of individual whales in Glacier Bay and Icy Strait (1985-2005), Neilson and Gabriele 2005.

Backgrounds

- In Korean waters, 8 family 35 species of cetacean have been observed.
- Minke whale and pacific white-sided dolphin are distributed widely and dominantly in Korean waters.

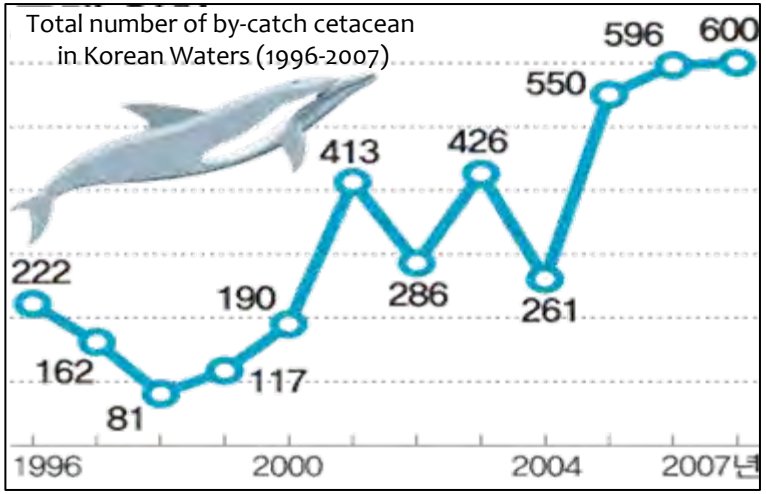
Migration of minke whale



Minke whale (8.6m, 12 ton)

Pacific white-sided dolphin (2.3m, 150 kg)

- The number of cetacean has been increased in Korean waters from 2000.
- Therefore, their ecological role and potential impact on fisheries become issued.

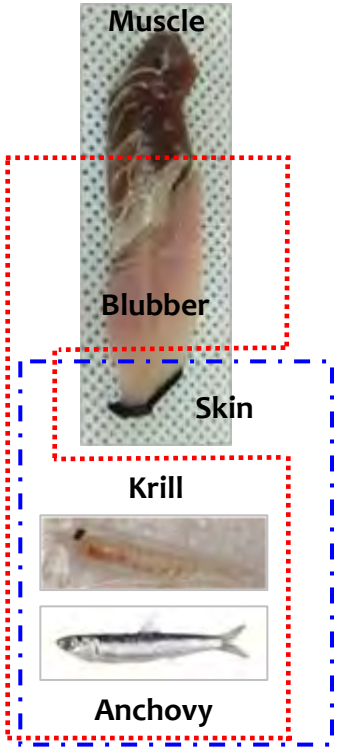


Objectives

- Understand the stratification of lipid content and class composition in blubber.
- Compare lipid content and class composition in blubber between two species (minke whale vs. pacific white-sided dolphin).
- Develop biochemical techniques to understand the lipid metabolism and feeding ecology of cetacean.

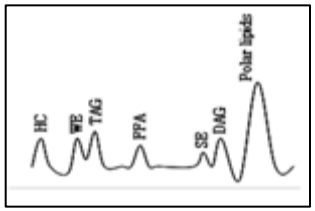
Biochemical approaches

Lipid & Isotope analysis

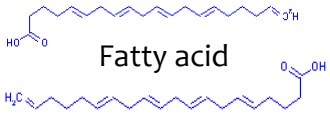


Lipid extraction

Lipid content & class
(TLC-FID)



Alkaline Hydrolysis



Fatty acid

Convert to FAME

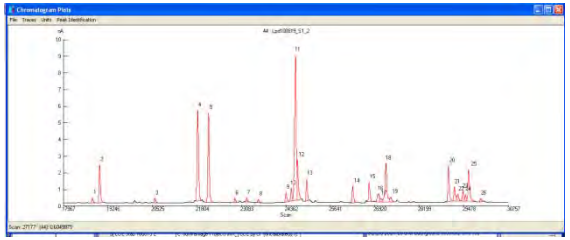
Quantification
(GC-FID)

Qualification
(GC-MSD)

FA-Stable Isotope
(GC-IRMS)

Lipid elimination

Bulk Stable Isotope
(EA-MS)

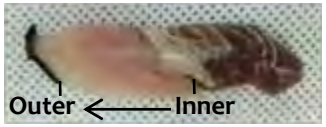


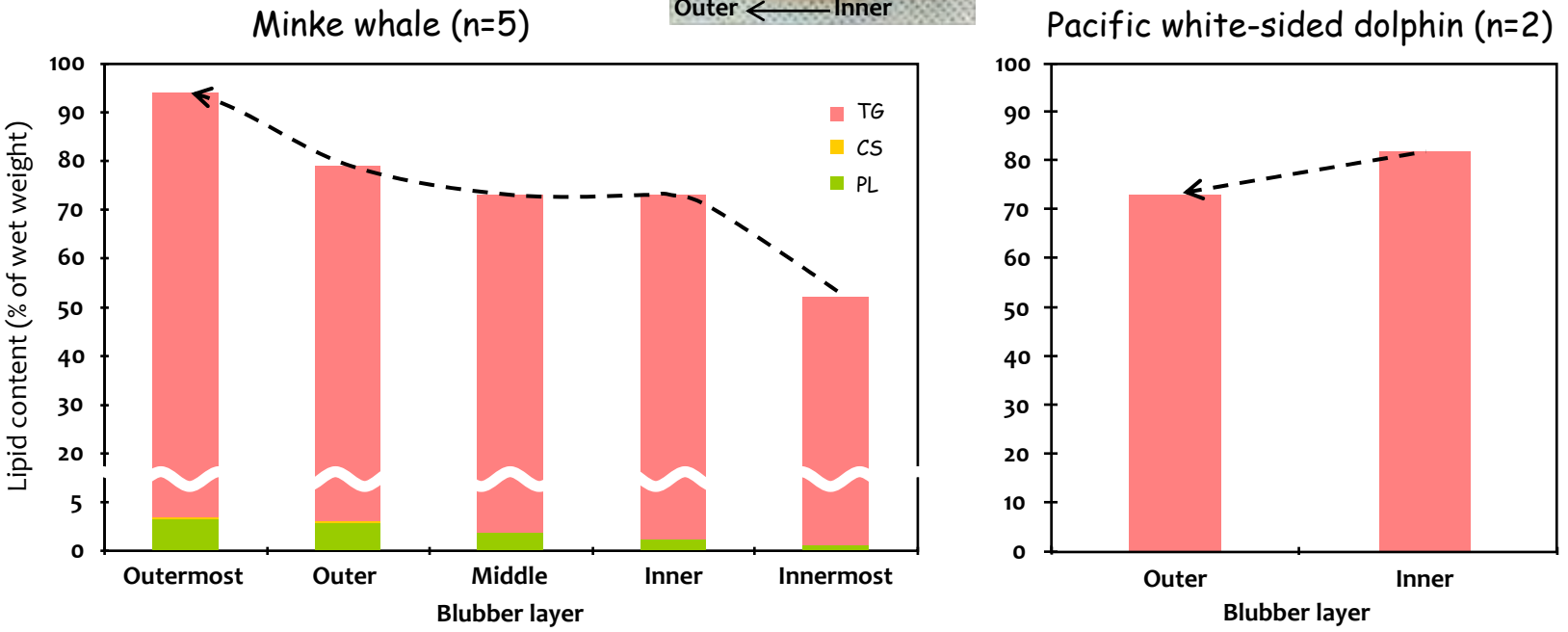
ex) Fatty Acid-Stable Isotope (GC-IRMS)

RESULT

Lipid content & class composition in blubber layers

- Lipid content in blubber is more than 70% of wet weight, except for the innermost layer of minke whale blubber, with dominance of triacylglycerol in both species.
- Lipid content in blubber of minke whale decreased from outermost to innermost layer, whereas for pacific white-sided dolphin it slightly increased. It is also possible to come from a few sample size (n=2) and/or examined less blubber layers (2 layers) than minke whale.

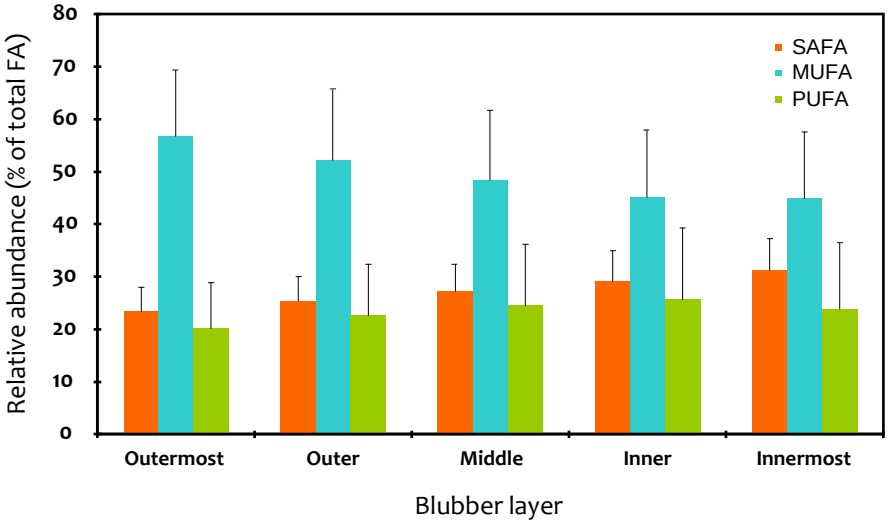


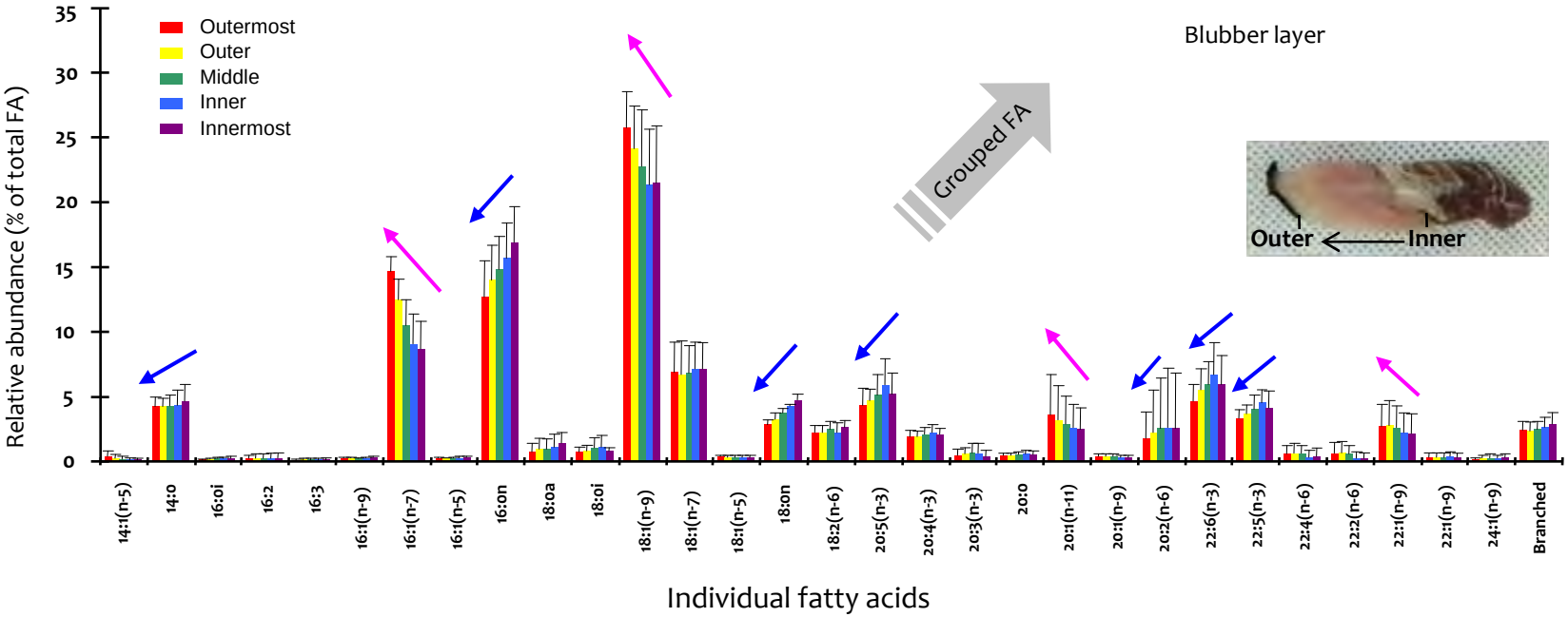


Fatty acid composition in blubber layers-1

Minke whale

- Monounsaturated fatty acids (MUFA) with dominance of 18:1(n-9)(oleic acid) were increased from the inner to the outer layer.
- Saturated (SAFA) and Polyunsaturated fatty acids (PUFA) were decreased from the inner to the outer layers.

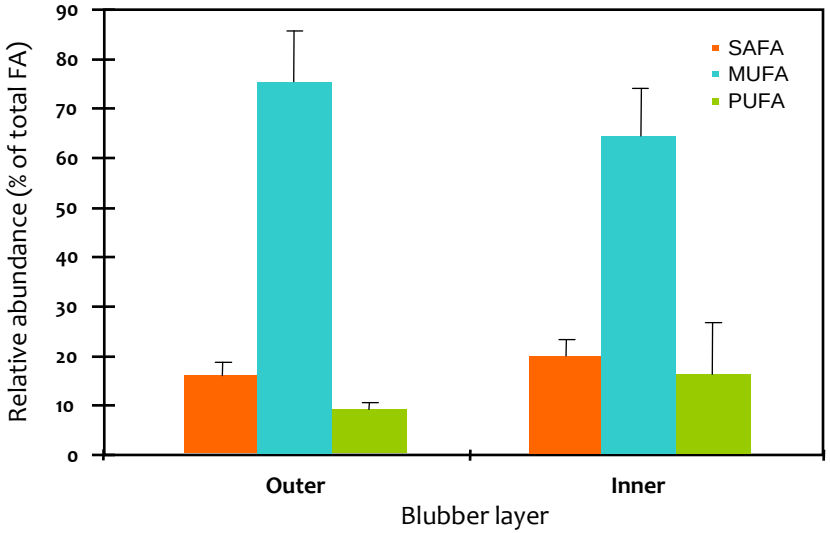


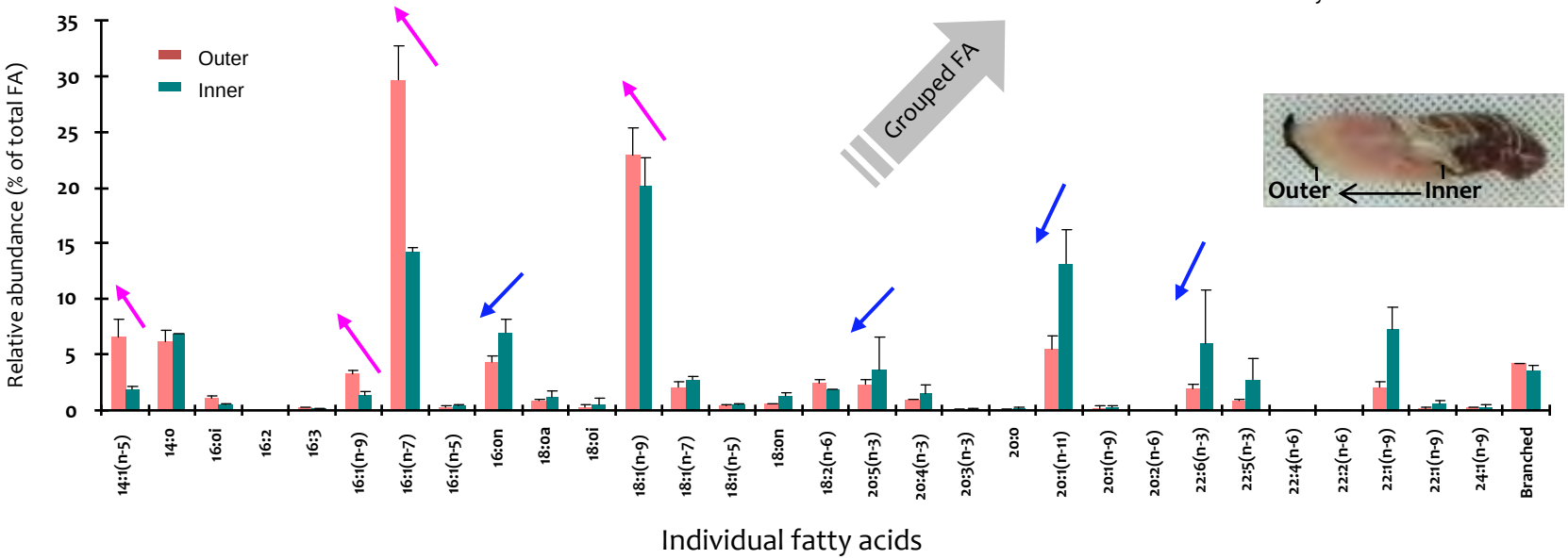


Fatty acid composition in blubber layers-2

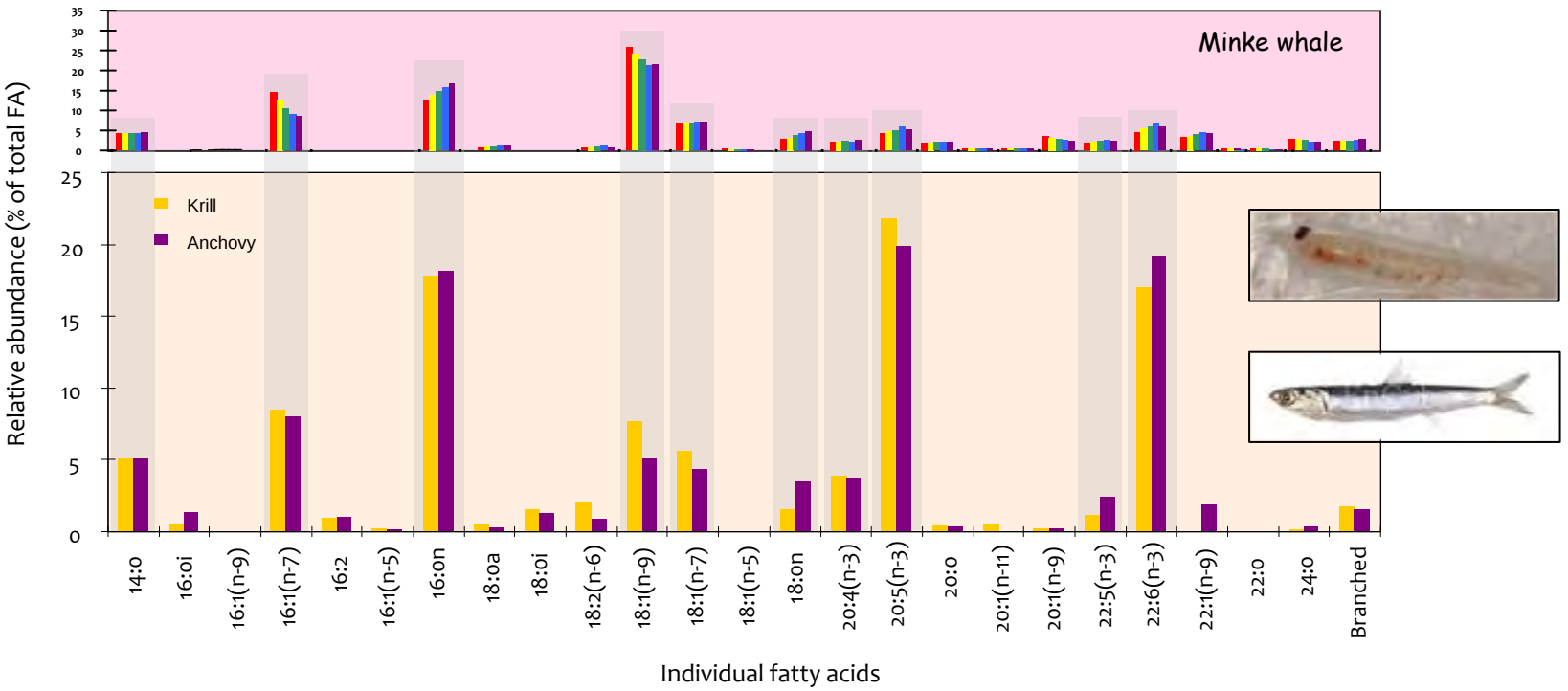
Pacific white-sided dolphin

- For pacific white-sided dolphin, even though only two layers of blubber were analyzed, the FA stratification pattern was clearly appeared that is very similar to that of minke whale.
- Especially, 14:1(n-5) of FAs is dominant in the outer layer with more Δ9 desaturase in minke whale and pacific white-sided dolphin.



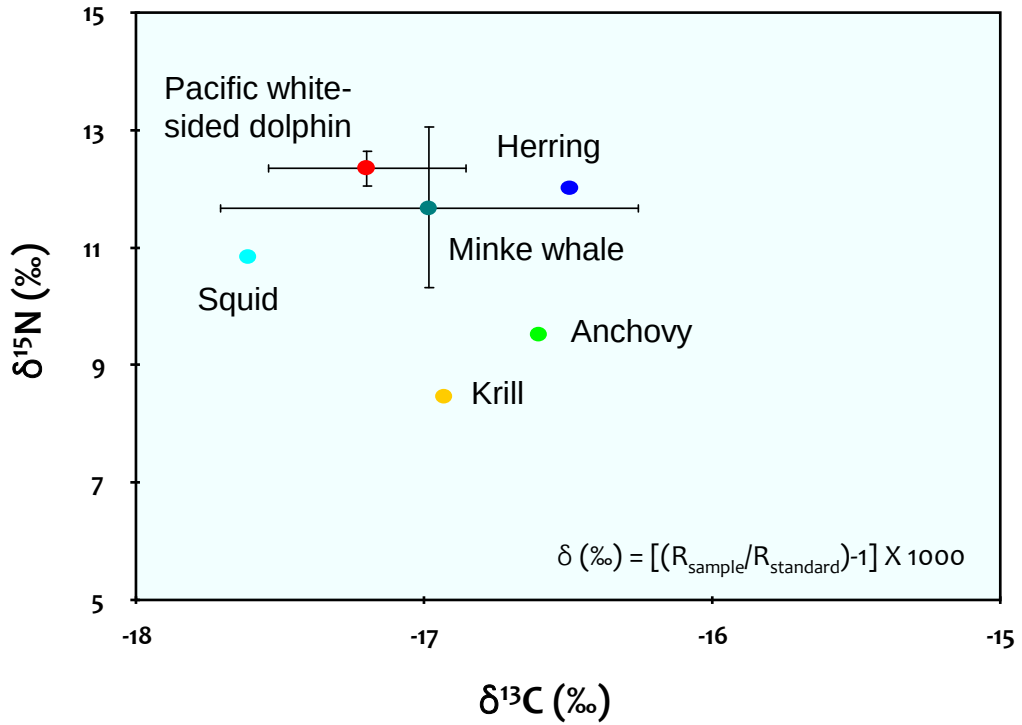


FA profiles of major preys of minke whale



- Some similarities of FA profiles found between minke whale and their diets (krill and anchovy).
- It suggested that minke whale modify some of FAs obtained from their diets for their physiological and structural requirements.

Bulk stable isotope ratios



- As we expected, the $\delta^{15}N$ and $\delta^{13}C$ values for organisms indicate food web (prey-predator) relationship.

- Based on bulk stable isotope analysis, minke whale and pacific white-sided dolphin could be occupied almost the same trophic levels (PWSD is little higher than MW) .

Conclusion - 1

✓ Lipid Stratification

I. Lipid content/composition are clearly stratified through blubber of minke whale.

II. Especially, the results from five layered blubber samples (minke whale) provide much more detailed information on the lipid stratification in blubber.

III. The lipid stratification in blubber may be the consequence of the different functions (role) of inner (near muscle) and outer layer (near skin) of blubber. For instance, outer layers play for structural support and inner layers play for energy storage.

IV. Detail information of lipid metabolism (modification, transfer, and accumulation) could be obtained through compound specific (each FA)-stable isotope analysis.

Conclusion - 2

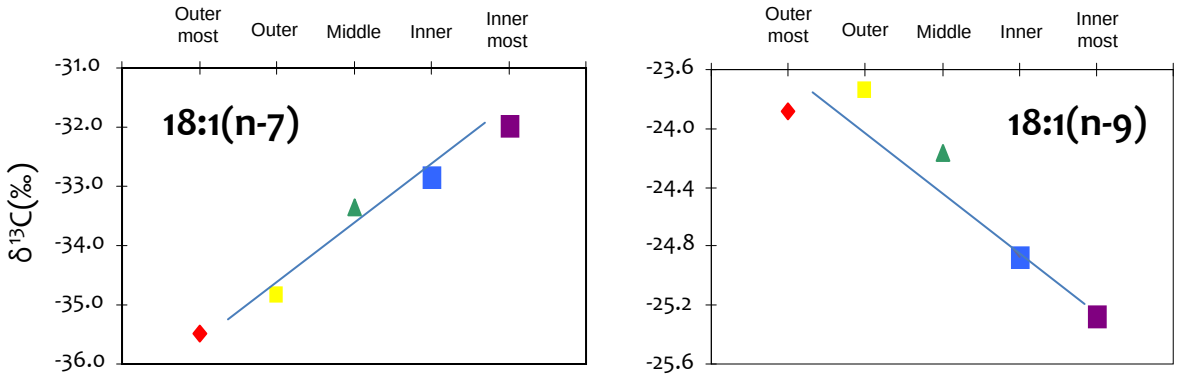
✓ Feeding Ecology

I. The trophic levels of minke whale and pacific white-sided dolphin were identified through bulk stable isotope ratios ($\delta^{15}N$ and $\delta^{13}C$).

II. Although FAs profiles of minke whale were similar to those of their major diets, some of FAs (16:0, 20:5(n-3) and 22:6(n-3)) seem to be significantly modified during the metabolism in minke whale.

III. Therefore, additional analyses, such as compound specific-stable isotope and QFASA (Quantitative fatty acid sequence analysis; Iverson *et al*. 2004), need to be conducted to better understand the feeding ecology of cetacean.

Preliminary results of FA compound specific-isotope ratio



Thank you for your attention !

Acknowledgment

All figures of cetacean used in this presentation were offered from Cetacean Research Institute, Rep. of Korea.