The Lobster NEWSLETTER

EDITORIAL

It's *our* Newsletter

For the second year in a row we are having trouble getting enough material for a second issue of the Newsletter. At a time when lobster fisheries are attracting more and more research attention – seen for example in the increasing attendance at and number of publications from the international lobster conferences – less and less material is being received each year by *The Lobster Newsletter* editors.

We urge everyone to submit at least one article every alternate year. It can be on clawed (including scampi and freshwater) lobsters, spiny (rock) lobsters, or slipper lobsters. Consider the following possibilities.

- Describe that interesting observation that doesn't warrant a note in a journal
- Describe new work you're planning or beginning
- Summarise something from your recent work already submitted for publication.
- Give us the main points from the conference and where people can find out more
- Tell us about new books, videos, and web sites, and forthcoming conferences
- Write a letter to the editors for information you need
- Have your student summarise their research plan

You can find the format in any recent issue. Articles should generally be less that three pages (including figures), and much shorter ones are also welcome. Now that we distribute electronically, colour is possible. If you have colour figures, scan them in at final printed size (preferably one column width) at 300 dpi. If you are using colour in graphs and charts, use ones that a black and white printer will differentiate. Note that there may be copyright implications with images going into the Newsletter – in particular, there is nothing stopping anyone obtaining and using your illustration without permission or credit.

Send your article to any one of the three editors (details later). They will make editorial suggestions, return the article for your acceptance, and have it in the Newsletter as soon as possible. The contact for any additions to the Newsletter distribution list is lobsternews@mar.dfo-mpo.gc.ca. If you know someone who is not on e-mail, please post them a copy of the Newsletter.

The first issue of *The Lobster Newsletter* appeared in 1988; an index (at least by topic and species) for all issues of the Newsletter would be very useful now that there are 14 volumes. Any volunteers?

The Editors

RESEARCH NEWS

Looking at macroalgae habitat change in Tasmania and its effect on lobster settlement

From: Sam Ibbott and Caleb Gardner

Larvae of the southern rock lobster (*Jasus edwardsii*) can spend up to 24 months in the plankton before they metamorphose from the phyllosoma stage to become pueruli. The puerulus then actively swim towards shore, where it settles and begins the benthic phase of the life cycle.

Settlement of pueruli of the southern rock lobster has been monitored at numerous sites around Tasmania, Australia since 1991. This long term project is now showing strong links between settlement trends and the commercial catches five years later (Gardner et al. 2001).

In an attempt to improve precision and reduce variability in the data, we modified several crevice collectors by the attachment of trawl mesh suspended above each collector (Figure). These modified collectors showed enhanced catches compared to the unmodified collectors checked at the same times at the same site. A hard, immobile collector situated below a large flexible structure in the water column is analogous to giant kelp (*Macrocystis pyrifera*) growing on subtidal reefs, a common habitat type in Tasmania.

Many areas of reef which once supported large communities of *M. pyrifera* no longer do so – for anthropogenic, biological and physical reasons. Up to 90% of the forests along eastern Tasmania have been lost, these areas now being dominated by 'urchin barrens' or by introduced species. There is potential for this gross alteration in community structure to impact on puerulus settlement and survival. Not only did research undertaken in the mid 1990's demonstrate that the giant kelp provides habitat and food for the early benthic stage lobsters (Edmunds 1995), but also our collector experiments suggest that settlement levels may be enhanced by kelp presence.

We are currently instigating a series of experiments to test the null hypothesis that the presence of *M. pyrifera* has no impact on the settlement rate or subsequent survival of *J. edwardsii* pueruli. In undertaking these experiments we also hope to gain a greater understanding of the processes affecting settlement selection and habitat utilisation by early benthic stage lobsters.

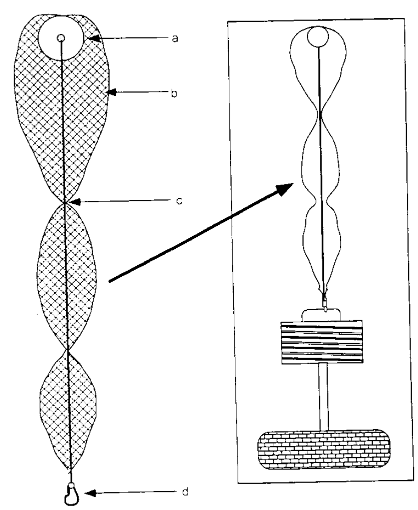

Figure. Mesh collector (left) and modified crevice collector (right). The mesh collector consists of a) 15 cm diameter styrene float; b) nylon trawl mesh bundled and tied to the main float line; c) 8 mm rope connecting snap clip and float; d) snap clip for attaching mesh to the top of a standard crevice collector.

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Lobster catches using crest nets in Uvea (Wallis and Futuna)

From: Emmanuel Coutures, Pascal Hebert, Laurent Wantiez and Claude Chauvet

Since 1999, the Marine Laboratory for Environmental and Resource Studies of the University of New Caledonia has been studying coral reefs and lagoonal communities in Wallis and Futuna, which lie a little northeast of Fiji. Uvea, the main island of this French Territory, is a typical tropical South Pacific Ocean high island and is surrounded by an almost continuous barrier reef (only 4 small passages) which delimits a 200 km^2 lagoon (Figure).

One part of the research program is to study fish and lobster colonization over the barrier reef using crest nets (Hebert 2001). When the tide is sufficiently high (tidal range is 2 m in Wallis), breaking ocean swells maintain a shoreward water flow over the reef. Lagoonal fishes and crustaceans that have oceanic larval development return to the lagoon by crossing the barrier reef by night. Crest nets fixed on the reef flat passively filter this water flow. This technique, developed in French Polynesia to catch fish larvae (Dufour et al. 1996), has also been effective in catching pueruli (Coutures 2001) and nistos (Coutures 2000) in New Caledonia.

According to Holthuis (1991), three shallow-water *Panulirus* species occur in this region: *P. penicillatus*, *P. longipes bispinosus* and *P. versicolor*. Two other species are probably also present, *P. albiflagellum* and *P. ornatus* (Environment Authorities of Wallis and Futuna Territory, pers. com.). Among the scyllarids (except *Scyllarus* spp.), two *Parribacus* (*P. antarcticus* and *P. scarlatinus*) and *Scyllarides squammosus* are present (Holthuis 1991).

In March-April 2001, three nets (2 m wide, 1.5 m high and 6 m long, manufactured by Aquafish™) were set over a lunar cycle in the north part of the barrier reef (Figure). In 84 net-nights (a net-night is one net used during one night), 13 pueruli and 1 nisto were caught. Animals were fixed in formaldehyde in the field and later transferred to 75% alcohol.

All the pueruli had an exopod on Mxp3 indicating that they were *Panulirus penicillatus*, *P. longipes* or *P. albiflagellum*. Michel (1971) separated *P. penicillatus* and *P. longipes* based on the length of the exopod of Mxp3 and Mxp2. However, our biometric data were not in agreement with those of Michel (Tables 1 and 2), and the puerulus of *P. albiflagellum* has not been described, so identifications remain uncertain. Growing pueruli to identifiable juveniles will be necessary to confirm identifications.

The nisto is *Parribacus scarlatinus* because of the presence of six teeth on the second segment of the antenna (as in *P. antarcticus*), and the presence of a rostrum with a dorsal tooth (Holthuis 1991).

As shown by Hebert (2001) using the same method to sample fish larvae, larval arrival was related to two factors, moon brightness and the tide. Some pueruli (and the nisto) crossed the reef around new moon (25 March), even though low tide was in the middle of the night and fluxes were limited by the water level above the reef. Maximum catches occurred on 3 April, two days after the moon's first quarter (FQ). Catches of fish larvae were also highest then, and additional sampling of fish, every two hours during the FQ night, showed that fishes colonized the reef only when there was no moon (Hebert 2001). Moreover, these samples contained lots of crustaceans, yet to be analysed. It is possible that they contain nistos of *Scyllarus* spp., as caught in crest nets in New Caledonia (Coutures & Webber in prep.); early phyllosoma stages of this genus were caught by plankton sampling in Uvea lagoon in 1999.

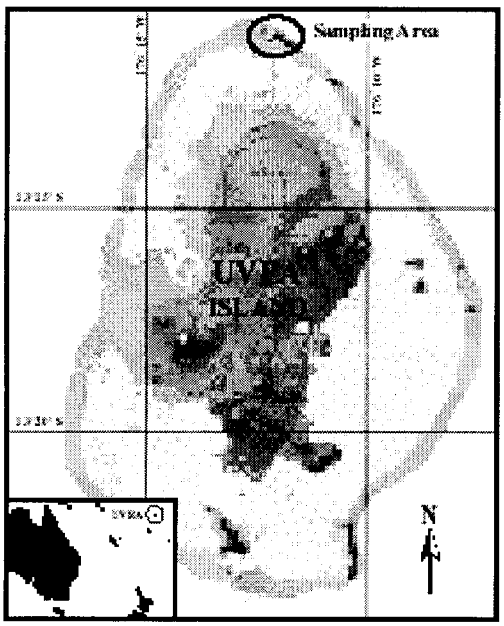

Figure. Location of Uvea (Wallis) and our sampling area.

Whereas several designs of collector have been used to catch pueruli around the world (Phillips & Booth 1994), none has worked for tropical Indo-Pacific species (Coutures 2000). Crest nets seem a good alternative way to study settlement variation.

This sampling was the pilot for a future one-year study. Links between larval and postlarval occurrence and environmental factors will be analysed, as well as spatial (lagoon) and temporal (over several lunar cycles) variations in catch. Pueruli and nistos will be kept alive to confirm identifications.

Table 1. Catches of pueruli and nisto (in italics) in Uvea. TL = Total length; CL = Carapace length; CW = Carapace width. Measurements in cm.

Date	No.	TL	CL	CW	Species[1]
23rd March	1	2.41	0.98	0.58	*P. longipes bispinosus*
	2	2.48	1.06	0.62	*P. penicillatus*
24th March	3	2.39	0.99	0.55	*P. longipes bispinosus*
25th March	4	2.75	1.06	0.63	*P. penicillatus*
	5	2.33	0.98	0.51	*P. longipes bispinosus*
	6	2.28	1.04	0.52	*P. longipes bispinosus*
	7	2.33	0.99	0.52	*P. longipes bispinosus*
3rd April	8	2.56	1.03	0.58	*P. penicillatus*
	9	2.66	1.04	0.57	*P. penicillatus*
	10	2.70	1.07	0.60	*P. penicillatus*
	11	2.80	1.08	0.54	*P. penicillatus*
19th April	12	2.60	1.03	0.62	*P. longipes bispinosus*
24th April	13	2.43	1.00	0.59	*P. penicillatus*
25th March	*A*	*4.49*	*2.06*	*2.96*	*Parribacus scarlatinus*

1 According to Michel (1971) except for *Parribacus scarlatinus* (Holthuis, 1991)

Table 2. Average measurements (and standard deviation in italics) of *Panulirus longipes bispinosus* and *P. penicillatus* from Uvea (in bold) and Michel (1971). TL = Total length; CL = Carapace length; CW = Carapace width. Measurements in cm.

***Panulirus* spp.**	**TL**		**CL**		**CW**	
P. longipes bispinosus	**2.39**	2.49	**1.00**	0.88	**0.55**	0.60
	1.17	*0.39*	***0.03***	*0.21*	***0.04***	*0.21*
P. penicillatus	**2.63**	2.90	**1.05**	1.19	**0.60**	0.70
	1.39	*0.34*	***0.03***	*0.29*	***0.04***	*0.24*

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Occurrence of the Prickly Deep-Sea Lobster, *Acanthacaris tenuimana* from Seas off Sri Lanka

From: P. A. A. T. Jayawardane and D.S. Jayakody

In the Western Indian Ocean, lobsters are represented by 5 families and about 47 species, although only a few are of interest to fisheries at the present time (Fischer & Bianchi 1984). Most spiny and slipper lobsters occur in fairly shallow waters, often on rocky bottoms or bottoms with coarse sediments, whereas most Nephropids are found in deeper waters on muddy bottoms (Fischer & Bianchi 1984).

The Prickly deep-sea lobster, *Acanthacaris tenuimana* (Bate, 1888) is a rather large lobster belonging to the Nephropidae. It lives in burrows on soft bottoms at depths between 850 and 1,670 m (Fischer & Bianchi 1984) and although it is not presently targeted by fishermen, it is taken incidentally in deep-water trawls (Fischer & Bianchi 1984). Within the Western Indian Ocean it has been previously recorded from Natal (South Africa) and off the Laccadive Islands near the west coast of India. It also occurs in the South China Sea and in the waters off Indonesia. A Caribbean species (*A. caeca*) has been caught in sizable quantities during exploratory deep-trawling operations with oversized bottom trawls (Fischer & Bianchi 1984). The present specimen was recorded from the seas off the west coast of Sri Lanka on 19th October 2001. This specimen, accidentally caught in a dogfish shark long-line deployed at a depth of around 600 m, was a male 13.7 cm in carapace length.

The specimen is pink in color. Body is cylindrical and completely covered with small spines and sharp tubercles. Carapace has a well developed median rostrum. Eyes are very small and lack pigment. Antennae are long and whip like and antennal scales are well developed. Tail powerful with a well developed fan. First three pairs of legs ending in true pincers. First pair of legs equal length, very slender, longer than body, covered with sharp spinules and ending in elongate and slender pincers (more than ten times longer than high). Second pair of legs very much longer and less spiny than third pair.

Figure. Male *Acanthacaris tenuimana* collected from the west coast of Sri Lanka in October 2001.

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Chemosensory communication in *Jasus edwardsii*

From: Natalie Raethke

Extensive research into the biology of the red rock lobster *J. edwardsii* has shown the gregariousness of this species. One to two years after the pueruli settle on inshore reefs the juveniles start sharing shelters, and by the time they are adults up to 100 or more can be found in a single den.

Recent experiments confirmed that rock lobsters are attracted by conspecifics, especially by their body odour (e.g., Butler et al. 1999). It is this odour that I am interested in and I am investigating the role of chemosensory communication between individuals to see how, when and why rock lobsters release chemical signals and how they detect them. Urine-borne chemical signals, or pheromones, play an important role in the social life of many crustaceans (Dunham 1978, 1988). Research mainly during the 1990s on *Homarus americanus* (e.g., Breithaupt & Atema 1993) and on Brachyura (e.g., Fontaine et al. 1989) has shown that these animals release pheromones with the urine. This seems to be quite odd at first glance, but it is indeed a perfect strategy. The urine is released through a pair of nephropores on the ventral bases of the antennae. The urine moves forward in the anteriorly directed gill currents which emerge just below the antennal bases. These currents are produced by large gill bailers constantly pulsating inside the gill cavity to support the animal's breathing. Carried by the currents, the urine, and with it the pheromones, may reach a nearby lobster which can then detect the signals with the help of chemoreceptors on its antennules.

The body of a rock lobster is organised in much the same way as a clawed lobster, so that it is very likely that they use similar mechanisms to communicate. With several experiments I have now confirmed that the two most common New Zealand rock lobster species, *J. edwardsii* and *Sagmariasus* (formally *Jasus*) *verreauxi*, do indeed release pheromones with their urine. Both species proved capable of distinguishing the sex of conspecifics just by their urine, without having access to any other cues.

To work exclusively with the urine, the lobsters have to be catheterised. Following a procedure described by Lindstrom (1991), pieces of PVC tubing are glued over the lobster's nephropores (see figure) which allows me not only to determine how much urine a lobster actually produces, but also to direct solely the urine to shelters in a test tank without providing visual or auditory cues to the test animals.

Further, the signals seem to be ontogenetically different. During the reproductive season in autumn, mature postmoult female *J. edwardsii* are particularly interested in cohabiting with mature males. Having been given the choice between urine from the same biomass of mature females or immature males, the mature female test animals were attracted to both to the same extent but avoided shelters without lobster cues. So, it seems likely that immature animals already produce important chemical signals for cohabitation. Having the choice between mature and immature males, the majority of the female test animals chose the adult males. This indicates that the mature males apparently produce one or more pheromones different from immature males to signal that they are in a reproductive state.

Also, shelter choice experiments with juvenile *J. edwardsii* turned out to be very interesting since the different size classes seemed to prefer different-sized conspecifics. All test animals had the choice between shelters that had previously been occupied by juveniles of the same size group, or by small mature females, or which had been soaked in plain seawater without any lobster cues. While the majority of small juveniles of 20-30 mm CL clearly chose the shelters with the cues of juvenile conspecifics, larger juveniles of 40-50 mm CL were generally attracted to shelters with lobster cues regardless of the size of the occupying animals. These results could be explained by the lobsters' different defence strategies against predators: while the best defence for very young juveniles is their small body size, larger animals are better off in groups and the larger the animals are the better they can defend themselves (Butler et al. 1999). The fact that the larger juveniles were attracted to the juvenile conspecifics as much as they were to the mature animals might signal a shift in sociality. Indeed, mixed groups of large juvenile and adult *J. edwardsii* are commonly found in the field.

Figure. Catheterised *Jasus edwardsii*

I am now further investigating how important chemosensory communication is for *J. edwardsii* during shelter occupation throughout the year and particularly for courtship behaviour and reproductive success during the short autumn mating season.

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New England lobster settlement index: update 2001

From: Richard Wahle, Lewis Incze, Robert Steneck and Robert Glenn

The New England lobster settlement index is a sampling program supported by Maine, Rhode Island, and Massachusetts to evaluate the strength of lobster year classes as they first arrive by larval settlement in shallow nearshore nurseries. The aim is to use this information in stock assessment and forecasting trends in the fishery. Surveys are conducted by diver-based suction sampling in nearshore cobble-boulder nurseries at the end of the settlement season – late August in southern New England to early October to the north. Because earlier experiments demonstrated that densities of young-of-year lobsters at this time correlate strongly with postlarval supply, they are taken as an index of settlement (Wahle & Incze 1997, Incze et al. 1997).

With sampling now conducted at some 58 sites from Jonesport, Maine to Point Judith, Rhode Island (Fig. 1), the past two years represent the largest sampling effort since the time series' early beginnings, first along Maine's midcoast and Rhode Island in 1989 and 1990, respectively (Incze et al. 1997). In the mid-90's the program expanded to Massachusetts and Maine's Mt. Desert region; then most recently, to the remainder of Maine's seven lobster fishing zones. Over the years the survey has been variously supported by Sea Grant, the National Science Foundation, the lobster industry, and the respective state marine resource agencies. Year-2001 is the first year the program has been mostly state and industry supported. New York is making moves to begin sampling Long Island Sound in the near future.

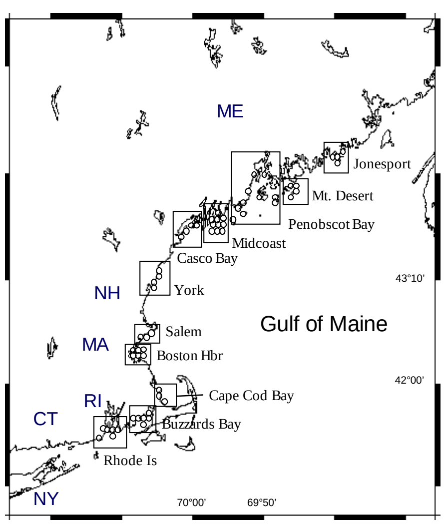

Figure 1. Sampling sites for the New England lobster settlement index. Boxes surround sites used for regional averages shown in Figure 2.

The expanded sampling along New England's coast over the past two years gives the best picture of the spatial pattern of settlement available to date (Fig. 2). Over the years settlement, juvenile densities, and landings per unit area have consistently been higher in regions to the west and south of Penobscot Bay (Steneck & Wilson 2001). In 2001 an intense burst of settlement was recorded along Maine's midcoast, just west of Penobscot Bay. More modest increases were seen within Penobscot Bay itself and south of Maine's midcoast.

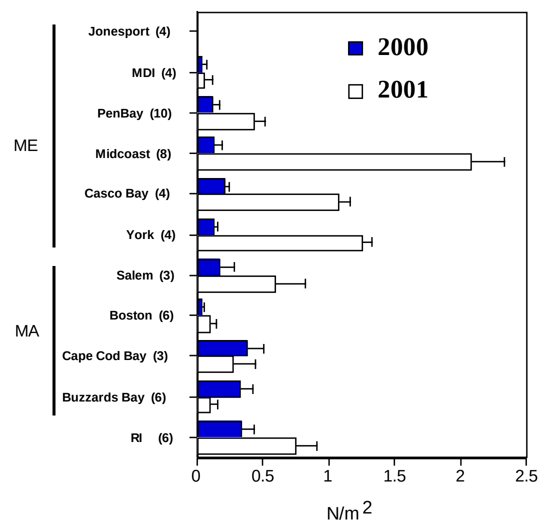

Figure 2. Regional average lobster settlement throughout New England in 2000 and 2001. In parentheses, the number of sites included in the regional mean.

The longer time series in midcoast Maine and Rhode Island puts recent years in perspective. Settlement along the midcoast in 2001 was the highest in its 13-year history, reversing what was becoming an increasingly worrisome downward trend for the region (Fig. 3). In Rhode Island settlement was also up, but not as much, and over the entire time series there has been less of a downward trend (Fig. 3). Despite the oceanographic differences between these two regions, strong settlement years in midcoast Maine have also tended to be strong years in Rhode Island. This regional coherence suggests a larger scale oceanic/atmospheric process driving annual settlement trends.

From these longer time series we have been able to demonstrate that settlement strength translates to year-class strength at least in the early years of benthic life (Incze et al. 1997, 2000). The extent to which recent fluctuations in settlement determine subsequent harvests, some 5-9 years later, will depend on whether ecological factors operating in the later years disrupt the linkage. Because lobsters of different ages overlap in size, annual fluctuations in settlement tend to be smoothed by the time lobsters recruit to the fishery. However, the stretch of poor settlement from 1995-2000 was long enough that a decline in landings west of Penobscot Bay seems likely in the near future (Wahle et al. 2000). Signs of an impending decline in that region have been corroborated by an independent time series of pelagic post-larval abundance off the New Hampshire coast (Normandeau Assoc., Inc. unpublished), and diver surveys of older juveniles at a number of stations along the Maine coast (Steneck unpublished). Any positive effect of the exceptional settlement of 2001 may be weak if poor settlement resumes in subsequent years. The best test of the predictive value of the settlement index will be to compare our projections to landings and other indices of mature lobster abundance in coming years. Indeed, this will be a telling decade for the utility of the New England lobster settlement index as a forecasting tool.

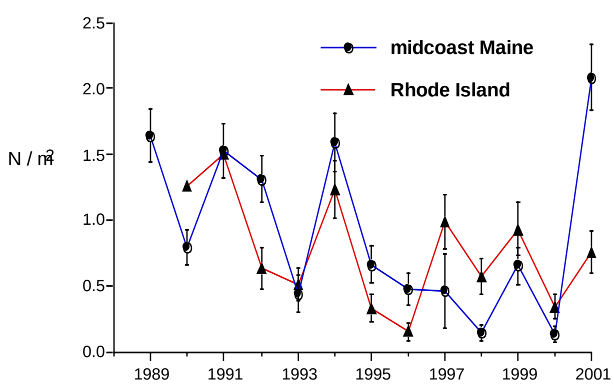

Figure 3. Lobster settlement index for Maine and Rhode Island, the longest settlement time series available for the species.

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Behaviour of *Jasus edwardsii* reared in captivity

From: Megan Oliver, Rob Stewart, Alison MacDiarmid, Caleb Gardner &Dave Mills

A collaborative study between New Zealand and Australia is looking at the viability of small-scale rock lobster enhancement. The direct enhancement of rock lobsters may take one of two approaches; translocation of pueruli or juveniles from one area of the coast to another, or the outplanting of juveniles that have been reared to a larger size in captivity. The survival of transplanted pueruli is expected to be very low, so a greater reward may be gained from ongrowing wild-caught pueruli to a larger size before releasing them. However, ongrowing them to a size at which they are less vulnerable to predation (30-35 mm CL) can take up to a year, and behavioural changes can occur during this time in captivity. A joint New Zealand and Australian study, funded by the Fisheries Research and Development Corporation of Australia, is looking at these behavioural changes and how they might affect survival when the lobsters are released into the wild. Predation of hatchery-reared animals soon after their release into the wild can be a significant source of mortality in both fish and invertebrates. The act of release disturbs and agitates the individuals, which might make them more susceptible to predation, but also they might emerge from the shelter at inappropriate times, they might not recognise potential predators, and they might fail to defend themselves.

We compared the behaviour of 1-year-old lobsters reared in captivity to similar-sized wild lobsters by using remote infrared video cameras to film them in the aquarium and in the wild. Juvenile lobsters reared in captivity, without predators, were more active during daylight, often leaving the den to eat or wander about the tank (Figure 1). In contrast, wild juvenile lobsters stayed well hidden in the den and did not leave the shelter until several hours after sunset (Figure 2).

We then reared some of the lobsters in tanks for almost a year with a nasty fish predator, namely blue cod. Lobsters reared with a predator showed the same nocturnal behaviour as wild lobsters, preferring to remain hidden in the den during daylight when the predator was most active. In contrast, lobsters raised without a predator were very active during the day.

So, periods in captivity can produce behavioural changes that could be fatal in the wild. Armed with this knowledge, we then released some captive-reared juveniles onto a coastal reef and observed their behaviour with remote infrared video cameras. Although the lobsters took several minutes to orient in their new environment, they knew exactly what to do when faced with the gaping jaw and steely gaze of a predatory fish! The defensive waving of the antennae and characteristic tail-flipping backwards to evade a predator came naturally to them. Most of the animals disappeared off camera after several hours so it was difficult to determine mortality rates. But we didn't see any signs of mortality, which suggests that the lobsters were able to adequately defend themselves, despite never having encountered a predator before.

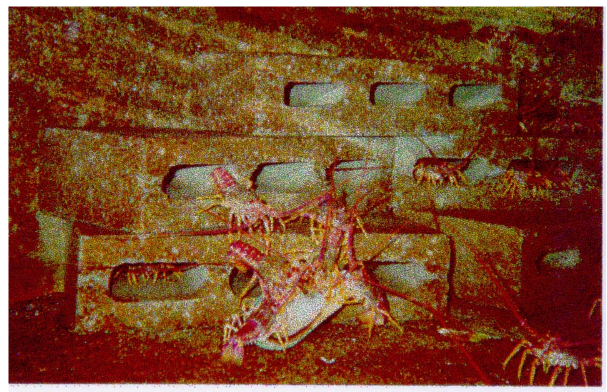

Figure 1. Lobsters raised in a typical hatchery situation without a predator become very bold and frequently leave the den during the day to eat or roam around the tank. This behaviour in the wild would expose the juveniles to a range of hungry predators they had never encountered. Would they survive?

Figure 2. Evil predator, aka blue cod. We chose medium-sized blue cod to play the heavies because that's the size of predator the juvenile lobsters would encounter on reefs. Blue cod also sleep well at night, which gives the lobsters a chance to go walk-about and forage for food.

Releasing numerous juvenile lobsters on to the coastal reefs of New Zealand or south Australia would only be viable if survival was high. Although juvenile lobsters seem to become tame and naïve about predators in captivity, they can still recognise a potential predator and show defense or escape responses when released into the wild. These hard-wired, innate responses mean it would be unnecessary to rear lobsters intended for outplanting with a predator. However, the release site and time of release are important. Depending on the number and type of fish present at the intended release site, it might be better to release the lobsters at night, or in winter when the predators are less active.

Our next step is to carefully choose several sites for the large-scale release of juvenile lobsters in both New Zealand and Tasmania. Then we can compare their survival rates in different habitats and weigh up not only what habitat is best for survival, but whether the bulk release of lobsters into the wild will restore or increase production of that coastal habitat.

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LETTERS TO THE EDITORS

Dear Editors

I have been contacted by a fisherman who wants to build a new potting vessel that reduces his crew size and efficiency by shipping pots directly onboard while hauling his lines. He currently uses a "traditional" hydraulic hauler that pulls the main line but the pots themselves have to be lifted aboard by hand. Does anyone know of a device that brings the pots onboard automatically?

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Dear Editors

I thought you would be amused by this. It is the cover of a menu of the New Campus, a seafood restaurant in New York City, for 1946. The times were different then - rationing was still on (no bread served with meals on Tuesdays, Wednesdays or Thursdays), and the prices were somewhat less: Boiled or broiled lobster, $1.50 and up, BLT for $0.45, pitcher of beer, $0.55. And you could get a caviar sandwich for $1.00.

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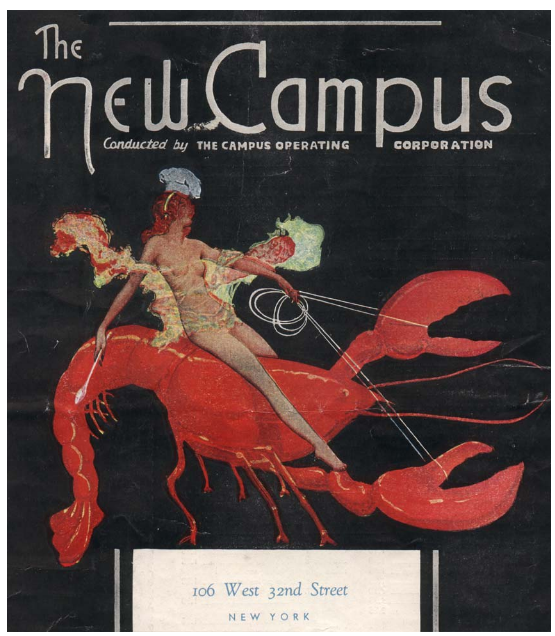

FISHERIES & AQUACULTURE UPDATE

Feeding strategies for rock lobster aquaculture

From: Craig Thomas, Chris Carter and Bradley Crear

The availability of formulated feed and the development of cost-effective feeding strategies are essential for the emerging southern rock lobster farming industry. In the absence of specific formulated feeds for lobsters, recent studies conducted at the Tasmanian Aquaculture and Fisheries Institute (TAFI) in Tasmania have shown potential for the use of formulated feeds used in the prawn farming industry. While the growth and survival of lobsters fed these feeds have been promising, the performance of mussel-fed (*Mytilus edulis*) lobsters has been consistently superior. The reduced growth of lobsters fed formulated feeds may be due, in part, to leaching of dietary components which occurs when formulated feeds are exposed to water, and more frequent feeding may mitigate the problem.

The development of efficient feeding strategies for lobsters will also require information on the effects of various feeding strategies on production. While the communal rearing of some crustacean species frequently leads to formation of social hierarchies, cannibalism and growth heterogeneity, no studies have examined how variations in feed availability affect production. In contrast, several studies on fish species have shown that the feeding strategy plays an important role in reducing aggression and production inefficiencies.

The aims of this study were determine if more frequent feeding of prawn-formulated feeds would improve growth of southern rock lobsters *Jasus edwardsii* and secondly, to evaluate how variations in feed availability influenced growth and survival (Thomas et al., in press).

Materials and methods A total of 252 tagged lobsters were graded and stocked into 28 black 52-L tanks at a density of 9 per tank (equivalent to 42 individuals per m^2). The trials were conducted in a recirculating system maintained at 18.8°C for a period of 119 days. Lobsters were fed at one of two rations, high or low, and at three different frequencies: 1 d^{-1} (L1 and H1), 2 d^{-1} (L2 and H2) or 4 d^{-1} (L4 and H4). When there was more than one meal per day, the ration was evenly divided between meals. The rations and feed times aimed to provide a range of feeding opportunities. Increasing the feeding frequency of a high ration was expected to increase feeding opportunities, thereby minimising competition. Increasing the feeding frequency of a low ration was expected to encourage competition by decreasing the opportunity for lobsters to feed simultaneously. In addition, one group of lobsters was fed fresh mussels 1 d^{-1}, at 1700 h. This enabled a comparison of the various feeding strategies to an industry standard.

Results and discussion For high ration levels, neither feed intake (FI) nor growth increased significantly when lobsters were fed 2 or 4 meals d^{-1} (FI = 1.7 and 2.0% BW.d^{-1}) compared to 1 meal d^{-1} (FI = 1.7% BW.d^{-1}). Furthermore, higher biomass yields were produced from feeding fresh mussels daily due to the combined effects of improved (albeit non-significant) growth and survival (Figure). Behavioural observations indicated feeding was primarily a nocturnal activity stimulated by the change from light to dark. These findings indicate there are no benefits, in terms of growth, survival or feed intake, of multiple daily feeding. The improved production of lobsters fed fresh mussels confirmed the nutritional superiority of mussels and indicated that formulated feeds lack essential nutrients for maximum growth. This highlights the need to further our understanding of the nutritional requirements of lobsters to aid the development of specific formulated feeds.

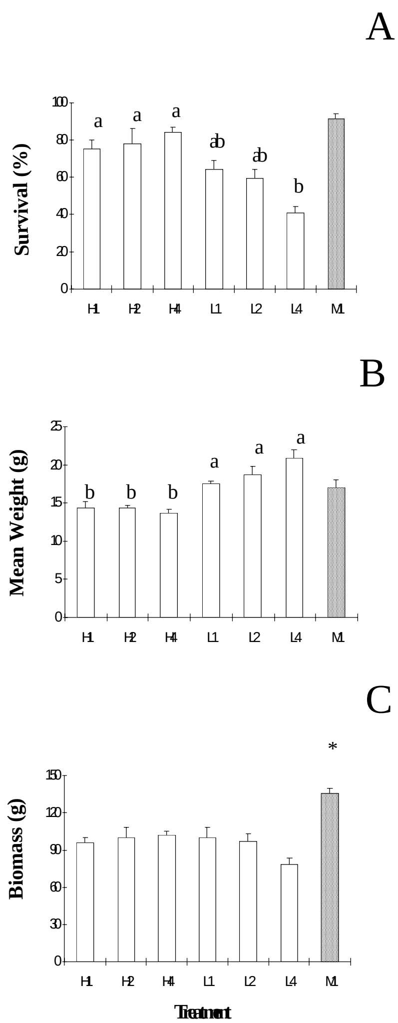

Figure. Survival (A), final mean weight (B), and biomass (C) (mean ± SE; n= 4) of juvenile *J. edwardsii* fed either a high or low ration of a commercial prawn diet for 119 d at feed frequencies of 1, 2 or 4 d^{-1}. A control group was fed fresh opened mussels (*M. edulis*) to satiation 1 d^{-1}. Means that were significantly different ($P<0.05$) have different superscripts;* indicates mussel treatment significantly different to best performing high ration treatment (from Thomas et al. in press)..

Most mortality (92%) was associated with cannibalism of soft-shelled, post-moult lobsters, with small lobsters being more vulnerable than large lobsters. Increasing the frequency of feeding tended to increase survival in high rations but decreased survival in low rations, suggesting that cannibalism was related, in part, to feed availability (Figure). Low ration lobsters grew faster than high ration lobsters, possibly due to the increased nutrient uptake from cannibalism. The carapace of low ration lobsters was dark red coloured while high ration lobsters were pink. Previous trials at TAFI have shown that the carapace colour is directly related to the carotenoid levels contained within feeds where reduced pigmentation is indicative of low dietary carotenoid. Carotenoid pigments are also contained in significant quantities in the carapace, eyes, blood and midgut gland of lobsters (Meyers and Latscha 1997). Cannibalism, and the subsequent intake of carotenoids, appears a likely reason for differences in carapace colouration.

The implications of the above findings have enabled criteria to be established for feed management practices of the juvenile rocks lobsters maintained at TAFI. Lobsters are fed once per day to slight excess just prior to “lights off”. The ration is fed to slight excess with ration level based on the previous evening’s intake. Further, recent studies have shown that when formulated feeds are supplemented with fresh mussels once or twice a week, the growth of lobsters is equivalent to the growth of lobsters fed solely on fresh mussels. Therefore, fresh mussels are incorporated into the feeding regime twice a week. Husbandry practices of stocks also involve the provision of shelters for refuge, grading, maintaining optimum stocking densities dependent on size, and regular cleaning of tanks. Clearly further information on the nutritional requirements of lobsters is needed to enable the correct formulation of diets. This is being addressed through the Fisheries Research and Development

Corporation Rock Lobster Enhancement and Aquaculture Sub-program (RLEAS). The research program is led by Kevin Williams at CSIRO in Queensland, with TAFI researchers at the Marine Research Laboratories in Hobart and at the School of Aquaculture in Launceston.

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Enhancing rock lobster survival

From: John Booth, Jeff Forman and Andrew Jeffs

In a study in New Zealand we are attempting to increase the survival of settling and recently settled lobsters (*Jasus edwardsii*), and so enhance the abundance of young ones (up to age two) on reefs, by installing appropriately-scaled, removable, artificial shelters. In areas of high puerulus settlement, such as along the southeast coast of the North Island, there is evidence for high mortality at and soon after settlement which may come about through insufficient suitable shelter. The lack of shelter is thought to lead to high levels of predation.

At the same time we are addressing other important issues in postlarval recruitment, such as a) if there is a bottleneck in lobster survival, is it most marked at settlement, soon after settlement during the asocial phase, or once the young lobsters become communal at about one year of age? b) is juvenile lobster survival also limited by food? c) to what extent is juvenile survival and growth density dependent?

There is growing interest worldwide in enhancement of rock lobsters, as evidenced by the increasing numbers of papers dealing with this issue presented at the International Lobster Workshops. Most if not all lobster stocks are fully exploited and enhancement is one of only a few ways to increase production.

We are conducting our study at Omanuka Bay (Figure 1), an hour's drive north of Gisborne on the east coast of the North Island. There is a 4-6 m deep, 300 m long lagoon protected by an offshore reef, with an intricate surrounding reef structure including isolated reefs. Rock lobsters of all sizes – pueruli to large mature individuals – live throughout the reefs. We have developed a strong working relationship with people from the nearby Hinetamatea Marae (a marae is the meeting house for the local Maori; Figure 2), who help us with installations and monitoring.

We are using natural reefs, each with more or less defined borders - where possible, open tracts of sand. Some of these reefs are treatment ones, others control. But because no two natural reefs are exactly the same, 12 identical, small artificial reefs have been built in the lagoon (but after the aerial photo was taken so you cannot see them), and again some are treatment and the others control. Each artificial reef is about 1.8 m square and made up of 75 holed bricks.

Open sand and shell ground between many of the reefs reduces or eliminates any immigration and emigration; available evidence is that settled pueruli and young juveniles do not move far, especially not onto open seafloor beyond the reefs.

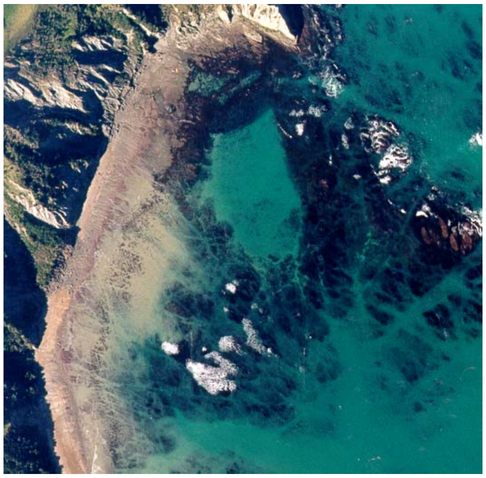

Figure 1. Omanuka Bay lagoon and reef system

The treatment natural reefs have set on them *koura* (rock lobster in Maori) *kainga* (village) – steel frames that support a single standard crevice collector (Booth & Tarring 1986) plus 12 holed bricks, all components being well conditioned – at a density of about one per 10 m^2 of reef surface. The control natural reefs have nothing added.

Figure 2. Hinetamatea Marae

The six treatment artificial reefs have on them standard, conditioned crevice collectors. The six control reefs have nothing added.

This project was set up during 2001, and we are now ready for the start of the 2002 settlement season in about April. We will monitor without disturbance lobster abundance and size on the natural and the artificial reefs at least every two months. We will also record the presence of potential predators (counts of cryptic species present on each reef, and rapid visual estimates from a distance of the abundance of other potential predators). The puerulus collectors associated with the treatments will be cleared every three months of any growth choking the crevices. The final census is expected to take place in mid 2003. The null hypothesis is that there will be no difference in the mean abundance by age group of rock lobsters present on the control and treatment reefs.

Depending on the results from the pilot year, we hope to expand the experiment by testing various shelter designs and by addressing some of the other postlarval recruitment issues mentioned above.

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Japanese Society of Fisheries Science meeting

From: Jiro Kittaka

The 2002 meeting of the Japanese Society of Fisheries Science was held at Kinki University in Nara during 1-5 April. Nara was the capital of Japan for a couple of centuries, before nearby Kyoto took its place. The society was established in 1932 and has about 4500 members of which 1200 attended the April meeting. There were 748 oral presentations, 69 posters, and 10 symposia.

Here is a list of some of the topics covered. For further detail, visit the JSFS website (wwwsoc.nii.ac.jp/jsfs/index.html).

1. Fisheries: gear, methods, grounds, resources, fisheries in relation to the oceanography, acoustics.
2. Biology: classification, morphology, physiology, ecology, nekton, benthos, plankton, macroalgae
3. Aquaculture: food, seed, nutrition, grow-out, disease, genetics, breeding, immunity
4. Environments: eutrophication, microorganisms, pollution, toxic uptake, toxic plankton
5. Chemistry and biochemistry: protein, enzyme, nucleic acid, lipids, saccharides, extracts, pigments, vitamins, active substances
6. Utilisation and processing: processing, preservation, hygiene, micro-organisms

There were 23 papers on decapods: 3 on the ecology of non-commercial crabs; 2 on the reproductive ecology of snow crabs; 2 on the aquaculture and management of king crabs; and 10 on the maturation, food, and immunity in penaeid shrimps. The remainder concerned spiny lobsters.

1. Complete development of *Panulirus penicillatus*, by K. Matsuda (fishmie@lilac.ocn.ne.jp) and T. Takenouchi, Fisheries Research Institute of Mie. Ten pueruli were cultured from hatching, taking 256-294 days. One individual molted to the juvenile.

2. Studies on spiny lobster resources in Boso Peninsula, by H. Idetsuki and K. Mizuguchi (kenya@tokyo-u-fish.ac.jp), Tokyo University of Fisheries. Most of the *Panulirus japonicus* catch in August and September is of lobsters that have been settled two years. The level of catch of these lobsters is correlated with the distance from Cape Inubo to the axis of the Kuroshio Current between July and September, when settlement takes place; the shorter the distance the higher the settlement.

3. Settlement of pueruli and early juveniles, by N. Takizawa and K. Mizuguchi, Tokyo University of Fisheries. Shizuoka Prefecture-type collectors used for *Panulirus japonicus* were placed at several stations near Kominato and pueruli and juveniles collected from them almost daily. Monthly totals were highest in August (97 pueruli and 25 juveniles on 13 collectors). Highest catches were when tides were between mid-range and spring, just before new moon.

4. Growth of juvenile spiny lobsters after settlement, by N. Takizawa and K. Mizuguchi, Tokyo University of Fisheries. Pueruli collected from the wild were reared in a small cage near the collecting site, using mussels, baby necked clams and euphausiids as food. Water temperature ranged between 27.2°C (July) and 12.0°C (January). One individual molted 8 times and grew

from 7.9 mm carapace length in July to 21.5 mm in January.

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NEWS RELEASES

Jasus (*Sagmariasus*) *verreauxi* has a name change

From: John Booth, Rick Webber, Jiro Kittaka and Jenny Ovenden

Recently it was proposed (Booth & Webber 2001) that the spiny (rock) lobster *Jasus* (*Sagmariasus*) *verreauxi* (H. Milne Edwards, 1851) be placed in a separate genus, *Sagmariasus* because it differs markedly from all *Jasus* spp. Holthuis (1991) erected the subgenus *Sagmariasus*, reflecting the unique characters of adult *J.* (*S.*) *verreauxi* compared with *Jasus* (*Jasus*) spp. He derived the name from the Greek word Sagmarion, meaning packhorse, in reference to the bulging branchial regions of the carapace in large individuals.

Compared with *Jasus* spp., adult *Sagmariasus verreauxi* have a stronger rostrum, stouter antennules, lack abdominal sculpturing, and as juveniles are distinctly green rather than red, becoming orange-yellow when large. *S. verreauxi* is also genetically very distinct (Ovenden et al. 1997) and it breeds during spring/summer, not winter/spring as *Jasus* spp. do. The larvae of *S. verreauxi* have an exopod on the fifth pereopod, and also, usually, one on the third maxilliped, both absent in *Jasus* spp. These and numerous other biological and behavioural differences support the raising of *Sagmariasus* to generic level, so creating the only palinurid genus that is monotypic in terms of extant species.

The *Jasus* spp., among themselves, differ far less in these characters. Furthermore, in separate cluster analyses of 19 larval characters, and 17 adult and larval characters, *S. verreauxi* and *Jasus* spp. were separated by Euclidean distances similar to or greater than those that separate several palinurid and scyllarid genera (Baisre 1994). In a cluster analysis of reproductive and early life history characters exhibited by a selection of spiny lobsters, *S. verreauxi* was closer to *Panulirus* spp. than to *Jasus* spp. (Cobb et al. 1997), having larger broods, smaller eggs, a shorter incubation period, and a shorter larval life.

Although it is unusual to treat such a recombination as a separate issue, *S. verreauxi* is of particular significance biologically, commercially and culturally. A short manuscript has therefore been submitted to *Marine and Freshwater Research* detailing these differences, and the way in which *Jasus* spp. vary among themselves in these characters. What was previously known as *Jasus verreauxi*, then *Jasus (Sagmariasus) verreauxi*, should, we believe, be referred to as *Sagmariasus verreauxi* (H. Milne Edwards 1851). The similarity of the fossil species *Jasus flemingi* Glaessner, 1960 to *S. verreauxi* implies that it should also be referred to *Sagmariasus*, giving *S. flemingi* (Glaessner, 1960).

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Updated website reports genetic diversity in the European lobster

http://www.qub.ac.uk/bb/prodohl/gel/gel.html has recently been updated and reports on the results of the EC-funded project GEL: 'Genetic diversity in the European lobster (*Homarus americanus*): population structure and impacts of stock enhancement'. This is probably one of the largest genetic surveys ever done for any marine species and the results will be of wide interest to everyone working on lobsters.

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The Lobster Newsletter is published twice yearly.

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