



# Microzooplankton and their associations with plankton



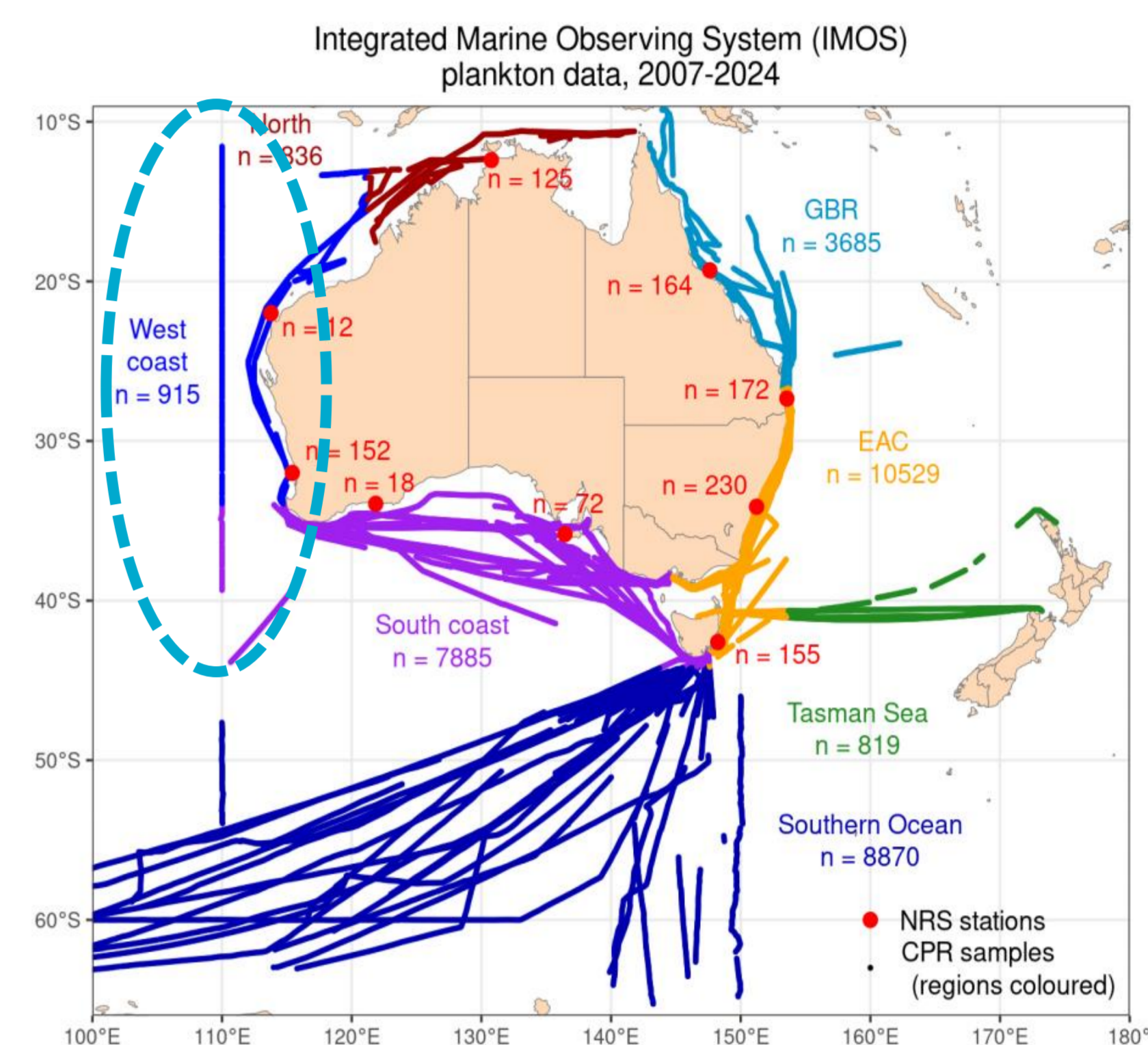
## Tintinnid / diatom associations and agglutination from the oligotrophic Indian Ocean

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**Tintinnids** : Tintinnids are planktonic ciliates, with a characteristic lorica secreted around the body, ubiquitous in our oceans. They play an important role in the food web being dominant grazers of primary production and being preyed upon by higher trophic levels. In oligotrophic regions it would be advantageous for tintinnids to develop strategies to increase their ability to capture prey or avoid predators, to strengthen their protective lorica against predators and, to access nutrition from other sources. Tintinnids have been observed to form many associations with phytoplankton, diatom frustules, coccoliths or non-biogenic particles. The process of agglutination, acquiring non-biological or biological particles on the lorica, may be incidental as particles adhere to a sticky lorica or deliberate. Studies have shown that tintinnids can select agglomerated cells based on particle size or availability whilst others select mono-specific coccoliths or diatoms (Henjes & Assmy, 2008).



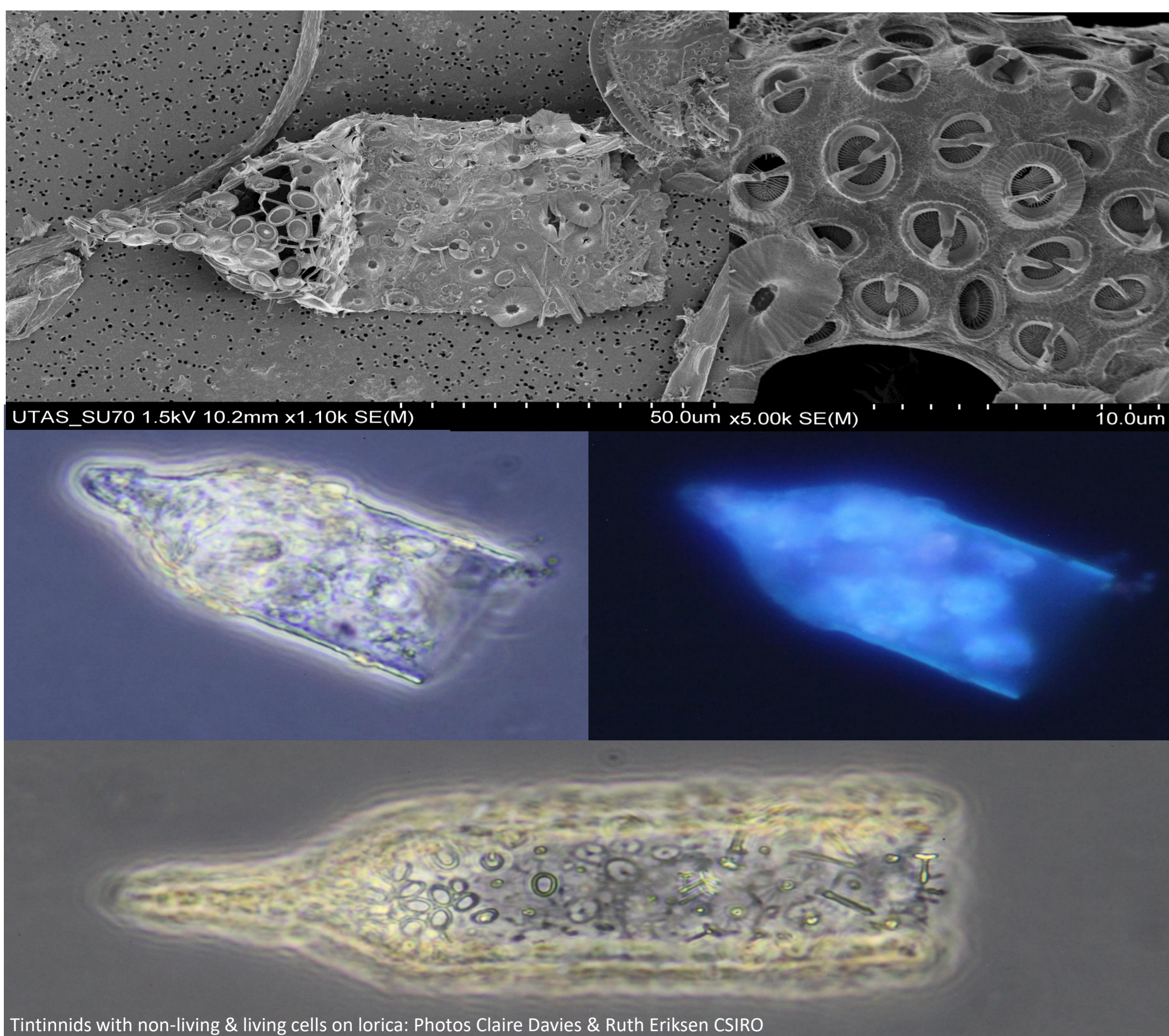
**Study area** : Samples were collected from the RV Investigator, IN2019\_V03, part of the International Indian Ocean Expedition II (IIOE2). IIOE2 repeated surveys from the 1960s along 110°E in the oligotrophic Indian Ocean, one of the world's five major gyres.

**Diatom / Tintinnid Associations** : Reports of associations of *Eutintinus* and *Chaetoceros* are widespread, including the Mediterranean, Caribbean and South Atlantic (Gómez, 2020). Here we add the Indian Ocean to this distribution as we found several examples of *Eutintinus apertus*, associated with *C. dadayi*, (left). A few examples of a consortia of *Salpingella* and *Thalassionema* were also seen in these IIOE2 samples (below). This association has also been documented previously, although it is more common to find *Fragillariopsis* adhered to *Salpingella* (Vincent et al., 2018). In these associations, a tintinnid may attain a higher clearance rate with attached diatoms improving its success rate in epipelagic and oligotrophic waters (Jonsson Per R. et al., 2004). A tintinnid may also be afforded extra protection from the long, spine bearing setae of a *Chaetoceros* and a larger overall size when attached to a diatom. In these associations the tintinnids free-swimming ability may improve the diatoms access to prey and predator avoidance. *E. apertus* also shows some adaptation by modifying its setae to better attach to the tintinnid. This association is likely to be mutually beneficial (Gómez, 2007).



Chaetoceros dadayi and Eutintinus apertus: who is hugging who? : Photos Ruth Eriksen CSIRO

**Tintinnid agglutination** : Tintinnid lorica may have many purposes, such as protection from predators and UV, aiding rapid sinking and attaching themselves to substrate or frustules to their lorica, (Armbrecht et al.), but less widely reported is the attachment of live cells. Why tintinnids agglomerate living cells is unclear, although Tintinnids may be able to draw out protoplasts and arrange particles on their lorica in specific ways (Gowing & Garrison, 1992). Particles may also give added protection or enhance feeding by increasing current flow around the lorica. The images mostly show non-living components of coccolithophores attached to lorica, whilst fluorescence confirms some of the particles are living and biological (below).



Tintinnids with non-living & living cells on lorica: Photos Claire Davies & Ruth Eriksen CSIRO

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**Conclusions** : In 15 years of counting samples from the Integrated Marine Observing (IMOS) surveys, the National Reference Stations (NRS) and the Continuous Plankton Recorder (SOCPR, AusCPR), from around Australia's coastal region, we had not documented any associations between tintinnids and diatoms or other living cells. However, during the Indian Ocean voyage we sampled in completely different oceanographic conditions and the samples were very different from our near coastal samples and demonstrated that in this part of the Indian Ocean microzooplankton are an integral part of a complex food web (Davies et al., 2022) . Here, our frequent observations of tintinnid / phytoplankton associations support the hypotheses that these associations are indicators of warm, oligotrophic seas supporting species, such as silicified *Chaetoceros*, that would not otherwise thrive in such conditions. Reasons for these behaviours remain speculative and more research is needed to understand if these are strategies to increase motility, improve feeding opportunities and / or protection against predation by strengthening their lorica.

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