Applications of stable isotopes in environmental studies at the University of Liege

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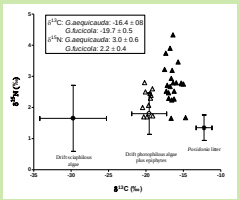
Since at least 30 years, at Prof Dauby initiative, applications of stable isotopes in marine ecosystems have been developed at University of Liege within the Laboratory of Oceanology and, more recently, within the Chemical Oceanography Unit. One research axis is the measurement of stable isotope compositions (C, N, S) in organic matter to delineate trophic web structure and study animal diet, their trophic niches and their alteration by human activities. Coupling between trophic ecology and ecotoxicology, as well as the study of biogeochemical processes are other areas of investigation.

Studying trophic ecology

▪ Delineation of marine trophic web



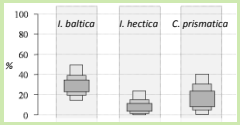
The fact that the isotopic composition of an animal is strongly determined by the isotopic composition of its food, allow the use of natural isotope abundance (C, N, S) as food web tracers.

Example of $\delta^{13}C$ and $\delta^{15}N$ of crustacean amphipods and potential food items (mean ± SD) sampled in Posidonia litter in the Gulf of Calvi, France (Lepoint et al. 2006)

▪ Description of the trophic niche

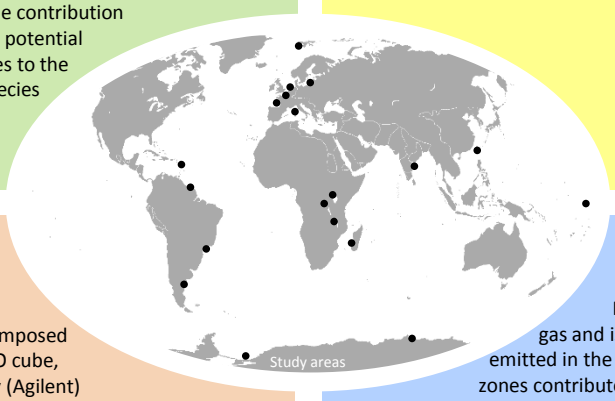
The trophic niche width can be evaluated using methods estimating the degree of individual specialisation within a population.

▪ Mixing modelling



The use of mixing models allow to calculate the contribution of different potential food sources to the diet of a species

Modelling with SIAR. Dietary contributions (%) of the food source "Crustaceans" to the diet of 3 isopods (Sturaro et al., 2010). Black and grey boxes are the 50, 75 and 95% credibility intervals



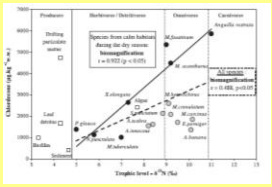
Coupling trophic ecology and ecotoxicology

Stable isotope compositions (C, N , S) allow us to investigate potential relations between animal diet and their pollutant contaminations.

▪ Applications

This approach has been applied mainly to marine vertebrates (fish, turtles, mammals, birds) and freshwater ecosystems. Targeted pollutants are trace elements (e.g. Hg) and organo-chlorated or brominated pollutants.

Stable isotope compositions may also help to explain spatial variability of pollutant contaminations.



Chlordecone concentrations versus trophic level in invertebrates colonizing a river of Guadeloupe with different water regimes (Coat et al. 2011)

Case study: Stable isotope compositions of feathers allow to discriminate the 3 habitats of the White-tailed eagle in relation with brominated flame retardant contamination (Eulaers et al. 2014)

Our equipment

▪ The Laboratory of Oceanology

The facilities, renewed in 2012, are composed of an elemental analyser (Vario MICRO cube, Elementar) and a gas chromatography (Agilent) coupled to an isotope ratio mass spectrometer (Isoprime 100, Isoprime). The GC is also equipped with a quadrupole mass spectrometer.

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▪ The Chemical Oceanography Unit

In 2014, the unit has acquired an off-axis cavity ring-down spectroscopy (CRDS, Los Gatos Research) for the measurements of $\delta^{15}N\alpha$, $\delta^{15}N\beta$, $\delta^{18}O$ of N_2O.

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Left: EA-GC-C-IRMS-MSD (Isoprime, Elementar, Agilent) of the Laboratory of Oceanology

Right: Isotopic N_2O Analyzer (Los Gatos Research) of the Chemical Oceanography Unit

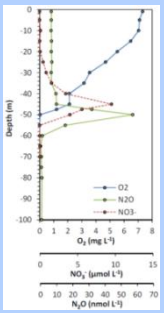
Studying biogeochemistry

Nitrous oxide (N_2O) is a potent greenhouse gas and is the dominant ozone-depleting substance emitted in the 21st Century. Rivers, estuaries and Coastal zones contribute to about 25% of total anthropogenic N_2O sources, while the oceans contribute to 35% of total natural N_2O sources.

▪ Aim of the research

The measurements of $\delta^{15}N\alpha$, $\delta^{15}N\beta$, $\delta^{18}O$ of N_2O will allow us to characterize the origin of N_2O in a variety of aquatic environments including groundwaters in Wallonia, rivers and lakes in Wallonia and Africa, coastal environments (Scheldt estuary, Lake Grevelingen, North Sea), Mediterranean seagrass bed and Antarctic and Arctic sea-ice.

This instrumentation will allow us to examine the isotopic composition in ^{15}N and ^{18}O of natural N_2O, or of N_2O produced in incubations with addition of labeled $^{15}N\text{-}NH_4^+$ and/or $^{15}N\text{-}NO_3^-$.



Example of N_2O data acquired by the unit in the frame of an on-going project in Lake Kivu