

Benelux Association of
BASIS
Stable Isotope Scientists

Annual Meeting 2026

March 31 & April 1

Brussels, Belgium



Colofon

Editors

Eva de Rijke

Samuel Bodé

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Contact

www.basis-online.eu

administratie@basis-online.eu

bestuur@basis-online.eu

commissie@basis-online.eu

webmaster@basis-online.eu

De Dageraad 43

1797 SK Den Hoorn (Texel)

The Netherlands

Bank Details: Rabobank Oosterschelde

IBAN: NL47 RABO 0122621565

Accountholder: Benelux Association of Stable Isotope Scientists

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Preface

Dear members of BASIS, dear fellow stable isotope enthusiasts,

After a year absence, it is time for our own interesting and exciting stable isotope meeting BASIS. This year we have 79 registered participants of which 14 sponsoring participants. We received excellent abstracts for both oral and poster presentations. There are contributions from well outside the Benelux boundaries, from (Southern-) France, Romania and Portugal to Australia even and, of course, plenty from within the Benelux and right here, Brussels itself.

As always, we hope to provide you with an exciting scientific and social program in Brussels. We are always looking for people to play a more active role within BASIS, including help with, providing content for, the website and possibly other, social, media. This year, the entire BASIS board is up for renewal, let us know if you would like to play an active role in the board.

The BASIS board would like to thank our industrial partners, **ThermoFisher Scientific, SciSPX-Elementar, Sercon, Picarro, IVA** and **Air Liquide** for their support. We wish you all, familiar faces and first-time participants alike, a very pleasant and productive 16th Benelux Association of Stable Isotope Scientists meeting.

I might be biased, but this is my favorite meeting.

Kind regards,

Marcel van der Meer
President of the BASIS board

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&



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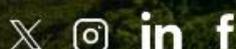
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G5131- <i>i</i>	$\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ in N_2O
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PI5310	N_2O , CO , H_2O

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Program

Tuesday, March 31st 2026

10:00 - 11:30	Arrival and registration of industrial partners
11:30 - 12:00	Arrival and registration of attendees/members
12:00 - 13:00	Lunch and sponsor trade show
13:00 - 13:15	OPENING BASIS 2026
13:15 - 13:30	Spatio-temporal dynamics of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values in <i>Arenicola marina</i> and organic sediment matter. <i>Sébastien Lefebvre</i>
13:30 - 13:45	Correcting for confounding tree height effects on tree ring ^{13}C signals, reveals coherent long term water use efficiency increase in a central African tree species. <i>Thomas Sibret</i> Candidate for young scientist award
13:45 - 14:00	The missing link in dynamic isotopic diet studies: a Bayesian-DEB framework. <i>Emilie Cathelin</i> Candidate for young scientist award
14:00 - 14:15	Optimized GC-IRMS PTV methodology for hydrogen isotope ratio analysis. <i>Mario Tuthorn</i> (Thermo Scientific)
14:30 - 15:25	COFFEE BREAK - TRADE SHOW – POSTER SESSION <i>Authors posters 1-8 be present from 14:30-14:55</i> <i>Authors posters 9-16 be present from 14:55-15:25</i>
15:25 - 15:45	Towards SI traceability for $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$. <i>Harro Meijer</i>
15:45 - 16:00	Birds of Pray: Uncovering the Lives of Rock Doves (<i>Columba livia</i>) from Hala Sultan Tekke, Cyprus through Stable Isotope Analysis. <i>Anderson Carter</i>
16:00 - 16:15	Synthesis Mechanisms Producing Isotopically Enriched Acetic Acid in Deep Groundwater Systems from the Canadian Shield. <i>Youki Sato</i> Candidate for young scientist award
16:15 - 16:30	Global mean ocean nitrate $\delta^{18}\text{O}$ as a tracer for the supply and recycling of fixed nitrogen in the ocean. <i>Simon Desmettre</i> Candidate for young scientist award
16:30 - 16:45	Laser Ablation IRMS – A technical overview. <i>Garry Armstrong</i> (Sercon)
17:30 - 19:00	Posters and drinks
20:00	Dinner @ Restaurant ‘Chez Léon’

Chair: Marcel van der Meer

Chair: Samuel Bode

Wednesday, April 1st 2026

- 9:00 - 9:15 Fluid-Inclusion Isotope Constraints on Hydroclimate in Ethiopia during the African Humid Period. *Jeroen van der Lubbe*
- 9:15 - 9:30 Systemic availability of short-chain fatty acids depends on their intestinal site of absorption: a randomized, crossover trial in healthy subjects. *Riet Rosseel*
Candidate for young scientist award
- 9:30 - 9:45 Meridional nitrate gradients in the Indian Sector of the Southern Ocean over the last glacial cycle. *Cedric Dumoulin*
- 9:45 - 10:00 Tracing Tropical Montane Tree Responses to Climate Using Herbarium Samples: An Isotopic Approach. *Andrea Janine Chávez Pacheco*
Candidate for young scientist award
- 10:00 - 10:15 Fully integrated TOC and TNb analysis of estuarine and sea water samples with the Elementar iso TOC cube®. *Sam Barker* (Elementar)
- 10:15 - 10:40 COFFEE BREAK –TRADE SHOW – POSTER SESSION**
- 10:40 - 10:55 Southern Ocean and atmospheric CO₂ during both Pleistocene Ice ages and Early Eocene Optimum. *François Fripiat*
- 10:55 - 11:10 Decoding Steroid Isotope Signatures with Orbitrap-based Isotope Ratio Mass Spectrometry? *Joshua Jager*
- 11:10 - 11:25 Identifying ammonia sources using an isotope-based approach. *Jun Zhang*
- 11:25 - 11:40 How Resilient is the Seagrass Nitrogen Cycle to Moderate Nutrient Enrichment? *Tijs Joling*
- 11:40 - 11:55 Members meeting 2026 and Young Scientist award and**
- 11:55 - 12:15 Closing of BASIS 2026**
- 12:15 - 13:30 Lunch and sponsor trade show**

Chair: Eva de Rijke

Chair: Loïc Michel

Abstracts

Oral Presentations

Oral 31/03 -13:15 - 13:30

Prof. Lefebvre Sébastien

Spatio-temporal dynamics of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values in *Arenicola marina* and organic sediment matter

Lefebvre S, Fernandez-Alias A., Hennion C., Cathelin E., Riboulleau A., Gaudron S.M.

Laboratory of Oceanology and Geosciences, UMR 8187, University of Lille, CNRS, IRD, ULCO, Station marine de Wimereux, 59000 Lille France.

Arenicola marina (lugworms) is a psammivorous species exploited for fisheries bait or hemoglobin extract for biotechnological applications by both professional and amateur anglers. While regulations on fisheries are recent and not particularly restrictive, we initiated a project to better understand the size structure, growth, and population dynamics of lugworms on a sandy beach in northern France. Our goal is to promote sustainable exploitation of this species.

This study aimed to identify the primary food sources of lugworms as they grow, specifically determining what constitutes the bulk of sediment organic matter (microphytobenthos, settled phytoplankton blooms, or stranded macroalgae). The survey was conducted over one year at three distinct sites along the beach: upshore, midshore, and low shore. We analyzed organic matter, chlorophyll-a (chl-a) content, C/N ratios, and $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values in the top centimeter of sediment. Lugworms were also analyzed for $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, and C/N ratios. Additionally, a diet-switch experiment was performed to determine trophic discrimination factors (TDFs).

The TDFs were found to be 2.01 for $\Delta^{13}\text{C}$ and 2.32 for $\Delta^{15}\text{N}$. Sediment organic matter (SOM) and chl-a content exhibited seasonal variations linked to the spring bloom and the summer microphytobenthos bloom. Both were present in very low quantities, making isotope analysis challenging. Preliminary results from one site showed temporal variations in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values for both sediment organic matter and lugworms. The differences in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values between lugworms and SOM were not consistent with the TDF values, potentially due to post-ingestion selectivity within the organic matter pool.

Currently, we are pursuing two main research directions to help us distinguishing between labile and refractory matter. First, we are analyzing the food web of macrofauna living in the sand in the proximity of lugworms. Second, we are examining the profile of organic matter using Rock-Eval, a method that assesses the thermal reactivity of organic and carbonate compounds in soils. These analyses are ongoing.

Oral 31/03 -13:30 - 13:45

Thomas Sibret

Candidate for young scientist award

Correcting for confounding tree height effects on tree ring ^{13}C signals, reveals coherent long term water use efficiency increase in a central African tree species

Thomas Sibret*, Marijn Bauters, Félicien Meunier, Samuel Bodé, Wannes Hubau, Hans Beeckman, Ramazani Elasi, Bernard Bonyoma, Filip Vandelook, Serge Alebadwa, Nestor K. Luambua, Hans Verbeeck, Pascal Boeckx

Long-term intrinsic water-use efficiency (iWUE) records are scarce for the Congo Basin, limiting assessment of how African tropical forests have physiologically responded to rising atmospheric CO_2 and climate change. Tree-ring $\delta^{13}\text{C}$ provides annually resolved iWUE reconstructions, but in tall tropical forests these records may be strongly influenced by tree height-related effects, potentially leading to systematic biases if not explicitly accounted for.

*Here, we reconstruct a century-long (1901–2025) iWUE record for *Pericopsis elata* (Harms) Meeuwen, a ring-forming, canopy-emergent tree from the central Congo Basin, and investigate the magnitude and origin of height-related influences in dendrochronological $\delta^{13}\text{C}$ records. By integrating outer-ring wood $\delta^{13}\text{C}$ across a wide diameter range, vertical leaf $\delta^{13}\text{C}$ profiles, locally measured within-canopy gradients in CO_2 concentration and $\delta^{13}\text{C}$ of source air, and historical canopy-level herbarium leaves as an independent benchmark, we assess how canopy structure and tree ontogeny shape isotopic signals.*

We further explore whether height-related effects can be quantitatively constrained and accounted for, and evaluate their implications for interpreting long-term iWUE trends derived from tree-ring archives. Particular emphasis is placed on distinguishing structural from physiological signals in $\delta^{13}\text{C}$ -based reconstructions.

This work aims to provide new insights into the reliability of isotope-derived iWUE records in dense tropical forests and to refine approaches for reconstructing long-term responses of tropical forests to environmental change in the Congo Basin.

Oral 31/03 -13:45 - 14:00

Emilie Cathelin

Candidate for young scientist award

The missing link in dynamic isotopic diet studies: a Bayesian-DEB framework

1: Emilie Cathelin, 2: Sébastien Lefebvre, 3: Carolina Giraldo

1,2: Univ. Lille, CNRS, Univ. Littoral Côte d'Opale, IRD, UMR 8187 – LOG – Laboratoire d'Océanologie et de Géosciences, 59000 Lille, France.

3: IFREMER, HMMN – Unité halieutique Manche-Mer du Nord, 62200 Boulogne sur mer, France.

Stable isotopes mixing models are widely used to estimate diets in ecology. Many of these models rely on a steady state assumption (referred to as static models). In natural systems, isotopic signatures (e.g., of sources and/or consumers) often vary through time, potentially biasing diet estimates when temporal dynamics are ignored. Additionally, a major but frequently overlooked limitation of isotopic diet studies is the lack of information on tissue-specific isotopic turnover rates, a key parameter governing the integration of dietary signals. Here, we developed a Bayesian Dynamic Mixing Model (BDMM) that explicitly accounts for temporal variability and uncertainty. The model requires at least two sampling dates for consumer and sources as well as an estimation of the isotopic turnover value. To address the common lack of turnover information, we formalize isotopic turnover rates using Dynamic Energy Budget (DEB) theory, allowing turnover to be expressed as a function of temperature and food availability. This approach enables the estimation of isotopic turnover rates for thousands of species across environmental conditions and provides biologically grounded priors for dynamic mixing models. We applied this BDMM-DEB framework to several datasets representing diet studies in dynamic settings. The results demonstrated that BDMM is a functional and robust model providing more accurate diet estimates than static models or previously developed dynamic models. It also offers flexibility regarding the amount of information required about the isotopic turnover for reliable information. Overall, this work provides methodological tools and practical guidelines for conducting reliable isotopic diet studies in temporally variable ecosystems, highlighting isotopic turnover as a central—and tractable—component of isotopic ecology.

Oral 31/03 -14:00 - 14:15

Dr. Mario Tuthorn

Optimized GC-IRMS PTV methodology for hydrogen isotope ratio analysis

1 Mario Tuthorn, 2 Maria de Castro

1, 2 Thermo Fisher Scientific

Hydrogen isotopic composition ($^2\text{H}/^1\text{H}$) of individual organic compounds is routinely determined by GC-TC-IRMS, providing critical insights across environmental, forensic, and biochemical applications. However, $\delta^2\text{H}$ analysis presents intrinsic analytical challenges, including the low natural abundance of deuterium, high hydrogen diffusivity, reduced ionization efficiency, and H_3^+ formation, all of which contribute to limited sensitivity and elevated detection limits.

Conventional GC injection restricts sample volumes to a few microliters, often requiring labor-intensive preconcentration steps that may introduce fractionation or analyte loss. We demonstrate how Large Volume Injection (LVI) using Programmed Temperature Vaporization (PTV) overcomes these limitations by enabling higher sample loads while preserving chromatographic integrity and isotopic fidelity.

Using certified n-alkane reference materials, we evaluate precision, accuracy, and linearity of PTV-acquired $\delta^2\text{H}$ data and directly compare performance with conventional Split/Splitless (SSL) injection. In addition, we present best practices for instrument setup, isotope data normalization, and evaluation strategies.

Oral 31/03 -15:25 - 15:45

Prof. Harro Meijer

Towards SI traceability for $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$

1 Harro A.J. Meijer, 2 Anita Th. Aerts-Bijma, 3 Farilde (P.M.) Steur

1-3. Centre for Isotope Research (CIO), ESRIG, University of Groningen, NL

Stable isotope ratios constitute the only remaining so-called traceability exception within the international measurement system. This is caused by the fact that relative isotope abundance measurements are one or more orders of magnitude more precise than absolute ones, and also much simpler to perform. This higher precision is also needed for many applications. Many hundreds of laboratories over the world are equipped with instrumentation for " δ measurements", with precisions easily better than $\pm 0.1\%$ on a relative scale. Absolute abundance (or abundance ratio) measurements on the other hand with such precision are only performed by a few metrology laboratories worldwide if at all.

Nevertheless, the possibility for absolute, SI-traceable measurements of isotope abundances would bring large advantages: isotope scales could be defined in terms of abundances, new Reference Materials could be tested and produced more reliably, and there would be no further increase in uncertainty each time new (scale defining) reference materials need to be produced.

In recent years, important steps have been taken into this direction for ^{13}C and ^{18}O : more accurate gravimetric procedures for determination of the ^{13}C abundance of VPDB, and work on the various aspects of the $\delta^{18}\text{O}$ scales VSMOW-SLAP and VPDB(-CO₂). In the talk, we will illustrate these achievements and look ahead to what is necessary in addition.

Oral 31/03 -15:45- 16:00

Anderson Carter

Birds of Pray: Uncovering the Lives of Rock Doves (*Columba livia*) from Hala Sultan Tekke, Cyprus through Stable Isotope Analysis

1. Anderson L. Carter 2. David S. Reese 3. Ronald van Bommel 4. Marcel T.J. van de Meer 5. Canan Çakırlar

1. *Groningen Institute of Archaeology, University of Groningen, Groningen, The Netherlands*
2. *Division of Anthropology, Peabody Museum of Natural History, Yale University, New Haven, Connecticut, USA*
3. *NIOZ The Royal Netherlands Institute of Sea Research, Texel, The Netherlands*
4. *NIOZ The Royal Netherlands Institute of Sea Research, Texel, The Netherlands*
5. *Groningen Institute of Archaeology, University of Groningen, Groningen, The Netherlands*

Pigeons (*Columba livia*) are among the earliest and most widespread domestic birds, yet their prehistory and pathways to domestication remain poorly understood. Endemic to the Mediterranean and Western Asia, their domestication is generally assumed to have taken place in prehistory, based largely on iconographic evidence. Although pigeon remains are present across the region, they are typically underrepresented in Bronze Age and earlier assemblages. This study examines a substantial collection of pigeon bones from Late Bronze Age Hala Sultan Tekke in Cyprus, a settlement renowned for its material culture and role in inter-regional Mediterranean exchange. Through the integration of zooarchaeological, isotopic, and contextual analyses, we assess the domestication status and management of pigeons at the site. By combining multiple lines of evidence, we discuss the role of pigeons in prehistoric Mediterranean societies and demonstrate their close relationship with humans, reflected in close similarities between human and avian diets. Methodologically, this research constitutes the earliest application of biometric and stable isotope analysis to Bronze Age pigeons, marking a significant advance in the study of avian domestication. As such, it represents a significant contribution to our understanding of this enduring biocultural icon, best known today as an urban commensal.

Oral 31/03 -16:00 - 16:15

Youki Sato

Candidate for young scientist award

Synthesis Mechanisms Producing Isotopically Enriched Acetic Acid in Deep Groundwater Systems from the Canadian Shield

1 - Youki J. Sato, 2 - Min Song, 3 - Weibin Chen, 4 - Barbara Sherwood Lollar, 5 - Katherine H. Freeman

1, 5 - *Astrobiology Center for Isotopologue Research, Department of Geosciences, Pennsylvania State University, University Park, Pennsylvania, 16802, United States*

2, 3, 4 - *Department of Earth Sciences, University of Toronto, 22 Ursula Franklin St., Toronto, ON M5S 3B1, Canada*

4 - *Institut de Physique du Globe de Paris (IPGP), Université Paris Cité, Paris, France*

Fracture waters collected from the Kidd Creek Observatory (KC) in Timmins, Ontario, Canada are hosted by 2.7 Ga Canadian Shield rocks with minimal surface water exchange over geologic timescales resulting in residence times of more than 1Ga. The dissolved organic carbon compound (DOC) inventory of these waters is predominantly composed of acetate and formate. Acetate is notably ^{13}C enriched (-4.9 to -7.3 ‰) compared to typical photosynthetically derived organic matter and is present at among the highest concentrations ever measured in natural groundwaters. Acetate and formate present in these fracture waters are hypothesized to be abiotically formed via radiolytic water-rock interactions over millions of years. To better understand the importance of radiolytic processes among the variety of abiotic organic synthesis reactions in the deep subsurface, we utilized the capabilities of a modified gas chromatography – Orbitrap – mass spectrometry (GC Orbitrap-MS) system to measure the intramolecular carbon isotope signature of acetate collected from Kidd Creek Observatory. These results were compared to acetate from another groundwater system at Birchtree, Manitoba, where fracture waters have a well-established microbial community and evidence of significant paleo-meteoritic water recharge and mixing. The carboxyl (C1) carbon of acetate from KC was enriched by 15.4‰ on average relative to the methyl (C2) carbon, whereas both positions were isotopically similar for the Birchtree sample. The contrasting intramolecular isotope patterns observed in acetate collected from KC vs. Birchtree fracture waters indicate the activity of two separate acetate synthesis pathways; one abiotic (likely radiolysis; KC) and the other biotic (metabolisms that consume or produce acetate; Birchtree). This approach demonstrates the utility of intramolecular isotope analysis for distinguishing abiotic and biotic sources of acetate in environments on Earth and elsewhere.

Oral 31/03 -16:15 - 16:30

Simon Desmettre

Candidate for young scientist award

Global mean ocean nitrate $\delta^{18}\text{O}$ as a tracer for the supply and recycling of fixed nitrogen in the ocean

*Simon Desmettre*¹, *Cédric Dumoulin*¹, *Violaine Coulon*¹, *Dario Marconi*², *Tanya Marshall*², *Sofia Muller*¹, *Yeongjun Ryu*², *Tanja Wald*³, *Alfredo Martínez-García*³, *Daniel M. Sigman*², *François Fripiat*¹

¹*Department of Geosciences, Environment and Society, Université Libre de Bruxelles, Brussels, Belgium*

²*Department of Geosciences, Princeton University, Princeton, USA*

³*Climate Geochemistry, Max Planck Institute for Chemistry, Mainz, Germany*

The nitrogen (N) cycle is essential for marine productivity, as it regulates biologically available N (or “fixed”, i.e., non- N_2), a key nutrient for phytoplankton. It can be divided into an internal and open cycle. The internal N cycle does not affect the total quantity of biologically available N in the ocean but changes the distribution of its different forms – such as nitrate, ammonium and organic matter – through processes like assimilation, export, remineralization and nitrification. The open N cycle adds biologically available N to the ocean, primarily through N_2 fixation, and removes it, primarily through denitrification. However, the relative contribution of the open and internal cycles remains poorly constrained in the literature, with an estimated ratio ranging from 2.9% to 45.5%. We propose that the mean ocean nitrate $\delta^{18}\text{O}$ (hereafter MON $\delta^{18}\text{O}$) can be used to place observational constraints on the ratio between open and internal N cycles (i.e., N_2 fixation vs. export production). Using a prognostic ocean box model, we explore the sensitivity of MON $\delta^{18}\text{O}$ to physical and biogeochemical parameters. The model is calibrated using a Bayesian approach, assigning greater weights to scenarios that best match observations from a worldwide database of approximately 30,000 nitrate $\delta^{18}\text{O}$ measurements. Our results indicate that MON $\delta^{18}\text{O}$ is sensitive to the ratio of open to internal N cycles, yielding a preliminary estimate of 17% (+/- 5%).

Oral 31/03 -16:30 - 16:45

Garry Armstrong Sercon

Laser Ablation IRMS – A technical overview

Garry Armstrong¹

1 Sercon

Laser Ablation Isotope Ratio Mass Spectrometry (LA-IRMS) represents a significant advancement in the spatially resolved analysis of stable isotopes, addressing long-standing limitations of traditional bulk techniques such as EA-IRMS needs to be expanded and defined and acid digestion IRMS. These conventional approaches, while robust, are inherently constrained by sample destruction, intensive preparation, and limited resolution—particularly problematic when investigating microscale heterogeneity in banded or incrementally grown materials.

This presentation outlines a fully optimized LA-IRMS system employing pulsed UV lasers (193–266 nm) coupled to a cryogenic trapping and GC interface (CryoFlex) for precise $\delta^{13}\text{C}$ analysis. The system demonstrates minimal sample preparation, low helium flow rates (5–30 mL/min), and negligible carryover, with a CFD-designed ablation cell engineered for efficient aerosol transport and low blank levels ($<1\text{e}^{-9}$ nA). Performance data confirm excellent agreement between LA and EA-derived $\delta^{13}\text{C}$ values across multiple matrices, including wood, dentine, and carbonates, without evidence of energy-dependent isotopic fractionation.

Application of LA-IRMS to dendrochronological samples (courtesy of Natural Resources Institute, Finland) reveals enhanced temporal resolution in $\delta^{13}\text{C}$ profiles, enabling sub-annual isotopic reconstructions not feasible with bulk methods. The method is laser-agnostic, supporting nanosecond and femtosecond UV sources, and is compatible with a broad range of matrices without extensive pre-treatment.

Application of simultaneous $\delta^{13}\text{C}$ $\delta^{18}\text{O}$ measurements in organic materials (courtesy of Natural Resources Institute, Finland) to allow new research opportunities in paleoclimate, archaeology, and plant sciences

Oral 01/04 -9:00 - 9:15

Dr. Jeroen (H).J.L. van der Lubbe

Fluid-Inclusion Isotope Constraints on Hydroclimate in Ethiopia during the African Humid Period

Jeroen van der Lubbe¹, Daniel Gebregiorgis², Jasmijn de Graaf¹, Thomas Langens¹, Mark A. Elungat³, Kim Cobb⁴, Victor J Polyak⁵, Yemane Asmerom⁶, Zelalem Bedaso⁷, Asfawossen Asrat⁸

¹*Vrije Universiteit Amsterdam*

²*Georgia State University*

³*Georgia State University*

⁴*Brown University*

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⁶*Botswana International University of Science & Technology*

⁷*University of Dayton*

⁸*Addis Ababa University*

Reconstructing wetting and drying patterns associated with the African Humid Period (AHP), spanning ~14.5 to 4.5 ka BP, is essential for understanding past hydroclimate dynamics in eastern Africa and improving future climate projections. The AHP is characterized by widespread greening of the Sahara and the expansion of eastern African lakes to their highest levels. Here, we present the first fluid inclusion isotope record of an Early Holocene speleothem (ACH2) from Ethiopia. Speleothem calcite contains small amounts of fossil drip water preserved as fluid inclusions, whose isotopic composition can be precisely analysed using a novel crushing technique developed at the Stable Isotope Laboratory of Vrije Universiteit Amsterdam. ACH2, collected from Achere Cave in the southeastern Ethiopian highlands, is a ~35 cm-long speleothem deposited rapidly between ~8.96 and 8.80 ka BP, during the peak of the African Humid Period. The fluid-inclusion record yields $\delta^2\text{H}$ and $\delta^{18}\text{O}$ values that align with those of modern rainfall during the wet season, indicating an intensified East African Summer Monsoon during the AHP. Although the fluid-inclusion data are of relatively low temporal resolution, they are complemented by annual resolution stable isotope and elemental records, which suggest a strong influence of ENSO and IOD variability on rainfall during the AHP similar to modern conditions.

Oral 1/04 -9:15 - 9:30

Riet Rosseel

Candidate for young scientist award

Systemic availability of short-chain fatty acids depends on their intestinal site of absorption: a randomized, crossover trial in healthy subjects

1 Riet Rosseel, 2 Greet Vandermeulen, 3 Tessa Dehau, 4 Kristin Verbeke

1,2,3,4: *Translational Research in Gastrointestinal Disorders, KU Leuven, Leuven, Belgium*

Short-chain fatty acids (SCFA), comprising mainly acetate, propionate and butyrate, are carboxylic acids produced through the fermentation of dietary fibers in the human colon and potentially play a mediating role in the health benefits associated with high fiber intake. Following their absorption, SCFA serve as energy source for colonic epithelial cells and as substrate for lipid and glucose synthesis in the liver. A small fraction of the produced SCFA escapes this first-pass metabolism in the gut and liver and enters the systemic circulation unchanged; this fraction is called the systemic availability. Unlike colonic cells, epithelial cells in the small intestine do not primarily use SCFA as an energy source. Therefore, we hypothesized that small intestinal delivery of SCFA results in a higher systemic availability than colonic delivery. To test this hypothesis, we conducted a randomized, crossover trial in healthy subjects ($n=11$; age: 28 ± 7 years; BMI: 22 ± 2 kg/m²). On 2 separate study visits, SCFA labeled with stable isotope ¹³C (400 mg ¹³C-acetate, 300 mg ¹³C-propionate, 800 mg ¹³C-butyrate) were administered either to the small intestine (SI) or to the colon (Co) using standard capsules or capsules with a colon-delivery coating, respectively. In addition, a primed, continuous intravenous infusion containing ²H-labeled SCFA ([²H₃]-acetate: 10 μmol.kg⁻¹ + 20 μmol.kg⁻¹.h⁻¹; [²H₅]-propionate: 1 μmol.kg⁻¹ + 2 μmol.kg⁻¹.h⁻¹; [²H₇]-butyrate: 0.5 μmol.kg⁻¹ + 1 μmol.kg⁻¹.h⁻¹) was administered for 12 hours to assess the clearance of SCFA from the circulation. Postprandial serum samples were collected at regular timepoints for 12 hours. All samples were analyzed for total (labeled + unlabeled) SCFA using gas chromatography-mass spectrometry (GC-MS) after derivatization with 2,4-difluoroanilin. ²H- and ¹³C-abundances were measured in ether extracts of the serum samples using GC-MS or GC- combustion- isotope ratio mass spectrometry, respectively. Serum concentrations of ¹³C-SCFA and ²H-SCFA were obtained by multiplying the respective abundances with the total SCFA concentrations. The clearance (L/hour) of SCFA were calculated by dividing the ²H-SCFA infusion rate by the ²H-SCFA steady state concentrations. The systemic availability was calculated as the area under the curve (AUC) of ¹³C-SCFA concentration over 12 hours multiplied with the clearance and divided by the administered dose of ¹³C-SCFA. After small intestinal delivery, the highest ¹³C-SCFA concentrations were obtained after 30 min whereas the ¹³C-SCFA concentration peaked between 200 and 400 min after colonic delivery. Systemic availability of acetate and propionate was higher following their small intestinal compared to colonic administration (median [IQR] acetate: 71.0 [54.9-87.3]% vs. 52.3 [42.5-62.0]%, $p=0.04$; propionate: 10.4 [7.7-13.0] % vs. 6.8 [4.9-8.8]%, $p=0.02$) whereas the availability of butyrate did not differ between the administration sites (SI: 3.2 [2.6-3.8]% vs. Co: 2.8 [1.9-3.7] %, $p=0.40$). Thus, our hypothesis was confirmed for acetate and propionate. These findings demonstrate that the systemic availability of SCFA depends on the intestinal site of absorption, highlighting its importance when interpreting SCFA-related effects and designing future clinical studies investigating their potential health benefits.

Oral 01/04 -9:30 - 9:45

Cedric Dumoulin

Meridional nitrate gradients in the Indian Sector of the Southern Ocean over the last glacial cycle

Cédric Dumoulin¹, Simon Desmettre¹, Ellen Ai², Matthew Lacerra², Frank Lamy³, Simone Moretti⁴, Sofia Muller¹, Anja Studer⁵, Gerald H. Haug^{4,6}, Alfredo Martínez-García⁴, Daniel M. Sigman², François Fripiat¹

¹*Department of Geosciences, Environment and Society, Université Libre de Bruxelles, Brussels, Belgium*

²*Department of Geosciences, Princeton University, Princeton, USA*

³*Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany*

⁴*Climate Geochemistry Department, Max Planck Institute for Chemistry, Mainz, Germany*

⁵*Department of Environmental Sciences, University of Basel, Basel, Switzerland*

⁶*ETH Zürich, Sonneggstrasse 5, 8092 Zürich, Switzerland*

The Antarctic Zone of the Southern Ocean ventilates both cells of the global overturning circulation, as wind-driven upwelling brings deep, nutrient-rich waters to the surface. Because phytoplankton growth is limited by iron and light, nutrients are only partially consumed, allowing CO₂ to escape to the atmosphere. The suppression of this leak is thought to have been central to the lower atmospheric CO₂ concentrations during ice ages. As surface waters are advected northward by wind-driven Ekman transport from the Antarctic zone into the Subantarctic Zone, progressive nutrient drawdown establishes a pronounced meridional nutrient gradient. The nitrogen isotopic composition of organic matter in microfossils (fossil-bound δ¹⁵N) records past surface nitrate concentrations, providing a window into these processes. Here, we present fossil-bound δ¹⁵N from a latitudinal transect of sediment cores in the Indian sector of the Southern Ocean, including a new record from core PS69/907-2. Together, these records allow us to reconstruct changes in meridional surface nitrate distributions over the past 150 kyr, illuminating the coupled roles of wind-driven upwelling and ice-sheet meltwater in shaping nutrient supply and their role in driving the rise of atmospheric CO₂ during deglaciations.

Oral 01/04 -9:45 - 10:00

Andrea Janine Chávez Pacheco

Candidate for young scientist award

Tracing Tropical Montane Tree Responses to Climate Using Herbarium Samples: An Isotopic Approach

Andrea Chávez-Pacheco¹, Marijn Bauters,^{1,2} Selene Báez³, Susana León-Yáñez⁴, Jürgen Homeier⁵, Ximena Palomeque⁶, Hans Verbeeck¹

¹Ghent University, Q-ForestLab, Coupure Links 653, Ghent, 9000, Belgium

²Ghent University, Isotope Bioscience Laboratory-ISOFYS, Coupure Links 653, Ghent, 9000, Belgium

³Escuela Politécnica Nacional, Departamento de Biología, Ladrón de Guevara E11-253 y Andalucía, Quito, Ecuador

⁴Pontificia Universidad Católica del Ecuador, Escuela de Ciencias Biológicas, Avenida 12 de Octubre 1076 y Vicente Ramón Roca, Quito, Ecuador

⁵University of Marburg, Conservation Ecology, Germany, Karl-von-Frisch-Straße 8, 35043 Marburg

⁶Universidad de Cuenca, Facultad de Ciencias Agropecuarias, Av. 12 de Abril y Agustín Cueva Cuenca, Ecuador

Tropical montane forests of the Northern Andes are natural laboratories that harbor unique and highly biodiversity. Under ongoing global change, these ecosystems may act as important reservoir, making it essential to understand how plant species respond and adapt to changing environmental conditions. However, ecophysiological datasets from tropical montane regions remain scarce.

Herbarium collections represent an underused yet valuable resource for addressing this gap. In this study, we investigated the stable carbon isotope composition ($\delta^{13}\text{C}$) to explore plant water-use strategies across the Andes-Amazon and since 1940's. Using this approach, we analyzed $\delta^{13}\text{C}$ from four dominant Andean tree species collected over multiple decades and distributed across an altitudinal gradient in the Ecuadorian Andes.

Preliminary results indicate that rising atmospheric CO_2 has led to detectable temporal changes in intrinsic water-use efficiency (iWUE). Responses appear to be species-specific. In general, species adapted to higher elevations, such as *Alnus acuminata* and *Vallea stipularis* (~4000 m), show an increase in iWUE over time. In contrast, *Guarea kunthiana* and *Myrsine coriacea*, which are commonly found at lower elevations (~1000–2000 m), show different responses: iWUE shows an apparent decrease at lower elevations but increases through time in the samples collected from the upper limits of their habitat range. Further analysis are expected, but these contrasting responses highlight species-specific adjustments to environments in the Andes.

This study demonstrates the potential of herbarium archives to uncover long-term physiological responses of tropical montane forests that enable retrospective ecological research. Our results emphasize the importance of maintaining and expanding herbarium collections, particularly in biodiverse regions such as the tropical Andes.

Oral 01/04 - 10:00 - 10:15

Sam Barker

Fully integrated TOC and TNb analysis of estuarine and sea water samples with the Elementar iso TOC cube®

1. Calum Preece, 2. Toby Boocock, 3. Mike Seed, 4. Marian de Reus, 5. Sam Barker,

1-3. Elementar UK Ltd, Manchester, UK

4-5. Elementar Analysensysteme GmbH, Langenselbold, Germany

Identifying and quantifying the processes that control the carbon and nitrogen cycling in aquatic systems is important for mitigating urban and agricultural pollution, optimizing environmental policy and understanding global nutrient cycles. The isotopic analysis of dissolved organic carbon (TOC) and total bound nitrogen (TNb) are particularly important to elucidate the different sources, track nutrient cycling processes and help contamination identification.

Here, we present the $\delta^{13}\text{C}$ performance of the Elementar iso TOC® cube for <5 mg/L carbon TOC concentrations in estuarine river water samples, highlighting a salinity gradient from 2g/L to 25g/L. We also present determination of TOC concentration and $\delta^{13}\text{C}$ TOC in seawater, demonstrating the performance of the iso TOC® cube for the analysis of seawater samples.

The iso TOC cube® elemental analyser has been developed for fully integrated TOC/TNb isotope ratio analysis. Optimised for precise measurements of TC, TOC, TIC and TNb isotope ratios covering a wide range of applications areas. All types of liquids from drinking water, industrial wastewater, soil leachates, or marine samples are determined reliably and with the highest isotopic precision.

Oral 01/04 -10:40 - 10:55

Prof. François Fripiat

Southern Ocean and atmospheric CO₂ during both Pleistocene Ice ages and Early Eocene Optimum

1, 2. François Fripiat, 2. Simone Moretti, 3. Mathis Hain, 1. Cédric Dumoulin, 4. Ellen Ai, 5. Anja Studer, 2. Alfredo-Martínez-García, 2,6. Gerald H. Haug, 1. D.M. Sigman

1 Department of Geosciences, Environment and Society, Université Libre de Bruxelles, Brussels, Belgium

2 Max Planck Institute for Chemistry, Mainz, Germany

3 Earth and Planetary Science Department, University of California, Santa Cruz, Santa Cruz CA, USA

4 Department of Geosciences, Princeton University, Princeton, New Jersey, USA

5 Department of Environmental Sciences, University of Basel, Switzerland

6 ETH Zürich, Sonneggstrasse 5, 8092 Zürich, Switzerland

The Southern Ocean is a major “leak” in the global ocean’s biological carbon pump and has been implicated in atmospheric CO₂ changes over recent glacial–interglacial cycles. However, it may have played a similar role throughout the Cenozoic, acting as a positive feedback to global warming by releasing previously sequestered CO₂ back to the atmosphere during warmer climates. Here, we use fossil-bound δ¹⁵N to reconstruct Southern Ocean surface biogeochemical conditions across both the last glacial–interglacial cycles and the Early Eocene Climatic Optimum (EECO) — a period in Earth’s history when temperatures and atmospheric CO₂ levels were among the highest of the entire Cenozoic Era. Our results allow to reconstruct the Southern Ocean’s overturning circulation during ice ages but also show that nitrate consumption at the surface increases under warmer conditions, enhancing CO₂ outgassing from the deep ocean and amplifying the initial warming. The low buffering capacity of seawater in the Eocene, combined with reduced global chemical weathering rates, suggests that the reconstructed decrease in biological pump efficiency in the Southern Ocean could account for at least half, or possibly all, of the atmospheric CO₂ rise observed during the EECO.

Oral 01/04 -10:55 - 11:10

Joshua Jager

Decoding Steroid Isotope Signatures with Orbitrap-based Isotope Ratio Mass Spectrometry?

1. *Joshua Jager*, 2. *Marco Blokland*, 3. *Gregg Roelofs*, 4. *Saskia Sterk*

1-4. Wageningen Food Safety Research, European Union Reference Laboratory, Wageningen, the Netherlands.

In the European Union the use of steroids in animal husbandry is forbidden. For control and enforcement purposes, urine samples of amongst others cattle are tested. However, for naturally occurring steroids, the only way to distinguish between abuse by administration of synthetic analogues and endogenous origin in urine is by analysing their stable carbon isotopic ratio. Traditionally, dedicated isotope ratio mass spectrometers (GC-c-IRMS) are employed, but these analyses require complex and elaborate sample preparation, and structural information is lost as combustion is used. Consequently, IRMS confirmation are only implemented by a few food safety laboratories, due to the associated high costs and expertise requirements.

Recent published methods have started to investigate the use of electrospray ionization and Orbitrap mass spectrometers to determine the isotopic ratios from intact protonated molecules. As no conversion to CO₂ is required, but high-resolution and accurate mass information is used, molecular and structural information remains. Furthermore, Orbitrap mass spectrometers are more readily available for food safety laboratories and could therefore enable wider implementation across official laboratories. So far, published work mainly focusses on measurement via direct infusion and is not applied to the discrimination of synthetic and natural steroids.

In our work, we have investigated the use of Orbitrap MS to determine the carbon isotopic ratio for this very purpose. Initially, a systematic study was conducted on stable isotope ratio measurements using direct infusion experiments to evaluate full-scan and MS/MS measurement parameters. Chromatographic separation was thereafter developed to both enable sufficient separation in complex urine samples but also provide sufficient datapoints for isotope ratio measurements. Optimal parameters were applied to samples to differentiate between treated and untreated animals and the obtained results are compared with those obtained from GC-c-IRMS measurements. This presentation highlights the obtained findings and their implications for future perspectives and eventual practical implementation.

Dr. Jun Zhang

Identifying ammonia sources using an isotope-based approach

1. Jun Zhang, 2. Enrico Dammers, 3. Harmen van Mansom, 4. Samuel Bodé, 5. Katja Van Nieuland, 6. Gerrit Jan de Bruin, 7. Martijn Schaap, 8. Arjan Hensen

1, 3, 6, 8. TNO, Environmental Modelling, Sensing and Analysis, Petten, the Netherlands

2. 7. TNO, Air Quality and Emissions Research, Utrecht, the Netherlands

4, 5. Isotope Bioscience Laboratory (ISOFYS), Department of green Chemistry and Technology, Faculty of Bioscience Engineering, Ghent University, Belgium

7. Institute of Meteorology, Freie Universität Berlin, Berlin, Germany

Elevated reactive nitrogen deposition remains a major environmental challenge in the Netherlands, with ammonium (NH₄⁺) representing the largest fraction of this. Yet uncertainties in the relative contributions of ammonia (NH₃) sources continue to constrain effective mitigation policy. Conventional emission inventories and atmospheric models are limited in their ability to distinguish NH₃ derived from agricultural and combustion activities. To improve empirical source attribution, a pilot study was conducted by TNO in collaboration with other EU partners in 2024. The study represents the first coordinated application of nitrogen isotope analysis ($\delta^{15}\text{N-NH}_3$) across multiple sites and seasons in the Netherlands using passive ammonia samplers.

Fifteen monitoring locations were selected to capture diverse source environments, including livestock-intensive regions, highways, industrial zones, and Natura 2000 areas. Samples collected from May to December 2024 exhibited distinct $\delta^{15}\text{N-NH}_3$ signatures, indicating pronounced spatial and temporal variability in $\delta^{15}\text{N-NH}_3$ signatures. Agricultural sources dominated in rural and natural areas throughout the year (>90%), while combustion-related contributions increased at urban and highway sites during winter (up to 45-52%), consistent with reduced agricultural activity. These results contrast with current national inventories that assume a uniform agricultural contribution (80-90%) across seasons .

The findings demonstrate that $\delta^{15}\text{N-NH}_3$ isotope analysis, using passive sampling, provides a robust and scalable approach for improving NH₃ source differentiation. Establishing a comprehensive $\delta^{15}\text{N}$ reference database and linking isotopic data with chemical transport models could substantially reduce source attribution uncertainty, thereby strengthening the scientific foundation for targeted nitrogen mitigation strategies in the Netherlands and other EU countries.

Oral 01/04 -11:25 - 11:40

Mr. Tijs Joling

How Resilient is the Seagrass Nitrogen Cycle to Moderate Nutrient Enrichment?

1 Tijs Joling, 2 Mona A. Andskog, 3 Naomi S. Wells, 4 Jack J. Middelburg, 5 Joanne M. Oakes

1, 2, 3 & 5 Centre for Coastal Biogeochemistry, Southern Cross University, Australia

3 Department of Soil & Physical Sciences, Lincoln University, New Zealand

4 Department of Earth Sciences, Utrecht University, The Netherlands

Seagrass meadows are highly productive systems that act as important nitrogen (N) sinks in the coastal zone. However, this service can be impacted by anthropogenic nutrient enrichment, which can increase the release of the greenhouse gas nitrous oxide. Anthropogenic climate change and coastal development will make moderate nutrient enrichment more commonplace in the future. Unlike high nutrient enrichment, our understanding of the impact of this moderate nutrient enrichment on N pathways in seagrass meadows is limited. In this study the water column above Australian seagrass patches (*Cymodocea serrulata*) was experimentally enriched in situ with N-P-K fertilizer, delivering $0.12 \text{ g N m}^{-2} \text{ day}^{-1}$ for 75 days. From days 35 to 75 of nutrient enrichment, an in situ ^{15}N pulse-chase experiment was conducted to compare N uptake and capture by seagrass, epiphytes, and sediment within nutrient-enriched and ambient patches. Simultaneously, the effect of nutrient enrichment on dissimilatory N pathways was measured using three incubation methods: sediment slurries, intact sediment cores, and in situ benthic chambers. ^{15}N -labelling indicated that moderate nutrient enrichment enhanced N uptake by epiphytes (median increased from $9.9 \pm 1.5\%$ to $19.9 \pm 5.2\%$ of ^{15}N label) and lowered N storage in belowground tissue (median decreased from $5.9 \pm 0.5\%$ to $3.9 \pm 1.9\%$ of ^{15}N at experiment end). Slurry incubations revealed that the potential denitrification rate in sediment was enhanced by nutrient enrichment. However, the more representative, intact sediment core and in situ incubations showed no change in denitrification rate due to nutrient-enrichment. Furthermore, denitrification was of minor importance in both the core and in situ incubations, while dissimilatory reduction of nitrate to ammonium (DNRA) was the dominant NO_3^- consuming pathway regardless of nutrient treatment. Moderate nutrient enrichment did not alter the rate of nitrous oxide production in the sediment, nor did it increase nitrous oxide flux from the sediment to the water. Our findings support the idea that seagrass functions as a buffer against nutrient enrichment, preventing drastic changes to dissimilatory N pathways. While moderate nutrient enrichment does not induce additional nitrous oxide release, it does decrease the long-term N storage efficiency of seagrass meadows.

Abstracts

Poster Presentations

P1 (31/10 - 14:30-14:55)

Dr. Erik Heeren

Advancing N₂O Isotopic Measurements Using Picarro's New PI5131-i Isotopic N₂O Analyzer and Sage Gas Autosampler

1. Erik Heeren, 2. Magdalena Hofmann, 3. Jan Woźniak, 4. Peter Swinkels, 5. Joyeeta Bhattacharya, 6. Tina Hemenway, 7. Jingang Zhou

1, 2, 3, 4 Picarro B.V.

5, 6, 7 Picarro Inc.

Nitrous oxide (N₂O) is a powerful greenhouse gas that also affects the ozone layer. To better understand how N₂O is produced and consumed in soils, oceans, the atmosphere, and wastewater, scientists measure its isotopes to reveal sources and transformation processes. Until now, making these measurements has often been complex and slow.

Picarro has developed a new instrument, the PI5131-i isotopic N₂O analyzer, that can measure site-specific ($\delta^{15}\text{N}_\alpha$, $\delta^{15}\text{N}_\beta$) and bulk isotopes ($\delta^{15}\text{N}$, $\delta^{18}\text{O}$) of N₂O continuously with high precision. The analyzer uses advanced laser technology to deliver stable and reliable results. It can also be paired with Picarro's new Sage gas autosampler, which makes it possible to process many small gas samples automatically. Together, these tools provide scientists with an efficient way to study N₂O across a wide range of environments. With the right sample preparation, this system can also be used to analyze nitrate isotopes, giving researchers a powerful new method for investigating the nitrogen cycle.

P2 (31/10 - 14:30-14:55)

Els Heyrman

Candidate for young scientist award

Using ¹⁵N Natural Abundance to Assess Nitrogen Fixation and Nitrogen Transfer in European Pure Stand and Mixed Intercropping Systems

1. *Els Heyrman*, 2. *Kate Buckeridge*, 3. *Irene Griffiths*, 4. *Takashi Tanaka*, 5. *Konstantinos Mattas*, 6. *Laura Leimbrock*, 7. *Vesna Župunski*, 8. *Adnan Šišić*, 9. *Susanne Vogelgsang*, 10. *Greet Verlinden*, 11. *Kevin Dewitte*, 12. *Steven Maenhout*, 13. *Steven Sleutel*

1, 10, 11, 12. *Department of Plants and Crops, Ghent University, Belgium.*

1, 13. *Department of Environment, Ghent University, Belgium.*

2. *Luxembourg Institute of Sciences and Technology, Luxembourg.*

3. *Inst. of Biological, Environmental and Rural Sciences, Aberystwyth University, UK.*

4. *Department of Agroecology, Aarhus University, Denmark.*

5. *Dep. of Agricultural Development, Democritus University of Thrace, Greece.*

6. *Institut fir Biologesch Landwirtschaft an Agrarökologie Luxemburg a.s.b.l, Luxembourg.*

7. *Small grains department, Institute of Field and Vegetable Crops, Republic of Serbia.*

8. *Section of Ecological Plant Protection, University of Kassel, Witzenhausen, Germany.*

9. *Agroscope, Zurich, Switzerland.*

The inclusion of legumes in European cropping systems offers multiple benefits, including reduced greenhouse gas emissions and increased agricultural biodiversity, while enabling European countries to become more self-sufficient in plant protein production. A key strategy is mixed intercropping, defined as the simultaneous cultivation of annual grain legumes and cereals on the same land unit. Unlike pure stand cultivation, this approach enhances nutrient resource-use efficiency through two key ecological principles: niche complementarity and facilitation (Duchene et al., 2017). In mixed intercropping systems, competition for soil mineral nitrogen (N) is minimized. Legumes can rely more heavily on atmospheric N₂, measured as the percentage of N derived from the atmosphere (Ndfa%), for their total N uptake. Consequently, the legume ‘spares’ available mineral N for the accompanying cereal, enabling a potential increase in the cereal’s N uptake. Furthermore, research suggests that legumes may make their fixed N directly available to the cereal via root exudation or through common mycorrhizal networks (Peoples et al., 2015). This may result in increased nitrogen-use efficiency of the mixed intercropping system compared to species grown in pure stands.

Despite the theoretical benefits of mixed intercropping, only a limited number of multi-year, multi-location field trials have assessed biological nitrogen fixation (BNF) and total N uptake in comparison with pure stands. Within the Horizon Europe LEGENDARY project, we established field experiments over two growing seasons (2024 and 2025) using an identical design across Europe. The participating countries - Serbia, Denmark, Belgium, Luxembourg, Greece, Germany, Switzerland and the United Kingdom – represent the wide range of climatic zones and soil types. The annual legume species included were narrow-leaved lupin (*Lupinus angustifolius*), faba bean (*Vicia faba*), lentil (*Lens culinaris*) and field pea (*Pisum sativum*), grown as pure stands or mixtures with oat (*Avena sativa*) or barley (*Hordeum vulgare*). To accurately quantify Ndfa% and BNF, the ¹⁵N natural abundance method was employed on the aboveground biomass. A critical component of this method is the choice of reference species. We assessed the use of the cereal grown in a pure stand versus the cereal grown within the mixed intercropping system. Finally, the amount of fixed N transferred from legume to cereal within the mixed plots was quantified.

Comparisons from both growing seasons demonstrate that the choice of reference species—whether the cereal was sourced from a pure stand or the mixed intercropping system—yielded no significant difference in the resulting Ndfa% values. This consistency was observed independently for each

legume species and across every field trial location. Consequently, the pure stand cereal was utilized as the reference species for Ndfa% and BNF calculations.

In both growing seasons, Ndfa% proved to be higher in mixed intercropping than in pure stand, irrespective of legume species (overall mean \pm sd for 2024: mix 88.3 \pm 10.2%, pure 81.0 \pm 11.8%; and for 2025: mix 72.2 \pm 26.6%, pure 57.3 \pm 26.5%). Total BNF varied by species, cropping system and season. Mixed intercropping increased the aboveground N content of the cereals and did not significantly decrease the legumes' N content, implying complementary nitrogen acquisition strategies.

To assess the resource-use efficiency of the mixed intercropping system, we calculated the Land Equivalent Ratio (LER) (De Wit & Van den Bergh, 1965), as well as the Crop Performance Ratio (CPR) (Harris et al., 1987) from the aboveground biomass and N uptake. The mixed intercropping systems demonstrated clear overyielding across both growing seasons. In 2024, the LER based on N uptake was 1.29 \pm 0.27 and 1.32 \pm 0.14 in 2025, confirming a consistent efficiency gain over pure stands. Furthermore, the CPR values in 2024 (3.47 \pm 1.35) and in 2025 (3.47 \pm 1.51) underscore the effectiveness of the system at acquiring resources, like nitrogen.

Quantifying the transfer of fixed N using ^{15}N natural abundance and the proposed equations of Snoeck et al. (2000) resulted in negative percentages. These results stem from the fact that intercropped cereals did not exhibit the expected depletion in $\delta^{15}\text{N}$ relative to their pure-stand counterparts. This may be attributed to the limitations of only sampling the aboveground biomass or to isotopic fractionation during the legume-cereal transfer.

Our results demonstrate that legume-cereal intercropping with field pea, lentil, faba bean or narrow-leaved lupin proves to be a robust strategy to enhance N use efficiency across different European agroecological conditions.

P3 (31/10 - 14:30-14:55)

Roberto Penasa

Enhanced Authentication of High-Value Food Products Using Combined GC-MS and GC-IRMS Approaches: Case Studies on Lavender and Mint Essential Oils

1. Roberto Penasa, 2. Roberto Larcher, 2. Mauro Paolini, 4. Alberto Roncone, 5. Long Chen, 6. Luana Bontempo

1-6. Fondazione Edmund Mach, via Mach 1, 38098 San Michele all'Adige, Trento

Food authentication and adulteration detection are essential to ensure product integrity, protect consumers from fraud, and support traceability and quality control across high-value food and natural product supply chains. In this context, lavender and peppermint essential oils are frequently subject to adulteration with lavandin oil or synthetic substitutes.

In this study, fast GC-MS/MS and GC-IRMS were investigated as a versatile analytical approach for the authentication of these high-value essential oils. Seventy-nine volatile organic compounds (VOCs) were profiled, and the $\delta^{13}\text{C}$ and $\delta^2\text{H}$ ratios of 32 compounds were measured in lavender, lavandin, and commercial lavender essential oil samples. Using sparse Partial Least Squares Discriminant Analysis (sPLS-DA), the model achieved complete classification between lavender and lavandin within the studied dataset, identifying key VOCs (including camphor, borneol, and eucalyptol) and isotopic markers discriminating these botanicals. Compound-specific $\delta^{13}\text{C}$ and $\delta^2\text{H}$ ratios enabled detection of adulteration when more than 15% of linalool, linalyl acetate, eucalyptol, or α -terpineol originated from synthetic sources.

Similarly, lab-made peppermint essential oils from Northern Italy and commercial peppermint essential oils available on the Italian market were analysed. Their volatile profiles and $\delta^{13}\text{C}$ – $\delta^2\text{H}$ isotopic signatures of menthol and other minor compounds were compared with those of mint-flavoured products (candies, chewing gums, mouthwashes, and syrups), highlighting the potential of this analytical approach for authentication and adulteration detection.

Overall, the results demonstrate that the combined GC-MS/MS and GC-IRMS approach provides a robust framework for determining botanical origin and detecting adulteration in high-value essential oils and related food products.

P4 (31/10 - 14:30-14:55)

Marie Tuerlinckx

Candidate for young scientist award

The Long-Term Impact of Excess Phosphorus Saturation on Soil Organic Carbon Sequestration in Flemish Sandy Cropland Soils

1. Marie Tuerlinckx, 2. Erik Smolders, 3. Steven Sleutel

1 Department of Environment, Ghent University, Belgium

2 Department of Earth and Environmental Sciences, KU Leuven, Belgium

3 Department of Environment, Ghent University, Belgium

Decades of animal manure and phosphorus (P) fertilizer application have led to significant P accumulation in Flemish cropland soils, yet the impact of this accumulation on soil organic carbon (SOC) storage remains poorly understood. It is hypothesized that SOC stocks follow a bell-shaped response to increasing soil P availability [1]: initially increasing under P-deficient conditions due to enhanced net primary production and carbon (C) inputs, plateauing as the soil organic matter (SOM) protection capacity is reached and potentially declining under excess P conditions. Such a decline may be driven by reduced rhizodeposition, increased SOC mineralization and competition between phosphate and organic anions for mineral binding sites at excess P levels.

To assess whether SOC indeed declines at elevated soil P levels, we investigated the mean conversion efficiency of plant C inputs into SOC pools as a function of the degree of phosphate saturation (DPS). This metric is particularly relevant to investigate competition between phosphate and organic anions in sandy, acidic Flemish agricultural soils, where pedogenic iron and aluminum (oxy)(hydr)oxides are the main sorbents for both SOC and orthophosphate. For these soils, DPS [2] is defined as $DPS = P_{ox} / [0.5 \times (Al_{ox} + Fe_{ox})]$, with P_{ox} , Al_{ox} and Fe_{ox} , contents of these elements extracted by acid ammonium-oxalate [3].

We hypothesized that at the frequently elevated DPS levels in these sandy acidic soils (in topsoil sometimes even above 100 %), competition between SOC and phosphate for mineral binding sites constrains the stabilization of new C inputs. In this study, we therefore examined the effect of DPS on C stability and long-term maize plant-C storage after approximately 30 years. A historical dataset of over 3,000 Flemish sandy agricultural soils, sampled in the 1990s, served as the basis for this study. Eighty-two fields were selected to represent a DPS gradient while maintaining comparable pH, clay content and sorption capacity, i.e. summed content of Al_{ox} and Fe_{ox} . Cropping history on these fields included maize for at least 16 of the past 26 years (the period for which crop history is available). The soils on the selected fields were resampled at 0-30, 30-60 and 60-90 cm.

The C-content and $\delta^{13}C$ values were measured via EA-IRMS for both the resampled and historical soils at the three depth increments, allowing calculation of a ^{13}C mass balance to estimate the buildup of 'new', maize-derived C. Maize-derived C conversion efficiency (Maize-C CE) was defined as the proportion of maize-derived carbon retained in soil relative to the total estimated maize-C input over the study period.

Average bulk soil Maize-C CE values over the past 30 years were 9.09 ± 6.22 , 31.46 ± 27.31 and 11.50 ± 12.57 % for the 0-30, 30-60 and 60-90 cm layers, respectively, and were not significantly affected by DPS. Given the large variability, we will investigate which other parameters are better predictors of the Maize-C CE. To further investigate SOC-P competition for mineral-binding sites, targeted analyses are ongoing on A-horizon soils to assess the relationship between DPS and C storage in the pedogenic Fe and Al bound SOC pool. Acid hydroxylamine extractions are used to quantify C bound to Fe and Al (oxy)(hydr)oxides, providing insight into SOC-P interactions at elevated DPS. Furthermore, incubation experiments will be performed to assess the stability of maize-derived C, while batch-sorption experiments will test whether DPS influences the sorption capacity for different organic molecules.

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P5 (31/10 - 14:30-14:55)

Kathrin Rosenthal

Evaluation of Sorbitol as an Endogenous Isotopic Reference Marker Compound for the Detection of C4-type Sugar Adulteration in Apple Juice

1. Mike Seed, 2. Philipp I. Schodder, 3. Marco Schmidt, 4. Hesham Abdallah, 5. Jan Hartwig, 6. Kathrin Rosenthal

1, 6. Elementar UK Ltd., Isoprime House, Earl Road, Cheadle Hulme, Stockport, SK8
2, 3, 4, 5. Elementar Analysensysteme GmbH; Elementar-Straße 1, 63505 Langenselbold

Apple juice is one of the world's most widely consumed fruit juices and is therefore a common target for economically motivated adulteration (EMA). Such adulteration may involve dilution with water, substitution with other juices, or the addition of exogenous sugars, each requiring robust analytical methods for detection. Here we present a new method for identifying the addition of exogenous C4-type sugars to apple juice by using the naturally occurring sorbitol compound as an endogenous isotopic reference marker. The method uses liquid chromatography coupled to isotope ratio mass spectrometry (LC-IRMS) to determine the $\delta^{13}\text{C}$ values of the major endogenous sugars in apple juice. We show that the $\delta^{13}\text{C}$ value of sorbitol can be measured in the same analytical run as the other major sugar components and that this value remains unaffected by the addition of exogenous C4-type sugars to the apple juice. This method offers strong advantages over existing approaches, notably eliminating the need for extensive sample preparation and the use of multiple analytical methods thereby improving analytical throughput and ease of use.

P6 (31/10 - 14:30-14:55)

Sander Hoekzema

Isotopic fingerprinting: using D/H analysis to trace hydrogen sources in Hydrotreated Vegetable Oil (HVO)

1. S.L. Hoekzema, 2. H.A.J. Meijer, 3. A. Hommes, 4. D. Blik

1 2. Rijksuniversiteit Groningen, ESRIG

3, 4. Rijksuniversiteit Groningen, ENTEG

Unlike first-generation biodiesel derived from food-competing biomass, Hydrotreated Vegetable Oil (HVO) is a second-generation biofuel produced from waste- and residue-based biomass through catalytic hydrotreatment. In this process, vegetable oils or waste fats react with hydrogen at elevated temperatures and pressures. The reaction saturates carbon-carbon double bonds and removes oxygen (via hydrodeoxygenation), replacing it with hydrogen to yield a hydrocarbon product that is chemically nearly indistinguishable from fossil diesel.

Although HVO based on biomass can reduce net CO₂ emissions relative to fossil-based diesel, its overall sustainability also depends on the carbon intensity of the hydrogen used during production. Hydrogen derived from water electrolysis ("green" hydrogen) carries a substantially lower carbon footprint than hydrogen produced via steam methane reforming of natural gas ("grey" hydrogen). Both production pathways yield high-purity molecular hydrogen that is chemically identical, resulting in HVO products that are likewise indistinguishable. Consequently, conventional analytical techniques cannot differentiate HVO based on the hydrogen source used during production.

However, interestingly, hydrogen from different production pathways possesses distinct stable isotope (D/H) signatures that reflect the isotopic characteristics inherent to their formation. Because the added hydrogen is partially incorporated into the hydrocarbon structure during hydrotreatment, part of this isotopic signature is transferred to the final HVO product.

In this work we show that the hydrogen isotopic composition of HVO retains a measurable imprint of the hydrogen source used during production. This results in D/H analysis offers a promising analytical tool for distinguishing between green and grey hydrogen in renewable diesel, supporting improved traceability, verification, and carbon accounting within low-carbon fuel supply chains.

P7 (31/10 - 14:30-14:55)

Laurien Folkerts

Scales of Change: Historical Ecology of gilthead seabream (*Sparus aurata*) in an Evolving Trojan Bay (Türkiye, 4800 BCE - 500 CE)

1. Laurien A. Folkerts, 2. Marcel T.J. van der Meer, 3. Ronald van Bommel, 4. Canan Çakırlar, 5. Willemien de Kock

1. *Groningen Institute of Archaeology, University of Groningen, Groningen, The Netherlands*

2. *Department of Marine Microbiology & Biogeochemistry, NIOZ Royal Netherlands Institute for Sea Research, Den Hoorn, The Netherlands*

3. *Department of Marine Microbiology & Biogeochemistry, NIOZ Royal Netherlands Institute for Sea Research, Den Hoorn, The Netherlands*

4. *Groningen Institute of Archaeology, University of Groningen, Groningen, The Netherlands*

5. *Groningen Institute of Archaeology, University of Groningen, Groningen, The Netherlands*

Gilthead seabream (*Sparus aurata* L.) is the main cultivated fish species in the eastern Mediterranean today, yet archaeological evidence indicates it was already exploited from the early Holocene, with increasing abundance from the Middle Holocene onward. Human populations in this region have long relied on marine resources such as *S. aurata* while continually adapting exploitation strategies to shifting environmental conditions, making the study of past exploitation crucial for understanding long-term human-environment interactions. This study examines 43 archaeological *S. aurata* specimens from two coastal archaeological sites in Türkiye, Kumtepe and Troy, to investigate the historical ecology of gilthead seabream in the Trojan Bay. Relative abundances (NISP), estimated body sizes (Total Length), and stable isotope analyses of carbon ($\delta^{13}\text{C}$), nitrogen ($\delta^{15}\text{N}$), and sulphur ($\delta^{34}\text{S}$) were used to assess environmental change and human fishing strategies from 4800 BCE to 500 CE. Neolithic and Chalcolithic specimens show predominantly marine isotopic signatures, while Bronze Age individuals reflect estuarine conditions consistent with progressive silting of the Trojan Bay. Hellenistic and Roman specimens suggest a partial return to marine fishing, linked to further geomorphological changes. These results demonstrate that shifts in coastal environments shaped resource availability and exploitation strategies. By integrating isotopic, ecological, and archaeological data, this study provides long-term insights into human-marine interactions in the eastern Mediterranean and illustrates the value of historical ecological approaches for understanding environmental and anthropogenic change.

P8 (31/10 - 14:30-14:55)

Gaia Emma Pettinello

Refining human–fauna interactions and mobility in the Western Mediterranean through multi-isotopic and compound-specific approaches

1. Gaia Emma Pettinello, 2. Ymane Gilbert, 3. Christine Enjalbal, 4. Ilham Bentaleb

1, 4 Institut des Sciences de l'Evolution - Montpellier (ISEM), Université de Montpellier, Montpellier, France

2, 3 Institut des Biomolécules Max Mousseron (IBMM), Université de Montpellier, Montpellier, France

The Holocene witnessed profound climatic and socio-environmental transitions that reshaped human–environment interactions across the Mediterranean Basin. Events such as the end of the Green Sahara, the 4.2 ka aridification event, and later climatic oscillations influenced subsistence strategies, animal management, and human mobility. Understanding past human-fauna interactions is crucial for reconstructing adaptation mechanisms and anticipating future environmental challenges. Stable isotope analysis of bone collagen has become a cornerstone for reconstructing past diets and ecosystems; however, traditional bulk isotopic analyses often face limitations in resolution and interpretation particularly concerning baseline variability, complex nitrogen cycling, and chronological uncertainties.

This PhD project investigates collagen from human, and animal remains pertaining to key archaeological sites in the Western Mediterranean (Algeria, France, Italy) spanning from Neolithic to Late Antiquity, using an integrated isotopic approach combining bulk collagen $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, $\delta^{34}\text{S}$, radiocarbon dating, and compound-specific isotope analysis of amino acids (CSIA-AA). By distinguishing trophic amino acids (e.g., glutamic acid) from source amino acids (e.g., phenylalanine), CSIA-AA allows refined reconstructions of trophic positions and environmental baselines, an approach still rarely applied to terrestrial palaeoecological contexts. The primary objectives of this project are to: (1) enhance dating accuracy in periods where radiocarbon (^{14}C) is imprecise, (2) refine nitrogen isotope interpretations for past human-animal interactions, and (3) improve the understanding of human and animal mobility by integrating sulphur isotopes.

This project aims to investigate well-dated faunal assemblages to assess the variability in nitrogen isotope baselines linked to environmental conditions and agricultural practices. The integration of plant remains and sulphur isotopes will provide complementary data on mobility patterns and geographical origins, allowing also to differentiate local versus non-local resource exploitation, particularly in coastal and island contexts, further enriching the reconstructions.

Future CSIA-AA data will consider improved discrimination between climatic effects and trophic enrichment compared to bulk collagen values alone. Expected outcomes include the evaluation of integrating chiral ZooMS analysis with isotopic methods, further enriching the dietary and chronological reconstructions and the eventual validation of amino acids epimerization as a complementary dating method. By integrating isotopic datasets within Bayesian mixing models (SIAR) and isotopic niche analyses (SIBER), this research aims to reconstruct dietary strategies, human–animal relationships, and mobility patterns with higher resolution. Ultimately, this project contributes new methodological and empirical insights into Mediterranean paleoecology, identifying environmental and sociocultural factors influencing dietary and mobility patterns.

The possibility to present a contribution in this conference represents an exciting opportunity to meet multiple experts of the BASIS community, collecting feedbacks and suggestions, insights in this field of study.

P9 (31/10 - 14:55-15:25)

Dr. Mario Tuthorn

New dimensions in isotope ratio analysis of amino acids with Orbitrap IRMS technology

1. Mario Tuthorn, 2. Nils Kuhlbusch, 3. Dieter Juchelka

1, 2, 3. Thermo Fisher Scientific Bremen

Intramolecular isotopic information is important as it can provide a better understanding of the processes of molecule formation and the world around us. With amino acids being the building blocks of proteins and hence a crucial part of life and life processes, we have an opportunity to explore their intramolecular isotopic information with the latest development is Orbitrap-based IRMS methodology. Here we demonstrate how Thermo Scientific™ Orbitrap Exploris™ Isotope Solutions enables carbon, nitrogen, oxygen, and hydrogen isotope analysis of amino acids, using glutamic acid as a model compound. Primarily, this includes simultaneous analysis of ^{13}C , ^{15}N , ^{18}O and ^2H carrying isotopocules from intact molecular ions. In addition, we show how next level of isotopic information can be gained by fragmentation of the molecular ion of glutamic acid into its immonium ion, giving access to the position specific isotope ratio of $^{13}\text{C}/^{12}\text{C}$ in the carboxyl group (C1-Position). Position specific isotope analysis (PSIA) allows the investigation of biochemically and even artificially induced signatures on specific positions in the molecule as well as clumping effects in parts of the molecule (e.g. $^{13}\text{C}^{13}\text{C}$ accumulation). This opens new routes into the deconvolution of biochemical pathways, points of origin and authenticity control.

P10 (31/10 - 14:55-15:25)

Dr. Margarida Nunes Cardoso

Developing a stable isotope-based analytical framework for macroalgae traceability

1. *Margarida Nunes*
2. *Sónia Cruz*
3. *Paulo Cartaxana*

1, 2, 3. ECOMARE - Laboratory for Innovation and Sustainability of Marine Biological Resources, CESAM - Centre for Environmental and Marine Studies, Department of Biology, University of Aveiro, Aveiro, Portugal

Growing market demand for high-quality and certified food products has intensified the need for reliable traceability systems across global supply chains. European Union legislation requires fisheries and aquaculture products to be traceable at all stages of production, processing and distribution, reinforcing the need for robust analytical tools capable of supporting origin certification and authenticity control. Macroalgae represent the fastest-growing sector of marine aquaculture and are increasingly marketed as sustainable and high-value food products. The ability to verify their geographical origin would strengthen certification schemes, add commercial value, and help mitigate fraudulent practices.

The objective of this project is to develop a stable isotope-based analytical method to certify the geographical origin of edible macroalgae using isotope ratio mass spectrometry (IRMS). Portuguese coastal regions are currently used as a structured case study to establish and validate the methodological framework, with the longer-term goal of developing an approach transferable to other production areas.

Two edible and economically relevant species, *Codium tomentosum* and *Fucus vesiculosus*, were collected across northern, central and southern Portuguese coastal regions and in different seasons to capture natural environmental variability. The analytical workflow follows a stepwise strategy. Bulk stable isotope ratios ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$) and elemental C:N ratios are first determined by EA-IRMS to characterise baseline isotopic variability and assess regional differentiation. This initial level establishes whether bulk isotopic signatures provide sufficient resolution for origin certification. Where additional analytical resolution is required, compound specific isotope analysis (CSIA) of monosaccharides by GC/MS-IRMS will be performed. Monosaccharide-specific $\delta^{13}\text{C}$ isotope signatures are then evaluated as higher-resolution markers of geographical origin. Macroalgae from aquaculture systems are additionally analysed to assess the applicability of the framework to farmed production.

Rather than assuming a single analytical solution, this work develops a scalable IRMS-based framework in which the level of isotopic resolution is aligned with the discrimination required. The proposed approach aims to provide a scientifically robust basis for macroalgae origin certification and to contribute to the analytical toolbox available for traceability of emerging marine food products.

P11 (31/10 - 14:55-15:25)

Dr. Sónia Cruz

Stashing the loot: Determining the benefits of kleptoplasty in Sacoglossa sea slugs

1 - Sónia Cruz, 2 - Joana Barata, 3 - Margarida Nunes, 4 - Maria Inês Silva, 5 - Paulo Cartaxana

1 - ECOMARE - Laboratory for innovation and sustainability of marine biological resources of the University of Aveiro, CESAM - Centre for Environmental and Marine Studies, Department of Biology, University of Aveiro, Aveiro, Portugal

2 - CESAM, University of Aveiro, Aveiro, Portugal

3 - ECOMARE - Laboratory for innovation and sustainability of marine biological resources of the University of Aveiro, CESAM - Centre for Environmental and Marine Studies, Department of Biology, University of Aveiro, Aveiro, Portugal

4 - ECOMARE - Laboratory for innovation and sustainability of marine biological resources of the University of Aveiro, CESAM - Centre for Environmental and Marine Studies, Department of Biology, University of Aveiro, Aveiro, Portugal

5 - ECOMARE - Laboratory for innovation and sustainability of marine biological resources of the University of Aveiro, CESAM - Centre for Environmental and Marine Studies, Department of Biology, University of Aveiro, Aveiro, Portugal

Kleptoplasty is the retention of functional algal chloroplasts by a non-photosynthetic host, a remarkable trophic innovation that blurs the boundary between autotrophy and heterotrophy. In sacoglossan sea slugs, kleptoplasts can remain photosynthetically active for weeks to months despite the absence of the algal nucleus, yet the adaptive value of this association remains unresolved. While numerous studies have demonstrated light-dependent effects on survival, growth, and starvation resistance, the metabolic contribution of photosynthesis to the animal host and its role in life-history traits such as reproduction remain controversial. Isotope and radiolabelling approaches suggest that photosynthates can be incorporated into host compounds, but the biochemical identity, tissue-level allocation, and transgenerational transfer of these compounds remain largely unknown.

We will present the workflow and preliminary data to demonstrate comprehensively how kleptoplast photosynthesis contributes to sea slug metabolism and reproductive investment. Using dual isotopic pulse-chase labelling with ^{13}C -bicarbonate and ^{15}N -ammonium, we traced the photosynthetically fixed carbon and assimilated nitrogen from kleptoplasts into host tissues across multiple animal–alga associations. Next steps aim to determine whether reproduction acts as a major metabolic sink; we will test whether kleptoplast-derived metabolites enhance parental investment by measuring isotopic enrichment, biochemical composition, and morphometrics of egg masses produced under controlled light regimes. If translocation of photosynthesis products to eggs is confirmed, offspring biochemical quality and the inheritance of photosynthate-derived resources will be evaluated under starvation. By applying an identical comparative framework to species with contrasting kleptoplast retention strategies, this work will deliver the first integrative evaluation of the qualitative and quantitative benefits of kleptoplasty, linking variation in kleptoplast functionality with metabolic integration, reproductive output, and potential fitness advantages.

This work has been funded by the H2020 European Research Council (ERC), in the frame of the ERC-STG-Starting Grant Funding Scheme, project KleptoSlug (Grant agreement ID: 949880).

P12 (31/10 - 14:55-15:25)

Joana Barata

CSIA (Compound Specific Isotope Analysis) – From Kleptoplasts to host: Study Design and Methodological Framework

1. Joana Barata, 2. Margarida Nunes, 3. Maria Inês Silva, 4. Paulo Cartaxana, 5. Sónia Cruz

1. CESAM - Centre of Marine and Environmental Studies, University of Aveiro, Aveiro, Portugal
2, 3, 4, 5. ECOMARE – laboratory for innovation and sustainability of marine biological resources of the University of Aveiro, CESAM - Centre of Marine and Environmental Studies and Department of Biology, University of Aveiro, Aveiro, Portugal

Sacoglossan sea slugs of the genus *Elysia* retain functional chloroplasts (kleptoplasts) capable of sustained photosynthetic carbon fixation. To quantitatively assess the contribution of kleptoplast-derived nutrients to host metabolism, we implemented a controlled stable-isotope labelling workflow coupled to Gas Chromatography/Mass Spectrometry-Isotope Ratio Mass Spectrometry (GC/MS-IRMS).

Specimens of *Elysia crispata* were incubated in artificial seawater enriched with dissolved inorganic carbon (^{13}C -sodium bicarbonate) and nitrogen (^{15}N -ammonium chloride), under defined light and dark regimes to discriminate photosynthesis-dependent assimilation from background metabolic incorporation. Following incubation, mucus secretions and animal tissues were separately collected, freeze-dried, homogenized, and prepared for isotopic analysis. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values were determined by Compound Specific Isotope Analysis (CSIA) by GC/MS-IRMS, and isotopic enrichment was quantified relative to unlabelled controls. Time-resolved sampling combined with NanoSIMS imaging, bulk tissue isotope analysis (EA-IRMS) and CSIA revealed the metabolic fates of photosynthates.

The experimental design enabled high-sensitivity detection of light-dependent ^{13}C incorporation into monosaccharides and long-chain fatty acids typical of marine invertebrates, demonstrating photosynthetic fixation and subsequent translocation of organic carbon from kleptoplasts to peripheral tissues and mucus secretions. In parallel, ^{15}N incorporation patterns also revealed assimilation under light and dark conditions, allowing differentiation between autotrophic and heterotrophic nutrient pathways.

This study establishes a reproducible IRMS-based framework for tracing metabolic fluxes in photosynthetic animal–organelle systems. The approach highlights the analytical power of stable isotope ratio measurements to quantify carbon and nitrogen transfer dynamics and resolve compound-specific biosynthetic routing.

P13 (31/10 - 14:55-15:25)

Dr. Pharahilda Steur

Towards direct linkage of $\delta^{13}\text{C}$ measurements of atmospheric CO_2 from IRMS and OIRS

1. P. M. Steur, 2. A. Th. Aerts-Bijma, 3. H. A. Scheeren, 4. H. A. J. Meijer

1,2,3,4: Centre for Isotope Research (CIO), ESRIG, University of Groningen, Netherlands

$\delta^{13}\text{C}$ measurements of CO_2 are traditionally done using Isotope Ratio Mass Spectroscopy, but Optical Isotope Ratio Spectrometry (OIRS) methods are upcoming and widely used as well (Wehr et al., 2013; Steur et al., 2024; Buono et al., 2025). All measurements should eventually be traced back to the VPDB scale, based on a single anchor being the IAEA-603 calcite ($+2.46 \pm 0.01\text{‰}$ on the VPDB scale (IAEA, 2016)) or to the VPDB-LSVEC scale, based on two anchors being the IAEA-603 and the USGS-44 calcite ($-42.21 \pm 0.05\text{‰}$ (Qi et al., 2020)), respectively. For atmospheric measurements, it is less straightforward to link directly to these calcite-based scales. For IRMS measurements the CO_2 needs to be extracted from the air matrix, and any potential fractionation occurring during this process should be either eliminated or controlled and corrected for. OIRS measurements enable us to measure on air samples directly. CO_2 in-air calibration materials are, however, not widely available so linking to VPDB(-LSVEC) requires the dilution of reference materials in an air matrix, again making sure this does not alter the isotopic composition of the CO_2 during this process.

Due to the increase in atmospheric monitoring stations doing stable isotope composition measurements, the demand for CO_2 in-air reference materials grows. At the Centre for Isotope Research (CIO) we will work further towards direct traceability of spectral measurements of CO_2 -in-air to the VPDB(-LSVEC) scale. This will be done using a closed-loop procedure, in which there is strived towards fully controlling and understanding extraction of CO_2 from air, and the dilution of CO_2 into an air matrix. In this way it will be possible to directly link CO_2 -in-air measurements to VPDB(-LSVEC), and to directly compare IRMS and OIRS measurements of atmospheric CO_2 .

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P14 (14:55-15:25)

Dr. Bernd Freymann

¹³C-Tracers and Standards in Termite Research – Applied and Basic Insights

1. Bernd Freymann 2. Ries de Visser 3. Ton Gorissen 4. Henri Veroude

1,2,3,4: IsoLife BV, Wageningen, The Netherlands

Traditionally, termite research focused mainly on the fields of taxonomy and biogeography, as well as applied eradication research, as termites were mostly perceived merely as agricultural and architectural pests. Over the last one to two decades, a multitude of studies unraveled the complex functional roles of termites in natural dynamics of ecosystems, i.e. their importance for nutrient cycling dynamics. Only over the last years, ¹³C labelled plants and phytochemicals were successfully used to study molecular processes taking place inside of termites. We highlight those novel studies and their applied and basic insights.

P15 (31/10 - 14:55-15:25)

Dr. Oana Romina Botoran

Raspberry isotopic signatures link soil–plant–atmosphere processes to production-system authentication

Oana Romina BOTORAN, Diana COSTINEL, Ana Maria SIMIONESCU, Roxana Elena IONETE

National Research And Development Institute For Cryogenic And Isotopic Technologies - ICSI Rm. Vâlcea

Stable isotopes offer integrative indicators that connect agricultural management to underlying soil–plant–atmosphere processes. We evaluated whether a four-isotope signature ($\delta^2\text{H}$, $\delta^{18}\text{O}$, $\delta^{13}\text{C}$, $\delta^{15}\text{N}$) measured in raspberry (*Rubus idaeus* L.) fruit can (i) distinguish locally managed production agroecosystems and (ii) resolve short-term responses to bio-based fertilisers relative to dominant hydroclimatic forcing. Ripe fruits from two cultivars (Opal, Delniwa) were collected over two growing seasons (2024–2025) in Romania from a minimally irrigated organic plot (Bucharest) and a rainfed agroforestry plot (Vlădești, Vâlcea). In 2025, a field trial compared unfertilised controls with two research fertilisers: a digestate–biochar formulation and an organo-mineral biocomposite derived from industrial/mineral and organic by-products. Across 130 complete four-isotope observations, production system was the primary driver of isotopic variability. Fruit $\delta^{15}\text{N}$ provided the clearest separation, with consistently enriched values in the organic system and depleted to near-zero values in the agroforestry system, reflecting contrasting nitrogen sources and N-cycling contexts supported by complementary soil isotope patterns. Fruit water isotopes captured strong seasonal and interannual variability and showed systematic deviation from meteoric water lines, consistent with variable evaporative enrichment along the soil–plant–atmosphere continuum; an empirical fruit–water relationship further indicated non-equilibrium processes dominating during fruit development. Carbon isotope ratios ($\delta^{13}\text{C}$) showed smaller but coherent shifts consistent with microclimate and plant water-status effects. Within the organic plot, year-to-year changes (higher $\delta^{18}\text{O}$ and lower $\delta^{15}\text{N}$ in 2025) were detectable, whereas within-season fertiliser effects on fruit isotope ratios were generally modest compared with the persistent system imprint and short-term hydroclimatic/physiological variability. Multivariate classification combining all four isotopes achieved complete separation of the two agroecosystems under cross-validation, demonstrating that raspberry fruit carries a robust, mechanistically interpretable “eco-fingerprint” useful for agroecosystem monitoring and production-system traceability.

P16 (31/10 - 14:55-15:25)

Annika Gruhlke

Candidate for young scientist award

Investigation of Oxidative Aminopolyphosphonate Degradation via LC-IRMS/HRMS

1 Annika Gruhlke, 2 Maik A. Jochmann, 3 Torsten C. Schmidt

1, 2, 3 Instrumental Analytical Chemistry, University of Duisburg-Essen, Universitätsstr. 5, 45141 Essen

1, 2, 3 Centre for Water and Environmental Research (ZWU), University of Duisburg-Essen, Universitätsstr. 2, 45141 Essen

Aminopolyphosphonates (APPs) are strong chelating agents that have been in use since the 1980s to remove cations from reverse osmosis concentrates, as bleach stabilizers in detergents, and in paper and textile industries. However, possible risks of APP use such as eutrophication of natural waters, remobilization of heavy metals and formation of toxic transformation products (TPs) during degradation are not sufficiently known [1].

Therefore, we plan to investigate the oxidative degradation of three commonly used APPs – Aminotris(methylphosphonic acid) (ATMP), Ethylenediaminetetra(methylenephosphonic acid) (EDTMP), and Diethylenetriaminepenta(methylenephosphonic acid) (DTPMP) – via persulfate oxidation, ozonation, and percarbonate oxidation by coupling Liquid Chromatography-Isotope Ratio Mass Spectrometry (LC-IRMS) and LC-High Resolution Mass Spectrometry (HRMS) with a flow-splitter after LC-separation. This method was successfully developed for ATMP and its photolysis products by Marks et al [2,3].

To measure the isotopic fractionation of carbon during degradation, the LC-IRMS is used. By measuring isotopic fractionation of the educts, Rayleigh-plots that are characteristic for each degradation pathway can be obtained. Moreover, the extent of isotopic fractionation provides insight into the reaction mechanism as pronounced isotopic fractionation indicates a reaction at a carbon atom. To gain further insights into the degradation pathways and to identify TPs, a LC-HRMS system is needed as for LC-IRMS measurements all analytes are converted to CO₂.

Of the few well-known TPs, (Aminomethyl)phosphonic acid (AMPA) is of particular interest as it is genotoxic and more stable than the APPs. It is a TP of all APPs as well as of the herbicide glyphosate [1]. Moreover, glyphosate itself was proposed to be a TP of EDTMP [4] and DTPMP [5].

During degradation of the APPs by heat-activated persulfate oxidation at 60 °C and pH 5 and 7, the main transformation product of all APPs was iminodi(methylphosphonic acid) (IDMP). AMPA was found during the degradation of EDTMP and DTPMP. Additionally, it was observed that the degradation became slower with an increase in molecular size of the APP, meaning that ATMP was degraded the fastest while DTPMP was the most stable under the investigated conditions. However, no isotope effect was measured for any APP. To gain further insight, the duration of degradation will be optimized and further pH-values and temperatures will be investigated.

1. Rott, E., Steinmetz, H. & Metzger, J. W. Organophosphonates: A review on environmental relevance, biodegradability and removal in wastewater treatment plants. *The Science of the total environment* 615, 1176–1191 (2018).
2. Marks, R. G. et al. Effects of pH-dependent speciation on the photolytic degradation mechanism of phosphonates. *Journal of Photochemistry and Photobiology A: Chemistry* 448, 115327 (2024).
3. Marks, R. G. et al. Mechanistic investigation of phosphonate photolysis in aqueous solution by simultaneous LC-IRMS and HRMS analysis. *Journal of Photochemistry and Photobiology A: Chemistry* 439, 114582 (2023).
4. Klinger, J. et al. Formation of Glyphosate and AMPA During Ozonation of Waters Containing Ethylenediaminetetra(methylenephosphonic acid). *Ozone: Science & Engineering* 20, 99–110 (1998).
5. Röhnelt, A. et al. Glyphosate is a transformation product of a widely used aminopolyphosphonate complexing agent (2024).

Minutes 15th general BASIS member meeting

26 April 2024

Amsterdam, Netherland

1. Welcome, opening and attendances

There were approximately 50 members present during the general BASIS meeting.

2. Minutes 14th general meeting

The minutes of the 14th meeting have been approved.

3. Financial report (01-01-2023 to 31-12-2023)

The financial report was approved and signed by the financial committee Jack DJ De Jong and Dewi van Harskamp this approval discharges the treasurer.

4. Board members and renewals

4.1 The board is composed of:

President:	Marcel van der Meer:	mandate:2023-2025
Secretary:	Loïc Michel:	mandate 2023-2025
Treasurer:	Jort Ossebaar:	mandate 2023-2025
Scientific committee:	Eva de Rijke:	mandate 2023-2025
	Samuel Bodé:	mandate 2023-2025

4.2. Replacement and re-election of the board

Not an issue yet, will be revisited in 2026

5. Meeting 2024 Feedback

Very nice and affordable venue with great staff, a great lecture hall and nice vendor room, the two rooms could have been more connected.

Due to the increase in prices for the venues, dinner and catering, the board will need to recalculate the participant fee again.

6. Meeting 2024 and 2025

We will try to hold the next meeting in Brussels, Belgium.

7. Some practical questions:

The majority of the members would still appreciate a printed booklet and keep the meeting in the current format.

8. Varia

BASIS2025 will be skipped due to JESIUM2025 in Groningen

Agenda 16th general BASIS member meeting

01 April 2026

Brussels, Belgium

1. Welcome, opening and attendances

2. Minutes 15th general meeting

3. Financial report (01-01-2024 to 31-12-2025)

4. Board members and renewals

President:	Marcel van der Meer:	mandate: 2020-2025
Secretary:	Loïc Michel:	mandate 2023-2025
Treasurer:	Jort Ossebaar:	mandate 2020-2025
Scientific committee:	Samuel Bodé:	mandate 2023-2025
	Eva de Rijke:	mandate 2020-2025
Webmaster:	Michiel Kienhuis	mandate 2020-2025

Everyone is up for re-election

Call for candidates to join the BASIS board.

5. Meeting 2024

Feedback

6. Meeting 2025 and 2026

Where and when?

Technical sessions?

Conference Booklet?

Other approach?

Participant fee?

7. Varia

List of participants to BASIS 2026

Name	Institute	Email Address
Anita Aerts-Bijma	University Groningen	a.t.aerts-bijma@rug.nl
Ludi Parwadani Aji	Naturalis Biodiversity Center, Leiden	ludi.aji@naturalis.nl
Joana Barata	University of Aveiro & CESAM	jbarata@ua.pt
Ilham Bentaleb	University of Montpellier	ilham.bentaleb@umontpellier.fr
Max Bocxe	Utrecht University	m.bocxe@uu.nl
Samuel Bodé	Ghent University	Samuel.bode@ugent.be
Pascal Boeckx	Ghent University	pascal.boeckx@ugent.be
Oana - Romina Botoran	National Research And Development Institute For Cryogenic And Isotopic Technologies - ICSI Rm. Vâlcea	oana.dinca@icsi.ro
Anderson Carter	University of Groningen	a.l.carter887@gmail.com
Emilie Cathelin Cathelin	University of Lille	emilie.cathelin@univ-lille.fr
Andrea Janine Chávez Pacheco	Ghent University	andrea Chavez94@gmail.com
Sónia Cruz	University of Aveiro & CESAM	sonia.cruz@ua.pt
Roxanne Daelman	Ghent University	roxanne.daelman@ugent.be
Robin Daenen	Ghent University	Robin.Daenen@ugent.be
Eva de Rijke	University of Amsterdam	e.derijke@uva.nl
Tessa Dehau	KU Leuven	tessa.dehau@kuleuven.be
Simon Desmettre	Université Libre de Bruxelles	simon.desmettre@ulb.be
Cedric Dumoulin	Université libre de Bruxelles	cedric.ar.dumoulin@ulb.be
Anastasia Edsell	University of Amsterdam	aedsell@fastmail.com
Desmond Eefting	Utrecht University	d.d.eefting@uu.nl
Laurien Folkerts	University of Groningen	l.a.folkerts@rug.nl
Bernd Freymann	Isolife	bernd.freymann@isolife.nl
François Fripiat	Université Libre de Bruxelles	Francois.Fripiat@ulb.be
Camilla Gianini	Utrecht University	gianinicamilla@gmail.com
Annika Gruhlke	University of Duisburg-Essen	annika.gruhlke@uni-due.de
Els Heyrman	Ghent University	els.heyrman@ugent.be
Sander Hoekzema	University of Groningen, Energy and Sustainability Research Institute Groningen (ESRIG)	s.l.hoekzema@rug.nl
Joshua Jager	Wageningen Food Safety Research	josha.jager@wur.nl
Tijs Joling	Southern Cross University	t.joling.10@student.scu.edu.au
Georgios Kaklamanos	OPCW	georgios.kaklamanos@opcw.org
Michiel Kienhuis	Universiteit Utrecht	m.v.m.kienhuis@uu.nl

Name	Institute	Email Address
Sébastien Lefebvre	University of Lille/UMR 8187 LOG	sebastien.lefebvre@univ-lille.fr
Gilles Lepoint	University of Liège	G.Lepoint@uliege.be
Jiaxin Liu	KU Leuven	jiixin.liu@kuleuven.be
Charlotte Maistriau	Université Libre de Bruxelles	charlotte.maistriau@ulb.be
Harro Meijer	University of Groningen, Centre for Isotope Research (CIO), ESRIG	h.a.j.meijer@rug.nl
Loïc Michel	University of Liège	loic.michel@uliege.be
Maryam Mirzaloo van der Lubbe	University of Amsterdam	m.mirzaloo@uva.nl
Teodora Negru	Utrecht University	t.negru@uu.nl
Margarida Nunes Cardoso	University of Aveiro & CESAM	mncardoso@ua.pt
Sarah Olmstead	University of Amsterdam	s.a.olmstead@uva.nl
Sharyn Ossebaar	NIOZ	sharyn.ossebaar@nioz.nl
Jort Ossebaar	NIOZ	jort.ossebaar@nioz.nl
Alexander Overman	Maastricht University	a.overman@maastrichtuniversity.nl
Roberto Penasa	Fondazione Edmund Mach	roberto.penasa@fmach.it
Gaia Emma Pettinello	University of Montpellier	gaia- emma.pettinello@umontpellier.fr
Gabriel Pinto	Vrije Universiteit Brussel	gabriel.pinto@vub.be
Melany Rios	Amsterdam UMC	m.riosmorales@amsterdamumc.nl
Gregg Roelofs	Wageningen Food Safety Research	gregg.roelofs@wur.nl
Riet Rosseel	KU Leuven	riet.rosseel@kuleuven.be
Youki Sato	NIOZ	ysato13@gmail.com
Jannick Scheepstra	University of Groningen	j.scheepstra@rug.nl
Matthias Schulze	Merck	matthias.schulze@merckgroup.com
Thomas Sibret	Ghent University	thomas.sibret@ugent.be
Pharahilda Steur	University of Groningen	p.m.steur@rug.nl
Marie Tuerlinckx	Ghent University	marie.tuerlinckx@ugent.be
Ronald van Bommel	NIOZ	Ronald.van.Bommel@nioz.nl
Jeroen (H).J.L. van der Lubbe	VU Amsterdam, Earth Sciences	h.j.l.vander.lubbe@vu.nl
Marcel van der Meer	NIOZ	Marcel.van.der.Meer@nioz.nl
Dewi van Harskamp	Amsterdam UMC	d.vanharskamp@amsterdamumc.nl
Katja Van Nieuland	Ghent University	katja.vannieuland@ugent.be
Kristin Verbeke	KU Leuven	kristin.verbeke@kuleuven.be
Elise Verstraete	Ghent University	elise.verstraete@ugent.be
Suzan Warmerdam- Verdegaal	VU Amsterdam	svl300@vu.nl
Jun Zhang	TNO	jun.zhang@tno.nl

List of participating sponsors of BASIS 2026

Name	Institute	Email Address
Jack de Jong	Air Liquide	jack.dejong@airliquide.com
Stefaan Moens	Air Liquide	stefaan.moens@airliquide.com
Kathrin Rosenthal	Elementar Analysensysteme GmbH	kathrin.rosenthal@elementar.com
Sam Barker	Elementar UK Limited	sam.barker@elementar.co.uk
Kerstin Pralle	IVA Analysentechnik GmbH & Co. KG	kp@iva-analysentechnik.de
Erik Heeren	Picarro B.V.	eheeren@picarro.com
Magdalena Hofmann	Picarro B.V.	mhofmann@picarro.com
Ann De Winne	SciSPX	dewinne@brs.be
Quinten Olbrechts	SciSPX	elsocht@brs.be
Cindy Scheffer	SciSPX	cindy.scheffer@scispx.com
Leroy van Dam	SciSPX	leroy.van.dam@scispx.com
Garry Armstrong	Sercon	garry.armstrong@sercongroup.com
Mark Gibson	Sercon	mark.gibson@sercongroup.com
Mario Tuthorn	Thermo Fisher Scientific	mario.tuthorn@thermofisher.com
Jan Vermeulen	Thermo Fisher Scientific	jan.vermeulen@thermofisher.com
Niel Williams	Thermo Fisher Scientific	niel.williams@thermofisher.com

Practical information

Venue



Avenue Général Jacques 210A
1050 Elsene Brussels
Email : info@usquare.brussels
T : +32 (0)2 899 38 00

Directions

<https://www.ulb.be/fr/plans-et-acces/usquare>

Parking Instructions

No car parking spots at the site
Bikes can be parked on the square (access through, Avenue de la Couronne 227)

Symposium dinner Tuesday 31 April 2026 (20:00)



Restaurant Chez Léon
Rue Des Bouchers 18
1000 Brussels
<http://chezleon.be>

Directions

Chez Leon is in the heart of the city; car access is difficult.

From U-square Chez Leon can be reach by public transport in different ways:
BUS 95 (direction Grand-Place / Grote markt)
Train toward (Brussel-Centraal / Bruxelles-central)
Several combinations of tram and metro