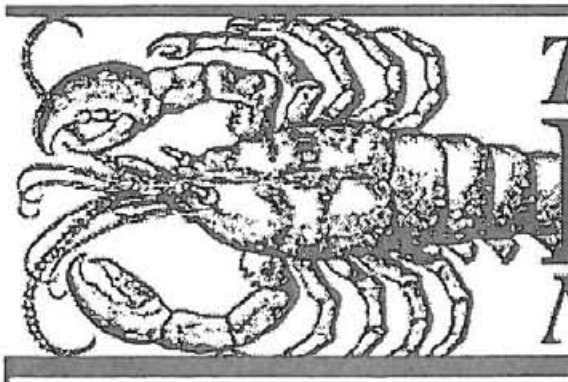
VOLUME TEN OCTOBER 1997 NUMBER ONE



The Lobster NEWSLETTER

EDITORIAL
Two Editors Quit!

Two of your Newsletter editors, Stan Cobb and John Pringle, are ending their duties with this issue. John Booth will continue and two new editors, Mark Butler and Peter Lawton, come on board. Below are letters from departing and arriving editors.

It has been a real pleasure to serve as editors for *The Lobster Newsletter*, and in many ways we are sorry to let go our commitment to it. We have greatly enjoyed being involved with the development and maturation of the Newsletter from the time of the initial suggestion by Jim Stewart at the 1985 Lobster Workshop in St. Andrews, Canada and the first issue in 1988. Now, 12 years and 9 volumes later, we are simultaneously eager to turn our attention to other things and reluctant to leave our editorial roles.

The response of the lobster community to the Newsletter has been very positive, and extremely rewarding. One of the best parts of the job has been communicating with you, whether for the purposes of cajoling an article from you, or simply welcoming you to the mailing list. We always were impressed by the ease of gathering articles for each issue, and the readiness with which correspondents sent interesting tidbits of information, clippings, or amusing anecdotes. These indicated a real commitment by all of you to a high-quality newsletter and made our job not only easy, but fun. However, we feel that it is time for change. *The Lobster Newsletter* will benefit from the new views and voices the new editors will bring.

The *Lobster Newsletter* is an expression of, and one mechanism to assist, the growing sense of community among lobster biologists, managers and fishers around the world. Thank you all for making *The Lobster Newsletter* a strong and interesting voice of the community! We look forward to our future roles as readers and contributors to *The Lobster Newsletter*, and wish new editors Mark Butler and Peter Lawton well as they join John Booth on the masthead of the Newsletter.

Stan Cobb
John Pringle

Trepidation over "filling big shoes" is cliché, but apropos. Stan Cobb and John Pringle have, for the past decade, provided an invaluable and under-appreciated service to the community of lobster biologists, managers, and fishers. *The Lobster Newsletter* filled a void. From its inception, the Newsletter became a primary, yet informal means of communicating important late-breaking news - or just interesting anecdotes. We've come to look forward to its arrival in the mail.

Its easy to forget that the Newsletter's lifeblood (haemolymph?) are its editors. Sitting here late at night in Stan Cobb's home amidst a

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EDITORIAL

pile of half-edited articles while listening to Stan recount the details of preparing, printing, and distributing the Newsletter, adds a new perspective and appreciation for the time that Stan and John have put into the past eighteen issues. Our collective and most sincere "thank you" goes out to Stan Cobb and John Pringle for initiating, producing, and funding *The Lobster Newsletter*. John Booth isn't yet off the hook, so we'll save his accolades for later.

We also would like to take this opportunity to mention a few issues affecting the Newsletter. First, we are establishing a world wide web site for *The Lobster Newsletter*. Details will be forthcoming in the next issue of the Newsletter. We hope that many of you will choose to access the web site in lieu of the regular mailing, so we may reap some savings in our production and mailing costs. The printed Newsletter is here to stay, but it is costly to produce since there is no subscription fee.

We are very grateful to The Canadian Department of Fisheries and Oceans and Rhode Island Sea Grant who have sponsored *The Lobster Newsletter* all these years. Those funding sources are unlikely to continue, however, so we are searching for new sources of funds to help cover the cost of producing and mailing the Newsletter. We are pleased to acknowledge one new sponsor, The Florida Department of Environmental Protection, whose sponsorship is orchestrated by John Hunt. We need additional sponsors and welcome institutional offers of financial support.

As we look forward to collaborating with John Booth on upcoming issues of *The Lobster Newsletter*, we will be counting on your continued support. Keep those articles, graphics, and interesting lobster tidbits coming! Thanks again, Stan and John.

Mark Butler
Peter Lawton

RECENT EVENTS

Fifth International Lobster Meeting - New Zealand

From: John Booth

The special lecture *Twenty years of international lobster workshops: communication and collaboration* by Stan Cobb and Bruce Phillips on the first morning provided compelling evidence for the value of this series of international lobster meetings. The *Fifth International Conference and Workshop on Lobster Biology and Management*, held in Queenstown, New Zealand from 9 to 14 February, came after ones in Australia, Canada, Cuba, and Japan. Cobb and Phillips showed how these meetings have facilitated publication of results, set research directions, and contributed to the development of scientific principles. Many of the workshops during the Queenstown meeting, and the final plenary session, resulted in recommendations for future research directions; and so this meeting, like those before it, will have an impact on the course of lobster research internationally.

The meeting went well. There were 117 full, 15 student, and 25 accompanying person registrants, from 19 nations. There were just over 70 oral papers, 9 workshops, and 40 posters. Oral papers were presented in the mornings and workshops occupied most afternoons. The poster session was on the evening of the second day, and the plenary on the last afternoon drew together all parts of the meeting.

The meeting began on Sunday evening with a formal welcome and it ended with a farewell function the following Friday evening. Both were led by Ngai Tahu, the local Maori people. The days between were full with papers, workshops, and informal meetings. The exception was Thursday

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afternoon, when people did a range of local activities, from bungy jumps to bush walks. Participants remarked on the scientific and management perspectives gained, the cultural experience, and the opportunity to experience something of this part of the world.

Queenstown is a small town, set among mountains and lakes in the south of New Zealand, known for its spectacular scenery and range of outdoor activities. The meeting was held at the Lakeland Hotel on the shores of Lake Wakatipu and just a few minutes stroll from the heart of Queenstown.

A wide range of formal science papers dealt with topics as diverse as aquaculture and artisan fisheries; habitats and harvesting strategies; live transport and larval dispersion. All types of lobster from around the world were considered - spiny, clawed, and slipper. The oral papers were organized into benthic, stock assessment, physiology, biology, oceanic processes, behavior, aquaculture, and management sessions.
The prize for the best student paper went to Shane Kelly and the prize for best paper on a developing fishery to Ramasamy Mohan. The afternoon workshops were convened by experts in the field: Stan Cobb oceanic processes, Mike Childress marine reserves, John Annala management strategies, Mark Butler benthic processes, Ray Hilborn and Julian Addison stock assessment, Rufus Wells physiology and live transport, Bruce Phillips aquaculture, and Rick Wahle fishing consequences.

After refereeing, papers and workshop reports will be published in a dedicated but regular issue of Australia's *Marine and Freshwater Research*. Ann Grant, the journal editor, attended the meeting and was able to help many participants with their papers. Publication is to be early in 1998.

Meetings such as this enhance the opportunities for international collaboration, particularly in areas such as the development of stock assessment techniques, live handling procedures, aquaculture and on-growing opportunities, the development of techniques such as those to determine larval recruitment mechanisms, and other projects where sampling and/or processing costs are high.

The next International Lobster Meeting (organized by Mark Butler, William Herrnkind, John Hunt, and Scott Quackenbush) will be held in Key West, Florida in September 2000.

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Industry Working Paper No. 4 - Not Catching Lobster

From: Steve Hinge

At the opening of the poster session held during the Fifth International Conference and Workshop on Lobster Biology and Management, Steve Hinge, a lobster industry representative from South Australia, offered this oratory. It was well-received by all in attendance and we considered it "a must" for the Lobster Newsletter.

By way of background, I have been fishing commercially for two lobster species, *Jasus edwardsii* and *J. novaehollandiae* for over 20 years. Since we've fished the *J. novaehollandiae* to extinction, I've been finding fishing extremely tough. But I've just received great news from home in South Australia - the first of many similar announcements expected worldwide. My first check from the government has arrived for $1,000 for *not fishing for lobster* this week. This is part of an experiment where, instead of spending $2 million each year on fishery research in South Australia, the research program has been shut down and the fishermen are paid $1,000 per week to not catch lobster.

The experiment was designed based on the results of a world-wide scientist-independent model, which

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predicted that the total cost of lobster research world-wide was $180 million. This figure was extrapolated from the cost of the South Australian research program estimated at $1,000 / ton of lobsters. A stochastic model including all known independent variables, such as: the *prima donna* factor, witchcraft, displaced research effort, and serendipity was knocked together using the "world-industry-collective-consciousness" method. After numerous runs, it was concluded that if we shut down the complete world lobster research effort, we could pay every lobster fisherman, including those in Maine and India, $1,000 per week to not fish for lobster. In doing so, sufficient surplus profit has been made to give the whole lobster research community a 20% pay raise to not research lobster.

I was a bit suspicious about the experiment at first, but now that my first check has come, I'm really enjoying this not fishing for *J. edwardsii*. This morning, when my mind somehow drifted during Andre Punt's expose on population modeling in one of the scientific meeting sessions, I figured that there may be opportunity to expand my new not fishing for lobster business into not fishing for *Panulirus cygnus* or *Homarus americanus* as well. If I held myself down to these two species at first, I reckon that this would give me an extra $2,000 per week to not go lobster fishing and would take some of the pressure off fisheries world-wide.

My hardest work in the not fishing for lobster business is going to be counting the lobster that I don't catch. Accurate monitoring and recording of the no-catch and no-effort figures as my business expands will be important so that the research team can get on with not modeling and not doing the stock assessments. The biggest worry will be working out what to do with all the moribund scientists in their new roles of not researching lobster. They will be part of a new world-wide problem of excess research effort. I guess that at the next conference we will have new scientific session topics such as: "Session 1: Dealing with Displaced Research Effort - Is Offense the Best Defense?". After lunch, a session might be convened on "Aggregations of large male researchers" and at dinner a lecture titled "Nocturnal foraging and den behavior among scientists". I just hope the scientists don't turn to not fishing, seeking access rights and threatening the sustainability of our now not fished lobster resource.

Well, I had best get on with looking at a new industry that just emerged called not fishing for bait. It has tremendous potential for diversification for me now that I'm not fishing for lobster. I've also got to get my application in for three recreational pots so I can get a feed of lobster every now and then. Overall, the change should be good for those scientists and fishermen, who, chained by their attitudes, are slaves and have forfeited their freedom. Only persons who take risks are free and this global initiative by the fishing industry will set us all free.

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Puerulus workshop in Tasmania

From: S. Frusher

In mid-May 1996, the Southern Rock Lobster Research Group held a workshop in Hobart to consider results of ongoing studies of *Jasus edwardsii* puerulus settlement in Australia. There were also contributions on larval recruitment of *J. edwardsii* in New Zealand and updates on recruitment studies of the eastern rock lobster *J. verreauxi.* and for the western rock lobster *Panulirus cygnus.*

The southern rock lobster occurs in five southern Australian states, with major fish

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eries in South Australia, Tasmania, and Victoria. During the past five years these three states have each begun to monitor puerulus settlement with crevice collectors in order to better understand larval recruitment processes, provide early warning of over fishing, and, if possible, to predict trends in recruitment to the fishery. Jim Prescott presented results from South Australia, Stewart Frusher and Bob Kennedy results from Tasmania, Dave Hobday data from Victoria, and Chris Chubb results from Western Australia.

Although these studies are still in their infancy, similarities in settlement patterns have emerged. Seasonal settlement patterns exist at most sites, although the timing of peak settlement varies even among nearby sites on a shore. The cause of this seasonality in settlement remains unknown and participants at the workshop recognized that oceanographic influences on larvae were not the only possible cause; planktonic predators and food availability were other possible factors. Years of high settlement tend to cooccur even among sites on different seas. For example, peaks in settlement of *J. edwardsii* on the east coast of Tasmania and southeast South Australia occurred during the same years, and those peaks matched similar patterns in *P. cygnus* settlement in Western Australia. The interannual pattern did not, however, extend across the Tasman Sea to New Zealand. More data are required, but it is possible that settlement patterns in southern Australia are linked to El Nino-Southern Oscillation events, as they are in Western Australia. Some settlement of *J. edwardsii* occurs throughout the year and this is consistent with a larval period of at least 12 months. In contrast, *J. verreauxi.* and *P. cygnus.* have shorter and more defined settlement periods suggesting a larval period less than one year or the possibility that larvae can delay metamorphosis.

Although the spatial and temporal patterns of settlement on collectors among nearby sites is usually consistent, workshop participants recognized the importance of maintaining several sets of collectors at each site. Participants also agreed that: 1) collectors need to be conditioned for several months before they become fully effective, 2) the carrying capacity or saturation level of crevice collectors is seldom approached, and 3) there appears to be ongoing immigration and emigration of recently settled juveniles between the collector and the surrounding substrate.

Phyllosoma abundance offshore seems to be important in determining levels of puerulus settlement, at least off the east coast of New Zealand where this has been investigated. High settlement regions coincide with areas with high numbers of mid and late-stage phyllosomas in adjacent oceanic waters. Phyllosomas are widespread off the southeast North Island of New Zealand, with high numbers occurring up to 1400 km from shore. A CSIRO study by Barry Bruce and colleagues, which relies on phyllosomas obtained from archived plankton collections, may lead to a better understanding of phyllosoma distributions of *J. edwardsii* off southern Australia. In a related study, David Griffin is using satellite altimetry to examine currents and eddies off southern Australia that could keep phyllosomas nearshore. George Cresswell outlined oceanographic information in the area recently collected from drogued current meters that demonstrated both the existence of eddies capable of retaining larvae and also the potential for the mixing of larvae between east and west Tasmania.

No relationship has yet been established between puerulus settlement and recruitment to the fishery for *J. edwardsii*. Different rock types, and the amount of cover that each of these settlement substrates provides young juveniles, can bring about big differences in survival through density-dependent effects. The long interval between settlement and recruitment (longer than for *P. cygnus*), the disparity in age at recruitment for males and females, and interannual differences in juvenile growth all suggest that we may only

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be able to predict trends in recruitment. A fishery model for the Tasmanian rock lobster fishery presently being developed simulates past recruitment levels. Continued puerulus monitoring will allow real larval recruitment data to be structured into the model and so refine model outputs. But a much longer time series of settlement data is required before this is possible.

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RESEARCH NEWS

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How Large a Harem Can One Rock Lobster Handle?

From: I.D. Gibson and S. Frusher

In waters deeper than 40 m off southern Tasmania, female rock lobsters (*Jasus edwardsii*) rarely reach legal size and the fishery is primarily based on males. This can result in disproportionately high numbers of females in the population: sex ratios from recent field surveys have been as high as six females to each male. Although virtually all mature females carry eggs during the spawning season, it is unknown whether these ratios approach the limit for maximum fertilization and egg production. It is also unknown whether unmated females reabsorb their eggs, shed unfertilized eggs into the water, or incubate their eggs for a period. The latter would give false indication of egg production, particularly if surveys are early in the spawning season.

As an adjunct to the Tasmanian Department of Primary Industry and Fisheries rock lobster catch sampling program, aquarium trials using lobsters captured from off southern Tasmania were conducted between 1993 and 1995. The primary objectives were to determine the number of female lobsters a single male could inseminate and to determine the fate of eggs from non-inseminated females. Additionally, lobsters were maintained in captivity for over 12 months to determine the effect captivity had on reproduction.

In this article, 'spawning' refers to egg extrusion and attachment under the tail, and 'berried' lobsters are those incubating eggs. The success of fertilization was verified by following egg development through to larval hatching.

To investigate the number of females a male could inseminate, lobsters were held in separate tanks at ratios of one male to 4, 8, 12, and 16 females. Each ratio was replicated three times. Females were 81-103 mm carapace length (CL), pre-molt, and non-berried. Males were 107-110 mm CL. Sexual maturity of the females was confirmed by the presence of well developed setae on the endopodites of the pleopods (Annala et al. 1980). All females were considered to have spawned in previous years because the size at onset of maturity at the place the lobsters were obtained was <70 mm CL. Lobsters were fed fish and molluscs.

All females in the 1:4 and 1:8 ratio tanks spawned. In the 1:12 ratio tanks 9, 11, and 12 lobsters spawned. For unknown reasons, several females in each of the larger tanks holding the 1:16 ratios died, which resulted in final ratios of 1 male to 12, 13, and 14 females. In those tanks, 12, 11, and 14 females (respectively) spawned. These results demonstrate that male lobsters can successfully mate with at least 12 females during a single spawning season. During the trial a delay of 4-6 weeks between molting and spawning was noted. Further trials with increased ratios are planned for 1997. Of the six non-berried lobsters, two were regenerating limbs.

During annual July field trips to south and east Tasmania, virtually all mature female lobsters caught are berried. In most cases (see below for exceptions), non-berried females had major limb regen

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eration. Limb regeneration has been linked to growth (Chittleborough 1975), and somatic growth and reproduction are also interrelated (Adiyodi 1985, Harrison 199); these observations suggest that major limb regeneration can be at the expense of egg production. The other four non-berried females had no regenerating or regenerated limbs, but they had dark red pigmentation in the haemolymph.

The fate of non-fertilized eggs was investigated by holding six post-molt females in separate tanks without males. All failed to spawn and by the time similar lobsters held with males were berried, the haemolymph of these lobsters was distinctly red. The color was the same as that of newly extruded eggs and may indicate re-absorption of the eggs. As already mentioned, four females that did not spawn in the 1:13 and 1:12 ratio tanks also developed this coloration. In the field, non-berried females caught during the egg-bearing period either had regenerating limbs or dark red color to the haemolymph.

To examine the effect of captivity on female reproduction, four female lobsters that had been held for 12 months were mated with a recently-caught male. All females spawned and their eggs were significantly lighter in color (pale orange to cream) compared with those of recently caught and spawned females, and to those seen in the field. Although these eggs were successfully brooded for several months, a fault with the water supply caused all lobsters to die and thus egg viability could not be confirmed.

The lack of pigment in the spawned eggs may be associated with the lack of carotenoids in the diet. Vincent (1977, cited in Harrison 1990) found that the only source of carotenoids for Crustacea was dietary and Harrison (1990) suggested that carotenoid levels may influence egg quality and larval viability. Our results demonstrate that female lobsters maintained in captivity for at least 12 months are able to spawn. They also suggest the need for carotenoids in the diet for normal pigmentation of eggs, although the effect of low pigmentation on egg quality and viability remains unknown.

To examine the effect of captivity on male reproduction, three males which had been held for 12 months were placed in separate tanks with twelve recently-caught female lobsters each. One female died in one tank and of those remaining, 8 spawned, 1 showed major limb regeneration, and the other 2 showed neither limb regeneration or pigmentation of the haemolymph. In the other two tanks, 11 females spawned in each; the non-berried females developed red color in the haemolymph. These results suggest that holding lobsters for long periods can reduce male reproductive performance, as neither male managed to mate with all females, in contrast to trials using newly-caught males. The reason for the poorer performance is unknown, although decreasing reproductive performance has been documented in male penaeid prawns held in captivity for increasing periods of time (Leung-Trujillo and Lawrence,1987).

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Molting and its Influence Over Agonistic Behaviors in the American Lobster

From: S. I. Cromarty

Aggressive displays are common in American lobsters and peak when food and shelter are limited, and when intra-sexual competition is high. Various factors that influence aggression and ultimately dominance, include, but are not limited to: body size, claw size and claw loss, age, sex and sexual condition (i.e., gravid vs. non-gravid), and prior social experience, which requires individual recognition.

A critical physiological aspect of crustacean survival involves molting, a cyclic process involving continuous and sequential stages. Within each stage, discrete morphological and physiological changes have been identified (Drach 1939, Aiken 1973). Physiological state within each molt stage has a clear influence on aggressive encounters between individuals. Soft-shelled postmolt lobsters are timid and tend to flee; hard-shelled premolt lobsters are aggressive and tend to fight (Tamm and Cobb 1978, Atema and Cobb 1980). These molt cycle–related changes provide a unique opportunity to study lobster physiology over a changing behavioral state—namely aggressiveness.

For the past 15 years, University of Rhode Island professors Gabriele Kass-Simon and Stanley Cobb have been studying the inherent physiological changes occurring over the molt cycle, which may relate to observed differences in aggressive behavior (see Davidoff 1984, Davidoff and Kass-Simon 1986, Fadool et al. 1989, Schwanke et al. 1990, Lobster Newsletter Vol. 3 (1)). Their approach has been to describe specific behaviors, specifically the meral spread display and the escape response behavior, and then to document possible changes—behavioral or physiological—through the molt cycle.

Much of my own research has focused on a single behavior—the escape response. This behavior is relatively easy to document and quantify. I found that soft-shelled postmolt juvenile lobsters were much more likely to respond to a threat with tail-flipping, whereas hard-shelled, juvenile premolt lobsters were more likely to respond with an aggressive display, such as the meral spread (Tamm and Cobb 1978, Cromarty et al. 1991). Premolt lobsters also had a quick, forceful initial power swim, followed by subsequent swims that rapidly decreased in velocity, acceleration, force, and work. As a consequence of the greater force of their initial power swim and subsequent swims, premolt lobsters do more work during an escape, but travel less distance, than do their soft-shelled counterparts (Cromarty et al. 1991).

We expected these behavioral differences in escape behavior to be reflected in differences in the neuromuscular physiology of the abdominal muscles for each molt stage. Therefore, this stage of our work focused on the flexor muscles that drive the escape response behavior. Our results showed that in juvenile lobsters, the neuromuscular properties, namely the excitatory junction potentials (EJPs) of hard-shelled lobsters failed at 4 and 5 Hz stimulation, whereas soft-shelled lobsters continued to produce EJPs to 6 Hz and beyond (Cromarty and Kass-Simon 1996). This correlates with the results from the behavioral experiments, which showed that hard-shelled lobsters reduce their swimming in the latter half of an escape episode, whereas soft-shelled lobsters do not (Cromarty et al. 1991).

It quickly became apparent that regardless of molt stage, juvenile and adult lobsters not only differ in their tendency to escape, but also have different escape behaviors. For example, juvenile lobsters choose to flee under

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laboratory conditions, adult lobsters do not (Cromarty 1995). Threshold and probability differences in escape between juvenile and adult lobsters have been documented, but no attempt was ever made to characterize molt cycle–related differences between juvenile and adult lobsters.

By experimenting with different stimuli, it was possible to initiate escape sequences in adult lobsters that could then be analyzed in a similar fashion to the juveniles. This study was the first to document escape behavior in adult American lobsters and record changes over the molt cycle (Cromarty and Kass-Simon 1996). The probability of adult escape behavior across the molt stages was dramatically different than that for juvenile lobsters. Very few postmolt lobsters escaped, but those that did showed little reduction in their escape swims, whereas the frequency of subsequent swims by premolt adult lobsters in the latter half of the escape sharply declined. All the above behavioral studies were performed on male lobsters, however a recent study on intermolt (stage C) adult female lobsters, showed that females have an identical escape behavior to adult male stage C lobsters, but gravid female lobsters when forced to escape, display a distinct escape sequence (S. Cromarty, J. Mello, and G. Kass-Simon unpub. data).

Similar neuromuscular electrophysiology experiments conducted on juveniles were performed on the adult abdominal muscle tissue, and again, the molt-related behavioral differences observed in the adults could be partially explained at the neuromuscular level. EJPs of hard-shelled lobsters failed at 4 Hz, while soft-shelled lobsters continued to produce EJPs to 5 Hz and beyond (Cromarty et al. 1995).

When juvenile and adult escape responses were compared by factoring out body-weight, juveniles of all molt stages traveled significantly further, took more tail-flips, and spent more time tail-flipping with a higher frequency—regardless of molt stage. Velocity, acceleration, and force were also higher for juveniles when compared to adult lobsters. Work expenditure was significantly higher for adults suggesting that energy expense partly explains the reluctance for adult to tail-flip (Cromarty and Kass-Simon 1996).

Although neuromuscular properties change with respect to the molt cycle, and correlate with escape behavior, there are other physiological mechanisms that may play a role in these molt-related behavioral differences. Growing evidence points to the role of hormones and neurohormones in the modulation of neuronal transmission in decapod crustaceans (see Kravitz 1988 for review).

Serotonin, octopamine, dopamine, and proctolin have modulatory effects at both central and peripheral synapses in lobsters (Schwarz et al. 1980, Kravitz et al. 1980, Glusman and Kravitz 1982). Further, serotonin and octopamine have differential effects on the postures of lobsters: serotonin causes lobsters to raise their claws and walking legs and loosely tuck in their abdomens; whereas octopamine causes them to flatten themselves to the substrate, with claws and walking legs pointing forward and abdomens hyperextended upwards (Livingstone et al. 1980, Kravitz et al. 1980, Kravitz 1988, 1990). Although these findings were provocative and raised the possibility that one or more of these substances might be involved in molt-related changes in agonistic behavior, none of the substances, including dopamine, varies over the molt cycle in a way that would account for the reported molt-cycle related behaviors (Fadool et al. 1989).

Recently, Kass-Simon and I focused our attention on 20-hydroxyecdysone (20-HE),

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the active principle of the molting hormone, since work in other laboratories (Snyder and Chang 1991, Chang et al. 1993) have reported high concentrations of 20-HE in premolt lobsters. This prompted us to examine whether the molting hormone could affect transmission at the neuromuscular junction in ways that were consistent with our earlier observation that blood from postmolt lobsters enhanced EJPs and depressed inhibitory junctional potentials at the claw-opener neuromuscular junction (Schwanke et al. 1983, 1990).

We recorded EJPs and spontaneous miniature excitatory junctional potentials (MEJPs) at the dactyl opener muscle of the claw—largely responsible for the meral spread display—and EJPs at the phasic flexor muscle of the abdomen, which drives the tail-flipping behavior, while simultaneously perfusing 20-HE onto these muscles (stage C only).

In the opener muscle of stage C lobsters, 20-HE caused an increase in EJP amplitude, and an increase in MEJP frequency; while in the abdominal muscle, it reduced EJP amplitude (Cromarty 1995). These results are consistent with changes in the activity of the two muscle systems in premolt animals, and support our earlier findings that one or more molt-related blood-borne factors can modulate peripheral synaptic transmission. It remains to be seen whether 20-HE modulates the other molt stages in a similar fashion and to what degree 20-HE can explain the changes in behavioral state of the American lobster.

Our results support the idea that one of the factors contributing to a heightened aggressive state of premolt lobsters is the molting hormone itself, and that its effects are apparent at both the central and peripheral nervous systems, including neuromuscular properties. This is consistent with the notion that molting is a global event that encompasses all aspects of the animal's physiology.

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Larval Dispersal and Ecological Groupings for *Panulirus* and *Jasus* Rock Lobsters

From: Ray George

Two recent Research News articles in The Lobster Newsletter by Booth (1995) and Pollock et al. (1995) highlight differing concepts in the scope for dispersal of the relatively long-lived phyllosomata of rock lobsters. Booth (1995) reports high abundances of *Jasus edwardsii* larvae east of the North Island of New Zealand, collecting almost 9000 specimens in 66 trawls. These larvae are retained within the eddies and recirculations of the East Cape Current System which itself seems to be defined by the Louisville Ridge some 1300 km to the east of the North Island. He summarizes: "the scale of the larval pool off S.E. North Island seems to be larger than elsewhere for *Jasus* and similar to that found for *P. cygnus* off Western Australia." *Panulirus cygnus* larvae are mainly concentrated and largely retained in waters up to 1100 km from shore with some to 1500 km (Rimmer and Phillips 1979). This oceanographic region is dominated by meso-scale gyres and eddies.

Pollock et al. (1995) found larvae of both *J. tristani* and *J. lalandii* across 3000 km of ocean in the southeast Atlantic. They also found nearly 50 phyllosomata of *P. versicolor*, carried into the south Atlantic from the southwest Indian Ocean in one or more of the rings and eddies shed from the Agulhas Current. These data are the basis for their "Case for Long-distance Dispersal". Nevertheless, Pollock et al. (1995) acknowledge that some species, like *P. cygnus*, occur in regions where local larval retention predominates and they state that "These findings suggest that a variety of larval transport and return mechanisms may exist,...". I believe that there are indeed a variety of mechanisms. Here I address the issues of potential larval dispersal and recruitment mechanisms considering the environmental and ecological conditions of the adults, as well as the oceanographic environment of the larvae.

My earlier ecological division of *Panulirus* species (George 1974) depended simply on whether there was a major influence from the adjacent land on the coastal waters (=Continental) or very little (=Oceanic). I now recognize, for *Jasus* as well as for *Panulirus*, five major ecological groupings based on: 1) the nature of the geographic region occupied (i.e., whether it be widespread, isolated islands, or restricted coastlines), 2) the influence of the continent on the coastal waters, and 3) the characteristics of the predominant oceanographic systems that house, nurture, and transport the larvae of each species. The five ecological types are:

Widespread: Adults live in shallow water around oceanic islands or equally clear water continental coasts in equatorial regions. Larvae of these species have been widely collected in open ocean situations. The species in this category epitomize the classical concept of widespread, large-scale dispersal by larvae to allow distribution of adults over extensive geographic regions. These species are: *Panulirus penicillatus, P. longipes* subspecies, and *P.versicolor* (Indian and Pacific), *P. homarus homarus* (Indian), and *P. echinatus* (Atlantic).

Coastlines fronting open oceans: Adults live on continental shelves with minimal run-off from the continent; the adjacent offshore oceanographic systems are well defined by gyres, eddies, or upwellings. Larvae are generally retained within 1000 - 1500 km of the coast. This group includes most of the important commercial species: *Panulirus*

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cygnus (Western Australia), *P. japonicus* (southern Japan), *P. interruptus* (California), *P. gracilis* (central East Pacific), *P. homarus rubellus* (southwest Indian), *P. homarus megasculpta* (Arabian Sea), *P. argus* (Brazil [a]) *Jasus verreauxi* (North Island, New Zealand and eastern Australia [b]), *J. edwardsii* (New Zealand and southern Australia), *J. lalandii* (south west Africa).

Isolated island chains and/or seamounts: Adults live down the slope to 200 m or more on island or seamount chains that lie in the path of well defined flows (e.g., the West Wind Drift of the Southern Ocean). Larval life histories are poorly known but Booth (1992) states that larvae can concentrate near these isolated adult stocks. Perhaps island or seamount backeddy systems play a major role in determining larval behavioral and subsequent retention. Species in this group include: *Panulirus marginatus* (Hawaii), *P. pascuensis* (Easter I.), *Jasus frontalis* (Juan Fernandez Arch.), *J. tristani* (Tristan da Cunha group), *J. paulensis* (St Paul and Amsterdam Is), *J. caveorum* (Foundation Seamounts, S.E. Pacific).

Marginal oceans: Adults are usually restricted to shallow, unique environmental areas that are maintained within local geographic boundaries and are little affected by continental input (e.g., the Caribbean Sea and the Gulf of California). Larval life histories are not well known but distributions are likely to be strongly influenced by the specific basin environments. *Panulirus guttatus* (Caribbean) and *P. argus* (Caribbean [a]), and *P. inflatus* (Gulf of California) are indicative of this group.

"Estuarine" ocean basins: Adults live in shallow coastal waters that are directly or indirectly influenced by local run-off from major rivers or persistent coastal streams. Larval characteristics are little understood but probably have evolved to respond to these "estuarine" conditions for their recruitment. These species include: *Panulirus polyphagus* (Himalayan rivers), *P. laevicauda* (Amazon and coastal streams), *P. regius* (Niger, Congo and coastal streams), *P. stimpsoni* (Pearl River and coastal streams), and *P. ornatus* (Fly River and coastal streams).

I hope that these observations assist future discussions about the factors that have influenced the evolution of the recruitment pathways for each rock lobster species. Reaching an understanding of larval recruitment factors for the other palinurid genera (i.e., *Palinurus* and *Projasus*) will be even more challenging since few phyllosomata or pueruli have been collected and the environmental constraints for the adults, which live in much deeper water than *Panulirus* or *Jasus*, have been little studied. An excellent start has been made, however, by Groeneveld (1995) who compared the geographic, depth, and substrate preferences of adults of the two species of *Palinurus* (*P. delagoae* and *P.* gilchristi) associated with the Agulhas Current.

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A vasopressin-like gene may have a role in controlling molting in the rock lobster, *Jasus edwardsii*

From: F.Y.T Sin and J. Khoo

It has been suggested that the molt inhibiting hormone (MIH) in Crustacea may be related to the mammalian vasopressin family. Using oligonucleotide primers derived from the conserved regions of the rat vasopressin gene, we have isolated by DNA amplification with the polymerase chain reaction (PCR) a short sequence (947 bp), which consists of part of both an intron and an exon. Using this PCR fragment we have demonstrated that the fragment hybridized predominantly to the eyestalk mRNA, although it also hybridized to epidermal and muscle mRNAs. *In situ* hybridization showed that the fragment hybridized to the eyestalk, particularly the sinus gland- X organ complex.

What is interesting is that the intensities of hybridization in the eyestalks of premolt and intermolt animals are significantly different. Using this PCR fragment we have isolated three cDNA clones, which we have called peKJ1, peKJ2 and peJK3. Two clones, peJK2 and peJK3 share 96% homology, while peJKI shares only about 50% homology with peJK2 and peJK3. The peJK1 clone hybridized to mRNAs from all the tissues that we have studied with equal intensity; these included muscle, eyestalk, muscle, epidermis, gut and brain tissues. However, peJK2 and peJK3 hybridized predominantly to the eyestalk, and less so with muscle and epidermis. *In situ* hybridization using these three sequences as probes also showed the same distribution. Sequence comparisons with genebank data showed that they share about 50% homology with the MIH family of proteins. At this stage we do not know if the genes are really the MIH from lobster. We are hoping to clone the three cDNAs into expression vectors, then isolate and analyze the physiological function of the three genes.

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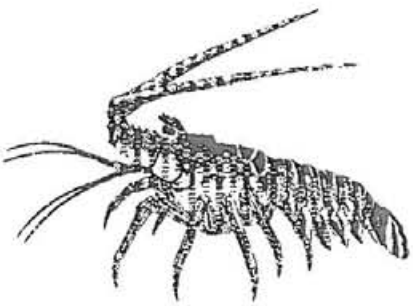

FISHERIES AND AQUACULTURE UPDATE

12451

Increasing live exports

From: B.F. Phillips

Australia's increasingly valuable live lobster sector is to be supported by a $1.5 million series of R & D projects aimed at increasing the number of lobsters suitable for live export. This will give industry greater choice in selling lobsters live or whole cooked, according to market demand and prices. Project funding is through the Fisheries Research & Development Corporation (FRDC), Curtin University in Western Australia, the Queensland Department of Primary Industries, and the University of Tasmania. In a co-ordinated exercise, researchers at opposite ends of the country will study western, southern, and tropical rock lobsters over three years.

Two Western Australian projects will run under the direction of Associate Professor Louis Evans, Director of the Aquatic Science Research Unit at Curtin University and Dr. Brian Patterson of the Centre for Food Technology, Queensland Depart

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ment of Primary Industries. Louis Evans has conducted many studies of rock lobster stress and physiology, and Brian Patterson has previously studied the physiology of prawns (shrimps) and spanner crabs to improve their survival for the live market.

Evans and Patterson will investigate the physiology of the western rock lobster, *Panulirus cygnus*, to define the major causes of stress during capture, handling, and holding which contribute to deaths. Results from these projects will include a standard autopsy protocol for identifying the cause of mortality and a list of stress indicators, including one or more simple indicators, that can be used as a tool to assist industry determine stress levels in lobsters. A third Western Australian study, by Paul Todd and Patrick Spanogue (Curtin University) will look at coastal transportation practices.

In the Tasmanian component, principal investigator Professor Nigel Forteath and doctoral student Brad Crear, of the National Key Centre for Aquaculture at the University of Tasmania, will assess optimum oxygen and temperature levels in holding tanks for the southern lobster, *Jasus edwardsii*, and the western rock lobster. In Queensland, Freshwater Seafoods Pty/Ltd will conduct a small complementary study on the tropical rock lobster, *Panulirus ornatus*, in a project funded by the National Seafood Centre and managed by Brian Patterson.

A steering committee chaired by Professor Bruce Phillips of Curtin University in Western Australia (formally Chief Scientist of AFMA) will oversee the research program and encourage close cooperation between researchers to ensure that research gaps are spotted and closed. Also on the committee are Western Australian industry representatives Richard Stevens and Glen O'Brian, as well as Louis Evans, Brian Patterson, Nigel Forteath and FRDC Executive Director Peter Dundas-Smith. The problems to be targeted all received high priority rating in a 1995 review of live rock lobster R & D needs by Bruce Phillips and FRDC's Simon Prattley. Seminars to report progress to industry will be held yearly. Improved handling techniques based on the results of the research will be featured in an updated edition of the Code of Practice for Handling Live Rock Lobster, produced jointly by FRDC and the Western Australian Fishing Industry Council.

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AMUSEMENTS

Ken Collins from the University of Southhampton sent us these two articles: the first was printed in The Sunday Times (Nov. 8, 1996) and the second piece was first printed in the American Seafood Institute Report (Vol. 6(7/8). It appears that lobsters - at least the clawed varieties - have quite a devoted group of followers.

Buddhist Monks Liberate Lobsters

Lobster fishermen watched in bewilderment last week after they sold L1,700 worth of fresh lobsters to a party of Buddhist monks, who promptly returned the catch to the sea, writes Steve Ball. About 200 bald-headed monks wearing flowing saffron robes filed into the Isle of Wight fish market in Sandown and bought every live lobster from the day's catch. They paid in cash and carried out a total of 160 kg. Then some of the party hired a boat from Bembridge on the island's east coast and dropped the entire catch back into the water, along with flower petals and sacred tokens, while reciting holy chants.

Kevin Francis, one of the fishermen, said: "The whole lot were just dropped straight

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back into the sea. At first we all thought it a terrible waste of prime lobsters - but at least we can go out and try to catch them again." A spokesman for the Buddhist Fellowship said: "Buddhists believe that all life is sacred and are vegetarian. They were simply trying to protect life."

Lobster liberation has become an increasingly fashionable cause in recent months. Jimmy Sommerville, former singer in the pop band Bronski Beat, paid L 1,000 to save a tankful of live lobsters from the pot at a top restaurant in Switzerland. He released them into a nearby lake where they each died an agonizing death - staff at the restaurant had failed to point out that they were saltwater lobsters, not the freshwater variety.

Mary Tyler Moore Protests Lobster Festival

Actress Mary Tyler Moore placed a full-page advertisement in a Maine newspaper to protest the 48th annual Maine Lobster Festival, a four-day lobster celebration held in Rockland each August. "To me, eating lobster is out of the question", read the ad in the Courier-Gazette. Lobsters were portrayed in the ad as "beings with complex social interactions, long child-hoods, and awkward adolescences. Like humans, they flirt with one another and even been seen walking 'claw-in-claw'". Moore asked lobster-lovers to contact the animal rights group People for the Ethical Treatment of Animals for information on alternative ways of preparing lobster. Moore's attempt to persuade people to not attend the Maine Lobster Festival was apparently unsuccessful. According to the Maine Lobster Promotion Council, the event drew record-breaking attendance this year.

Readers may remember that last November Moore became involved in the plight of 'Spike' - a 65 year old lobster being displayed at a seafood restaurant in Los Angeles. Moore offered to buy Spike from the restaurant for $1,000 to have him flown back to the waters of Maine. In a verbal sparring match with talk show host, Rush Limbaugh, Limbaugh offered to pay $2,000 for the privilege of eating Spike. The restaurant owners rejected both offers.

ANNOUNCEMENT

The next International Crustacean Congress will be held in Amsterdam, July 20-24, 1998. For more, contact::

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The Lobster Newsletter is cosponsored by Fisheries & Oceans, Canada and The Florida Department of Environmental Protection, USA. It is published twice yearly.

Contact any Editor about submission of articles. Send change of address requests to Peter Lawton. Comments on final editing and production should be sent to Mark Butler.

FLORIDA WOMAN WINS WORST LOBSTER RECIPE CONTEST

Lobster and Scrambled Eggs

Put 4 fresh eggs and a live lobster into a cast iron skillet. Cover TIGHTLY and place on a hot barbecue grill. Cook 15 minutes. The lobster will scramble the eggs. Add fruit cocktail.

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October 1997

The Lobster NEWSLETTER

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The Lobster Newsletter - Volume 10, Number 1: October 1997