# #40 – Sept 2017 (http://nzoac.nz/)

## News

**Hot off the press**: A new paper reviewing ocean acidification in New Zealand is now published in the NZ Journal of Marine and Freshwater Research <http://www.tandfonline.com/doi/full/10.1080/00288330.2017.1374983>. This review, led by Cliff Law, summarises the ocean acidification work that has been undertaken in New Zealand over the last 10 years. It highlights the wide range of work that has been undertaken on this topic. I’m sure it will be a useful summary for researchers, students, government and industry. If you don’t have access to the journal then please get in touch and we will send you a copy.

The NZOAC committee met on the 18th September and discussed a range of issues relevant to the community. The most important one is the date of the next NZOA workshop:

**The 11th New Zealand Ocean Acidification Workshop, 13-14th February 2018**

**Location:** University of Waikato

Scientists, policy makers and stakeholders are all welcome. The workshop this year will include plenary speakers (to be confirmed) short talks, updates from OA projects, and discussion sessions on OA research coordination, directions and value to management, mitigation and adaptation. Please submit formatted abstracts **(see instructions at the end of the Newsletter) by December 15th 2017.** Any enquiries please contact: [conrad.pilditch@waikato.ac.nz](mailto:conrad.pilditch@waikato.ac.nz).

## CARIM RA2 – John Zeldis

Research Aim 2 focusses on modelling and understanding the inputs and outputs to the carbonate system in the Firth of Thames and Hauraki Gulf area. Over the last year Helen MacDonald and David Plew have been developing a regional ocean model system (ROMS) to model the physical oceanography, and are now linking it with a biogeochemical model to understand changes in nutrients, oxygen and productivity. Changes in these factors will influence dissolved inorganic carbon (DIC), while run-off from rivers can alter alkalinity. There are still some issues with the boundary conditions of the model with regards to changes in river flows, but in general the model appears to be working well. Helen and David are now starting to compare the model outputs with satellite observations of productivity (chlorophyll a – MODIS Satellite), and also a large dataset from John Zeldis covering the last 20 years of measurements from voyages and moorings in the Hauraki Gulf and Firth of Thames focussing on the period from 2003 to 2013.

In related news, the mooring programme supported by the NIWA Coasts and Oceans ‘Productivity’ project (COOF1802), continues to maintain SeaFET pH sensors mounted on moorings in the inner and outer Firth of Thames. These are supported by quarterly maintenance trips and sampling for carbonate parameters (alkalinity and dissolved inorganic carbon) and other variables, which are analysed within RA1. The SeaFET sensors are experiencing biofouling and we have installed a biofouling-protected SeaFET on the inner Firth mooring.

Selection of reports, theses and recent papers from the SW Pacific

**Iron sources alter the response of Southern Ocean phytoplankton to ocean acidification.** The rise in anthropogenic CO2 and the associated ocean acidification (OA) will change trace metal solubility and speciation, potentially altering Southern Ocean (SO) phytoplankton productivity and species composition. As iron (Fe) sources are important determinants of Fe bioavailability, we assessed the effect of Fe-laden dust versus inorganic Fe (FeCl3) enrichment under ambient and high pCO2 levels (390 and 900 μatm) in a naturally Fe-limited SO phytoplankton community. Despite similar Fe chemical speciation and net particulate organic carbon (POC) production rates, CO2-dependent species shifts were controlled by Fe sources. Final phytoplankton communities of both control and dust treatments were dominated by the same species, with an OA-dependent shift from the diatom *Pseudo nitzschia prolongatoides* towards the prymnesiophyte *Phaeocystis antarctica*. Addition of FeCl3 resulted in high abundances of *Nitzschia lecointei* and *Chaetoceros neogracilis* under ambient and high pCO2, respectively. These findings reveal that both the characterization of the phytoplankton community at the species level and the use of natural Fe sources are essential for a realistic projection of the biological carbon pump in the Fe-limited pelagic SO under OA. As dust deposition represents a more realistic scenario for the Fe-limited pelagic SO under OA, unaffected net POC production and dominance of *P. antarctica* can potentially weaken the export of carbon and silica in the future. Trimborn S., et al., 2017. Marine Ecology Progress Series 578: 35-50. [Article](https://doi.org/10.3354/meps12250).

**Modern planktic foraminifers in the high-latitude ocean.** Planktic foraminifers can be sensitive indicators of the changing environment including both the Arctic Ocean and Southern Ocean. Due to variability in their ecology, biology, test characteristics, and fossil preservation in marine sediments, they serve as valuable archives in paleoceanography and climate geochemistry over the geologic time scale. Foraminifers are sensitive to, and can therefore provide proxy data on ambient water temperature, salinity, carbonate chemistry, and trophic conditions through shifts in assemblage (species) composition and the shell chemistry of individual specimens. Production and dissolution of the calcareous shell, as well as growth and remineralization of the cytoplasm, affect the carbonate counter pump and to a lesser extent the soft-tissue pump, at varying regional and temporal scales. Diversity of planktic foraminifers in polar waters is low in comparison to lower latitudes and is limited to three native species: Neogloboquadrina pachyderma, Turborotalita quinqueloba, and Globigerina bulloides, of which N. pachyderma is best adapted to polar conditions in the surface ocean. Neogloboquadrina pachyderma hibernates in brine channels in the lower layers of the Antarctic sea ice, a strategy that is presently undescribed in the Arctic. In open Antarctic and Arctic surface waters T. quinqueloba and G. bulloides increase in abundance at lower polar to subpolar latitudes and Globigerinita uvula, Turborotalita humilis, Globigerinita glutinata, Globorotalia inflata, and Globorotalia crassaformis complement the assemblages. Over the past two to three decades there has been a marked increase in the abundance of Orcadia riedeli and G. uvula in the subpolar and polar Indian Ocean, as well as in the northern North Atlantic. This paper presents a review of the knowledge of polar and subpolar planktic foraminifers. Particular emphasis is placed on the response of foraminifers to modern warming and ocean acidification at high latitudes and the implications for data interpretation in paleoceanography and paleoclimate research. Schiebel R., et al., 2017. Marine Micropaleontology 136: 1-13. [Article](https://doi.org/10.1016/j.marmicro.2017.08.004) (subscription required).

**Diel CO2 cycles reduce severity of behavioural abnormalities in coral reef fish under ocean acidification.** Elevated CO2 levels associated with ocean acidification (OA) have been shown to alter behavioural responses in coral reef fishes. However, all studies to date have used stable *p*CO2 treatments, not considering the substantial diel *p*CO2 variation that occurs in shallow reef habitats. Here, we reared juvenile damselfish, *Acanthochromis polyacanthus*, and clownfish, *Amphiprion percula*, at stable and diel cycling *p*CO2 treatments in two experiments. As expected, absolute lateralization of *A. polyacanthus* and response to predator cue of *Am. percula* were negatively affected in fish reared at stable, elevated *p*CO2 in both experiments. However, diel *p*CO2 fluctuations reduced the negative effects of OA on behaviour. Importantly, in experiment two, behavioural abnormalities that were present in fish reared at stable 750 µatm CO2 were largely absent in fish reared at 750 ± 300 µatm CO2. Overall, we show that diel *p*CO2 cycles can substantially reduce the severity of behavioural abnormalities caused by elevated CO2. Thus, past studies may have over-estimated the impacts of OA on the behavioural performance of coral reef fishes. Furthermore, our results suggest that diel *p*CO2 cycles will delay the onset of behavioural abnormalities in natural populations. Jarrold M. D., et al., 2017. Scientific Reports 7: 10153. doi:10.1038/s41598-017-10378-y. [Article](http://dx.doi.org/10.1038/s41598-017-10378-y).

**Responses of neurogenesis and neuroplasticity related genes to elevated CO2 levels in the brain of three teleost species.** The continuous increase of anthropogenic CO2 in the atmosphere resulting in ocean acidification has been reported to affect brain function in some fishes. During adulthood, cell proliferation is fundamental for fish brain growth and for it to adapt in response to external stimuli, such as environmental changes. Here we report the first expression study of genes regulating neurogenesis and neuroplasticity in brains of three-spined stickleback (Gasterosteus aculeatus), cinnamon anemonefish (Amphiprion melanopus) and spiny damselfish (Acanthochromis polyacanthus) exposed to elevated CO2. The mRNA expression levels of the neurogenic differentiation factor (NeuroD) and doublecortin (DCX) were upregulated in three-spined stickleback exposed to high-CO2 compared with controls, while no changes were detected in the other species. The mRNA expression levels of the proliferating cell nuclear antigen (PCNA) and the brain-derived neurotrophic factor (BDNF) remained unaffected in the high-CO2 exposed groups compared to the control in all three species. These results indicate a species-specific regulation of genes involved in neurogenesis in response to elevated ambient CO2 levels. The higher expression of NeuroD and DCX mRNA transcripts in the brain of high-CO2–exposed three-spined stickleback, together with the lack of effects on mRNA levels in cinnamon anemonefish and spiny damselfish, indicate differences in coping mechanisms among fish in response to the predicted-future CO2 level. Lai F., et al., Biology Letters. [Article](http://dx.doi.org/10.1098/rsbl.2017.0240) (subscription required).

**Overcalcified forms of the coccolithophore *Emiliania huxleyi* in high CO2 waters are not pre-adapted to ocean acidification.** Marine multicellular organisms inhabiting waters with natural high fluctuations in pH appear more tolerant to acidification than conspecifics occurring in nearby stable waters, suggesting that environments of fluctuating pH hold genetic reservoirs for adaptation of key groups to ocean acidification (OA). The abundant and cosmopolitan calcifying phytoplankton *Emiliania huxleyi* exhibits a range of morphotypes with varying degrees of coccolith mineralization. We show that *E. huxleyi* populations in the naturally acidified upwelling waters of the Eastern South Pacific, where pH drops below 7.8 as is predicted for the global surface ocean by the year 2100, are dominated by exceptionally overcalcified morphotypes whose distal coccolith shield can be almost solid calcite. Shifts in morphotype composition of *E. huxleyi* populations correlate with changes in carbonate system parameters. We tested if these correlations indicate that the hypercalcified morphotype is adapted to OA. In experimental exposures to present-day vs. future pCO2 (400 µatm vs. 1200 µatm), the overcalcified morphotypes showed the same growth inhibition (−29.1 ± 6.3 %) as moderately calcified morphotypes isolated from non-acidified water (−30.7 ± 8.8 %). Under OA conditions, production rates of particulate organic carbon (POC) increased, while production rates of particulate inorganic carbon (PIC) were maintained or decreased slightly (but not significantly), leading to lowered PIC/POC ratios in all strains. There were no consistent correlations of response intensity with strain origin. OA affected coccolith morphology equally or more strongly in overcalcified strains compared to moderately calcified strains. OA conditions appear not to directly select for exceptionally overcalcified morphotypes over other morphotypes directly, but perhaps indirectly by ecologically correlated factors. More generally, these results suggest that oceanic planktonic microorganisms, despite their rapid turn-over and large population sizes, do not necessarily exhibit adaptations to naturally high CO2 upwellings, and this ubiquitous coccolithophore may be near a limit of its capacity to adapt to ongoing ocean acidification. von Dassow P., et al., Biogeosciences Discussions. doi: 10.5194/bg-2017-303. [Article](https://doi.org/10.5194/bg-2017-303).

**Special issue of 9 papers from the High-CO2 world conference, Hobart, Tasmania 2016 in Biology Letters** <http://royalsocietypublishing.org/cc/ocean-acidification>

* New perspectives in ocean acidification research: editor’s introduction to the special feature on ocean acidification. P. Munday.
* Adult exposure to ocean acidification is maladaptive for larvae of the Sydney rock oyster Saccostrea glomerate in the presence of multiple stressors. L.M. Parker et al.,
* Spatial-temporal environmental variation mediate geographic differences in phenotypic responses to ocean acidification. J.D Gaitan-Espitia etal.,
* Ocean acidification alters predator behaviour and reduces predation rate. S-A. Watson et al.,
* Inter- and intraspecific phenotypic plasticity of three phytoplankton species in response to ocean acidification. G.A.I. Hattich et al.,
* Geographical gradients in selection can reveal genetic constraints for evolutionary responses to ocean acidification. J.D. Gaitan-Espitia et al.,
* Does sex really matter? Explaining intraspecies variation in ocean acidification responses. R.P. Ellis et al.,
* Biological responses of sharks to ocean acidification. R. Rosa.
* Embracing interactions in ocean acidification research: confronting multiple stressor scenarios and context dependence. K.J., Kroeker et al.,
* Effects of hypoxia and ocean acidification on the upper thermal niche boundaries of coral reef fishes. R. Ern et al.,

**Ocean acidification alters zooplankton communities and increases top-down pressure of a cubozoan predator.** The composition of local ecological communities is determined by the members of the regional community that are able to survive the abiotic and biotic conditions of a local ecosystem. Anthropogenic activities since the industrial revolution have increased atmospheric CO2 concentrations, which have in turn decreased ocean pH and altered carbonate ion concentrations: so called ocean acidification (OA). Single-species experiments have shown how OA can dramatically affect zooplankton development, physiology and skeletal mineralization status, potentially reducing their defensive function and altering their predatory and antipredatory behaviors. This means that increased OA may indirectly alter the biotic conditions by modifying trophic interactions. We investigated how OA affects the impact of a cubozoan predator on their zooplankton prey, predominantly Copepoda, Pleocyemata, Dendrobranchiata, and Amphipoda. Experimental conditions were set at either current (pCO2 370 μatm) or end-of-the-century OA (pCO2 1,100 μatm) scenarios, crossed in an orthogonal experimental design with the presence/absence of the cubozoan predator Carybdea rastoni. The combined effects of exposure to OA and predation by C. rastoni caused greater shifts in community structure, and greater reductions in the abundance of key taxa than would be predicted from combining the effect of each stressor in isolation. Specifically, we show that in the combined presence of OA and a cubozoan predator, populations of the most abundant member of the zooplankton community (calanoid copepods) were reduced 27% more than it would be predicted based on the effects of these stressors in isolation, suggesting that OA increases the susceptibility of plankton to predation. Our results indicate that the ecological consequences of OA may be greater than predicted from single-species experiments, and highlight the need to understand future marine global change from a community perspective. Hammill E., et al., Global Change Biology. [Article](http://dx.doi.org/10.1111/gcb.13849) (subscription required).

**Reviews and syntheses: Ice acidification, the effects of ocean acidification on sea ice microbial communities.** Sea ice algae, like some coastal and estuarine phytoplankton, are naturally exposed to a wider range of pH and CO2 concentrations than those in open marine seas. While climate change and ocean acidification (OA) will impact pelagic communities, their effects on sea ice microbial communities remain unclear. Most OA studies have examined the impacts on single sea ice algae species in culture. Although some studies examined the effects of OA alone, most examined the effects of OA and either light, nutrients or temperature. With few exceptions, increased CO2 concentration caused either no change or an increase in growth and/or photosynthesis. In situ studies on brine and surface algae also demonstrated a wide tolerance to increased and decreased pH and showed increased growth at higher CO2 concentrations. The short time period of most experiments (< 10 days), together with limited genetic diversity (i.e. use of only a single strain), however, has been identified as a limitation to a broader interpretation of the results. Sea ice ecosystems are ephemeral, melting and re-forming each year. Thus, for some part of each year organisms inhabiting the ice must also survive outside of the ice, either as part of the phytoplankton or as resting spores on the bottom. During these times, they will be exposed to the full range of co-stressors that pelagic organisms experience. Their ability to continue to make a major contribution to sea ice productivity will depend not only on their ability to survive in the ice but also on their ability to survive the increasing seawater temperatures, changing distribution of nutrients and declining pH forecast for the water column over the next centuries.  
McMinn A., 2017.  Biogeosciences 14, 3927-3935. [Article](https://doi.org/10.5194/bg-14-3927-2017).

**Low recruitment due to altered settlement substrata as primary constraint for coral communities under ocean acidification.** The future of coral reefs under increasing CO2 depends on their capacity to recover from disturbances. To predict the recovery potential of coral communities that are fully acclimatized to elevated CO2, we compared the relative success of coral recruitment and later life stages at two volcanic CO2 seeps and adjacent control sites in Papua New Guinea. Our field experiments showed that the effects of ocean acidification (OA) on coral recruitment rates were up to an order of magnitude greater than the effects on the survival and growth of established corals. Settlement rates, recruit and juvenile densities were best predicted by the presence of crustose coralline algae, as opposed to the direct effects of seawater CO2. Offspring from high CO2 acclimatized parents had similarly impaired settlement rates as offspring from control parents. For most coral taxa, field data showed no evidence of cumulative and compounding detrimental effects of high CO2 on successive life stages, and three taxa showed improved adult performance at high CO2 that compensated for their low recruitment rates. Our data suggest that severely declining capacity for reefs to recover, due to altered settlement substrata and reduced coral recruitment, is likely to become a dominant mechanism of how OA will alter coral reefs. Fabricius K. E., et al., Proceedings of the Royal Society B. [Article](https://doi.org/10.1098/rspb.2017.1536) (subscription required).

**Future marine ecosystem drivers, biodiversity, and fisheries maximum catch potential in Pacific Island countries and territories under climate change.**

* Under the RCP 8.5 scenario, tropical Pacific temperature will rise by ≥ 3 °C by 2100.
* This is accompanied by declines in dissolved oxygen, pH, and net primary production.
* This will lead to local extinctions of up to 80% of marine species in some regions.
* 9 of 17 Pacific Island entities experience ≥ 50% declines in maximum catch potential.
* Impacts can be greatly reduced by mitigation measures under the RCP 2.6 scenario.

The increase in anthropogenic CO2 emissions over the last century has modified oceanic conditions, affecting marine ecosystems and the goods and services that they provide to society. Pacific Island countries and territories are highly vulnerable to these changes because of their strong dependence on ocean resources, high level of exposure to climate effects, and low adaptive capacity. Projections of mid-to-late 21st century changes in sea surface temperature (SST), dissolved oxygen, pH, and net primary productivity (NPP) were synthesized across the tropical Western Pacific under strong climate mitigation and business-as-usual scenarios. These projections were used to model impacts on marine biodiversity and potential fisheries catches. Results were consistent across three climate models, indicating that SST will rise by ≥ 3 °C, surface dissolved oxygen will decline by ≥ 0.01 ml L−1, pH will drop by ≥ 0.3, and NPP will decrease by 0.5 g m−2 d−1 across much of the region by 2100 under the business-as-usual scenario. These changes were associated with rates of local species extinction of > 50% in many regions as fishes and invertebrates decreased in abundance or migrated to regions with conditions more suitable to their bio-climate envelope. Maximum potential catch (MCP) was projected to decrease by > 50% across many areas, with the largest impacts in the western Pacific warm pool. Climate change scenarios that included strong mitigation resulted in substantial reductions of MCP losses, with the area where MCP losses exceeded 50% reduced from 74.4% of the region under business-as-usual to 36.0% of the region under the strong mitigation scenario. Asch R. G., et al.,. Marine Policy. [Article](https://doi.org/10.1016/j.marpol.2017.08.015) (subscription required).

**Thesis: Dissolution of abiogenic and biogenic calcium carbonate under ocean acidification conditions.** Under ocean acidification conditions, the chemistry of the seawater will change including a decrease in pH, a decrease in carbonate ion concentration and a decrease in the calcium carbonate saturation state of the water (Ω). This has implications for solid marine calcium carbonates including calcifying organisms and carbonate sediments. The dissolution kinetics of marine carbonates are poorly understood, therefore modelling of the future ocean under ocean acidification scenarios is hampered. The goal of this research was to provide an increased understanding of the kinetics of marine carbonate dissolution, including dependence of the dissolution rate of calcium carbonate mineral phases (calcite, calcite-aragonite, low Mg-calcite) on conditions relevant to ocean acidification, and then to apply this to biogenic samples (Pāua, kina and oyster). The effects of saturation state (Ω), surface area, and temperature were studied. Two methods were refined and used to collect and analyze the dissolution data – a pH-stat method and a pH free-drift method, with manipulation of the carbonate chemistry by addition of NaHCO3 and HCl. A LabVIEW® based program was developed for instrument control and automation and for data acquisition. The empirical equation R = k(1-Ω)n, was used to determine the reaction rates (R), the rate constants (k) and the reaction orders (n) for the each of the mineral phases and shellfish species.

The results from the pH-stat and pH free-drift methods are not significantly different, and even close to equilibrium conditions (Ω=1), the dissolution rate determined using the pH free-drift method had an accuracy similar to that of the pH-stat method. For abiogenic calcium carbonate, Iceland spar showed a higher dissolution rate in artificial seawater compared with marble at the same value of Ω. For crushed marble, the dissolution rate constant increases in accordance with a rise in temperature, and a high apparent activation energy for the dissolution reaction was calculated (37.6 kJ mol-1) using the Arrhenius equation (K=Ae-Ea/(RT)), which indicated that dissolution was dominated by surface controlled processes.

The study of the dissolution rates of biogenic carbonates focused on three species of particular economic and cultural value to New Zealand. Kina (Sea-urchin – Evechinus Chloroticus) have spines composed of low magnesium calcite; Pāua (New Zealand abalone – Haliotis Iris) have bi-mineral shells made of calcite and aragonite, and Oyster (Tiostrea chilensis) shell is primarily calcite. All crushed biogenic samples (oyster, sea-urchin spine and Pāua), owing to their complex microstructure and the higher amount of available active surface area, have higher dissolution rates than the abiogenic carbonate samples (marble and Iceland spar). Pāua shells, containing fractions of fine crystalline aragonite in the calcite structure, dissolved faster than the sea-urchin spines composed of low Mg-calcite. That was because grain microstructure complexity overrode the mineral stability and caused a selective dissolution of the more stable mineral. The pure calcite oyster shell dissolved with a rate between that of Pāua and sea-urchin spines.Our results provide valuable insight into the dissolution rates of marine organisms under acidified seawater conditions and thus also provide perspective on how these organisms may be influenced by future OA. Adhami Z., 2017. Abridged abstract from PhD Thesis, University of Otago. [Thesis](https://ourarchive.otago.ac.nz/handle/10523/7537) (subscription required).

**Impacts of ocean acidification on sensory function in marine organisms.** Ocean acidification has been identified as a major contributor to ocean ecosystem decline, impacting the calcification, survival, and behavior of marine organisms. Numerous studies have observed altered sensory perception of chemical, auditory, and visual cues after exposure to elevated CO2. Sensory systems enable the observation of the external environment and therefore play a critical role in survival, communication, and behavior of marine organisms. This review seeks to (1) summarize the current knowledge of sensory impairment caused by ocean acidification, (2) discuss potential mechanisms behind this disruption, and (3) analyze the expected taxa differences in sensitivities to elevated CO2 conditions. Although a lack of standardized methodology makes cross-study comparisons challenging, trends and biases arise from this synthesis including a substantial focus on vertebrates, larvae or juveniles, the reef ecosystem, and chemosensory perception. Future studies must broaden the scope of the field by diversifying the taxa and ecosystems studied, incorporating ontogenetic comparisons, and focusing on cryptic sensory systems such as electroreception, magnetic sense, and the lateral line system. A discussion of possible mechanisms reveals GABAA receptor reversal as the conspicuous physiological mechanism. However, the potential remains for alternative disruption through structure or cue changes. Finally, a taxonomic comparison of physiological complexity reveals few trends in sensory sensitivities to lowered pH, but we hypothesize potential correlations relating to habitat, life history or relative use of sensory systems. Elevated CO2, in concordance with other global and local stressors, has the potential to drastically shift community composition and structure. Therefore research addressing the extent of sensory impairment, the underlying mechanisms, and the differences between taxa is vital for improved predictions of organismal response to ocean acidification. Ashur M. M., et al., 2017. Integrative and Comparative Biology 57(1): 63–80. [Article](https://doi.org/10.1093/icb/icx010) (subscription required).

**In vivo pH measurement at the site of calcification in an octocoral.**Calcareous octocorals are ecologically important calcifiers, but little is known about their biomineralization physiology, relative to scleractinian corals. Many marine calcifiers promote calcification by up-regulating pH at calcification sites against the surrounding seawater. Here, we investigated pH in the red octocoral *Corallium rubrum* which forms sclerites and an axial skeleton. To achieve this, we cultured microcolonies on coverslips facilitating microscopy of calcification sites of sclerites and axial skeleton. Initially we conducted extensive characterisation of the structural arrangement of biominerals and calcifying cells in context with other tissues, and then measured pH by live tissue imaging. Our results reveal that developing sclerites are enveloped by two scleroblasts and an extracellular calcifying medium of pH 7.97 ± 0.15. Similarly, axial skeleton crystals are surrounded by cells and a calcifying medium of pH 7.89 ± 0.09. In both cases, calcifying media are more alkaline compared to calcifying cells and fluids in gastrovascular canals, but importantly they are not pH up-regulated with respect to the surrounding seawater, contrary to what is observed in scleractinians. This points to a potential vulnerability of this species to decrease in seawater pH and is consistent with reports that red coral calcification is sensitive to ocean acidification. Le Goff C., Tambutté E., Venn A. A., Techer N., Allemand D. & Tambutté S., 2017. Scientific Reports 7: 11210. doi:10.1038/s41598-017-10348-4. [Article](http://dx.doi.org/10.1038/s41598-017-10348-4).

**Late-summer biogeochemistry in the Mertz Polynya: East Antarctica.** A marked reconfiguration of the Mertz Polynya following the 2010 calving of the Mertz Glacier Tongue has been associated with a decrease in the size and activity of the polynya. We report observations of the oceanic carbonate (CO2) system in late-summer 2013, the third post-calving summer season. Estimates of seasonal net community production (NCP) based on inorganic carbon deficits and the oxygen-argon ratio indicate that the waters on the shelf to the east of Commonwealth Bay (adjacent to the Mertz Glacier) remain productive compared to pre-calving conditions. The input of residual or excess alkalinity from melting sea ice is found to contribute to the seasonal enhancement of carbonate saturation state and pH in shelf waters. Mean rates of NCP in 2012–2013 are more than twice as large as those observed in the pre-calving summers of 2001 and 2008 and suggest that the new (post-calving) configuration of the polynya favors enhanced net community production and a stronger surface ocean sink for atmospheric CO2 due at least in part to the redistribution of sea ice and associated changes in summer surface stratification. Shadwick E. H., et al.,. Journal of Geophysical Research. [Article](http://dx.doi.org/10.1002/2017JC013015).

**Latitudinal trends in shell production cost from the tropics to the poles.** The proportion of body mass devoted to skeleton in marine invertebrates decreases along latitudinal gradients from large proportions in the tropics to small proportions in polar regions. A historical hypothesis—that latitudinal differences in shell production costs explain these trends—remains untested. Using field-collected specimens spanning a 79°N to 68°S latitudinal gradient (16,300 km), we conducted a taxonomically controlled evaluation of energetic costs of shell production as a proportion of the total energy budget in mollusks. Shell production cost was fairly low across latitudes at <10% of the energy budget and predominately <5% in gastropods and <4% in bivalves. Throughout life, shell cost tended to be lower in tropical species and increased slightly toward the poles. However, shell cost also varied with life stage, with the greatest costs found in young tropical gastropods. Low shell production costs on the energy budget suggest that shell cost may play only a small role in influencing proportional skeleton size gradients across latitudes relative to other ecological factors, such as predation in present-day oceans. However, any increase in the cost of calcium carbonate (CaCO3) deposition, including from ocean acidification, may lead to a projected ~50 to 70% increase in the proportion of the total energy budget required for shell production for a doubling of the CaCO3 deposition cost. Changes in energy budget allocation to shell cost would likely alter ecological trade-offs between calcification and other drivers, such as predation, in marine ecosystems. Watson S.-A., et al., 2017. Science Advances 3(9): e1701362. doi: 10.1126/sciadv.1701362. [Article](http://dx.doi.org/10.1126/sciadv.1701362).

**Sponge bioerosion on changing reefs: ocean warming poses physiological constraints to the success of a photosymbiotic excavating sponge.** Excavating sponges are prominent bioeroders on coral reefs that in comparison to other benthic organisms may suffer less or may even benefit from warmer, more acidic and more eutrophic waters. Here, the photosymbiotic excavating sponge *Cliona orientalis* from the Great Barrier Reef was subjected to a prolonged simulation of both global and local environmental change: future seawater temperature, partial pressure of carbon dioxide (as for 2100 summer conditions under “business-as-usual” emissions), and diet supplementation with particulate organics. The individual and combined effects of the three factors on the bioerosion rates, metabolic oxygen and carbon flux, biomass change and survival of the sponge were monitored over the height of summer. Diet supplementation accelerated bioerosion rates. Acidification alone did not have a strong effect on total bioerosion or survival rates, yet it co-occurred with reduced heterotrophy. Warming above 30 °C (+2.7 °C above the local maximum monthly mean) caused extensive bleaching, lower bioerosion, and prevailing mortality, overriding the other factors and suggesting a strong metabolic dependence of the sponge on its resident symbionts. The growth, bioerosion capacity and likelihood of survival of *C*. *orientalis* and similar photosymbiotic excavating sponges could be substantially reduced rather than increased on end-of-the-century reefs under “business-as-usual” emission profiles. Achlatis M., et al., 2017.  Scientific Reports 7: 10705. doi:10.1038/s41598-017-10947-1. [Article](http://dx.doi.org/10.1038/s41598-017-10947-1).

**Ecological performance of construction materials subject to ocean climate change.** Artificial structures will be increasingly utilized to protect coastal infrastructure from sea-level rise and storms associated with climate change. Although it is well documented that the materials comprising artificial structures influence the composition of organisms that use them as habitat, little is known about how these materials may chemically react with changing seawater conditions, and what effects this will have on associated biota. We investigated the effects of ocean warming, acidification, and type of coastal infrastructure material on algal turfs. Seawater acidification resulted in greater covers of turf, though this effect was counteracted by elevated temperatures. Concrete supported a greater cover of turf than granite or high-density polyethylene (HDPE) under all temperature and pH treatments, with the greatest covers occurring under simulated ocean acidification. Furthermore, photosynthetic efficiency under acidification was greater on concrete substratum compared to all other materials and treatment combinations. These results demonstrate the capacity to maximise ecological benefits whilst still meeting local management objectives when engineering coastal defense structures by selecting materials that are appropriate in an ocean change context. Therefore, mitigation efforts to offset impacts from sea-level rise and storms can also be engineered to alter, or even reduce, the effects of climatic change on biological assemblages. Davis K. L.,et al., . Marine Environmental Research. [Article](https://doi.org/10.1016/j.marenvres.2017.09.011) (subscription required).

## Upcoming meetings

**11th NZOA Workshop – 13-14th February 2018 - Abstracts due Dec 15 2017  
Instructions:**

* **Paper title:** Calibri 11 point, bold, sentence case, leave one blank line below the title.
* **Authors' names:** Calibri 11 point. First name or initials should come before the family name for each author. Highlight the **presenting author** in bold. Use superscript numbers to indicate different affiliations and list below.
* **Authors affiliation:** Calibri 11 point, sentence case**.**
* Use “**Calibri**” 11 point with single line spacing for all text including headings. Left align all text.
* **250 words maximum.**
* Margins should be set at 2 cm all round.

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