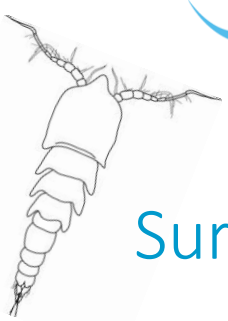
Issue 13
June 2020

IMOS Integrated Marine Observing System



IMOS Australian Plankton Survey 2020 Annual Newsletter

Directors report

Welcome to our mid-year 2020 plankton newsletter. It has certainly been a very different last few months during the COVID-19 pandemic. This has challenged everyone, including scientists who maintain time series. With lockdown in many countries around the world, the continuation of many time series has been compromised. Although the collection of data on small vessels at the seven Integrated Marine Observing System (IMOS) National Reference Stations ceased, we were fortunate that sample collection for the IMOS Australian Continuous Plankton Recorder (AusCPR) survey, which is by commercial shipping, continued. Well done to Mark and Frank for ensuring that CPRs were loaded with silk and at the ships on time. We have also been lucky that some of our team have continued to work in the lab. Frank, Mark, Julian and Claire found the lack of other staff at work not only peaceful but safe in terms of social distancing. It has helped take the pressure off having a huge backlog. Meanwhile Anita, Felicity, Ruth and myself have been busy with other tasks working from home. Thanks everyone for continuing to deliver.

I'd also like to highlight the production of the State and Trends of Australia's Oceans Report (colloquially called STAR, see https://www.imosoceanreport.org.au/). This was released at the IMOS Annual Planning Meeting in March 2020. STAR was a data-driven assessment of Australia's Ocean underpinned by indicators generated by time series. A total of 27 time series datasets were included and grouped into four themes: viz. 1. Physical and chemical environment; 2. Biological productivity; 3. Water quality; and 4. Marine animals. The collating, synthesising, and reporting of meaningful indicators of marine ecosystem health provided information in a clear way to a broad, and often non-scientific audience. A flavour of what is in STAR is seen in Figure 1. Not only were IMOS data used, but here Harmful Algal Bloom (HAB) data were collated from the shellfish industry and you can see long-term changes over the past 15 years.

STAR was a wonderful opportunity to deliver a product with purpose and impact beyond what we normally deliver individually. For me, it was rewarding working with the broader marine research community. Thank you to Ruth Eriksen for jointly leading this and her hard work to deliver a quality product. Thank you also to Claire Davies who re-drew many of the figures in R and contributed analyses to several chapters.

Thanks especially to the IMOS Office, particularly Indi Hodgson-Johnston for ensuring that as scientists we focused on a useful product to others. And Jake Wallis led the online delivery, producing an attractive and accessible product, which we can all be proud of. And last, I would like to thank Tim Moltmann. Without his support, motivation, vision, reliability and diligence STAR would not have been possible. It was a pleasure working with you to deliver STAR.

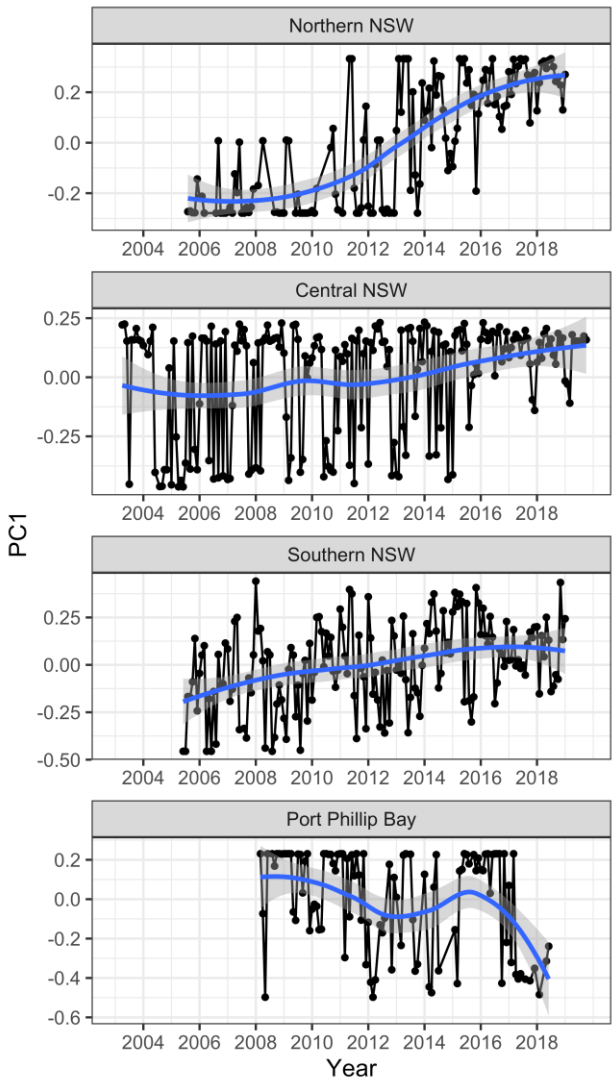


Figure 1. Principal Components Analysis (PCA) of long-term data (1st PC) for 12 dinoflagellate species in four regions in Southeast Australia (Brett et al. 2019).

Reference:
Brett S, Davies C, Eriksen R, Richardson AJ (2020) Harmful Algal Blooms and the shellfish industry. In State and Trends of Australia's Ocean Report, Integrated Marine Observing System, Hobart. Richardson AJ, Eriksen R, Moltmann T, Hodgson-Johnston I, Wallis JR (Editors). 7pp. doi: 10.26198/5e16ac8149e83.

I'd also like to highlight some of the science that we have produced in the last year. Well done to the Team working with Gustaaf Hallegraeff (University of Tasmania) – led by Ruth and Claire – to produce a summary of 80 years of *Tripos* research in Australia, discussing some 50 species in Australian waters (Hallegraeff *et al*. 2020). And well done to Ruth Eriksen for providing a detailed description of the plankton observation at the IMOS National Reference Stations (Eriksen *et al*. 2019). This will be the bible for anyone wanting to use these data for years to come. Finally, a key part of our work is using plankton data in ecosystem and biogeochemical model assessment. A good example of that is the paper by Robson *et al*. (2020) where we validated the large zooplankton biomass estimates in the eReefs biogeochemical model based on 996 observations.

We also hosted the Global Alliance of CPR Surveys (GACS) in 25-27 November 2019 in Hobart. It was great to have the Heads of the CPR surveys from around the world together discussing collaboration and science. There were many insights discussed about how to best run global CPR activities, new developments on the horizon, and how we could expand. On this theme, a recent output from the group is the Batten *et al*. (2019) paper where GACS members describe the existing surveys and what a global plankton diversity survey would look like.

This was followed by a 2-day molecular workshop with 25 participants. This was led by Willie Wilson form the Marine Biological Association. We discussed strategies for using molecular techniques on plankton samples, including those preserved in formalin. There were many robust discussions by molecular experts. The AusCPR survey then hosted Jenny Huggett and Marco Worship (South Africa CPR) and Octavio Esqivel (Brazil CPR) in our Brisbane CSIRO lab. They were embedded in our survey during for a week, learning about CPR logistics, microscopy and taxonomy of plankton, databasing, and our research. Thanks to POGO who provided money to fund workshop participation for researchers from developing nations.

I hope you enjoy the Newsletter. Thanks once again for Anita's hard work putting it together.

Anthony

References

Batten SD, Abu-Alhaija R, Chiba S., Edwards M, Graham G, Jyothibabu R, Kitchener JA, Koubbi P, McQuatters-Gollop A, Muxagata E, Ostle C, Richardson AJ, Robinson KV, Takahashi KT, Verheye HM, Wilson W (2019) A Global Plankton Diversity Monitoring Program. Frontiers in Marine Science. June 2019, Vol. 6, Article 321: 14 pp.

Eriksen RS, Bonham P, Davies CH, Coman FE, Edgar S, McEnnulty FR, McLeod D, Miller MJ, Rochester W, Slotwinski A, Tonks ML, Uribe-Palomino J, Richardson AJ (2019) Australia's Long-term Plankton Observations: The Integrated Marine Observing System National Reference Station Network. Frontiers in Marine Science 6: 161. 17 pp.

Hallegraeff G, Eriksen R, Davies C, Slotwinski A, McEnnulty F, Coman F, Uribe-Palomino J, Tonks M, Richardson AJ (2020) The marine planktonic dinoflagellate Tripos: 60 years of species-level distributions in Australian waters. Australian Systematic Botany 33: 392-411

Robson BJ, Skerratt J, Baird ME, Davies C, Herzfeld M, Jones EM, Mongin M, Richardson AJ, Rizwi F, Wild-Allen K, Steven A (2020) Enhanced assessment of the eReefs marine models for the Great Barrier Reef using a four-level model evaluation framework. *Environmental Modelling and Software* 129: 104707. 15 pp.

Table of Contents

We have now towed
228,092 km and this is more than
5 times around the Earth!

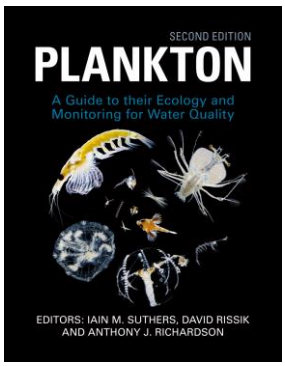
National Reference Stations
858 zooplankton samples counted
745 biomass samples completed
695 phytoplankton samples counted

521,000 zooplankton counted
262,998 phytoplankton counted

Continuous Plankton Recorder
24,632 Phytoplankton Colour Index segments counted
6,608 zooplankton segments counted
6,666 phytoplankton segments counted

123,160 nautical miles towed
169 trips processed

769,908 zooplankton counted
76,302 phytoplankton counted



Plankton book published 2019
See page 21 for details...

Contact Information

Visit the AusCPR website
http://imos.org.au/auscpr.html

Visit the NRS website
http://imos.org.au/anmnnrs.html

IMOS Australian Plankton Survey Leader
Professor Anthony J. Richardson
Anthony.Richardson@csiro.au

Further team contact details
http://imos.org.au/cpr_staff.html

Social media

Anthony Richardson

Position: Leader IMOS Australian Plankton Survey
Location: CSIRO, Brisbane, Queensland
I manage the CPR project, I help secure funding, guide research directions, develop relationships with other plankton surveys, and support and develop CPR staff. My research interests are marine climate change ecology, plankton ecology, pelagic ecosystem dynamics, and ecosystem modelling. In my spare time I love to spend time with my family.

Frank Coman

Position: Deputy Leader
Location: CSIRO, Brisbane, Queensland
My role involves liaising with ships that tow the CPR, the management of the North Stradbroke Island NRS sampling, zooplankton sorting of IMOS NRS samples, and plankton analysis of CPR samples. I am interested in plankton biology and ecology, climate change impacts on marine ecosystems and aquaculture. In my spare time I play sport, enjoy fishing, camping and photographing Australian wildlife.

Claire Davies

Position: Plankton Biologist
Location: CSIRO, Hobart, Tasmania
My job includes identifying and counting CPR and NRS samples. I also manage the NRS and CPR databases, and am a boat driver for SE NRS sampling. My research interests include plankton ecology, climate change impacts and the feeding dynamics between zooplankton and megafauna. In my spare time I spend as much time in and out of the water as possible.

Julian Uribe-Palomino

Position: Plankton Biologist
Location: CSIRO, Brisbane, Queensland
My role involves analyses of plankton samples, operational tasks, data collection and quality control and contributing to publications and presentations. I am interested in biological oceanography, environmental modelling, biogeography, remote sensing and GIS.

Anita Slotwinski

Position: Plankton Biologist
Location: CSIRO, Brisbane, Queensland
I analyse CPR & NRS samples. I also manage the project website, communication materials, and the zooplankton species reference collection. My research interests are in marine plankton ecology, environmental change and species response and photomicroscopy. In my spare time I enjoy time with family & friends, photography, gardening and exploring nature.

Mark Tonks

Position: Experimental Scientist
Location: CSIRO, Brisbane, Queensland
My tasks include liaising with shipping companies, including owners, agents and crew to ensure that CPR sampling is maintained, and counting NRS and CPR zooplankton samples. I also have a coxswain's certificate and drive our research vessel to the NRS site where I then assist with plankton and water sampling. My research interests include plankton ecology, bycatch sustainability and fish and crustacean ecology. I also enjoy playing a variety of sports.

Felicity McEnnulty

Position: Plankton Biologist
Location: CSIRO, Hobart, Tasmania
I analyse CPR and NRS samples, am involved in data collation and quality control and contributing to publications and presentations. My research interests include plankton ecology, deep-sea invertebrates, introduced marine species and Antarctic marine invertebrates and fishes.

Ruth Eriksen

Position: Plankton Biologist
Location CSIRO, Hobart, Tasmania
I analyse CPR and NRS samples, and am involved in data collation and quality control and contributing to publications and presentations. My research interests are phytoplankton ecology and taxonomy, phytoplankton physiology and response to contaminants, tintinnid ciliates and temperate and sub-Antarctic phytoplankton community dynamics.

James McLaughlin

Position: Marine Biologist/ Biogeochemist
Location: CSIRO, Floreat, Western Australia
My job is helping to expand the survey into WA waters and the analysis of phyto- and zooplankton samples. I have been with CSIRO for 5 years and work 10% of my time with AusCPR. My research interests include marine phytoplankton dynamics and ecology, benthic and pelagic primary production, and ocean acidification. I enjoy spending time with my family, travelling and keeping tropical aquarium fish.

Wayne Rochester

Position: Quantitative Ecologist
Location CSIRO, Brisbane, Queensland
I help the survey by the analysis of plankton data for ecosystem health assessment. My research interests are quantitative ecology, spatial ecology and natural resource management.

Karl Forcey

Position: Technical Officer
Location CSIRO, Brisbane, Queensland
I am helping the survey by working on the integration of marine instrumentation to CPR projects, data recovery and quality control, maintenance and repair of CPR units and technical advice. My research interests include underwater video systems, oceanographic instrumentation and AUV's gliders and other emerging technologies.

Fiona Scott

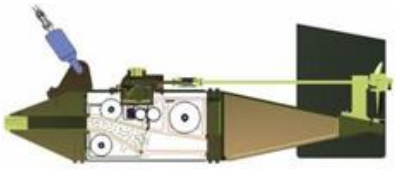
Position: Phytoplankton Biologist
Location Australian Antarctic Division, Hobart

I analyse CPR samples from the Southern Ocean including data collection and photomicrography at both Light- and Electron Microscope levels. My research interests include ecology of phytoplankton and other protists as well as biogeography and systematics of Australian marine macroalgae.

How our CPR Survey works : step-by-step

1. The CPR was designed by Sir Alistair Hardy in 1930, and the design has remained essentially unchanged since then.

2. It is a towed sampling device measuring plankton communities.



3. We use 'Ships of Opportunity' and CSIRO research vessels to tow our CPRs.

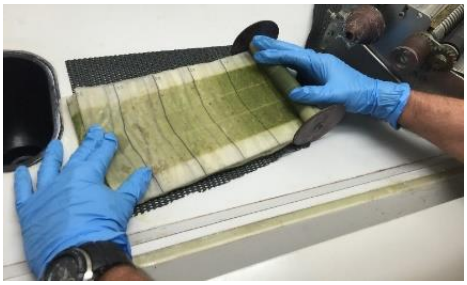
4. The CPR is towed:
- 100 metres behind the ship
- at 10 metres water depth
- 400 nautical miles per 'tow'

5. The mouth aperture of the CPR is 1.62 cm^2 - this is where the water and plankton flow through is captured.

6. The internal cassette has 2 layers of silk mesh, the silk mesh is wound between 2 rollers.

7. Plankton is 'sandwiched' between the two layers.

8. The cassettes are removed from the CPR and sent back to the lab for analysis within a few days of towing, in the lab we unroll the silk.

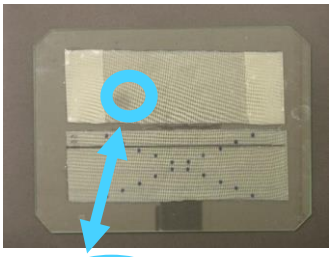


9. We analyse the Phytoplankton Colour Index.

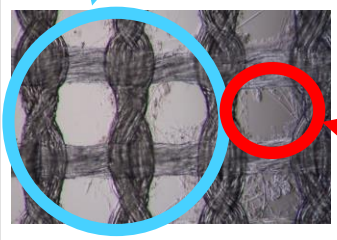
10. The silk is cut into 5 nautical mile segments that equate to is 1.5 m^3 of filtered seawater.

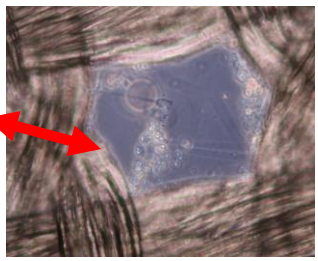
11. We analyse the segments for phytoplankton abundance and species composition.

12. We identify the phytoplankton in 20 mesh holes.

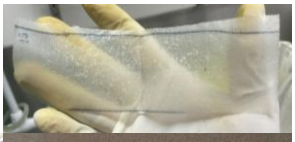


Each silk mesh hole is 270 micrometres (0.27 mm) and can contain many phytoplankton species.



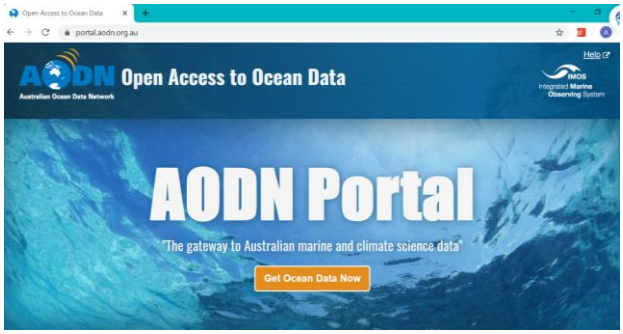


13. We wash all the plankton off the silk.



14. We identify and count all the zooplankton.

15. We enter our data into our plankton database, and all the data (and all previous data) are available each night for free here http://imos.aodn.org.au

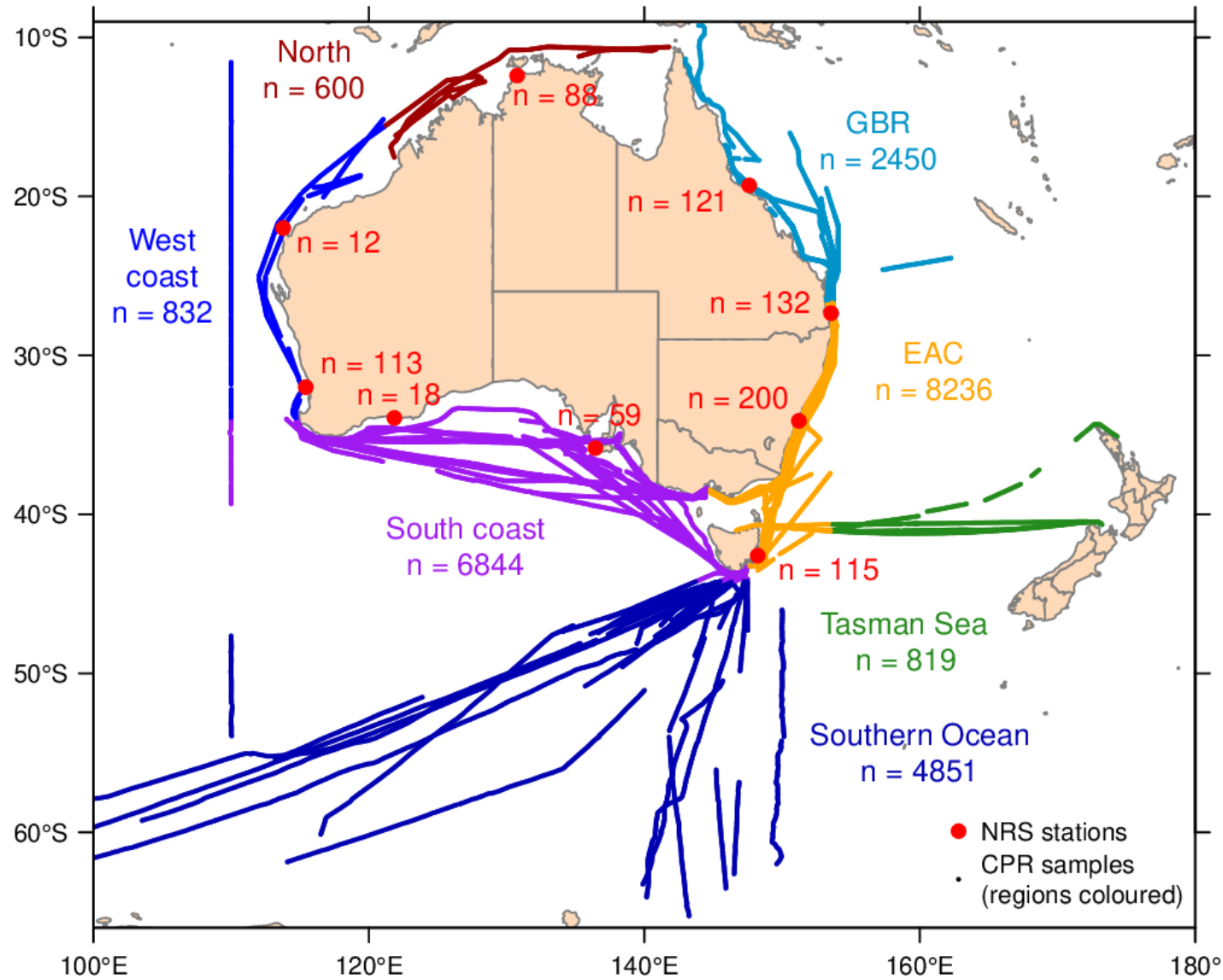


The EAC route is towed quarterly from Brisbane to Melbourne and follows the southward-flowing warm-water East Australia Current. This region is forecast to warm more than anywhere else in the Southern Hemisphere this century.

The National Reference Stations are sampled monthly.

The Great Barrier Reef (GBR) route is towed seasonally from Gladstone to Cairns in the GBR lagoon. Long-term observations on the GBR, such as those by the CPR, will help support management of the healthy reef

Integrated Marine Observing System (IMOS) plankton data, 2007–2020

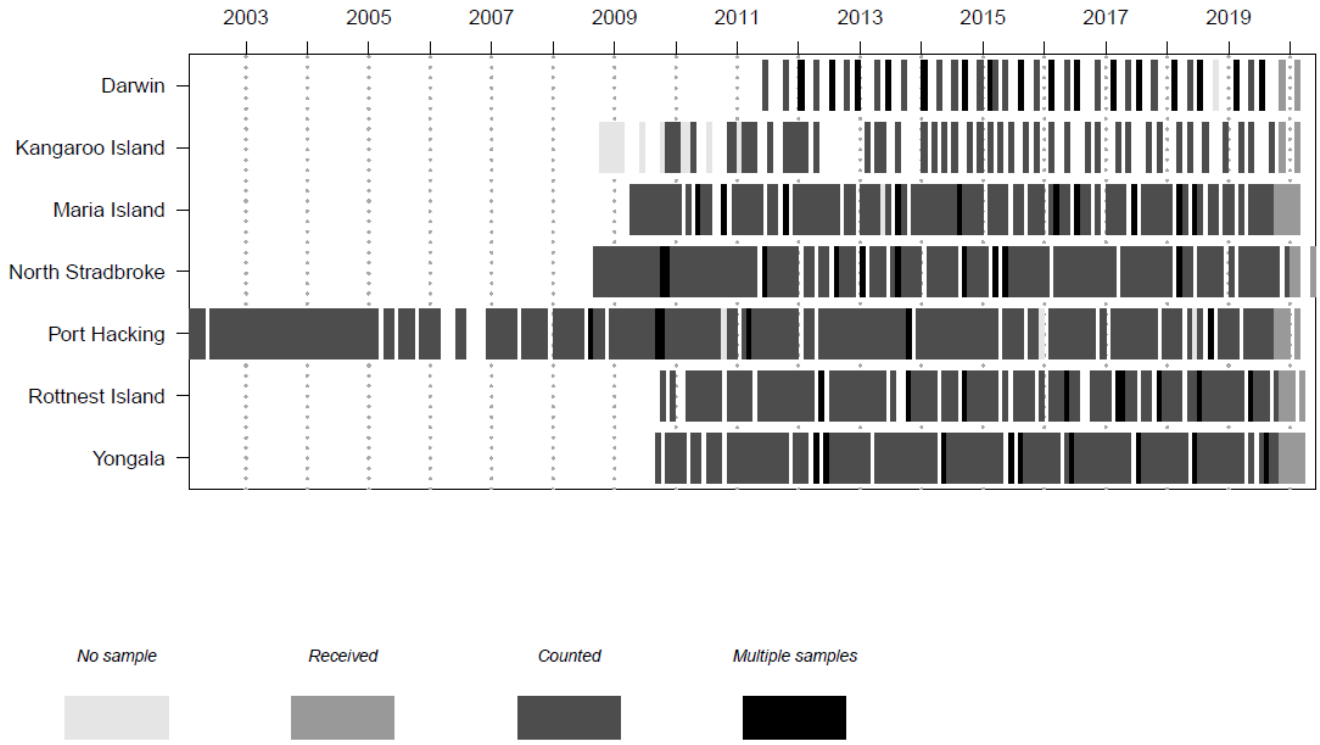


The route from Melbourne to Adelaide is one of our longest-running routes and traverses the productive upwelling waters of the Bonney upwelling system..

Our Southern Ocean routes are towed in collaboration with the SCAR SO-CPR Sruvey based at the AAD. Together with the EAC route, the Southern Ocean sampling provides an almost continuous transect running from warm tropical to polar waters.

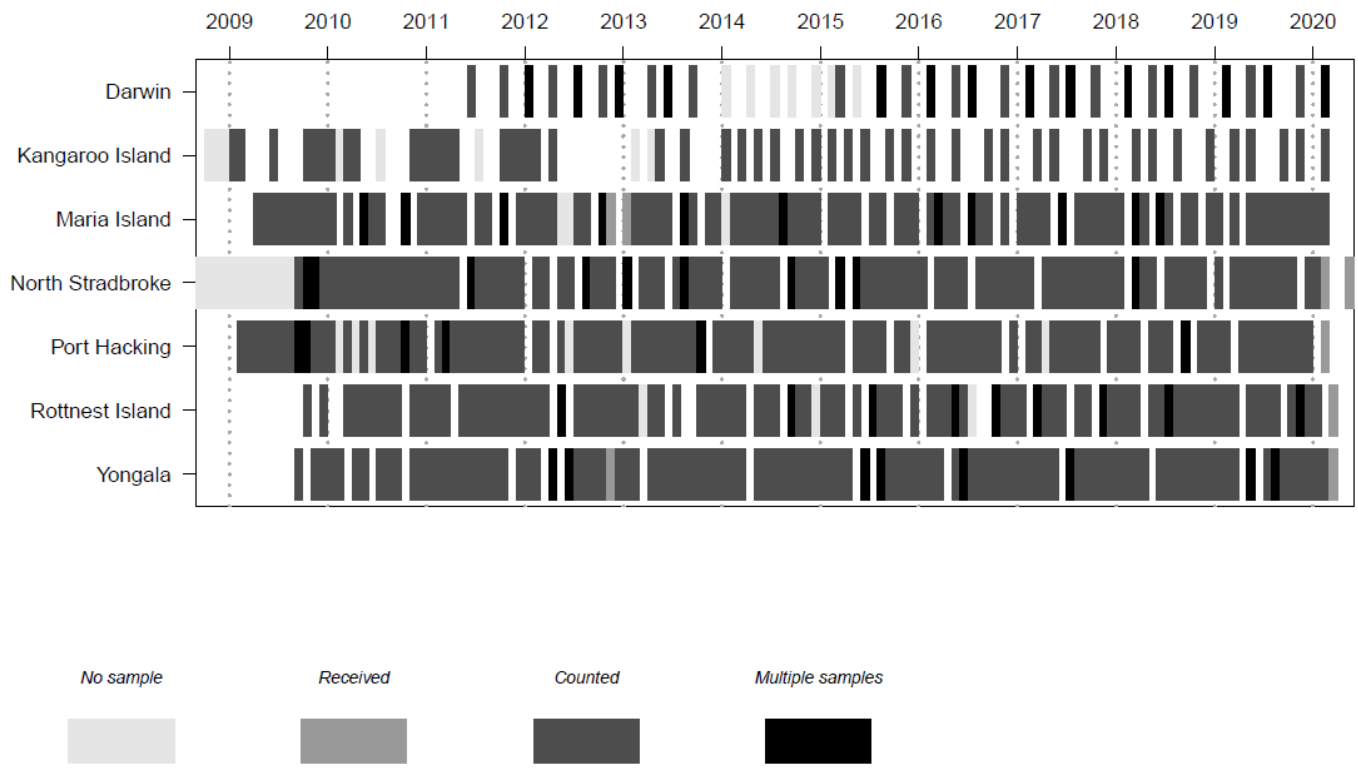
National Reference Stations Zooplankton Progress

NRS zooplankton progress - 2020-06-15

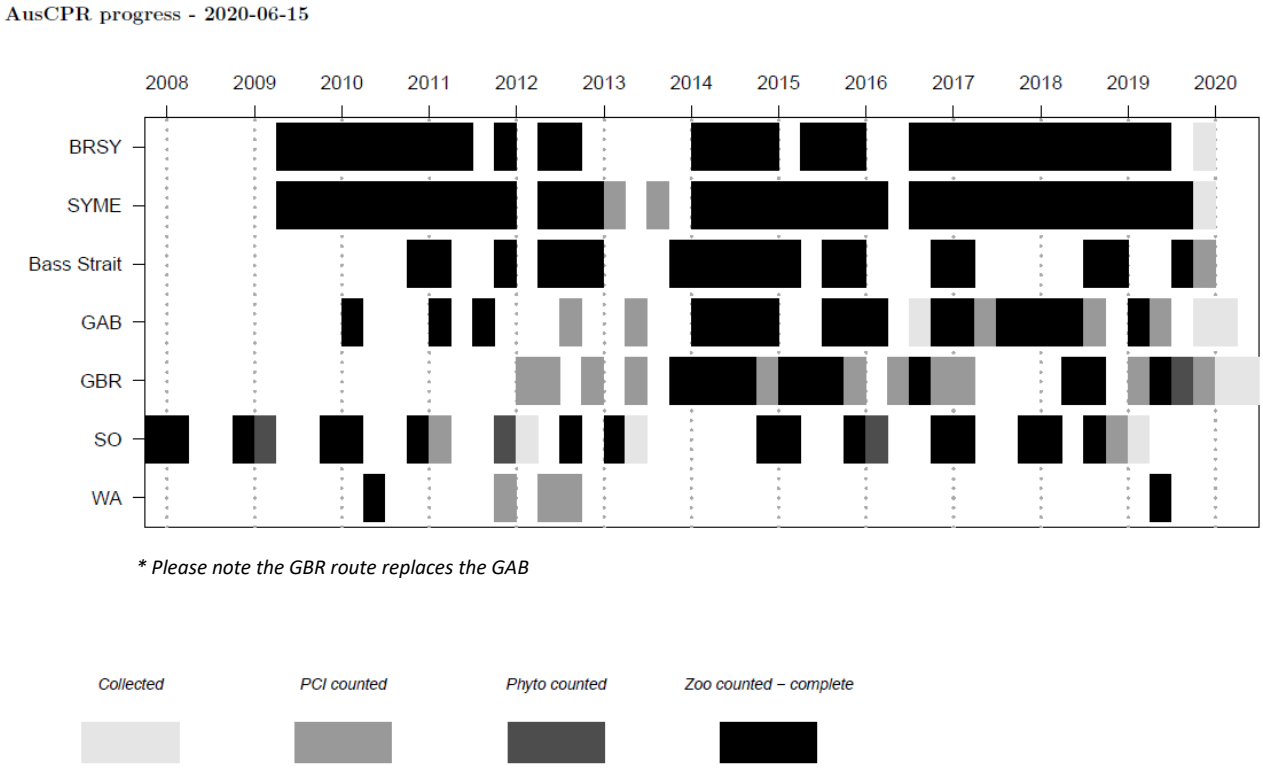


National Reference Stations Phytoplankton Progress

NRS phytoplankton progress - 2020-06-15



Australian Continuous Plankton Recorder Progress



Instrumentation: The HitchHiker

Karl Forcey

For the last two years, CSIRO deployed Continuous Plankton Recorders (CPRs) have had the option of carrying a HitchHiker. Designed and built by Ocean and Atmosphere's Engineering and Technology Program, HitchHiker is an instrumentation package and logger, designed to record previously unobtainable deployment data that can complement the physical specimens that each CPRs cassette provides.

Mounted behind the exhaust port under the tail, the package contains a temperature sensor (accurate to 0.1 °C) and a pressure sensor that measures depth. These sensors are both calibrated by the Calibration centre in Hobart. HitchHiker also has a GPS receiver that records its location when on the surface, and an Inertial Measurement Unit (IMU) that records the CPR's pitch, roll and yaw while deployed. Data are recorded at ten second intervals during deployment and recovery, and every minute while being towed below the surface. All data is timestamped by an onboard real time clock to allow researchers quick and easy matching to the data retrieved from the recorders cassettes and bridge log books. Intelligent circuitry and low power consumption mean that HitchHiker will last for fourteen days before requiring a battery recharge. This allows it to be used on even long transits on the RV *Investigator*, or on vessels of opportunity travelling internationally, with minimum work required from the volunteer crew.

When used on commercial vessels and deployed on a recorder that travels through the water at speeds of up to twenty three knots, Hitchhiker needs to be built tough. Early models suffered from breakages and water ingress in the harsh conditions. However, thanks to custom machined housings and engineering, the current generation of devices is providing consistent and reliable data from transits right around Australia.

Above: The Hitchhiker (Image: Karl Forcey).

The Engineering and Technology program is planning to increase the number of Hitchhikers available for deployments within IMOS. We are also always looking at ways to innovate and provide impact with new technologies and new designs that will provide even more data to complement the long and successful history of plankton recording.

Shipping

Mark Tonks

The *Wallenius Wilhelmsen* roll-on/roll-off ships, *Tonsberg* and *Salome* (both 265 m long), continue to tow CPRs through eastern and southern Australian coastal waters between the ports of Brisbane, Port Kembla, Melbourne and Adelaide. Since the commencement of sampling with this company in July 2016, combined both vessels have completed a combined 68 CPR tows covering more than 20,000 nautical miles. We are extremely grateful to Captain Sunil Dhowan (Head of Port & Cargo Operations, Oceania), Captain Roman Rossa (Brisbane Port Operations Manager), Captain Patrick Lobo (Fremantle Port Operations Manager) and the crews of the ships involved for their support of our plankton survey. Thanks to their professionalism and attention to detail we continue to maintain an extremely high level of sample return with associated metadata.

Above: Typical *Tonsberg* and *Salome* tow route (Google Earth).

The Rio Tinto ship, *RTM Wakmatha* (236 m long) continues to tow CRPs along the inner Great Barrier Reef between Cairns and Gladstone. This ship travels regularly between Weipa and Gladstone carrying bauxite for Gladstone's alumina refineries. Since their initial CPR tow in June 2018, a further 5 tows (at approximately 3-month intervals) have been completed up until December 2019. In total, over 2000 nm have been sampled. We thank Rio Tinto and the *Wakmatha* crew, particularly Chief Officer Robert Spencer-James for their continued support.

Above: Typical *RTM Wakmatha* tow route (Google Earth).

Above: Stern of *Tonsberg* (Image: Mark Tonks).

Ship Name	Operator	Length	Dead Weight
MV Tonsberg	Wallenius Wilhelmsen	265 m	41820 tonnes
MV Salome	Wallenius Wilhelmsen	265 m	43878 tonnes
RTM Wakmatha	Rio Tinto Shipping	236 m	89605 tonnes

Images: MV Tonsberg (Dexter), MV Salome (Mick Prendergast), RTM Wakmatha (all from www.marinetraffic.com)

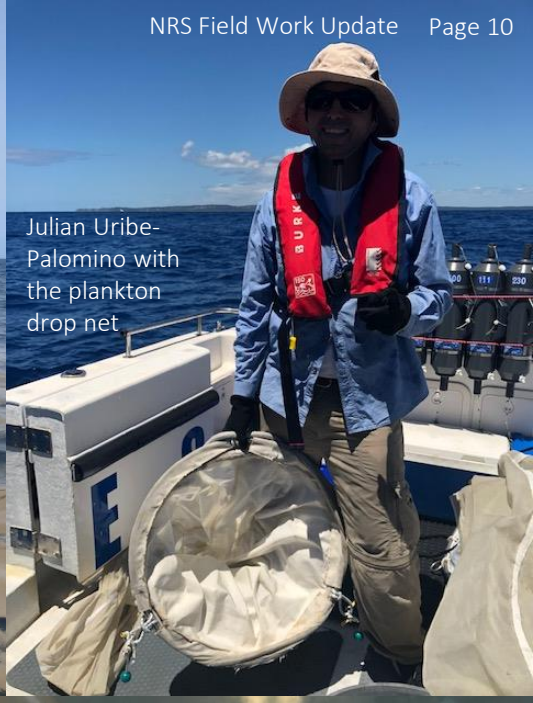
We continue to do our monthly sampling at the North Stradbroke Island National Reference Station. It takes us 90 minutes to reach the site from the Manly Marina where our research vessel *'Scylla'* is berthed.

On site

- we deploy a secchi disc to measure turbidity;
- deploy a CTD to record salinity and temperature profiles from the surface to 55 meters
- collect three discrete plankton samples with a drop net (sampling the water column to 55 meters);
- sample water at discrete depths using Niskin bottles (57 m, 50 m, 40 m, 30 m, 20 m, 10 m, surface) and
- complete two 12 minute fish larval tows (samples are combined).

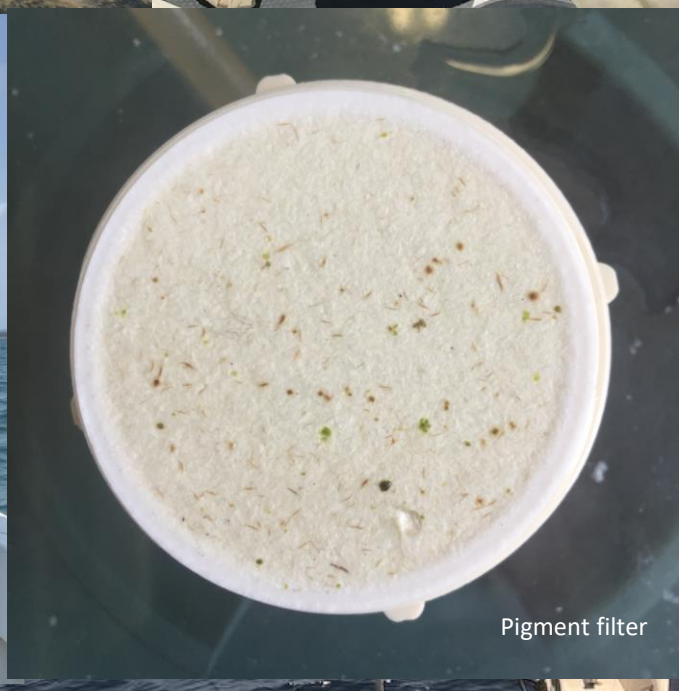
Images: Julian Uribe Palomino and Frank Coman.

Trichodesmium bloom



Julian Uribe-Palomino with the plankton drop net

Mark Tonks, Frank Coman & Jacob Rogers collecting the last North Stradbroke Island sample for 2019



Pigment filter

Microbial genetics filters

The plankton net being lowered for sample collection

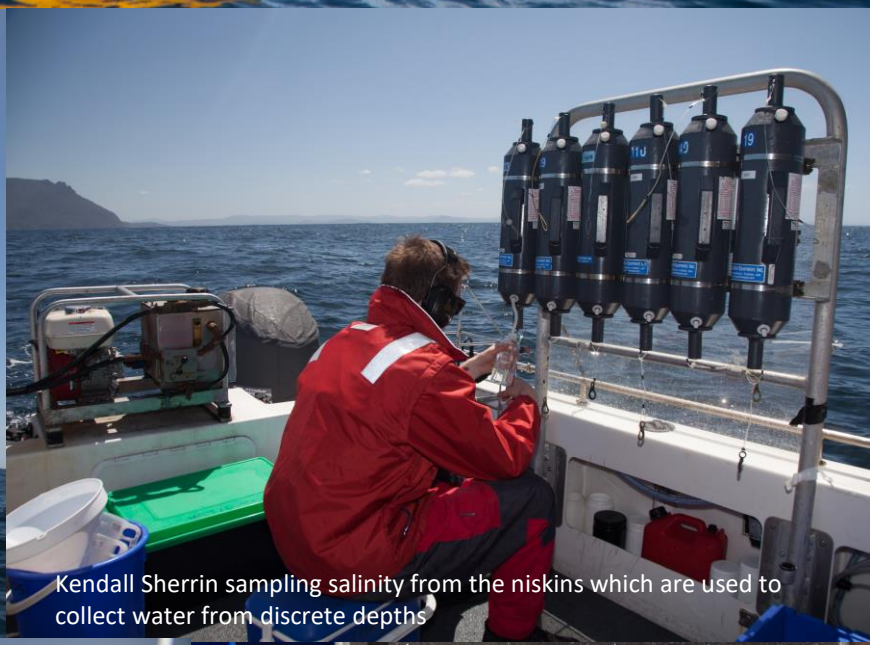
Maria Island is another of the National Reference Stations where monthly sampling also takes place. The sampling protocol is the same as NSI although Maria Island is deeper, 80 m. The mooring is about 8 nautical miles east of Maria Island off the east coast of Tasmania. The IMOS funded NRS sampling has been conducted monthly since 2009, but CSIRO have monitored this site since the 1940s taking temperature, salinity and nutrient samples.

All photos credit Carlie Devine, CSIRO

The mooring with Maria Island in the background

The resulting sample with lots of krill

Dave Kruse deploying the CTD



Kendall Sherrin sampling salinity from the niskins which are used to collect water from discrete depths

Kendall Sherrin and Dion Frampton preparing to use the Heron zooplankton drop net

At Maria island we also sample at discrete depths for dissolved oxygen as a calibration for the sensor on the CTD

Brisbane Lab Update

Frank Coman

The main focus of staff at the Brisbane laboratory has again been collecting and analysing samples from both AusCPR and the National Reference Stations (NRS), but it was great to see the release of the second edition of the Plankton book in April of this last year. Several of us had spent a considerable time working on the book, and both the book and the chapter on coastal and marine zooplankton have received good reviews. The team are very happy with the final product.

Throughout 2019, members of the team from Brisbane travelled for both plankton related projects and other CSIRO projects. Mark Tonks spent several weeks in the field including a prawn survey in the Gulf of Carpentaria, a lobster survey in Torres Strait, a fish survey near Ashmore Reef, and a BRUV survey off Ningaloo. Frank travelled to Hobart for the annual National Reference Station QC summit in April and along with Anthony, Julian, Sarah Pausina, Jason and Claire attended the AMSA conference in Perth in July, there is a full report on this elsewhere in the newsletter. Anthony also travelled to Sweden to attend the ICES annual science symposium and the size spectrum modelling workshop in August and was back in Perth in November to teach an R course for CSIRO staff. Anthony and Julian attended the (Global Alliance of CPR Surveys (GACS) meeting and zooplankton Genetics workshop in Hobart in November, along with the staff from Hobart. Julian also spent time in Hobart the week prior to the GACS meeting collaborating with Sharon Appleyard to begin to develop a genetic library for Australian copepods.

In the first week of December, Jenny Hugget and Marco Worship from South Africa and Octavio Esquivel from Brazil, who had all attended the GACS meeting the week before came to Brisbane to spend time discussing and learning about the way we conduct the sampling and analysis of CPR samples for our survey. Earlier in the year we were also visited by Gustaaf Hallegraeff, Claire Davies, Ruth Eriksen and Jason Everett when they were all in Brisbane for the annual IMOS planning meeting and the STAR workshop. The STAR workshop was part of ongoing work, in collaboration with IMOS, to produce the Status and Trends report of Australia's open-ocean ecosystems released at the IMOS Annual Planning Meeting in March 2020.

With a greater focus on students working with our data to produce ecological and food web models incorporating zooplankton and phytoplankton over the last couple of years, we have had less students working in the laboratory than in the past.

Syngnatidae pipefish

Alpheidae larvae

Female Pontellid, *Labidocera cervi*

Syngnatidae pipefish

Gebiidae shrimp

We were, however, fortunate to have Barbara Nuic volunteer to help us out with the ZooScan. Barbara achieved some excellent results and presented her work at the CSIRO Oceans and Atmosphere mini symposium in Brisbane in December 2019. Apart from the educational outreach that Julian regularly participates in, this year he was also involved in a project to instruct researchers at the Queensland Government Aquaculture Research facility at Bribie Island, in coastal zooplankton identification using microscopy.

The AusCPR work based from Brisbane has continued well this year, with both the *Salome* and the *Tonsberg* continuing to collect samples between Brisbane and Adelaide for us and the *Wakmatha* collecting samples along the Great Barrier Reef between Cairns and Gladstone. We have been successful in collecting seasonal samples without any interruptions throughout the year. We also had the opportunity to place some cassettes on board the *RV Investigator* when it was in port in Brisbane in October. The vessel continued north and passed through Darwin on the way to Perth. The CPR will be deployed by the ship's crew whenever the opportunity arises, and with several reasonable transits amongst the research legs of the voyage we should obtain several tows from regions where we have poor coverage from commercial shipping.

Sampling at the National Reference station at North Stradbroke Island has continued successfully in 2019, with samples collected from 10 months throughout the year. In February we were unable to sample due to bad weather, and in November there were issues with our vessel the *Scylla*. The boat has now been repaired and we were able to complete our final sampling trip in December. Mark Tonks, Julian Uribe-Palomino and Frank continue to be the regular crew, but we have also received plenty of help from other staff and students who have been visiting the laboratory including Lauren Hardiman, Katie Hillyer, Gary Fry, Steve Edgar, Kinam Salee, Margaret Miller and Jacob Rogers. The sampling procedures have not changed in 2019, but there has been an increase in the number of stations collecting the ichthyoplankton samples.

This year we also had it confirmed that we would be part of the team hosting the 7th Zooplankton Production Symposium, which will be held in Hobart in mid-March in 2022. This will perhaps be an opportunity to meet up with many others from the zooplankton community around the world.

Hobart Update

Felicity McEnnulty

Summer of 2018/2019 was a busy time for collecting Continuous Plankton Recorder (CPR) samples in the Southern Ocean. Our collaboration with the Australian Antarctic Division (AAD) is ongoing and we have been counting the CPR tows collected by *RV Aurora Australis* from Hobart to 47° South from voyages 1, 2 and 3. CPR tows further south are counted as part of the AusCPR survey and the SCAR SO-CPR survey. The AAD charted *RV Investigator* (IN2019_V01) for a whale research voyage on which they also collected CPR samples, so we had additional tows from the Southern Ocean from January to March 2019. *RV Investigator* went to the Southern Ocean Time Series mooring at 47° South and towed the CPR for us in March (INV2019_V02).

The IMOS National Reference Station sample counting has continued for 2019 with Ruth and Claire counting phytoplankton from all the stations and Felicity counting Maria Island zooplankton. We are now collecting an extra zooplankton sample stored in ethanol from the NSI and MAI NRS stations for a pilot project for genetic extractions of copepods to get more species DNA sequences to match up with eDNA samples collected in IMOS microbial studies and other projects such as AAD CPR genetics analyses. Julian was in Hobart in November working with Sharon Appleyard to trial extraction techniques using whole copepod specimens and to determine if sufficient DNA could be obtained from just copepod legs.

Claire was on the research cruise, the Indian Ocean Expedition (IIOE2) on *RV Investigator* (IN2019_V03) along the 110° meridian in May on which she collected CPR and net samples which she has subsequently been analysing in the lab. We had a visiting student Madeline Anderson from September 2019 looking at the IIOE2 phytoplankton samples.

Claire visited the MBA (formerly SAHFOS) in March to discuss databases and microplastics. She met with analysts and looked at the microplastics on the silks from the North Atlantic which were similar in appearance to those seen in the Australian region. It is much harder to pick up microplastics when you do on-silk analysis, we wash off our zooplankton and they are much easier to spot. The MBA has the same concerns and challenges with contamination of microplastics on the silks as we do. Claire also attended a GACS database working group meeting whilst in Plymouth where the final decisions were made about formats for the global surveys to send in data to the GACS global database. The decision was also taken to progress the GACS OBIS node and provide all CPR data to OBIS via the GACS database.

IMOS Moorings BGC QC summit was held in Hobart in April 2019. Frank attended from Brisbane and demonstrated zooplankton sampling techniques (see photo below).

Frank Coman demonstrating zooplankton sampling techniques

Along with team members from Brisbane, Claire attended the AMSA Conference in Fremantle in July where she presented on the *Trichodesmium* modelling work she is currently involved in with Barbara Robson at AIMS. She also helped run a data workshop before the conference advising on how to use IMOS data. The workshop was attended by about 50 students, mostly with biological backgrounds.

Hobart Update continued...

The workshop covered accessing IMOS data from the portal and using this to create simple data products, with R code supplied for students to access.

For her IMOS appointment looking at the phytoplankton from SO-CPR samples, Fiona Scott started our Hobart labs in August for training for QA/QC purposes to ensure we all identify the species consistently once she is set-up at AAD (see next page).

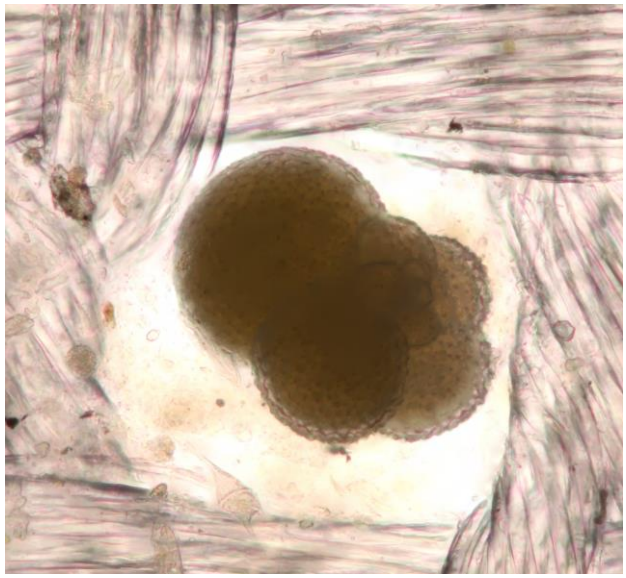
Ruth attended the International Conference on Paleoceanography in Sydney in August and invited Dr Julie Meilland from the University of Bremen to visit us in September. Julie provided some much appreciated advice on Foraminifera (forams) identifications (see image right) and will collaborate with us on the development of a Lucid key in 2020.

Anthony hosted the Global Alliance of CPR Surveys (GACS) meeting in Hobart in November, the first meeting outside of Europe. It was attended by members from United Kingdom, Cyprus, South Africa, Japan, Canada, Brazil, France, New Zealand and Australia. This included a tour of our plankton lab and demonstration of our microscopy processes. We also hosted a POGO CPR Molecular workshop investigating molecular studies for the CPR, run by Willie Wilson from the Marine Biological Association of the UK later that week (see separate story for details). During that same week, we worked with Dr Claude Jianping and his team of technicians from Shenzen University in China who were visiting CSIRO on a CAS exchange with Professor Tom Trull. Ruth and Julian helped Claude with imaging and identification of local zooplankton and phytoplankton species as part of the assessment of two optical plankton systems developed by Claude.

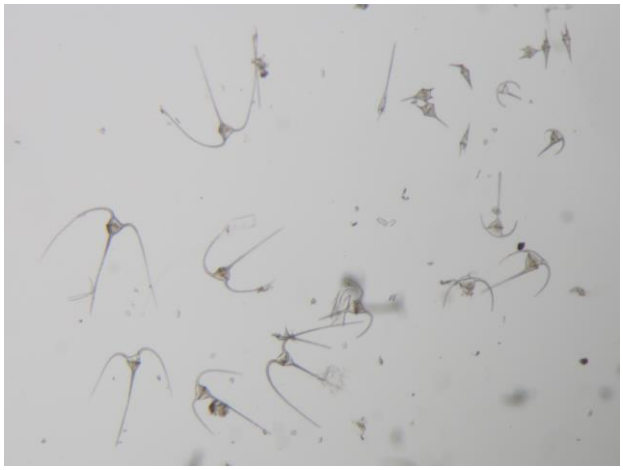
Staff training has been ongoing with Ruth and Felicity attending an Oracle course and Ruth attending an R-workshop Anthony ran for IOMRC in Western Australia. Ruth and Felicity attended an R course on mapping from a polar perspective using the new package SOMap developed by the AAD: https://github.com/raymondben/SOmapSOCPR/

As part of our general lab maintenance all Hobart staff have participated in a chemical training course, and to meet Health and Safety requirements we have undertaken a risk assessment for the lab and are producing safe working instructions (SWIs) for the lab processes.

Ruth and Claire have been working on the phytoplankton genus, *Tripos* (see image right) for the past few years with Gustaaf Hallegraeff from IMAS. The first in a series of publications on *Tripos* has been accepted by Australian Systematic Botany. "The marine planktonic dinoflagellate *Tripos*: sixty years of species-level distributions in Australian waters' was led by Gustaaf and describes many of the 77 species of *Tripos* observed in the Australian Plankton Survey.



Above: Photo of newly identified foram - *Globigerina bulloides,* composed from a stack of 14 images using Helicon Focus software from AAD tow 1 on voyage 3 from Hobart to Mawson in January 2018 about 46.8S 141.4E (image G. Hallegraeff, IMAS).



Above*: Tripos sp.* (image Felicity McEnnulty).

Welcome Fiona Scott to the Plankton Team

Position: Phytoplankton Biologist

Location: Australian Antarctic Division, Hobart

I have recently been employed by Kerrie Swadling (IMAS, University of Tasmania) to analyse the phytoplankton on the CPR silks from the Southern Ocean. I majored in biological sciences at Monash University before specialising in marine botany at the University of Melbourne. I spent several years diving, collecting algae and processing material for Transmission Electron Microscopy, completing my M.Sc. along the way. Subsequent opportunities enabled me to work at James Cook University (GBR macroalgal taxonomy and distribution), Kirstenbosch Botanic Gardens (temperate African macroalgae), University of Tasmania (Ph.D. in rare marine macroalgae distribution and conservation) and the Australian Antarctic Division (Antarctic and Southern Ocean protist community structure, taxonomy and seasonality).

For the first two months of the new position at UTAS, my time was spent completing a myriad of “onboarding” requirements for the University, CSIRO and AAD, as well as undertaking specialist AusCPR training for phytoplankton analysis with Ruth, Felicity and Claire. The training has proved invaluable, both in understanding the challenges presented by the methods and also in being able to confirm species identifications with other analysts. I am currently working my way through the multi-year backlog of samples taken during S.O. or Hobart–Antarctic voyages primarily from the R/V *Aurora Australis*. I have recently set up workspace at the AAD and will be working on the same CPR samples as zooplankton biologist John Kitchener. I am keen to contribute photomicrographs to the Portfolio image database and I also have the opportunity to examine material using the AAD Scanning Electron Microscope, for samples containing species of notable ecological importance or other specific (e.g. taxonomic) interest.

I am looking forward to generating useable Southern Ocean phytoplankton datasets for further analysis.

IN2019_V03 Collecting plankton samples across 30° of latitude in the Indian Ocean

Claire Davies

In May 2019, Claire had the opportunity to take part in the second International Indian Ocean expedition (IIOE-2) voyage on the *Investigator*. The IIOE-2 program is an International collaboration of institutions from around the Indian Ocean whose aim is to provide new observational data that will be processed, curated, managed and used to underpin characterisation of key oceanic and related atmospheric processes at a wide spectrum of spatial and temporal scales. IN2019_V03 was the Australian contribution to IIOE-2, repeating the work done along this transect in the 1960s, which included research by plankton expert David Tranter.

The voyage left Fremantle in May 2019 and travelled south west towards 110°E 40°S. Here we started the transect, moving northwards along the 110°E line we sampled at 20 stations spaced every 90 nautical miles until we reached the edge of the Indonesian EEZ at 11°S. A whole range of samples were taken at each station, including 8 different methods of collecting plankton!

- 20 µm mesh tow for phytoplankton
- High speed micro-zooplankton sampler (see Plankton Planet: https://planktonplanet.org)
- 100 µm mesh IMOS Heron drop net for zooplankton including microzooplankton
- 200 µm mesh oblique tow for mesozooplankton
- 330 µm mesh vertical Indian Ocean standard net for zooplankton biomass comparison with IIOE-1,
- 500 µm mesh EZ net for larger zooplankton & larval fishes
- 1000 µm mesh night-time surface net targeting phyllosoma, tuna larvae & myctophids
- Continuous Plankton Recorder for phytoplankton and zooplankton between stations

At each station, Claire collected a zooplankton sample to 100 m depth with the Heron net following the IMOS NRS protocol. The CPR was towed between each station for a complete surface transect of 30° of latitude. Together these samples will help add to our knowledge of the plankton ecosystems on the Western side of Australia, where historically there has been little sampling effort. Now the fun work of counting the samples begins and Claire has already noticed that the proportion and diversity of radiolarians and forams is much higher in the net samples than those from the more coastal NRS stations. This may be indicative of the longer food chains expected in oligotrophic waters. Ruth has started to look at the CPR silks and has found that the phytoplankton is very sparse in the southern, colder waters. Madeline Anderson, on a student placement from UTAS and the University of Southampton (see Madeline's section), has also been photo documenting the samples collected using the 20 µm mesh phytoplankton net. Tripos is abundant in these samples and is showing a wide diversity, so Madeline has decided to concentrate her student project on *Tripos* and will be testing out the Lucid key that Ruth has developed.

Claire will present the findings from this voyage at the International Copepod Conference (ICOC 2020) in Kruger, South Africa in June 2021.

For more information on IIOE2 go to: https://iioe-2.incois.gov.in/

For more information on ICOC 2021 go to: https://www.abevents.co.za/web_icoc2020/

Above: Claire Davies preparing a CPR reading for towing (Image: https://iioe-2.incois.gov.in/IIOE-2/Gallery.jsp)

Above: Claire Davies removing a cassette from a CPR after towing (Image: https://iioe-2.incois.gov.in/IIOE-2/Gallery.jsp)

AMSA 2019

Frank Coman

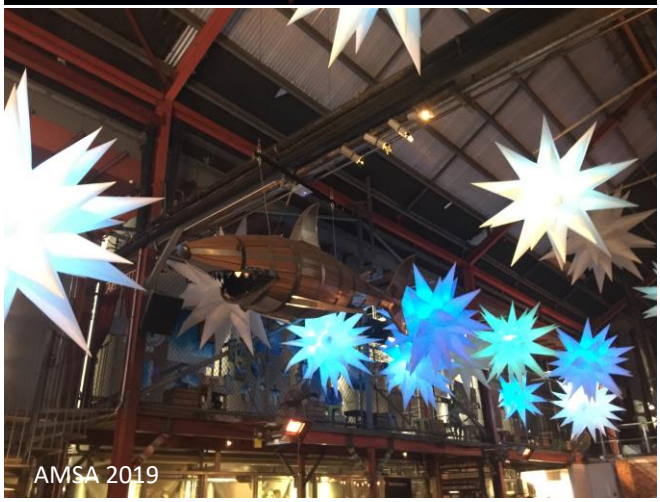
The annual AMSA (Australian Marine Science Association) conference was held at the Esplanade Hotel in Fremantle form the 7th – 11th of July, with an overall theme of marine science for a blue economy. The AMSA conference provides a platform for a wide range of marine research and is a great opportunity for students to present their work, with a variety of different awards available specifically for students. Nearly 600 delegates attended the conference, and took part in 28 symposia, 12 workshops and presented nearly 50 posters and over 300 oral presentations, across 5 concurrent sessions. Tim Moltmann, who at the time was the director of IMOS, was an invited keynote speaker on the opening day of the conference and spoke on driving the development of Australia's blue economy.

For the first time in several years there was a symposium targeting plankton research convened by our own Anthony Richardson and Kerrie Swadling from UTas. The symposium was entitled the evolving view of the role of plankton in marine ecosystems. Fifteen talks were scheduled for the symposium, and our team was well represented. Anthony kicked off proceedings with a talk about size spectrum modelling, and later assisted Jason Everett, who was suffering from laryngitis, by also presenting his talk on mapping zooplankton biomass in Australian waters. Sarah Pausina presented work from her PhD on the response of zooplankton to severe flooding in Moreton Bay and Frank talked about new copepod records in Australian waters. The topic for Claire's presentation was *Trichodesmium* time series from Australian waters, while Julian gave two presentations, one on the distribution of tintinnids around Australia, and the other concerned *Noctiluca* in Australian waters. The final talk of the symposium was from Kerrie Swadling who presented 25 years of the Southern Ocean CPR survey.

The symposium was well received by all who attended, and it was great to catch up with fellow plankton researchers from throughout around Australia. Outside of the plankton symposium there were many other interesting and innovative presentations and workshops and the social events organised by the committee were very successful. Anthony did manage to leave his bag and computer in the final venue after the conference dinner, and had to fly home early the next day without them; luckily for him the Australian Marine science community are a very helpful bunch and he was reunited with his belongings just a few days later.

Images: Julian Uribe Palomino

AMSA 2019



AMSA 2019

Anthony Richardson presenting at AMSA

GACS down-under: The annual meeting of the Global Alliance of CPRs

Julian Uribe-Palomino

The Global Alliance for Continuous Plankton Recorder (CPR) Surveys (GACS) meeting was held at CSIRO in Hobart last November 2019. Delegates of the CPRs Teams from: The North Pacific, The North Atlantic, Cyprus, Brazil, South Africa, Australia and the Southern Ocean, had the opportunity to update the alliance on their surveys progress.

Innovations, challenges faced, and interesting research findings and products of the CPR surveys were some of the topics discussed during the meeting.

For example, the development of a Global CPR database looking to integrate CPR data to improve research, and modelling across time and space, is a task in progress. This will be possible using the Global Biodiversity Information Facility (GBIF) Integrated Publishing Toolkit. Initiatives like this will help with the production of global status reports, and will support the testing of ecological theories, identify ecological patterns, and help to address global challenges.

Technological advances and miniaturization of electronic components are providing the possibility to add sensors and other devices to the CPRs to collect environmental data such as: temperature, salinity, fluorescence, partial pressure of gases, or even the collection of waters samples for molecular and chemical analysis.

The meeting was an opportunity to explore the application of artificial intelligence for the classification of images collected for already known devices such as the FlowCam and the ZooScan, as well as new products that are currently in the process of development for *in situ* monitoring of marine ecosystems (though this kind of technology might not be available for fast moving devices such as the CPRs yet).

Finally, the attendees discussed the importance of extending the CPR program to tropical areas of the globe to cover the gap of information from these latitudes.

Professors Willian Wilson from the MBA and Anthony Richardson from CSIRO were the convenors facilitating the development of this meeting. POGO supported and funded two of the attendees (from South America and South Africa) to participate in the GACS meeting, as well as at the Molecular workshop that was hold also in Hobart (see next page).


GACS Meeting


GACS Meeting


GACS Meeting

Molecular Plankton Workshop

Claire Davies

After the GACS workshop most of the participants stayed on for a two-day molecular workshop to discuss how these newer molecular techniques can be used in conjunction with the traditional microscopic methods used in CPR analysis to increase the value from CPR tows. The CPR representatives were joined by experts in molecular ecology, bioinformatics, marine instrumentation and engineering. The Hobart workshop was convened by Professor Willie Wilson, the Director of the Marine Biological Association of the UK and hosted locally by Anthony. The aim of the workshop was to develop an understanding of how molecular techniques could enhance the value of the global CPR collection. Presentations were given on in-situ molecular samplers, metabarcoding analysis from CPR silks, microbial work currently being done in Australia, and the challenges around using formalin preserved samples in molecular work. This last topic dominated much of the discussion, as the whole archive of CPR samples globally is currently all preserved in formalin.

There then followed a series of more open discussion about where to from here. It was widely acknowledged in the group that the value of the CPR data was in the 70 year timeseries and changing anything that jeopardises that was not the way to go. Molecular techniques are developing fast and instruments are being deployed to take in-situ measurements, but not at the scale that could easily attach to a CPR for a simultaneous towing. The instruments are still bulky in comparison and require space for storing filtered water whilst underway. The discussion then turned from instrumentation to the lab analysis, to concentrate on what information we could extract from the samples we have and develop a robust method of analysing the formalin preserved time series of samples that we have in storage. Also discussed was the lack of consistency and information in the genomics databases and it was recognised that molecular experts could collaborate with taxonomists to barcode distinctive isolated specimens to confirm the identifications in the databases. This is something that the IMOS plankton team is actively doing at CSIRO, in conjunction with molecular biologists Sharon Appleyard and Lev Bodrossy.

Rowena Stern, also from the Marine Biological Association, has done much of the work to date on extracting molecular information from CPR silks. We will be working closely with Rowena who will lead the drive to develop methods of using molecular techniques to add value to the CPR surveys.

Molecular Workshop Participants

The Role is IMOS Time-Series Data in Education

The government funded Integrated Marine Observing System (IMOS) provides a unique opportunity for students and next generation scientists to use current real-world data free of charge. IMOS have created two data time-series focusing on an educational context. The first, a masters level course at the Sydney Institute Marine Science (SIMS), and the second, an online-only lecture series prepared by IMOS at the University of Tasmania.

Established in 2012, the Topics in Australian Marine Science (TAMS) is taught as a collaborative masters level course among Macquarie University, the University of New South Wales, the University of Sydney, and the University of Technology Sydney. Students take a practical tour through different IMOS datasets and technologies including:
- Satellite observations
- Moorings data
- Gliders
- ARGO floats
- Phytoplankton and zooplankton observations
- Animal tracking
- Benthic photo interpretation from the Autonomous Underwater Vehicle.

Students learn to:
- Access raw data on the Australian Ocean Data Network
- Process these datasets in the R statistical package
- Understand how their results influence research and management through lectures from researchers and government scientists/managers.

As active IMOS researchers teach these classes students are able to ask direct and relevant questions regarding up-to-date topics such as climate change and shifting ocean currents.

Also, a new e-lecture series has been launched (by IMOS and the University of Tasmania in conjunction with the Australian Institute of Marine Science) teaching marine scientists how they might use IMOS data within their research programs. This e-lecture series offers analysis skills in a flexible learning environment.

These educational initiatives are so exciting in maximising the efficiency of marine data that is being collected by many dedicated researchers and scientists on a daily basis around Australia. Providing hand-in-hand the data and pathways of accessing analyses skills, IMOS and SIMS are contributing to educating the upcoming generation of Marine Scientists, with the end goal of better understanding Australia's marine environment.

Above: Images http://imos.org.au/

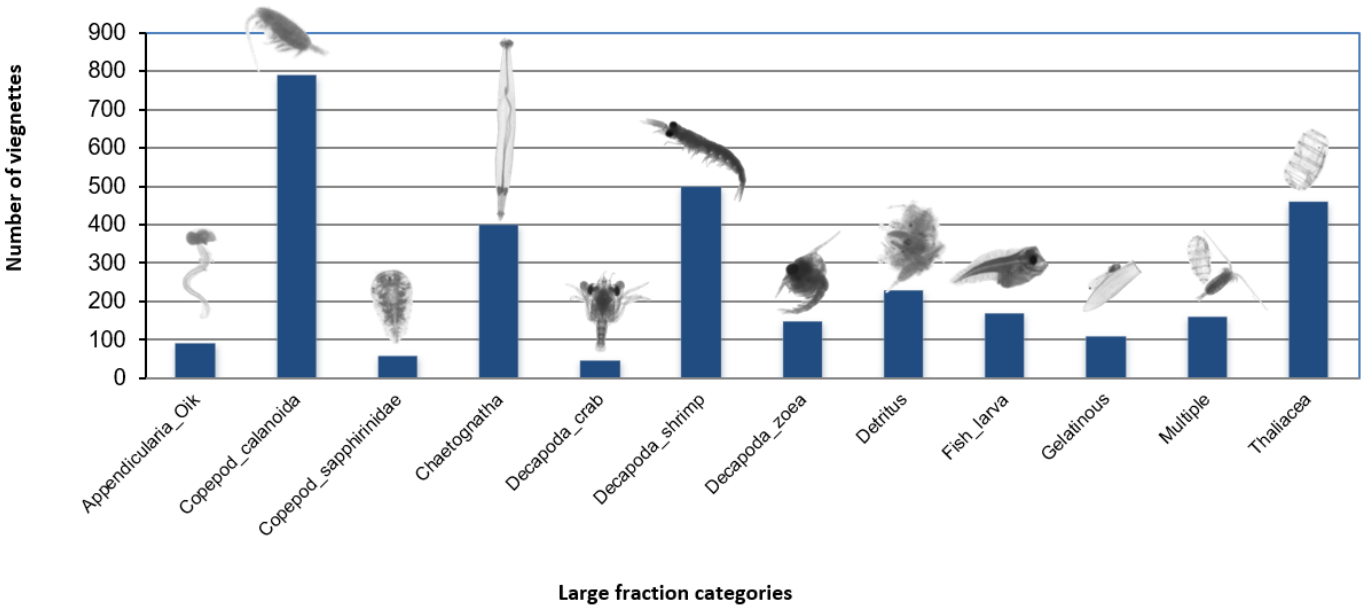
ZooScan – The Challenge of an Efficient Learning Set

Barbara Nuic

ZooScan is a scanner used to digitize specimens in water and is a very efficient tool that creates clear images of objects over 0.3 mm. After scanning, the image is processed using the ZooProcess software. This program separates the image in sub images called vignettes. Each vignette should have one organism that will be later classified using the PlanktonID software. Thus ZooScan and ZooProcess can be used together to automatically identify specimens to broad taxonomic groups.

To classify the vignettes, PlanktonID needs a learning set, which consists of pre-selected images divided into categories. So it is essential to be very particular when building a learning set, because not only will it determine which categories your images will be separated and classified into, but also how efficient this classification will be. If this step does not work well, it is necessary to spend several hours correcting the classification manually.

For the last couple of months I've worked with Julian Uribe-Palomino on a learning set for the large fraction (objects >1.4 mm). In total, over 3000 objects were sorted into 29 categories. The main categories and number of vignettes per category are presented in Figure 1.

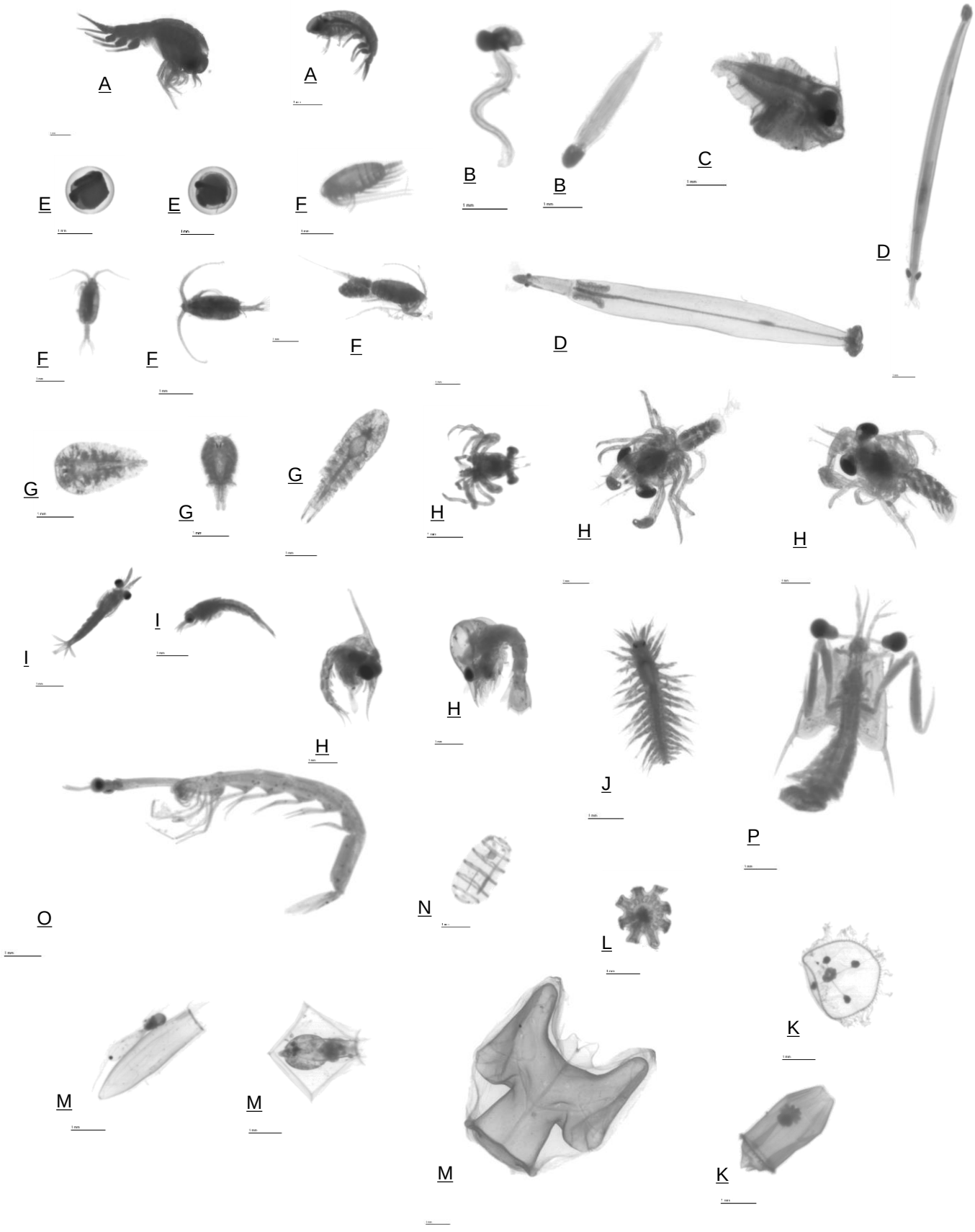


The images used on this learning set were selected from scans I've done from North Stradbroke Island and Maria Island (Figure 2 over the page). In addition, it was necessary to select organisms from other samples to be scanned separately to obtain a significant number of items for less abundant but frequent categories such as amphipod, copepod, decapod (crab-like), Sapphirinidae, gelatinous organisms and fish larva.

A determining factor considered was the number of vignetted per category. GORSKY et al. (2010) recommend over 200 individuals. Also, it was important to consider the shape and size of the organisms so the software could recognise a pattern. It was possible to achieve this goal for the most frequent categories, but ongoing work is necessary to keep improving the learning set to increase the accuracy (true positives).

Reference

GORSKY, Gaby et al. Digital zooplankton image analysis using the ZooScan integrated system. **Journal of plankton research**, v. 32, n. 3, p. 285-303, 2010.



A. Amphipod **B.** Appendicularia Oikopleura **C.** Fish larva **D.** Chaetognath **E.** Fish Embryo **F.** Copepod Calanoida **G.** Copepod Sapphirinidae **H.**Decapoda **I.** Euphausiid **J.** Polychaeta **K.** Medusa **L.** Ephira (Medusa) **M.** Siphonophore **N.**Thaliacea Doliolida **O.** Luciferidae **P.** Stomatopoda.

Published in 2019 - PLANKTON: A Guide to Their Ecology and Monitoring for Water Quality

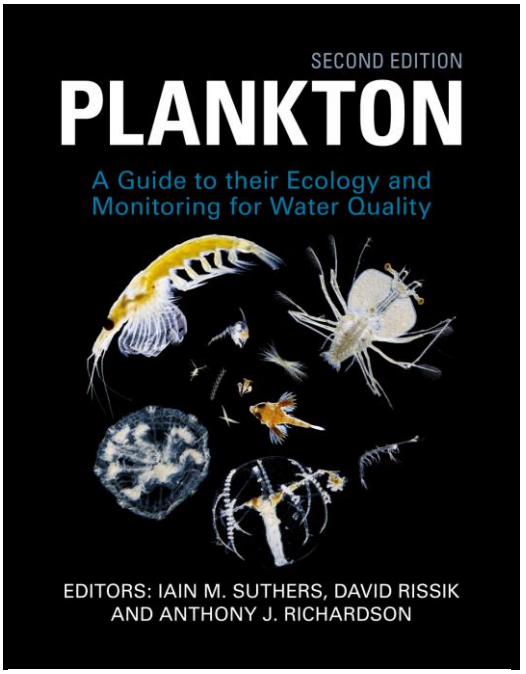
Healthy waterways and oceans are essential for our increasingly urbanised world. Yet monitoring water quality in aquatic environments is a challenge, as it varies from hour to hour due to stormwater and currents. Being at the base of the aquatic food web and present in huge numbers, plankton are strongly influenced by changes in environment and provide an indication of water quality integrated over days and weeks. Plankton are the aquatic version of a canary in a coal mine. They are also vital for our existence, providing not only food for fish, seabirds, seals and sharks, but producing oxygen, cycling nutrients, processing pollutants, and removing carbon dioxide from our atmosphere.

This Second Edition of *Plankton* is a fully updated introduction to the biology, ecology and identification of plankton and their use in monitoring water quality. It includes expanded, illustrated descriptions of all major groups of freshwater, coastal and marine phytoplankton and zooplankton and a new chapter on teaching science using plankton. Best practice methods for plankton sampling and monitoring programs are presented using case studies, along with explanations of how to analyse and interpret sampling data.

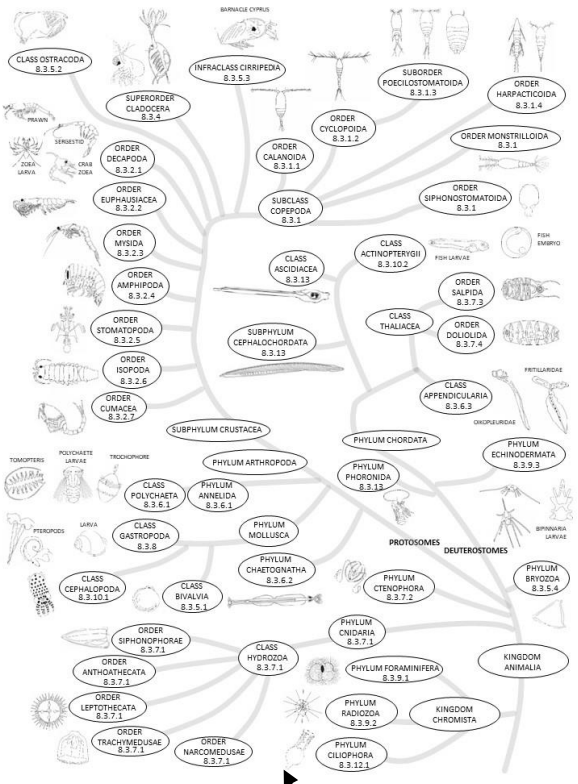
Plankton is recommended for teachers and students, environmental managers, ecologists, estuary and catchment management committees, and coastal engineers.

Features:
- Fully revised and expanded edition with a new chapter on teaching science (K-12 and tertiary studies) using plankton
- Covers all major freshwater, coastal and marine phytoplankton and zooplankton groups and provides a list of up-to-date references
- Explains the role of plankton in aquatic ecosystems and its usefulness as a water quality indicator
- Describes best practice methods for plankton sampling and monitoring programs using case studies
- Demonstrates how to analyse and interpret the results of sampling programs

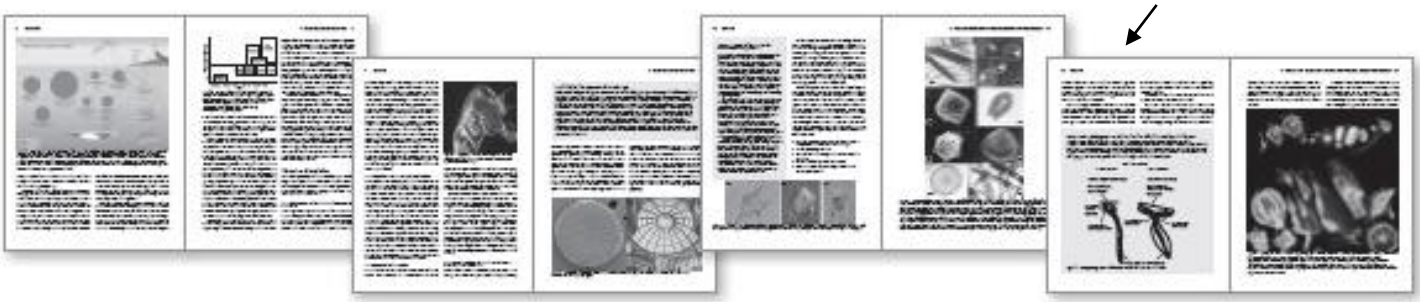
We welcome any feedback and the Team would like to hear what people think of the new updated edition. Please feel free to get in touch.



Available now
via CSIRO publishing:
https://www.publish.csiro.au/book/7808/



these are some of the sample pages



Training on Copepod Identification

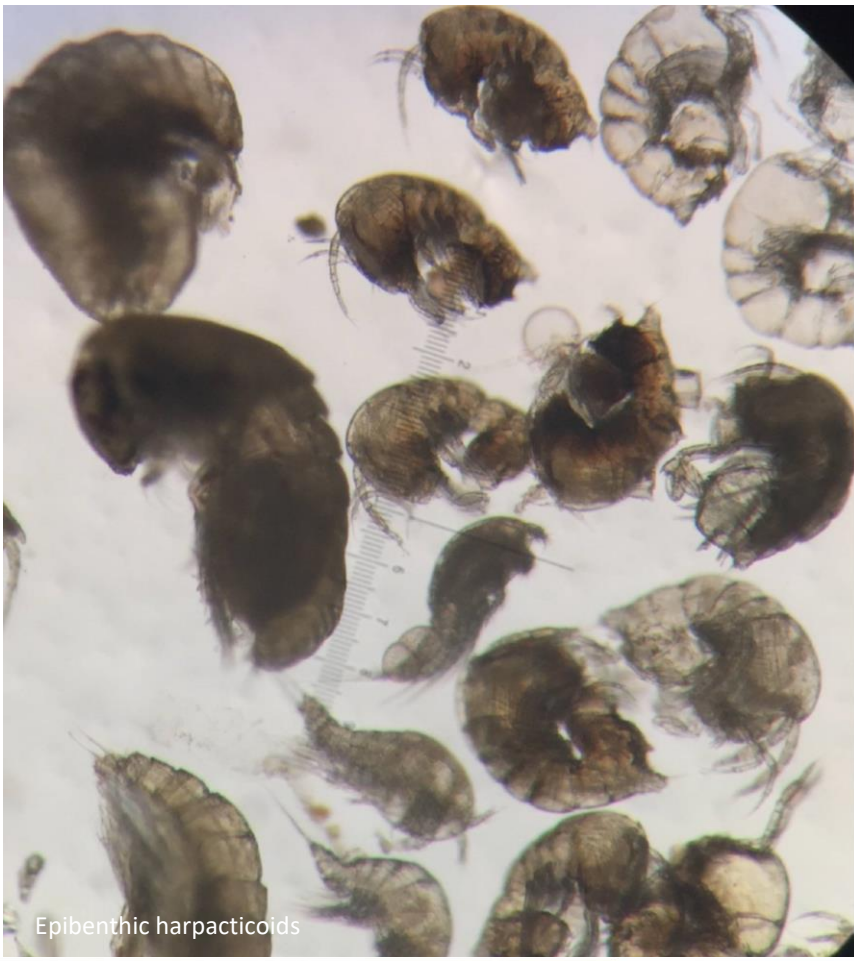
Julian Uribe-Palomino

In early 2019, we trained a team of 4 people from the Queensland Department of Agriculture and Fisheries (DAF) to identify the most common groups of plankton found in samples collected in the Logan River, an estuarine ecosystem.

The first training session focused on the different zooplankton taxa present. The other 3 sessions focused on the most common orders, genera and species of copepods found in the samples.

The sessions were mostly practical to give the participants the confidence to manipulate and identify the specimens to the highest level possible. Practical quizzes helped the team to prove their abilities identifying copepods found in the samples.

We also focused on the understudied group of harpacticoid copepods of epibenthic habits that were often found in the samples collected by the team. Learning to identify the most common harpacticoid species is a priority considering the lack of information of harpacticoid diversity of Australian marine, estuarine and freshwater ecosystems.



Epibenthic harpacticoids

Diversity of harpacticoid copepods found in the samples


Smiths Lake

Zooplankton of Smiths Lake

Julian Uribe-Palomino

In March 2019 a group of students from the University of New South Wales visited the research station at Smiths Lakes for a 3 day field trip aiming to study the biological communities and the environmental conditions of this marine coastal ecosystem. Julian Uribe was invited by Professor Iain Suthers to help train the students.

The group was split according to the particular interests of the participants, such as primary productivity, fish and zooplankton. Some of the students focused on the zooplankton of the water column and others were interested in the emerging organisms from the epibenthos that migrate through the water column during the night.

Samples of zooplankton were collected during the day and night to compare changes in composition, abundances and size spectrum of the samples.

Julian Uribe-Palomino from the CSIRO Plankton team taught the students to identify some of the main zooplankton taxa found in the samples, focusing on the copepods.

Two main species of copepods (*Gladioferens* cf. *G. pectinatus* and *Pseudodiaptomus inflexus*) were found to dominate the water column in the Smiths lake.


Diverse plankton sample

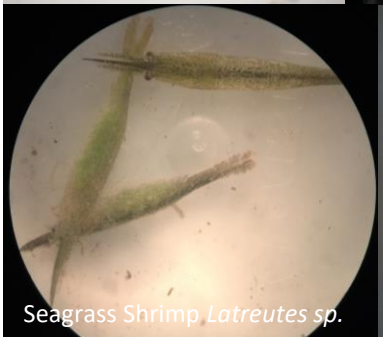

Juvenile Isopod


Gladioferans pectinatus


Pseudodiaptomus sp. and *Gladioferans sp*. with eggs


Unidentified benthic harpacticoid


Diverse plankton sample


Seagrass Shrimp *Latreutes sp.*


Unidentified Tanaidacean

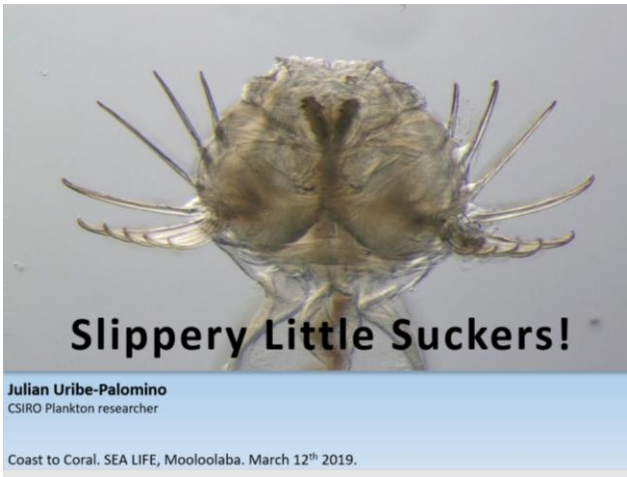

Thalassionema nitzchioides

Plankton for everyone

Julian Uribe-Palomino

Reef Check Australia invited us to give plankton talks to the general public as part of their Coast to Coral project early in 2019. The talk 'Slippery little suckers: Planktonic life in SEQ' was delivered at the Sunshine Coast Aquarium in Mooloolaba 13th March 2019 and the talk 'where the wild bugs are!' was presented at the Bearded Lady in Brisbane 26th March 2019. The aim of our talks was to connect the general public with the microscopic world of plankton. A 'tiny' world that usually passes unappreciated for most of us, even though plankton are fundamental to the wellbeing and health of our aquatic ecosystems.

The Moreton Bay Environmental Education Centre leads an initiative aimed at students from different schools around Brisbane who are interested in learning more about the marine environment. Students have the opportunity to spend a day in Moreton Bay on board of 'the *Inspiration*' to learn about basic environmental data collection techniques and to learn about benthic and planktonic ecosystems. The CSIRO plankton team are often involved with this field trip to help teach students about the important role of planktonic organisms in the oceans. The kids can check live samples of colourful plankton on board using microscopes and they often see other sea life (such as fish) that is recorded using an underwater camera.



Australia's Integrated Marine Observing System (IMOS) is enabled by the National Collaborative Research Infrastructure Strategy (NCRIS). It is operated by a consortium of institutions as an unincorporated joint venture, with the University of Tasmania as Lead Agent.

IMOS Integrated Marine Observing System

NCRIS National Research Infrastructure for Australia
An Australian Government Initiative

Visit the AusCPR website at
http://imos.org.au/auscpr.html

Visit the NRS website at
http://imos.org.au/anmnnrs.html

IMOS Australian Plankton Survey Leader
Professor Anthony J. Richardson

Anthony.Richardson@csiro.au

Newsletter - Anita Slotwinski
Anita.Slotwinski@csiro.au

CSIRO

Further team contact details can be located at
http://imos.org.au/cpr_staff.html

Follow us on social media for up to date national and international plankton news, plankton images and videos, free educational resources and stunning plankton posters!
Search IMOS Australian Plankton Survey or go to
www.facebook.com/ imosaustralianplanktonsurvey
www.twitter.com/IMOS_Survey