

## Detecting $^{15}\text{N}$ records in paleo-laminaria specimen; Evidence of herrings derived DIN to the west coast of Hokkaido, Japan

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We suggested the possibility of the evidence of nitrogen supply impact along the west coast of Hokkaido, Japan, derived a large quantities of herrings from the end of the 19th century to the early of the 20th century, by detecting  $^{15}\text{N}$  recorded in long-term paleo-laminaria specimens. This result may support the "nutrients transport hypothesis by herring" based on empirical results until now.

We had started to monitor of nutrients concentrations in the west coast of Hokkaido from 1989, the no data before 1988 were achieved unfortunately. So we would have to make effort to research the good indicator of nutrients conditions in the past time. In general, attached seaweeds such as laminaria are primary producer in the coastal zone of marine environments, which synthesize body components by absorbing nutrients for the spot, therefore they reflected the integrating nutrients environment for the spot in a past environments. This may suggest that the past nutrients environment can be presumed by analyzing the body components.

We had obtained the long-term paleo-laminaria specimens which had inhabited at the sea areas around Hokkaido before 1880 to 2011 (for the past 133 years) and they were conserved as specimens at the Herbarium, Graduate School of Science, Hokkaido University (SAP) in the Hokkaido University Museum. On the other hand, the living laminaria, which inhabits at the same sites, where those paleo-laminaria had been collecting as long as possible. The nutrient conditions between the present and the past of the west coast of Hokkaido, Japan were compared by analyzing  $^{15}\text{N}$  of the algal body components, which were used as an indicator of the origin of DIN.

$^{15}\text{N}$  of the laminaria which had inhabited the sea areas surrounding Hokkaido after 1980s showed 5~6 per mill order which was the range of a general  $^{15}\text{N}$  of primary producer utilizing nitrogen in the sea water, while it showed the high value of 10 per mill order around the wide coastal area of the Sea of Japan, Hokkaido between 1880 and 1920. Although these results could not be explained by only an isotope fractionation or deterioration of specimens, inflowing of anthropogenic nitrogen, and denitrification, the possible high concentrations of DIN which had different origin of the present and the other sea areas were utilized by laminaria.

Once herring, *Clupea pallasii* fishery had supported the economy and culture of Hokkaido. Herring catches in the Sea of Japan between 1880 and 1920 reached about 500 to 1000 times of the present catches and occupied more than 90% of only in the Sea of Japan. The  $^{15}\text{N}$  of the laminaria detected by this study showed a similar trend to the herring catches of only in the Sea of Japan. Therefore we thought a possibility that DIN originated from a large amount of herrings in those days distributed in the west coast of Hokkaido and laminaria had absorbed these nutrients. This result may support the "nutrients transport hypothesis by herring" based on empirical results until now, we suggested the possibility of the evidence of nitrogen supply impact along the west coast of Hokkaido, Japan, derived a large quantities of herrings from the end of the 19th century to the early of the 20th century, by detecting  $^{15}\text{N}$  recorded in long-term paleo-laminaria specimens.

Keywords: laminaria,  $^{15}\text{N}$ , west coast of Hokkaido, herrings, DIN