



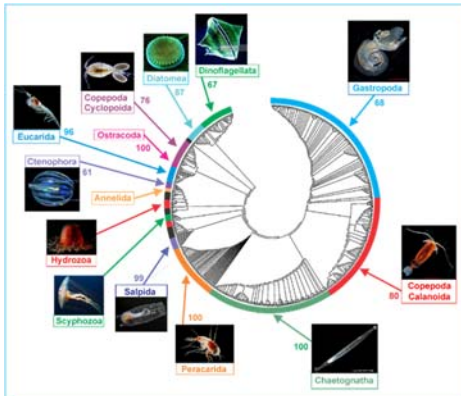
SCOR WG157

# MetaZooGene



**Toward a new global view of marine zooplankton biodiversity based on DNA metabarcoding and reference DNA sequence databases**

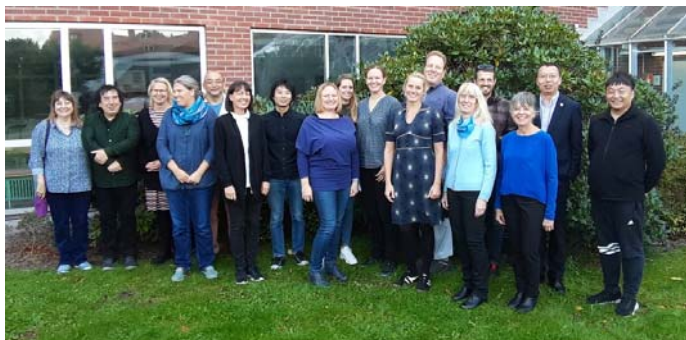
*Pennie Lindeque, Plymouth Marine Laboratory  
Ann Bucklin, University of Connecticut (USA)  
Ocean Biomolecular Observing Network Meeting Sept. 22*



[metazoogene.org/](http://metazoogene.org/) and [scor-int.org/group/157](http://scor-int.org/group/157)

SCOR WG157

# MetaZooGene



2019 – Gothenburg Global Biodiversity Centre (Sweden)



2020 – Ocean Sciences Meeting, San Diego (USA)

**Total of 23 members from 19 countries**



## **Chair and Co-Vice-Chairs**

- Ann Bucklin (Chair), Univ. Connecticut (USA)
- Katja Peijnenburg (Vice-Chair), Naturalis Biodiversity Centre (NL)
- Ksenia Kosobokova (Vice-Chair), Russian Acad. Sciences (RU)

## **SCOR WG157 Full Members:**

- Leocadio Blanco-Bercial, Bermuda Inst. Ocean Sciences (BM)
- Tone Falkenhaus, Inst. Marine Research (NO)
- Junya Hirai, Univ. Tokyo (JP)
- Jenny Huggett, Dept. Environmental Affairs (SA)
- Chaolun Li, Chinese Acad. Sciences (CN)
- Ryuji Machida, Academia Sinica (TW)
- Todd O'Brien, NOAA Fisheries (USA)

## **SCOR WG157 Associate Members:**

- Keun-Hyung Choi, Chungnam National Univ. (KR)
- Astrid Cornils, Alfred Wegener Inst. (DE)
- Bruce Deagle, Australian Antarctic Div. (AU)
- Ruben Escibano, Univ. Concepción (CL)
- Erica Goetze, Univ. Hawaii at Manoa (USA)
- Tamar Guy-Haim, National Inst. Oceanography (IL)
- Aino Hosa, Univ. Museum of Bergen (NO)
- Silke Laakmann, Univ. Oldenburg (DE)
- Pennie Lindeque, Plymouth Marine Lab (UK)
- Maria Grazia Mazzochi, Stazione Zool. Anton Dohrn (IT)
- Mary Mar Noblezada, Univ. Philippines (PH)
- Naiara Rodriguez-Ezpeleta, AZTI (ES)
- Agata Weydmann, Univ. Gdańsk (PL)

SCOR WG157

# MetaZooGene



## Primary focus:

~8,000 species of holozooplankton (15 phyla, 32 classes) of animals that drift with ocean currents

## Primary goal:

Integrative molecular – morphological taxonomic analysis of marine zooplankton biodiversity throughout global ocean

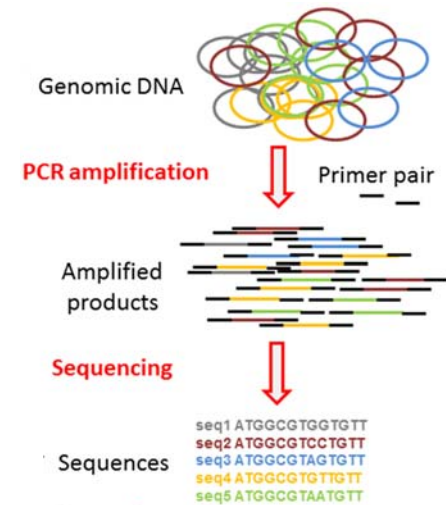
## Terms of Reference

- 1) Create an open-access web portal for DNA barcodes for marine zooplankton
- 2) Design an optimal DNA barcoding pipeline for marine zooplankton
- 3) Develop best practices for DNA metabarcoding of marine zooplankton biodiversity





# Metabarcoding of Marine Zooplankton

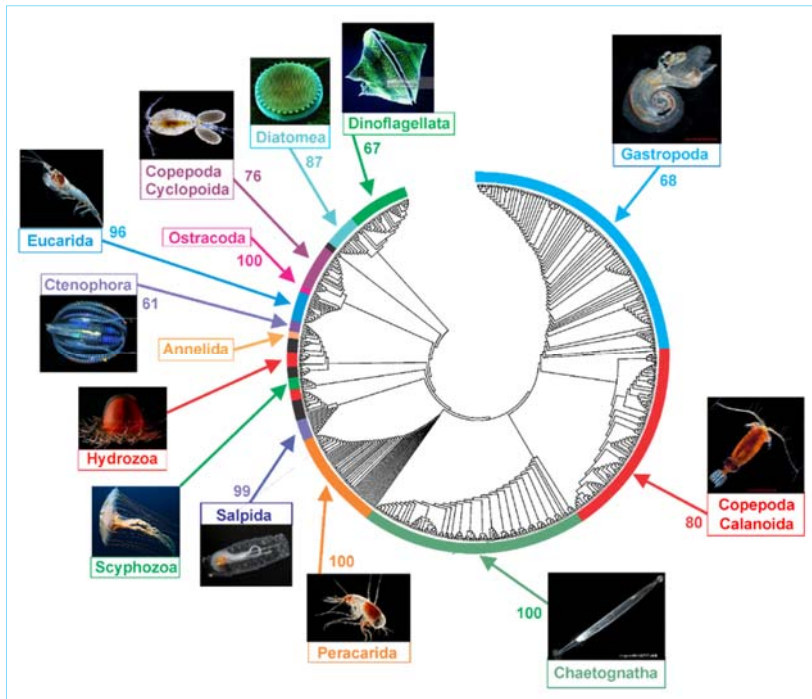


- **Extraction of genomic DNA from environmental samples**
- **High-throughput DNA sequencing (Illumina MiSeq)**
- **PCR of short gene regions (mtCOI, 18S rRNA, others)**
- **Bioinformatic pipelines (Mothur, DADA2) for sequence QC and analysis**
- **Statistical analysis of biodiversity (Mothur, R, MatLab)**

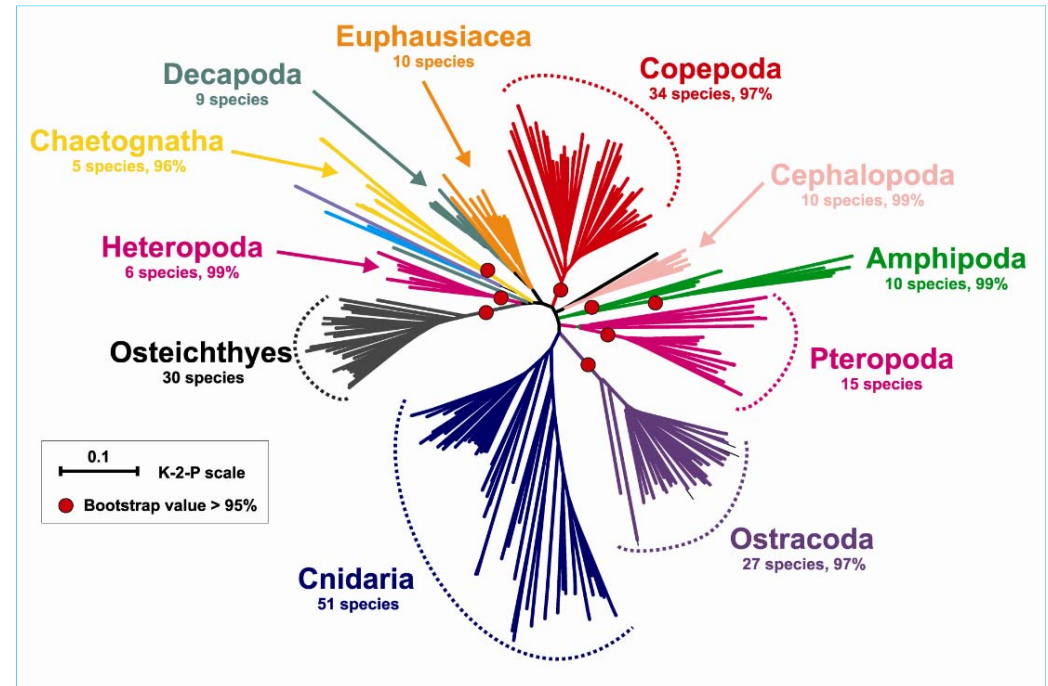
# MetaZooGene

## Metabarcoding of Zooplankton Diversity

- 18S rRNA “Tree of Life” gene resolves groups (not species) of pelagic assemblage
- MtCOI barcode region identifies species of some (not all) groups



18S rRNA V9 hypervariable region  
Figure: Bucklin et al. (2019)



MtCOI barcode region  
Figure: Bucklin et al. (2010)



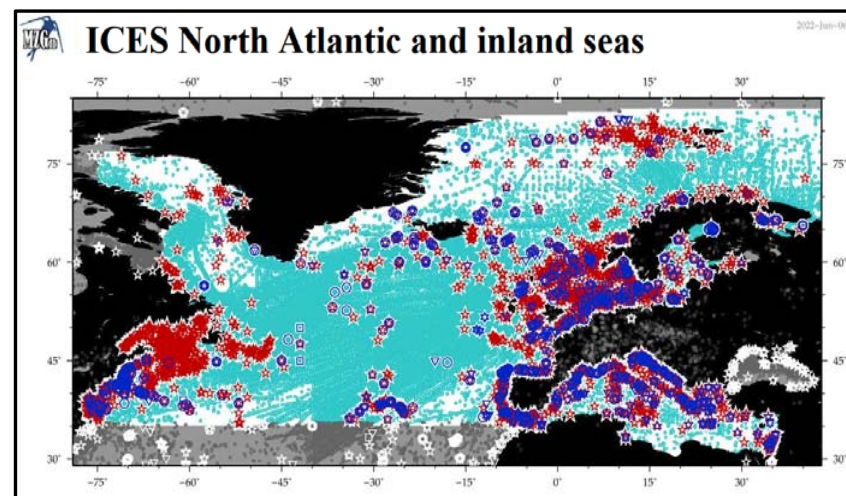
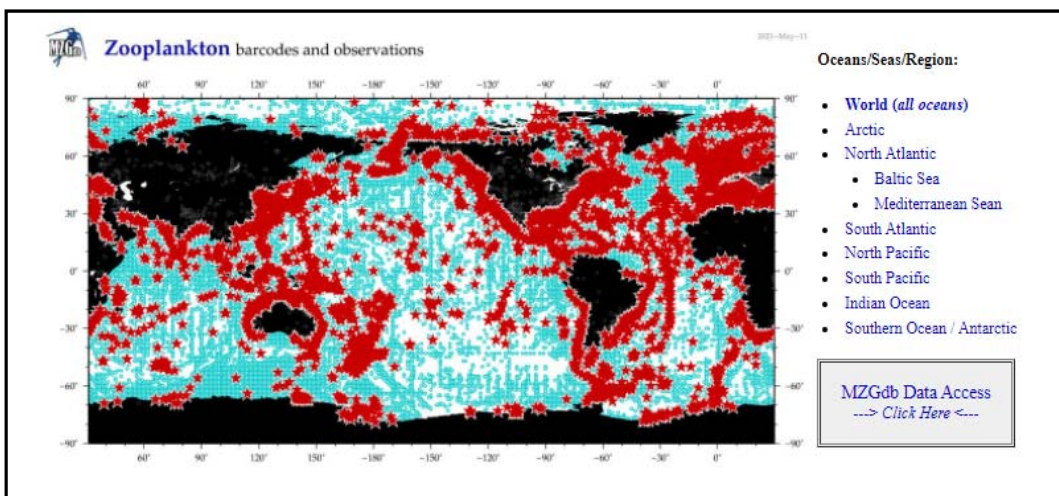
SCOR WG157

# MetaZooGene



## MetaZooGene Barcode Atlas & Database (MZGdb) Todd O'Brien, NOAA Fisheries (USA)

- Over 218,299 COI sequences for 11,356 species of marine zooplankton
- MZGdb expanded to include 18S rRNA & other gene regions; adding fish & protists
- Data from NCBI GenBank & BOLD (duplicates removed)
- Searchable by taxonomic group and ocean region



<http://metazoogene.org/atlas> & <https://wgimt.net/molecular/atlas>







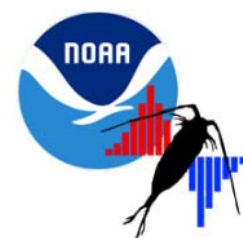
Exploring Marine Zooplankton with the  
MetaZooGene Barcode Atlas and Database (MZGdb)  
Todd O'Brien\*, NOAA Fisheries (USA)

*“What we know, where we know it, and what we still need to discover”*

Barcoding/Biodiversity Question	GenBank / BOLD	COPEPOD / OBIS	MZGdb
<i>How many zooplankton species have already been barcoded?</i>	✓	n/a	✓
<i>Which species are found in my ocean or region of interest?</i>	✗	✓	✓
<i>Which species (globally or in my focus region) have <u>not</u> been barcoded?</i>	✗	n/a	✓
<i>Which taxonomic groups are “under-barcoded” in my region?</i>	✗	n/a	✓
<i>Which oceans and taxa have the greatest need for new barcoding?</i>	✗	n/a	✓

<http://metazoogene.org/atlas>

COPEPOD: Coastal and Oceanic Plankton Ecology, Production, and Observation Database





Todd O'Brien  
SCOR WG157  
MetaZooGene

# The MetaZooGene Barcode Atlas and Database

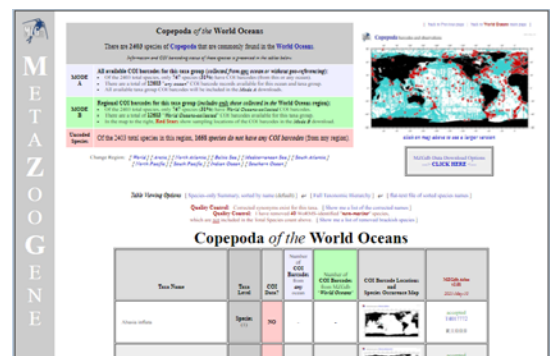
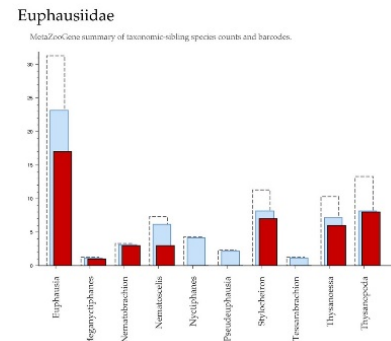
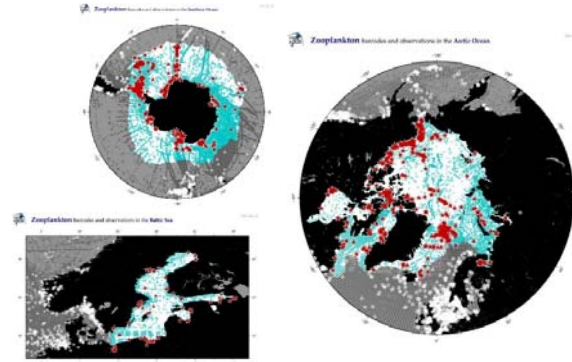
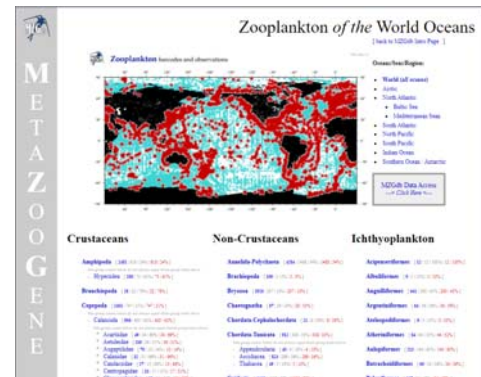
<http://metazoogene.org/mzgdb>

an **ATLAS** with *thousands* of **maps** and figures and summary tables that detail coverage by taxonomic group, and geographic region, and barcode type.

- Which taxa groups and ocean regions have the best coverage?
- Which taxa groups and regions need work (e.g., ideal for expanded/future sampling focus)?

a **DATABASE** with **data** divided by taxa group, geographic region, and barcode type.

- Reduce data processing by limiting barcodes to the taxa and geographic regions relevant to your work.
- The Mediterranean Sea has 1/3 of the species found in the North Atlantic, and 1/9 of "global" species.



METAZOOGENE

METAZOOGENE





Todd O'Brien  
SCOR WG157  
MetaZooGene

## What we discovered ...

- Best barcoding **geographic (spatial) coverage** was usually along the coastlines, and densest in the North Atlantic and North Pacific.
  - The Indian Ocean and South Pacific need more barcode sampling.
- Best barcoding **taxonomic (species) coverage** was found in the larger (*easier to identify?*), dominant/common species and taxa groups.
  - Barcodes for rarer species will be needed for accurate biodiversity applications.
- The original MZGdb focus was “**marine zooplankton**” ... but ...
  - *benthic* species (“*meroplankton*”) are often present (especially nearshore)
  - our Baltic Sea and estuarine colleagues/users have *non-marine* species
  - zooplankton nets **also** capture various *phytoplankton* and *larval fish*
  - eDNA wants “everything else” (*marine mammals* and *sea turtles*)

## ***Toward a global reference database of COI barcodes for marine zooplankton. Marine Biology (2021)***

<https://doi.org/10.1007/s00227-021-03887-y>



Bucklin, A.\* , K.T.C.A. Peijnenburg\*, K.N. Kosobokova\*, T.D. O'Brien\*, L. Blanco-Bercial\*, A. Cornils\*, T. Falkenhaus\*, R.R. Hopcroft, A. Hosia\*, S. Laakmann\*, C. Li\*, L. Martell, J.M. Questel<sup>EC</sup>, D. Wall-Palmer<sup>EC</sup>, M. Wang, P.H. Wiebe, A. Weydmann-Zwolicka<sup>EC</sup>



- Introduce, explain and promote the MetaZooGene Barcode Atlas and Database (MZGdb, <https://metazogene.org/MZGdb>)
- Acknowledgements: MetaZooGene (SCOR WG157) and NSF

Photos by R.R. Hopcroft and C. Clarke (UAF) and L.P. Madin (WHOI); see <http://www.cmarz.org/galleries.html>

SCOR WG157

# MetaZooGene



## ***Patterns of Biodiversity of Marine Zooplankton Based on Molecular Analysis***

**Special issue will be published in 2021; 14 papers available online**

**- Howard I. Browman - ICES JMS Editor-in-Chief**

**- Ann Bucklin\*, Katja Peijnenburg\*, Ksenia Kosobokova\*, Ryuji Machida\* - Themed Set motivators**

### **Of 15 Publications: 7 papers by co-authors from MetaZooGene WG157:**

- Bucklin, A.\* , Peijnenburg, K.T.C.A.\* , Kosobokova, K.\* , Machida, R.J.\* (2021) New insights into biodiversity, biogeography, ecology, and evolution of marine zooplankton based on molecular approaches. Introduction to the Themed Set. ICES JMS <https://doi.org/10.1093/icesjms/fsab198>
- Bucklin, A.\* , Questel, J.M.<sup>EC</sup>, Blanco-Bercial, L.\* , Frenzel, A. <sup>EC</sup>, Smolenack, S. <sup>EC</sup>, and Wiebe, P.H. (2021) Population connectivity of the euphausiid, *Stylocheiron elongatum*, in the Gulf Stream (NW Atlantic Ocean) in relation to COI barcode diversity of *Stylocheiron* species. ICES JMS, <https://doi.org/10.1093/icesjms/fsab158>
- Di Capua, I. <sup>EC</sup>, Piredda, R., Mazzocchi, M.G.\* , and Zingone, A. (2021) Metazoan diversity and seasonality through eDNA metabarcoding at a Mediterranean long-term ecological research site. ICES JMS, <https://doi.org/10.1093/icesjms/fsab059>
- Hirai, J.\* <sup>EC</sup>, Hidaka, K., Nagai, S., and Shimizu, Y. (2020) DNA/RNA metabarcoding and morphological analysis of epipelagic copepod communities in the Izu Ridge off the southern coast of Japan. ICES JMS, <https://doi.org/10.1093/icesjms/fsab064>
- Machida, R.J.\* , Kurihara, H., Nakajima, R., Sakamaki, T., Lin, Y.-Y., and Furusawa, K. (2021) Comparative analysis of zooplankton diversities and compositions estimated from complement DNA and genomic DNA amplicons, metatranscriptomics, and morphological identifications. ICES JMS, <https://doi.org/10.1093/icesjms/fsab084>
- Matthews, S.A. <sup>EC</sup>, Goetze, E.\* , and Ohman, M.D. (2021) Recommendations for interpreting zooplankton metabarcoding and integrating molecular methods with morphological analyses. ICES JMS, <https://doi.org/10.1093/icesjms/fsab107>
- Parry, H.E., Atkinson, A., Somerfield, P.J., and Lindeque, P.K.\* (2021) A metabarcoding comparison of taxonomic richness and composition between the water column and the benthic boundary layer. ICES JMS, <https://doi.org/10.1093/icesjms/fsaa228>

ICES Journal of  
Marine Science



ICES  
CIEM

International Council for  
the Exploration of the Sea  
Conseil International pour  
l'Exploration de la Mer



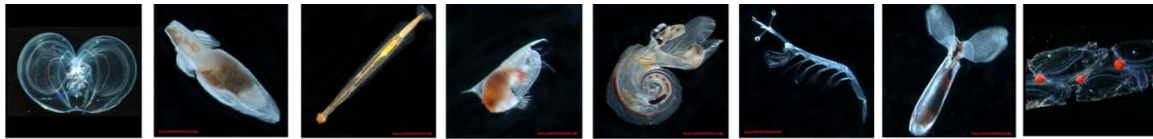


# ASLO 2021

Aquatic Sciences Meeting  
22-27 June 2021



**SS32 Session Co-Chairs:  
Silke Laakmann\*, Ann Bucklin\*, Katja Peijnenburg\*, Leocadio Blanco-Bercial\***



**ASLO 2021 AQUATIC SCIENCES MEETING**



## SS32 - Name that species: Toward a new global view of species diversity of marine zooplankton

**Silke Laakmann<sup>1,2</sup>, Ann Bucklin<sup>3</sup>, Katja T.C.A. Peijnenburg<sup>4,5</sup>, Leocadio Blanco-Bercial<sup>6</sup>**

<sup>1</sup> Helmholtz Institute for Functional Marine Biodiversity at the University of Oldenburg (HIFMB), <sup>2</sup> Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, <sup>3</sup> University of Connecticut, <sup>4</sup> Naturalis Biodiversity Center, <sup>5</sup> University of Amsterdam, <sup>6</sup> Bermuda Institute of Ocean Science



Photos by R.R. Hopcroft and C. Clarke (UAF) and L.P. Madin (WHOI); see <http://www.cmarz.org/galleries.html>

- 7 Talks, 2 Posters
- Invited talks by WG157 members: Astrid Cornils\* & Todd O'Brien\*
- Good audience turnout (>40 people)
- Discussion of best practices for molecular analysis of zooplankton species diversity



# ICES 2021 Annual Science Conference 6-10 September 2021 (Virtual)



## Theme Session D:

**Past, present, and future of marine plankton assemblages and communities**  
Conveners: Dafne Eerkes-Medrano (UK), Piotr Margoński (Poland) Todd D. O'Brien\* (USA)

---

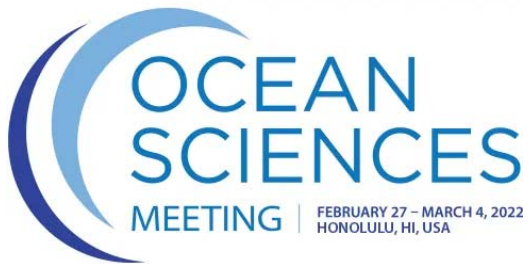


## Topics and approaches:

- empirical analysis of time series observations
- numerical and statistical modelling
- molecular genetic analysis of diversity or function
- new techniques to observe community change

## Talks by MetaZooGene SCOR WG157 members\*:

- \* O'Brien, T.D., *Spatiotemporal visualization of the North Atlantic copepod community change*
  - \* Bucklin, A., et al. *Time-series COI metabarcoding of zooplankton species diversity*
-



OSM 2022  
27 Feb – 4 Mar 2022  
Hawaii, USA (Hybrid & Virtual)



## Zooplankton diversity through space and time (ME20)

Co-Chairs: Katja Peijnenburg\* (NL), Erica Goetze\* (USA), Galice Hoarau (NO), Matthew Miller (CA)

---

This session will explore new insights into zooplankton, their diversity and roles in the ecosystem, which are being revealed through emergent approaches, such as 'omics and/or environmental DNA methods, imaging techniques combined with machine learning, and/or trait-based or distribution modelling, while also being inclusive of studies using more conventional methods.

This session is co-organised by SCOR WG157 MetaZooGene and is open to all members of the ocean science community. See: <https://metazoogene.org>

---





# MetaZooGene Symposium

## *New Insights into Biodiversity, Biogeography, Ecology and Evolution of Marine Zooplankton Based on Molecular Approaches*

Convenors: Ann Bucklin (University of Connecticut, USA); Katja Peijnenburg (Naturalis Biodiversity Center, NL); Leocadio Blanco-Bercial (Bermuda Institute of Ocean Sciences, BM); Silke Laakmann (University of Oldenburg, DE)



*Symposium in-person participants, including 11 Early Career Scientists.  
Presenters & participants (~25 people) also joined virtually.*

Sponsor: Scientific Committee for Ocean Research (SCOR); MetaZooGene Working Group (SCOR WG157)  
MetaZooGene Symposium associated with ICES 2022 Annual Science Conference  
Aviva Stadium, Dublin, Ireland - September 23, 2022  
<https://metazoogene.org/symposium2022>



## Focus on Early Career Scientists

---

**Early Career colleagues & students have joined all WG157 activities.**

- **Participants at MetaZooGene meetings**
- **Presenters at special sessions**
- **Co-authors of WG157 publications**
- **Receive regular updates via WG157 email list**

**Capacity Building Workshops planned by WG157 for training in molecular & bioinformatics methods not yet possible.**

### ***MetaZooGene Early Career Symposium***

**September 10, 2022**

**ICES Annual Science Conference**

**Dublin, Ireland (In-person)**



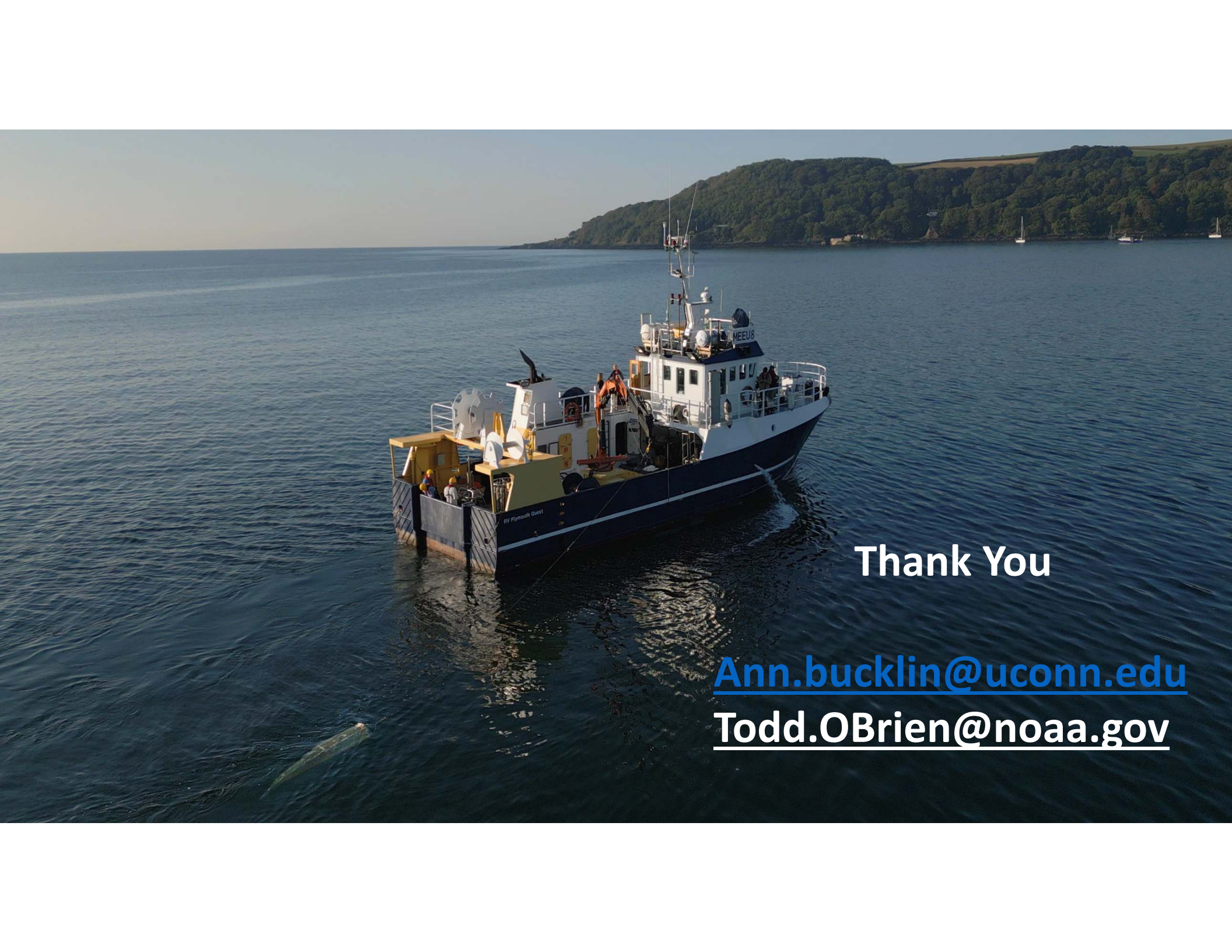
# MetaZooGene

**Metabarcoding Zooplankton Diversity**  
**Ocean Decade Action No. 102.2**



- ***MetaZooGene: Metabarcoding Zooplankton Diversity*** is endorsed as a new UN Ocean Decade Action (No. 102.2; <https://www.oceandecade.org/>)
- The project is attached to the Ocean Decade Programme, *Marine Life 2030* (<https://marinelife2030.org/>)





**Thank You**

[Ann.bucklin@uconn.edu](mailto:Ann.bucklin@uconn.edu)

[Todd.OBrien@noaa.gov](mailto:Todd.OBrien@noaa.gov)