The 14th International Conference on the Applications of Stable Isotope Techniques to Ecological Studies

Book of Abstracts

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Contents

KEYNOTE SPEAKERS 1

Keynote 1 – Lin 2
Keynote 2 – Tejada 3
Keynote 3 - Wall....4
Keynote 4 - Zeng 5

ORAL PRESENTATIONS 6

Abstract 001 - Quezada-Romegialli 7
Abstract 002 - Hayden 8
Abstract 003 - So 9
Abstract 004 - Pi 10
Abstract 007 - Bowen....11
Abstract 010 - Palacios Narvaez 12
Abstract 014 - Reich 13
Abstract 015 - Leung....14
Abstract 022 - Bennett-Williams....15
Abstract 023 - Liu 16
Abstract 026 - Allcock....17
Abstract 027 - McIlroy....18
Abstract 028 - Conti-Jerpe....19
Abstract 030 - Leray....20
Abstract 031 - Brömme 21
Abstract 032 - Wang....22
Abstract 033 - Açaf 23
Abstract 035 - Che-Pelicier 24
Abstract 036 - Cybulski....25
Abstract 037 - Kim 26
Abstract 038 - Dingle 27
Abstract 039 - Saboret 28
Abstract 042 - Urbano....29
Abstract 044 - H. S. Basilio 30
Abstract 045 - Welles....31
Abstract 047 - Qi....32
Abstract 049 - Zhou 33
Abstract 052 - Polito 34
Abstract 062 - Savory....35
Abstract 066 - Miller....36
Abstract 070 - Reynard....37
Abstract 071 - Vesala 38
Abstract 077 - Riekenberg 39
Abstract 078 - Lowe 40
Abstract 079 - Huang 41
Abstract 081 - Cheung 42
Abstract 082 - Shipley....43
Abstract 083 - Newton 44
Abstract 092 - Ro 45
Abstract 099 - Genelt-Yanovskiy 46
Abstract 101 - Sherritt....47
Abstract 102 - Addison....48
Abstract 110 - Vink 49
Abstract 111 - Devine....50

Abstract 113 - Lüdecke 51
Abstract 121 - Rothschild 52
Abstract 122 - Slesser 53
Abstract 124 - Reis de Carvalho 54
Abstract 125 - Zubarev 55
Abstract 126 - Veselý 56
Abstract 127 - Marguin 57
Abstract 132 - Bataille 58
Abstract 135 - Swarth 59
Abstract 136 - Liew 60
Abstract 137 - Stewart 61
Abstract 141 - Brennan 62
Abstract 145 - Sparks 63
Abstract 146 - Sparks 64

✧ **LIGHTNING TALKS** **65**

Abstract 006 - Fox-Dobbs 66
Abstract 009 - Di Ganci 67
Abstract 012 - Scholten 68
Abstract 016 - Kayfetz-Vuong 69
Abstract 020 - Açaf 70
Abstract 024 - Pernicova 71
Abstract 029 - Xia 72
Abstract 034 - Fan 73
Abstract 051 - Wehi 74
Abstract 057 - Hatten 75
Abstract 058 - Bones 76
Abstract 061 - Kan 77
Abstract 068 - Guzmán Álvarez 78
Abstract 075 - Andersson 79
Abstract 087 - Briones-Hernández 80
Abstract 105 - Sokołowski 81
Abstract 115 - Muehl 82
Abstract 117 - Tilley 83
Abstract 140 - Brennan 84

✧ **POSTER PRESENTATIONS** **85**

Abstract 013 - Pei 86
Abstract 017 - Webster 87
Abstract 021 - Bennett-Williams 88
Abstract 025 - Martinková 89
Abstract 040 - Prigge 90
Abstract 041 - Urbano 91
Abstract 050 - Wang 92
Abstract 053 - Polito 93
Abstract 059 - Qu 94
Abstract 060 - Yang 95
Abstract 065 - Stantis 96
Abstract 069 - Joka 97
Abstract 072 - Siegl 98
Abstract 074 - Fung 99
Abstract 076 - Arppe 100
Abstract 080 - Isidro 101
Abstract 085 - Fritsch 102
Abstract 088 - Sykes 103

Abstract 090 - Ullmann 104
Abstract 097 - Genelt-Yanovskaya 105
Abstract 098 - Genelt-Yanovskiy 106
Abstract 103 - Krajcarz 107
Abstract 104 - Krajcarz 108
Abstract 108 - Matthews 109
Abstract 112 - Storsberg 110
Abstract 116 - Jędruch 111
Abstract 119 - Rakauskas 112
Abstract 120 - Rakauskas 113
Abstract 128 - Newton 114
Abstract 130 - Jędruch 115
Abstract 131 - Paredes de la Vega 116
Abstract 134 - Kopp 117
Abstract 139 - Edwards 118
Abstract 142 - Hayden 119
Abstract 143 - Choi 120
Abstract 144 - Tong 121

Abstracts | ISOECOL 2026

Keynote Speakers

Keynote 1 – Lin

Applications of stable isotopes to blue carbon provenance studies

Guanghui Lin

Department of Earth System Science, Tsinghua University

Abstract:

Coastal wetlands including mangroves, salt marshes and seagrass beds provide numerous ecosystem services, including coast protection, fisheries production, water purification and carbon sequestration, etc. There are increasing interests in quantifying and enhancing carbon sinks of coastal wetlands to offset carbon emission for mitigating global climate change, so called blue carbon. However, the source and fate of blue carbon accumulating within these coastal wetlands, an important consideration in accounting for the carbon sequestration value through ecological restoration, have not been well studied. With strong capabilities of tracing, indication and integration, stable isotopes are useful in helping to identify the provenance of carbon, including the contributing source and the permanence of carbon, and how long it survives in the sediments. In this talk, I will highline some key progresses of applying stable isotopes to blue carbon provenance studies in China, and discuss the implications of these findings for blue carbon accounting and ecological restoration implementation. Our case study results showed that blue carbon stocks and carbon sources varied based on habitat type, anthropogenic disturbances and climate conditions, highlighting the importance of taking measurements not only in the habitat of interest, but also other habitats within an estuary. Through the use of stable isotopes, these studies underscore the interconnected nature of coastal blue carbon ecosystems and provides information that can be used to better understand the impacts of climate and anthropogenic disturbances on blue carbon stocks. These case studies also illustrated the value of using stable isotopes to better understand blue carbon ecosystems.

Keynote 2 – Tejada

Beyond Glx–Phe: Multi–Amino Acid Nitrogen Isotopes Reveal Hidden Structure in Dietary Ecology

Julia Tejada

Division of Geological and Planetary Sciences, California Institute of Technology

Abstract:

Diet shapes nearly every aspect of organismal biology, influencing growth, physiology, ecological interactions, and evolutionary trajectories. Yet reconstructing diets through time remains a fundamental challenge, particularly when direct observation is impossible and inference must rely on fragmentary or fossilized remains. Despite these limitations, dietary signals are durably encoded in organismal tissues, offering a rich archive of past ecological behavior.

Trophic reconstruction from amino acid nitrogen isotopes ($\delta^{15}N$) has relied almost exclusively on a single pair of amino acids, leaving most of the isotopic information in a sample unused and producing misclassifications in terrestrial systems. Here, I present a new framework for dietary classification based on the nitrogen isotope composition of multiple individual amino acids, implemented through an unsupervised clustering approach that does not depend on predefined dietary categories. Applied to a comprehensive modern mammal dataset, this multi-amino acid approach substantially improves dietary resolution and resolves misclassifications that persist under canonical two amino acid frameworks. These results show that multi–amino acid $\delta^{15}N$ signatures capture ecological structure invisible to traditional approaches, with broad implications for reconstructing trophic ecology across modern and fossil systems.

Keynote 3 - Wall

Energy channels and nutrient plasticity in reef building corals

Christopher Wall

Department of Earth Sciences, University of Hawai'i at Mānoa

Abstract:

Understanding mechanisms of coral physiological resilience is paramount to predicting ecological outcomes for coral reefs. One such mechanism is coral trophic plasticity and/or a greater reliance on heterotrophic food sources (plankton, suspended particles) to meet metabolic demands. New molecular methods using compound specific isotope analyses (CSIA) of individual amino acids (AA) may overcome many shortcomings in traditional bulk-tissue stable isotope analyses (SIA) and provide greater resolution to detect contributions of eukaryotic and bacterial symbionts to host animal nutrition. In my talk, I will first demonstrate the importance of considering biomass composition and symbiont community effects on isotope proxies of coral nutrition. I will further highlight how CSIA-AA are being used to understand both trophic plasticity and fidelity in marine symbioses and how these approaches can assist in bridging the gap between classic perspectives of bipartite, two-partner symbioses and new concepts of the holobiont in microbiome research.

Keynote 4 - Zeng

Soil invertebrates reduce plant nitrogen assimilation from decomposing litter in tropical but not temperate forests

Xiaoyi Zeng

School of Biological Sciences, The University of Hong Kong

Abstract:

Nitrogen is a key nutrient for plant growth in terrestrial ecosystems. Invertebrates play a crucial role in nitrogen mineralization through litter decomposition, yet the role of invertebrates in mediating downstream plant nitrogen assimilation remains unclear. In a large-scale field experiment using nitrogen stable isotope ^{15}N-labeled leaf litter across three tropical rainforests and two temperate forests, we found that invertebrates reduced plant assimilation of litter-derived nitrogen by ~80% in tropical rainforests but had no detectable effect in temperate forests. Tropical invertebrates, such as termites, act as potential nitrogen reservoirs, immobilizing nitrogen within their biomass or colony and potentially mitigating soil nitrogen loss from the system via leaching. By quantifying the functional role of invertebrates in plant nitrogen assimilation using cutting-edge stable isotope tracing, our findings provide experimental evidence that soil invertebrates represent an underappreciated pathway linking soil biodiversity, plant nutrition and nutrient cycling, particularly in tropical rainforests. Given that the nutrition status mediates plant carbon sequestration, the patterns and new concepts we present here are important in predicting how the forest biosphere-atmosphere interface will respond in an era of rapid global change.

Oral Presentations

Abstract 001 - Quezada-Romegialli

Integrating compound-specific isotope analysis (CSIA-AA) into Bayesian trophic position models: extending tRophicPosition for unified bulk and amino acid $\delta^{15}N$ inference

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[2]Scottish Centre for Ecology and the Natural Environment, School of Biodiversity, One Health and Veterinary Medicine, University of Glasgow, G63 0AW, UK

Abstract:

Stable isotope approaches are widely used to estimate trophic position (TP), yet methodological discrepancies between bulk $\delta^{15}N$ and compound-specific isotope analysis of amino acids (CSIA-AA) remain a major limitation for cross-study comparability. While bulk isotope models rely on baseline selection and trophic discrimination factors (TDFs), CSIA-AA approaches estimate TP based on source and trophic amino acids (e.g., Phe vs Glu), reducing baseline dependency but introducing alternative sources of uncertainty.

Here, we present a novel extension of the R package tRophicPosition that formally integrates CSIA-AA into a unified Bayesian framework. Building on the original model structure, where consumer and baseline isotope values are treated as probabilistic variables and uncertainty is propagated via MCMC, we incorporate amino acid–specific $\delta^{15}N$ data by explicitly modelling trophic enrichment (ΔGlu-Phe) and baseline offsets (β) as hierarchical parameters at the individual level. This allows estimation of TP from bulk and CSIA-AA data within a single probabilistic model, accounting for variance in TDFs, baselines and analytical error.

We demonstrate the performance of this framework using modelled, marine and freshwater consumers, including systems with poorly constrained baselines. Results show convergence between methods under realistic parameterizations, but also highlight systematic deviations linked to ecological context and biochemical routing. This integration represents a key methodological advance for isotope ecology, providing a flexible and reproducible framework to reconcile bulk and CSIA-AA approaches, and enabling more robust inference of trophic structure across diverse ecosystems.

Keywords: *compound-specific isotope analysis, food webs, Bayesian modelling*

Abstract 002 - Hayden

Seasonality of temperate stream food webs?

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[1]*Atomic Ecology*
[2]*University of New Brunswick*
[3]*UC Davis*

Abstract:

Temperate streams are the arteries of a diverse array of interconnected ecosystems. They biodiversity hotspots which play a fundamental in nutrient transport and provide a link between terrestrial and aquatic realms. Given this importance it is unsurprising that the river continuum concept, the idea that headwater food webs are fuelled by terrestrial inputs whereas food webs in the lower reaches of rivers derived their energy from within stream production, has underpinned almost 50 years of stream ecology. What is surprising however, is that the seasonality inherent in temperate environments has not been incorporated into this model.

Here we present data from a field-based investigation spanning two catchments in New Brunswick, Eastern Canada. We used a combination of $\delta^{13}C$, $\delta^{15}N$, $\delta^{18}O$ and $\delta^{2}H$ isotopic tracers applied to water, primary producers and invertebrate functional feeding guilds to determine the food web processes underpinning stream ecological function during summer (warm water, high shading), fall (cool water, low shading) and spring (cold water, immediately following ice-out) periods.

Our data show:

- Summer evaporation affects not only the isotopic composition of the water, but also organisms which live in it.
- A strong pulse of terrestrial derived fuel entering the food web during the fall and being assimilated throughout the year
- Food web area is highest in fall owing to increased inter-guild variability in resource use.

Seasonality is an important but often overlooked aspect of stream ecology, but (fortunately) stable isotope analysis provides wonderful insights into the mechanisms through which it influences ecosystem function.

Keywords: *Deuterium, Food web, Invertebrate, Winter ecology*

Abstract 003 - So

Establishing Ecological Redundancy Baseline for Hong Kong Mangroves Using Amino Acids Nitrogen Isotopes

Mandy Wing Kwan So[1], Maximiliano Rodriguez[2], Nga Man Chung[1], Benoit Thibodeau[1]

[1]*Department of Earth and Environmental Sciences, The Chinese University of Hong Kong*
[2]*Institute of Science and Technology Austria*

Abstract:

Mangrove forests play a crucial role in nutrient and carbon cycling within coastal ecosystems, providing coastal protection and aiding in global climate mitigation. However, these vital ecosystems are facing threats from various anthropogenic stressors, such as urbanization and pollution. Additionally, the ecological redundancy of mangrove forests is low due to limited species diversity and high functional richness, suggesting they can be vulnerable to minor losses in species diversity. This vulnerability can undermine their ecosystem services and lead to cascading effects in adjacent ecosystems.

Determining the food web is the first step in understanding species interactions and habitat functions within the ecosystem. Bulk stable isotope analysis (BSIA) of nitrogen and carbon isotopic composition has traditionally been used to assess trophic niches; however, reconstructing food webs with this method is challenging due to the complexity of nitrogen sources available to primary producers and consumers, particularly omnivores, which exhibit broad trophic spectra. Notably, omnivorous crabs are a prevalent invertebrate group in mangrove habitats. Recently, the emergence of compound specific isotopic analysis (CSIA) has facilitated more precise food source identification compared to traditional approach.

In this study, we sampled across both western and eastern regions of Hong Kong. Our aim was to create a comprehensive database of mangrove fauna ecological redundancy. Integrating amino acid nitrogen isotopic analysis with traditional carbon and nitrogen isotope method enhances our resolution of the food web within mangrove habitats and improves our understanding of mangrove vulnerability to anthropogenic impacts, providing insights for developing more effective conservation strategies.

Keywords: *Mangrove, Food web, Compound specific isotopes, Bulk stable isotopes*

Abstract 004 - Pi

Amino acid isotopes reveal sources and degradation of organic matter in mangrove and mudflat sediments

Joshua Pi[1], Mandy Wing Kwan So[1], Benoit Thibodeau[1]

[1]*Chinese University of Hong Kong*

Abstract:

Coastal wetlands (e.g. mangroves and mudflats) play a critical role in regulating and reprocessing organic matter (OM) from both marine and terrestrial sources. However, the mechanisms by which OM is transformed are complex, and degradation processes among different wetland habitats are not fully understood. In this study, we will compare the sources and degradation of OM between mangrove and mudflat sediments using amino acid carbon ($\delta^{13}C_{AA}$) and nitrogen ($\delta^{15}N_{AA}$) isotopes. 50 cm sediment cores will be collected from mangrove forests and mudflats in Mai Po Nature Reserve, Hong Kong and subsampled at 2 cm intervals for $\delta^{13}C_{AA}$ and $\delta^{15}N_{AA}$ analysis. Using a Bayesian mixing model built from the $\delta^{13}C$ of essential amino acids, we will quantify the relative degradation of terrestrial OM versus marine OM in sediments at 5 depth intervals (0-2 cm, 8-10 cm, 18-20 cm, 28-30 cm, 38-40 cm, 48-50 cm). For both sediment types, we expect rapid degradation of marine OM compared to terrestrial OM. Meanwhile, downcore $\delta^{15}N_{AA}$ measurements allow for trophic position (TP) and degree of microbial reworking (ΣV) estimates, both of which are expected to increase with depth. However, exact patterns may differ between sediment types due to differences in nitrogen cycling. Principal component analysis of $\delta^{15}N_{AA}$ values may reveal certain amino acids or patterns diagnostic of unique nitrogen pathways. Together, our data will reveal how OM degradation differs between mangrove and mudflat sediments. These findings will improve our understanding of coastal biogeochemistry, while encouraging the use of amino acid isotope techniques in wetland sediments.

Keywords: *Amino acids, isotope fingerprinting, mangroves, mudflats, mixing model, sediment, wetland biogeochemistry*

Abstract 007 - Bowen

Stable carbon isotopes in enamel carbonate of modern U.S. humans

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Abstract:

Stable carbon isotopes have long been exploited as an indicator of diet in animal ecology, anthropology, and forensics. In modern forensic contexts, the use of carbon isotopes is often founded on national-level differences in food systems that affect the consumption of foods derived (directly or indirectly) from C_4 plants. Less clear is the extent of, and controls on, $\delta^{13}C$ variation within nations or regions. We report new tooth enamel carbonate $\delta^{13}C$ data from the third molars of almost 600 modern residents of the USA. Overall, these data are consistent with previous work showing the strong influence of C_4 carbon in American food systems and show that approximately ½ of the carbon atoms in modern Americans are fixed by corn or other C_4 crops. However, our results also show robust geographic variation in tooth enamel $\delta^{13}C$ values within the USA, with higher values, implying greater consumption of C_4-derived foods and food products, in the southeastern USA. Moreover, enamel $\delta^{13}C$ values are correlated with self-reported childhood socioeconomic status, implying that individuals who grew up in lower-income households consumed a higher proportion of C_4-derived foods. These results show that sub-national geographic and demographic patterns in diet are reflected in the isotopic composition of modern human tissues, supporting the use of isotopes as biomarkers in dietary and health studies and implying opportunity for the forensic application of $\delta^{13}C$ values beyond drawing national-scale distinctions.

Keywords: *Human diet, forensic ecology, tooth enamel*

Abstract 010 - Palacios Narvaez

Linking trophodynamics of coral reef fish to seasonal upwelling in the southern Red Sea

Stephania Palacios Narvaez[1], Darren J. Coker[1], Juan F. Rivera-Cifuentes[1], Alex Kattan[1], Walter Rich IV[1], Luca Stirnimann[1], Michael Fox[1], Michael Berumen[1]

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Abstract:

Coral reef fish community structure and function are shaped by environmental, oceanographic, and anthropogenic factors that vary across spatial and temporal scales. Oceanographic processes, such as upwelling, introduce cooler, nutrient-rich waters to coral reefs, altering primary production and benthic community composition, with potential consequences for reef fish trophodynamics. Despite observational and experimental evidence indicating that coral reef fish may change their performance and feeding habits in response to decreases in water temperature or shifts from coral to algal dominance due to environmental disturbances, it remains unclear whether reef fish exhibit trophic flexibility in response to seasonal shifts in resource availability driven by upwelling. We investigated changes in trophodynamics of coral reef fishes across two seasonal periods, June (pre-upwelling) and October 2024 (post-upwelling), in the Southern Red Sea. Using an interdisciplinary approach that combined stable isotope analysis ($\delta^{13}C$ and $\delta^{15}N$) of dorsal muscle tissue and gut-content metabarcoding with temperature sensor arrays to measure upwelling, we quantified trophic position, diet composition, and resource use across multiple trophic groups. We then evaluated whether shifts in isotopic niches and prey composition corresponded with seasonal changes in upwelling exposure, primary productivity, or benthic structure. Our approach links isotopic variation to underlying dietary shifts, providing a holistic understanding of how oceanographic processes influence reef fish feeding ecology and offering new insight into the mechanisms underpinning ecological resilience in coral reef ecosystems. Understanding how fish communities respond to seasonal productivity pulses is critical for predicting ecosystem responses on coral reefs in a changing climate.

Keywords: *Muscle-tissue stable isotope analysis, trophodynamics, coral reef fish, upwelling, trophic plasticity, Red Sea*

Abstract 014 - Reich

Follow the lead: Constructing foliar Pb isoscapes in eastern Canada to assess geolocation potential

Megan Reich[1], Felipe Dargent[2,3], Jean- Noël Candau[3], Petrus Le Roux[4], Clement P. Bataille[3,5]

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[2]*Canadian Forestry Service*
[3]*University of Ottawa*
[4]*University of Cape Town*
[5]*University of Ottawa*

Abstract:

Lead (Pb) is a toxic heavy metal that occurs naturally in the environment but has also been concentrated and dispersed through industrial waste, the historic use of leaded gasoline and aviation fuel, smelting operations, and other anthropogenic pollution sources. While Pb isotopes have an established role in identifying anthropogenic sources of Pb, their potential for tracing the provenance of ecological materials remains underdeveloped. Conifer needles of fir and spruce trees were collected at 179 sites across eastern Canada and analysed for Pb isotope ratios on a MC-ICP-MS ($^{208}Pb/^{7}Pb$, $^{208}Pb/^{206}Pb$, $^{207}Pb/^{206}Pb$, $^{208}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, and $^{206}Pb/^{204}Pb$). Random forest regression was leveraged to integrate the foliar Pb isotope ratios with climatic, geological, and atmospheric geospatial predictors, yielding moderate to strong model performance (e.g., $R^2 = 0.55$). Spatial patterns were primarily driven by atmospheric predictors, including black carbon deposition and sea salt deposition. We then measured the Pb isotope ratios of local eastern spruce budworm moths (Choristoneura fumiferana), an important forestry pest, and their host trees across 27 sites to characterize changes in Pb isotope ratios across trophic levels. Strong correlations were observed between moths and host tree Pb isotope ratios ($R^2 = 0.66 – 0.75$), but spatial patterns in the residuals suggest an additional atmospheric source of Pb to the moths. Nonetheless, Pb isotope-based geographic assignment estimated moth origin with ~70% accuracy. This study demonstrates the potential of Pb isotope geolocation for provenance tracing and establishes Pb isotopes as a viable addition to multi-isotope geolocation frameworks.

Keywords: *lead isotope ratios; metal isotopes; insect migration; isoscapes*

Abstract 015 - Leung

Multi-Isotope Approaches Reveal Seafood Provenance, Feeding Histories, and Contaminant Pathways in Urban Fish Markets

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Abstract:

Understanding the origin, feeding history, and traceability of fish sold in urban markets provides unique insight into regional biodiversity, seafood authentication, and the stories behind local fisheries practice and consumer demand. Here we demonstrate a suite of isotopic methods that allow us to investigate these ecological dynamics in Hong Kong's fish trade, utilizing a combination of bulk stable isotope analysis (SIA) of carbon and nitrogen, compound-specific isotope analysis of amino acids (CSIA-AA), and mercury isotope (Hg) analysis.

SIA provide an overview of the trophic ecology within urban fish markets, whilst using CSIA-AA to delve deeper, providing robust trophic positions for sampled species and elucidating differences between fish sources, specifically wild and farmed fish. Mercury isotopes then build a critical ecological and traceability dimension. They distinguish between farm-reared and wild-caught farmed fish, and provide methylmercury estimates relevant for food safety. Importantly, CSIA-AA and mercury isotopes do not yield identical trophic positions. For example, TPHg>TPAA in wild fish suggests recent re-feeding on pellets, whereas TPHg≈TPAA reflects long-term stable diets in both wild and farmed fish. This distinction demonstrates the unique ecological benefit of mercury isotopes, as they capture cumulative feeding histories, contamination pathways, and stress responses that carbon and nitrogen isotopes alone cannot.

We show how a multi-biomarker approach—combining bulk SIA, CSIA-AA, and mercury isotopes—provides a clearer and deeper understanding of the seafood provenance, feeding regimes, and contaminant pathways within fish markets. This framework strengthens seafood authentication while also supporting consumer choice, ecological sustainability, and public health in Hong Kong's fisheries.

Keywords: *Seafood authentication, Stable isotope analysis, Compound-specific isotope analysis, Mercury isotopes, Trophic ecology, Traceability, Food safety, Multi-Biomarker, Ecological sustainability*

Abstract 022 - Bennett-Williams

Evaluating Bulk and Amino Acid Isotope Approaches for Reconstructing the Trophic Structure of Market-Derived Fish Assemblages

Joshua Bennett-Williams[1], Joshua Bennett-Williams[1], Cheuk Ying Leung[1], Markus Rummel[1], Alex S.J. Wyatt[1]

[1]*The Hong Kong University of Science and Technology*

Abstract:

Stable isotope analysis is widely used to reconstruct food webs, yet its application typically assumes relatively constrained baseline conditions. Consumer "wet" fish markets challenge this assumption by aggregating species from diverse habitats and geographic regions into a single assemblage. Here, we treat a wet fish market as an anthropogenically aggregated trophic resource and evaluate the utility of bulk stable isotope analysis ($\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$) for resolving trophic structure under conditions of high baseline variation, demonstrating how compound-specific isotope analysis of amino acids (CSIA-AA) can alleviate some of these constraints.

Bulk isotope data displayed broad trophic and habitat gradients, with $\delta^{15}N$ indicating a wide range of apparent trophic positions and $\delta^{13}C$ and $\delta^{34}S$ reflecting multiple production pathways. However, substantial overlap in isotope space and elevated within-group variability suggested that baseline differences obscure ecological interpretation. CSIA-AA carried out on a subset of individuals allowed trophic position estimates and provided a baseline-corrected framework for comparison.

Results showed that while bulk $\delta^{15}N$ broadly reflected trophic trends, it over- or under-estimated trophic position from isotopically distinct baselines. CSIA-derived trophic positions revealed more constrained and ecologically consistent structure, against which the aggregated trophic structure could be re-evaluated. Integrating both approaches allowed reconstruction of a composite trophic framework, accounting for both ecological diversity and baseline variability.

Here, we demonstrate the strengths and limitations of bulk isotope approaches in mixed-origin systems and highlight the value of CSIA-AA for validating trophic interpretations in complex, non-traditional sampling environments, including for exploring the trophic structure of seafood resources and fisheries exploitation.

Keywords: *Compound-specific isotope analysis (CSIA-AA), trophic reconstruction, seafood traceability, baseline variability*

Abstract 023 - Liu

Tide-driven carbon cycling and export in the mangrove-coastal continuum: insights from stable isotopes

Yang Liu[1], Xiaoshan Zhu[1]

[1]*School of Ecology, Hainan University*

Abstract:

Hydrological connectivity regulates carbon exchange between mangroves and coastal waters, but source-sink patterns remain unclear. We hypothesize that carbon dynamics differ between open and closed tidal creeks, and that $\delta^{13}C$ can trace carbon sources.We conducted 24h time-series sampling during spring tides in dry (April 2025) and wet (September 2025) seasons along two contrasting tidal creeks in Wenchang Wetland, Hainan. Surface water and porewater were collected hourly for particulate organic carbon (POC), dissolved organic carbon (DOC), and dissolved inorganic carbon (DIC) and their $\delta^{13}C$ values.Source apportionment and lateral carbon fluxes were calculated using hydrodynamic coupled with a $\delta^{13}C$-based mixing model.Preliminary results show that different carbon fractions have distinct sources. For example, POC has a high terrestrial contribution, DOC shows the most complex source mixing, and DIC is predominantly marine-derived. Lateral carbon flux results indicate that DIC flux is higher in the wet season, whereas POC export is favored in the dry season. Moreover, the open tidal creek, with stronger hydrological connectivity, exhibits higher carbon fluxes for all fractions than the closed creek, with DIC consistently as the dominant component. Our findings demonstrate that hydrological connectivity is a key factor controlling the source-sink function of mangrove carbon, which has important implications for blue carbon assessment and coastal management under sea-level rise.

Keywords: *hydrological connectivity; mangrove carbon export; stable carbon isotopes; carbon fractions (POC, DOC, DIC); blue carbon*

Abstract 026 - Allcock

Stable isotope analysis and geolocator tracking suggest mixed migration strategies in White-shouldered Starlings (*Sturnia sinensis*)

John A. Allcock[1], Caroline Dingle[2], Pia M.C. Ricca, Paul J. Leader[3], Chloe E.R. Hatten[4], Juha Merilä[1]

[1]*The University of Hong Kong*
[2]*Capilano University*
[3]*Aurecon*
[4]*Lingnan University*

Abstract:

Among the major global flyways for migratory birds, the East Asian – Australasian Flyway (EAAF) is one of the most species rich but also one of the least studied, especially for migratory passerines. With increasing threats to bird populations, better understanding of the migratory behavior of birds along the EAAF is critical to inform conservation efforts. White-shouldered Starlings (*Sturnia sinensis*) breed in southern China and northern Vietnam, with at least some populations migrating to distinct wintering grounds. We investigated whether a population breeding in Hong Kong is resident or migratory using a combination tracking devices (geolocators) and stable isotopes. We discovered that most tagged individuals (7/8) migrated southwest from Hong Kong to winter in Vietnam/Cambodia, with one individual migrating northeast to overwinter in southern China. Stable isotope analyses of feathers revealed that the $\delta^{2}H$ and $\delta^{34}S$ values differed between the individual that migrated northeast and those that migrated southwest. Two individuals showed differences in $\delta^{2}H$ and $\delta^{34}S$ values between successive years, possibly indicating a change in wintering grounds between years. Together our results confirm that the Hong Kong breeding population is migratory, with both stable isotope and geolocator data suggesting that at least two different migration strategies occur within the Hong Kong population of this species and that some individuals may switch strategy between years.

Keywords: *migration routes, East Asian-Australasian flyway, geolocation, landbirds*

Abstract 027 - McIlroy

The influence of trophic strategy on coral responses to increased nutrients and thermal stress.

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[2]*Lingnan University*
[3]*The University of Hong Kong*
[4]*University of California Santa Barbara*

Abstract:

Increasing ocean temperatures, particularly summer heatwaves, are driving the breakdown of the symbiosis between corals and endosymbiotic dinoflagellates. This bleaching phenomenon is exacerbated by local stress such as nitrogen pollution, which can further destabilise the co-dependent nutrient cycling between corals and symbionts. Yet, coral species differ in their trophic strategies i.e., variation in the degree to which coral hosts rely on symbiont derived nutrients. Here, we examined the stable isotope signatures of corals following an 18-month field experiment in which different forms of nitrogen (nitrate vs. ammonium/urea) were applied to reef patches spanning two natural thermal stress events. SIBER analysis confirmed that *Acropora* and *Pocillopora* have different trophic strategies. *Acropora* is highly reliant on autotrophy, while *Pocillopora* is relatively more mixotrophic. Bleaching patterns were in line with expectations that autotrophic corals are more sensitive to bleaching. Under nutrient enrichment, the isotopic signature of synthetic N was identified in host and symbiont tissues of *Acropora* in both nutrient treatments which confirms that nitrate and urea served as nitrogen sources that were assimilated and translocated in the symbiosis. In *Pocillopora*, this is only observed in the symbiont tissues of the urea treatment which has a lower natural ^{15}N value and an enlarged isotopic niche in the urea treatment. Data supports previous hypotheses that *Pocillopora* is opportunistic with high variation among individuals; symbionts incorporate urea-derived nitrogen when needed and available. Surprisingly however, despite no signal in *Pocillopora* ^{15}N long-term nitrate exposure relative to the control, this group demonstrated the most pronounced bleaching effect.

Keywords: *SIBER, corals, bleaching, eutrophication*

Abstract 028 - Conti-Jerpe

Investigating nutrient exchange between partners within the lichen Letharia columbiana across elevations

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[1]*Division of Science, Lingnan University*
[2]*Department of Integrative Biology, University of California Berkeley*

Abstract:

Lichens are classic models of nutritional mutualisms in which a fungus (the mycobiont) exchanges nutrients with photosynthetic green algae or cyanobacteria (the photobionts), allowing these organisms to thrive in harsh, nutrient-limited environments. In these relationships, the photobiont is thought to provide carbon via photosynthesis while the mycobiont harnesses nitrogen, phosphorus, and minerals predominantly from depositional sources. However, recent evidence has challenged this paradigm, suggesting that carbon is also directly acquired by mycobionts and shared bidirectionally with photobionts, while nitrogen dynamics remain largely unexplored. Additionally, there are no studies investigating how the acquisition and sharing of nutrients by lichens change across environmental conditions. We conducted a transplantation experiment where we out-planted individuals of *Letharia columbiana*, a dominant lichen in the Sierra Nevada mountain range, to two elevations for 1.5 months. Following deployment, individual lichens were processed using a novel method that isolated sufficient mass for stable isotope analysis of paired myco- and photobionts for the first time. We applied Stable Isotope Bayesian Ellipses in R (SIBER) analysis and the Host Evaluation: Reliance on Symbionts (HERS) index to quantify carbon and nitrogen exchange between lichen partners and assess mycobiont reliance on associated photobionts. Our results show no change in the lichen mutualism across elevations and suggest that mycobionts are not highly reliant on their photobionts for nitrogen but do depend on them predominantly for carbon. Future application of this novel technique presents broad potential to further our understanding of the functioning of the model lichen symbiosis.

Keywords: *Nutritional mutualism, lichen, symbiosis, SIBER*

Abstract 030 - Leray

Marine trophic niche evolution across the Isthmus of Panama

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Abstract:

Differences in environmental conditions can reshape trophic niches, yet whether these niches are conserved over evolutionary timescales remains poorly understood. Such divergence may arise through multiple, non-mutually exclusive mechanisms, including shifts in resource availability, changes in competitive environments, and differences in the physiological and microbial processes that mediate resource assimilation. Disentangling these processes requires systems in which environmental differences are strong, while evolutionary history is well constrained. The formation of the Isthmus of Panama provides such a natural experiment. The closure of the seaway ~3 million years ago separated marine populations into the Caribbean and Eastern Tropical Pacific (ETP), two regions that differ markedly in productivity, community composition, and environmental variability. This well-dated event, combined with replicated pairs of closely related species on either side of the Isthmus, provides the backdrop for quantifying changes in trophic niche over evolutionary time scales. We combine compound-specific stable isotope analysis of amino acids (CSIA-AA) of carbon (primary energy source) and nitrogen (trophic position/primary protein source) and gut content analyses to quantify trophic niches across species pairs. Preliminary gut content data show that species in the Caribbean feed on a greater diversity of prey types, which suggests larger niches. Conversely, CSIA-AA results show that Caribbean and ETP have similar trophic positions and trophic niches at the community level, although guild and species-level analyses reveal differences. This integrated approach provides new insight into the mechanisms underlying trophic niche evolution and offers a basis for predicting how trophic roles may respond to ongoing environmental change.

Keywords: *Trophic niche, evolution, reef fishes, CSIA-AA, coral reefs*

Abstract 031 - Brömme

From Roots to Seeds: Inter- and Intra-Plant Variation of $\delta^{15}N$ and $\delta^{13}C$ across an African Savanna Ecosystem

Sven Brömme[1], Tina Lüdecke[1], Marion Bamford[2], Marissa Vink[1], Jacinto Mathe[3], Francisca de Salma Andicene[3], Susana Carvalho[3], René Bobe[3], Alfredo Martínez-García[1]

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Abstract:

Stable isotope analyses are a key component for reconstructing trophic interactions within food webs and for paleoenvironmental reconstructions of African savanna ecosystems. However, the reliability of such reconstructions depends on robust isotopic baselines and a detailed understanding of isotopic variations at the base of the food web. While isotopic differences between C_3 and C_4 vegetation are well documented, inter- and intra-plant nitrogen isotopic variation remains poorly constrained, particularly across heterogeneous microhabitats (e.g., miombo woodlands, floodplains, grasslands) such as those in Gorongosa National Park (GNP) in Mozambique.

This study investigates the anatomical and seasonal variation in nitrogen ($\delta^{15}N$) and stable carbon ($\delta^{13}C$) isotopes throughout GNP by sampling foliage, roots, fruits and seeds for inter-and intra-plant variation from dominant grasses, trees, and shrubs across the park's key microhabitats. Our results show systematic intra-plant variation in $\delta^{15}N$: in C_4 plants, roots are typically depleted and seeds enriched relative to foliage, whereas in C_3 plants, fruits and branches are relatively depleted compared to leaves and seeds. This pattern suggests progressive enrichment from roots to seeds, which is more prominent in C_4 vegetation compared to C_3, likely driven by differences in internal nitrogen transport and fractionation during assimilation. Seasonal comparison further indicates higher $\delta^{15}N$ values during the dry season across all plant components in both photosynthetic pathways, with C_4 roots exhibiting the strongest seasonal shift.

These findings highlight the importance of high spatial and temporal resolution sampling when constructing isotopic baselines for dietary and environmental reconstructions and provide a refined framework for paleo-ecological applications.

Keywords: *plant physiology, isotope ecology, nitrogen isotopes, paleoecology*

Abstract 032 - Wang

Eutrophication Alters Biogeochemical Cycling in Mangroves: Evidence From Nitrogen and Phosphate Oxygen Isotopes

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Abstract:

Mangroves are globally important blue carbon ecosystems, yet their climate-mitigation function is highly vulnerable to eutrophication. Here, we combined nitrogen stable isotopes ($\delta^{15}N$) and phosphate oxygen isotopes ($\delta^{18}O_P$) to trace nutrient cycling and reveal eutrophication-induced shifts in mangrove biogeochemical cycling. Using the $\delta^{15}N$-based eutrophication indicator that does not require controlled experiments, together with a global dataset, we show that eutrophication causes a striking plant–soil decoupling: soil N content and N:P ratios decline as N cycling and losses intensify, while leaf N increases, indicating altered plant N acquisition pathways. A parallel shift occurs in carbon dynamics, with maintained or enhanced plant biomass but reduced soil organic carbon stocks. In parallel, $\delta^{18}O_P$ of Ca-bound phosphate in mangrove forests and adjacent mudflats remained above theoretical equilibrium values and increased significantly with phosphorus enrichment from 1990 to 2008, pointing to substantial exogenous P inputs. Together, these dual-isotope results demonstrate that eutrophication reshapes mangrove biogeochemical cycling across nitrogen, phosphorus, and carbon pools. Although eutrophication may stimulate plant growth in the short term, it can simultaneously deplete soil nutrient and carbon reservoirs, threatening long-term ecosystem resilience and blue carbon stability. Our study highlights stable isotopes as powerful tools for diagnosing nutrient-driven biogeochemical change in mangroves.

Keywords: *mangrove; eutrophication; nitrogen isotope; phosphate oxygen isotopes*

Abstract 033 - Açaf

To Use or Not to Use: Assessing the Reliability of CSIA-AA $\delta^{13}C$ and $\delta^{15}N$ Signals in Archaeological Marine Matrices

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Abstract:

Reconstructing past marine ecosystems using compound-specific isotope analysis of amino acids (CSIA-AA) requires that isotopic signals remain stable despite post-mortem alteration. However, the preservation of amino acid compositions and associated $\delta^{13}C$ and $\delta^{15}N$ values in calcified organic matrices over archaeological timescales remains insufficiently constrained. We assess the molecular preservation and isotopic fidelity of bone collagen from *Sparus aurata* and shell organic matrices from *Ruditapes decussatus* recovered from the Étang de Berre (NW Mediterranean, France), spanning ~7,000 years. Archaeological samples were directly compared with modern specimens to evaluate potential diagenetic alteration. Amino acid composition, C:N ratio, degradation indices (ΣV), and CSIA-AA measurements of $\delta^{13}C$ and $\delta^{15}N$ were used to assess preservation. Bone collagen shows well-preserved amino acid distributions and consistent isotopic values across time, supporting its robustness as a reference material. In contrast, shell organic matrices exhibit selective amino acid loss, notably glycine depletion consistent with abiotic leaching. Comparison with modern shell matrices indicates that, despite these compositional changes, $\delta^{15}N$ values remain consistent through time, indicating strong resistance to diagenetic alteration. Conversely, $\delta^{13}C$ values display greater variability among specific amino acids, suggesting differential sensitivity to degradation. These results demonstrate that CSIA-AA can provide reliable isotopic information from archaeological calcified matrices when preservation is carefully assessed. While $\delta^{15}N$ signals appear robust across substrates and timescales, $\delta^{13}C$ variability and compositional changes in shell matrices highlight important limitations, underscoring the need to integrate molecular preservation proxies with isotopic analyses.

Keywords: *CSIA-AA; $\delta^{13}C$; $\delta^{15}N$; isotopic preservation; diagenesis; archaeological biomolecules; bone collagen; shell organic matrix*

Abstract 035 - Che-Pelicier

Puzzling out Aotearoa New Zealand eels' mysterious marine journey through particulate organic matter isoscapes and isotopic clues found in their eye lenses

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Abstract:

Determining the origin and migration patterns of migratory fish larvae is important for understanding their life cycles. This is particularly challenging for catadromous fish, like freshwater eels, which spawn in the open ocean before their larvae disperse, migrate, and eventually recruit to freshwater systems. Despite their ecological, cultural and economic importance, the early oceanic stages of freshwater eels remain poorly understood, mainly because telemetry or bio-logging of such small individuals across large oceanic areas is not yet feasible. To overcome these limitations, stable isotope analysis of inert tissues has emerged as a powerful tool. Tissue isotopic ratios can be combined with oceanic isoscapes to infer larval origins from spatial variation in baseline isotopic composition. Here, we combine stable isotope analyses of eel larval eye lenses with particulate organic matter (POM) isoscapes across the southwest Pacific Ocean to investigate the marine origins of Aotearoa New Zealand shortfin eels (*Anguilla australis*). Particulate organic matter was collected during a research voyage from Aotearoa New Zealand to the Solomon Islands across three depth strata to generate nitrogen isotope ($\delta^{15}N$) isoscapes of POM representative of the larval depth range. Nitrogen isotopic composition of the eye lens was measured using nano-EA/IRMS, enabling nanomolar-scale bulk analyses, and GC-IRMS to target $\delta^{15}N$ of individual amino acids. Linking eye lens isotope ratios with POM $\delta^{15}N$ isoscapes provides new insights into the oceanic regions traversed during early eel development and establishes a regional isotopic framework to support future studies of migration and trophic ecology in the southwest Pacific.

Keywords: *Larval migration | Stable Isotope Analysis | Marine isoscape | Eye lens | New Zealand eels*

Abstract 036 - Cybulski

Microbial food webs in Late Holocene Panamá reveal overlooked pathways in human diets

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Abstract:

Food provisioning is one of humanity's greatest ecosystem impacts, often spanning millennia. Yet reconstructing ancient diets and their ecological consequences remains challenging due to the interplay of cultural preferences, resource availability, and environmental factors. Panamá, with its diverse cultural and ecological histories, provides an ideal setting to explore this interplay. Here, we ask the seemingly simple question: what did ancient Panamanians eat? Using Bayesian mixing models, we reconstruct human diets (n > 60) across the Isthmus over the last 4,500 years using bulk collagen $\delta^{15}N$ and $\delta^{13}C$ alongside compound-specific isotope analysis of amino acids (CSIA-AA), allowing identification of primary protein and energy sources and trophic position. $\delta^{15}N$ values vary by site and time, indicating distinct subsistence strategies and a strong reliance on coastal resources. However, conventional food web endmembers did not fully explain variation in amino acid $\delta^{13}C$ fingerprints. Instead, microbial food webs—a biochemically elusive food source typically excluded from dietary reconstructions—account for a significant dietary component. In Panamá, we hypothesize this signal largely reflects "chicha", a fermented maize beverage with strong cultural significance. Notably, similar microbial contributions are evident across all known published human CSIA-AA datasets reanalyzed here. This study provides the first quantitative evidence that microbial food webs contributed substantially to human diets, offering a more complete view of subsistence over millennial timescales.

Keywords: *Panama, CSIA, Amino Acids, Microbial food web, Nitrogen, Carbon, Human diets, Marine*

Abstract 037 - Kim

Identifying individual movement among groups within a metapopulation using stable isotopes

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[4]*Escuela Superior de Medicina, Instituto Politécnico Nacional*

Abstract:

Population connectivity emerges from the cumulative movement decisions of individuals, yet identifying which individuals conform to local population structure and which deviate remains a major empirical challenge. Stable isotope analysis provides a powerful lens for resolving ecological variation because spatial heterogeneity in isotopic baselines becomes recorded in consumer tissues. Chronological tissues that grow incrementally preserve temporally ordered isotopic records, allowing reconstruction of individual ecological histories rather than time-averaged snapshots. Here, we adapt a keystone niche–individual framework to distinguish individual movement among groups within a metapopulation the isotopic variation between marine and estuarine baselines. We apply this framework to Leopard Sharks (*Triakis semifasciata*) sampled across four Central California estuaries from 2021–2024, using sequential tooth series to generate individual isotopic time series of $\delta^{13}C$ and $\delta^{15}N$ values. Bayesian multivariate mixed-effects models were used to estimate population total niche width (TNW), and individual contributions to TNW were quantified through a removal-based approach. Hierarchical generalized additive models evaluated seasonal isotopic trajectories across day of year. Most individuals exhibited coherent seasonal isotopic patterns consistent with shared, within-subpopulation habitat use, indicating stable subpopulation structure despite environmental variability. However, a small subset of individuals disproportionately expanded TNW by occupying isotopic niches misaligned with local baselines, consistent with transient movement among estuaries. These results indicate that connectivity among estuarine subpopulations may be maintained by relatively few mobile individuals. This framework using chronological tissues provides a generalizable approach for identifying cryptic individual behaviors that shape population connectivity, resilience, and niche structure across heterogeneous landscapes.

Keywords: *Leopard Shark, Pacific Ocean, Dental collagen, Time Series, Bayesian Modeling*

Abstract 038 - Dingle

Prevalence and source of microplastics in pellets of the Great Cormorant Phalacrocorax carbo sinensis

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[2]*The University of Hong Kong*

Abstract:

Microplastics in the environment, a global horizon threat, are ingested by aquatic organisms and accumulate through the food web. It has been estimated that most seabirds will have ingested plastic in some form within the next few decades, with potential impacts on fitness. Microplastics enter a seabird's diet either through their prey or by direct ingestion of microplastics in water. Using regurgitated pellets from multiple roosting sites, we tested whether Great Cormorants ingest microplastics through their diet and used stable isotope analysis (SIA) of carbon, nitrogen and sulfur isotopes to determine the potential source of microplastic in the cormorant's diet. We found microplastics in 36.7% of the pellets collected, mostly as polyester and olefin fibers. Great Cormorants feed primarily on fish in both freshwater and saltwater environments. To determine whether We conducted SIA on fish bones from the cormorant pellets to determine whether the likely source of these ingested microplastics was fresh-water fish farms or wild marine fish species. We were able to differentiate between fish from freshwater fish farms and those from marine habitats primarily based on differences in $\delta^{34}S$ between habitats. From the pellets we analyzed, cormorants most likely ingested microplastics while feeding in freshwater fish farms, with plastics potentially originating from textiles or fishing gear. More work is required to identify whether the presence of microplastics in cormorant pellets is harmful to the birds, but this study confirms the presence of microplastics in the diet of Great Cormorants.

Keywords: *microplastics, sulfur, diet, seabird*

Abstract 039 - Saboret

Ontogenetic dietary shifts shape rockfish dietary niches revealed by bulk and amino acid–specific isotopes in eye lenses

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Abstract:

Most organisms undergo ontogenetic dietary shifts, yet reconstructing these trajectories at the individual level remains a major challenge, leaving a critical gap in understanding how dietary niches are formed. Eye lenses, composed of successive protein layers deposited over an individual's life, offer a new approach to address this gap. Here, we investigated ten sympatric rockfish species from a dynamic upwelling system off the coast of central California, to examine how ontogeny contributes to niche partitioning. Cluster analyses of lens bulk isotopes reveal that species exhibit distinct patterns of dietary shifts and marked differences in inter-individual variability. By aligning juvenile stages with age estimates, we show how interannual variability and species identity jointly shape individual dietary trajectories, highlighting that species niches are built from distinct sets of individual dietary pathways. We further refined these trajectories by applying amino acid–specific nitrogen isotope analysis to disentangle baseline $\delta^{15}N$ variation from changes in trophic position. In addition, we present the first application of amino acid–specific carbon isotopes in eye lenses, enabling reconstruction of how individuals integrate habitat-specific sources of primary production throughout ontogeny. Together, these results demonstrate that eye lens isotope analysis, especially when combined with amino acid–specific isotope analyses, is a transformative tool for explaining the individual ontogenetic component of species dietary niches. As global change increasingly affects all marine habitats, our approach provides a path to better understand the impacts of global change on trophic interactions across an organism's lifespan.

Keywords: *Eye lens isotopes, rockfish, ontogenetic dietary shifts, amino acid isotopes, dietary niche*

Return to Table of Contents

Abstract 042 - Urbano

Tracing methane-derived carbon in aquatic food webs: insights from stable isotope mixing models

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[2]*Lancaster University, United Kingdom*
[3]*Federal University of Minas Gerais, Brazil*

Abstract:

Methane is a key greenhouse gas that strongly influences Earth's climate. It can be oxidized by methanotrophic bacteria and incorporated into aquatic food webs, although its contribution as a carbon source for aquatic consumers remains poorly quantified. Stable carbon isotopes provide a promising tool for investigating methane-derived carbon assimilation along aquatic food webs, as methanotrophic pathways generate strongly ^{13}C-depleted values. We evaluated the use of $\delta^{13}C$ Bayesian and non-Bayesian mixing models to quantify methane-derived carbon contributions to fish biomass in environments with contrasting methane influence (one floodplain lake and one stream). Methane-derived carbon assimilation was estimated both through direct uptake by fish and indirectly via aquatic invertebrates. Consumers from the floodplain lake exhibited $\delta^{13}C$ values lower than all local basal resources (-42 to -28‰), whereas in the stream, consumer $\delta^{13}C$ values fell within the range of basal resources (-30 to -22‰). A proporção de carbono derivado do metano para os consumidores na planície aluvial foi de aproximadamente 12%, enquanto no córrego foi de cerca de 1-2%. The Bayesian model produced results consistent with those obtained by tracing methane-derived carbon flux through benthic invertebrates and zooplankton. Additionally, methane-derived carbon contributions were negligible in the stream. Overall, $\delta^{13}C$ Bayesian mixing models may provide a reliable and robust framework for quantifying methane-derived carbon in fish biomass and assessing the role of fish communities in the methane cycle. Thus, they emerge as promising tools for understanding the role of aquatic organisms in mitigating the emissions of this important greenhouse gas.

Keywords: *Greenhouse gases, fish, floodplain, method, mixing model, stream*

Return to Table of Contents

Abstract 044 - H. S. Basilio

Stable isotopes reveal trophic dynamics in Amazonian streams

Pedro H. S. Basilio[1], Paulo dos Santos Pompeu[1], Débora Reis de Carvalho[2], Cecília Leal[2]

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[2]*Lancaster University*

Abstract:

The Amazon River Basin, the largest on Earth, is formed by a vast network of rivers and streams harbouring unparalleled biodiversity. We used carbon and nitrogen stable isotopes to assess the trophic ecology of Amazonian aquatic organisms in streams with varying levels of forest conversion to agriculture. In low-disturbed streams, aquatic and terrestrial invertebrates were the main carbon sources for fish, with the surrounding forest playing a key role in providing basal resources for both. In degraded streams, fish exhibited a broader isotopic niche and carbon range than in low-disturbed streams, indicating that deforestation alters the energy sources available to the assemblage. Shrimps and crabs also showed shifts in their isotopic niches and carbon assimilation in degraded streams, indicating that these poorly studied groups are also affected by changes in resource availability and energy pathways. Furthermore, incorporating ecomorphological approaches revealed that phylogenetically related fish species exhibit distinct patterns of resource assimilation and isotopic niches, indicating niche differentiation despite morphological similarities and suggesting a high degree of trophic partitioning within these diverse assemblages. Our results reinforce the value of stable isotopes as a critical tool for understanding complex ecological interactions in Amazonian streams while revealing the impacts of anthropogenic pressure on these ecosystems.

Keywords: *Carbon, Energy flow, Environmental change, Nitrogen, Trophic structure*

Abstract 045 - Welles

Optimal foraging theory predicts diet and niche dynamics in a boom-bust mammalian population

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Abstract:

Dietary plasticity enables generalist species to persist by switching resources as prey availability shifts seasonally. In hard mast-driven ecosystems, such as pine barrens, generalist small mammals are essential for seed dispersal yet are known to consume invertebrates. Here, we provide evidence for diet switching and niche dynamism throughout boom-bust population cycles of white-footed mice (*Peromyscus leucopus*). To do so, we conduct isotopic analyses of long- and short-term time-averaged samples from populations sampled seasonally over a four-year period. Using fecal and hair isotopic composition ($\delta^{13}C$, $\delta^{15}N$), we quantified dietary dynamics intra- and inter-annually using Bayesian mixing models to reconstruct diet and standard ellipses to estimate isotopic niche. During peaks in population abundance following a hard mast resource pulse, we find that white-footed mice consume equal proportions of mast and omnivorous invertebrates. This confirms the mast use by generalist granivores and reduces their isotopic niche area. The proportion of invertebrates consumed increases when mast is depleted and population abundance troughs. This switch in resource use drives isotopic niche expansion in low-abundance years. These results suggest that white-footed mice forage optimally by specializing on a pulsed resource and expand their diets to include alternative resources when their preferred resource is scarce. Additionally, as integrated records of resource assimilation since last molt, hair samples prove to be a better estimator of dietary dynamics than short-term records of forage in fecal samples. Temporal variation of white-footed mouse diet underscores the importance of the species' multitrophic interactions in contributing to stability in seasonal and mast-controlled ecosystems.

Keywords: *Peromyscus leucopus, optimal foraging, niche dynamics, generalist consumers, resource pulse, pine barrens*

Return to Table of Contents

Abstract 047 - Qi

Detritus-dominated energy flow acts as a stabilizer for food web structure in Southern Ocean regions with low net primary production

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Abstract:

The Southern Ocean, as a critical regulator and amplifier of global climate change, lacks holistic characterization of ecosystem structure, function and dynamics, due to severe research neglect of its vast regions with low net primary productivity (NPP). In contrast to high-NPP hotspots, it remains poorly understood how these areas maintain ecosystem structure and energy flow under limited productivity. Using six years of observational data from China's Antarctic scientific expeditions, we applied Ecopath with Ecosim to construct the first ecosystem model for the Cosmonaut Sea, one of the regions with the lowest NPP in East Antarctica, based on a food web framework traced by stable carbon and nitrogen isotopes. Results show that the topological food web in the Cosmonaut Sea exhibits considerable modularity and relatively weak benthic-pelagic coupling. Detritus plays a more important role than primary producers, contributing 66.0% of total energy flow and sustaining a mean transfer efficiency of 16.8% in this low-NPP ecosystem. Furthermore, we provided evidence for the decoupling between NPP and food chain length in both the parameter space and the geographical space under the optimal foraging theory. These findings advance the mechanistic insights into the biogeochemical cycles in the Southern Ocean and how its ecosystems respond to global climate change, which provides scientific support for the conservation of the Southern Ocean ecosystems.

Keywords: *Cosmonaut Sea, Stable isotope analysis, Ecopath with Ecosim, Food web structure, Net primary productivity, Southern Ocean*

Return to Table of Contents

Abstract 049 - Zhou

Microbial role in shaping the land plant leaf alkane-versus-chain length profiles

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Abstract:

Despite the widespread use of δ^2H of higher plant leaf alkanes for reconstructing past climate, environment, and vegetation, it remains difficult to attribute observed isotopic variations to specific controlling factors. A major source of uncertainty is our limited understanding of how phyllosphere microorganisms contribute to alkane biosynthesis. Methods capable of tracing H flow from host into microbes and of characterizing microbial community structure are essential for rigorously assessing microbial contributions to leaf alkanes in field grown plants. Building on two recently identified contrasting patterns in alkane δ^2H-versus-chain length profiles, we investigate microbial roles in fatty chain elongation and shortening, as well as microbial selection of host metabolites for alkane biosynthesis. These goals were partially achieved through two complementary experiments using field grown plants.

The first experiment surveyed the δ^2H-versus-chain length profiles of leaf alkanes from 59 plant species in Hainan, representing both herbaceous and woody life forms and C_3 and C_4 photosynthetic pathways. The survey confirmed that the characteristic decrease in alkane δ^2H with increasing chain length is universal. It also revealed strong correspondences among alkane hydrogen isotopomic patterns, operational taxonomical unit-based metagenomic reconstructions of microbial community structure, and key metabolomic profiles across plant life forms and photosynthetic types.

The second experiment examined how selective inhibition of phyllosphere bacterial or fungal growth in six plant species spanning different life forms and photosynthetic pathways affected δ^2H-versus-chain length profiles and microbial community structure. The inhibition treatments provided additional indirect evidence that phyllosphere microbiota help shape the distinctive δ^2H-decrease-with-chain-length trend.

Keywords: *land plant leaf alkanes; hydrogen isotopes; selective utilization of metabolites; chain extension mechanism; plant-microbe interaction*

Return to Table of Contents

Abstract 052 - Polito

Are penguins "what they drink"? Relationships between eggshell carbonate and water oxygen stable isotope values and implication for modern and paleoecological studies

Michael Polito[1], Todd Dawson[2]

[1]*University of California Santa Cruz*
[2]*University of California Berkeley*

Abstract:

Eggshells have been used to examine avian physiology and diets and reconstruct past environmental conditions. This is because birds are "what they drink", with the oxygen within eggshell carbonate derive from water sources consumed prior to eggshell formation. We compared the oxygen stable isotope values ($\delta^{18}O$) of eggshells and their water sources from seven species of penguins at 25 zoological institutions around North America. Our study takes advantage of the fact that rain and tap water $\delta^{18}O$ values vary dramatically, but predictably, leading to a large range of water $\delta^{18}O$ values across the institutions examined (-17.9 to 0.7 ‰). We found a positive relationship between eggshell and water $\delta^{18}O$ values with eggshells $\delta^{18}O$ values being 29.65 ± 3.65 ‰ higher on average than the water consumed. We also found a strong relationship between $\Delta^{18}O$ and $\delta^{18}O_{water}$ with a greater difference between $\delta^{18}O_{eggshell}$ and $\delta^{18}O_{water}$ values in captive penguins drinking lower $\delta^{18}O_{water}$ values. Even so, we explored the potential to apply these data to stable isotope mixing models to predict the relative use of snow/melt water vs. ocean/prey water in wild penguins. Our model predicted higher use of meteoric water in Adelie penguins vs. gentoo penguins with agrees with differing life history behaviors of fasting vs. foraging, respectively, during eggshell formation. The results highlight the potential for eggshell $\delta^{18}O$ to be used as a non-invasive method to track water sources to captive and wild penguins but also indicate the need for greater understanding of physiological and/or environmental effect on ^{18}O fractionation.

Keywords: *oxygen, paleoecology, water, avian, ecology*

Return to Table of Contents

Abstract 062 - Savory

Amino acid $\delta^{15}N$ values predict body condition status in a captive population of muskoxen

Garrett Savory[1], John Blake[!], Diane O'Brien[!], Greg Breed[!], Molly Cook[!]

[1]*University of Alaska Fairbanks*

Abstract:

Measures of body condition, particularly protein balance, are important in understanding the health of wildlife populations but can be difficult or impossible to obtain from free-living animals. One potential biomarker, the $\delta^{15}N$ value of bulk tissue, has had mixed success in predicting body condition. $\delta^{15}N$ values of amino acids (AAs) have been shown to be more sensitive measures of trophic position than the bulk $\delta^{15}N$ value and may also be more sensitive to changes in body condition. Here we evaluate AA $\delta^{15}N$ values as a method to assess body condition using archived serum samples from a captive population of muskoxen (*Ovibos moschatus*) that had decreased body condition resulting from feed that
inadvertently provided marginal to deficient levels of several dietary trace elements. We predicted that AA $\delta^{15}N$ values would be associated with deviations from expected body mass, and they would be more sensitive than bulk $\delta^{15}N$ values. We evaluated several linear mixed-effect models including $\delta^{15}N$ values of bulk and AAs, and other variables. In females, the $\delta^{15}N$ values of glutamate/glutamine, leucine, aspartate/asparagine, and serine, plus pregnancy status, best predicted difference from expected mass; in males, the $\delta^{15}N$ values of glutamate/glutamine, leucine, and proline best predicted difference from expected mass. Bulk $\delta^{15}N$ values were not associated with the difference from expected mass. $\delta^{15}N$ values of AAs have potential as a tool for researchers to evaluate body condition in animals.

Keywords: *Nitrogen stable isotope ratios, compound-specific stable isotope analysis, body mass loss, wildlife health, ungulate, general linear mixed-effect regression*

Return to Table of Contents

Abstract 066 - Miller

Toward a global insect δ^2H isoscape

Marrissa Miller[1], Megan Reich[2], Peter Holder[3], Gerard Talavera[4], Clement Bataille[5]

[1]Departement of Biology, Carleton University, Ontario, Ottawa, Canada; Purdue University, West Lafayette, Indiana, USA
[2]Department of Biology, University of Ottawa, Ottawa, Ontario, Canada
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Abstract:

Hydrogen isotopes have been used to trace insect movement since the seminal work of Profs Keith Hobson and Len Wassenaar on monarch butterfly migration in 1998. Since then, hydrogen isotope-based geographic assignment has been used on a diversity of insect taxa including some beneficial insects, such as dragonflies, hoverflies, and painted lady butterflies, as well as some not-so-beneficial insects like stink bugs and mosquitoes. In this study, we conducted a systematic data synthesis, combining all publicly available known-origin insect δ^2H data as well as over 1000 original δ^2H data points, to investigate the sources of variation in insect δ^2H values and to create a global insect δ^2H isoscape. We investigated sources of variation in δ^2H values including analytical method, habitat, diet, and sample type. We found that the analytical method had an impact on insect δ^2H values, even after calibration chain transformation was applied to align reference scales. Although both insect habitat and diet impacted δ^2H values, we found a consistent relationship between the δ^2H values of insects and precipitation, permitting the construction of a global insect-calibrated δ^2H isoscape using spatial mixed models. Finally, we provide concrete recommendations to guide future research using hydrogen isotopes in insect ecology and migration research.

Keywords: *insect migration; hydrogen isotopes; hydrogen isoscape*

Return to Table of Contents

Abstract 070 - Reynard

Hydrogen isotopes in bone collagen vary with climate over the Late Pleistocene

Linda Reynard[1], Rhiannon Stevens[2]

[1]Boise State University
[2]University College London

Abstract:

Bones and teeth at sites associated with human activity represent a rich resource for generating local or regional palaeoenvironmental records. Here we investigate stable hydrogen isotope ratios (δ^2H) of bone collagen in horses (*Equus* sp.) from sites across Europe across the Late Pleistocene to the Early Holocene (50 – 8 ka BP). Bone collagen δ^2H values vary substantially over time within each of four regions, with shifts up to ~30 ‰ between time periods. We also assess the covariation of collagen δ^2H with $\delta^{15}N$ and $\delta^{34}S$, which suggest that hydrogen isotopes respond to environmental changes that also indirectly influence soil nutrient cycling and landscape hydrology during deglaciation. We conclude that bone collagen δ^2H is a promising additional tool for locally resolved environmental information alongside other isotope ratios from animal tissues.

Keywords: *hydrogen isotopes, collagen, palaeoenvironment*

Return to Table of Contents

Abstract 071 - Vesala

Methane carbon and hydrogen isotopes ($\delta^{13}C\text{-}CH_4$, $\delta^{2}H\text{-}CH_4$) reveal substrate-dependent controls on termite methanogenesis

Risto Vesala[1], Sonja Leitner[2], Darius Kimuzi[3], Peter Mwasi[3], Alina Siegl[1], Lucas Mwangala[4], Jouko Rikkinen[1], Laura Arppe[1]

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[3]*Taita Research Station, Wundanyi, Kenya*
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Abstract:

Microbial methane (CH_4) production is a major driver of rising atmospheric CH_4 concentrations and contributes significantly to climate change. Termites are among the most important natural sources of microbial CH_4, yet the mechanisms controlling methanogenesis and associated isotope fractionation in termite guts remain poorly understood. Here, we combined CH_4 flux measurements with dual stable isotope analyses ($\delta^{13}C\text{-}CH_4$, $\delta^{2}H\text{-}CH_4$) from laboratory incubations of the fungus-growing termite *Macrotermes michaelseni* to investigate how diet influences CH_4 production and isotope signatures.

Both CH_4 production rates and isotope composition differed strongly between termite castes. Despite a shared initial carbon source, workers produced CH_4 that was substantially more depleted in ^{13}C and ^{2}H than that of soldiers. Carbon isotope fractionation during CH_4 formation ($\Delta\delta^{13}C_CO_2\text{–}\ CH_4$) increased with increasing substrate $\delta^{13}C$ values, indicating that dietary shifts between grass-derived (C_4) and woody (C_3) substrates influence CH_4 isotope signatures not only through source isotope composition but, more importantly, through effects on microbial fractionation processes. Consequently, stronger fractionation associated with C_4-based substrates can override source signals, resulting in more ^{13}C-depleted CH_4 than in C_3-feeding conspecifics despite substantially higher substrate $\delta^{13}C$ values. A strong positive relationship between $\delta^{13}C\text{-}CH_4$ and $\delta^{2}H\text{-}CH_4$ further demonstrates that carbon and hydrogen isotope systems are tightly coupled and governed by shared process-level controls, likely linked to substrate-dependent variation in hydrogen turnover during methanogenesis.

Integrating isotope approaches with flux measurements provides new opportunities to link greenhouse gas emissions with variability in substrate use and gut microbial metabolism, advancing process-based representations of termite contributions to the global CH_4 budget.

Keywords: *termites, methane, methanogenesis, microbial fractionation, carbon, hydrogen*

Return to Table of Contents

Abstract 077 - Riekenberg

Decomposition-induced change in stranded megafauna: Decoupling post-mortem impacts from the isotopic niche

Philip Riekenberg[1], Lonneke IJsseldijk[2], Mardik Leopold[3], Andrea Gröne[2], Marcel T.J. van der Meer[4]

[1]Center for Applied Isotope Studies, University of Georgia
[2]Division of Pathology, Department of Biomolecular Health Sciences, Utrecht University, The Netherlands
[3]Wagengingen Marine Research, Wagenengingen University and Research, The Netherlands
[4]Department of Marine Microbiology and Biogeochemistry, NIOZ Royal Netherlands Institute for Sea Research, The Netherlands

Abstract:

Diet throughout an animal's lifetime can be reconstructed using stable isotope analyses of tissues with different turnover times, yet the effects post-mortem changes on stable isotope values remain understudied. Here we investigate bulk $\delta^{13}C$, $\delta^{15}N$, and $\delta^{34}S$, amino acid $\delta^{13}C$ and $\delta^{15}N$ values from multiple tissue types sampled from stranded harbor porpoises across a range of initial decomposition states. Decomposition caused consistent decline in $\delta^{13}C$ values across tissues and amino acid classifications indicating anaerobic microbial fermentation as a dominant metabolism driving changes in early decomposition. $\delta^{15}N$ and $\delta^{34}S$ values were largely stable, suggesting limited microbial transformation of nitrogen and sulfur pools prior to more advanced decomposition. Tissue-specific isotopic differences were larger than decomposition effects and likely driven by metabolic differences between tissue types as well as difference in elemental turnover from diet. Our findings indicate predictable isotopic carbon shifts during early decomposition and call for caution when interpreting stable isotope data from potentially degraded samples.

Keywords: *nitrogen, carbon, sulfur, compound specific*

Return to Table of Contents

Abstract 078 - Lowe

Habitat preference drives stable isotope variation in the organic matrix of shark teeth

Kelsey Lowe[1], Gregory A. Henkes[1,2], Michael G. Frisk[1], Veronica A. Borracci[2], Christopher G. Lowe[3], Oliver N. Shipley[1,2]

[1]School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY, 11794
[2]Department of Geosciences, School of Earth and Space Sciences, Stony Brook University, Stony Brook, NY, 11794
[3]Department of Biological Sciences, California State University, Long Beach, CA, 90840

Abstract:

Isotopic assessments of shark tooth organics imply that teeth of different ages, that is, those sampled from different rows within a jaw, preserve ecological chronologies. As such, teeth from individuals associated with more isotopically homogenous environments, such as pelagic species, should exhibit lower isotopic variability than coastal species. These basic predictions have yet to be robustly tested but are critical for accurately describing functional and physiological plasticity within and among individuals. For several species of pelagic and coastal sharks (bull, dusky, and white sharks), we quantified $\delta^{13}C$ and $\delta^{15}N$ variation in tooth organics extracted from dentine and enameloid across whole jaws. Dentine organic material exhibited higher $\delta^{13}C$ ranges for coastal (bull = 3.9‰, white = 6.3‰) relative to pelagic species (dusky = 2.5‰). Similar ranges in $\delta^{15}N$ values were observed across all species (bull = 2.6‰, white = 3.3‰, dusky = 2.3‰). Enameloid organic material was more isotopically variable than dentine, with higher $\delta^{13}C$ (bull = 6.8‰, dusky = 4.0‰) and $\delta^{15}N$ (bull = 2.6‰, dusky = 2.8‰) ranges. Differences between isotopic ranges associated with dentine and enameloid organic material likely result from continuous fractionation occurring between the blood supply and dentine organic material, which does not occur for highly crystalline enameloid. This suggests that organic material extracted from enameloid may provide a more accurate representation of functional and physiological variability. Our findings guide the ecological interpretation of isotopic variation within shark tooth organics sampled across contemporary, historical, and paleoenvironments.

Keywords: *Shark tooth organics, Habitat preference, $\delta^{13}C$, $\delta^{15}N$*

Return to Table of Contents

Abstract 079 - Huang

From baseline to food webs: amino acid-specific $\delta^{15}N$ in bivalve shells and fish bones over the last millennium in the North Sea

Qian Huang[1], Oliver E. Craig[2], Fröhlich[1], Bernd R. Schöne[1]

[1]*nstitute of Geosciences, University of Mainz*
[2]*Department of Archaeology, University of York*

Abstract:

Reconstructing long-term changes in nutrient sources and food webs is essential for understanding ecosystem responses to natural variability and anthropogenic pressures. Nitrogen isotope ($\delta^{15}N$) records from biogenic archives are widely used to reconstruct past nitrogen sources and food webs, but integrate both environmental and trophic signals. Compound-specific nitrogen isotope analysis of amino acids (CSIA-AA $\delta^{15}N$) enables separation of nitrogen isotope baseline from trophic effects, offering enhanced insights into past ecosystem dynamics. Here, we apply CSIA-AA $\delta^{15}N$ to shells of the long-lived bivalve *Arctica islandica* which provide annually resolved growth increments and preserve organic matter within their shells for long time intervals. Using $\delta^{15}N$ values of phenylalanine ($\delta^{15}N_{phe}$), trophic position estimates and amino acid fingerprinting, we reconstructed nitrogen isotope baselines and basal food web dynamics over the last millennium in the northern North Sea. These records were compared with published CSIA-AA data from Atlantic cod (*Gadus morhua*) bones from the same area. Both archives showed an increase in trophic position since around 1800 CE. Bayesian mixing models further indicated an increasing contribution of microbially reworked organic matter in recent centuries. Shell-derived $\delta^{15}N_{phe}$ exhibited a clear long-term decline toward the present, while a similar trend is not shown in $\delta^{15}N_{phe}$ from cod bones. This difference highlights the influence of spatial integration in higher trophic level consumers. Our results showed that integrating multiple biological archives could provide critical insights into the transfer of biogeochemical signals through marine food webs over centennial timescales.

Keywords: *CSIA-AA; Biogenic archives; Trophic position; Microbial pathway*

Return to Table of Contents

Abstract 081 - Cheung

Marine Ecological Changes in Hong Kong over the Last Two Millennia: Insights from Compound Specific Isotope Analysis of Fish (Labridae) Amino Acids

Christina Cheung[1], Mark Man Chung Li[1], Mandy Wing Kwan So[2], Jonathan Cybulski[3], Josh Pi[2], Nga Man Chung[2], Benoit Thibodeau[2]

[1]Department of Anthropology, Chinese University of Hong Kong
[2]Department of Earth and Environmental Sciences, CUHK
[3]School of Biological Sciences, HKU

Abstract:

Marine ecosystems are highly sensitive to human activities. Over recent decades, intensified fishing activities, land reclamation, and large-scale urban development have heavily disturbed marine habitats around Hong Kong. To evaluate how the marine ecology in Hong Kong has changed in response to these developments, we apply compound-specific isotope analysis (CSIA) to analyse the $\delta^{13}C$ and $\delta^{15}N$ of amino acids (AA) in both modern and archaeological fish samples to assess changes in the marine food-web structure over the last two millennia. Focusing on fish from the family Labridae (wrasse), normalised essential CSIA-AA data from 10 archaeological wrasse samples collected from Sha Po Tsuen, Lamma Island, dated to the Six Dynasties and Tang Dynasty (200–907 CE), are compared with 10 modern wrasse samples acquired from the local fish market. Preliminary results show that modern fish derive nutrients from different basal sources compared with archaeological fish, suggesting a disruption in the local marine ecosystem. Furthermore, by combining CSIA data with other archaeological and ethnographic data, findings from this study demonstrate a bidirectional relationship between coastal environmental changes and human lifeways: human activities likely affected nearshore resource availability, while changes in resource availability may also have contributed to changing human settlement and subsistence practices, which in turn exerted stresses on the marine environment. Together, these results provide valuable insights into the dynamic relationship between humans and the marine ecosystem in Hong Kong.

Keywords: *Compound specific isotope analysis; Hong Kong; Archaeology*

Return to Table of Contents

Abstract 082 - Shipley

Stable isotope human ecology of pastoralist, agro-pastoralist, and fishing ethnic groups from the Turkana Basin, Kenya

Oliver Shipley[1], Thure Cerling[2], Purity Kiura[3], Grace Parkhill[4], Alexandra Grey[4], Gregory Henkes[5]

[1]*School of Marine and Atmospheric Sciences, Stony Brook University*
[2]*Department of Geology and Geophysics, University of Utah*
[3]*National Museums of Kenya*
[4]*Interdepartmental Doctoral Program in the Anthropological Sciences, Stony Brook University*
[5]*Department of Geosciences, Stony Brook University*

Abstract:

The Turkana Basin is one of the oldest and most continuously inhabited landscapes by hominins in the world. Modern humans in the basin possess distinct physiological and behavioral mechanisms for enduring persistent environmental heat and aridity, but how these vary among ethnic groups is poorly documented. We investigated carbon, nitrogen, oxygen, and hydrogen stable isotope variation in human hair (n = 154) contributed from three ethnic groups, the Daasanach, El Molo, and Gabra, to validate water and dietary resource use derived from ethnographies. Carbon and nitrogen isotope values revealed diverse nutritional strategies ranging from extensive use of lake resources by the El Molo to modes of (agro)pastoralism by the Daasanach and Gabra. Dietary niche areas were larger among (agro)pastoralists that utilize a mix of C_3 and C_4 resources, such as caprines, (Daasanach = 36.4‰2, Gabra = 34.9‰2) relative to those more reliant on lake resources, such as fishes (El Molo = 14.5‰2). We observed some of the highest δD and $\delta^{18}O$ values recorded in modern human hair, ranging from -56.3 to -8.4‰ and 13.5 to 23.1‰, respectively. The Daasanach and El Molo were enriched in D and ^{18}O relative to the Gabra, illustrating a reliance on lake-ward drinking water. Modeling data from all groups illustrated a high reliance on drinking water to main overall water balance, with smaller contributions from metabolic water production. These findings describe distinct behavioral and physiological plasticity and highlight adaptive mechanisms for living in one of the hottest and driest ecosystems on earth.

Keywords: *Deuterium excess, water balance, trophic ecology, pastoralism, resource use*

Return to Table of Contents

Abstract 083 - Newton

Pangolin Ecology and Provenance from Stable Isotope Analysis of Scale Keratin

Jason Newton[1], Ruth Lewis-Smith[1], Kate Abernethy[2], David Lehmann[3], Luc Bussière[4]

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[2]Biological and Environmental Sciences University of Stirling, Stirling, FK9 4LA, UK
[3]Okala, Gabon
[4]Department of Biological and Environmental Sciences, University of Gothenburg, Gothenburg, Sweden

Abstract:

Pangolins are widely regarded as the world's most trafficked mammals, and all nine African and Asian species are on the IUCN's Red List. The ongoing crisis highlights an urgent need for innovative forensic approaches to combat illegal trade. In addition to their dwindling numbers, some pangolin species are often nocturnal and/or fossorial, making them difficult to study by conventional means, leaving significant gaps in our knowledge of their ecology.

In this study, we analyse stable isotope compositions of pangolin scales from 26 UK museums as well as field samples from Lope National Park Gabon. Our objectives are twofold: to refine current knowledge of pangolin ecology, and to evaluate the potential of stable isotope analysis as a forensic tool for determining the geographic origin of confiscated scales.

We present stable isotope (HCNS) data from 73 individuals of 7 species. We firstly discuss how stable isotope analysis confirms or extends our knowledge of their feeding and habitat preferences. Sequential drilling of scales further allows us to investigate temporal variation within individuals, revealing evidence of dietary or habitat shifts over time.

Crucially, we explore the broader forensic application of this dataset. By integrating samples of varied provenance—including historical museum material with uncertain metadata—we assess the strengths and limitations of isotope-based geolocation. Our findings highlight both the promise and the practical challenges of applying this method to real-world wildlife trafficking cases, underscoring its potential as a powerful, yet critically evaluable, tool in pangolin conservation.

Keywords: *pangolin, keratin, provenancing, diet*

Return to Table of Contents

Abstract 092 - Ro

Spatiotemporal impacts on individual dietary variability in Scandinavian grey wolves (*Canis lupus*)

HyeJoo Ro[1], Sora L. Kim[1], Robin B. Trayler[1], Daniela C. Kalthoff[2]

[1]*University of California, Merced*
[2]*Swedish Museum of Natural History*

Abstract:

Grey wolves are classified variably as generalist carnivores or large-ungulate specialists, but resolving this debate requires moving beyond population averages to examine individual-level variation. We used stable isotope analysis ($\delta^{13}C$, $\delta^{15}N$) of serially sectioned guard hairs to assess isotopic variability between and within individuals across Sweden from 1912 to 2023. Males showed greater isotopic variability over time than females, consistent with their role as dispersers moving beyond established pack territories and accessing more diverse prey. Females were isotopically less variable, likely reflecting site fidelity and consistent prey selection. Isotope values for historical wolves showed greater variability and less overlap between individuals compared to modern individuals, suggesting dietary patterns have shifted over the past century. We identified regional differences where northern Swedish wolves had higher isotopic variability than central or southern Swedish wolves. This could indicate greater access to aquatic ecosystems in the north, where there are fewer human barriers to seasonal pulses of anadromous fish, such as Arctic char, salmon, and herring, which may be important dietary subsidies in spring and summer. Together, these findings highlight how individual behavioral differences, regional landscape access, and spatiotemporal prey dynamics shape dietary niche breadth in apex carnivores.

Keywords: *carnivores, individual variability, landscape, baseline*

Return to Table of Contents

Abstract 099 - Genelt-Yanovskiy

Tracing the provenance of blue whale *Balaenoptera musculus* in the early decades of 20th century industrial whaling at South Georgia.

Evgeny Genelt-Yanovskiy[1], Anna Genelt-Yanovskaya[1], Oliver E. Craig[2], Kweku Afrifa Yamoah[2], Oliver E. Craig[2], Helen Talbot[2], Maria Fontanals-Coll[2], Sam Greeves[2], Richard Sabin[3], James Scourse[1]

[1]*University of Exeter, Department of Earth and Environmental Sciences*
[2]*University of York, BioArCh*
[3]*The Natural History Museum, London*

Abstract:

Whaling has left an enormous impact on populations of most baleen whale species in Antarctica, and the datasets obtained during and after the ban on commercial whaling are crucial for understanding the pre-whaling state of their populations. The migratory and foraging behaviour of Southern Hemisphere blue whales remains unclear, but their seasonal feeding grounds in the waters surrounding South Georgia are very well known, and this was the primary region of whaling in subantarctic waters. The modern Antarctic blue whales are considered to spend most of the year within Antarctic and subpolar waters, a pattern assumed to be unchanged since the period of industrial whaling. However, there is significant acoustic evidence for Antarctic blue whale seasonal presence in the lower latitudes. We have analysed bulk and compound-specific stable isotope analysis of bone collagen samples from blue whales hunted near South Georgia in the 1913-1920s and preserved at the Natural History Museum, London, with the aim of understanding their past migratory routes. Our data indicate several groups of specimens based on bulk and essential amino acid $\delta^{13}C$, $\delta^{15}N$, as well as bulk $\delta^{34}S$, suggesting multiple provenances in the higher and lower latitudes, and striking differences in the trophic ecology of whales landed over two consecutive decades expressed in $\delta^{15}NAA$. These findings are important for our understanding of long-term changes in the migratory and foraging behaviour of blue whales in the Southern Hemisphere and may have important implications for understanding the changes in regional population structuring throughout the 20th century.

Keywords: *Blue whale, Antarctica, South Georgia, CSIA*

Return to Table of Contents

Abstract 101 - Sherritt

Reproductive Investment Strategies of a Long-lived Arctic Giant

Madison Sherritt[1], Steve Ferguson[1], Colin Garroway[1], Melissa McKinney[1], Cory Matthews[1]

[1]Fisheries and Oceans Canada and The University of Manitoba

Abstract:

In many long-living species, the boundary between reproductive events leading to increased or decreased cumulative lifetime fitness is narrow. Females therefore maximize outcomes with reproductive strategies that balance the priorities of the mother with the priorities of current and future offspring. Previous bulk stable isotope (SI) and hormone analyses of chronologically sampled bowhead whale (*Balaena mysticetus*) baleen have revealed that the regular $\delta^{15}N$ cycles which reflect seasonal migration and foraging patterns are disrupted during pregnancy. We used compound specific stable isotope analysis (CSIA) of amino acids (AA) to differentiate between potential physiological (e.g., protein allocation) and behavioural mechanisms (diet and/or habitat variation) driving the disruption in the $\delta^{15}N$ cycles. During pregnancy, elevated $\delta^{15}N$ of trophic and physiologically sensitive AAs (e.g., glutamic acid, alanine, and leucine) indicate an increase in trophic level and/or catabolism of maternal body reserves. The $\delta^{15}N$ of source AAs reflecting baseline values (e.g., lysine, phenylalanine) are similar for pregnant and non-pregnant individuals, suggesting they are foraging in similar locations. This pattern is also seen in the $\delta^{13}C$ of essential AAs, which generally do not differ between pregnant and non-pregnant individuals, but $\delta^{13}C$ of non-essential AAs are more variable in pregnant whales. This suggests pregnant individuals forage in similar habitats but rely more on de-novo AA synthesis and/or maternal body catabolism than non-pregnant whales. Advancing our understanding of bowhead whale reproductive physiology will help to describe reproductive constraints present in the species and serve as a framework to evaluate foraging patterns in long-lived mysticetes facing rapid environmental change.

Keywords: *Reproductive investment, cetaceans, Arctic*

Abstract 102 - Addison

Decadal shifts in foraging behavior of juvenile Striped Bass (*Morone saxatilis*) are linked to major climate modes in the Hudson River Estuary, New York, USA

Cara Addison[1], Oliver Shipley[1], Gregory Henkes[1], Yong Chen[1]

[1]*Stony Brook University*

Abstract:

The Hudson River Estuary (HRE) is one of the most important waterways on the US east coast, providing critical habitat for many fish species of economic and ecological interest. Over the last century, the HRE has experienced profound biological, chemical, and physical changes largely driven by urbanization and global climate change. Previous monitoring of the HRE has indicated changes in surface temperatures and sea level, however the impact of these changes on the ecology of estuarine fishes is largely unexplored. We determined the environmental drivers of trophic variation in the HRE from 1989 to 2017 using $\delta^{13}C$ and $\delta^{15}N$ values of archived striped bass scales (0–1-year-old), including amino acid $\delta^{15}N$ analyses. Scale $\delta^{13}C$ values were highly variable but exhibited no clear trend through time, while $\delta^{15}N$ values increased moderately over time. Relative trophic position (TP) of striped bass, inferred through offsets in $\delta^{15}N$ values between glutamic acid, proline, phenylalanine, and lysine revealed cyclical fluctuations throughout the record. We observed a positive association between relative TP and the North Atlantic Oscillation (NAO) index and a negative association between TP and mean sea level. Given that positive phases of the NAO bring strong, cold winds and reduced precipitation to the Northeastern US, we propose that altered primary productivity reshapes predator-prey interactions of juvenile striped bass. These findings demonstrate the potential of molecular isotope approaches for revealing intricate relationships between food web structure and climate variability, underscoring the importance of long-term monitoring for predicting the drivers of ecosystem structure and function.

Keywords: *Amino acid stable isotope analysis, North Atlantic Oscillation (NAO), trophic position, archived fish scales*

Return to Table of Contents

Abstract 110 - Vink

Dietary niche reconstruction of early hominins based on $\delta^{13}C$, $\delta^{15}N$, and $\delta^{18}O$ from fossil tooth enamel at Sterkfontein Caves

Marissa Vink[1], Jennifer Leichliter[1,2], Hubert Vonhof[3], Recognise Sambo[4], Dominic Stratford[4,5], Marion Bamford[2], Alfredo Martinez-Garcia[2], Tina Lüdecke[1,2]

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[2]Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, South Africa
[3]Department for Climate Geochemistry, Max Planck Institute for Chemistry, Mainz, Germany
[4]School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, Johannesburg, South Africa
[5]Department of Anthropology, Stony Brook University, Stony Brook, New York

Abstract:

Stable isotope analyses of fossil tooth enamel are used to reconstruct paleodiets and environments of early hominins. Carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotopes in the inorganic carbonate fraction distinguish browsing from grazing herbivores and are related to drinking water sources, respectively. Nitrogen isotopes ($\delta^{15}N$) in the organic fraction reflect trophic level.

Here we present $\delta^{13}C$, $\delta^{15}N$, and $\delta^{18}O$ of Plio-Pleistocene tooth enamel from hominins and coexisting fauna from Sterkfontein Caves, South Africa. We analyzed *Australopithecus* (n = 6) from Jacovec Cavern (3.61 ± 0.09 Ma), as well as *Paranthropus* (n = 2) and early *Homo* (n = 3) from Member 5 (2.1 – 1.4 Ma).

The Jacovec australopithecines overlap with browsing bovids and non-hominin primates across all three isotope systems, indicating a browsing-dominated, plant-based diet. They show a more restricted $\delta^{15}N$ (3.4 ‰) range compared to younger Member 4 *Australopithecus* (3.4 ± 0.11 Ma; 6.7 ‰). This pattern mirrors the broader food web at Sterkfontein where trophic enrichment between herbivores and carnivores is lower in Jacovec Cavern (3.6 ‰) than in Member 4 (6.0 ‰), indicating dietary flexibility in South-African *Australopithecus*.

Paranthropus and early *Homo* did not consume substantial amounts of mammalian meat, as their $\delta^{15}N$ values (7.7 and 4.3 ‰, respectively) are lower than those of contemporaneous carnivores (10.9 and 8.3 ‰, respectively). Both genera overlap with mixed-feeders based on $\delta^{13}C$ values and *Paranthropus* has more enriched $\delta^{18}O$ values than early *Homo* (-2.3 vs -3.7 ‰, respectively).

Keywords: *Plio-Pleistocene, Paleodiet, South Africa, Early hominins*

Return to Table of Contents

Abstract 111 - Devine

Cycad Strontium Isoscape (CSI): A Forensic Tool to Combat Poaching of Endangered South African Plants

Jess Devine[1], Clement Bataille[2], Adam West[1], Michele Pfab[3]

[1]University of Cape Town
[2]Purdue University
[3]South African National Biodiversity Institute (SANBI)

Abstract:

Cycads are one of the most threatened groups of organisms globally. South Africa is a hotspot of cycad diversity, with 38 species and 76% endemism; yet four of these species are already Extinct in the Wild, and eleven are Critically Endangered. The primary driver of South African cycads' population declines is rampant illegal harvesting for the private horticultural trade. All South African cycad species are protected under CITES Appendix I. Locally, the harvesting, trade, or receipt of wild-origin cycads is strictly prohibited, but there is a legal horticultural trade, so proving the wild origin of seized specimens to the satisfaction of the court of law remains a critical problem. This research addresses this forensic gap by developing a high-resolution bioavailable strontium isoscape for South African cycads, leveraging the high spatial and low temporal variability of $^{87}Sr/^{86}Sr$. To account for spatial autocorrelation and non-linear relationships, we implement Random Forest Spatial Interpolation (RFSI) using process-based model output and environmental covariates. Crucially, the model is validated for 18 species using an unprecedented dataset of over 200 samples from wild cycads collected under strict chain of custody. These forensic-grade samples ensure that the resulting isoscape is statistically robust and legally defensible for use as evidence in court. We employ Quantile Regression Forest (QRF) to calculate a spatially-explicit pseudo standard deviation uncertainty map. This enables geographic assignment via a Bayesian continuous approach. This project bridges isotope geochemistry and geospatial data science to provide a vital defence for an ancient lineage of plants.

Keywords: *bioavailable strontium, $^{87}Sr/^{86}Sr$, isoscape, machine learning, provenance, wildlife forensics, cycads, South Africa*

Return to Table of Contents

Abstract 113 - Lüdecke

Refining $\delta^{15}N$-Based Trophic Interpretations: Insights from Early Homo Tooth Enamel

Tina Lüdecke[1], Alfredo Martínez-García[1], Amy L. Rector[2], Kaye E. Reed[3]

[1]*Max Planck Institute for Chemistry*
[2]*Virginia Commonwealth University*
[3]*Arizona State University*

Abstract:

We present paired carbonate carbon ($\delta^{13}C$) and mineral-bound nitrogen ($\delta^{15}N$) isotope data from tooth enamel of early *Homo* specimens (Ledi-Geraru, Ethiopia; ca. 2.6–2.8 Ma) to evaluate trophic positioning in the earliest members of our own genus and assess $\delta^{15}N$ as a dietary proxy in deep-time terrestrial ecosystems. While $\delta^{15}N$ enrichment is typically associated with increasing trophic level, the analyzed hominin dataset (n = 6) exhibits unexpectedly low $\delta^{15}N$ values. Five individuals display depleted $\delta^{13}C$ and $\delta^{15}N$ signatures, defining a discrete isotopic niche that does not overlap with an extensive coeval faunal baseline (n = 142), including grazers, mixed feeders, terrestrial and aquatic carnivores, and non-hominin primates.

To contextualize these values, we compare the fossil data to isotopic patterns observed in modern primates from the Issa Valley (Tanzania). There, chimpanzees exhibit similarly low $\delta^{13}C$ and $\delta^{15}N$ values despite occasional vertebrate consumption. This pattern is most plausibly linked to termite consumption (*Macrotermes* spp.), which are depleted in both $\delta^{13}C$ and $\delta^{15}N$ and can strongly influence consumer tissue values when contributing substantially to dietary protein.

These results highlight a decoupling between trophic level and $\delta^{15}N$ enrichment in systems where isotopically distinct resources play an important dietary role. The Ledi-Geraru data suggest that low $\delta^{15}N$ values in enamel in these early members of the human lineage may reflect incorporation of such resources rather than exclusively indicating low trophic position. More broadly, this study underscores the importance of dietary composition and environmental baselines when applying $\delta^{15}N$ as a trophic proxy in paleoecological reconstructions.

Keywords: *Early hominins, Insect consumption, Mineral-bound nitrogen*

Return to Table of Contents

Abstract 121 - Rothschild

Studying the Diet of Deep Reef Fishes Through Bulk Stable Isotope Analysis

Isaiah Rothschild[1], Luke Tornabene, Rachel Welicky, Megan Ewing

[1]*University of Washington - Seattle*

Abstract:

Deep tropical reef fishes are a poorly studied community due to their depths exceeding recreational SCUBA limits (40-300+ m). This has severely limited the knowledge on trophic relationships among deep reef fishes, and most of what we "know" about their diets is simply inferred from their shallow water relatives. However, deep reefs are ecologically distinct from shallow reefs with unique biotic and abiotic conditions that result in food webs that differ from those on shallow reefs. Nevertheless, trophic data for nearly all deep-reef fishes is non-existent. This study seeks to examine the ratios of $\delta^{15}N$ and $\delta^{13}C$ in six common deep reef fishes and to map trophic relationships for the ecosystem. $\delta^{15}N$ acts as a proxy for trophic position while $\delta^{13}C$ tracks carbon sources and trophic plasticity. We used the submersible Curasub to collect specimens from six abundant species that occur on deep reef slopes in Curacao: *Pronotogrammus martinicensis* (Serranidae), *Chrionema squamentum* (Bembropidae), *Symphysanodon beryi* (Symphysanodontidae), *Epigonus* occidentalis (Epigonidae), *Epigonus hexacanthus* (Epigonidae) and *Decodon puellaris* (Labridae). Data from deep reef species will be compared to six abundant shallow water reef fishes from the same area: *Stegastes diencaeus* (Pomacentridae), *Chaetodon capistratus* (Chaetodontidae), *Scarus iseri* (Labridae), *Myripristis jacobus* (Holocentridae), *Haemulon flavolineatum* (Hemulidae), and *Acanthurus tractus* (Acanthuridae). Muscle and heart samples were taken to have a broader timespan of measurements as these tissues have distinct cell turnover rates. These values will be compared with samples from invertebrates and primary producers to begin to build a scaffold for food webs on Caribbean deep reefs.

Keywords: *Deep Coral Reefs, Caribbean, Fish*

Abstract 122 - Slesser

The diet, trophic position and habitat use of humpback whales in the Southwestern Atlantic Ocean

Henry Slesser[1], Tamsin O'Connell[2], Gabriele Stowasser[1],Jennifer Jackson[1], Amy Kennedy[3], Caroline Weir[4], Emma Carroll[5], Joanna Kershaw[5], C. Scott Baker[6], Bassoi[7] ,Stephanie Martin[1], Sabena Blackbird[8]

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[4]*Falklands Conservation*
[5]*University of Auckland*
[6]*Oregon State University*
[7]*Universidade Federal do Rio Grande do Norte*
[8]*University of Liverpool*

Abstract:

Humpback whales (*Megaptera novaeangliae*) feeding in the Southwestern Atlantic are understood to be heavily reliant on Antarctic Krill (*Euphausia superba*), however the extent of individual variation in diet and foraging location is poorly resolved.

We investigated the foraging ecology of humpback whales using biopsy samples taken at South Georgia (n=36), the Falkland Islands (n=10) and the South Orkney Islands (n=1) between 2010 and 2024, through an integration of stable isotope analysis and fatty acid analysis. Isotope-based geolocation grouped individuals into three main foraging regions: the waters around South Georgia, the Subantarctic Front, and the Patagonian Shelf. Stable isotope-based trophic position estimates placed the majority of whales (~98%) as secondary consumers. Fatty acid analysis and stable isotope mixing models indicated that, while a substantial cohort (~90%) of whales primarily consumed Antarctic Krill, several individuals exhibited dietary signals consistent with foraging on alternative prey taxa, including other crustacean prey such as the squat lobster (*Munida gregaria*).

Our findings demonstrate that whilst krill is of key importance to humpback whales in this region, there is heterogeneity in foraging strategies among individuals, highlighting the behavioural plasticity of this species and the importance of considering individual-level ecological variation when evaluating predator-prey dynamics. With the Southwest Atlantic and Southern Ocean ecosystems facing increasing pressure from climate-driven changes in prey distribution and expanding krill fisheries, such insights are critical for ecosystem-based management. This study contributes valuable information to ongoing assessments of Southern Ocean ecosystem health and connectivity in a rapidly changing climate.

Keywords: *foraging ecology, tropic position, geolocation, isoscapes, cetaceans*

Return to Table of Contents

Abstract 124 - Reis de Carvalho

Stable isotopes as a tool to assess anthropogenic impacts on aquatic food webs in tropical ecosystems

Débora Reis de Carvalho[1], Paulo Santos Pompeu[2], Carlos B. M. Alves[3], Vinícius Urbano[2], Pedro H. S. Basílio[2], Patrícia Fráguas[2], Aline J. Grossi[2], Cecília Leal[4]

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[2]*Federal University of Lavras*
[3]*Federal University of Minas Gerais*
[4]*Lancaster University*

Abstract:

Tropical freshwater ecosystems are under intense anthropogenic pressure that can significantly alter carbon and nitrogen fluxes. We employed stable carbon and nitrogen isotopes analyses to assess how aquatic food webs respond to diverse human impacts, including domestic and industrial sewage pollution, mining dam failures, land-use changes, non-native species introductions, and methane production. Our projects encompass more than 20,000 isotopic samples collected from streams, rivers, lakes, and reservoirs across diverse Brazilian biomes and watersheds. Key findings include: (1) detection of domestic sewage as a direct food source for fish in a highly degraded watershed; (2) extremely enriched $\delta^{15}N$ values (up to 35‰) in primary producers and fish in response to elevated water nitrogen concentrations; (3) uncertainty in trophic position and niche estimates in severely degraded ecosystems; (4) marked influence of land use on trophic structure and carbon sources sustaining aquatic communities; and (5) invertebrates and fish contribution to methane-derived carbon assimilation through direct or indirect consumption of methanotrophic bacteria. Our results underscore the power of stable isotopes in providing novel evidence of anthropogenic impacts on tropical freshwater ecosystems and on the effectiveness of restoration actions. Stable isotopes have also shown promise in environmental biomonitoring, as shifts in the trophic structure of aquatic communities tracked changes in environmental quality with great sensitivity. We further demonstrate that complementary approaches, such as stomach content analysis, heavy metal concentrations, and fatty acid profiles, can enhance this understanding and substantially increase the informative potential of isotopic data.

Keywords: *Carbon, Nitrogen, Fish, Trophic diversity, Pollution, Amazon, Savanna, Brazil*

Return to Table of Contents

Abstract 125 - Zubarev

Is it time to retire Δ?

Roman Zubarev[1]

[1]*Karolinska Institutet*

Abstract:

The paradigm postulating that tissue stable isotopic ratios (δtissue) equal those of the diet (δdiet) plus a small, quasi-constant isotope discrimination factor Δ emerged in the late 1970s, establishing stable isotope analysis as a dietary proxy. Today, this framework is still widely used across multiple branches of science, despite growing contradicting evidence. Here, we reanalysed dozens of well-controlled laboratory experiments and found that Δ not only varies strongly with δdiet, but also changes sign at a certain δeq = δdiet = δtissue value, which we term the Δ-equilibrium. The Δ-equilibrium phenomenon results from the not-unity slope of the linear regression between δdiet and δtissue and leads to converging of δtissue values. The most frequently observed slope is below unity and the Δ-equilibrium position on the ($\delta^{13}C$, $\delta^{15}N$) plane is (-21±1‰, 12±1‰). These findings firmly establish that stable isotopes are not neutral spectators but active participants in biochemical processes. If presented evidence holds in a much broader study, the paradigm δtissue = δfood + Δ can finally be retired after half a century of service, being replaced by δtissue = a⩤ δfood + Const, where a is the newly defined isotope assimilation factor. The Δ-equilibrium position is then found as δeq = Const/(1 - a). The reason for isotope convergence remains a subject for future research, but likely hypotheses include evolutionary adaptation and isotopic resonance.

Keywords: *isotope discrimination factor*

Return to Table of Contents

Abstract 126 - Veselý

"Hey Bro, Don't Bite Me": Wastewater Promotes Cannibalism in Brown Trout population

Lukáš Veselý[1], Fabio Ercoli[2,3], Timo Ruokonen[4], Jan Turek[5], Vladimír Žlábek[5], Miloš Buřič[5], Tomáš Randák[5], Martin Bláha[5]

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Abstract:

Municipal and industrial wastewater (WW) represent an important source of pollution in aquatic ecosystems. Increasing evidence indicates that WW, even when treated in wastewater treatment plants, can create unfavorable conditions in receiving waters. The impact of WW is often associated with the loading of inorganic nutrients as well as hormones and psychoactive compounds. These substances can alter the structure and functioning of food webs and influence consumer behavior and trophic interactions. However, empirical evidence describing how wastewater inputs affect trophic structure in natural stream ecosystems remains limited. We investigated the effect of wastewater treatment (WWT) on food source preferences of brown trout in a small stream (Živný Stream) using stable isotope analysis of carbon and nitrogen. Brown trout and their putative food sources were sampled at four sites along the stream separated by 2.5 km. Two sites were located upstream of the WWT effluent and served as controls. A third site was located 50 m downstream of the effluent, while a fourth site was located further downstream to assess longitudinal effects of WWT. At the two control sites, brown trout fed mainly on riparian insects (51–52 %; median), followed by macrozoobenthos (17 %) and conspecifics (25–26 %). At sites influenced by WWT, cannibalism increased markedly and reached 55–59 % of the utilized food sources. These results demonstrate that wastewater inputs can substantially alter predator feeding behavior. The strong increase in cannibalism suggests that even treated wastewater can restructure trophic interactions and potentially destabilize aquatic food webs.

Keywords: *Pollution, food web; food source changes*

Return to Table of Contents

Abstract 127 - Marguin

Compound-specific $\delta^{13}C$ and $\delta^{15}N$ analyses of amino acids in modern and archaeological samples of marine fishes and bivalves reveal long-term trophic changes in a coastal lagoon

Audrey Marguin[1], F. Rossi[1], L. Açaf[2], A. Vignier[3], M.D. McCarthy[4], T. Theodoropoulou[3]

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[3]*CNRS, Cultures, Environnements, Préhistoire, Antiquité, Moyen Âge (CEPAM, UMR 7264), Nice, France*
[4]*University of California Santa Cruz, Department of Ocean Science, Santa Cruz, USA*

Abstract:

Mediterranean coastal lagoons have been inhabited and exploited since prehistoric times and have undergone substantial ecological change, largely driven by human pressures. As such, they provide a unique setting for investigating the long-term links between human activities and ecosystem functioning.

In this study, we reconstruct the trophic ecology of coastal fishes and bivalves from a Western Mediterranean coastal lagoon (Berre, France) from the Mid-Holocene to the present, spanning 9,000 years. We applied $\delta^{15}N$ and $\delta^{13}C$ compound-specific stable isotope analysis of amino acids to fish bone collagen and shell organic matrix. We focused on three historically exploited fish species (*Dicentrarchus labrax*, *Sparus aurata*, *Sarpa salpa*) and one bivalve clam (*Ruditapes decussatus*). These species have been fished by humans since the Mesolithic, and archaeological remains were recovered from sites around the lagoon and compared with modern specimens.

Comparison of amino acid patterns indicates that original isotopic ecological information is well preserved for an extended time period, highlighting their potential as long-term bioarchives. Preliminary analyses reveal early shifts in carbon sources supporting the food web, likely linked to the development of human settlement around the lagoon. In contrast, nitrogen sources show a more recent shift consistent with increasing anthropogenic inputs. These changes are associated with significant variations in trophic levels, reflecting long-term alterations in food-web structure and ecosystem functioning. Together, these results reveal progressive changes in food webs in response to human settlement and exploitation over time, and highlight the potential of multi-proxy isotopic approaches to resolve past anthropogenic impacts in coastal ecosystems.

Keywords: *Historical Ecology, Coastal Lagoons, Trophic Ecology, CSIA-AA, Anthropogenic Impacts*

Return to Table of Contents

Abstract 132 - Bataille

Multi-Proxy Annual Profiles in Narwhal Tusks Reveal Biogeochemical Baseline Restructuring Under Rapid Arctic Change

Clement Bataille[1], Shanie Brault-Nikolajew[2], Justine M. Hudson[3], Cortney A. Watt[3,4], Peter Crockford[5], Danielle Fraser[5,6,7], Petrus Le Roux[8], Matthew Wooller[10,11]

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[10]Alaska Stable Isotope Facility, University of Alaska Fairbanks, Fairbanks, Alaska, USA
[11]College of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Fairbanks, Alaska, USA

Abstract:

The rapidly changing environment in the Arctic is affecting the ecology of marine mammalswith shifts in sea ice dynamics modulating their diet, movements and contaminant exposure. However, similar geochemical responses may arise through changes in environmental baselines. Disentangling these competing geochemical influences is essential for both understanding past mammal behavior through various archives and for future conservation. Here, multi proxy geochemical profiles were measured along 25 annual growth layers in tusks from three narwhals; two from Baffin Bay spanning 1997-2020 and 1946-79 and one individual from northern Hudson Bay spanning 1998-2021. Stable isotopes in collagen and carbonate, lead isotope ratios, and trace element ratios were integrated with regional time series data of sea ice extent, ocean conditions, and climate models. We find a pronounced decline in $\delta^{15}N$ values in the modern Baffin Bay individual around the year 2005, a pattern absent in the historic Baffin Bay tusk and the northern Hudson Bay tusk. The $\delta^{18}O$ profile of the modern Baffin Bay individual indicates no major change in movement or timing, however, the Ba:Ca, Sr:Ca, carbonate-collagen spacing, and Hg:Ca reflect expected ontogenetic dietary transitions and bioaccumulation typical of maturing individuals. A compilation of $\delta^{15}N$ values from historical and modern narwhals and belugas spanning 1960-2015 in Baffin Bay shows a similar population-level decline in $\delta^{15}N$ values starting around 2005. Because neither distribution nor diet can explain this pronounced decline in $\delta^{15}N$ values, the decline most likely reflects an ecosystem scale baseline shift linked to sea ice loss and associated reorganization of nitrogen cycle.

Keywords: *Climate change, marine mammals, isotopes, tusk, baseline, nitrogen, conservation*

Return to Table of Contents

Abstract 135 - Swarth

Trophic shift or environmental tracking: Using stable isotopes to examine a century of change in the resident birds of the San Jacinto Mountains, California

Christopher W Swarth[1], Lori Hargrove[1], Marilyn Fogel[1], Philip Unitt[1]

[1]*San Diego Natural History Museum*

Abstract:

Stable isotopes in biological tissues can be reliable indicators of ecosystem changes over time. We compared the stable isotopes of C and N in feathers from 118-year-old museum specimens of birds (n = 181) collected in 1908 in the San Jacinto Mountains, California, to those in feathers from birds (n = 421) captured in these mountains from 2008 to 2014, testing whether isotopic signatures reveal environmental tracking or ecological (trophic) changes in 18 resident bird species over the past century. Historic and modern plant specimens and modern insects were also analyzed. We used linear mixed-effects models to control for sampling effects and to assess the relative influence of time period, elevation, latitude, longitude, recent precipitation relative to average, and diet category on N and C isotopes. Over the century, across all species of both birds and plants, $\delta^{15}N$ was considerably depleted and $\delta^{13}C$ was slightly depleted. In the birds only, however, the depletion of $\delta^{15}N$ was disproportionately greater at higher elevations and especially so for secondary consumers. The effect of recent precipitation was strongly positive on $\delta^{15}N$ for birds but negative for plants and insects, suggesting precipitation, which tends to increase insect abundance, causes an upward trophic shift in birds. The drier climate since 1908 is a likely explanation for the strong long-term decrease in $\delta^{15}N$ in birds, by depressing insect abundance and so causing birds' diets to shift to lower trophic levels, the effect being greatest for insectivores and omnivores at higher elevations.

Keywords: *functional ecology, trophic levels, songbirds, ecosystem change, southern California*

Return to Table of Contents

Abstract 136 - Liew

Do amino-acid-specific $\delta^{13}C$ data improve spatial inference beyond bulk isotope data?

Jia Huan Liew[1], YIP Hon Tim[2], Anthony LAU[2]

[1]*University of Tasmania*
[2]*Lingnan University*

Abstract:

Spatial assignment in streams depends on whether isotope data can resolve position along a short longitudinal gradient. We tested this problem in two streams on Lantau Island, Hong Kong, by comparing bulk $\delta^{13}C$ with amino-acid-specific $\delta^{13}C$ from basal carbon sources. We analysed each stream as an estuary-to-headwater path and asked whether either approach could distinguish fine-scale spatial structure along that path. We sampled both streams at approximately 30 m intervals from downstream brackish sections to upstream freshwater reaches. At each point, we collected periphyton as an autochthonous carbon source and leaf litter as an allochthonous source, and in one of the streams, we also sampled fresh leaves to test whether they could substitute for deposited litter. We measured bulk $\delta^{13}C$ and focused on the $\delta^{13}C$ of four essential amino acids: valine, leucine, isoleucine and phenylalanine.

Periphyton provided the clearest spatial signal, separating brackish and freshwater sections in both streams. However, within freshwater reaches, neither bulk nor amino-acid-specific $\delta^{13}C$ consistently resolved a progressive longitudinal gradient. Leaf litter showed weaker and more stream-specific structure. Specifically, we found a slight directional pattern in one stream, while another fluctuated along the stream path. Amino-acid-specific data reduced some local variability but did not consistently improve spatial resolution relative to bulk $\delta^{13}C$. Fresh leaves also differed from leaf litter, indicating that standing riparian vegetation may not reliably represent deposited organic matter. These results show that amino-acid-specific isotope analysis adds information, but fine-scale longitudinal resolution remains constrained by heterogeneity.

Keywords: *compound-specific isotope analysis; spatial assignment; carbon baselines; basal resources; freshwater ecology*

Return to Table of Contents

Abstract 137 - Stewart

Rewilding rivers in Aotearoa: a diet-based conservation approach to longfin eel conservation

Simon Stewart[1], Jess Lueders-Dumont[2], Robin Holmes[1], Andrew Watson[3]

[1]*Cawthron Institute, Nelson Zew Zealand*
[2]*Boston College, MA, USA*
[3]*Earth Science NZ, Christchurch, New Zealand*

Abstract:

New Zealand's longfin eels (*Anguilla dieffenbachii*) are endangered, and conservation action is needed. One aspect of their biology that has traditionally been considered a major limitation to their population recovery, slow growth rate, could in fact present an opportunity for innovative new conservation strategies – enhancing their grow rates through improving high quality food supply. Here we present evidence showing that, when the diadromous fish īnanga (*Galaxias maculatus*) are abundant, they are an important food source for longfin eels and boost production. We use a range of stable isotope proxies to show that, through trophic interactions, īnanga are able to propagate trophic resources from lowland wetlands throughout the catchment to the benefit of apex predators, longfin eels. This is showing by quantifying the landscape-scale benefit of intact wetlands, the implication of historic wetland loss and, finally, the benefit o contemporary wetland restoration.

Taken together, the findings from this work show accounting for food web interactions can enable precision restoration of which the benefits are propagated across the landscape. Moreover, stable isotope ecology provides a promising framework through which to quantify landscape-scale trophic connections and inform food web -based restoration approaches.

Keywords: *Trophic subsidies; diadromous fishes; freshwater; conservation; restoration*

Return to Table of Contents

Abstract 141 - Brennan

Hydrogen Stable Isotope Proxies Reveal Divergent Symbiodiniaceae Metabolic Strategies under Thermal Stress

Joseph Brennan[1], David M. Baker[2], Emily Chei[1]

[1]*Lingnan University*
[2]*The University of Hong Kong*

Abstract:

Scleractinian corals often rely on nutritional symbioses with Symbiodiniaceae for a majority of their daily energy budget. Though advantageous in oligotrophic environments, this reliance also represents a risk as the thermal tolerance of the algal symbiont can impact coral survival under thermal stress. Photo-physiological metrics defining symbiont thermal tolerance often capture downstream photochemical collapse, obscuring metabolic strategies deployed prior to physiological breakdown. To uncover metabolic defense mechanisms defining thermal tolerance, we developed a novel diagnostic framework tracking water-derived hydrogen cellular fluxes. Acute photoinhibition trials on a symbiont isolate revealed a paradoxical bulk isotopic stress response: depletion of δ^2H baselines paired with a spike in active tracer assimilation. Amino acid compound-specific isotope analysis (CSIA-AA) resolved this, demonstrating that stress suppressed AA synthesis, indicating that the tracer flux bypassed proteins into alternative macromolecular sinks, while fractionating emergency pathways drove baseline depletion. Applying the bulk proxy across a gradual thermal change for a multi-species assemblage revealed that conserved photochemical failure thresholds (ED50) can mask metabolic decoupling into distinct functional phenotypes. Species with lower thermal optima exhibited a tracer assimilation spike preceding photosystem collapse to actively fight stress. Conversely, species with high thermal optima passively conserved energy by shutting down biosynthesis. These findings establish hydrogen stable isotopes as a multi-dimensional proxy for stress response and display that identical expressions of thermal stress can hide differing survival strategies. Through cellular level examination, we distinguish helpful symbionts from those entering parasitic dormancy, revealing the underlying metabolic mechanisms that dictate coral survival in a warming ocean.

Keywords: *Coral Symbiosis, Climate Change, Ecophysiology, Hydrogen, Compound-Specific Isotope Analysis, Amino Acids*

Return to Table of Contents

Abstract 145 - Sparks

Isotopic evidence for a revised understanding of global terrestrial nitrogen: do nitrogen isotope ratios through time suggest oligotrophy?

Jed Sparks[1], Hannah M. Monti[1], Ben T. Uveges[1]

[1]*Cornell University*

Abstract:

The effect of concurrent increases in the concentration of atmospheric CO_2 and magnitude of reactive nitrogen inputs on terrestrial nitrogen availability is currently unknown. Recently, decreasing $\delta^{15}N$ values observed across multiple records have been interpreted as evidence of closed nitrogen cycling driven by reduced nitrogen availability. However, patterns in terrestrial $\delta^{15}N$ are shaped by changes in both cycling and source. Here, we present $\delta^{15}N$ values derived from epiphytic lichens which provide the most direct biological proxy for the isotopic composition of atmospheric nitrogen deposition. Lichen $\delta^{15}N$ values have decreased by >6‰ over the past 130 years which, when coupled with a terrestrial nitrogen cycle model, indicates that signals of oligotrophy could be partially to fully explained by shifting of the isotopic composition of nitrogen sources.

Keywords: *Nitrogen Isotope, Oligotrophy, Global Nitrogen Cycling*

Return to Table of Contents

Abstract 146 - Sparks

Tracing source and mobility of phosphorus using uranium isotopes

Jed Sparks[1], Ben T. Uveges[1]

[1]*Cornell University*

Abstract:

Phosphorus (P) is monoisotopic, precluding the use of stable isotope ratios to trace sources and cycling processes as is commonly done with other major nutrient elements. Uranium (U) can serve as an analog for P in environments where their mobility is similar and has several isotopes that are long-lived relative to human timescales. For example, in agricultural systems elevated concentrations of U coupled with distinctive fertilizer-like U activity ratios, ($^{234}U/^{238}U$), can be used to trace the influence and mobility of P derived from past fertilizer applications both within a catchment, as well as through a soil profile. Here we present U isotope measurements of subtropical pastureland from Archbold Biological Station's Buck Island Ranch. We investigate the spatial distribution of fertilizer derived U, and by extension P, in surface soils, as well as across soil depth.

Keywords: *Phosphorus, Uranium, isotope*

Return to Table of Contents

Lightning Talks

Return to Table of Contents

Abstract 006 - Fox-Dobbs

Monitoring how the removal of non-native trout from alpine lakes in Mount Rainier National Park impacts ecological interactions among aquatic organisms

Kena Fox-Dobbs[1], Rebecca Lofgren[2], Sophia Haynes[1], Naomi Wurtzel[1]

[1]*University of Puget Sound*
[2]*Mount Rainier National Park*

Abstract:

Over the past century, geohistorically fishless alpine lakes within Mount Rainier National Park (MRNP) in Washington State, USA were stocked with non-native trout species for recreational fishing. While fish have been completely removed from some lakes, others are still undergoing the removal process for ecosystem restoration. Over three summers (2024-2026) we collected samples for bulk organic $\delta^{13}C$ and $\delta^{15}N$ analyses to investigate trophic structure and microhabitat use of organisms in MRNP lakes that are monitored annually. Specifically, we sampled periphyton, algae, macrophytes, benthic macroinvertebrates, amphibians, and fish to estimate food web interactions in four alpine lakes. By comparing these data across lakes in various stages of fish removal, we have gained insight into how these aquatic food webs are responding to the removal of non-native predators (trout). Our isotopic study contributes an ecological perspective that complements extensive observational data collected from aquatic organisms in these alpine lakes. For example, previous research in MRNP has shown that salamanders, which are native top predators, have changes in behavior and abundance in lakes that have undergone fish removal. Initial isotopic estimates of trophic position and food web interactions suggest that many consumers, including amphibians, may not have experienced a substantial ecological response yet to fish removal. Since "complete" fish removal has only occurred relatively recently in a few monitored lakes at MRNP, there may be a lag time for potential re-sorting of food web interactions in these seasonally productive lakes, and long term sampling will resolve ecological responses.

Keywords: *restoration, amphibians, trophic position*

Abstract 009 - Di Ganci

Trophic niche dynamics of the blue crab *Callinectes sapidus* Rathbun, 1896 across native and invaded areas: insights from carbon, nitrogen and sulphur stable isotopes

Roberta Di Ganci[1], Cristina Andolina[1,2,3], Giovanna Cilluffo[4], Roberta Bardelli[1], Matthew Ogburn[5], Leandro Bergamino[6], Giorgio Mancinelli[8], Salvatrice Vizzini[4,1,2,3]

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[3]*National Biodiversity Future Center (NBFC)*
[4]*Department of Earth and Marine Centro di Sostenibilità e Transizione Ecologica (CSTE), Università degli Studi di Palermo, Italy*
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Abstract:

Stable isotope analysis is a powerful tool to investigate trophic mechanisms underlying biological invasions. This approach is particularly relevant for invasive species, whose ecological impact and invasion success are often closely linked to their trophic ecology, as for the blue crab *Callinectes sapidus*. Native to the western Atlantic, this species has rapidly expanded in the Mediterranean Sea over recent decades, raising ecological and socio-economic concerns due to its predatory pressure and high adaptability. This study compares the isotopic niche ($\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$) of *C. sapidus* used as a proxy for the trophic niche between native (three sites along the western Atlantic coast) and invaded areas (two sites in the Mediterranean Sea) to assess whether its invasion success reflects niche conservatism or expansion. The blue crab showed a significantly broader isotopic niche in invaded areas, as indicated by Bayesian standard ellipse area, with Layman's metrics also showing higher values, supporting niche expansion. Furthermore, the isotopic niche of C. sapidus was compared with that of *Carcinus* spp., including *C. maenas* (invasive within the native area of the blue crab) and *C. aestuarii* (native to the Mediterranean), to evaluate potential trophic overlap and competition. *C. sapidus* occupied a broader niche than *Carcinus* spp., reflecting a higher degree of trophic generalism. Overall, stable isotopes reveal an expansion and greater dispersion of the blue crab's isotopic niche in invaded areas. The wide trophic niche is likely involved in its establishment and persistence, with potential consequences for the restructuring of food webs in recipient ecosystems.

Keywords: *Invasive species; Isotopic niche; Trophic position; coastal lagoon*

Return to Table of Contents

Abstract 012 - Scholten

Linking coral trophic plasticity to reef restoration outcomes

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Abstract:

In response to ongoing climate change, coral restoration is expanding rapidly. Yet, its success depends on whether transplanted colonies can acclimatize to the new environmental conditions, which are often already degraded or polluted reef environments. Corals are mixotrophic organisms that derive energy and nutrients through both autotrophic and heterotrophic pathways, and trophic plasticity refers to their ability to adjust this balance in response to changing environmental conditions, yet the extent to which coral species do so remains poorly understood. Here, we measured tissue stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) to investigate trophic niches and assess trophic plasticity in 13 coral species from two distinct reef environments in Puerto Galera, Philippines, before and after translocation to a nearby degraded reef site. We compare coral species from a clear-water and a turbid reef site, and examine isotopic differences in outplanted colonies after a six month translocation to the new degraded reef environment. We hypothesize that non-acclimatized corals originating from turbid environments will exhibit greater performance and survival following transplantation on a degraded reef than conspecifics from clear-water sites, due to prior adaptation to low-light, high-particulate conditions and reduced reliance on heterotrophic feeding under improved light availability. By linking isotopic signatures to habitat context, this study will strengthen understanding of species-specific acclimatization and trophic plasticity in Southeast Asian corals, improving the effectiveness and long-term resilience of coral reef restoration efforts.

Keywords: *Turbid Reefs, Coral Triangle, Coral Restoration*

Return to Table of Contents

Abstract 016 - Kayfetz-Vuong

Calibrating the SIBER mixotrophy spectrum: quantifying nutrient inputs in three corals with different trophic strategies using stable isotope tracing

Novia Kayfetz-Vuong[1], Emily Chei[1], Inga E. Conti-Jerpe[1]

[1]*Lingnan University*

Abstract:

Reef-building corals form a mutualism with endosymbiotic Symbiodiniaceae algae, enabling mixotrophy via the host heterotrophic feeding and the symbiont autotrophic photosynthesis. Stable isotope analysis and SIBER of the paired host-symbiont tissue reveal that coral species span a trophic strategy gradient from predominantly heterotrophic (minimal host-symbiont isotopic niche overlap) to predominantly autotrophic (high host-symbiont niche overlap). Despite the proliferation of trophic strategy data for coral species worldwide using SIBER techniques, the specific mechanism underlying the observed patterns remains unclear. For example, it is unclear whether high overlap between host and symbiont niches results from increased photosynthesis, reduced heterotrophy, or enhanced nutrient recycling within the holobiont.

We linked physiological measurements to the SIBER mixotrophic spectrum by quantifying photosynthesis, respiration, feeding, and host-symbiont nutrient cycling in three coral species ranging from heterotrophic to autotrophic: *Platygyra carnosa*, *Pavona decussata*, and *Acropora samoensis*. Photosynthesis and feeding were quantified relative to the host's overall respiration, expressed as the percentage of C or ^{13}C each contributed. Host-symbiont nutrient cycling was assessed using stable isotope-labeled heterotrophic sources (^{13}C- and ^{15}N-Artemia) and autotrophic sources (^{13}C-bicarbonate and ^{15}N-nitrate).

We hypothesize that variation in isotopic niche overlap reflects trophic diversification along the mixotrophy spectrum: strongly heterotrophic corals rely more on feeding, while strongly autotrophic corals depend more on their symbionts for photosynthesis. Preliminary data confirm that *A. samoensis* has the highest photosynthesis-to-respiration ratio, linking autotrophic capacity to trophic strategy. These findings reveal physiological drivers of the coral mixotrophy spectrum and refine stable isotope analysis for assessing trophic ecology.

Keywords: *stable isotope tracer, SIBER, coral mixotrophy, trophic ecology, trophic strategy, coral ecology, isotopic niche overlap*

Return to Table of Contents

Abstract 020 - Açaf

Integrating Stomach Content and Stable Isotope Analyses to Resolve Trophic Relationships in Coastal Fish of the Eastern Mediterranean

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Abstract:

Trophic ecology studies off the Lebanese coast (Eastern Mediterranean) remain scarce and are mostly limited to dietary descriptions of small pelagic species. Existing research has focused on stock assessment rather than ecological interactions. This study is the first to assess trophic relationships among selected coastal fish species by combining traditional stomach content analysis with stable isotope techniques to better resolve trophic positions and feeding relationships. Five specimens from each species (*Sardinella aurita, Diplodus sargus, Pagellus acarne, Siganus rivulatus,* and *Coris labrus*) were collected off Sidon, south Lebanon. Stomach contents were examined under a stereomicroscope and classified into: zooplankton, phytoplankton, macroalgaeand detritus. This approach allowed the identification of broad trophic strategies. However, stomach content analysis provides a short-term snapshot of feeding activity and may be biased by differential digestion rates or empty stomachs. To overcome limitations, we complemented this method with stable isotope analysis of muscle and fish bone collagen. Samples were analyzed for $\delta^{13}C$ and $\delta^{15}N$ using EA-IRMS. In addition, collagen was analyzed using amino acid compound-specific isotope analysis (AA-CSIA) for $\delta^{13}C$ to better resolve dietary sources and trophic pathways.Stomach content analysis revealed distinct trophic roles among species, ranging from planktivory (*Sardinella aurita*), to benthic omnivory and carnivory (*Pagellus acarne, Diplodus sargus,* and *Coris labrus*), and herbivory/detritivory (*Siganus rivulatus*), indicating a structured trophic gradient within the assemblage. Stable isotope analyses are currently underway and are expected to corroborate these findings while providing additional insights into species with limited stomach content data and improving understanding of trophic structure and dietary sources.

Keywords: *Eastern Medieterranean, Trophic Ecology, Fish diet, AA-CSIA, Stomach content analysis*

Return to Table of Contents

Abstract 024 - Pernicova

Advancing tree physiological interpretation using combined carbon isotope-based intrinsic and evaporative water-use efficiency metrics

Natalie Pernicova[1], Otmar Urban[1], Tomas Kolar[1,2], Michal Rybnicek[1,2], Mirek Trnka[1,3]

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Abstract:

Stable isotope ratios offer powerful insights into past environmental conditions by preserving plant physiological responses in their tissues. In trees, stable isotope analysis of annual rings enables evaluation of long-term responses to environmental variability at high temporal resolution. The carbon isotope ratio ($\delta^{13}C$) in tree-ring cellulose reflects the balance between carbon assimilation and stomatal conductance, making it a well-established proxy for intrinsic water-use efficiency (iWUE). Although iWUE is highly responsive to drought through stomatal regulation, it does not account for absolute water loss via transpiration and therefore provides only a partial view of plant water-use strategies under climate stress.

Evaporative water-use efficiency (eWUE), defined as the ratio of CO_2 assimilation to transpiration, explicitly incorporates atmospheric evaporative demand and is highly sensitive to rising vapor pressure deficit (VPD). As global VPD increases due to climate warming, metrics integrating carbon and water fluxes are essential for assessing tree resilience. Our research along an altitudinal gradient in Central Europe shows that while iWUE has increased over the past 60 years, particularly at lower altitudes, eWUE has remained stable or declined at higher altitudes, where 22% increase in VPD has offset the physiological benefits of elevated CO_2.

Combined assessment of iWUE and eWUE provides more comprehensive understanding of tree physiological performance, enabling more accurate interpretations of isotope records and improved predictions of forest responses to future environmental change.

We acknowledge support from AdAgriF - Advanced methods of greenhouse gases emission reduction and sequestration in agriculture and forest landscape for climate change mitigation (CZ.02.01.01/00/22_008/0004635).

Keywords: *stable isotopes, $\delta^{13}C$, tree rings, forest physiology, water-use efficiency, vapor pressure deficit, climate change*

Return to Table of Contents

Abstract 029 - Xia

Nitrogen form reorganizes intramolecular ^{13}C partitioning and shapes plant respiratory $\delta^{13}CO_2$

Yang Xia[1], Jaleh Ghashghaie[2], Guillaume Tcherkez[3], Xin Song[1]

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[2]*Université Paris-Saclay*
[3]*Université d'Angers*

Abstract:

Nitrogen form may leave a distinct imprint on terrestrial carbon-isotope fluxes by reorganizing carbon routing within plant respiration. Yet the metabolic origin of plant-respired $\delta^{13}CO_2$ remains difficult to resolve because key isotope effects may be hidden at the intramolecular level. Here, we combined $H^{13}CO_3^-$ pulse labeling, quantitative ^{13}C-NMR, and multivariate statistics to trace phosphoenolpyruvate carboxylase (PEPc)-derived carbon in leaves and roots of C_3 plants supplied with NO_3^- or NH_4^+, with emphasis on diel dynamics and organ-specific metabolism. PCA and OPLS-DA were used to resolve treatment-driven metabolic patterns, ANOVA to test factor effects, and OPLS regression to identify metabolites most predictive of respiratory $^{13}CO_2$ flux. We found that in leaves, NO_3^- nutrition produced consistently stronger ^{13}C enrichment at specific carbon positions of malate (C-1, C-3, C-4) and citrate (C-2/C-4, C-2/C-5) than NH_4^+ nutrition, linking intramolecular ^{13}C distribution in organic acids to the more ^{13}C-enriched leaf-respired CO_2 under NO_3^- supply. After night-time labeling, delayed enrichment of leaf-respired CO_2 on the following day coincided with strong positional ^{13}C enrichment in amino acids and citrate, supporting upward transport of root-fixed carbon, likely as amino acids, into leaf respiratory metabolism. In roots, natural-abundance differences in $\delta^{13}CO_2$ were weak, but labeling revealed tighter coupling of PEPc-derived carbon to respiration under NH_4^+, especially at night. Position-specific enrichment in GABA, alanine, and glucose C-1 further pointed to roles for amino-acid turnover and possibly the pentose phosphate pathway. These results show that nitrogen form reorganizes intramolecular ^{13}C partitioning and thereby shapes plant respiratory $\delta^{13}CO_2$ across the soil–plant–atmosphere continuum.

Keywords: *respiratory $\delta^{13}CO_2$; nitrogen form; intramolecular ^{13}C distribution; ^{13}C-NMR; organic acids*

Return to Table of Contents

Abstract 034 - Fan

Tree-Ring Stable Isotopes from Tianshan Mountains: Applications in Hydroclimate Reconstruction

Yuting Fan[1], Qian Li[2], Ye Wu[1], Tong Li[2]

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Abstract:

Understanding long-term hydroclimate variability in arid Central Asia is critically important but constrained by short instrumental records. This study explores the potential of stable oxygen ($\delta^{18}O$) and carbon ($\delta^{13}C$) isotopes in tree rings of *Picea schrenkiana* from the Tianshan Mountains, Xinjiang, for palaeoclimatic reconstruction. We developed annually resolved $\delta^{18}O$ and $\delta^{13}C$ chronologies spanning the past two centuries. Our analysis demonstrates that both isotopic proxies are sensitive to regional moisture conditions. The $\delta^{18}O$ record responds strongly to summer precipitation and atmospheric humidity, primarily reflecting source water composition and evaporative enrichment. In contrast, the $\delta^{13}C$ series is closely linked to stomatal conductance, providing insights into plant physiological responses to water stress. Using a combined isotopic approach, we reconstructed past variations in drought severity. The reconstruction captures multi-decadal pluvial and dry phases not fully represented in historical records. Notably, a coherent trend emerges over recent decades: a long-term decline in $\delta^{18}O$ alongside a gradual rise in $\delta^{13}C$. This pattern is interpreted as indicating reduced moisture input from distant sources and enhanced plant water-use efficiency under changing atmospheric conditions. Our findings confirm that tree-ring stable isotopes from the Tianshan Mountains serve as robust, high-resolution proxies for hydroclimate variability in arid Central Asia. The dual-isotope framework offers a more complete picture of past moisture dynamics than any single proxy alone.

Keywords: *Tree-ring stable isotopes, Tianshan Mountains, hydroclimate reconstruction, arid Central Asia*

Return to Table of Contents

Abstract 051 - Wehi

Rats on islands: Kiore (*Rattus exulans*) isotopic niche in five New Zealand island populations

Priscilla Wehi[1], Amandine Sabadel[2]

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[2]*Auckland University of Technology*

Abstract:

Invasive species such as rats have accompanied human colonization, and expanded into of novel habitats, including islands with vulnerable and endemic species. Yet it isn't always clear how trophic position expands or contracts in different environments with colonization events, even for generalists. We extracted collagen from kiore (Pacific rat, *Rattus exulans*) trapped on five New Zealand offshore islands and from one mainland location, to characterize trophic position and niche variability at sites where other rats (*Rattus rattus*) that out-compete them were present and absent using bulk stable isotope estimates for carbon, nitrogen, and sulphur. We estimated BMI and then trophic variability using measurement and isotopic mixing models, and used CSIA-AA amino acid relationships to confirm basal food sources. BMI was lower on Mauitaha Is, and in mainland kiore, although Mauitaha kiore with high BMI were feeding at a high trophic position. Trophic position was high in populations with, and without, human presence, but low in mainland kiore, and in some individuals from Mauitaha Is. Kiore at most locations were feeding on terrestrial food sources. Slipper Is kiore had notably wider trophic variability than other islands, and indications of marine foods in some individuals. In contrast, food sources and niche width at Aotea, where other rats were present, appeared both consistent and small. On Rakiura, niche width was consistent with scavenging from human source terrestrial foods influenced by seaspray. The data suggest that on some islands kiore shift to marine or brown food web sources to maintain trophic position and condition.

Keywords: *CSIA-AA, compound-specific, fractionation, islands, marine sources, rat diet, trophic position*

Return to Table of Contents

Abstract 057 - Hatten

Improving traceability of precious corals using stable isotope analyses in Hong Kong's coral trade

Chloe Hatten[1], Inga Conti-Jerpe[1]

[1]*Division of Science, Lingnan University*

Abstract:

Invertebrates are among the most heavily traded taxa globally, with marine species like precious corals (genera *Corallium, Pleurocorallium, Hemicorallium*) at significant risk of over-exploitation due to extensive wild harvesting for ornamental use. Hong Kong SAR, China, serves as a major international trade hub for these corals, benefiting from its strategic location and status as a free trade port. Of eight commercially important precious coral species, four are regulated under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). However, high trade volumes and the use of trade names based on colour and harvest location, rather than species, challenge enforcement efforts. Colour variations within species and limited knowledge among sellers about species identity and origin further complicate regulation. Effective CITES enforcement requires reliable methods for species identification and geographic origin determination. This pilot study evaluates the potential of stable isotope analysis (SIA) as a tool to differentiate between traded precious corals. We analyse carbon, nitrogen, hydrogen, sulphur, and oxygen isotopes from various coral samples and use clustering analyses to identify distinctive patterns. Preliminary findings indicate that SIA may provide valuable information on coral origins. To enhance these results, we plan to confirm species identity using previously published DNA-based 'Coral-ID' forensic assay. Integrating trade, SIA, and genetic information aims to clarify relationships between trade names, geographic sources, and species. Ultimately, this multidisciplinary approach seeks to develop robust traceability tools and datasets to support researchers and enforcement agencies in the conservation management of precious coral resources.

Keywords: *Precious coral; wildlife trade; traceability; SIA; multi-disciplinary*

Return to Table of Contents

Abstract 058 - Bones

Evaluating marine consumption in Brazilian coastal human populations using compound specific isotope analysis of amino acids

Annie Bones[1], André Carlo Colonese[2], Krista McGrath[2], Joan Villanueva Ribes[2], Verônica Wesolowski[4], Maria Cristina Alves, Alexandro Demathé[5], Helen M Talbot[1], Oliver E. Craig[1]

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[4]Museu Arqueológico de Sambaqui de Joinville, Brazil
[5]Grupo de Pesquisa em Educação Patrimonial e Arqueologia, Brazil /

Abstract:

The Atlantic forest coast of Southern Brazil has been extensively exploited by humans for at least 7,000 years, often with periods of intensive and prolonged exploitation of marine resources. Understanding the true extent to which populations relied on coastal resources over this period is critical for reconstructing long-term social and economic development, as well as for assessing anthropogenic impacts on this biodiversity hotspot. Bulk stable isotope data of human bone collagen has been widely collected in this region to estimate the degree of marine resource consumption; however, their interpretation is complicated, in part, due to the complexity of the aquatic isoscape.

Here, we evaluate the utility of compound-specific stable isotope analysis of individual amino acids in bone collagen, applying both LC-IRMS and GC-C-IRMS, from pre-colonial and historic human remains and a wide range of fauna to improve the accuracy and precision of dietary reconstruction. Statistical approaches, including isotopic fingerprinting and Bayesian modelling, were deployed to identify likely autotrophic nutrient sources and to estimate human trophic levels. Our results provide greater resolution than bulk collagen isotope analysis, revealing substantial dietary variation across sites and time periods. Crucially, they also highlight the limitations of bulk approaches for estimating human trophic level and marine consumption. We argue that casual interpretations of bulk collagen nitrogen isotopes may systematically overestimate marine input due to differences in the metabolic behaviour of glycine, the dominant amino acid in collagen, between terrestrial and aquatic organisms.

Keywords: *Human palaeoecology, sambaquis, historic fishing, compound specific stable isotopes, collagen*

Abstract 061 - Kan

Selective Electrochemical Enrichment of Lithium Isotopes Enabled by Diffusion–Reaction Coupling in Functional Materials

Wang Hay Kan[1], Hua Yang[1], Fengjin Qu[1]

[1]*China Spallation Neutron Source*

Abstract:

Efficient separation of natural lithium isotopes is critical for nuclear and energy applications but remains challenging using conventional chemical processes. In this study, we present a materials-driven electrochemical strategy for isotope separation based on the coupling of ionic diffusion and electrochemical reduction reactions. Using tailored electrode materials with engineered defect structures, we demonstrate preferential transport and redox activity of lithium isotopes, leading to controllable isotope enrichment. The separation mechanism is governed by differences in diffusion kinetics, solvation/desolvation behavior, and interfacial electron transfer processes. Electrochemical measurements combined with structural characterization reveal that local structural heterogeneity and defect distributions play a key role in amplifying isotope selectivity. This approach provides a scalable and environmentally benign pathway for lithium isotope separation and opens new opportunities for integrating isotope control into electrochemical energy systems.

Keywords: *Lithium isotope separation, Defect chemistry, Ionic transport, Electrochemical kinetics, Local structure*

Return to Table of Contents

Abstract 068 - Guzmán Álvarez

Isotopic signals of Carbon and Nitrogen in marine invertebrates as indicators of wastewater pollution in reef lagoons of the Mexican Caribbean.

Emilio Guzmán Álvarez[1], Vanesa Papiol[1], Korynthia López-Aguiar[2]

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[2]*Facultad de Química. Universidad Nacional Autónoma de México (UNAM)*

Abstract:

The Mexican Caribbean, which harbours a large portion of the Mesoamerican Barrier System, is under severe anthropogenic pressure, causing elevated wastewater inputs through submarine groundwater discharges. These pose a major threat to coastal ecosystems, especially in the north, where population growth and tourism are more intense, raising the need for bioindicators that provide early evidence of wastewater impact. This study aimed to evaluate the usefulness of $\delta^{13}C$ and $\delta^{15}N$ signatures in marine invertebrates as bioindicators of wastewater pollution. We analysed nitrogen and carbon isotopic signatures in four invertebrate species with different feeding habits; the gorgonian *Gorgonia ventalina*, the gastropods *Volutella muricata* and *Cyphoma gibbosum*, and the crab *Mithraculus sculptus*, across eight reef lagoons with varying degrees of anthropogenic pressure along the Mexican Caribbean in the dry and rainy seasons. Six to eight individuals per site and period were analysed. To assess wastewater influence, we measured caffeine, enterococci, isotopes of suspended particulate organic matter, and nutrients (TRIX Trophic Index). Preliminary dry-season results show $\delta^{15}N$ values ~4‰ higher in northern sites, consistent with wastewater-derived enrichment compared to less populated southern areas. Conversely, $\delta^{13}C$ values showed no clear spatial gradient. Wastewater influence was confirmed by the presence of enterococci and caffeine. $\delta^{15}N$ of all species were negatively correlated with pH ($R^2 \geq 0.68$), except for C. gibbosum, positively correlated with TRIX ($R^2 \geq 0.43$) and negatively with temperature ($R^2 \geq 0.39$). These findings highlight the potential of $\delta^{15}N$ in marine invertebrates as a bioindicator of wastewater impacts in the Mexican Caribbean.

Keywords: *Stable isotopic analysis; wastewater, nutrients; invertebrates; coastal pollution.*

Return to Table of Contents

Abstract 075 - Andersson

Toolkit to detect provenance of laundered, critically endangered cockatoos

Astrid Andersson[1], Juha Merilä[1], Caroline Dingle[2]

[1]*The University of Hong Kong*
[2]*Capilano University*

Abstract:

Stable Isotope Analysis (SIA) is increasingly being applied in wildlife trade research to discern wild-origin from captive-bred/cultivated wildlife. This tool has the potential to be used in a forensic capacity to detect laundering of poached wildlife in legal markets. However, the accuracy of this method can be impacted by environmental/biological factors that may influence stable isotope ratios in wildlife, and thereby reduce the reliability of SIA data – and its admissibility as evidence in court. Moreover, pan-species practical applicability of this method is limited by the absence of a comprehensive reference database. Therefore, best practice is to use SIA as one of multiple tools to establish provenance. Here, we demonstrate a 2-step approach that leverages SIA and genetic relatedness tests which can be used to identify the source of critically endangered cockatoos in a Hong Kong bird market.

Keywords: *SIA; genetics; forensics; cockatoo*

Abstract 087 - Briones-Hernández

Ontogenetic variations of habitat use of roosterfish (*Nematistius pectoralis*) off two ecologically distinct fishing areas through eye lens stable isotope analysis

Sergio A. Briones-Hernández[1], Carson Jeffres[2], Adele Ferrer[2], Bruce Pohlot[3], Ulianov Jakes[4]-Cota, José M. Carvajal-Rodríguez[5], Sofía Ortega-García[1]

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[5]*Instituto Costarricense de Pesca y Acuacultura, Costa Rica*

Abstract:

Roosterfish is a coastal predator endemic to the Eastern Tropical Pacific and holds high economic importance due to its popularity among sportfishing anglers. Despite this, little is known about its life history, including habitat and food resource utilization, and genetic evidence suggests population structuring at small geographical scales. The aim of this study is to reconstruct diet history and habitat use of roosterfish captured off Cabo San Lucas, Mexico and the Pacific coast of Costa Rica using eye lens stable isotope analysis (SIA), complemented with muscle and liver tissues. Muscle and liver tissues samples from 33 individuals (36 to 96 cm of fork length, FL) were analyzed, while eye lenses were preliminarily examined for three individuals (36, 76, and 96 cm FL; 8, 27, and 42 months old, respectively). Carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope values from muscle and liver were analyzed using SIBER ellipses to evaluate their distribution in isotopic space and compared with individual eye lens isotopic trajectories. Eye lens growth rates ranged from 0.2 to 0.6 mm per month, with smaller individuals exhibiting faster growth. Isotopic trajectories revealed variability in individual starting points and diet history pathways. The outermost layers of the eye lens overlapped with muscle and liver isotopic values, suggesting consistent recent use of marine habitats. These results indicate that eye lens SIA is a valuable tool for reconstructing individual ontogenetic variation in diet and habitat use in roosterfish. Further research is needed to identify the drivers of this variability and its implications for management.

Keywords: *isoscapes, sportfishing, ecology*

Abstract 105 - Sokołowski

Differing behaviours of per- and polyfluoroalkyl substances (PFAS) in benthic-pelagic food webs in the brackish low-diversity Baltic Sea as revealed by a stable isotope approach

Adam Sokołowski[1], Tove Porseryd[2], Josefine Larsson[3], Katarzyna Smolarz[1], Mariusz Sapota[1], Gilles Lepoint[4], Mats Grahn[2]

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[4]Université de Liêge, Laboratory of Trophic and Isotope Ecology, Liêge, Belgium
[5]Södertörn University, Technology and Environmental Studies, Huddinge, Sweden

Abstract:

In recent decades, per- and polyfluoroalkyl substances (PFAS) have become distributed globally across various environmental matrices and marine ecosystems, raising concerns about their ecological impacts and human health risk due to biomagnification. Although empirical studies indicated biomagnification of some PFAS in coastal environments, the mechanisms underlying trophic transfer remain uncertain. Water-basin- and food web-specific studies are therefore required to account for local ecological conditions and the structure of trophic links, particularly in systems which serve as an ultimate reservoir for organic pollutants. This study set up to assess the biomagnification potential of selected PFAS in benthic-pelagic food webs in the brackish, low-diversity, semi-enclosed Baltic Sea using the trophic magnification factor (TMF). Stable isotope ratios of carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$) and sulphur ($\delta^{34}S$), and concentrations of 11 compounds were measured in selected food web components at two coastal areas located in the northern (ASKÖ, Himmerfjärden, Sweden) and southern part (JAS, the Gulf of Gdańsk, Poland) in summer. In the northern Baltic, all compounds except PFOS and the sum of congeners (i.e. PFBSA, PFHpA, PFOA, PFOSA, PFNA, PFDA, PFUdA, PFDoA, PFTrDA, PFTeDA) showed a decreasing pattern (TMF from 0.45 to 0.96) with trophic level, providing evidence for biodilution. In contrast, concentrations of all long-chain PFAS (PFNA, PFOA, PFDA, PFUdA, PFDoA and PFOS) measured at JAS increased in successive trophic levels (TMF from 1.08 to 2.35) as a function of trophic position but significant patterns were detected only for PFOS, PFUdA and the sum of four dominant compounds.

Keywords: *trophic transfer, PFAS, benthic-pelagic food web, Baltic Sea*

Abstract 115 - Muehl

Energy channel coupling by mid-trophic level fish challenges the landscape theory for food web architecture in a large tropical lake ecosystem

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[2]*Michigan Technological University, Department of Biological Sciences*
[3]*Kenya Marine and Fisheries Research Institute, Kisumu, Kenya*

Abstract:

Landscape theory for food web architecture (LTFWA) posits that the stability of food webs is supported by the coupling of fast pelagic and slow littoral energy channels mediated by large mobile consumers. Empirical tests of the LTFWA are limited, and support for the LTFWA varies among and within aquatic ecosystems. While the LTFWA is thought to be supported in large lake ecosystems, empirical studies have focused on temperate environments with little emphasis on large tropical lake ecosystems. Lake Turkana, a climatically sensitive East African Great Lake, is an ideal model for examining how consumer fish species may mediate the coupling of fast and slow energy channels within food webs in a large tropical lake ecosystem. To empirically test the LTFWA, we used stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope values to explore the ecological niche characteristics of five important Lake Turkana fish species including *Alestes baremoze, Brachyalestes ferox, Hydrocynus forskahlii, Lates niloticus,* and *Oreochromis niloticus* across ontogeny and used a Bayesian isotope mixing model approach to identify which species play important roles in coupling fast pelagic and slow littoral energy channels. We reveal that mid-trophic level fish species play important roles in coupling energy channels in Lake Turkana, subverting expectations that upper trophic level consumers would couple energy channels the most. Thus, we demonstrate that the energy coupling patterns proposed by the LTFWA are not ubiquitously supported across all large lake ecosystems, and small-bodied mid-trophic level fish species are vital for coupling energy channels in Lake Turkana.

Keywords: *Energy channels, fisheries, food webs, lake ecology, stable isotopes*

Return to Table of Contents

Abstract 117 - Tilley

Baseline research: Stable isotopic labelling to protect native incense trees (*Aquilaria sinensis*) in Hong Kong SAR

Hannah Tilley[1], Kit Sum Leung[1], Uva Fung[1], Juha Merila[1], David M. Baker[1]

[1]*The University of Hong Kong (HKU)*

Abstract:

Hong Kong's incense trees are an endemic species to southern China with significant cultural significance. Highly traded as 'agarwood' for their highly valued perfumed resin, this species has been protected under Hong Kong law since 2018 (Cap. 586) through the Hong Kong governments' Agricultural, Fisheries and Conservation Department (AFCD). A. sinensis is also internationally protected under Appendix II of CITES. Despite this, poaching efforts continue, with 730 cases, 1463 injured trees and ~1325 kg of agarwood confiscated from 2005-18. At the Conservation Forensics Laboratory (CFL) at The University of Hong Kong we are investigating the use of stable isotopic labelling to distinguish Hong Kong's incense trees from those in southern China, to provide evidence to aid with the conviction of criminals found trafficking agarwood. We present results of a pilot greenhouse experiment (2021-22) which was conducted to test the utilisation of enriched nitrogen tracer as a means of distinguishing trees. 5 incense tree saplings (~5 m height) were watered with enriched sodium nitrate (^{15}N, ≥98 atom%) with 3 additional trees serving as controls. Stable isotope analyses (SIA) through repeated sampling showed continual significant differences in nitrogen between control and labelled trees (GLMM, β= 455.4, p1 year. Subsequent preliminary SIA comparisons with wild samples show that baseline nitrogen levels are also different from enriched greenhouse samples (GLMM, β= 15.8, $p<0.0001$). Results therefore suggest that this method can be applied to trees in natural conditions and plans commence to utilise this protocol in a wild tree study.

Keywords: *agarwood, conservation forensics, poaching, stable isotopes, greenhouse experiment*

Return to Table of Contents

Abstract 140 - Brennan

Is the Shifting Habitat Mosaic of Salmon Production Repeatable?

Kyle Brennan[1], Gabriel Bowen[1], Timothy Cline[2], Curry Cunningham[3]

[1]University of Utah, Spatio-Temporal Isotope Analytics Lab (SPATIAL)
[2]Montana State University
[3]University of Alaska Fairbanks

Abstract:

Spatial diversity stabilizes salmon populations as habitat contributions rise and fall asynchronously through time. But whether habitat contributions within this shifting mosaic simply reshuffle or reorganize predictably as productivity rises and falls remains unknown. We combined otolith $^{87}Sr/^{86}Sr$ with a strontium river isoscape to reconstruct probabilistic natal origins of sockeye (*Oncorhynchus nerka*) across the Taku, a major sockeye-producing river network. We analyzed ten spawning-year cohorts spanning 1996–2014 across three high–low productivity contrasts (n = 1,237), allowing us to ask whether spatial reorganization repeated across population cycles. We quantified these shifts with a novel application of optimal transport to river networks, measuring how far production was redistributed through the branching network. The mosaic did not simply reshuffle. Across all three downturns, production reorganized in the same broad direction, shifting from less-radiogenic stream reaches toward radiogenic peripheral tributaries. That direction repeated over 68% of changing river length and 86% of the redistribution magnitude. Production from radiogenic reaches gained relative importance because they declined less, retaining 58% of high-productivity output during low years compared with 38% from less-radiogenic reaches. These results show that habitat value depends not only on how much production a habitat supports, but on how well that production persists during population downturns.

Keywords: *sockeye salmon; otolith microchemistry; strontium isotopes; shifting habitat mosaic; portfolio effect; response diversity*

Return to Table of Contents

Poster Presentations

Return to Table of Contents

Abstract 013 - Pei

Tracing Nutrient Inputs Driven by Internal Waves on a Remote Atoll Reef with Stable Isotopes: A Preliminary Study

Yu-De Pei[1], Timothy B. King[1], Joshua Bennett-Williams[1], I-Huan Lee[2], Alex S. J. Wyatt[1]

[1]Department of Ocean Science, The Hong Kong University of Science and Technology, Kowloon, Hong Kong
[2]Department of Oceanography, National Sun Yat-sen University, Kaohsiung, Taiwan

Abstract:

Internal waves (IW) can push episodic cool, nutrient-rich water onto shallow reefs, yet the degree to which these subsidies support local food webs remain unresolved in many locations, including Dongsha Atoll in the South China Sea. We asked whether IW-driven oceanic inputs support reef communities and how source use varies among taxa and sites. We combined high-resolution temperature time series (10–25 m; north, east, south outer reef slopes) with bulk tissue stable isotopes ($\delta^{13}C$ and $\delta^{15}N$) from reef organisms (i.e., damselfish, larger predators, crinoids, seagrass, corals). Time-series data showed that thermal variability increases with depth, consistent with internal-wave forcing, while temperature-derived nitrate estimates indicated episodic nutrient delivery to shallow reef slopes. Preliminary bulk isotope results suggested two potential nutrient pathways: (1) a mixed pathway, with $\delta^{13}C$ of small planktivorous damselfish, crinoids, and some corals fallen between particulate organic matter (POM) of oceanic (-22 – -18 ‰) and benthic/seagrass (-16 ‰) productions, and (2) a benthic/seagrass pathway, with more enriched $\delta^{13}C$ in some larger predators and corals (-16 – -10 ‰), consistent with seagrass or benthic carbon use. These preliminary results suggest that internal-wave events despite can provide episodic nutrient support to Dongsha Atoll's reef slope communities, but benthic/seagrass productions can be equally important. Source elucidation using more source-specific carbon and nitrogen compound-specific isotope analysis of amino acids (CSIA-AA) is warranted to verify bulk stable isotope results and further shed light on internal waves' influences on the nutrient dynamics of Dongsha Atoll's outer reef communities.

Keywords: *Internal waves, oceanographic processes, oceanic nutrition, coral reefs, Dongsha Atoll, South China Sea*

Return to Table of Contents

Abstract 017 - Webster

Investigating the trophic strategies of sympatric forest-forming black corals across a shallow-to-mesophotic depth gradient

Samuel Webster[1]

[1]*The University of Hong Kong*

Abstract:

Intense human activities along urbanised coastlines pose a considerable threat to benthic communities and can result in habitat degradation and biodiversity loss. Black coral forests (BCFs, order Antipatharia) contribute greatly to the habitat-complexity of benthic communities and often function as ecosystem engineers, creating microhabitats that serve as refuge for marine organisms while influencing hydrodynamic gradients, material and nutrient cycles. Understanding how co-occurring black corals partition their resources is fundamental for predicting the responses of BCFs and their associated biodiversity to human-induced stressors. Black corals are found across reef communities worldwide and are known to thrive in light-limited environments, typically at mesophotic depths (30–150m) or deeper. Within Hong Kong, however, forest-forming black coral from the genera Antipathes and Cirrhipathes co-occur in dense aggregations from shallow (<30m) to mesophotic depths, with the former having one of the shallowest reported populations to date (4m). The depth distribution of BCFs in Hong Kong thus provides a unique opportunity to investigate the shared and/or distinct trophic strategies of sympatric black corals across a shallow-to-mesophotic depth gradient. This research proposes to use Stable Isotope Bayesian Ellipses in R (SIBER), complemented by Bayesian mixing models, to identify the relative isotopic niches of abundant habitat-forming members of BCFs over a depth gradient. Overall, this work will provide key insights into black coral adaptation across depth-driven environmental gradients and will directly inform targeted conservation strategies central for managing the ecosystem functions and associated biodiversity of BCFs.

Keywords: *Antipatharians, ecosystem engineers, marine animal forests, environmental gradients, stable isotope analysis, isotopic niche*

Return to Table of Contents

Abstract 021 - Bennett-Williams

Manta Mucus: Its Sticky and Tricky Application as an Isotopic Tracer of Trophic Ecology

Joshua Bennett-Williams[1], Wong Tsun Ho[2], Luk Man Ho[2], Muhammad Faiz Abdulah bin Ismail[3], Alex S.J. Wyatt[1]

[1]Department of Ocean Science, The Hong Kong University of Science and Technology, Kowloon, Hong Kong
[2]Research Department, Ocean Park, Hong Kong
[3]Animal Care, Singapore Oceanarium, Resorts World Sentosa, Singapore

Abstract:

Manta rays are an iconic and enigmatic species, yet major gaps remain in understanding their trophic ecology. Tissue sampling and satellite/acoustic tag deployments may prove difficult in many locations due to concerns regarding the negative effects on manta ray tourism from invasive tag placements or biopsies. Even where permits are possible, the high costs of tagging can limit sample sizes and the breadth of ecological insights. The non-invasive collection of mucus from manta skin for low-cost isotope analysis may therefore offer a valuable alternative. While manta mucus has been used successfully in multiple DNA studies, and a previous fatty acid and isotope study, the accuracy of mucus isotopes for reflecting diets and the timeframe over which the diet is represented (turnover time), has yet to be validated. From the first controlled feeding studies of manta rays, we have quantified the isotopic shift between manta feed and mucus (the diet-tissue discrimination factor, DTDF). Initial results suggest a DTDF of +2.0 ‰ (depending on diet quality), an isotopic half-life of 62 days, and a 95 % turnover time of 268 days, thereby defining the temporal window represented by mucus samples. These findings demonstrate that isotopic analysis of mucus from captive mantas offers significant potential for advancing understanding of the trophic ecology of wild manta ray populations through non-invasive mucus sampling.

Keywords: *Manta Ray, Mucus, Trophic Ecology, Methods, Controlled Feeding Study*

Abstract 025 - Martinková

Mobility and isotopic behavior of hazardous elements in e-waste dusts from different processing lines: Implications for environmental fate and source apportionment

Eva Martinková[1], Ondřej Šebek[1], Alexandre Andronikov,[1] Štěpánová[1], Jan Čuřík[1], Zuzana Čvančarová[1], Zuzana Čvančarová[1], Anna Vynnychuk[1], Vít Sládeček[1]

[1]*Czech Geological Survey*

Abstract:

Electronic waste (e-waste) processing generates hazardous dusts with elevated trace metal concentrations. This study evaluates the mobility and environmental risk of trace metals in e-waste processing dusts. Nine e-waste dust samples were collected, including eight actively aspirated dusts sampled directly from specific processing lines (mixed e-waste, LCD, CRT, and photovoltaic panels) and one swept storage facility (SF) floor dust. Trace element concentrations were exceptionally high, reaching 1,095 mg kg^{-1} Cd, 25,454 mg kg^{-1} Pb, and 31,082 mg kg^{-1} Zn. To assess chemical speciation, a modified five-step BCR sequential extraction procedure was employed, defining the following fractions: exchangeable (F1), reducible (F2), organic-bound (F3), residual after aqua regia extraction (F4), and residual after aqua regia + HF digestion (F5). Results showed that Zn exhibited the highest mobility (71–98% in F1+F2) across most e-waste dusts. In contrast, the mobility of Cd and Pb was highly source-dependent; they were highly mobile in mixed e-waste (up to 95% Cd and 85% Pb in F1+F2) but remained predominantly in residual fractions (F4–F5) in CRT and LCD dusts due to encapsulation in glass/ceramic matrices. Less mobile elements (Ba, Sb, As, Cr) remained in least accessible fractions. Isotopic analysis identified three distinct lead clusters. Zinc and cadmium isotopes ranged from light isotope enrichment in early fractions to heavy isotope enrichment in residual phases, reflecting both primary source signatures and extraction-induced fractionation. Mixed e-waste dust presents the highest immediate environmental risk, while CRT, LCD, and storage facility dusts require long-term monitoring due to potential weathering-induced metal release.

Keywords: *e-waste dusts, trace metal mobility, BCR extraction procedure, Cd, Zn, Pb isotopic composition*

Return to Table of Contents

Abstract 040 - Prigge

Multivariate stable isotope analyses reveal geographic origins and habitat use of trafficked pangolins

Tracey-Leigh Prigge[1], Timothy C. Bonebrake[1], Caroline Dingle[1,2]

[1]*The University of Hong Kong*
[2]*Capilano University*

Abstract:

Pangolins are heavily trafficked, with devastating impacts on all species. Due to low numbers and elusive natures, pangolins have been historically understudied. Because of this, little is known about the eight currently described species and even less about the possible fifth Asian species, *Manis cf. mysteria* - for which no live specimen has been identified. Stable isotope concentrations in animal tissues vary due to differences in diet and spatially explicit processes. The different pangolin species vary in their behaviours, habitat usage, dietary preferences, and water source access. Because of this variation, stable isotope analysis (SIA) can potentially be used as a method for exploring the ecologies and geographic origins of pangolins. Using scales from seven of the eight currently described species, and from Manis cf. mysteria, we tested for variation between species in the ratios of multiple stable isotopes: $\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$, $\delta^{18}O$, and $\delta^{2}H$. Significant differences were observed between African and Asian pangolin species for $\delta^{15}N$, $\delta^{34}S$, $\delta^{18}O$, and $\delta^{2}H$. Furthermore, substantial differences in $\delta^{13}C$ and $\delta^{15}N$ ratios were found to correspond to different habitat types. Notably, isotopic signatures suggest that Manis cf. mysteria occupies forested habitats in Asia, providing critical evidence that may aid in locating this putative species in the wild. Results confirm that SIA of pangolin scales can help reliably infer the geographic origin of seized specimens, serving as a powerful tool for forensic identification and conservation management. Filling these kinds of gaps in our knowledge of pangolins is a crucial step towards their conservation.

Keywords: *Pangolin, wildlife trade, Stable Isotope Analysis (SIA), conservation, fifth Asian species*

Return to Table of Contents

Abstract 041 - Urbano

Community structure drives isotopic niche breadth of a non-native freshwater fish

Vinícius Urbano[1], Patrícia Santos Fráguas[1], Débora Reis de Carvalho[2], Carlos Bernardo Mascarenhas Alves[3], Cecília Leal[2], Paulo Santos Pompeu[1]

[1]*Federal University of Lavras, Brazil*
[2]*Lancaster University, United Kingdom*
[3]*Federal University of Minas Gerais, Brazil*

Abstract:

Understanding why some non-native species successfully establish and spread while others fail is a central goal of invasion biology. Numerous theoretical frameworks have been proposed to explain the mechanisms underlying biological invasions. However, empirically testing these theories at the community level remains challenging. In this study, we used our stable isotope dataset encompassing the entire fish community and basal resources from 31 sites in tropical rivers and streams where the small Characid *Knodus moenkhausii* is non-native. We aimed to investigate the mechanisms driving variation in its isotopic niche breadth. Community trophic diversity emerged as the most important predictor of the isotopic niche breadth of *K. moenkhausii*, highlighting that in communities where resources are extensively exploited by resident consumers, this species exhibits a reduced isotopic niche. Additionally, environmental drivers (i.e., catchment area and resources range) played an important indirect role by positively influencing community trophic diversity, which in turn constrained the isotopic niche size of *K. moenkhausii*. Together, these results indicate that trophic diversity communities with extensive resource exploitation offer less trophic space for non-native species, consistent with predictions of the vacant niche hypothesis. Nevertheless, the high trophic plasticity of *K. moenkhausii* likely facilitates its establishment and persistence even in species-rich communities, suggesting that trophic plasticity may be a key mechanism for its persistence, reflected in a narrower isotopic niche.

Keywords: *Biological invasion, consumers, Knodus moenkhausii, Neotropics, stable isotopes*

Return to Table of Contents

Abstract 050 - Wang

Multi-isotope tracing reveals water partitioning and coupled C–N regulation in root-channel source-water wetlands of a canal-dominated plain river network

Weidong Wang[1], Ting Yang[1], Xiaofeng Gao[1]

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Abstract:

Constructed root-channel wetlands in the canal-dominated plain river-network region of eastern China provide a valuable model for tracing coupled ecohydrological and biogeochemical processes. Here, we integrated water isotopes (δD, $\delta^{18}O$) with preliminary carbon and nitrogen isotope evidence ($\delta^{13}C$, $\delta^{15}N$) to examine water partitioning, isotopic fractionation, and sediment–soil–plant interactions across a series of source-water wetlands, with emphasis on the Taishangang plant-bed/ditch system. Across four wetlands, open-water isotopes showed clear spatial differentiation, with δD ranging from −55.3‰ to −45.1‰ and $\delta^{18}O$ from −7.8‰ to −5.8‰, indicating strong control by water-source mixing and evaporation. Wetland waters were generally enriched in heavy isotopes relative to local precipitation, while the heterogeneous root-channel purification zones showed further isotope enrichment. Within the plant-bed/ditch system, outlet low ditches were isotopically lighter than inlet high ditches after filtration through the beds, revealing internal flow partitioning and an isotopic turning point linked to purification processes. Subsurface water also showed clear seasonal shifts in deuterium excess, with d-excess increasing from 5.3 ± 1.4‰ in summer to 11.5 ± 0.8‰ in winter, indicating stronger deuterium depletion during the wet monsoon season. Preliminary $\delta^{13}C$–$\delta^{15}N$ results further suggest that endogenous algal production dominates organic carbon storage, whereas anthropogenic nitrogen inputs and denitrification coexist, and plant species differ strongly in carbon transport and nitrogen assimilation strategies. These results highlight the value of multi-isotope tracing for resolving hydrological connectivity and coupled C–N regulation in engineered wetlands.

Keywords: *root-channel wetland; water isotopes; d-excess; carbon and nitrogen stable isotopes; ecohydrology; plain river-network regio*

Return to Table of Contents

Abstract 053 - Polito

Pour Some Sugar in Me: Using stable isotopes to characterize and quantify ketchup sweeteners

Michael Polito[1], Katherine Loesser[2], Seth Chapman[2], Kendell Fontenot[2], Angela Stahl[1]

[1]*University of California Santa Cruz*
[2]*Louisiana State University*

Abstract:

Ketchup is a ubiquitous condiment, traditionally composed of tomato (a C_3 plant), vinegars, and added sweeteners. In the United States when labels list "sugar" as an ingredient, the specific source, often sugar cane (a C_4 plant) sugar or beet (a C_3 plant) sugar, is not always provided. Moreover, many ketchups use corn syrup or artificial sweeteners in addition to, or instead of sugar and some do not include added sugars. Stemming from an undergraduate stable isotope ecology class project, we explored this saucy issue using carbon stable isotope values ($\delta^{13}C$) to identify the source of added sugar and calculate the relative contribution of tomatoes C_3 vs. C_4 ingredients within 22 commercial ketchup brands purchased in the United States. To establish a baseline, we also measured, $\delta^{13}C$ values in representative ingredients, including tomato paste and various sugars and sweeteners. We found that $\delta^{13}C$ values of ketchup ranged from -14.0 to -27.4‰ and help to differentiate ketchup brands based on the type of sweetener, or lack thereof. Isotopic differences between cane sugar (-12.4‰) and beet sugar (-26.7‰) allowed us to predict the use of cane sugar versus beet sugar in ketchup brands where product labeling was ambiguous. Data analysis is ongoing and will use isotopic mixing models to quantify the relative contribution of C_3 ingredients (e.g., tomatoes, beet sugars, etc.) vs C_4 ingredients (cane sugars, corn syrups, etc.). Ultimately, these results will ketchup the scientific community on the hidden complexities of this ubiquitous condiment.

Keywords: *food forensics, condiment ecology, sugar sourcing, C_3, C_4*

Abstract 059 - Qu

Combined Electrochemical Impedance Spectroscopy and Neutron Activation Analysis for Lithium Isotope Determination in Ceramic Materials

Fengjin Qu[1], Wang Hay Kan[1], Hua Yang[1]

[1]*China Spallation Neutron Source*

Abstract:

Accurate determination of lithium isotopic composition ($^{6}Li/^{7}Li$) in solid materials is essential for applications spanning nuclear technology, energy storage, and materials science. Here, we present a combined analytical approach that integrates electrochemical impedance spectroscopy (EIS) with neutron activation analysis (NAA) to quantify lithium isotope ratios in a series of ceramic samples. Defect-engineered ionic conductors are employed to enhance isotope-sensitive transport properties, enabling EIS to detect subtle differences in ionic mobility and relaxation behavior between ^{6}Li and ^{7}Li. These electrochemical signatures are systematically correlated with absolute isotope ratios obtained independently from NAA, providing a robust validation framework. The complementary nature of the two techniques—EIS as a rapid, non-destructive probe of isotope-dependent transport and NAA as a highly sensitive and quantitative nuclear method—enables cross-validation and improved accuracy. Furthermore, the role of defect chemistry in amplifying isotope effects is elucidated through controlled doping and local structural tuning. This work establishes a dual-technique platform for lithium isotope analysis in solid-state systems and highlights new opportunities for integrating neutron-based methods with electrochemical characterization.

Keywords: *Lithium isotope analysis, Electrochemical impedance spectroscopy, Neutron activation analysis, Defect-engineered ceramics*

Abstract 060 - Yang

Electrochemical Impedance Spectroscopy for Lithium Isotope Quantification Enabled by Defect-Engineered Fast Ionic Conductors

Hua Yang[1], Wang Hay Kan[1], Fengjin Qu[1]

[1]*China Spallation Neutron Source*

Abstract:

Accurate determination of lithium isotopic composition ($^{6}Li/^{7}Li$) is essential for nuclear, energy, and geochemical applications, yet conventional techniques rely on expensive and time-consuming mass spectrometry. Here, we report a novel analytical method based on electrochemical impedance spectroscopy (EIS) for rapid and non-destructive quantification of lithium isotopes in standard samples. By designing defect-engineered ceramic electrolytes with high ionic conductivity, we amplify isotope-dependent differences in ionic transport and relaxation dynamics. The method exploits subtle variations in diffusion coefficients and vibrational properties between ^{6}Li and ^{7}Li, which manifest as distinguishable features in impedance spectra across multiple frequency regimes. Systematic calibration using standard reference materials demonstrates that the extracted impedance parameters correlate directly with isotope ratios. Furthermore, defect chemistry—through controlled doping and local structural distortion—plays a critical role in enhancing sensitivity and selectivity. This work establishes EIS as a powerful platform for lithium isotope analysis and opens new opportunities for integrating electrochemical sensing with advanced solid-state materials design.

Keywords: *Lithium isotope analysis, Electrochemical impedance spectroscopy, Defect-engineered ceramics, Ionic transport, Isotope-sensitive conductivity*

Abstract 065 - Stantis

That other isotope repository: utilizing IsoArcH for ecological research

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[1]*Southern Illinois University Carbondale*
[2]*University of Aruba*
[3]*Vrije Universiteit Brussel*
[4]*University of Exeter*
[5]*Department of Anthropology, Chinese University of Hong Kong*

Abstract:

Originally built in 2011 as a repository for collating stable isotope data from Greco-Roman contexts, IsoArcH became a non-profit organization in 2019 with the goal of advancing the standardization, preservation, and accessibility of isotope data for archaeological research. Over the years, archaeological scientists have generated crucial data used to construct isotopic baselines in both domestic and wild species, thus contributing to many fields, including palaeoecology. We highlight three reasons ecologists should consider IsoArcH.

First, many archaeologists work closely with biologists and ecologists and produce large isotope datasets of pre-industrial flora and fauna, covering many isotope systems, dominantly of $\delta^{13}C$, $\delta^{15}N$, $\delta^{18}O$, $\delta^{34}S$, and $^{87}Sr/^{86}Sr$. For non-hominin animals, IsoArcH has over 54,433 measures and 10,640 samples. For plants and lichen, 13,547 measures and 8,625 samples are hosted in the repository. These data span from 130kya to modern sampling and include submissions from six continents, providing a high degree of spatio-temporal coverage.

Second, IsoArcH has a robust infrastructure for data management including a standardized data model that improves research transparency, data management plan resources, and the ability to assign individual DOIs for datasets.

Last, we support a vibrant community of researchers interested in open-access isotope data. Anyone can use the database, but we welcome all committed to the democratization of stable isotopes data to join, in order to stay informed of study days, workshops, and database innovations.

We hope that more ecologists will join us to help build on, and expand, this valuable resource.

Keywords: *data repository; open access; archaeology*

Abstract 069 - Joka

Stable Isotope Analysis of Perennial Plants in Archaeology: New Perspectives and Applications

Karolina Joka[1]

[1]*Nicolaus Copernicus University*

Abstract:

The development of perennial fruit cultivation marks a significant shift in ancient land-use strategies, reflecting long-term investment in agricultural landscapes and the increasing commodification of high-value crops. Among the earliest and most economically important perennial crops were olives (*Olea europaea*) and grapes (*Vitis vinifera*), which were widely cultivated from the Early Chalcolithic period and became key commodities by the Early Bronze Age. However, the specific agronomic practices used in their cultivation prior to historical documentation remain poorly understood.

This study evaluates the potential of stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope analysis applied to archaeobotanical remains of olives and grapes from the Early Bronze Age site of Tel Qedesh, Israel. For grapes, I present the first published $\delta^{13}C$ values derived from archaeobotanical material of this crop, providing a baseline for future comparative research and methodological refinement. Olive $\delta^{13}C$ values are compared with existing datasets, indicating that the trees at Tel Qedesh likely experienced relatively efficient water management or access to adequate moisture resources. In contrast, $\delta^{15}N$ analyses for both crops did not produce reliable results, underscoring current methodological limitations in applying this proxy to perennial plant remains.

Finally, Ioutline a proposed framework for developing robust methodological and interpretative models for perennial crops, basingon established approaches used in cereal and pulse isotope studies. We argue that improving the reconstruction of perennial cultivation practices is essential for understanding broader agricultural change and its role in major socioeconomic transformations in antiquity.

Keywords: *archaeobotany, perennial plants, plants cultivation, commodification*

Abstract 072 - Siegl

Seasonal shifts in carbon and nitrogen processing drive greenhouse gas dynamics in termite mounds

Alina Siegl[1], Risto Vesala[1], Darius Kimuzi[2], Peter Mwasi[2], Sonja Leitner[3], Lucas Mwangala[4], Jouko Rikkinen[1], Laura Arppe[1]

[1]Finnish Museum of Natural History, University of Helsinki, Finland
[2]Taita Research Station, Wundanyi, Kenya
[3]International Livestock Research Institute (ILRI), Nairobi, Kenya
[4]Programme and Planning, Academic Research and Outreach Division, Taita Taveta University, Kenya

Abstract:

In tropical drylands, where nutrient availability is limited and seasonal, termite mounds play a key role in decomposing plant litter and recycling nutrients, causing substantial CO_2 and CH_4 emissions. However, the mechanisms linking seasonal dynamics to internal mound processes and gaseous emissions remain poorly understood.

Here, we investigate how seasonal variation in environmental parameters and colony structure regulates internal carbon and nitrogen processing and how this controls gas concentrations in mounds of the fungus-growing termite Macrotermes michaelseni. We used a two-year monitoring campaign with monthly sampling of nest internal gases, soil walls, termites, fungus gardens and surrounding vegetation, combining gas measurements and stable isotope analyses across vegetation types in Kenya.

Wetter conditions were associated with both lower CO_2 concentrations and more ^{13}C-depleted CO_2 than dry seasons, suggesting lower metabolic activity and shifts in respiration sources. As fungus combs produce strongly ^{13}C-depleted CO_2 compared to termites, this seasonal $\delta^{13}C$ shift implies increased fungal contribution to colony metabolism during the wet season. C/N ratios and $\delta^{13}C$ signatures of termites, fungus combs, and nest soils reveal that internal carbon and nitrogen processing varies across sites and is linked to seasonal changes in colony metabolic activity, inferred from mound CO_2 concentrations. Methane dynamics integrate these processes and are affected by environmental conditions, colony structure, and overall mound activity. Termite nutritional status may further impact methane emissions, as their tissue %N shows a consistent positive relationship with mound CH_4 concentrations. Thus, termite greenhouse gas emissions reflect complex mound processes that are importantly shaped by seasonality.

Keywords: *termite mounds, nutrient dynamics, greenhouse gases*

Abstract 074 - Fung

Exploring the potential of SIA for conservation forensics of incense trees (*Aquilaria* spp.)

Uva Fung[1], Hannah B. TILLEY[1], Juha MERILÄ[1], David M. BAKER[1]

[1]*The University of Hong Kong*

Abstract:

Aquilaria sinensis, a tree species native to southern China, is threatened by illegal harvesting and trafficking driven by the high value of agarwood formed after wounding. In Hong Kong, wild *A. sinensis* are protected by law, but they are still under continuous threat of illegal harvesting. Currently, the Hong Kong Government adopts genetic analysis to trace the origin of agarwood products suspected to be sourced illegally. This study explores the potential of stable isotope composition analysis as an alternative approach to determine the geographic origin of different A. sinensis products and distinguish between multiple commonly traded *Aquilaria* species.

We aim to investigate whether there are diagnosable differences in stable isotope profiles of *A. sinensis* originating from different geographic regions within Hong Kong, and between three threatened Aquilaria species within Southeast Asia: *A. sinensis, A. yunnanensis* and *A. malaccensis*. These results will reveal the potential of stable isotopes to distinguish between different A. sinensis provenances and different *Aquilaria* species for wildlife forensic purposes. This method may offer a complementary tool for conservation and law enforcement efforts targeting agarwood trade.

Keywords: *conservation forensics, stable isotopes, incense tree, Aquilaria sinensis, Aquilaria yunnanensis, Aquilaria malaccensis*

Abstract 076 - Arppe

IsoMuseomics: Integrating stable isotopes and museum genomics to reconstruct ecological and evolutionary change in Lepidoptera

Laura Arppe[1], Kyung Min Lee[1]

[1]*Finnish Museum of Natural History, University of Helsinki*

Abstract:

Stable isotopes remain underused in insect ecology, particularly in studies linking ecological change to evolutionary responses. Insects, however, are well suited for such work due to short generation times, large population sizes, and strong environment driven selection, allowing ecological shifts recorded in tissue isotopic composition to align with genomic change over decadal scales.

We present IsoMuseomics, a project initiated at the Finnish Museum of Natural History to benchmark combined stable isotope and whole genome sequencing approaches using museum collections of Lepidoptera from the past 150 years to reconstruct ecological histories and evolutionary responses. The project ultimately targets currently endangered species (*Parnassius apollo, Calamia tridens*), but prior to destructive sampling of historic material, a pilot study examines geographic and ecological variation in wing $\delta^{13}C$, $\delta^{15}N$, and $\delta^{2}H$ of two widespread Palearctic moths: *Hepialus fusconebulosus* and *Catocala fraxini*.

With potential interference from small sample numbers (n=15+14) and unknown preservation agents, preliminary $\delta^{13}C$ and $\delta^{15}N$ results show limited systematic geographic trends and substantial within region variability, particularly in $\delta^{15}N$. The interspecific difference in $\delta^{15}N$ likely reflects contrasting larval feeding ecologies. Elevated $\delta^{15}N$ values in *H. fusconebulosus* are consistent with larval reliance on below ground roots and rhizomes influenced by microbial nitrogen cycling, whereas lower $\delta^{15}N$ values in *C. fraxini* align with foliar feeding on *Populus, Betula,* and *Fraxinus*. Subsampling of wings with and without major veins yielded identical isotope values, indicating negligible contribution from adult diet in wing vein tissue. Ongoing analyses of $\delta^{2}H$ are expected to mainly reflect geographic precipitation patterns.

Keywords: *Lepidoptera, evolutionary ecology, museum collections, museomics, anthropogenic change, $\delta^{13}C$, $\delta^{15}N$, $\delta^{2}H$*

Abstract 080 - Isidro

Mapping nutrient dynamics on Palmyra Atoll using macroalgal stable isotopes

Mafalda Isidro[1], F. Joseph Pollock[2], Maggie D. Johnson[1], Michael D. Fox[1]

[1]King Abdullah University of Science and Technology (KAUST)
[2]The Nature Conservancy, Hawaii and Palmyra Programs, Honolulu, HI, USA

Abstract:

Natural nutrient subsidies to coral reef ecosystems are crucial for ecosystem functioning and play an important role in reef resilience to climate change. Palmyra Atoll National Wildlife Refuge is a remote atoll in the Northern Line Islands (Central Pacific Ocean) and is recognized as a global benchmark for understanding how coral reef ecosystems function in the absence of local human impacts. Despite its current protected status and near-pristine conditions, Palmyra atoll experienced intense lagoon and island modification during the 1940s, including the introduction of non-native coconut palm, dredging, and land reclamation. These activities disrupted lagoon–ocean connectivity, sedimentation patterns, and nutrient cycling (e.g., guano-derived inputs). With many of these physical alterations naturally collapsing and with efforts to remove the non-native coconut palms, the hydrological and nutrient dynamics of the atoll are shifting once again. To monitor these changes, we combined macroalgal stable isotope data ($\delta^{15}N$, $\delta^{34}S$) from 2012 to 2025 with over a decade of high-resolution temperature monitoring in the lagoon. Together, these datasets were used to investigate temporal and spatial changes in nitrogen sources, water flow, and residence times. We demonstrate higher residence times in central and east lagoons, suggesting reduced connectivity to the open ocean, alongside a shift towards higher macroalgae $\delta^{15}N$ valued in the eastern lagoon. These patterns may reflect increased seabird-derived nutrients linked to native vegetation recovery or enhanced sediment resuspension associated with changes in water flow. Understanding how hydrodynamic changes can alter lagoon conditions will improve conservation efforts to rehabilitate natural nutrient pathways on coral reefs.

Keywords: *Stable isotopes; Nutrient influx; Isoscapes; Atoll systems; Macroalgae*

Abstract 085 - Fritsch

Developing a novel non-invasive methodology for stable isotope sampling on crustaceans

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Abstract:

One of the advantages of stable isotope analysis (SIA) is the possibility of non-lethal and even non-invasive sampling. However, these methods are mostly applicable to vertebrates due to the presence of easily exploitable inert tissues (e.g. hairs, feathers), as well as their generally higher protection status and stricter ethical requirements. Non-invasive sampling techniques are less commonly applied to invertebrates such as crustaceans, despite their importance in freshwater food webs and their widespread use in SIA studies. While non-lethal methods exist for crustaceans, they require the removal of limbs or appendages, which can compromise survival by increasing susceptibility to infection, thereby limiting their applicability to protected species. Thus, developing non-invasive tissue sampling methods is crucial for obtaining SIA data for such key species in trophic webs without conservation drawbacks. The exuvia, the shed exoskeleton from which the organism detaches during moulting, could serve as a non-invasive proxy for muscle or exoskeleton stable isotope ratios. To test this hypothesis, we conducted a diet-switch experiment using the marbled crayfish *Procambarus virginalis* (Lyko, 2017) as model species, and assessed the relationship between carbon and nitrogen isotopic ratios in the muscle, exoskeleton, and exuvia. In addition, we assessed whether the isotopic ratios of the exoskeleton change continuously or discretely, in order to better understand the tissue's assimilation time, and hence improve the accuracy of the interpretation of the result. These results could pave the way for further applications of SIA to other moulting taxa (e.g. other crustaceans and insects).

Keywords: *Moult, Exuviae, Decapods, Crayfish, Freshwater, Non-lethal, Exoskeleton*

Abstract 088 - Sykes

Exploring the foraging ecology of recently-extinct Hispaniolan sloths using stable carbon and nitrogen isotopes

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Abstract:

While extant sloths are represented by only two arboreal genera (six species) living in the Neotropics, sloths are a 35-million-year-old lineage that was historically diverse both geographically and phylogenetically. In the Late Pleistocene, 27 genera thrived in North, Central, and South America, and the Caribbean Islands. Caribbean sloths belonged to their own unique family, Megalocnidae, which went extinct in the Holocene along with most Caribbean non-volant vertebrates. The extinction and foraging ecology of megalocnids is largely unknown. We used collagen $d^{13}C$ and $d^{15}N$ values to elucidate the foraging behavior and niche partitioning of three megalocnid genera from montane sinkholes in southwestern Hispaniola: *Parocnus* (79 kg), *Acratocnus* (15 kg), and *Neocnus* (8 kg). Based on morphological research, we anticipated Neocnus was semi-arboreal and browsed leaves in forest canopies, *Acratocnus* was semi-arboreal and foraged closer to the ground, and *Parocnus* was terrestrial and consumed grasses. Preliminary data suggest all three genera exclusively ate C_3 plants. There is no evidence of C_4 grass consumption. *Acratocnus* had relatively elevated $d^{13}C$ values and low $d^{15}N$ values, which we interpret as foraging in the canopy. Parocnus had variable $d^{13}C$ values and relatively elevated $d^{15}N$, which suggests foraging in more open habitats. Finally, *Neocnus* had highly variable $d^{13}C$ and $d^{15}N$ values. This could indicate flexible foraging behavior, but we suspect several sampled individuals were non-local, and their remains were discarded by humans (we observed numerous butchered bones). Hydrogen or oxygen isotopes may clarify this possibility. We also plan to radiocarbon date specimens to explore temporal isotopic patterns.

Keywords: *extinction, Pleistocene, orographic effect, Haiti, canopy effect*

Abstract 090 - Ullmann

Isotopic constraints on the ecology of extinct cephalopods

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Abstract:

Fossils of belemnites, extinct cephalopods of the Mesozoic, were among the first materials subjected to stable isotope measurements. Despite the proliferation of belemnite C and O isotope data over the decades, the debate about the meaning of such measurements has not been settled. It still remains undecided, whether belemnite calcite constitutes a faithful record of ambient conditions, and what the preferred habitats and migration patterns of these animals may have been.

C and O isotope measurements of marine macroinvertebrates from the Early Jurassic sedimentary record of Europe have now reached a breadth that belemnite ecology can be more comprehensively studied. Comparison of isotopic records of belemnites and benthic animals from multiple epicontinental sedimentary basins with varying connectivity and proximity to open oceans is consistent with the following hypotheses:

The earliest belemnites that are found in many European sections preferred open ocean habitats of the Tethys and appear to have migrated into shallow waters comparatively rarely. However, belemnites did also occupy basins further away from the Tethys, and in the northeast of the United Kingdom have isotopic signatures consistent with local benthos, indicating a limited migration range and preferred bottom water habitat. A major environmental perturbation of the Early Jurassic, the Toarcian Oceanic Anoxic Event (T-OAE), may have been causative in a shift and diversification of belemnite ecology.

Following the T-OAE, belemnite isotope data are consistent with an increased adoption of shallow marine habitats and near surface waters, even in basins in relative proximity to the Tethys Ocean.

Keywords: *Belemnite, Jurassic, palaeoecology*

Abstract 097 - Genelt-Yanovskaya

Trophic interactions among fishes in coastal nursery habitats of the Gulf of Finland, the Baltic Sea.

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[3]*Tsinghua Shenzhen International Graduate School, Institute of Ocean Engineering*
[4]*Institute of Ecology and Evolution, laboratory of behaviour of lower vertebrates*
[5]*University of Tartu, Estonian Marine Institute*

Abstract:

Temperate estuaries are important spawning and nursery groups for marine and freshwater fish species. Several estuarine fish taxa belong to a group of 'small fish', adults of which generally do not exceed 10-15 cm, can form large shoals and are important prey items for larger fish taxa, birds and marine mammals. Also, during seasonal large aggregations, these taxa might have a significant pressure on coastal communities foraging for planktonic and benthic prey. In here, we explored diversity and trophic interactions among the small adult and juvenile fish species in the nearshore areas of the Gulf of Finland, Eastern Baltic Sea. In total, 16 fish species were recorded in beach seine hauls at 8 localities along the 260-km coastline during the two years of study. Among these, two species of sticklebacks, three-spined *Gasterosteus aculeatus* and nine-spined *Pungitius pungitus*, and several species belonging to the family Cyprinidae seasonally made an important contribution to the general fish community abundance. Based on data on abundance and species diversity of benthic and planktonic communities, as well as fish stomach content data obtained in this study, we analysed trophic niche overlaps between the key fish species using bulk $\delta^{13}C$ and $\delta^{15}N$ isotope analysis. Our data indicate that most species are characterised by wide niches, which is consistent with a high variability of studied coastal nursery habitats.

Keywords: *small fish, estuarine coastal habitats, trophic niche overlap*

Abstract 098 - Genelt-Yanovskiy

Shifts in Patagonian shelf marine communities from 19th to 20th centuries traced from changes in isotopic composition of South American fur seal bone and teeth museum specimens.

Evgeny Genelt-Yanovskiy[1], Anna Genelt-Yanovskaya[1], Bernd Schöne[2], E. Craig[3], Maria Fontanals-Coll[3], Kweku Afrifa Yamoah[3], Clemens Ullmann[4], David Reynolds[1], Richard Sabin[5], James Scourse[1]

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[4]China University of Geosciences (Wuhan), State Key Laboratory of Geomicrobiology and Environmental Changes
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Abstract:

South American fur seal is the target of one of the longest and largest continuous commercial harvesting operations in the Southern Hemisphere. Colonies of this species at the Strait of Magellan and Falkland Islands mark the southernmost edge of its distribution range. These colonies are currently in focus of many researchers and were extensively sampled during the period of exploration and exploitation of Subantarctic archipelagos, yet publications on such collections are scarce. We present the historical stable isotope dataset for these populations obtained from bone and tooth collection of the Natural History Museum, London, collected during the period of the “Heroic Age” of Antarctic exploration. This dataset provides isotopic baselines and suggests long-term changes in foraging ecology and seasonal migrations in one of the key marine mammal species in Patagonian waters. Our data suggest a temporal decrease in the trophic position of fur seals that might be explained by a decreased availability of higher trophic level prey items. The sclerochronological analysis of teeth available in the collection suggests shorter longevity compared to modern fur seal populations. Using serial $\delta^{18}O$ and $\delta^{13}C$ data from the carbonate fraction and $\delta^{15}N$ of tooth dentine samples collected at sub-annual resolution, we provide evidence of past putatively long-distance migrations in South American fur seals consistent with modern satellite tracking data. Seasonal variation in $\delta^{18}O$ data also provides age constraints for historical collections, making use of a shift in the pre-precipitation regime shift at Falkland Islands around the 1940s, when difference between seasons became less pronounced.

Keywords: *South American Fur Seal, Falkland Islands, tooth isotope sclerochronology*

Abstract 103 - Krajcarz

Tracking individual dietary choices in complex past food webs: integrated bulk collagen and compound-specific stable isotope analysis of urban cats

Magdalena Krajcarz[1], Kyungcheol Choy[2], Hee Young Yun[3], Daniel Makowiecki[1], Anna Gręzak[4], Urszula Iwaszczuk[5], Wim Van Neer[6,7]; Maciej T. Krajcarz[8]

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Abstract:

Reconstructing individual dietary strategies in isotopically complex food webs is a fundamental challenge in trophic ecology. It is particularly difficult in urban settings - anthropogenic environments where diverse local and imported resources with variable isotopic baselines limit the interpretive power of stable isotope analysis. We address this challenge using domestic cats as dietary proxies, exploiting their opportunistic foraging behavior to track individual resource choices in a historically complex urban-sea port landscape. We present an integrated multi-isotope study of cat bone collagen from medieval Gdańsk (northern Poland) and six regional comparative sites, combining bulk collagen $\delta^{13}C$, $\delta^{15}N$, and $\delta^{34}S$ analysis with compound-specific $\delta^{13}C$ and $\delta^{15}N$ analysis of amino acids. Despite apparent isotopic homogeneity within the conventional bulk collagen dual-isotope (carbon and nitrogen) space, the expanded isotopic framework reveals substantial individual-level dietary variability. Sulfur isotopes indicate diverse resource provenances, including marine ecosystem baselines and isotopic signatures of grain imported from inland regions. Amino acid $\delta^{13}C$ fingerprinting identifies diets spanning terrestrial C_3 and C_4, freshwater, and marine baselines, while amino acid-based trophic position proxies reveal highly variable individual trophic levels uncorrelated with bulk collagen $\delta^{15}N$ values. These findings demonstrate that isotopic homogeneity in conventional dual-isotope space can mask substantial dietary heterogeneity at the individual level — a problem relevant to any isotopically complex food web, ancient or modern. Our study highlights the potential of integrating compound-specific amino acid isotope analysis with sulfur isotope analysis to reconstruct individual-level dietary ecology in terrestrial environments, including environments with variable isotopic baselines.

Keywords: *isotopic ecology, zooarchaeology, anthropogenic ecosystem, Felis, domestic cat*

Abstract 104 - Krajcarz

Essential amino acid isotope fingerprinting of dietary niches in Quaternary large mammals: from woolly mammoths to modern forest ungulates

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[3]*Mammal Research Institute, Polish Academy of Sciences; Białowieża, Poland*
[4]*Institute of Archaeology, Nicolaus Copernicus University in Toruń; Toruń, Poland*

Abstract:

Reconstructing dietary niches in past ecosystems demands isotopic tools capable of resolving fine-scale variation among consumers sharing similar ecologies. Essential amino acid (EAA) stable isotope fingerprinting meets this need, at least theoretically, by exploiting the near-direct routing of EAAs from food sources to consumer tissues, enabling source tracking without the confounding effects of trophic fractionation that limit conventional bulk isotope approaches. While widely adopted in contemporary food web research, this method has rarely been applied to fossil terrestrial megafauna—a significant gap given the ecological complexity of Quaternary large mammal communities. An important limitation is the lack of knowledge about EAA isotopic variability in terrestrial ecosystems and its potential for fingerprinting.

To address this, we applied GC-C-IRMS $\delta^{13}C$ and $\delta^{15}N$ analysis of four EAAs (Phe, Val, Ile, Leu) in bone collagen of two contrasting faunal assemblages: Late Pleistocene megafauna from Perspektywiczna Cave, southern Poland (mammoth, woolly rhinoceros, bison, horse, reindeer, spotted hyena), and extant fauna from the Białowieża Primeval Forest, northeastern Poland (red deer, roe deer, wild boar, wolf—to check how EAA fingerprinting replicates patterns documented through direct ecological observation).

The results expose dietary structure invisible to bulk collagen analysis. Isotopic niche separation reveals discrete ecologies among herbivores, while herbivore-to-carnivore routing allows for tracking main prey choices. Taken together, these findings establish EAA fingerprinting as a high-resolution lens for examining terrestrial herbivore niche partitioning, predator–prey relationships, and community-level ecological change across Quaternary timescales.

The study has been supported by the National Science Center of Poland, grant No. 2025/57/B/ST10/02969.

Keywords: *bone collagen; mammals; terrestrial; Pleistocene; amino acids*

Abstract 108 - Matthews

Physiological individuality confounds trophic inference: an overlooked axis of long-term individual isotopic variation

Cory Matthews[1], Steven Ferguson[2]

[1]*Fisheries and Oceans Canada*

Abstract:

Individual isotopic variation is often interpreted as evidence of dietary specialisation, yet bulk isotope values can also vary with baseline and physiological processes unrelated to trophic position. We reconstructed life-long isotopic histories of eastern Canadian Arctic beluga whales (*Delphinapterus leucas*), a generalist marine consumer with a broad diet of fish and invertebrates, from sequential measurements of stable nitrogen and carbon isotope ratios ($\delta^{15}N$ and $\delta^{13}C$) in annual dentine growth layers. Although individuals differed markedly in bulk $\delta^{15}N$ and $\delta^{13}C$ (by up to 5 and 3 ‰, respectively) after accounting for sex, age class, and size, trophic level (as inferred from several trophic-source AA $\delta^{15}N$ metrics) explained virtually none of the among-individual variation in bulk $\delta^{15}N$ (R2 = 0.0 to 0.07). Baseline variation (δ^{15}NPhe and δ^{15}NLys proxies) was moderately correlated (R2 = 0.24 to 0.50) with bulk differences. In contrast, $\delta^{15}N$ of the physiology-sensitive AA Gly exhibited the strongest correlations with bulk $\delta^{15}N$ (R2 = 0.61), and accounted for substantial residual variation independent of baseline effects (R2 = 0.43). Strong bulk $\delta^{15}N$ correlations with δ^{15}NGly suggests persistent physiological individuality can impact long-term isotopic composition, likely amplified in collagen-rich tissues comprising relatively large amounts of Gly. Physiological masking of trophic signals in bulk $\delta^{15}N$ has direct implications for interpreting isotopic profiles and isotopic niches within the contexts of individual dietary specialisation and dietary breadth, while life-long consistency in isotopic composition points to the existence of physiological phenotypes (e.g., intrinsic metabolic differences) that could be as relevant as ecological differentiation.

Keywords: *beluga, compound-specific stable isotope analysis of amino acids (CSIA-AA), Delphinapterus leucas, individual specialisation, isotopic niche, MixSIAR, physiological phenotype*

Abstract 112 - Storsberg

Amino acids from dental enamel: A foundation for compound-specific isotope analyses

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[5]Department of Anthropology, University of Colorado, Boulder, Colorado, USA

Abstract:

Dental enamel represents an excellent bioarchive for the preservation of organic compounds. During biomineralisation, organic molecules become incorporated within bioapatite crystallites, protecting them from chemical and thermal alteration. This enables long-term preservation of endogenous amino acids (AAs) in fossil enamel, providing insights into ancient biological and environmental processes.

We have developed a method to purify AAs from enamel, involving oxidative cleaning with sodium hypochlorite to remove exogenous organic matter, hydrolysis of proteins to release individual AAs, ion exchange chromatography to separate these AAs from the mineral matrix, followed by quantification of 17 AAs using high-performance liquid chromatography (HPLC) and comparison with synthetic and enamel standards. We present data from modern African fauna (n = 62) and Plio-Pleistocene mammals from the hominin-bearing deposit of member 4 in the Sterkfontein Caves, South Africa (n = 10).

Amino acid ratios in modern specimens are highly consistent across taxa, indicating that taxonomy and diet exert minimal influence on enamel AA profiles. Consequently, AA quantification in diagenetically robust fossil dental enamel offers a promising screening tool for assessing the preservation of organic compounds in fossil remains. The preliminary fossil dataset reveals AA ratios and concentrations that are consistent with modern taxa, indicating good AA preservation in this deposit.

Future work will expand the dataset across broader temporal and spatial ranges and apply compound-specific isotope analyses of preserved AAs, which can be utilised for paleodiet reconstruction, such as the assessment of trophic level and tracing energy and nutrient flows, including differentiating between meat and plant intake.

Keywords: *paleo ecology, CSIA-AA, bioarchive, diagenesis*

Abstract 116 - Jędruch

Trophic plasticity of *Odontaster validus* under variable environmental and human impact in Antarctic coastal ecosystems: a stable isotope approach

Agnieszka Jędruch[1], Marcelina Ziółkowska[1], Agnieszka Jędruch[1], Dominika Saniewska[2]

[1]*Institute of Oceanography Polish Academy of Sciences*
[2]*University of Gdansk*

Abstract:

This study investigates the trophic plasticity of the sea star Odontaster validus across three Antarctic coastal zones subjected to different environmental pressures: anthropogenic, marine, and glacial impact. Stable isotope analysis of nitrogen ($\delta^{15}N$), carbon ($\delta^{13}C$), and sulfur ($\delta^{34}S$) was used to show trophic variability of *O. validus*. Results revealed notable differences in trophic niche size and location indicating high trophic plasticity of *O. validus*. The greatest niche similarity was observed between individuals from glacial and anthropogenic sites, while populations from marine-influenced areas exhibited distinct feeding strategies. A broad range of $\delta^{15}N$ and $\delta^{13}C$ values supports the opportunistic feeding behavior of this species. These findings highlight the adaptive capacity of *O. validus* to variable environmental conditions in Antarctic benthic ecosystems.

Keywords: *CNS stable isotopes; trophic ecology; benthic macrofauna; Antarctica*

Abstract 119 - Rakauskas

Invasive *Neogobius fluviatilis* in the Nemunas River basin: trophic role and overlap with native benthivorous fish

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Abstract:

The partitioning of trophic niches is central to understanding the ecosystem processes associated with biological invasions. The successful establishment of the monkey goby (*Neogobius fluviatilis*) in the Nemunas River basin in 2020 raised critical questions regarding whether this invader has occupied a distinct niche, the extent of its competition with native benthivorous fish, and the potential impact on commercially important species. We investigated two ecosystems within the Nemunas River basin: the Kaunas Reservoir (a lentic system) and the Neris River (a fast-flowing lotic system). Using a stable isotope approach, we identified potential trophic competitors of *N. fluviatilis*. We estimated standard ellipses as well as prediction ellipses scaled to 95% of the assemblage to represent the core and total trophic niches exploited by these benthivores, respectively.

The trophic niche width of the invader varies significantly between habitats. The invader exhibited a narrow isotopic niche in the lotic system (standard ellipse area: 2.8 ‰^{2}), compared to a considerably broader niche in the lentic ecosystem (standard ellipse area: 13.2 ‰^{2}). Analyses of total niche area overlap indicate potential trophic competition with only one species (*Cottus gobio*) in the lotic system, whereas in the lentic system, the invader overlaps with four commercially important species (*Rutilus rutilus, Perca fluviatilis, Cyprinus carpio,* and *Sander lucioperca*).

These findings suggest that *N. fluviatilis* possesses strong potential for competition in lentic waters. Conversely, in lotic environments, which are characterized by greater habitat heterogeneity, its competitive impact appears considerably weaker.

Keywords: *fish, trophic ecology, stable istope*

Abstract 120 - Rakauskas

Taxonomic sufficiency in the isotopic niche approach of lake macroinvertebrate assemblages: the effects of taxonomic resolution

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Abstract:

Taxonomic sufficiency has been extensively applied to lake macroinvertebrate assemblages, however empirical tests of its utility within the community-wide isotope niche approach remain scarce.

In this study, we analyzed the effects of taxonomic resolution (order, family, genus, and species levels) and data transformation on community-wide trophic niche metrics (Layman et al., 2007) in lake benthic macroinvertebrate assemblages. Samples were collected from 19 boreal lakes during the autumns of 2009–2014, and all specimens were identified to the species level. For Stable Isotope Analysis, whole-body amphipods, mysids, and insects were used, whereas mollusks were removed from their shells to analyze only soft tissues (mantle muscle, where possible). Each taxonomic group was divided into five analytical replicates, consisting of 3–15 individuals per replicate.

Six community-wide isotope metrics were employed to evaluate the impact of taxonomic resolution on macroinvertebrate isotopic niche shifts. The results indicated no significant differences in any of the metrics between the family and genus levels. However, the ecological information retained at the species level was statistically richer than at the family and genus levels. Conversely, information at the order level was significantly poorer. Interestingly, the overall degree of trophic diversity remained statistically reliable up to the order level. In conclusion, these results suggest that for macroinvertebrate community-wide isotopic niche studies, taxonomic identification to the family level is optimal, as it provides a robust balance between ecological accuracy and the effort required for species-level identification.

Keywords: *stable isotope, trophic niche, macroinvertebrate assemblages*

Abstract 128 - Newton

Raptors Unwrapped: Stable Isotopes Reveal Origins, Diet, and Capture Strategies of Mummified Birds of Prey in Ancient Egypt

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Abstract:

This project applies stable isotope ecology to investigate the large-scale exploitation of birds of prey in Late and Ptolemaic Egypt, when vast numbers of raptors were mummified on an industrial scale and interred in subterranean catacombs. By integrating isotope analysis with archaeological, textual, and iconographic evidence, we aim to reconstruct capture strategies, provisioning, and management of these birds.

Completely intact mummies were excluded to avoid destructive sampling, while highly fragmentary remains were unsuitable; partially unwrapped, well-preserved individuals were therefore selected for analysis. We analyse stable isotopes of hydrogen ($\delta^{2}H$), carbon ($\delta^{13}C$), nitrogen ($\delta^{15}N$), and sulfur ($\delta^{34}S$) in feathers from mummified raptors, identified to species level using radiographic methods, and including both migratory and resident taxa. These proxies provide insight into geographic origin, diet, and movement patterns. $\delta^{2}H$ values are particularly useful for identifying whether migratory birds were captured locally or imported, based on comparisons with modern keratin isoscapes. Carbon and nitrogen isotopes inform on trophic level and feeding regimes, while sulfur isotopes help refine geographic assignments.

We test the hypothesis that captive-bred or managed birds exhibit lower isotopic variance, reflecting controlled diets, compared to wild-caught individuals. Additionally, we assess whether increasing demand during industrialised mummification led to the procurement of birds from more distant regions over time.

By reconstructing individual life histories and population-level patterns, this study demonstrates the value of stable isotope ecology approaches to solve archaeological problems. It also provides a deep-time perspective on human impacts on raptor populations, offering insights relevant to modern conservation and wildlife exploitation.

Keywords: *Raptors, Migration, captive breeding, Ancient Egypt*

Abstract 130 - Jędruch

Triple-isotope insights into the trophic ecology of benthic macrofauna from Admiralty Bay, Antarctica

Agnieszka Jędruch[1], Marcelina Ziółkowska[1], Natalia Bulik[2], Ewa Korejwo[1], Dominika Saniewska[2]

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[2]*University of Gdańsk*
[3]*Lodz University of Technology*

Abstract:

Stable isotope analysis is a powerful tool for tracing trophic interactions and environmental change in polar marine ecosystems. In this study, we used a triple-isotope approach ($\delta^{13}C$, $\delta^{15}N$, and $\delta^{34}S$) to investigate the isotopic composition and trophic niches of four benthic macrofauna species from Admiralty Bay, maritime Antarctic: *Nacella concinna, Sterechinus neumayeri, Odontaster validus,* and *Ophionotus victoriae*. The aim was to assess how diet, spatial variability, glacier-related processes, and human activity influence isotopic patterns in this environmentally dynamic coastal system. Results showed that feeding strategy was the main driver of isotopic variability among species, with clear differences reflecting trophic position, dietary composition, and the relative importance of benthic versus pelagic food sources. Enriched $\delta^{13}C$ values together with depleted $\delta^{34}S$ indicated a stronger reliance on benthic-derived material, whereas lower $\delta^{13}C$ combined with higher, marine-like $\delta^{34}S$ suggested a greater contribution of pelagic sources. Spatial differences in isotope composition further revealed the influence of glacial melt and local environmental conditions, with consumers from glacier-affected areas showing distinct isotopic signatures compared with those from more open-marine settings. Notably, $\delta^{34}S$ emerged as a particularly informative tracer, helping to distinguish food sources and indicating potential human-related disturbance linked to anthropogenic sulfur inputs and altered redox conditions. The combined use of carbon, nitrogen, and sulfur isotopes therefore provides valuable insight into trophic ecology, benthic–pelagic coupling, and ecosystem responses to both natural and anthropogenic drivers in Antarctic coastal environments.

Keywords: *CNS stable isotopes; trophic ecology; benthic macrofauna; Antarctica*

Abstract 131 - Paredes de la Vega

The Gorgonian-Symbiont Partnership: Nutritional Dynamics Revealed by Stable Isotope Analysis

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Abstract:

As scleractinian corals decline across the Caribbean, gorgonians are becoming increasingly dominant, yet their nutritional ecology remains poorly understood. Early studies categorized gorgonians as uniform opportunistic suspension feeders, but recent evidence suggests species-specific variation in the balance between autotrophy (symbiont-derived nutrition) and heterotrophy (captured prey). This study asks whether colony morphology predicts a species' position on the autotrophy-heterotrophy spectrum. We hypothesized that sea fans would be more autotrophic, while sea rods would be more heterotrophic.

To test this, we applied the Host Evaluation Reliance on Symbionts (HERS) index, a novel metric that quantifies trophic strategy using stable isotopes data. Host and symbiont tissues from four Caribbean gorgonian species: sea fans (*Gorgonia ventalina, G. flabellum*) and sea rods (*Eunicea flexuosa, Plexaurella* sp.*).* Bulk $\delta^{13}C$ and $\delta^{15}N$ values, and isotopic niches were quantified using Stable Isotope Bayesian Ellipses in R (SIBER). HERS scores were calculated, integrating core (40%) and full (95%) niche overlap between symbiotic partners. Bootstrapping (10,000 resamples) generated robust estimates with 90% credible intervals.

Results revealed a clear trophic spectrum. *E. flexuosa* (HERS = 0.72) and G. ventalina (HERS = 0.78), indicating <70% reliance on symbiont-derived carbon. In contrast, *G. flabellum* (HERS = 0.38) and *Plexaurella* sp. (HERS = 0.21) demonstrating predominant reliance on heterotrophy. Notably, the two congeneric sea fans occupied opposite ends of the spectrum, challenging a morphology-based hypothesis.

The HERS index provides a novel quantitative metric for assessing nutritional strategies in symbiotic marine organisms, with applications for predicting reef community trajectories under climate change.

Keywords: *Niche, Trophic, Caribbean, Octocorals, Autotrophy, Heterotrophy*

Abstract 134 - Kopp

Variations in the trophic niche of elasmobranchs: rays' stable versus sharks' adaptative niches

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Abstract:

Sharks and rays, declining worldwide, display particularly slow life-history traits that increase their sensitivity to environmental variability by reducing their adaptative abilities. In a context of global warming and overfishing, elasmobranch distributional shifts were already observed but still, no evidence were provided to infer altered feeding behavior over short timescales in response to new environmental conditions. We examined the trophic niche variations of nine sharks and rays species over a 10-years period in the Celtic Sea using stable isotopes. A substantial expansion of the shark isotopic niche occurred in the Celtic Sea between 2014 and 2024 indicating a broader exploitation of trophic levels and prey resources. This increase is due to niche segregation among species, notably *Mustelus asterias* that diverge from *Scyliorhinus canicula* and *Squalus acanthias*. Regarding the ray community, a shift toward prey from more trophic levels and reduced reliance on carbon sources was highlighted but overall trophic niches remained quite stable.

Keywords: *Chondrichthyes; stable isotopes; dietary overlap; Celtic Sea*

Abstract 139 - Edwards

Ostrich Eggshell Beads as Proxies for Hunter-Gatherer Social Networks in the Later Stone Age of Southern Africa

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Abstract:

Our research aims to investigate the role of social networks among hunter-gatherers as a cultural adaptation to climate-induced resource stress. Ethnographic studies of hunter-gatherer groups in the central Kalahari describe social networks as a risk-buffering system during times of resource inaccessibility, such as drought. Social ties with groups occupying distinct ecological biomes allow resource-stressed groups to shift out of barren resource zones, sharing resources with groups situated in comparatively rich biomes. Social networks like this are an effective risk-mitigation strategy for groups occupying regions with fickle resource access, as seen across much of southern Africa. Ostrich eggshell beads are used to maintain these social bonds in ethnographic contexts, and archaeological evidence suggests a similar function in the past. The applicability of this model to Later Stone Age (LSA) communities will be tested using material from Klipfonteinrand (KFR1). A strontium ($^{87}Sr/^{86}Sr$) isoscape will be utilised to identify the most likely origins of OES beads. Comparing the spatial distribution of unworked, finished, and unfinished beads provides a proxy for the extent of interaction between groups. Together, these data allow the reconstruction of both social connectivity and environmental variability through time.

Keywords: *Hunter-gatherer social networks; Later Stone Age; Ostrich eggshell beads; Strontium isotopes; Isoscape; Social exchange*

Abstract 142 - Hayden

Individual variability in the isotopic composition of fish scales revealed by LA-IRMS

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Abstract:

LA-IRMS (laser ablation coupled with an IRMS system) has been demonstrated to be highly effective at generating high-precision characterisations of the isotope ratios of continuously growing plant tissues, suggesting potential for applications in animal hardstructures (bones, scales, feathers etc). Fish scales are one promising area for this research: scale samples from common species are routinely stored in fishery monitoring programs with EA-IRMS and GC-IRMS of these scales used to infer diet and migration of marine and freshwater fishes.

We used LA-IRMS to characterise the $\delta^{13}C$ values of scales sampled from fish belonging to three distinct life histories: freshwater (carp), anadromous-estuarine (sea trout) anadromous-marine (Atlantic salmon). To assess lifetime variation, we measured multiple locations corresponding to distinct summer growth bands on the upper and underside of fish scales.

No sample preparation was necessary except for cleaning and drying. Samples were placed in a specially designed ablation chamber (isoScell Δ200, Terra Analitic, Romania) and ablated using an LSX 213 G2+ laser module (Teledyne Photon Machines, USA) connected via a combustion and pre-concenration unit (CryoPrep, Sercon, UK) to a HS2022 IRMS (Sercon, UK). Ultra pure helium, at flows totalling 18 mLPM, was used as carrier gas. Spatial resolution on the smallest fish scale was set at 65µm.

The results provide some entirely novel insights into the isotopic composition of fish scales, revealing greater variability in transverse than longitudinal sections through scales. Crucially, while the lamellar composition of scales makes comparison between visual growth band and underlying isotopic composition challenging, LA-IRMS provides a new suite of tools with which to address these challenges.

Keywords: *LA-IRMS, fish scale, carbon, keratin & fisheries*

Abstract 143 - Choi

Tree-ring $\delta^{18}O$ cross-dating between Korea and Japan across different historical periods

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Abstract:

Previous studies using living trees have shown that tree-ring oxygen isotope ($\delta^{18}O_{tr}$) chronologies from southern Korea and central Japan reflect common summer hydroclimatic signals and show similar year-to-year variations despite the large distance between the two regions. This spatial coherence has allowed cross-dating between $\delta^{18}O_{tr}$ chronologies from Korea and Japan (Choi et al., 2024, 2025).

In this study, we examined whether this spatial coherence in $\delta^{18}O_{tr}$ can also be identified in archaeological and historical wood from different periods in the past. We analyzed excavated wood from Bangu-dong, Ulsan, and timbers from a traditional house on Jeju Island, both in southern Korea. Their $\delta^{18}O_{tr}$ chronologies were successfully cross-dated with a long $\delta^{18}O_{tr}$ chronology from central Japan. The Ulsan wood was dated to 752–861 CE, while the Jeju timbers were dated to 1549–1859 CE.

These results show that the spatial coherence in $\delta^{18}O_{tr}$ signals between Korea and Japan can be traced back at least to the eighth century. This finding suggests that common broad-scale hydroclimatic influences may have affected $\delta^{18}O_{tr}$ in both regions during different historical periods in the past. Building a continuous long-term $\delta^{18}O_{tr}$ chronology in Korea will help us better understand the temporal stability and climatic drivers of this spatial coherence. Extending these chronologies could also support long-term paleoenvironmental reconstruction and, when combined with archaeological and historical records, provide a framework for investigating relationships between environmental change and past societies in East Asia.

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Keywords: *Tree ring, Oxygen isotope, Korea, Japan, Cross dating, Archaeological wood*

Abstract 144 - Tong

How Coral Trophic Strategies Drive Post-Bleaching Recovery Dynamics

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Abstract:

Since 1997, several major bleaching events in Hong Kong have revealed differential susceptibility and recovery capacities among local corals. While the trophic strategy of a coral is well established as a strong predictor of stress resistance and resilience, resistance patterns do not always predict long-term recovery trajectories. For instance, a previous warming experiment on local coral species demonstrated that trophic strategies strongly correlate with bleaching resistance—obligate autotrophs bleached first, while heterotrophic species bleached last. Yet, post-bleaching field surveys indicated that the highly heterotrophic *Platygyra carnosa* actually took the longest to recover. Stable isotopes serve as effective tracers of nutritional recovery; specifically, the carbon isotopic compositions of the animal host ($\delta^{13}C_h$) and the endosymbiont ($\delta^{13}C_e$) reflect shifts in autotrophic versus heterotrophic carbon allocation. This study aims to elucidate the distinct roles of photoautotrophy and heterotrophy during long-term recovery following experimental bleaching. We will artificially bleach two species with contrasting trophic strategies: *Acropora digitifera* (autotrophic) and *Duncanopsammia peltata* (heterotrophic). By using $\delta^{13}C$-enriched dissolved inorganic carbon to label photoautotrophic pathways and $\delta^{13}C$-enriched rotifers to label heterotrophic pathways, we will quantify the proportional contribution of each carbon source monthly over a four-month period—the timeframe typically reported for most local corals to recover from bleaching. Ultimately, these results will test whether recovery patterns mirror resistance patterns, a critical insight for scenarios of recurrent bleaching where recovery capacity increasingly dictates coral survival.

Keywords: *Recovery, trophic strategy, coral*