

Curriculum Vitae



Niculina Musat
Associate Professor

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Research Interests

My research interest lies within microbial ecophysiology and single cell microbiology with emphasis on the study of microbial metabolic interactions in natural and synthetic environments. My aim is to understand the way microorganisms are pairing with each other structurally and metabolically and the underlying mechanisms that lead to the successful functioning of such partnerships. A dedicated part of my research involves methodological developments coupling the use of chemical imaging by mass spectrometry and spectroscopy, isotope tracers and high-resolution electron and light microscopy to study microbial metabolism and interactions with single cell resolution. Correlative analyses for identification, quantification and chemical mapping of microbial cells, subcellular components and their metabolic products it is at the forefront of my current research.

Academic employment

CURRENT POSITION

Associate Professor, Dept. Biology, Section for Microbiology, Aarhus University

PREVIOUS POSITIONS

- 2012- 2023 Scientific Head of Centre for Chemical Microscopy (ProVIS), Department of Isotope Biogeochemistry, UFZ, Leipzig, Germany
- 2008 – 2012 Scientist, Max-Planck Institute for Marine Microbiology (MPI-MM), Department of Biogeochemistry, Bremen, Germany
- 2006 – 2008 Postdoctoral Fellow, MPI-MM, Nutrient research group, Bremen, Germany

OTHER POSITIONS

- 2001 – 2002 Research assistant in microbiology, National Institute for Research and Development in Physics and Nuclear Engineering, 'Horia-Hulubei', Romania.
- 2000 – 2001 Biologist, Shigella–Pseudomonas Department, Cantacuzino Institute, RO.
- 2000 – 2001 Research assistant, Microbial-Genetics Department, Faculty of Biology, University of Bucharest, RO (part time job).
- 2021 – 2023 Associate Research Fellow, Centre of Systemic Biology, Biodiversity and Bioresources, University Babes-Bolyai, Cluj-Napoca, RO.

Education

- 2002 – 2006 PhD (Dr. rer. nat.) in Biology, *magna cum laude*, Max Planck Institute for Marine

Microbiology & University of Bremen, Germany. Dissertation title: *Molecular characterization of symbiotic associations between chemoautotrophic sulphur-oxidizing microorganisms and nematodes in shallow marine sediments.*

PhD defence date: June 2006. PhD Advisor: Prof. Dr. Nicole Dubiler.

The PhD program was part of the International Max Planck Research School of Marine Microbiology (MARMIC), Bremen, Germany.

1999 – 2001 Master of Science (M.Sc.) in Microbial Genetics, Department of Genetics, Faculty of Biology, University of Bucharest, Romania. Thesis title: *Comparative analyses of Pseudomonas aeruginosa strains isolated from clinical products and natural environments.* University of Bucharest, Romania. MSc defence date: February 2001.

1995 – 1999 Bachelor of Science (BSc) in Biological Sciences
Faculty of Biology, University of Bucharest, Romania

Identifiers & Web Profiles

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Scopus Author ID	16304834300
Institution Homepage	https://pure.au.dk/portal/da/persons/niculina.musat%40bio.au.dk
ResearchGate profile	https://www.researchgate.net/profile/Niculina-Musat
Google Scholar profile	https://scholar.google.de/citations?user=ZnprWEAAAAAJ&hl=en

Research expertise

For over 15 years I have centered my research on developing novel single-cell chemical imaging and correlative microscopy approaches to answer fundamental questions in environmental microbiology and microbial ecophysiology. I was pioneering the development and application of FISH-SIP-nanoSIMS, a technique that combines stable isotope probing (SIP), Fluorescence In Situ Hybridization (FISH) and nano-scale Secondary Ion Mass Spectrometry (nanoSIMS) to link microbial phylogeny to function at single-cell level in complex environmental samples. My initial developmental single cell work (Musat et al., 2008, PNAS) led to the establishment of the first nanoSIMS facility in Germany, at the Max-Planck Institute for Marine Microbiology in Bremen. This facility is dedicated exclusively to chemical imaging in life sciences and microbiological research. For over 10 years I have led the ProVIS Centre for Chemical microscopy at the Helmholtz Centre for Environmental Research - UFZ, Leipzig. I was involved in the establishment of ProVIS, starting from April 2012, its organization and management. I have conducted research on microbial ecophysiology and cell-to-cell metabolic interactions leading a team of over 15 scientists, including senior scientists, PhD and MSc students, and postdocs. My responsibilities included the coordination of the instrument operators, technicians, scientific activities (project meetings, collaborative projects, teaching), internal and external usage of instrumentation.

As scientific head of ProVIS, I was pursuing an own research agenda focused on the development and application of correlative, high-resolution chemical imaging approaches to understand single cell metabolism, to study cell-to-cell metabolic interactions, and to define the role of individual cells in biogeochemical processes in natural and human-impacted ecosystems. My main expertise is associated with fundamental aspects of microbial interactions and microbial associations, including nutrient and carbon transfer within fresh water and marine communities, metabolic interactions in multispecies assemblages, and in permanently established symbiotic associations.

My broad research & methodological expertise extends to the following:

Microbial Molecular Ecology with single cell resolution
Cell to cell metabolic interactions

Single cell techniques and approaches (FISH, CARD-FISH, NanoSIMS, Laser dissection microscopy (LMD), Raman microscopy
Stable isotope probing (SIP) to study cellular metabolism and interspecies interactions in complex microbial communities in situ and ex situ
Application of SIP-Nanoscale Secondary Ion Mass Spectrometry (NanoSIMS) in microbiology & cell biology
Correlative microscopy, chemical imaging and underlying sample preparation concepts and techniques for environmental samples, including cryo-fixation, freeze substitution, resin embedding and ultramicrotomy/cryomicrotomy.

Research grants & awards (selected)

2023 – 2026 PI, Allen Distinguished Investigator award (1.999.732 \$), Paul G. Allen Frontiers Group, USA
2023 – 2026 PI, PNRR/2022/C9/MCID/I8 EU financed National Recovery and Resilience Plan program for Romania (1.4 mil. €), EU, RO - **declined**.
2022 – 2025 Co-I, DFG SPP 2330 grant (243.000 €), German Science Foundation, DE
2020 – 2023 PI, Helmholtz-UFZ PhD College project grant (150.000 €), UFZ Leipzig, DE.
2018 – 2022 Co-I, DFG SPP grant, (321.000 €), German Science Foundation, DE
2016 – 2019 PI, Helmholtz-UFZ PhD project grant (150.000 €), UFZ Leipzig, DE
2015 – 2017 Co-I, PhD project grant (244.000 €), Federal Ministry of Education and Research (BMBF), DE

Academic Service

Since 2017 **Reviewer for international funding agencies:** Swiss National Science Foundation (SNF), Austrian Science Foundation (FWF), German Science foundation (DFG), European Research Council (ERC), British Research Council (NERC), UTS: GRADUATE RESEARCH SCHOOL, University of Technology Sydney, School of Life Sciences. REinforcing Women In REsearch (REWIRE) Fellowship Programme of the University of Vienna, French National Research Agency (Agence Nationale De LA Recherche - ANR), Swedish Research Council
Since 2017 **External referee & opponent** at Ph.D. defences in Sweeden, Australia, Germany
Since 2015 **Conference committee member & organizer:** ICCE in Leipzig (2015), Goldschmidt in Paris (2017); NanoSIMS user meeting in Leipzig (2017), ISME 17 in Leipzig (2018) and NanoSIMS workshop, Teddington, (2022).
2018 – 2019 **Guest Editor**, Frontiers in Microbiology, Microbial Physiology & Metabolism
Since 2010 **Reviewer for 20+ journals**, including Nature Microbiology, Nature Communications, and ISME Journal

Research expeditions

Mediterranean Sea, Elba, Italy 07/2003 and 06/2004
Wadden Sea, Sylt, Germany, 10/2003; 03/2004; 10/2006; 5/2011
Atlantic Ocean, Lee Stocking Island, the Bahamas, 11/2004
Lake Cadagno, Switzerland, 09/2009
Atlantic Ocean, Cape Verde Islands, 12/2010
Holtemme River, Saxony-Anhalt, Germany, 2016-2019, several sampling campaigns

Mentoring & Training

2013 – 2023 6 postdoctoral fellows (Dept. of Isotope Biogeochemistry, Helmholtz Centre for Environmental Research-UFZ Leipzig; Medical centre, IFB Adiposity Diseases, University Hospital Leipzig, Germany; Department for Biology and Environmental Sciences, University of Gothenburg, Sweden).

2009 – 2023 10 PhD Students (2 ongoing) (Section for Microbiology, Aarhus University; Isotope Biogeochemistry Department, Helmholtz Centre for Environmental Research-UFZ & University of Leipzig, Germany; Faculty of Chemistry and Physics, University of Freiberg, Germany; UNESCO-IHE, University of Cassino and Southern Lazzio, Italy; Spanish Institute of Oceanography (IEO) Gijón/Xixón, Spain; Max Planck Institute for Marine Microbiology and University of Bremen, Germany).

2008 – 2022 6 M. Sc. Students (Medical centre, IFB Adiposity Diseases, University Hospital Leipzig, Germany. ICBM and University of Oldenburg, Germany; MPI, Bremen, Germany, Dept. of Isotope Biogeochemistry, UFZ Leipzig).

Career Brakes: Maternity leave 01.06. 2008 –30.06.2009 and 15.06.2014 – 1.10.2015 (29 months)

Track Record

- **Publications:** > 60 of which 30 as first, last, or corresponding author
- Sum of times cited 4800+ (see <https://scholar.google.de/citations?user=ZnprWEAAAAAJ&hl=en>)
- **h-index** 30 according to Google Scholar
- **16 highly cited** papers, in Ecology/Environment, Biology/Biochemistry, Web of Science
- **Other publications:** 2 books chapters on Stable isotopes in Single-cell Microbiology
- **30+ invited talks** at conferences & universities

Organisation of scientific meetings

2015 Organizer of Satellite session – *High-resolution imaging and correlative analyses in life sciences down to sub nanometre scale* – ICCE meeting, Leipzig, Germany.

2017 Theme chair *Innovation in (bio) geo-chemicals methods*, Goldschmidt, Paris, France

2017 Organizer of the 7th International NanoSIMS user meeting - *NanoSIMS & correlative microscopy: exploring physical and biochemical boundaries*, August, Leipzig, Germany

2018 Convener of the *Microbial interactions - a single cell perspective* session, ISME17, 18-22 August, Leipzig, Germany.

2022 Organizing & Scientific committee member of the 2022 NanoSIMS Workshop, NPL, Teddington, UK

Reviewing Activities

2008 – 2024: Manuscript reviewer for peer-reviewed journals: *Nature Communication, Nature Microbiology Environmental microbiology, ISME-Journal, Polar Biology, Systematic and Applied Microbiology, Journal of Microbiological Methods, Aquatic Microbial Ecology, Rapid Communications in Mass Spectrometry, Scientific Reports – Nature, L&O methods, O-sphere, Frontiers in Microbiology.*

2013 – 2024: External reviewer and panel member for: *Swiss National Science Foundation (SNF), Austrian Science Foundation (FWF), German Science foundation (DFG), European Research Council (ERC), Marie Skłodowska-Curie Actions, British Research Council (NERC), UTS: GRADUATE RESEARCH SCHOOL, University of Technology Sydney, School of Life Sciences. REinforcing Women In Research (REWIRE) Fellowship Programme of the University of Vienna, French National Research Agency (Agence*

Nationale De LA Recherche - ANR), Swedish Research Council.

Invited Presentations (selection, past 7 years)

ASM meeting, New Orleans, USA **1-5 June 2017**, (invited speaker) for the Ecology of the Individual Microbe symposia. Title of the talk - *NanoSIMS & ToFSIMS to tackle cell-to-cell interactions in symbiotic and commensal systems*.

Summer school, **13-15th September 2017**, UFZ Leipzig, organized within the Priority programme “Iron-Sulfur for Life” (SPP 1927) of the German Research Foundation (DFG). Invited speaker, title of the talk - *NanoSIMS at the cutting edge – applications, challenges and future research directions in single-cell microbiology*.

WIMEK-Hi-grade course “Stable isotope applications in microbiology and environmental studies, **10-14th December 2017**, Wageningen University, Netherlands. Invited speaker, title of the talk – *Linking microbial identity and function– a single cell approach using nanoSIMS and FISH*.

ISME 17, Microbial Interactions - a single cell perspective, **12-17th August 2018**, Leipzig, Germany, invited speaker, title of the talk – *Metabolic interactions in permanent and temporary formed associations*

Advanced Microscopy & Biomedicine meets NanoSIMS, Symposium, **23rd – 24th, 2018**, University Medical Center, Göttingen, Germany. Invited speaker, title of the talk – *NanoSIMS single-cell imaging – challenges, recent applications and future research directions in environmental microbiology*

Guest Seminar Series, Stockholm University, **5th of November 2020**. Invited speaker, title of the talk: *Correlative and chemical microscopy as tools to analyze the function of microorganisms – one cell at the time*

Seminar Soil science, Institute of Plant Nutrition and Soil Science, Christian-Albrechts-University Kiel, **24th February 2021**. Invited speaker, title of the talk: *Fluorescence in situ hybridization for identification and quantification of microbial cells in soil, sediment and water samples & its combination with nanoSIMS*

MS Imaging Seminar Series, University of Gothenburg, **9th of September 2021**. Invited speaker, title of the talk: *Spatially resolved function of microbial cells in natural habitats – A single cell approach by nanoSIMS imaging and complementary techniques*

Science Ongoing seminar, Romania, outreach talk, 12th of January 2022. Invited guest, talk title: *Spatial dimension of microbial function in the environment – from single cells to biogeochemical cycles*

NanoSIMS Webinar: Imaging nature on a nano-scale, **11th of May 2022**, organized by nanoSIMS facility Utrecht. Invited Speaker, title of the talk – *Nano-scale Secondary Ion Mass Spectrometry (nanoSIMS) to identify and trace microbial processes and interactions*

UK Surface Analysis Forum, Summer meeting **2022, 13-14th July**, Manchester UK. Invited Speaker, title of the talk – *Isotope and molecular probing coupled to NanoSIMS in (micro)-biology*

30th Anniversary of Max Planck Institute for Marine Microbiology, Bremen, Germany, **August 22nd-23rd, 2022**. Declined on short notice due to CoVID infection.

NanoSIMS Conference, National Physical Laboratory, Teddington, UK **17th –19th October 2022**.

Contributed talk 1. *NanoSIMS and stable isotope probing to trace the fate and effects of microplastics and antibiotics at the single cell level*

Contributed talk 2. *Isotope labelling & biological sample preparation for correlative imaging and NanoSIMS*

RoBioinfo Conference, Institute of Cellular Biology and Pathology "Nicolae Simionescu" Romanian Academy, Bucharest, **May 11-13, 2023**; *Linking phylogenetic identity to cell function by fluorescence and chemical imaging*

Electromicrobiology Conference **May 2023**, Aarhus, DK; *Microbial interactions - a nanoSIMS perspective*

GeoBio seminar series, German Research Centre for Geosciences (GFZ), Potsdam, Germany, **March 12th, 2024**; *Microbial processes under beam: correlative microscopy and chemical imaging to investigate single-cell metabolism and cell to cell interactions*

EMBO course "Imaging Marine Organisms Across Scales" Napoli, **April 9-12, 2024**; *Imaging microbial cells - identity and function at a glance*

Major Collaborations

Stefan Sievert, Scientist; anaerobic microbial communities in deep sea habitats; Woods Hole Oceanographic Institution, USA; Amelia-Elena Rotaru, Professor; Syntrophic interspecies interactions; University of Southern Denmark; Horia Banciu, Professor, Molecular Biology and Biotechnology; University Babes-Bolyai Cluj, Romania Visualization of extremophiles by FISH and CARD-FISH; Cristina Moraru, Scientist; Marin heterotrophic bacteria-phage interactions, Institute for Chemistry and Biology of the Marine Environment, Oldenburg; Peter Kovacs, IFB-Professor Universität Medizin, Leipzig; identification of bacteria in adipose tissue; Bilal Sheikh, group leader, Helmholtz Institute for Metabolic, Obesity and Vascular Research (HIMAG)*, Helmholtz Munich; epigenetics, subcellular imaging mass spectrometry; Daniela Branzan, Prof. Dr. Dr. med. habil Clinic and Polyclinic for Vascular and Endovascular Surgery at Klinikum rechts der Isar, Munich, Germany, association between cardiovascular disease (CAD) and microbiota and potential implications for human health. Uta Paszkowski, Professor, Plant Molecular Genetics, Department of Plant Sciences, University of Cambridge; root-fungi interactions & imaging mass spectrometry.

Publications

The following list contains a selection of major publications I made significant contributions as first, corresponding or last author. A full list of publications is available at <https://orcid.org/0000-0001-9539-189X>

1. **Musat N.**, Halm H., Winterholer B., Hoppe P., Peduzzi S., Hillion F., Horreard F., Amann R., Jorgensen B.B., Kuypers M.M.M. (2008) A single cell view on the ecophysiology of anaerobic phototrophic bacteria, *Proc Natl Acad Sci USA*, 105 (46), p. 17861-17866
2. **Musat N.**, Musat F., Weber P.W. & Pett-Ridge J. (2016): Tracking microbial interactions with NanoSIMS, *Curr Opin Biotechnol* 41:114–121
3. Worrich A., Stryhanyuk H., **Musat N.***, König S., Banitz T., Centler F., Frank K., Thullner M., Harms H., Richnow H.-H., Miltner A., Kästner M., Wick L.Y. (2017): Mycelium-mediated transfer of water and nutrients stimulates bacterial activity in dry and oligotrophic environments, *Nat Communications* (DOI: 10.1038/ncomms15472), * Corresponding author
4. Decelle, J., Stryhanyuk, H., Gallet, B., Veronesi, G., Schmidt, M., Balzano S., Marro, S., Uwizeye, C., Jouneau, P.-H., Lupette, J., Jouhet, J., Marechal, E., Schwab, Y., Schieber, N.L., Tucoulou, R., Richnow, H.H., Finazzi, G., and **Musat, N.** (2019): Algal Remodeling in a Ubiquitous Planktonic Photosymbiosis *Current Biology* 29 (6), 968 – 978
5. Decelle, J., Veronesi, G., Gallet, B., Stryhanyuk, H., Benettoni, P., Schmidt, M., Tucoulou, R., Passarelli, M., Bohic, S., Clode, P., **Musat, N.** (2020): Subcellular Chemical Imaging: New Avenues in Cell Biology *Trends in Cell Biology* DOI: <https://doi.org/10.1016/j.tcb.2019.12.007>
6. Arandia-Gorostidi*, N., Alonso-Sáez, L., Stryhanyuk, H., Richnow H.H., Xosé Anxelu, X., Morán, G., **Musat, N.*** (2020): Warming the phycosphere: differential effect of temperature on the use of Diatom derived carbon by two copiotrophic bacterial taxa, *Environmental Microbiology*, DOI:10.1111/14622920.14954 (*Corresponding author)
7. Calabrese, F., Stryhanyuk, H., Moraru, C., Schlomann, M., Wick, L., Richnow, H., Musat, F., **Musat, N.** (2021): Metabolic history and metabolic fitness as drivers of anabolic heterogeneity in isogenic microbial populations, *Environmental Microbiology*, DOI:10.1111/1462-2920.15756
8. Decelle, J., Veronesi, G., LeKieffre, C., Gallet, B., Chevalier, F., Stryhanyuk, H., Marro, S., Ravanel, S., Tucoulou, R., Schieber, N., Finazzi, G., Schwab, Y., **Musat, N.** (2021): Subcellular architecture and metabolic connection in the planktonic photosymbiosis between Collodaria (radiolarians) and their microalgae, *Environmental Microbiology*, <https://doi.org/10.1111/1462-2920.15766>
9. Bandara, C.D., Schmidt, M., Davoudpour, Y., Stryhanyuk, H., Richnow, H.H., **Musat, N.** (2021): Microbial Identification, High-Resolution Microscopy and Spectrometry of the Rhizosphere in Its Native Spatial Context, *Frontiers in Plant Science*, 12, 668923
10. Arandia-Gorostidi, N., Berthelot, H., Calabrese, F., Stryhanyuk, H., Klawonn, I., Iversen, M., Nahar, N., Grossart, H.-P., Ploug, H., **Musat, N.** (2022): Efficient carbon and nitrogen transfer from marine diatom aggregates to colonizing bacterial groups. *Scientific Reports*, 12, art. 14949
11. Li Cui, Yuhan Xin, Kai Yang, Hongzhe Li, Fengjiao Tan, Yulong Zhang, Xingrui Li, Zhi Zhu, Jun Yang, Shuh-Ji Kao, Bin Ren, Yong-Guan Zhu, Florin Musat, **Niculina Musat**, (2023); Live tracking metabolic

networks and physiological responses within microbial assemblages at single-cell level, **PNAS Nexus**
doi.org/10.1093/pnasnexus/pgad006

12. Xiang Q., Stryhanyuk, H., Schmidt M., Kümmel S., Richnow H.H., Zhu Y.G., Li Cui L., **Musat, N. (2024)**: Stable isotopes and nanoSIMS single-cell imaging reveals soil plastisphere colonizers able to assimilate sulfamethoxazole, **Environmental Pollution**, DOI: 10.1016/j.envpol.2024.124197

13. Musat F., Kjeldsen K.U., Rotaru A.E., Chen S.C., **Musat N., (2024)**: Archaea oxidizing alkanes through alkyl-coenzyme M reductases, **Current Opinion in Microbiology**, DOI: 10.1016/j.mib.2024.102486