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The Lobster NEWSLETTER

ANNOUNCEMENTS

Lobster Newsletter Editor Retires! Haere ra and Farewell to John Booth

From Alison MacDiarmid

On Friday May 26th friends and colleagues from around New Zealand gathered at NIWA in Wellington to celebrate the career of John Booth. After 33 years as a researcher of all things lobstery, John is resigning and moving to the more tropical climes of northern New Zealand to forage, fish, relax and write books.

John's contribution to the area of rock lobster biology and ecology is nothing less than staggering. He has worked almost exclusively on rock lobster since his career began at the Fisheries Research Division in 1973. During that time he has made significant contributions towards our understanding of rock lobster growth, movement, distribution and the elusive phyllosoma and puerulus stages. What's more, his collaborative efforts with NIWA oceanographer, Steve Chiswell, have elucidated some of the oceanic mechanisms that entrain and deliver lobster larvae to their destinations.

John with his famous crevice collector and his new toy, the Z3.

In keeping with the theme of destinations, a body of work close to John's heart is that of puerulus settlement. Back in the seventies, John devised a curious structure called a crevice collector – a device still in much use around the country today. These, he reckoned, were a reliable tool for estimating settlement indices potentially predicting recruitment to the fishery. The 25 year long time series of data resulting from their extensive use is an incredibly valuable data set today

Another significant part of John's career would have to be his body of work on the packhorse lobster

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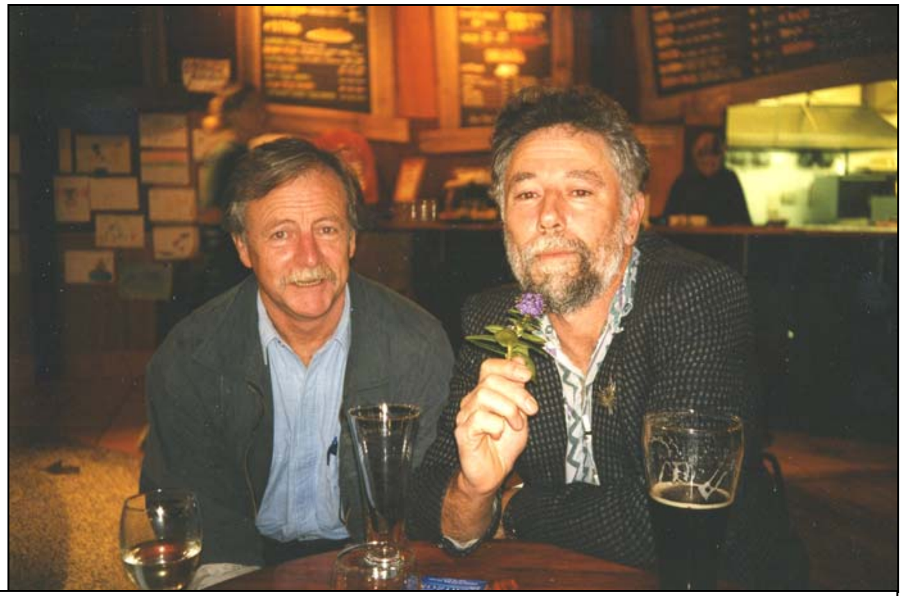
(*Sagmariasus verreauxi*), including determining their maturation and migration north-west up the east coast of the North Island to the main breeding population at Cape Reinga.

Amongst the New Zealand colleagues celebrating John's career were Alison MacDiarmid, John McKoy, Bob Street, Daryl Sykes from the Rock Lobster Industry Council, Kevin Stokes, Andrew Jeffs, Rick Webber, John Cranfield, and Paul Starr. Andrew Jeffs recalled a particularly funny occasion when, undeterred by the lack of a vessel and eager to do some sampling, John rigged up a phyllosoma net to a length of wood on the roof of the NIWA truck and towed it along the length of the Gisborne wharf. Despite their best efforts, no phyllosoma were caught and it was necessary to finish the box of wine later that evening.



John and long-time friend and drinking companion, Rick Webber.

John was presented with a beautiful line drawing of Jasus edwardsii, drawn by long-time friend and colleague, Rick Webber from Te Papa, Museum of New Zealand. John's NIWA colleagues gave him two gorgeous paintings of Wellington to remind him of the windy city when he is sitting in the fragrant heat and dining on freshly caught scallops and snapper.

John at his retirement ceremony with one of the gifts bestowed him, a painting of Wellington Harbour.

Numerous written tributes arrived from esteemed international colleagues and friends, amongst them, Mark Butler, Caleb Gardner, Peter Lawton, Richard Musgrove, Gro Van der Meeran and Bruce Phillips. Many recalled his sage advice and wisdom offered to them as younger scientists and others, John's penchant for a dram or two and a good ole chat. John's kind, encouraging manner and attention to detail have made him a valuable friend, scientist and mentor to many, myself included.

In the weeks preceding John's departure from NIWA he took possession of a BMW Z3, a car he had coveted for some time. And so it is with great style and reckless abandon that "Boothy" departs for more relaxed environs in the Bay of Islands. There is absolutely no doubt we will miss you John, but the good news (for us) is you will be receiving lots of visitors. Keep the boat fuelled and the snorkel gear handy!!

RESEARCH NEWS

Success! Caribbean spiny lobster, *Panulirus argus* is cultured from egg to juvenile for the first time

From: Jason Goldstein, Hirokazu Matsuda, and Mark Butler

The Caribbean spiny lobster (*Panulirus argus* Latreille, 1804) occurs in the Gulf of Mexico, the Caribbean Sea, and the northeastern coast of Brazil (Williams, 1988) and sustains one of the most important spiny lobster fisheries in the world, comprising nearly 46% of the total catch for spiny lobsters (FAO, 2006). Ironically, we know relatively little about its larval life history or linkages between larval sources and adult stocks. One of our research goals is to understand the connectivity of metapopulations that exist within the Carribbean basin. Working towards this goal requires both an understanding of the biological attributes of early-life history including larval development and duration, but also stage-specific larval behaviors such as phototaxis, vertical migration, and swimming capabilities. These characteristics of early life history coupled with oceanographic elements (*e.g.* currents, gyres, fronts), help to shape larval distribution and may promote larval retention, as has recently been shown for some marine fishes (Sale and Kritzer, 2003; Cowan *et al.*, 2006). Four species of *Panulirus* have been cultured to date, all of Indo-Pacific origin. Here we report that *P. argus*, one of five speces of *Panulirus* inhabiting the Atlantic Ocean, has now been cultured completely from egg to the early benthic juvenile stage.

Attempting to 'fill in' the pieces of the early life history puzzle for *P. argus* we undertook a culturing study for *P. argus* using two methodologies: (1) individual cultures in a static-seawater to quantify individual growth and (2) group cultures using 40 L acrylic tanks (see Matsuda and Takenouchi, 2005 for tank details) in a flow-through system designed to obtain samples for morphological measurements and behavioral observations. Adult lobsters with intact spermatophores but no external eggs were collected on reefs in the Florida Keys (Fig. 1) and shipped air-frieght to the Mie Prefectural Fisheries Station in Japan.

Figure 1. *Mark Butler assesses the reproductive status of adult P. argus in the lab in the Florida Keys. Photo: J. Goldstein*

Twenty phyllosomes were cultured individually in a static seawater system at 25-27^{0}C. Six of the 20 phyllosomata metamorphosed after 18 - 21 molts (mean = 19.7) to the puerulus stage after 140 - 198 days (mean = 173.8 days). Body lengths in the final phyllosomal stage and the puerulus stage ranged from 25.60-28.20 mm (mean = 27.00 mm) and 16.40-17.50 mm BL (mean = 17.00 mm), respectively. Time-to-metamorphosis to the first benthic juvenile stage averaged 192d (range: 165 – 214 d)(Fig. 2). We also mass cultured 550 newly hatched phyllosomata in a flow-through system at a constant temperature of at 25^{0}C. Of the 550 larval animals, 146 were sampled for description and illustration of larval stages, and for experiments on stage-specific phototaxis. We will report on those results at a later date.

Several unpublished trials at *P. argus* culture were attempted in the 1970's in the Florida Keys with only limited success through very early stages (reviewed in Moe, 1991). Early and some late-stage specimens

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***Figure 2**. At left: late stage cultured P. argus phyllosome; Middle: day-old P. argus puerulus. At right: early benthic stage P. argus juvenile, reared in captivity for the first time from an egg. Photo: H. Matsuda.*

were observed and documented from either freshly hatched eggs or from plankton tows (Crawford and DeSmidt, 1922; Gurney, 1936) however many figures and descriptions from these studies are incomplete. Only one published study by Lewis (1951) contains a comprehensive overview of the phyllosomal stages of *P. argus* collected from plankton tows in the Florida current and throughout the West Indies (n = 300 specimens) on the R/V Atlantis. Although findings from that study described 11 distinct phyllosomal stages and a puerulus stage (companion paper, Lewis *et al.*, 1952), the work is confounded by specimen material from two other genera, *Scyllarus spp.* and *Thenus spp.* as well as other *Panulirus spp.* as noted by Lewis. More problematic is that the age at each larval stage was unknown. Previous estimates of larval duration (6-12 months) have been extrapolated from modal progressions of larval stages in field samples (Lewis, 1951; Sims and Ingle, 1967). Our laboratory data on larval duration (5 - 7 mos), which are potentially subject to laboratory artifacts as are all culture data, fall at the low end of those previous estimates. We hope to provide further details on our findings in upcoming peer-reviewed papers, but wanted to share our success first with our colleagues who read *The Lobster Newsletter*.

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Effect of Emamectin Benzoate on the Molt Cycle of Ovigerous American Lobsters: An Example of Neuroendocrine Disruption?

From: Susan Waddy

A few years ago, Sarah Mercer, a student working with me at the Biological Station in St. Andrews discovered that emamectin benzoate (EMB)—an in-feed drug used by the aquaculture industry to control sea lice *(Lepeophtheirus salmonis* and *Caligus* spp.) infestations on farmed salmonids—can cause ovigerous American lobsters to molt prematurely and lose their attached eggs with the cast shell (Fig. 1). EMB is a second generation avermectin, a class of pesticides originally developed to control insect pests on agricultural crops. Avermectins are GABA agonists that disrupt nerve impulses; they are not considered to be endocrine disruptors and do not cause premature molting in insects. So the molt-promoting effect of EMB on American lobsters was unexpected.

Since that time, a research team (that also included Natalie Hamilton-Gibson, Dave Aiken, Les Burridge, Vicki Merritt, and Krista Brooksbank) has been studying the effect of EMB on the American lobster. Over the past 6 years, several hundred premature molts have been induced in ovigerous American lobsters by forcing them to ingest high doses of EMB. Many of the molts occurred almost a year earlier than in the control lobsters. The lobsters used in our studies molt on a 2-year cycle and were given EMB while they were in a prolonged anecdysis (a developmental plateau in which they remain in molt stage C_4 and early D_0 for about 20 months) during which the ovaries mature, spawning occurs, and the eggs are incubated. Such lobsters would not normally molt until after the attached eggs had hatched, a year after spawning.

It is the predictability of the timing of ecdysis in ovigerous lobsters that makes it obvious that EMB is having a dramatic effect on the molt cycle. For example, when ovigerous females that spawned in early July were given controlled doses of EMB (2 and 0.4 μg/g) in late July a significant proportion molted between mid September and early November, 60 to 100 days after ingesting the drug (Waddy et al., in press). The controls, in contrast, did not molt until the following year on experimental day 380 and later. The dramatic difference in the timing of the molts between the control and EMB-treated groups provides strong evidence that the hormonal system controlling the molt cycle is being disrupted by EMB. Although there are rare cases of American lobsters molting while carrying well-developed "old" eggs that are close to hatching, it is almost unheard of for lobsters to molt while carrying newly-extruded eggs unless their eyestalks—the source of molt inhibiting hormone—are removed.

The effect of EMB on the molt cycle of the American lobster is also unusual in that it appears the drug is trigging the onset of premolt (transition from molt stage D_0 to D_1). Most of the lobsters molt successfully and development of the new shell appears normal. The only compounds known to cause premature molting in arthropods are those that act as molting hormone (MH) agonists which bind to the ecdysteroid receptors, producing symptoms of ecdysteroid excess, and lethal molts. Avermectins act on the nervous system and are not MH agonists.

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Lobsters treated with EMB do not show the classic signs of ecdysteroid excess, such as abnormal setal development or rapid progression through premolt. Once the EMB-treated lobsters reach stage D_1 progression through stages D_1 to D_3 occurs at a normal rate. We have observed lethal molts in some treated lobsters, but this may be due to the effect of the drug on neuromuscular control and the animal's ability to free itself from the old shell, as the deaths have occurred at various substages of E (ecdysis).

Although the mechanism of action of EMB on the molt cycle is still unknown, our hypothesis is that EMB is affecting the neurohormones that regulate the Y organs (molting gland). As stated by Zou (2005), any event in the endocrine cascade of molting regulation (MIH synthesis and release, molting hormone (MH) synthesis, or ecdysteroid signaling in the epidermis) could be a target of environmental chemicals. Howeever, there are no known examples of chemicals that disrupt the neuroendocrine control of molting.

According to the classical view of molt control in crustaceans, two antagonistic hormones, a molt-inhibiting neuropeptide and molt-promoting steroid regulate the molt cycle of crustaceans. The neuropeptide inhibitor (MIH, or molt-inhibiting hormone) is thought to be the primary regulator of the molting glands. When released from inhibition, the molting gland synthesizes and secretes ecdysteroids (molting hormones), which cause the animal to move from intermolt (anecdysis) to premolt, and are responsible for the complex series of physiological and biochemical changes that culminate in ecdysis.

Our hypothesis of the mechanism of action of this drug explains how avermectins are able to delay molting in insects but accelerate molting in lobsters. The molting glands of insects are under positive control by neurohormones while the molting glands of crustaceans are under negative control. The hypothesis is also supported by the fact that EMB is a GABA agonist and GABA has also been shown to nhibit the release of other eyestalk neurohormones (Sarojini et al., 2000).

Our finding of the molt-promoting effect of high doses of EMB on egg-bearing lobsters has caused concern among environmentalists and fishermen about the use of this drug in areas with commercially-significant crustacean fisheries. Because of such concern, work is now focused on producing information for risk assessment. Studies conducted by Natalie Hamilton-Gibson and Sarah Mercer suggest that ovigerous lobsters are unlikely to eat enough medicated feed to affect the molt cycle. They found that lobsters eat relatively little salmon feed, whether medicated or not. We have also identified doses of EMB that have no detectable effect on the molt cycle of egg-bearing lobsters (the no-observed effect level; Waddy et al., in press). Even when a group of lobsters is given a dose of EMB that affects a significant proportion of animals, the majority of the lobsters in the group appear to be unaffected by the drug and molt at the normal time. The results to date suggest that lobsters appear to be at little risk of ingesting enough of the drug to affect the molt cycle.

If anyone is interested in a collaboration to determine the mechanism of action of this drug on ovigerous American lobsters please contact us.

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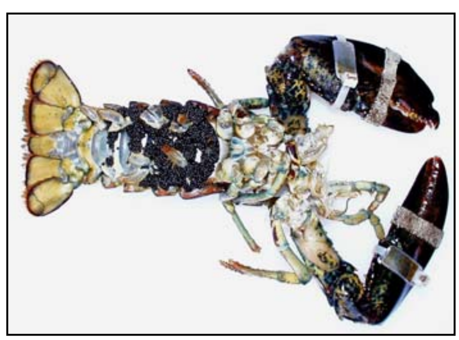

Fig. 1 Shell of ovigerous lobster that molted prematurely after ingesting EMB

The role and importance of olfaction during reproduction in the New Zealand red rock lobster

From: Natalie Raethke

In an earlier edition of the Lobster Newsletter (Vol. 15, no. 1, June 2002) I reported about my PhD research on the role of chemosensory communication in the New Zealand rock lobster *Jasus edwardsii*. During the first half of my study I mainly focused on its importance for cohabitation and also developed a catheterisation method to allow for work exclusively with the urine. Having shown that immature males already produce pheromones facilitating cohabitation, I also determined that mature post-moult females are able to differentiate between signals from immature and mature males. This indicates that mature males produce one or more pheromones different from immature males to signal that they are in a reproductive state. Below, I concentrate on the use of olfaction during the reproductive period.

Although male spiny lobsters, *Jasus edwardsii*, share shelters with their peers throughout most of the year, male to male agonistic interactions can be observed during the mating season (Fig. 1). In a set of three trials, I investigated the importance of urine signal detection during these agonistic encounters. Treatment males had their antennule chemoreceptors temporarily blocked with distilled water while control males had not. Comparable experiments with *Homarus americanus* (Karavanich & Atema, 1991, 1993, 1998b; Breithaupt & Atema, 1993, 2000; Kaplan et al., 1993) suggest that impairing the detection of urine-borne pheromones can have significant effects on the duration of the fight and the males' aggressiveness. However, in my experiments no differences could be observed regarding the fighting behaviour of the males or the length of the fights, suggesting that pheromones do not

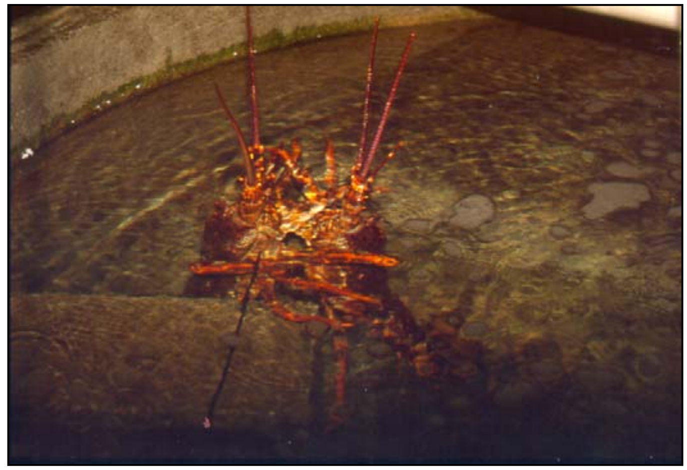

Figure 1: A dominance fight between two male *Jasus edwardsii*

seem to play a major role during these interactions or that the visual and tactile senses may compensate for a loss of olfaction.

In another set of experiments I studied the importance of urine-borne male signals for female mate choice. In this case, urine output was switched among large and small mature males and post-moult mature females were tested for their response. While the majority of females in a control study (where the urine was not switched among the males) sheltered with the large male, in the experiment the females failed to make a clear choice, indicating that pheromones seem to play an equally important role as visual and tactile signals for female mate choice.

Since chemoreceptors on the antennules are responsible for the detection of pheromones, scanning electron micrographs were taken of these structures and I compared their morphology with the receptors of other Palinuridae, enabling better comparison of behavioural studies on other species.

Further, the antennules of either female or male *J. edwardsii* were ablated to examine the importance of signal detection for the mating success. Similar laboratory experiments with *H. americanus* resulted in dramatic behaviour aberrations during courtship

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and mating and led to males inflicting female injury or death (Cowan, 1991). In my experiments, treated males were coupled with untreated females and vice versa. Their mating dates and the size of the resulting egg clutches were then compared with those of untreated control pairs. Interestingly, no significant effects could be found when females had their antennules removed. In contrast, when the males' antennules were ablated a systematic difference in size of the resulting egg clutches was apparent with the treatment group producing smaller clutches than the control group.

In summary, I conclude that while chemosensory communication is used during reproduction by *J. edwardsii* it does not seem to play as crucial a role as in the clawed lobster *Homarus americanus*, where the prevention of olfaction has been shown to have dramatic results on mating success. I hypothesise that the observed differences in chemosensory communication between *J. edwardsii* and *H. americanus* are a consequence of different population structures, social life and mating strategies of the different species.

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Individual based, spatially explicit models to explore the mating systems of the red rock lobster *Jasus edwardsii* and the Caribbean spiny lobster *Panulirus argus*

From: Alison MacDiarmid, Ed Abraham, Andy McKenzie, Thomas Dolan, Michael Goodrich and Mark Butler

Field and laboratory experiments have been undertaken over the last decade investigating various aspects of the mating system of the red or southern rock lobster *Jasus edwardsii* (Fig. 1) and the Caribbean spiny lobster *Panulirus argus* (briefly reported in earlier editions of the Lobster Newsletter: Vol. 8 No. 2, December 1995; Vol 12, No. 1, June 1999; Vol. 18 No. 1, February 2005). We have now constructed separate, but similar models describing the mating systems of these two species. For *Jasus,* a numerical model was developed by the research team from New Zealand using the object-oriented language Python. The *P. argus* model is also object-oriented and written in C++. The models allow us to simulate the mating behavior of a small lobster population, showing how population structure, mate competition, mate choice, female fecundity, and male sperm supply affect reproductive success.

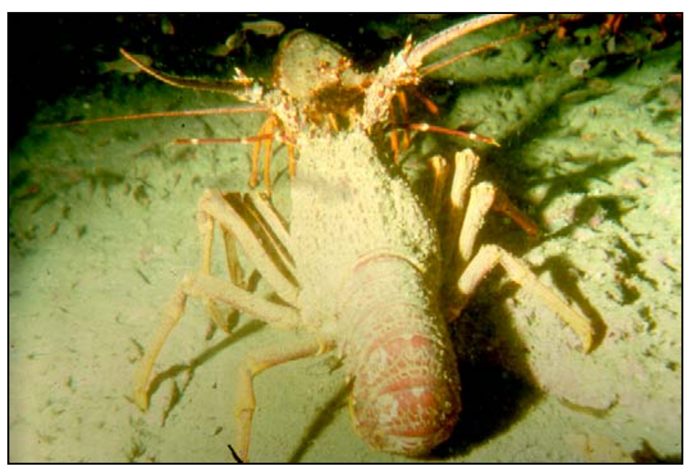

Figure 1: Male *J. edwardsii* courting a female

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The models are individually based and include spatial structure in form of unique dens. The size structure and sex ratio of a population are specified, and each lobster is followed through the mating season. The lobsters interact with other lobsters within dens, competing for occupancy and mating opportunities. The model follows experimentally determined behavioral rules to decide which lobsters mate and the consequences of each mating, in terms of sperm and egg production. The individual-based view allows for detailed output of the distribution of mating success among individuals, including: the number of matings, the size of mates, the number of fertilized eggs produced, and the number of males or females who fail to mate. Changes in the distribution of lobsters among dens over the duration of the mating season can also be tracked.

We are using these models to explore the consequences of fishing intensity, fishery regulations (e.g., minimum sizes), and the targeted fishing of males on production of fertilized eggs. For example, a male-based fishery on *J. edwardsii* occurs in some parts of New Zealand and Tasmania and has markedly decreased the ratio of males to females in the population. Comparison of results between two species with vastly different mating systems will also yield insight into the generality of our results relative to fishing effects. Initial results comparing modelling predictions with field data on larval production from fisheries and marine reserves in New Zealand and Florida, indicates the model behaves realistically. The models also successfully represent the variation in production seen in mesocosm experiments on *J. edwardsii* where the number of males per female is controlled.

We anticipate that these models will be useful in exploring how quickly egg production increases in populations rebuilding in marine reserves or other spatial management areas. It will also allow exploration of how reproductive output will be affected by fisheries management that leads to changes in the exploitation of different sizes and sexes. Results to date underscore the need to take into account both male and female abundance, size structure and size-specific fecundity when modelling reproductive output.

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Update on four New Zealand rock lobster themed PhD theses

From: Alison MacDiarmid

Four young New Zealand researchers working on various aspects of rock lobster biology and ecology are at various stages of completing their PhD's. Below is a brief update on each of them.

Natalie Raethke has been working on chemosensory communication in the spiny lobster *Jasus edwardsii* since mid 2000 and has been jointly supervised by Prof. John Montgomery at the University of Auckland and Alison MacDiarmid. She submitted her thesis in June 2005 and defended her work successfully during an oral exam earlier this year. Natalie

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reported on early aspects of her work in an earlier edition of the Lobster Newsletter (Vol. 15, no. 1, June 2002) and summarises her more recent work in an accompanying article in this issue. Currently, she is focusing on the publication of several intriguing results of her study including the differentiation of immature and mature males by mate seeking females on the basis of urine alone, the absence of any effect of urine detection on the outcome of male-male agonistic interactions and comparison of the fine structure of the antennules with those in other lobster genera. Natalie hopes to find an interesting position in the field of marine ecology, preferably in Wellington, New Zealand.

Debbie Freeman has been working on the effects of commercial fishing and protection on rock lobster demographics and ecological interactions inside or adjacent to marine reserves since 2003. She is registered at the University of Auckland and has undertaken her research while working for the Department of Conservation based in Gisborne on the east coast of North Island. She is supervised by Dr Richard Taylor from the Leigh Marine Laboratory at Auckland University and Alison MacDiarmid. Debbie reported on some of her work in the previous issue of the Lobster Newsletter (Vol. 18 no. 1) and has recently found that female size-specific brood size is higher in the Te Tapuwae o Rongokako marine reserve than in the adjacent fished population. Debbie has concluded the fieldwork necessary for her PhD and is currently writing up her thesis with a view to submitting it later in 2006.

Megan Oliver hopes to complete her thesis by December 2006 after taking a year off on maternity leave. Megan is registered through the University of Tasmania (UoT), in Hobart, Australia but is based at NIWA in Wellington, New Zealand and has conducted her research in both New Zealand and Tasmania. She is supervised by Caleb Gardner at UoT and Alison MacDiarmid at NIWA. Megan's thesis examines the potential for stock enhancement of the New Zealand and southern Australian red rock lobster *Jasus edwardsii* and specifically determines behavioural differences between wild and seeded juvenile lobsters, rates of predation on captive-reared juvenile released into the wild, patterns of residency and foraging by wild and captive-reared released juveniles and density dependent effects on growth of the target population. Megan reported on changes in behaviour of juveniles raised for later release into the wild in an earlier issue of the Lobster Newsletter (Vol. 15 no. 1, June 2002).

Lesley McLeod is 18 months into her thesis work determining how the behaviour of larvae from a range of coastal marine invertebrates including spiny lobsters are affected by larval stage and age, lipid reserves, parental nutrition and a variety of environmental parameters including light, temperature and depth. Her work is entirely laboratory based and will provide critical inputs into numerical simulation models of larval dispersal and population connectivity being developed by her NIWA colleagues. Lesley is registered at Victoria University of Wellington, New Zealand where she is supervised by Dr Nicole Phillips and is co-supervised by Alison MacDiarmid.

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FISHERIES & AQUACULTURE UPDATE

Initiating a lobster, *Homarus americanus*, enhancement project in the Gulf of St. Lawrence, Canada

From: Michel Comeau and Martin Mallet

Although American lobster (*Homarus americanus*) landings are still generally high in Canada, they have actually declined substantially in some areas over the past fifteen years to levels that now represent all time lows for local fishing communities (Comeau et al., 2004). Not surprisingly, fishermen in these areas are keenly interested in lobster enhancement and sea ranching projects. In 2001, the Canadian Department of Fisheries and Oceans (DFO) was approached by the Maritime Fishermen's Union (MFU) to collaborate in a lobster enhancement program in the southwestern Gulf of St. Lawrence. The MFU also sought the collaboration of other fishermen's associations, research institutes, the private sector, and provincial government, creating the *Homarus* group to carry out the enhancement project. The goals of this non-profit group are to: (1) increase lobster abundance through innovative and practical approaches to lobster enhancement and sea ranching; (2) increase scientific knowledge of lobster biology, coastal habitat structure, and ecosystem processes; and (3) introduce educational tools to better explain ecological processes to the fishing industry.

Development of technologically-simple and cost-effective hatchery production of stage IV lobster larvae for seeding purposes is one of the projects that was initiated through this collaboration. This activity is conducted at the Coastal Zones Research Institute in Shippagan, New Brunswick (Canada), using hatchery installations originally designed to produce juvenile haddock (*Melanogrammus aeglefinus*).

The American lobster has four larval stages. Stages I to III are pelagic, and they are found swimming in the water column. At stage IV (Fig. 1), the animal goes through a metamorphosis, chelipeds appear for the first time, and the lobster settles to the bottom. Besides being the first benthic stage, stage IV was selected as the seeding stage because it can be produced in two weeks in the hatchery, therefore keeping production costs low. As Stage IV larvae are biologically-driven to seek shelter on-bottom once released, it was felt that this behaviour could be leveraged in developing cost-effective field release approaches which could be easily operated by commercial fishermen.

Figure 1: Stage IV hatchery reared larvae.

Stage I larvae used in the hatchery come from berried (ovigerous) female lobster collected in the wild between late-May and early-June. Berried females are easily accessible from the wild at this time of year and hatchery operational costs are thereby reduced (no extra cost related to holding a broodstock in tanks over long periods). Development of the eggs from wild-caught females is well synchronized with the natural conditions whereas females held in artificial conditions tend to

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desynchronize their natural spawning cycle. At the hatchery, the females are kept at low temperatures (<10°C) in order to delay egg development. Stage I larvae are produced as needed by exposing females to 20°C water temperature, thus providing a regular inventory of larvae during the production period. Stage IV lobster production spans from late-June to early-September.

Between 2002 and 2005, several rearing experiments were tried with various successes and under these trial-and-error-type approaches over 150,000 stage IV lobsters were produced and released. The first production in 2002 was achieved using 250 L K-wall tanks equipped with a filtering system (closed system). Larval density was 5-9/L, and they were fed live *Artemia*. The survival rate ranged between 2-18% and produced 1,500 larvae. This system demanded a great deal of manipulation and was labor intensive. The production cost of *Artemia* was also a problem for the type of low-cost hatchery the *Homarus* group wanted to develop.

In 2003, comparison trials were made between 250 L K-Wall and 1,200 L cylindrical tanks (Fig. 2) equipped with a flow-through system (eliminating a great deal of labor-intensive daily cleaning). With experimental density ranging from 3-20 larvae/L, the survival rate between the two types of tanks was similar (ranging between 2-9%). Hence, the K-wall tanks were replaced with the easy to maintain larger cylindrical tanks. A total of 3,500 larvae were produced and released in 2003. It was noticed during the release, however, that stage IV lobsters swam to the surface instead of adopting the typical cryptic behavior (seeking a shelter). It was hypothesized that the stage IV lobsters had been conditioned by being fed during the day within the hatchery, and thus associated light with food. It was then proposed to change their feeding from day to night to alleviate this undesirable behavior.

The main focus in 2004 was to test, on a small scale, alternative and less expensive food to replace the

Figure 2: Large, cylindrical 1200 L tanks used in the larval rearing hatchery.

live *Artemia*, and improve the rearing system. Eight types of aeration prototypes were tested, and one reduced cannibalism and promoted a higher survival rate. Of the eleven commercially available alternative foods that were tested, frozen *Artemia* ($20/kg) was the best alternative to live *Artemia* ($500/kg). Using densities of 10 larvae/L, survival rate was over 15% and over 60,000 larvae were produced. Another improvement to the rearing system involved adjusting the feeding pattern from day to night. During field releases this resulted in the stage IV lobster immediately settling to the bottom and seeking a shelter.

Following three years of experience, bringing with it a steady improvement in hatchery techniques, the *Homarus* group was able to achieve a production of over 90,000 stage IV lobsters, with a survival rate of over 35%, in the hatchery trials conducted in 2005. More importantly, cost of larval production was progressively reduced from about $30 to $1 per larva. Ultimately, the *Homarus* group hopes to reduce the production cost even further to about $0.20 per larva, and to transfer a proven low-technology hatchery system with high production capacity and low operational cost to fishermen's groups that wish to pursue their own lobster enhancement and sea ranching programs.

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New approaches in assessment of lobster off southwest Nova Scotia

From: John Tremblay

The lobster fishery off southwest Nova Scotia (Lobster Fishing Area 34) is a major source of *Homarus americanus (*Fig. 1). Recorded landings from the 2004-05 season were 17,007 metric tons, which was almost 40% of Canadian landings, and about 23% of world landings. This fishery is prosecuted by some 967 licenses that fish from late November until the end of May. The fishery is managed primarily by limits on participants, seasons and trap number, a minimum legal size and a prohibition on retention of egg-bearing females. In Canada the management of lobsters is a federal responsibility and periodic assessments are conducted by the Department of Fisheries and Oceans (DFO). These assessments are documented in Research Documents and in Scientific Advisory Reports (SARs). Both these

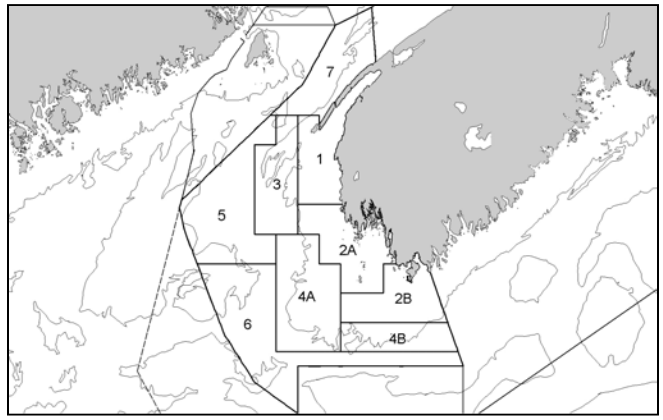

Fig. 1. Grid groups from LFA 34 fishing logs. Groups are aggregations of 10 minute grids.

series are available on the Canadian Science Advisory Secretariat (CSAS) website:

http://www.dfo-mpo.gc.ca/csas/Csas/

The SAR from a February 2006 assessment of Lobster Fishing Area 34 is currently available and the Research Document (Pezzack et al. 2006) will be available in the coming months.

The recent assessment was novel in two regards: the heavy use of data provided directly by fishermen and the high level of industry participation. A major data source was Lobster Catch and Settlement Reports ("LFA 34 fishing logs"), provided by fishermen and maintained by DFO. Begun in 1998 (Pezzack et al. 2001), the LFA 34 fishing logs consist of fishermen reports of daily catch, trap hauls and fishing locations (10 minute grid squares). These LFA 34 fishing logs provided an unprecedented spatial perspective of catch and effort over this large fishing area. A catch rate model was developed and applied to grid groups and spatial trends were identified. A key finding was that since 2000 there has been an increase in effort in more midshore and offshore fishing locations (Fig. 2).

A second data source provided by fishermen was via the Lobster Recruitment Index Project. Conducted under the auspices of the Fishermen and Scientist Research Society (FSRS), this project involves fishermen participants measuring, sexing and counting all lobsters from two standard traps with

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small wire mesh. The project is described at : http://www.fsrs.ns.ca/projects/Lobster/Lobsterindex.html

In 2004-05 there were 45 participants in LFA 34, mainly in the nearshore portion (grid groups 2a, 2b and 1 in Fig. 1). The data from the FSRS project indicate that in nearshore areas recruitment has continued high but has trended downwards in the last one to two years.

Direct participation by industry in the assessment came in the form of a Science Committee with representatives from industry (fishermen, buyers and processors), DFO, the province of Nova Scotia, the FSRS and the Lobster Science Centre (at University of Prince Edward Island). During five meetings leading up to the February 2006 assessment meeting, industry contributed on several fronts. Fishermen validated the all-important fishery data contained in logbooks, and endorsed the scientific analysis of it. They brought attention to important changes in the fishery such as increased fishing pressure resulting from an increase in boat size and the targeting of larger lobsters which, in turn, may impact the reproductive capacity of the population. Fishermen also raised valid questions about assumptions made in models of catch rate and exploitation rate.

The assessment used an indicator framework. Abundance indicators were landings, catch rates from LFA 34 fishing logs and FSRS logs and the bycatch of lobsters in a dredge survey for scallops. An important aspect here was the spatial component provided by the grid-referenced landings. Fishing pressure indicators were numbers of traps fished and several exploitation rate estimators. Production indicators (prerecruits and spawners) were more limited, consisting of FSRS data for nearshore areas, and catch rates in at-sea samples of the commercial catch. The only available ecosystem indicator (albeit an important one) was temperature.

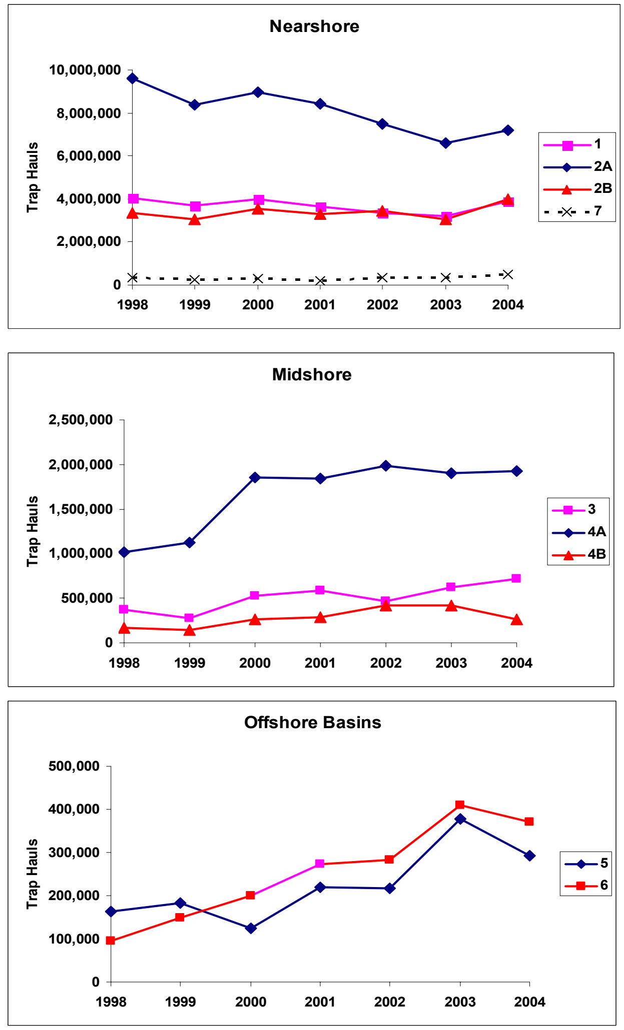

Fig. 2. Total trap hauls from LFA 34 fishing logs by grid groups (see Fig. 1).

A goal of the assessment was to recommend the suite of indicators that should be maintained or developed in the future. A key point was the need for fishery-independent indicators of abundance to overcome the uncertainty associated with indicators based on commercial fishing where efficiency and strategy change.

Please refer to the CSAS website for further information.

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Meeting Review

BRAZIL Responsible Fisheries: IBAMA President Under Pressure to Ban Use of Gill Nets in Brazilian Lobster Fishery

From Michelle T. Schärer

The President of IBAMA (the Brazilian Environmental Institute), Dr. Marcus Barros, is coming under increased pressure to ban the use of gill nets in the Ceará lobster fishery, as was evident among the 300 participants at the II International Seminar for Responsible Fisheries in Brazil. They demanded an end to the turtle mortality and the discarded by-catch of the excessively large gill net fleet, and for preferential access rights to be granted to traditional fishers using sailing boats and lobster traps. A ban on gillnets had been requested by a majority of lobster fisheries stakeholders since 2002, but Dr. Barros caved in to pressure from industry, government, and political interests and allowed the use of gillnets to continue in 2005.

The call by seminar participants was endorsed by 400 local stakeholders from the fishery at meetings organized in parallel with the International Seminar. Over the last 20 years, catches from the Ceara State lobster fishery have declined from over 9,000 tonnes to less than 6,000 tonnes. Poor management, government subsidies, and irresponsible fishing practices are some of the main reasons cited for this decline.

The International Seminar, jointly organized by the NGO Terramar and the Fisher Forum of Ceará State, was supported by the FAO FishCode Programme, the AVINA Foundation, and the philanthropic Association of Friends of Prainha do Canto Verde, Switzerland. The 300 participants were drawn from all stakeholders groups in the fishery: artisanal fishers, NGO´s, industry, fleet owners, government and non governmental organizations, researchers, consumers, university professors, and students. The objective of the seminar was to call on the fishing sector, fisheries managers and political leaders to apply the precautionary approach to fisheries management, instead of yielding to political pressure from short-term sectoral interests.

This initiative built on the foundations laid by the I International Seminar for Responsible Fisheries in Brazil, which took place in 1997. That meeting marked the first efforts made by artisanal and small-scale fishers to lobby for the precautionary approach to be applied, and for their guaranteed participation in fisheries management decisions, from which they had been excluded.

Artisanal fishers, who hold 74 % of the boats in the fishery yet represent less then 5% of the fishing effort, began fishing for lobsters in 1955 have been at the forefront of the drive to save the once lucrative fishery. They have lobbied the government to prohibit gillnets, - responsible for significant by-catch of valuable fish, endangered sea turtles, and

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undersized lobsters – and they called for an end to the illegal use of hookah (compressor) gear, which is associated with excessive fishing effort, destruction of marine habitat, and armed conflicts at sea. Artisinal fishers also want to see the establishment of marine protected areas, open only to fishers using low impact fishing gear (e.g., traps) under a co-management regime. They also want the licensing system of the lobster fishery to guarantee their historical rights of access to the fishery and for social benefits to be provided.

Participants at the seminar heard presentations from the Australian lobster specialist, Bruce Phillips, on the well managed Australian Rock Lobster Fishery, and from Paul Raymond of the US Dept. of Commerce (NOAA) about the Lacey Act. That act regulates enforcement of illegal undersized lobster exports. Brazilian researchers, NGO, industry and community representatives as well as fisheries managers completed the line up for the three-day seminar. Noteworthy was the presentation of TAMAR, Brazil's highly successful turtle conservation project

(http://www.projetotamar.org.br/ingles/ and http://www.projetotamar.org.br/ingles/)

that provided evidence on the high number of marine turtles (green, hawksbill and leatherback turtles) caught in lobster gillnets.

Another dimension was highlighted by the SEAFOOD Report of the Monterrey Bay Aquarium:

(http://www.mbayaq.org/cr/cr_seafoodwatch/content/media/MBA_SeafoodWatch_CarribbeanSpinyLobsterReport.pdf http://www.mbayaq.org/cr/cr_seafoodwatch/content/media/MBA_SeafoodWatch_CarribbeanSpinyLobsterReport.pdf)

, which showed how Brazilian lobsters face rejection by US consumers, earning a red flag (avoid consumption) against the green and yellow flags awarded to the Florida and Bahamas lobster fisheries. Brazil, it was noted, fails to protect egg-bearing females, and the lack of control over the fleet and the use of gears (compressor diving and gillnets) will quickly lead to the collapse of the fishery.

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OBITUARY: PAUL KANCIRUK

Dr. Paul Kanciruk, palinurid lobster biologist died in February 2006 of natural causes. He was born in 1947 in New York City, attended City College of New York for his B.S. and received his Ph.D. from Florida State University in 1976.

Kanciruk actively researched spiny lobster behavior and ecology only during graduate school and several years thereafter (1970-80), so most contemporary lobster researchers have never met him. Yet he remains well known and widely cited for his remarkably durable 1980 review chapter, Ecology of Juvenile and Adult Palinuridae (Spiny Lobsters), *in* "The Biology and Management of Lobsters", edited by Stan Cobb and Bruce Phillips. It is one of the most highly cited of the eighteen chapters (>1000 total volume citations).

His research defined the physical environmental conditions associated with the onset of mass migration in Caribbean spiny lobster. His approach was to coincidently monitor lobsters in the field, by scuba, and in captive conditions, comparing patterns, then using correlates to devise experimental investigations. He pioneered application of time-lapse cinematography and computer recording from actographs in semi-field arenas to reveal long-term behavioral changes in lobster activity. He also introduced the Index of Reproductive Potential to

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estimate the female size-class contribution to offspring by populations of different size structure.

As a doctoral student, Paul developed innovative computer assisted data storage and retrieval programs to facilitate accumulation, integration and analysis of large, long-term data sets. He transformed this penchant for computerization into an extremely successful career at the Environmental Sciences Division of Oak Ridge National Laboratory. There, he developed systems to handle massive, continuous input of information from worldwide carbon dioxide monitoring and environmental data from the National Aeronautics and Space Administration. Moreover, he persuaded the powers-that-be that access to the ORNL data bank should remain available upon request, free of charge, to researchers, despite efforts to institute payment for such access as a way to "make money". He received in the 1990s a Distinguished Accomplishment Award, from then Vice President Albert Gore, for his contributions to his field. Kanciruk retired from ORNL in 2004.

Those of us who knew him personally will miss his great wit, his outstanding chef skills, and his outrageous luck at catching sailfish and tarpon.

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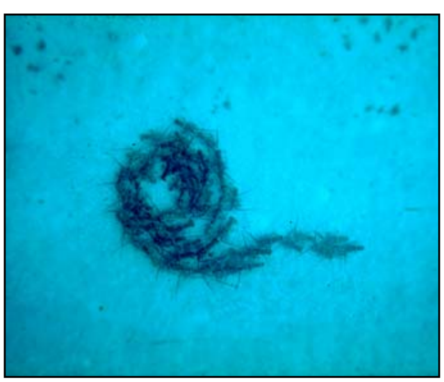

Panulirus argus defensive rosette during migration

The Lobster NEWSLETTER

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