MSA THE MALACOLOGICAL SOCIETY OF AUSTRALASIA

NEWSLETTER

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Molluscs 2018, the triennial MSA conference to be held at The Museum of New Zealand Te Papa Tongarewa, Wellington, Sunday 2nd—Wednesday 5th December, 2018

Time has flown by and the Molluscs 2018 conference is almost upon us. Delegate registration is on Sunday 2nd December, with proceedings finishing on Wednesday 5th December. Keynote speakers are Serean Adams (Cawthron Institute), Robert Cowie (University of Hawai'i), Satoshi Chiba (Tohoku University), Amy Moran (University of Hawai'i), Pauline Ross (University of Sydney) and Phil Ross (University of Waikato). A program of proceedings is presented on pages 6 and 7.

The MSA Annual General Meeting (AGM) will be held at lunchtime on Wednesday 5th December, 2018 (please see the program and the AGM announcement on pages 6 - 8).

A post-conference genomics workshop will be conducted on Thursday 6th December in Wellington, examining current high through-put DNA sequencing methods for use in an ecological and population biology context, and will be focused on molluscs. This will incur an additional cost and prior registration is essential.

We look forward to seeing you there!

Above: the land snail *Cepaea* (Helicidae) showing shell colour polymorphism. Photograph by Daniel Ramos Gonzales (University of Nottingham, United Kingdom). Daniel has been awarded an MSA travel grant to Molluscs 2018; other travel grant recipients are listed on page 9. We congratulate them and look forward to meeting them in New Zealand!

The MSA's sister society is The Society for the Study of Molluscan Diversity (SSMD). Further information about SSMD can be found at:
http://marine1.bio.sci.toho-u.ac.jp/md/index-e.html

Society information

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Enquiries

All enquiries and orders should be sent to the Secretary, Kara Layton. Email: kara.layton@museum.wa.gov.au

Victorian branch

Secretary: Michael Lyons, 19 Banksia Street, Blackburn, VIC 3130. Phone (03) 9894 1526 or Email: Michael_lyons1@bigpond.com

Meetings are held at the Melbourne Camera Club, corner of Dorcas and Ferrars Streets, South Melbourne, on the third Monday of the month. No meeting in January, March, May, July, September or December.

Membership fees 2018

Includes *Molluscan Research* (published four times per year), the MSA Newsletter (electronic-only publication since Number 158), and discounted registration at the MSA *Molluscs 2018* conference.

Ordinary members (worldwide)	$AU 70
Institutional membership	$AU 100
Student member/concession	$AU 45

Membership fees can be paid (preferably) via the Society's website. Otherwise, send subscriptions via mail to: Malacological Society of Australasia, c/o Matt Nimbs, National Marine Science Centre, PO Box 4321, Coffs Harbour, NSW, Australia, 2450.

Newsletter

Editor: Platon Vafiadis
Email: newsletter@malsocaus.org
The deadline for articles for the next issue of the Newsletter is Friday 25 January, 2019.

MSA website: http://www.malsocaus.org

Facebook: http://www.facebook.com/groups/Malsocaus

Note: This publication is not deemed to be valid for taxonomic purposes — see article 8.2 in the International Code of Zoological Nomenclature, 4th Edition. Also, opinions expressed within articles in this newsletter belong to the author(s) and are neither necessarily shared nor endorsed by the MSA.

Notoacmea alta Oliver, 1926 (arrowed), on *Austromytilus rostratus* (Dunker, 1857) (Mytilidae), mid littoral zone, San Remo back beach, Victoria, Thursday 29 March, 2018. Photo: P. Vafiadis.

Locating molluscs by knowledge of habitat—the case of *Notoacmea alta* Oliver, 1926 (Lottiidae)

Notoacmea alta is a small limpet (growing to about 5mm in length) with a tall profile. Because it is often associated with the mussel *Austromytilus rostratus*, locating it in the field will usually be successful if beds of this mussel are present and carefully examined. Both are south-eastern Australian temperate species with roughly similar ranges of distribution (South Australian to southern New South Wales, including Tasmania). It is a good example of the value of habitat knowledge in locating living specimens.

Reference and futher reading:

Marine Research Group of the Field Naturalists Club of Victoria (2006). *Coastal invertebrates of Victoria—an atlas of selected species* (Revised edition). Privately printed, Field Naturalists Club of Victoria, Melbourne (i-vi, 170 pp).

P. Vafiadis

Detection of the invasive exotic Japanese softshell clam *Mya japonica* Jay, 1857 (Bivalvia: Myidae) in Tasmania

Simon Grove [1], Richard Willan [2], Kevin Ellard [3] and Alison Dann [3]

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Here we present a brief timeline outlining the detection of the Southern Hemisphere's first known incursion of the Japanese softshell clam. In providing the details, we hope that this summary will serve as a useful reference-point for future publications documenting research on, and management of, this incursion.

The Japanese softshell clam *Mya japonica* Jay, 1857 is a large bivalve native to muddy intertidal and shallow subtidal habitats in the temperate north-western Pacific Ocean (Japan, China, Korea and Russia). It is morphologically very similar to another *Mya* species, *M. arenaria* Linnaeus, 1758, and has often been considered synonymous with that species. *Mya arenaria* is native to the north-western Atlantic Ocean, but was apparently introduced into northern European waters several hundred years ago (possibly by the Vikings—Strasser, 1999) and, through further transplantation, has since colonised the Mediterranean and Black Sea. It was also accidentally introduced to California via oyster seedings in the 1860s or 1870s, and, either through natural spread or transplantation, has since colonised northwards to Alaska. Very recently, molecular analyses reinstated *M. japonica* as a valid species, and additionally determined that it too had been introduced to the north-eastern Pacific, most likely via either oyster seedings or ballast water, with confirmed records from two widely separated localities along the coast of British Columbia (Zhang et al., 2018). In the same publication, the authors also asserted that the two species could be separated on the basis of subtle differences in shell morphology and sperm ultrastructure.

The propensity for *M. arenaria* to colonise coasts beyond its native range and build up large densities led to the recognition of this species (and, by extension, the newly reinstated *M. japonica*) as a potential marine pest should it ever be detected in southern Australian waters (Hayes & Sliwa, 2003). Being a deep burrower, it has no potential as a fouling species, but it certainly has the potential to compete with native species (of clams and other invertebrates) for space and for food.

On 29 April 2018, a post on the *Tasmanian Marine and Seashore Life* Facebook group alerted the senior author (SG) to the apparent presence of *M. arenaria* at Orford on Tasmania's lower east coast (lat. 42.557° S, long. 147.876° E). The post, by local environmental consultant (and beachcomber) Andrew North, featured four photos and the following text: *"Large bivalve, seems most likely to be a type of sunset-shell. Up to 100 mm. Double-rayed sunset-shells shown for size comparison. Raspins Beach, Orford."*

In an exchange of subsequent comments on this Facebook post, SG provisionally identified the clam as *Mya arenaria*, and noted that this was potentially very concerning if it represented an incursion of that species. Andrew North agreed to bring the shells to SG at TMAG to confirm the identification.

It was at this point that SG realised that two dead shells from West Shelly Beach, Orford that had been collected by Jeanette Jackson on 4 August 2013, and delivered to TMAG soon after, were also apparently of this species. At the time, SG had examined the shells and, considering their worn and sun-bleached appearance, had concluded that they were of non-Tasmanian origin and had most likely been dumped high on the beach following a local's return from a European holiday. While this may now sound naïve, it is actually not uncommon to find such 'foreign' shells on local beaches and seemed like the most parsimonious explanation at the time.

On 13 May 2018, this same Facebook post, and the subsequent exchange of comments, caught the eye of a further group member, Bernadette Northeast, who added: "*There are hundreds in the Prosser River at Orford. They are dead now but appear to have been uncovered during recent rain/storm and may live in the mud … Many are 150mm long.*"

The rain/storm event referred to here was two days previously (11 May 2018). It delivered record rainfall to much of south-eastern Tasmania and caused flash flooding in many catchments, including the Prosser River. It seemed likely, then, that this event had scoured the surface sediments at the mouth of the river, exposing

the clams and flushing some of them out.

It took until 25 May 2018 for SG to examine one of these shells, when Andrew North brought in one of the shells that had been the subject of his original Facebook post. Having seen the shell (Figure 1) and concluding that it was *Mya arenaria*, SG then contacted the other authors of this paper on 28 May to alert them to the recent finds and to seek further advice. It was at this point that the possibility of the shells being *M. japonica* rather than *M. arenaria* first came to light.

Figure 1. The *Mya japonica* shell collected at Orford by Andrew North in late April 2018. Longest dimension of shell 94 mm. Photo: Simon Grove.

A day later, on 29 May 2018, a further Facebook message from Bernadette North clarified that it was her father, John Bostock, an Orford resident, who had spotted the clams. In the interim she had asked him to take some photos of the clams *in situ*, which she also sent to SG (Figure 2). The next day, SG and KE travelled to Orford to meet with John Bostock and to search for clams at the mouth of the Prosser River, timing the visit for low tide. While some sandy sediment had been redeposited since the storm, John Bostock was still able to locate the area, submerged in 10–20 cm of water, where he had first spotted the clams (Figure 3). Digging in this area with a long-handled spade turned up several live (or recently dead) *Mya* clams (Figure 4) at a depth of up to 30 cm in the anoxic and more solidified mud lying beneath the sand. We found that we could home in on the little mounds of pale sand surrounding the hole made by the animal's siphon (or exhalant current) – these seemed to be quite diagnostic, at least at this locality. Within about 15 minutes we had enough material to not only confirm the clam's presence but also to provide a few specimens for the TMAG collections, plus tissue samples for genetic analysis. John Bostock, a diver, also told us that he had seen shells like these on dives in the greater Orford area, and on Orford beaches, for many years, indeed decades. However, via his daughter he later conceded that he might have actually been seeing shells of *Panopea australis*, a fairly common species in this part of Tasmania, although it does not live in the same inshore environments as *Mya*.

Figure 2. *Mya japonica clams* exposed at the mouth of the Prosser River, Orford, mid-May 2018, following the storm event of 11 May. Photo: John Bostock.

Genetic analysis was undertaken by AD and completed by mid-June 2018. The sequences used by Zhang *et al.* (2018) as a basis for reinstating *M. japonica* as a valid species had been deposited in GenBank. When 16S, 28S and COX1 genes sequences from the Orford molluscs were compared with those for various *Mya* species on GenBank, they grouped clearly with north-western Pacific-origin *M. japonica* rather than with *M. arenaria*.

On May 30 2018 Biosecurity Tasmania initiated an invasive marine pest response, having first reported the detection to the Australia-wide Consultative Committee on Introduced Marine Pest Emergencies (of which KE is a member and for which RW is an advisor). The response involves surveillance planning and implementation, prioritising the Orford-Triabunna area in the first instance; establishment of population distribution and densities within this area; larval dispersal modelling; and research on population age-structure based on shell size -distributions and analyses of growth patterns. Preliminary findings suggest that *Mya japonica* has been present at a number of discrete locations in the Orford-

Triabunna area for at least a decade; and that in some areas they already occur at very high densities. This distribution is suggestive of the species having arrived as larvae in ballast water from a Japanese-origin ship docking at the former Triabunna export woodchip facility – but this cannot be confirmed. While their deep-burrowing habit in fine sediment militates against these clams posing an immediate threat to native species, they may become so in future, especially if further populations establish elsewhere in the region through natural spread, or if the species were transported (for instance, as larvae in ballast water) from Tasmania to, for example, New Zealand. These aspects will be the subject of future publications.

Figure 3. The same section of the Prosser River shoreline featured in Figure 2, where *Mya japonica* clams were detected *in situ* by Simon Grove and Kevin Ellard, 30 May 2018. Photo: Simon Grove.

Postscript: On 8 September 2018 Andrew North emailed SG with photos of a *Mya* clam that he had just come across in his shell collection. He had collected the shell from Millingtons Beach, Orford, on 21 July 2013, and had been unable to put a name to it at the time. This shell is therefore currently the earliest known specimen of *Mya japonica* from Orford, from Tasmania and from the Southern Hemisphere.

Figure 4. A *Mya japonica* recently dug up by Kevin Ellard from the same section of the Prosser River shoreline featured in Figures 2 & 3. Photo: Simon Grove.

References:

Hayes, K.L. & Sliwa, C. (2003). Identifying potential marine pests—a deductive approach applied to Australia. *Marine Pollution Bulletin* 46: 91–98.

Strasser, M. (1999). *Mya arenaria* – an ancient invader of the North Sea coast. *Helgolander Meeresunters* 52: 309-324.

Zhang, J., Yurchenko, O.V., Lutaenko, K.A., Kalachev, A.V., Nekaev, I.O., Aguilar, R., Zhan, Z. and Ogburn, M.B. (2018). A tale of two soft-shell clams: an integrative taxonomic analysis confirms *Mya japonica* as a valid species distinct from *Mya arenaria* (Bivalvia: Myidae). *Zoological Journal of the Linnean Society* 184 (3): 605–622.

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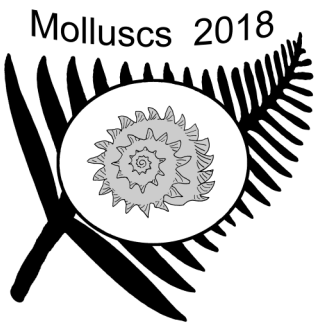
The conference logo for Molluscs 2018

The Molluscs 2018 conference logo features the New Zealand silver fern, representing this special land and all of its inhabitants (including its unique land snail fauna). Within the silver fern is an outline of *Astraea heliotropium* (Martyn, 1784) (Turbinidae), a spectacular marine species endemic to New Zealand.

We are very happy to host Molluscs 2018 in New Zealand. This is the first MSA conference to be held outside of Australia, and we hope that more will follow in the years to come.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Molluscs 2018: Triennial conference of the MSA. Program

Sunday 2nd December, 2018

16:15	Registration opens (ICON room)
17:00-18:00	Welcome Function (ICON room)

Monday 3rd December, 2018

8:45-9:00	Welcome introduction by **Lisa Kirkendale** and **Simon Hills** (Rangimarie 1)	
9:00-9:45	Keynote presentation – **Phil Ross**, University of Waikato Ancient aquaculture and the mystery of the disappearing surf clams	
9:45-10:30	Keynote presentation – **Serean Adams,** Cawthron Institute Growing, enabling and securing New Zealand's mollusc aquaculture industry - a research perspective	
10:30-11:00	Morning Tea (Rangimarie 1)	
11:00-12:20	Symposium: Systematics, taxonomy and biogeography (Rangimarie 1)	
12:20-13.30	Lunch (Rangimarie 1)	
	AFTERNOON PARALLEL SESSIONS	
13:30-15:10	Symposium: Systematics, taxonomy and biogeography (Rangimarie 1)	Symposium: Aquaculture, fisheries and human uses of molluscs (Rangimarie 2)
15:10-15:40	Afternoon Tea (Rangimarie 1)	
15:40-17:00	Symposium: Systematics, taxonomy and biogeography (Rangimarie 1)	Symposium: Community engagement and citizen science (Rangimarie 2)

Tuesday 4th December, 2018

8:55-9:00	Announcements (Rangimarie 1)
9:00-9:45	Keynote presentation – **Amy Moran,** University of Hawaii TBA
9:45-10:30	Keynote presentation – **Satoshi Chiba,** Tohoku University Lessons from the ongoing mass extinction of land snails in Ogasawara: direct and indirect effects of multiple invasive species
10:30-11:40	Morning Tea and **Poster Session** (Rangimarie 1)
11:40-12:20	Symposium: Open symposium (Rangimarie 1)

Tuesday 4th December, 2018 (continued)

12.20-13.30	Lunch (Rangimarie 1) **Molluscan Research Editors' meeting** – (Rangimarie 2)		
	AFTERNOON PARALLEL SESSIONS		
13:30-14:50	Symposium: Paleontology (Rangimarie 1)	Symposium: Genomics and molecular Biology (Rangimarie 2)	
14:50-15:10	Afternoon Tea (Rangimarie 1)		
15:10:17:30	Mini-Workshop: Photography of molluscs (Rangimarie 1)	Mini-Workshop: TBA (Rangimarie 2)	Field Trip: Victoria University of Wellington marine laboratory and Taputeranga Marine Reserve
18:00	Conference dinner (Foxglove)		

Wednesday 5th December, 2018

8:55-9:00	Announcements (Rangimarie 1)	
9:00-9:45	Keynote presentation – **Robert Cowie,** University of Hawaii Denying the Sixth Extinction: a counterpoint	
9:45-10:30	Keynote presentation – **Pauline Ross,** University of Sydney TBA	
10:30-11:00	Morning Tea (Rangimarie 1)	
	PARALLEL SESSIONS	
11:00-12:20	Symposium: Invasive species and biosecurity (Rangimarie 1)	Symposium: Climate Change (Rangimarie 2)
12:20-13.50	Lunch (Rangimarie 1) **MSA Annual General Meeting** (Rangimarie 2)	
13:50-15:10	Symposium: Ecology, conservation and environmental restoration (Rangimarie 1)	Symposium: Biochemistry and Physiology (Rangimarie 2)
15:10-15:40	Afternoon Tea (Rangimarie 1)	
15:40-16:40	Symposium: Ecology, conservation and environmental restoration (Rangimarie 1)	Symposium: Open symposium (Rangimarie 2)
16:40-17:00	**Closing session**: Student prizes and concluding address by the MSA President (Rangimarie 1)	

(Please note: program may be subject to slight changes)

Notice of the Malacological Society of Australasia Annual General Meeting

Date: Wednesday December 5th, 2018
Time: 12:50pm NZDT
Venue: 'Rangimarie 2' at Te Papa, Wellington New Zealand

Please forward any agenda items, nomination forms or proxy forms to Kara Layton via mail or email by the **25th of November**. If you cannot participate in the meeting and would like to appoint a proxy, please complete the form provided and nominate a person **who will be participating in the meeting** to vote on your behalf. If no suitable nominee is available, I as secretary can act as your proxy. Please contact me prior to the meeting to discuss your voting preferences.

Nominations are sought for MSA council positions (please use the following form; self-nominations will be accepted).

If you would like to receive a copy of the agenda for the meeting and proposed council nominees, please contact me by the 25th of November.

Yours faithfully,

Kara Layton (Secretary) kara.layton@museum.wa.gov.au
Western Australian Museum
Locked Bag 49,
Welshpool DC, Western Australia, 6986, Australia

Nomination form for council positions of the Malacological Society of Australasia 2018–2019

Nominee: _____

Position: _____

Nominated by: _____ (name) _____ (signature)

Seconded by: _____ (name) _____ (signature)

* nominations may also be seconded by participants during the meeting

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Proxy Form

I, _____, hereby appoint _____ as my true and lawful proxy to vote on my behalf at the Annual General Meeting of the Malacological Society of Australasia to be held at Wellington, New Zealand on 5th of December, 2018.

Signed: _____ Date: _____

Molluscs 2018 Student Travel Grants

Carmel McDougall **Email: c.mcdougall@griffith.edu.au**

This year the MSA was in the fortunate position to be able to offer seven travel grants to Molluscs 2018 to assist aspiring scholars. Congratulations to:

Kara Layton, University of Western Australia,

Daniel Ramos Gonzalez, University of Nottingham, United Kingdom,

Kate Ballard, University of the Sunshine Coast, Queensland, Australia

Sherry Lyn Sayco, University of the Philippines,

Priscila Salloum, The University of Auckland, New Zealand,

Olga Aksenova, Northern Federal University, Russia, and

Felicity Masters, University of the Sunshine Coast, Queensland, Australia.

We look forward to your presentations and to learning more about your work!

Your MSA membership at work

Lisa Kirkendale **Email:** lisa.kirkendale@museum.wa.gov.au

The cost of completing a PhD these days is exorbitant and often research costs and attending conferences are the areas that suffer. For example, Dr. Kara Layton just completed her doctorate at the University of Western Australia in Perth. Without a research grant from MSA, she would not have been able to add a cutting-edge transcriptome-based exon capture aspect to her PhD. This method was necessary to better delineate species of *Chromodoris* nudibranchs in Australia. Incorporating the latest methods is important to best answer your research question(s), but also to stay competitive in rapidly advancing fields. Matt Nimbs, conducting his PhD at Southern Cross University in Coffs Harbour, New South Wales, has been able to direct some of his MSA research funds to visit Perth, Western Australia. He was able to collect sea hares to better understand how many species we have in Australia, one of the focuses of his doctorate.

Along with research grants, your membership fees also support travel grants for students to present their research at MSA triennial conferences. This year, the MSA has awarded seven of these to offset travel costs for students from as far away as Russia and the United Kingdom to attend our conference in Wellington, New Zealand. Presenting your research to peers and receiving feedback and support is a vital aspect of scientific development. Conference attendance also allows students the opportunity to network and link up with others while considering the next phase of their career.

The MSA membership also comprises amateur malacologists and conchologists who are supported and encouraged to enjoy and develop their interests in an effective collaboration with their professional colleagues.

While it is wonderful to discover the world of the MSA through social media, taking the next step and becoming a society member (and maintaining your membership!) opens up an interesting and enjoyable field and also assists the next generation in their molluscan studies. Thank you to all our members for their support of malacology in the region!

Students that the MSA has supported in their molluscan research endeavours. Above left — Dr. Kara Layton (photo by Steve Keable), Lord Howe Island, post dive. Above right — Matt Nimbs (photo by Steve Smith), Lord Howe Island, intertidal zone.

PhD thesis summary: Ocean climate impacts on the primary and secondary metabolites of a muricid mollusc

Roselyn Valles-Regino, Marine Ecology Research Centre, Southern Cross University
Supervisors: Assoc. Prof. Kirsten Benkendorff and Dr. Lachlan H. Yee

Rapid increases of atmospheric carbon dioxide are driving global ocean warming and acidification causing direct and indirect effects on marine species. However, few studies have investigated the impacts of ocean climate change on the secondary metabolites of marine species. The muricid *Dicathais orbita* is used as a model species in this study because it has well-characterised secondary metabolites and functional food potential. The family Muricidae is the only known natural source of Tyrian purple (6,6-dibromoindigo) and its precursors have pharmacological properties and a potential role in the reproduction of this species. This thesis addresses gaps in knowledge of the possible effects of ocean climate change on secondary metabolism in a predatory gastropod to facilitate better insight of the long-term vulnerabilities of marine molluscs to changing oceanic conditions.

To quantify the secondary metabolites from the hypobranchial glands of *D. orbita*, a standardised and validated procedure for the extraction and analysis of the metabolites using liquid chromatograph-mass spectrometry (LC-MS) was developed (Valles-Regino, 2016). Extraction by homogenising the fresh gland in solvent was compared using organic solvents. The alcoholic solvents recovered the full suite of the Tyrian purple precursors, whilst chloroform recovered only the bioactive oxidation products. Ethanol was selected as the preferential solvent because it is safe to use and suitable for examining the polar secondary metabolites. The total ion current MS in positive mode was able to detect murexine, 6-bromoisatin, tyrindoleninone, and tyriverdin, whilst the negative mode detected tyrindoxyl sulphate and tyrindoxyl S-oxide sulphate. The dye pigment 6,6'-dibromoindigo was only detected in chloroform extracts. The validated method demonstrated linearity of the standards murexine, 6-bromoisatin and tyrindoxyl sulphate with correlation coefficient equal to 0.999, indicating precision of the method. Stability studies revealed more oxidised products were detected in chloroform than in ethanol extracts after months of cold storage. This study confirmed that a simple ethanol extraction and LC-MS quantification protocol can be used for standardised comparison of the secondary metabolites from *D. orbita*. Hence, this repeatable procedure was used throughout the subsequent chapters to investigate the impacts of environmental stressors on the secondary metabolites.

Roselyn Valles-Regino with *D. orbita* in the field.

Rising seawater temperature is an important climate change stressor that can affect the rate and nature of biochemical reactions and physiology of organisms. The thermal tolerance of adult *D. orbita* was first tested and the individuals that reached the upper thermal limits were used in the subsequent investigation of secondary metabolites. Elevated temperature led to a loss of muscle control at 30.6 ˚C and 35.2 ˚C in the long-term (1 ˚C increase for every 12 hours) and short-term (1 ˚C increase for every hour) heat-stress experiments, respectively. A static heat-stress experiment where the whelks were exposed to 30 ˚C relative to the control temperature of 20 ˚C for one week was also undertaken. The overall secondary metabolite composition was negatively affected by chronic and acute heat stress, however, quantitative analysis of the individual compounds revealed that only murexine was reduced at high temperature.

The effects of carbon dioxide (CO_2)-enriched seawater on the secondary metabolites in the hypobranchial gland and egg capsules of *D. orbita* were also investigated. The normal pH was 4.7 for the hypobranchial gland of both male and female whelks and between pH 5.3 and 6.8 for the egg capsules, depending on the stage of development Nevertheless, e*x situ* exposure of the dissected gland and intact egg capsules to CO_2-enriched seawater

resulted in changes in the quantity of the secondary metabolites. Murexine from both glands and capsules and tyrindoxyl sulphate only from the gland, dropped at pH 7.0, whilst 6-bromoisatin from the hypobranchial gland increased at pH 7.0 relative to the seawater controls at pH 8.1. Furthermore, CO_2-enriched seawater lowered viability of the larvae at pH 7.0. Despite the naturally low pH environment of both the gland and capsules, results indicate the tendency of *D. orbita* larval development and secondary metabolism to be negatively impacted by exposure to elevated water CO_2 levels.

Dicathais orbita shell and, at right, dorsal view of animal after removal from shell. Photos: Roselyn Valles-Regino.

To establish a more complete understanding of the impacts of climate change on the secondary metabolite composition, a manipulative experiment using combined temperature and CO_2 treatments was conducted. Adult *D. orbita* individuals were exposed in a flow-through mesocosm for 35 days with two temperatures (ambient: 23 ˚C and future: 25 ˚C) and two CO_2 treatments (ambient: ~380 ppm and future: ~765 ppm). The overall secondary metabolite composition was negatively impacted by temperature but not by acidification. Murexine and tyriverdin were reduced under elevated temperature conditions, whilst 6-bromoisatin and tyrindoleninone increased. Tyrindoxyl sulphate was the only secondary metabolite that was affected by the interactive effect of future warming and acidification. The concentration of tyrindoxyl sulphate tended to decrease with elevated temperature, but it increased at higher water CO_2 levels, suggesting a counteractive effect.

D. orbita has been identified as a potential functional food, hence it is also relevant to investigate the impacts of climate change on the lipid and fatty acid composition of this whelk. The fatty acids in the foot tissue of *D. orbita* were dominated by polyunsaturated fatty acids (PUFA), with a ratio of omega *n*-3/*n*-6 fatty acids within the recommended range for a healthy human diet. However, elevated temperature resulted in a decrease in the total lipid yield to almost 50%, and a reduction in PUFAs, although *n*-3/*n*-6 ratio remained unchanged. The results indicate that ocean warming could affect the lipid storage and modify the fatty acid composition of the whelks (Valles-Regino et al. 2015).

In conclusion, this study revealed that *D. orbita* is likely to be negatively affected by future environmental changes. Its functional food and nutraceutical potential might be compromised by chronic exposure to elevated seawater temperatures in particular. However, elevated water CO_2 also impacted the viability of the encapsulated larvae and fatty acid storage in adults, suggesting a suite of potential sub-lethal and lethal effects on the reproductive potential and survival of this species. Longer-term mesocosm studies involving multiple stressors in addition to warming and acidification are needed to further investigate future climate conditions and to address possible acclimatisation or adaptive responses of *D. orbita*.

Thesis publications:

Valles-Regino, R., Tate, R., Kelaher, B., Savins, D., Dowell, A. Benkendorff, K. (2015). Ocean warming and CO_2-induced acidification impact the fatty acid content of a marine predatory gastropod. *Marine Drugs* 13: 6016-6037. Doi: 10.3390/md13106019

Valles-Regino, R., Mouatt, P., Rudd, D., Yee, L.H. and Benkendorff, K. (2016). Extraction and quantification of bioactive Tyrian purple precursors: A comparative and validation study from the hypobranchial gland of a muricid *Dicathais orbita*. *Molecules* 21, 1672, 20 pp. doi:10.3390/molecules21121672

Erratum

In the MSA conference advertisement on page 10 of the last newsletter (No. 166, July, 2018), the name of Bruce Marshall was missing from the list of conference organisers.

Apologies are extended for this inadvertent error.

Notice

A reminder to readers to please consider writing articles for the MSA newsletter. Please send these into the editor at:
newsletter@malsocaus.org

Thank you!

MOLLUSCS 2018

2-5 December 2018
Te Papa Museum, Wellington, NZ

Organising committee:
Simon Hills
Hamish Spencer
Nicole Phillips
Bruce Marshall
Carmel McDougall
Kerry Walton

Brought to you by the Malacological Society of Australasia

Conference themes
Systematics, taxonomy and biogeography
Aquaculture, fisheries and human uses of molluscs
Ecology, conservation and reef restoration
Invasive species and biosecurity | Climate change
Genomics and molecular biology | Palaeontology
Biochemistry and physiology | Open symposium
Community engagement and citizen science

Minor workshops (December 4)
Mollusc photography | TBA

Field trip (December 4)
Victoria University Wellington Marine lab and South Coast Marine Reserve visit

Major workshop (December 6)
Introductory genomics

Keynote Speakers


Amy Moran
University of Hawaii


Phil Ross
University of Waikato


Satoshi Chiba
Tohoku University


Serean Adams
Cawthron Institute


Pauline Ross
University of Sydney


Robert Cowie
University of Hawaii

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