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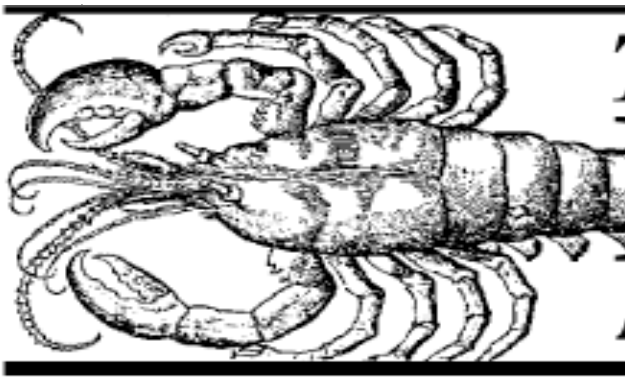


The Lobster NEWSLETTER

ANNOUNCEMENTS

Co-editor Torch Passed Along: Melville-Smith to Caputi

A Farewell From Roy Melville-Smith

This issue is unfortunately going to be my last as one of the editors of *The Lobster Newsletter*. I have really enjoyed being closely associated with the production of the *Newsletter*, because having this means of regular communication going out to those with an interest in lobsters and lobster research is something that I really believe in. In its own little way, *The Lobster Newsletter* helps make the lobsterphile community welcoming and open, and I think the *Newsletter* is something we all need to support.

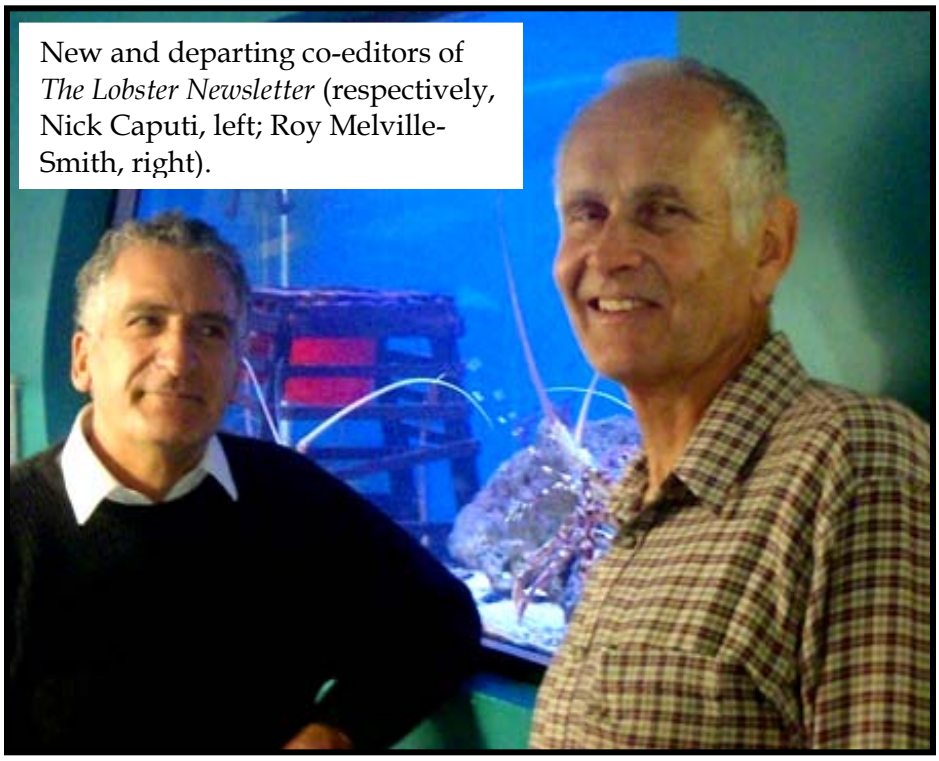
In the last five years since I have been an editor there has been quite a bit of coming and going – Peter Lawton and Mark Butler who co-edited with me moved on in quick succession of each other and we have now moved to a two-person editing team – one serving in the northern hemisphere and one in the south. Rick Wahle has been my opposite number in the north and I have really enjoyed working with him in trying to squeeze you all for contributions and in getting the publication into shape.

One of our changes a couple of years back, was moving the hosting website for *The Lobster Newsletter* from the Old Dominion University in the US to the Department of Fisheries in Western Australia. It makes it a bit easier for production if the hosting website is at the organisation where one or other of the editors is working. So on that note, it is fortuitous that my successor is in the Department of Fisheries in Western Australia - welcome Nick Caputi !

We all enjoy receiving our *Newsletters* every six months to catch up on different snippets of lobster news and activity, but obviously each issue can only be interesting if it is supported by contributors. These days we are all running faster and faster on the treadmill, leaving very little time for non-essential tasks, but in my last communication as an editor, l would like to urge you all to consider writing a contribution. Remember, it doesn't have to be heavy duty science in content – we are looking for a range of content and it would be nice to get some contributions to *The Lobster Newsletter* from our many subscribers who are not professional scientists.

Over to Nick…

Greeting From Nick Caputi



New and departing co-editors of *The Lobster Newsletter* (respectively, Nick Caputi, left; Roy Melville-Smith, right).

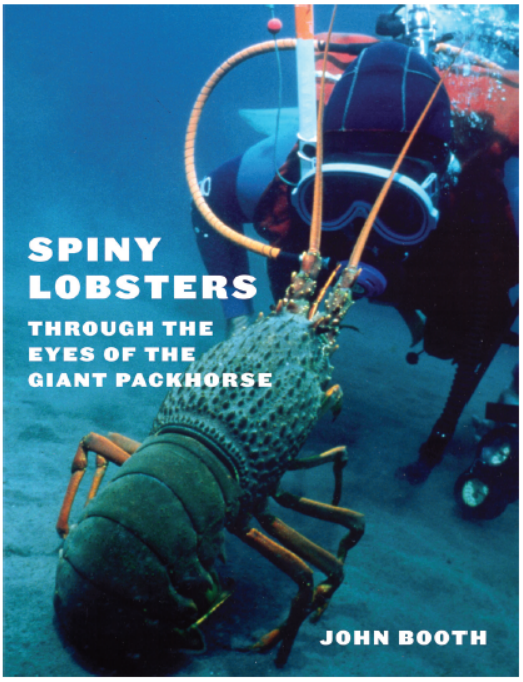
I would like to thank Roy for his contribution to the *Newsletter* over the last five years. I am pleased to take over his role and work with Rick on keeping the *Newsletter* going. I am the supervising scientist of invertebrate fisheries in Western Australia with the rock lobster fishery being our most important fishery. I have been involved in lobster research since the early 1980s and attended my first Lobster workshop in St Andrews in 1985, and have been hooked since then. I have also had a personal interest in the lobster fishery in Western Australia as my father was part of the developing phase of the fishery in the early 1950s until the mid-1970s.

It has been a great opportunity for me to meet those involved in lobster research, management and industry over the years across many countries and learn from each other's experiences. It has been interesting to see the progress in research over these years and hopefully the *Newsletter* continues to provide a good channel to quickly communicate the key developments that are happening in the lobster world so that we don't have to wait for publications that can take 2-3 years to come to fruition. I look forward to hearing from you with your contributions to the *Newsletter* so that we can keep the tradition going.

Spiny Lobsters
Through the eyes of the giant packhorse

John Booth

Published by Victoria University Press



Here's a lively account. It's about the comings and goings, and the doings, of spiny lobsters. Taxonomy, ecology, behaviour, life history, fishery, and so on. It deals with all species, using the packhorse *Sagmariasus verreauxi* as a template. It is written primarily with a lay audience in mind—one reviewer described it as 'a rollicking read'.

But these writings also have much to offer the expert of the world of spiny lobsters. They update Holthuis (1991): maps show in colour the distribution of all 55 species, including those of the recently re-established *Nupalirus*. For the first time, all known larval recruitment mechanisms are brought together diagrammatically. (Naturally, these include all known long-distance migrations.) Line drawings and a key allow you to identify late-stage phyllosomas to genus. You are shown how to distinguish a puerulus, and why the ocean climate's role in determining spiny lobster abundance—and therefore fishery success—shouldn't be ignored. There are labelled dissections. And so on.

This book has been written by an authority on spiny lobsters, with flair—and with the help of specialist colleagues. Why pay an academic press price when you can purchase this, in full colour, for just NZ$50? Released October 14th.

You can pre-order *Spiny Lobsters* now, using the form below, or at www.vuw.ac.nz/vup

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New Reviews of Lobsters in the *Treatise on Zoology*

Brill has taken over the production of the ***Treatise on Zoology: Crustacea***, the English version of the old ***Traité de Zoologie.*** Two of these volumes are of interest to readers of *The Lobster Newsletter*.

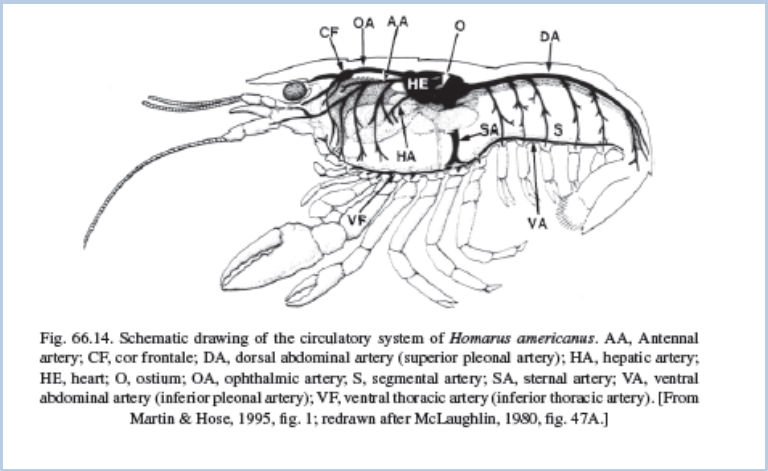
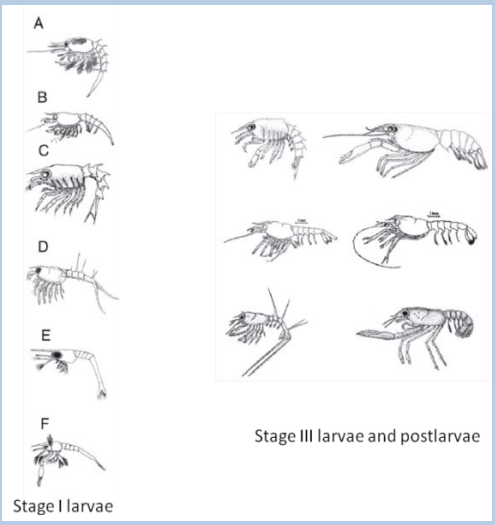


Fig. 66.14. Schematic drawing of the circulatory system of *Homarus americanus*. AA, Antennal artery; CF, cor frontale; DA, dorsal abdominal artery (superior pleonal artery); HA, hepatic artery; HE, heart; O, ostium; OA, ophthalmic artery; S, segmental artery; SA, sternal artery; VA, ventral abdominal artery (inferior pleonal artery); VF, ventral thoracic artery (inferior thoracic artery). [From Martin & Hose, 1995, fig. 1; redrawn after McLaughlin, 1980, fig. 47A.]

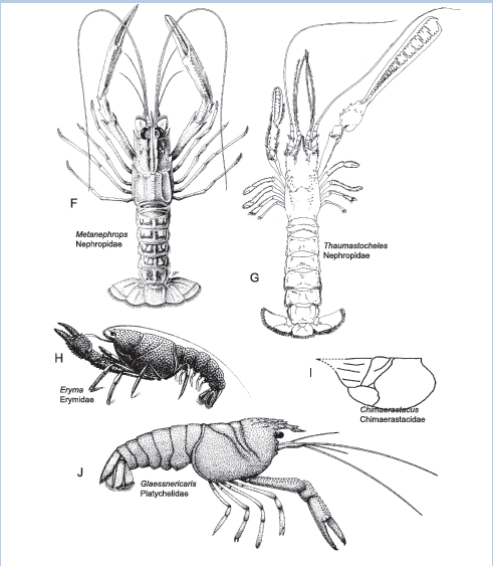


The first book covering the decapods, Volume 9A, was published in December 2010 and contains a chapter, ***"Infraorder Palinura,"*** by Kari Lavalli and Ehud Spanier.

In early 2012, volume 9B will have a chapter on ***"Infraorder Astacidea: the Marine Clawed Lobsters"*** by Richard Wahle, Dale Tshudy, J. Stanley Cobb, Jan Factor, and Mahima Jaini.

These chapters present comprehensive reviews of external and internal morphology, embryonic and larval development, ecology and behavior, economic issues, phylogeny and biogeography, and family level systematics.

Orders can be placed with Brill at http://www.brill.nl/.



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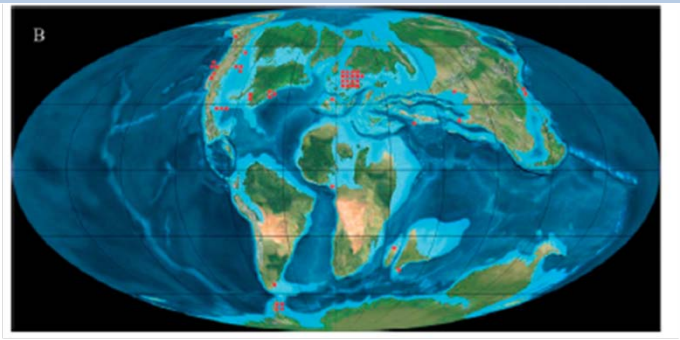

Fig. 66.33. Occurrences of fossil lobsters of Nephropidae plotted on Late Cretaceous (Turonian, 90 mya) paleogeographic reconstructions (Blakey 2006).

International Conference and Workshop on Lobster Biology and Management

Conference Synthesis

From: Gro I. van der Meeren

The lobster conference is over for now, and it is wrap-up time. As convener, I have a good feeling that this conference went down pretty well. The buzz in the corridors, the good spirit in the presentation halls, especially during the midweek cruise and the banquet, were all positive. Our first gathering was the meet-and-greet at the Institute of Marine Research cantina Sunday night June 19th. A good group of enthusiastic and expectant participants were welcomed by Norway's Director General of Fisheries, Liv Holmefjord. All in all, 135 participants attended the conference, representing 21 countries and all the inhabited continents of the world.

The conference was officially opened on Monday June 20th by the Managing Director of IMR, Tore Nepstad, and closed Friday June 24th, first with summaries by the chairs of the workshops and special seminars, and final remarks by Karin Kroon Boxaspen, leader of IMR's Aquaculture Research Programme.

From start to close it was a week filled with new, cool, and interesting talks and posters on lobsters of all kinds. Three themes were selected for special focus: Aquaculture, Disease, and Sensory Biology. Summaries of these and other sessions are below.

The award for Best Student Oral Presentation went to Mahima Jaini (University of Maine, USA), and the Best Poster Presentation to Hilke Alberts-Hubatsch (Carl von Ossietzky University, Oldenburg, Germany). These awards were presented by Elena Mente, European Governor of the Crustacean Society, and included a one year student membership to the Crustacean Society along with a cash prize.

In addition, three talented students were awarded the newly established Paul Kanciruk Student Travel Award: Nancy Hererra Salvatierra (Universidad Autónoma de México), Andrew Keough (University of Miami, USA) and Dan Hines (University of Prince Edward Island, Canada). Great thanks to Prof. William Herrnkind, who made the donation from the late Paul Kanciruk to this wonderful student support. Thanks also go to

ICWL Conference participants on the *Statsraad Lehmkuhl* in Bergen.

Mark Butler and Raquel Goñi for their efforts in selecting the lucky awardees. Hopefully, the travel award will continue to attract student participation in the future.

On the evening of the second day, the poster session created a nice transition from science to social events. And thanks to the generosity of the IMR directorship, the centerpiece of the midweek break was the fjord cruise aboard the magnificent three-masted barque, *Statsraad Lehmkuhl* of Bergen, Norway. We do hope all 130 participating passengers enjoyed the fjords and refreshments as we sailed our way south of the harbor.

For the banquet, our hosts, the Radisson Blue Hotel Norge prepared an excellent halibut dinner. Jazz singer-songwriter, Oded ben-Horin had composed a special lobster song *'Deep Down Lobster,'* which he included in a jazz concert, along with other compositions from *'The Science Fair.'* He was accompanied by musicians Thomas Dahl and Stein Inge Brækhus. Our multi-talented lobster scientist, Jelle Atema, treated us to a musical novelty: *'On the evolution of civilisations of humans and lobsters,'* in which he fashioned flutes of fossilized bones, and of course, lobster claws. The evening rounded out with dance to the swinging Per Pahr Band. The only complaints reported were from hotel guests not included in the conference!

Publication preparations are in progress. With the efforts of our conference editors, we hope to have enough good manuscripts to allow us to have five special-issues in excellent journals:

Aquaculture (Andrew Jeffs: a.jeffs@auckland.ac.nz),

Diseases of Aquatic Organisms (Don Behringer: behringer@ufl.edu),

Frontiers in Aquatic Physiology (Steffen Harzsch: steffen.harzsch@uni-greifswald.de),

Fisheries Research (Adrian Linnane: adrian.linnane@sa.gov.au), and
Marine Biology Research (Friedrich Buchholz: friedrich.buchholz@awi.de).

On behalf of my colleagues and staff at the IMR, I extend thanks to all our guests who made our preparations so worthwhile and were so patient with the mishaps on our way to getting the 9th ICWL going. It was a conference we will remember with pride and happiness forever.

Please stay tuned with the conference web-site (http://www.imr.no/icwl_bergen), as it continues to release information from the conference in the next months and years, at least until preparations for the 10th ICWL in Cancún, Mexico get under way for 2014.

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Session Summaries

Special Session and Workshop on Disease

From: Donald Behringer

It seems the anticipation of the 9th ICWL in Norway lasted forever – then it was over! We saw many regular faces and quite a few new ones, but I think all would agree it was a grand time. The quality of presentations was superb, but the Session and Workshop on Disease was a true highlight.

The effect of disease is increasingly recognized as a major driving force in marine organism abundance, population and community structure, and fishery dynamics. Lobsters are model organisms to study these processes. Several diseases have major impacts on lobsters from different families (Nephropidae and Palinuridae), different latitudes (tropical and temperate), and different habitats (coral reef, rocky, and soft sediment). These diseases, *Panulirus argus* virus 1 (PaV1, Fig. 1), epizootic shell disease (ESD, Fig. 2), *Hematodinium*, and others were showcased in a dynamic and intriguing series of talks that culminated in a vibrant discussion of various disease topics during the workshop.

Fig. 1. PaV1 infected lobster close up.

Keynote addresses: Mark Butler set the stage for the disease theme with a keynote address outlining the importance and ramifications of disease on fisheries, populations, communities, and even ecosystems. He noted the direct effects, but brought attention to the subtle, indirect effects of disease through examples such as the effect of marine protected areas on disease dynamics. Kathy Castro followed this introduction with a keynote that focused on ESD infecting American lobsters in southern New England and the issue of managing disease in fisheries. Her presentation underscored the need to take a comprehensive approach to studying disease from pathogen identification and pathobiology to population-level effects, ecological alterations, and fishery impacts.

Disease session: The broad overviews prepared us well for the varied suite of talks that answered many long-standing questions, but posited many more. Nina Sutherland kicked us

off with a homegrown study of the American lobster *Homarus americanus* in Norway, and the potential for shell disease infecting the European lobster *H. gammarus*. Although shell disease was observed in some of the American lobster specimens discovered in Norway, transmission to the European lobster does not appear to have occurred. However, *H. gammarus* does appear susceptible to Gaffkemia caused by the bacteria *Aerococcus viridians*, which Paul Stebbing described infecting European lobsters around the UK, and may have originated from *H. americanus* imports.

Fig. 2. *Homarus americanus* with shell disease. (B. Somers, University of Rhode Island)

Rick Wahle then brought attention back to the original home of *H. americanus* and discussed a remarkably strong linkage between ESD and recruitment failure in the southern New England stocks so heavily impacted by the disease. Grant Stentiford then swept us down to New Zealand to introduce us to *Myospora metanephrops*, the first microsporidian parasite described from a Nephropid lobster in *Metanephrops challengeri*. Joseph Kunkel and Barbara Somers followed with their "100 Lobster Project" research on ESD in American lobsters during the morning session. Joe's work on mineralization and the structural defense of the exoskeleton has taken us a leap forward in understanding how the cuticle structure itself might moderate susceptibility to shell disease, and opened up numerous new channels to explore. Barbara's presentation capped the shell disease talks by giving us an overview of the New England Lobster Research Institute (NELRI) and their mission to address the problem of ESD. The NELRI, funded through a $2.3 M Congressional appropriation, is a fine example of how resources can be brought to bear on an issue if there is political and scientific will.

Standing in for Brian Jones, Nick Caputi gave a brave performance regarding disease in Australian and New Zealand lobsters, before we moved to the tropics for a series of talks on PaV1 in *P. argus*. Andrew Keogh (Paul Kanciruk Award recipient) gave a provocative presentation evaluating Caribbean lobster population connectivity and the potential for PaV1-infected lobster larvae to act as vectors of disease. Patricia Briones-Fourzán and Enrique Lozano-Álvarez then teamed up for a pair of presentations evaluating the effect of casitas on PaV1 prevalence and transmission in juvenile lobsters. Due to their large size compared to natural shelters, casitas appear to permit more cohabitation than would otherwise be expected in a system where healthy animals avoid sheltering with disease conspecifics, and although preliminary, there is evidence of density-dependent prevalence in some areas where casitas were experimentally deployed.

The fisheries theme continued as I presented work we have done on PaV1 in the Florida trap-based fishery. We found a surprising 11% of lobsters in the fishery were PCR-positive for PaV1, other lobsters avoid traps that contain PaV1-infected lobsters, and PaV1-infected lobsters have the potential to transmit the virus to other lobsters confined with them. Finally, Nancy Herrera-Salvatierra (Paul Kanciruk Award recipient) and I discussed the physiological and ecological effects of PaV1, respectively. Nancy showed that PaV1 infection has significant effects on lobster

metabolism and potentially depresses the immune system of infected lobsters, while I showed that PaV1 has significant ecological effects, reducing movement of juvenile lobsters, excluding some lobsters from shelter, and potentially raising the rate of predation on diseased and healthy lobsters. We all then took a collective breath and a coffee before heading into the workshop!

Disease workshop: Jean Lavallée launched the workshop with a fascinating crime scene investigation of sporadic mortalities in *H. americanus* from large lobster pounds. Jean's presentation and the stimulating prior series of disease presentations whet the appetite to talk about how to manage fisheries and culture in the face of disease. Despite the waning time (not light, as it never gets dark in Norway in June!), the discussion was vibrant and included ideas on how to reduce ESD, such as the culling of infected lobsters and not returning them to the water, and the controversial suggestion of harvesting all the reproductive females in southern New England to eliminate the host with the highest prevalence! Possible causes of ESD were discussed at length, including hypoxia, oil spill contamination, and rising ocean temperature. Discussion then moved to the question of emergence and the difficulty in establishing it in diseases, such as PaV1, which have their greatest effect on juveniles. Grant Stentiford concluded the workshop with a presentation on the recently formed European Union Reference Laboratory for Crustacean Diseases and the role they play in monitoring and controlling the spread of crustacean diseases to the EU and world-wide.

Disease posters: The poster session was a great casual affair that fostered discussion and hatched new collaborations. Disease featured prominently with eight disease-themed posters. Nick Beevers gave an update on *Hematodinium* infection in *N. norvegicus* around Scotland, Nathan Rycroft presented his work on the effects of ESD on *H. americanus* female mate choice and male dominance, and Andrea Battison showed an odd case study of a "lumpy" American lobster with numerous subcuticular uric acid accumulations. The remaining posters focused on PaV1, where Josh Anderson displayed his work on olfactory detection of PaV1 by *P. argus*, Jess Moss revealed the discovery that PaV1 has been found in post-larvae and shows high genetic variability, Tom Dolan detailed his modeling work on PaV1 avoidance behavior, and Juan Huchin-Mian presented the details of work focused on the effects of casitas on PaV1.

As the curtain closed on the 9th ICWL and we all said farewell to our gracious Norwegian hosts, colleagues, and the fair city of Bergen, plans were already afoot for a disease session at the next ICWL. See you on the sunny shores of Cancun, Mexico in 2014!

Hasta luego!

Don

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Aquaculture Session Summary

From: Jason Goldstein

The aquaculture session commenced with a total of 19 talks and over ten posters from Australia, New Zealand, Indonesia, Vietnam, the United States, Canada, Japan, the UK and of course, Norway. Three major themes were considered and presented for this session that included: (1) innovations in larval culturing; (2) advances in larval and juvenile lobster diet and nutrition and; (3) hatchery culturing operations, emerging technologies, and grow-out.

Highlights from larval culturing included Nik Sachlikidis and Roger Barnard's (Lobster

Harvest, MG Kallis, LTD, Australia) success with *P. ornatus* culture and subsequent scale-up production, while Keisuke Murakami (National Institute of Aquaculture, Japan) presented advances in *P. h. homarus* culture using new rearing techniques. Quinn Fitzgibbon (Institute for Marine & Antarctic Studies, University of Tasmania) and Dominic Boothroyd (The National Lobster Hatchery, UK) discussed the use of ozone and chemical disinfectants to control bacterial communities in larval culture along with the use of probiotics in phyllosoma gut tracks (Carly Daniels, The National Lobster Hatchery).

Improved culture tank designs, scaled-up production, nutritionally optimal feeds, and new candidate lobster species were among some of the items that participants were excited about working on for future studies. Presentations in lobster diet and nutrition considered the feeding requirements for growout between fresh and pelleted feeds (Cedric Simon, Tasmanian Aquaculture & Fisheries Institute, University of Tasmania) and the effects of biofouling on sea cages for juvenile spiny lobster growth. Le Lan Huong (Queensland Government, Australia) followed up with results from a large-scale study of trash fish feeding on lobster growth (*P. ornatus*) in sea cages of varying densities in Vietnam and the environmental impacts associated with waste from cages.

Floating lobster cages made of wood and fixed on the bottom in Vietnam (photo courtesy of: ACIAR, 2009).

Clive Jones (Northern Fisheries Center, Cairns, Australia) and Bayo Priyambodo (Lombok Marine Aquaculture Development Center, Indonesia) further detailed their ongoing cage-culture studies in Indonesia focusing on sources for seed stock as well as disease issues and transportation of product. Participants commented on the need for further improvements in artificial feeds, particularly sustainable sources of protein and the role of carbohydrates.

Measurement of a field-caught (with seine net) P. ornatus puerulus. (photo courtesy of: ACIAR, 2009).

With regards to clawed lobsters, Louise Gendron (Department of Fisheries and Oceans, Canada) spoke of postlarval competency in clawed lobster (*H. americanus*) by means of formulated lipid-rich diets. Asbjorn Drengstig (Norwegian Lobster Farm) presented methods for the genetic tracking of broodstock in hatcheries while Ann-Lisbeth Agnalt (Norwegian Lobster Farm) discussed the various conditioning studies that may modify lobster behavior and the ability to compete for shelter.

In addition, Canadians Michelle Theriault (Universite Sainte-Anne, Canada) and Michel Comeau (Department of Fisheries and Oceans, Canada) outlined studies that were designed to assess the polyculture of juvenile *H. americanus* (with sea scallops) and local community-based postlarval lobster seeding projects, respectively. Speakers and participants voiced a host of topics that they wanted to explore

from this theme including new ways to control disease, opportunities for land-based production systems, the use of pelleted feeds, and the improved sustainability (and collection) of seed stock.

Hatchery-raised Stage IV postlarval lobster, H. americanus (photo courtesy of: J. Goldstein).

Finally, Andrew Jeffs (University of Auckland) outlined the concerns and challenges with reconciling aquaculture and the environment that included the sustainability of harvesting post-larval and juvenile tropical species of spiny lobster, the impact and use of 'trash fish' in cage culture, and biosecurities. Some of the solutions discussed included the continued hatchery production of juveniles, the development of cost-effective artificial feeds, and more studies of the environmental impact of farming activities.

Participants had the opportunity to make suggestions for future aquaculture sessions that included bringing in lessons and information sharing from other related species (e.g., crab aquaculture), the creation of a panel discussion, and the integration of some of the aquaculture talks with other lobster-related themes. The success and information sharing from this special session was greatly enhanced by all the participants. The session organizers (Jason Goldstein and Ann-Lisbeth Agnalt) greatly acknowledge the support and help from Andrew Jeffs, the section editor for journal submissions, and to Clive Jones & ACIAR for arranging the participation of presenters from Southeast Asia.

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Summary: Neurobiology, Sensory Biology and Behavior Session

From: Win Watson

Win Watson kicked off the session by summarizing some of his research related to the abilities of lobsters to sense and respond to particular features of the environment. Thus, the title, *See me, feel me, touch me, eat me!* First, he described a cardiac assay that he uses to determine their sensitivity to changes in salinity and temperature. He further showed how their responses could explain aspects of their population dynamics and season migrations. Second, he provided evidence that they can orient underwater and he speculated that these responses might be mediated by mechanoreceptors. They might also use mechanoreceptors to hear each other. His recent studies have shown that they have the ability to produce sounds and these sounds appear to be aversive to some fish predators. Finally, Dr. Watson presented some preliminary data indicating that lobsters have the ability to modulate their visual sensitivity so that they can see better at night when they tend to be most active.

In their presentation, *How predator kairomones and substrate quality affect and influence the behavior response of the European lobster,* Kjerstin and van der Meeren summarized studies aimed at determining how environmental characteristics influenced the behavior and potential settlement of juvenile lobsters. In

particular, they examined the influence of substrate type and predator odors or kairomones. The authors found that predator odors had the greatest impact on the foraging and shelter-associated behavior of the juvenile lobsters. Various substrates had less of an influence on behavior, but, in combination with kairomones, there was an alteration of freezing behavior. These studies will hopefully help improve stock enhancement efforts by enabling scientists and managers to release juvenile European lobsters in areas that will yield optimal settlement.

Tracy Pugh and co-authors then discussed the question of whether large female lobsters (*Homarus americanus*) in southern New England are failing to mate? The goal of this project was to determine if all the sexually mature females that are capable of mating in Southern New England are actually mating. Tracy and her colleagues sampled females to determine if they had a spermatophore in their seminal receptacle, which indicated they had successfully mated. Generally, their results showed that more small females were mating than would be expected based on existing maturity ogives, and in some locations fewer larger females had mated. There appeared to be some spatial differences in the size ranges of females that were mating successfully. Several possible scenarios were provided to explain these findings and Tracy emphasized that both males and females should be taken into account when assessing management options.

Lobsters have long been known to recognize and remember the urine smell of their familiar opponent. In a talk by Francesca Gherardi and co-authors, called *Class-level vs. true individual recognition in the American lobster,* we learned that they can also use vision to show familiarity with the opponent. After a brief familiarization phase through an opaque (control), transparent (vision), perforated (olfaction), or transparent-perforated (vision and olfaction) barrier, lobsters showed fewer approaches and less threat, but more avoidance and aggression only when they had seen each other before. Olfactory experience did not contribute to a behavioral difference from controls, i.e. unfamiliar opponents. This matched well with the results shown in a related presentation showing that olfactory memory of an opponent is formed only after a claw crunching fight. (see Atema et al). The results were embedded in a detailed discussion of True versus Class-level individual recognition.

In their talk, *Crushing Defeat Remembered*, Jelle Atema and co-authors discussed male dominance hierarchies in the American lobster. Male dominance is directly related to mating success, which has led to sexual dimorphism with males growing very large claws. During fights lobsters release urine that may serve to help the loser size up the risk of winning. The signal might also help individuals to know who to avoid subsequent fights with. The focus of this study was to determine the rule of the crusher claw in memory consolidation. Fight duration declined more rapidly in lobsters with claws banded except when both lobsters were equally banded. Pairs with both claws banded shut, or just the crusher, showed no subsequent decline in duration. In contrast, when only the seizer claw was shut, fight duration declined significantly. This shows that the crusher claw provides the information critical for memory consolidation.

Peter Bouwma and Michael Childress investigated spiny lobster sound production as an antipredator behavior. Spiny lobsters are known to produce sounds, via stridulation, that serve to deter predators. The focus of this talk was on how this type of behavior might be advantageous on a larger population scale, in variable habitats. First, he presented evidence demonstrating that naïve fish responded differently to sounds than experienced fish. Then, to determine how such behaviors might impact the entire population Peter developed a computer model using NETLOGO. He also incorporated habitats with variable numbers of shelters into the model. His model demonstrated that, on a population level, stridulation was an effective antipredator adaptation for spiny lobsters, especially in

habitats with a reduced number of shelters relative to the density of lobsters.

Finally, in the final presentation, *Olfactory Orientation in European lobster larvae,* Hilke Alberts-Hubatsch and co-authors revealed that postlarvae showed strong preference for their home water (Helgoland Station tank water), when tested against offshore water. When offered two unfamiliar stimuli (sand vs. stone), the postlarvae did not express any directional orientation. They concluded that European lobsters are able to recognize and differentiate between different odor plumes and might use this ability for orientation and for settlement in suitable habitat. For this they probably undergo an imprinting phase during their first hours after hatching, which they could use for later olfactory-guided homing.

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Fisheries Session Summary

From: Nick Caputi

The Fisheries session was separated into management and technology sessions with a total of 15 presentations and over 21 posters from 13 countries represented by Australia, New Zealand, India, USA, Canada, Japan, Spain, France, UK, South Africa, Italy, Mexico and Norway.

The New Zealand presentations focused on their quota management system and the development of legislative framework for collective industry management initiatives to improve economic performance (N. Gibbs). The management approach in New Zealand was described as changing from a reactive system trying to maintain sustainability to a proactive approach that has been focused on rebuilding stocks so that financial returns are maximized (M. Lawson). The third presentation focused on the responsibility that comes with rights highlighting their support for data collection to assist in the stock assessment and management (L Wichman).

The Norwegian presentations included a comparison of the official commercial catch landings with actual field estimates in the Norwegian lobster fishery which showed a significant discrepancy demonstrating the need for continual validation of catch records as well as taking into account the recreational component (A. Kleiven). The assessment of management options using a length-structured model to rebuild local Norwegian lobster populations highlighted the long-term timeframe (20-40 years) required (E. Mjolhus). This assessment benefited from the population parameters measured from a large-scale enhancement program. A. Wolf described issues associated with the Norwegian Nephrops fishery focusing on trials to improve the quality and survival of live product. Research to assist the development of the live trade of the Nephrops in Iceland was also presented (H. Philp).

The improved catch performance of double parlour pots compared with single parlour pots was highlighted with the warning of the implications it may have for increased fishing pressure on the input-controlled fisheries in inshore Atlantic Canada (J. Garland). A comparison of two different fishing methods (traps and trammel nets) on a fishery and ecological perspective was the focus of S. Mallol's presentation on the Mediterranean spiny lobster fishery. The use of artificial shelters for stock evaluation and management of the spiny lobster fishery in Mexico was examined (K. Ley). The assessment of aspects of fishing mortality that are usually not considered explicitly such as discarding practices, ghost fishing, unreported landings, illegal fishing were examined for the eastern rock lobster of Australia (G. Liggins).

An overview of the lobster research and management in south and southeast Asia was provided by M. Vijayakumaran highlighting the development of aquaculture of spiny lobsters in sea cages using naturally settling post larval and juvenile lobsters. The decline of the spiny lobster fishery of Brittany (France) was described as well the plans for new management measures to improve the situation (L. Martial).

The value of electronic logbooks was highlighted as a valuable tool to enable fishers to enhance their fishing capability and provide researchers with accurate catch and effort information for stock assessment and management (A. Barkai).

The potential to collect valuable habitat and environmental data in a cost-effective manner using a camera attached to rock lobster pots provided a great opportunity to study the interaction between lobsters and their habitat and the behaviour of lobsters around pots (S de Lestang).

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Ecological and Ecosystems Sessions Summary

From: Roy Melville-Smith

All together, there were five sessions which dealt with the general subject of Ecology and Ecosystems.

The ecology and ecosystem session covered three species. Two papers dealt with changes in American lobster abundance over time. One study (Wahle *et al*.), reported on changes in biomass and average body mass of predatory ground fish since the 1980s and its possible relationships with the dramatic increase in lobster abundance over that same period. The second American lobster paper (Jaini *et al*.) examined statistical correlations between annual settlement sea surface temperature anomalies, wind stress and river discharge over the last twenty years. There were two spiny lobster papers. One (Díaz *et al*.), reported on resilience of *P. elephas* in the Mediterranean, despite many years of intense fishing pressure. The second (Bellchambers *et al*.) reported on a study which is currently underway, examining the impact of fishing *P. cygnus* on the ecosystem.

The recruitment and management session had four papers, three of which dealt with the *P. cygnus* fishery. This trio of papers dealt with the possible causes for, and the management responses to, the very low puerulus settlement that has been experienced by the fishery in recent years. The first of this set of papers (Feng *et al*.) reported on the use of an individual-based model that incorporated outputs from a data-assimilating hydrodynamic model. The next (Caputi *et al*.) considered possible causes for the record low puerulus settlement and reported on recent management changes that have been introduced into the fishery. The last (de Lestang *et al*.), discussed the use of a spatial population assessment model in developing the management strategies

that have been introduced in the fishery as a result of the low recruitment. The only other paper in this session (Tremblay *et al*.) dealt with spatial and temporal changes in size at maturity of American lobster using data sets going back to 1916.

The competition and predation session had only two papers. The first (Haarr and Rochette), examined agonistic interactions between green crab and juvenile American lobsters in a laboratory experiment. Watts *et al*. reported on a study examining whether starvation occurs in European lobsters due to different feeding behaviors of the sexes at different times of the year.

The reproduction and reproductive behavior session had eight papers – split as four spiny and four clawed lobster studies. The papers in this session were varied in their subject matter. Of the spiny lobster papers, two *P. guttatus* studies (Lozano-Álvarez*et al*. and Magallón-Gayón*et al*.) covered reproductive behavior, a *P. ornatus* paper (Sachlikidis and Jones) covered larval culturing and a *J. edwardsii* (Linnane *et al*.) paper covered puerulus fluctuations and recruitment pulses in that fishery. Three papers dealt with the American lobster fishery, one (Hines *et al*.) on genetic profiling of different larval stages, a second (Giulianini *et al*.) on hormonal control in reproduction and a third (Larsen Haarr *et al*.) examined metapopulation dynamics and stock structure of the species in Atlantic Canada. A single paper dealing with European lobster (Moland *et al*.), showed that larger females tended to produce larger eggs, which in turn developed into larger larvae and that these larger larvae survived better than small individuals.

The early life stages: dispersal, retention and behavior session also had eight papers. Of those papers, two dealt with scyllarid species, one with a spiny species, one with both a slipper and spiny species, while four covered clawed lobster studies. Of the scyllarid papers, one (Sekiguchi and Tanaka) covered the interesting behavior of a final stage larvae riding on the dorsal bell surface of a scyphozoan, while the second paper (Spanier and Lavalli) hypothesized on the settlement behavior of the rarely seen nistos/juvenile stage of the Mediterranean slipper lobster. The single purely spiny lobster paper (Keulder *et al*.) dealt with factors affecting recruitment of *J. lalandii* pueruli off the Namibian coast. The dual spiny-slipper lobster study (Palma *et al*.) presented data supporting the proposition that the larvae produced around Robinson Crusoe Island are held by oceanographic retention mechanisms throughout their larval life until recruitment. The four clawed lobster papers (three *H. americanus* (Deppermann *et al*., Wahle *et al*. and Sigurdsson and Rochette) and one *H. gamarus* (Øresland and Ulmestrand)) all dealt in one way or another, with patterns of settlement in those species.

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RESEARCH NEWS

Crustacean diseases in Europe: an overview of recent developments

From: Grant D. Stentiford

Crustacean production in European marine waters is based around a large cold-water fishery for crabs, lobsters and shrimp and a small aquaculture industry for temperate water shrimp and crayfish. Despite the commercial and ecological importance of these populations, studies on their diseases are a

relative deficit discipline compared to those from molluscan and finfish host groups. In addition to capture production from native stocks, European states are major importers of farmed crustaceans (mainly tropical shrimp) as these products become an increasingly significant component of the European seafood diet. Due to these factors, EC Directive 2006/88, applied from August 2008, has for the first time listed the three viral diseases White

Fig. 1. The EU Reference Laboratory for crustacean diseases in Weymouth (top), and its biosecure facility (bottom).

Spot Disease (WSD), Yellowhead Disease (YHD) and Taura Syndrome (TS) as exotic pathogens of concern. In addition to the listing of these pathogens, and in line with infrastructural arrangements for fish and mollusc diseases, the EC have designated a European Union Reference Laboratory (EURL) to cover crustacean diseases (Fig. 1), with individual Member State National References Laboratories (NRL) being designated by Member State Competent Authorities. The designation of an EURL for crustacean diseases formally recognizes the ecological and commercial importance of crustaceans in the aquatic habitats of EU Member States and also the potential for exotic disease introductions to these populations via the international trade of live and commodity products. The designations have also revealed a relative paucity in crustacean disease expertise across the EU. Improvements in the biosecurity status of native crustacean populations within the EU and a concomitant enhancement of knowledge on native pathogens and mortality drivers in natural and farmed stocks are expected to develop in coming years. A recent presentation at the 9th International Conference and Workshop on Lobster Biology and Management in Bergen, Norway (19-24 June 2011) discussed the crustacean disease components of EC Directive 2006/88 and placed this into context for nations importing live crustaceans and their products to the EU and highlighted current research interests of the EURL. The EURL for crustacean diseases is located at CEFAS in Weymouth, UK.

Further details of the remit of the EURL and CEFAS at: www.crustaceancrl.eu.

RELATED READING

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Using acoustic telemetry to observe indirect behavioral effects of groundfish on the American lobster, *Homarus americanus*

From: Marissa D. McMahan, Graham D. Sherwood, Jonathan H. Grabowski, Diane F. Cowan

Historically production in the nearshore Gulf of Maine (GOM) fishery ecosystem was dominated by large predatory groundfish which, in recent years, have become functionally absent (Steneck, 1997). Today the most economically important species in this ecosystem is the American lobster (*Homarus americanus*), whose landings have more than quadrupled in the last two decades. This increase has coincided with the collapse of large predatory groundfish such as Atlantic cod (*Gadus morhua*), which may have resulted in lower lobster predation rates, as well as indirect benefits for lobsters, including reduced *fear* of predation. In the presence of predators lobsters are known to exhibit predator-avoidance behavior including changes to foraging behavior and shelter use (Wahle, 1992; Spanier et al, 1998). In the absence of predators lobsters may increase their habitat range and foraging success, potentially increasing their growth, rather than remaining in refuge habitat to avoid being consumed.

We used acoustic telemetry within large-scale, enclosed embayments (Fig. 1) to test the hypothesis that the presence of large predators reduces lobster movement. Lobsters were tagged with VEMCO V9-2L transmitters and released into the system two weeks prior to the addition of predators. Cod were also tagged with V9-2L transmitters (Fig. 2) and released into the system for a two week time period, and lobster movement between these two time periods was compared.

Fig. 1. Aerial view of first enclosure used in lobster movement experiments in Friendship, ME.

Preliminary analysis of the results suggests that there was a significant decrease in lobster movement after the addition of cod into the system. Analysis of home range, kernel density, time spent in versus out of shelter areas, velocity of movement, and turning angle will further improve our understanding of how the presence of predators influenced lobster movement. Because this experiment was conducted in a large field enclosure with naturally occurring habitats, physical

conditions, and lobster populations, the interactions that occurred are likely representative of larger populations and ecosystems. Therefore these results may provide insights into why lobster stocks in the GOM have exponentially increased since the collapse of many groundfish stocks.

Fig. 2. Insertion of VEMCO V9-2L tag into Atlantic cod. Photo courtesy of Diane Cowan.

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Broad insights in lobster metamorphosis: Using a DNA microarray to investigate larval development in the American lobster, *Homarus americanus*

From: Dan Hines and Spencer Greenwood

The American lobster (*Homarus americanus*) has a complex life cycle, involving a larval phase lasting 1-4 months (MacKenzie, 1988). The larval phase varies considerably from adult lobster, as larvae live in near surface waters and begin to dive to the benthos during their postlarval stage (Charmantier et al., 1991). There are three larval stages followed by a metamorphosis into a postlarval stage during development; the stages can be distinguished by distinct morphological characteristics (Herrick, 1895). Changes that occur during the progression through larval development and metamorphosis include: response to light and salinity, diet, shell composition, behaviour, muscle, and function of appendages (Charmantier et al., 1991). The processes by which larvae progress through development has been the focus of various studies; many investigations have applied knowledge gleaned from studies with adult lobsters, other crustaceans and even some insects (Charmantier et al., 1991). It appears that growth and metamorphosis are regulated strongly by ecdysone, a hormone produced in the eyestalk of several crustacean species; the specific mechanisms by which ecdysone causes the various tissue changes during development of American lobster larvae remains relatively unclear (Charmantier et al., 1988; Hopkins, 2009).

During the last decade, microarray technology has been used to investigate underlying genetic mechanisms behind various physical phenomena. Microarray analysis provides the unique opportunity to measure activity of

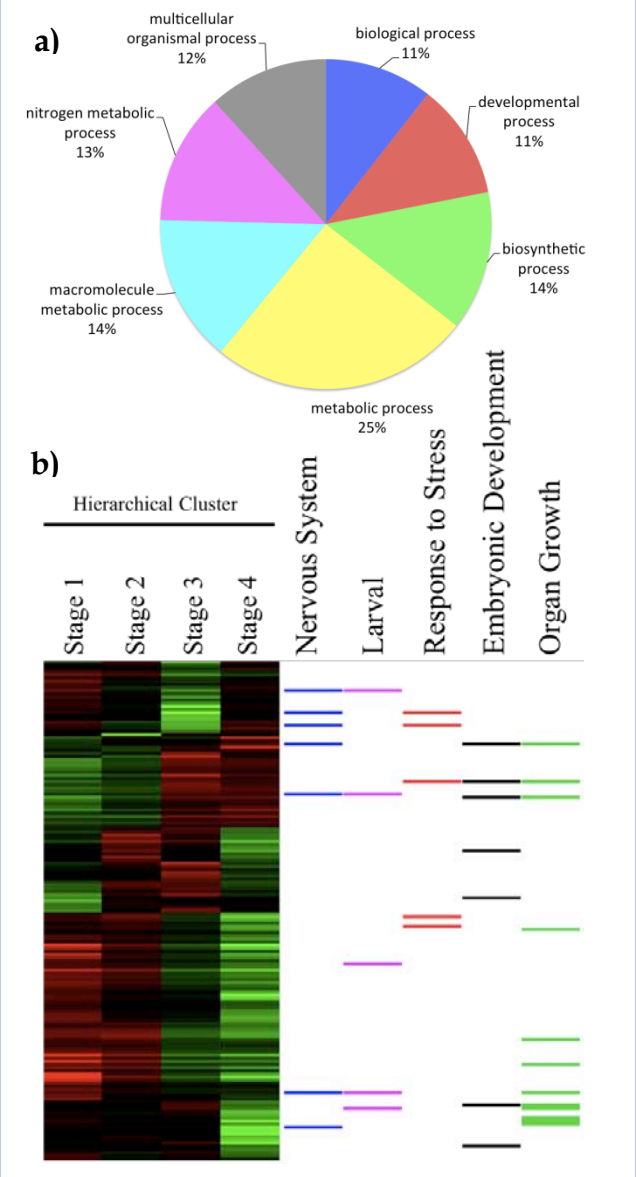

Fig. 1 **(a)** Distribution of functional properties of 161 differentially expressed genes between larval stages of American Lobster, *Homarus americanus*. Functions of proteins retrieved from Gene Ontology (GO) database using BLAST2GO software. **(b)** Hierarchical cluster of the 161 differentially expressed genes. The hierarchical cluster columns designate larval stage (1-4); rows indicate relative activity of individual genes (red = low activity, green = high activity). Subsets of gene functions are indicated using additional columns to the right of the hierarchical cluster; subset of gene functions used are groups within developmental process function in **(a)**.

thousands of genes simultaneously, and compare patterns in expression to observed physical changes. Furthermore, the activity of unknown genes or genes that were not expected to be involved with a given process can be measured to generate new information regarding potential regulators or effectors of physical change. Using this method, novel data elucidating the mechanisms underlying complex physical changes can be acquired rapidly and efficiently. To this end, we have investigated larval development using a lobster oligonucleotide microarray and measured changes in the activity of approximately 14,500 genes, during different larval stages. The analysis of thousands of genes during stages of larval development identifies different clusters of active or non-active genes. Because lobster is not a model organism for extensive genetic studies, and the genome has not been completely sequenced, we were only able to infer functional properties of ~40% of the genes measured on our microarray by similarity to published protein sequences. Inferring gene functions allowed us to focus on genes involved in developmental processes during our analysis (Fig. 1a).

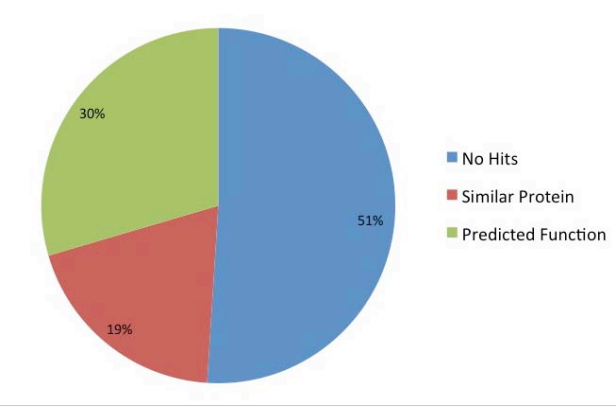

Fig. 2 Percentage of differentially expressed genes (n=550) with similarities to previously published protein sequences. Similar proteins were found in NCBI GenBank using BLAST2GO software. Genes returning similar proteins were cross-referenced with the Gene Ontology (GO) database to obtain previously published functional descriptions.

The study was performed using 10 individuals from each of the four larval stages. Larvae were provided by Homarus Inc, which operates a hatchery and restocking program in Shippagan, New Brunswick. Individuals were measured independently, providing 40 microarrays in total. Gene activity was compared between the stages using an Analysis of Variance (ANOVA) to test for statistical significance in the differences between larval stages. We found that the activity of 550 genes differed significantly between larval stages. Many of these genes are involved with processes such as organ and neural growth (Fig. 1b). Furthermore, there was a large subset of the significantly different genes that have no determined function (Fig. 2). Given the amount of genes lacking a functional inference, it appears that many of the genes responsible for the physical changes during larval development have not been fully described.

Our research investigated larval development with a broad focus. Using a lobster microarray, the activity of thousands of genes, with and without a known function, were measured. Our results show clear patterns of activity during development, implicating these genes being involved with the overall changes exhibited in specific larval stages (Fig. 1b). This study provides new information on the genetic mechanisms that are involved with larval development; it also demonstrates the power of microarray analysis to broaden the research focus when investigating a complex phenomenon such as larval development and metamorphosis.

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Lobster Larval Nomenclature – Progress or Regress?

From: Bill Johnson

Increasingly, decapodologists (is that a word?) are discouraging use of the term "postlarva." Much of the literature that I find on *Homarus* through 2003 retains use of 'postlarva', although some papers prefer 'larval stage IV'. I hope that *Lobster Newsletter* readers can provide the proper term to use for this last lobster “larval” stage or enlighten me as to the current status or consensus regarding this issue. The reason for my question is that Dennis Allen and I are revising our guide to the identification and ecology of marine plankton (Johnson and Allen 2005). We sent drafts of the section on decapods out to a number of reviewers, and more than a few objected to the term postlarva. I emailed Rick Wahle to find out what larval terms are currently in vogue in lobsterland. After I sent Rick some background information on the controversy, he suggested that I submit a note to *The Lobster Newsletter* to see if someone can clarify the nomenclature regarding decapods in general and clawed lobsters in particular.

There are indeed some problems with the term ‘postlarva’. For starters, there are semantic difficulties: the term postlarva, by definition, implies a non-larval stage, yet it has been widely used for larval stages. Another problem is that the term postlarva has evolved to apply to different developmental stages in different

groups of decapods over the decades. The Crustacean Glossary from the Los Angeles County Natural History Museum site (Updated 2011) courtesy of Joel Martin: http://crustacea.nhm.org/glossary/all.html shows the inconsistencies in use of 'postlarva.'

Apparently, some specialists now prefer to restrict the term postlarva to the juvenile stage(s) AFTER the final larval stage. While this makes semantic sense, it leaves us in need of some other terms to refer to those larval stages that are morphologically and behaviorally transitional between the planktonic larval stages and the benthic adult stages. Since some specialists seem to regard the megalops as a postlarval stage, it would seem to follow that the stage IV *Homarus* would also be a 'postlarval' stage. But some 'specialists' still regard the megalopa as a larval stage. Nothing is simple.

One approach that seems to be gaining acceptance was first proposed by Kaestner (1980) who provided a rationale for dropping the term 'postlarva' altogether in favor of 'decapodid'. Anger (2001) provides historical background and further defined the terminology. Felder et al. (1985, p 166) proposed the following clear and succinct definitions for both "postlarva" and "decapodid".

"postlarva: Any form that occurs after the zoeal stages inclusive of all developmental stages to the adult."

"decapodid: The first postlarval stage, the state that occurs immediately after the molt from the last larval stage and that has setose natatory pleopods on some of all of the first five abdominal somites."

"The following are all decapodid stages
Glucothöe - Anomura
Puerulus - Panulira
Megalops - Brachyura"

Replacing the term postlarva with decapodid throughout the decapods is an appealing concept, but its application in specific situations seems more uncertain. Just how would the terms postlarva and decapodid apply to the clawed lobsters? Or should they? Anger's (2001) detailed treatment of *Homarus* (p. 24-27) illustrates the attendant difficulties. In his treatment it seemed that specialists could not agree on whether the traditional Stage IV is a larva or not, let alone what to call it.

I am an ecologist inadvertently caught up in a discussion best left to decapod specialists. I apologize if, in my confusion, I misstated the issues. It is also possible that my preliminary search for answers is incomplete and that these issues have been resolved. In retrospect, I am truly sorry that I brought up what I hoped would be a simple question. I would have been far happier in ignorance. However, Rick thought that this issue might generate a constructive discussion.

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Exciting Development: Spiny lobster aquaculture in Australia produces second generation (F2) of the tropical *Panulirus ornatus*

From: Roger M. Barnard, Matthew D. Johnston, Bruce Phillips

All spiny wild lobster fisheries are either fully exploited or over-exploited, with many experiencing trends of catch declines over the past several years. The tropical spiny (rock) lobster *Panulirus ornatus* is the most highly prized and most valuable of all the tropical spiny lobster species. Increasing demand from China has outstripped supply. The solution to this imbalance clearly is lobster aquaculture. However, spiny lobster are widely recognised as one of the most difficult of all aquaculture species (and the most difficult crustacean) to propagate due to the protracted, complex and delicate larval phase, the phyllosoma.

Research was initiated on propagating *P. ornatus* by an Australian company MG Kailis more than ten years ago, together with Queensland Department of Primary Industries, headed by Clive Jones. MG Kailis produced the first hatchery-reared *P. ornatus* post-larvae (pueruli) in 2006, in Exmouth, Australia, believed to be a 'World First.' The achievements of producing pueruli and juveniles in 2006, were repeated in subsequent years by Lobster Harvest, a company established by MG Kailis in 2007 for the purpose of commercialising lobster aquaculture technology. The cohorts were again reared from eggs in the hatchery through the complete larval phase (Stages I – XI) and through metamorphosis to the puerulus and juvenile stages in 2007 and 2008.

First generation (F1) female tropical spiny lobsters from the 2006 cohort were stocked in maturation raceways, together with first generation males from the 2007 cohorts. In 2009 mating occurred, with 'tar-spots' observed on the females. Spawning of these first generation females occurred in late December 2009, with the first hatch of second generation (F2) larvae on the 24th January 2010. Three cohorts of the second generation and one cohort of the first generation *P. ornatus* have been successfully cultured through the larval phase to pueruli and the juvenile stage in 2010. Survival rates from Stage I newly-hatched larvae to juveniles of 9.6% was achieved using small-scale tanks, with concurrent production at survival rates near to rates deemed commercially viable achieved in larger tanks.

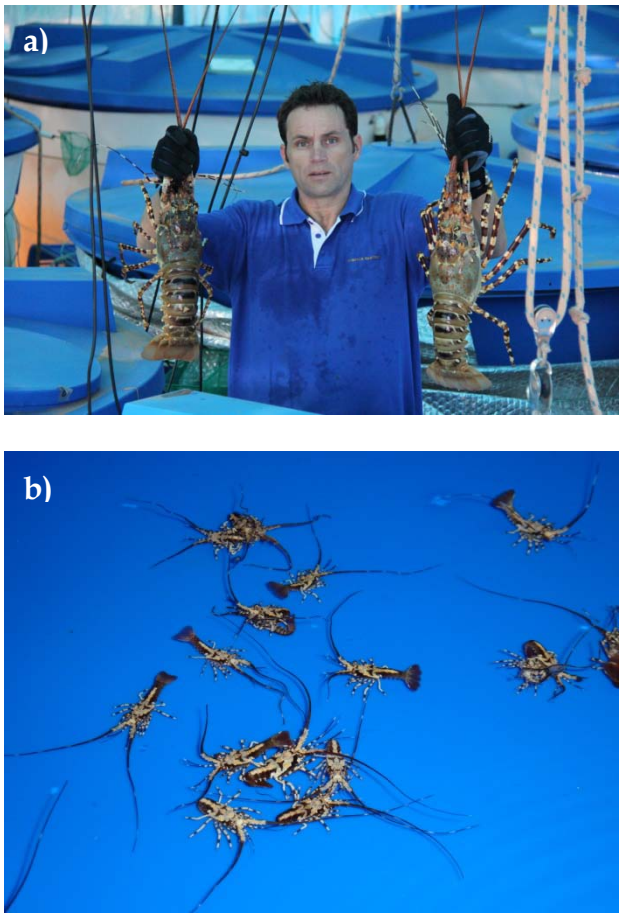

Fig. 1 (**a**) Roger Barnard holding the proud parents of the F 2 generation (**b**).

Lobster Harvest has been spectacularly successful in rearing the tropical rock lobsters *P. ornatus* and *Panulirus versicolor* and also the

slipper lobsters (bugs) *Thenus australiensis* and *Thenus parindicus* through their complete life cycles in the company's large scale laboratory and pilot-scale lobster hatchery systems.

The companies R&D and Commercial Development program is now focused on further developing the larval nutrition and scaling-up of larviculture tanks in the hatchery. Commercial survival rates in the hatchery of 5-10% have already been achieved, albeit using small-scale tanks, in replicated experiments. Mean survival in the best feed formulation replicated experiment was 8.1% to the juvenile stage in 2010, with the highest tank survival in a small-scale tank of 9.6%. Scale-up to commercial scale began in 2010 with the unique Lobster Harvest larviculture custom-designed and built tanks. Production-scale tanks in 2010 repeatedly produced juvenile *P. ornatus* from Stage I larvae at survival rates of 4.0-4.4%.

Repeated production of first generation *P. ornatus* and the recent success in truly closing the life cycle with the production of second generation progeny are significant steps towards the commercialisation of tropical spiny lobster aquaculture. The development of Lobster Harvest's unique propagation technology places them in a strong unprecedented position to benefit from this situation and to expand the lucrative spiny lobster market. Vietnam has an established grow-out industry, fattening the fast-growing and robust *P. ornatus,* which relies on using wild-caught post-larvae and juveniles, with an estimated annual export value of $US 80 million.

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Magnificent American Lobster Claw on Display in Norway

From: Gro I. van der Meeren

A local old ship society in Southern Norway has had a magnificent lobster claw on display for a long time. It was purchased in Canada about one hundred years ago, probably from Newfoundland. The club members want to know if it is possible to learn more about the lobster which had this claw.

The claw is 310 mm long. See the cigarette lighter in the figure for scale (I'm told it's a 'normal' sized lighter).

Fig. 1 Hummerklo.

Is there anyone out there who can answer the questions: What is the estimated age, weight, sex and size of this lobster. I have told them that it definitely is from a *Homarus americanus* specimen, and it will not be possible to tell the exact age based on one claw, but I put their questions to readers of *The Lobster Newsletter*.

Please send your comments to me and to the Risør Aquarium (mail@risorakvarium.no).

Thank you.

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The Lobster NEWSLETTER

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