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The Lobster NEWSLETTER

ANNOUNCEMENTS

The 7th International Conference and Workshop on Lobster Biology and Management will be held in Hobart, Tasmania from the 8 – 13 February 2004.

Since the last conference in Florida in 2000 new challenges have emerged for scientists, managers and industry. Co-management and cooperative research is seen as the future model for managing the world's marine resources. Ecosystem based management has refocused research into meta-population studies including marine protected areas and ecosystem modeling. Incorporation of environmental and socio-economic performance indicators is a requirement for a new generation of fishery management plans. Record high prices have also attracted interest in aquaculture and enhancement. Meeting these challenges has resulted in significant advances in the methods used to study lobster resources. This conference will provide the opportunity for researchers and managers with an interest in lobsters to meet, discuss and learn of these new and exciting advances.
More information can be found at the conference website:

www.cdesign.com.au/lobster2004

Please pass on this address onto your colleagues who may be interested in attending. We plan to put the program together early in 2003 and would welcome any suggestions regarding themes or sessions. We also welcome offers for hosting the 8th International Conference. If you are interested please contact Stewart Frusher at stewart.frusher@utas.edu.au or write to Stewart Frusher, Marine Research Laboratories, Tasmanian Aquaculture and Fisheries Institute, University of Tasmania, Private Bag 53, Hobart, 7001,Tasmania, Australia.

FISHERIES & AQUACULTURE UPDATE

Threats to the sustainability of *Palinurus elephas* fisheries

From: Raquel Goñi, Antoni Quetglas, Olga Reñones and Javier Mas

Palinurus elephas is the most commercially important spiny lobster species in the Mediterranean and North-eastern Atlantic. Known as "red lobster" in the Western Mediterranean and as "crayfish" in the North-eastern Atlantic, *P. elephas* has been traditionally targeted by artisanal fisheries throughout its range. Customarily, lobster were caught with baited traps until the 1960-1970s when trammel nets were introduced, leading to the virtual disappearance of trap fishing. Concomitantly, fishing effort increased and populations in the NE Atlantic where depleted to the point that it is now a bycatch species of finfish netting. Although Mediterranean populations are thought to be overfished, they are still targeted in many areas, especially in remote areas such as archipelagos and islands. In the Spanish Mediterranean, over six hundred artisanal vessels and some 1100 fishermen engage in lobster fishing with trammel nets every year. A relict trap fishery exists in the Balearic Islands. The annual economic value of the fishery in Spain has been estimated at 8-16 million euro (first sale).

The history of depletion of *P. elephas* populations has prompted a study to assess the main threats to the sustainability of these fisheries with the aim of incorporating this knowledge to the management of Spanish Mediterranean fisheries. We are looking into four aspects of lobster fishing: the regulatory framework, the adequacy of the minimum landing size for protecting the reproductive potential of the populations, the current exploitation pattern and the potential impacts of trammel net fishing on lobster habitats. For this analysis we use data from various recent and ongoing studies of *P. elephas*: a comparison of the ecological and economic efficiency of trammel net and trap fisheries in the Balearic Islands (Quetglas et al., in preparation), catchability in traps and trammel nets (Goñi et.al, in press), bycatch and discard practices in Mediterranean artisanal fisheries (Mas et al., in preparation), and reproductive biology and spawning potential of a protected population (Goñi et al., submitted).

The regulatory framework

No quotas exist in *P. elephas* fisheries and reliable catch statistics are not available. In the Spanish Mediterranean effort controls and technical measures are used to manage fisheries. Fishing effort is regulated by an annual 6-month closure during the egg-bearing period (September to February) and there are caps on the amount of gear fished per boat (5000 m trammel nets) and on the soak time (<48 hours). The minimum mesh size of the trammel net outer and inner panels and the maximum size of the traps are also regulated. Finally, it is forbidden to land lobster smaller than 80 mm CL (about 4 years) and berried females.

Despite this multiplicity of regulations, the reality is that effort limits are not enforced -boats may have up to 10000 m of trammel nets that are fished simultaneously through the season of which they may haul 2000-3000 m per day - and nets may be soaked 3 or more days. This state of affairs is aggravated by the unpredictability in the number of boats among those with license for artisanal fishing that will fish for lobster during any given season, the dispersion of the fleet in many small harbours along the coast and that landings are often sold directly to restaurants. In these circumstances, the temporal closure and the fishermen's acceptance that immature and berried lobsters should be returned to the water, remain the only practical controls in the Spanish fishery (as in other Mediterranean fisheries).

The minimum landing size

Observations onboard fishing vessels suggest that it is common practice to release undersized specimens when they are freed from the net in good condition (condition depends on season, water temperature, and soak time among other factors). Undersized lobsters in trap fisheries are usually caught and released in good condition.

Knowing the wide acceptance of this measure, our interest was to determine the biological basis and adequacy of the 80 mm CL minimum landing size (MLS) to protect the spawning potential of the population. The current MLS was set on the basis of empirical observations of berried females and a study of the reproductive biology of Western Mediterranean populations indicated that the mean size of functional maturity was 77-78 mm CL (Goñi et al., submitted). The same study showed that if an unfished population were to be harvested, a MLS of 80 mm CL would protect only 12% of the catchable population and 1% of the population potential egg production (Fig. 1). The same study suggests that a MLS of 87 mm CL or 92 mm CL would allow lobsters to reproduce once or twice before being susceptible to fishing. The larger of the two MLS would afford protection to 25% of the population potential egg production.

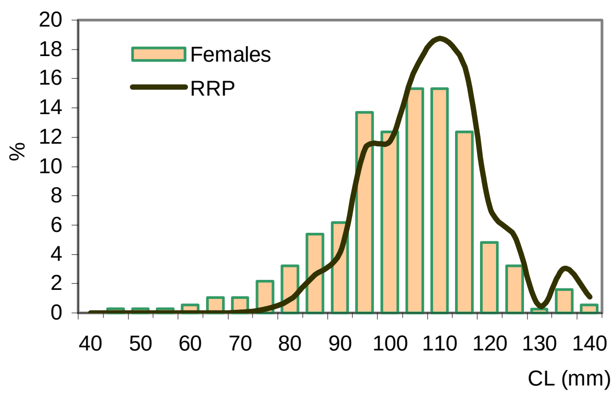

Figure 1: Female size structure and relative reproductive potential of the P. elephas population from the Columbretes Islands Marine Reserve. MLS: Minimum landing size. RRP: Relative reproductive potential.

Exploitation pattern

Our investigations on the catchability and selectivity of traps and trammel nets for P. elephas (Goñi et al., in press) indicated that, from the point of view of conservation, traps were preferable to trammel nets because they retained a smaller proportion of juveniles and because the largest lobsters (mostly males) were either too large to enter traps or were able to feed without entering (Fig. 2). On the basis of the size structures of trap and trammel net catches of the protected population of the Columbretes Islands Marine Reserve, the study concluded that the exploitation pattern of the females would be similar in trap and trammel net fisheries, while the exploitation pattern of the male component would differ. Thus it may be inferred that large males would be more abundant in populations fished with traps than in populations fished with trammel nets.

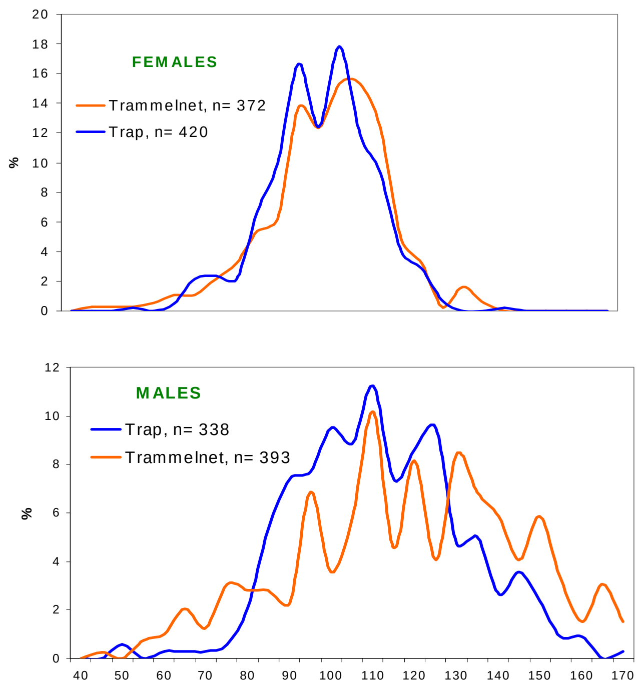

Figure 2: Size structure of females and males fished with traps and trammel nets from the protected population of P. elephas in the Columbretes Islands Marine Reserve.

In the Spanish Mediterranean, no *P. elephas* population exists that is solely fished by traps and thus it is not possible to verify these predictions. However, when we compared size distributions of trammel net catches from various fished populations with those from the protected population in the reserve, we observed that the unfished population contained a greater proportion of large males than exploited populations (Fig. 3). As predicted, the size structure of females did not differ between the fished and unfished populations.

Sustainability of *P. elephas* exploited populations are difficult to assess in full. However, the decline in the availability of large males for mating in exploited populations may result in loss of reproductive potential of the population to an extent formerly attributed only to large females. Thus the change in exploitation pattern brought about by the substitution of traps by trammel nets in all *P. elephas* fisheries may be one of the causes of their demise.

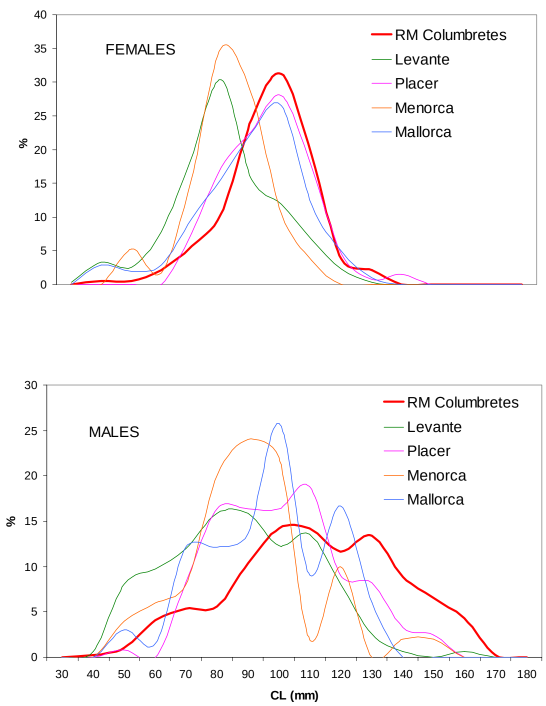

Figure 3: Size structure of trammelnet catches in fished (various Western Mediterranean fisheries) and unfished (Columbretes Islands Marine Reserve) populations of P. elephas.

The implications of the pattern of exploitation of trammel nets for the sustainability of *P. elephas* exploited populations are difficult to assess in full. However, the decline in the availability of large males for mating in exploited populations may result in loss of reproductive potential of the population to an extent formerly attributed only to large females. Thus the change in exploitation pattern brought about by the substitution of traps by trammel nets in all *P. elephas* fisheries may be one of the causes of their demise.

Impacts of trammel net fishing on lobster habitats

The causes of the collapse of Atlantic *P. elephas* fisheries and of the depleted status of Mediterranean ones may also be sought in the differential impacts of trammel net and trap fishing on lobster habitats. Both traps and trammel nets generate bycatch, much of which is made up of finfish, molluscs and crustacean commercial species that are increasingly relied upon to supplement dwindling lobster yields. But while 66% of the individuals caught by traps are lobsters, in trammel net catches this proportion declines to 43% if the non-commercial benthos - bryozoans, sponges, algae, echinoderms, etc- is excluded from the calculation. However, in an attempt to assess more comprehensively the impacts of lobster fishing on benthic ecosystems, we devised an arbitrary method of "counting" the bycatch of these taxonomic groups, which often are not taken into consideration in bycatch / discard studies. Thus we "counted" all algae and bryozoans "units", sponges, echinoderms, tunicates, annelids, etc. and added them to the finfish, macrocrustacean and macromollusc bycatch. Then we used two indicators of the ecological impact of fishing (Alverson & Hughes 1996): (a) the "lobster ecological use efficiency" (LEUE) – or number of lobster caught divided by the number of all organisms caught, and (b) the "fishery ecological use efficiency" (FEUE) – or number of lobster and other commercialised bycatch caught divided by the total number of organisms caught.

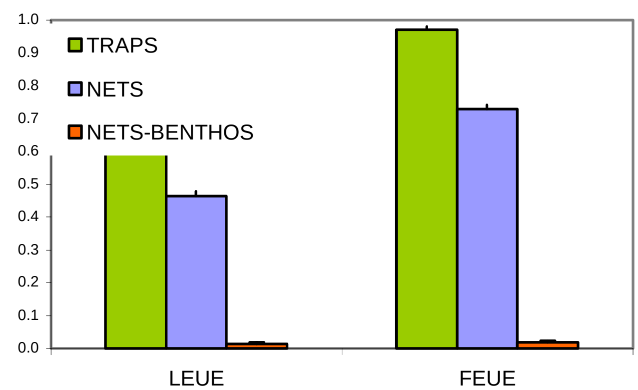

Figure 4: Indices of performance of traps and trammelnet lobster fisheries in the Western Mediterranean. See text.

Using these more comprehensive indices we learned that in traps lobster still made up 61% of the catch (in number) while in trammel nets lobster made up only 1.4% of the catch (in number) (Fig. 4). When considering the efficiency of the fishery as a whole (that is, not only lobster but all the commercialised catch), the ecological efficiency of the trap fishery rose to 97% while that of the trammel net fishery reached only 1.8%. Close examination of the taxonomic composition of the benthos-bycatch reveals a large fraction of structural species such as coralline and incrusting algae (Maërl), bryozoans, or sponges characteristic of lobster habitats. Some of these species have very slow growth rates.

The results of the studies here summarized point to major problems in the management and exploitation scheme of *Palinurus elephas* fisheries that can be traced to the introduction of trammelnets and to the increased fishing effort associated with technological advances in materials, hauling gear and positioning systems occurred in recent decades. Further research will focus on developing performance indices, both ecological and economic, of the fisheries to provide operative advice for the sustainability of *P. elephas* fisheries.

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Larval culture of the Southern Rock Lobster (Jasus edwardsii)

From: Michel Bermudes

As part of ongoing research into rock lobster propagation supported by the Australian Fisheries Research and Development Corporation (Rock Lobster Enhancement and Aquaculture Subprogram), I recently completed a PhD on the larval biology of *J. edwardsii* in Tasmania. Here is a summary of my study.

Meeting the environmental requirements of a species throughout its larval development is paramount to successful propagation. In rock lobsters, accurate definition of environmental preferences is complicated by the complex and prolonged larval development. Like other crustacean larvae, the growth of phyllosomas (Fig. 1) is incremental and takes place at the moult through a series of instars (up to 17; Kittaka 1994) and 11 developmental stages (Lesser 1978). The first difficulty arises from possible shifts in environmental preference during larval development, since in the wild, phyllosomas migrate between such distinctly different environments as coastal and oceanic waters. A second, less obvious difficulty is the manner in which nutritional needs are met, with phyllosomas accumulating reserves and then drawing on them to continue development under sub-optimal conditions (Mikami *et al.* 1995). Thus, for a given developmental stage, the effect of culture conditions will be biased (accentuated or lessened) by the environmental and / or nutritional history of the larva.

Figure 1: Stage I southern rock lobster phyllosoma in flight.

The idea of the project was to study each early phyllosoma stage independently, and for each to obtain a snapshot of behaviour and physiology under different environmental conditions. This could lead to an ability to control larval distribution in tanks and thus maximise space and food use. A powerful performance index, where:

potential growth = energy intake – energy output

could be derived experimentally for each developmental stage, independent of the previous environmental and / or nutritional history (Fig. 2).

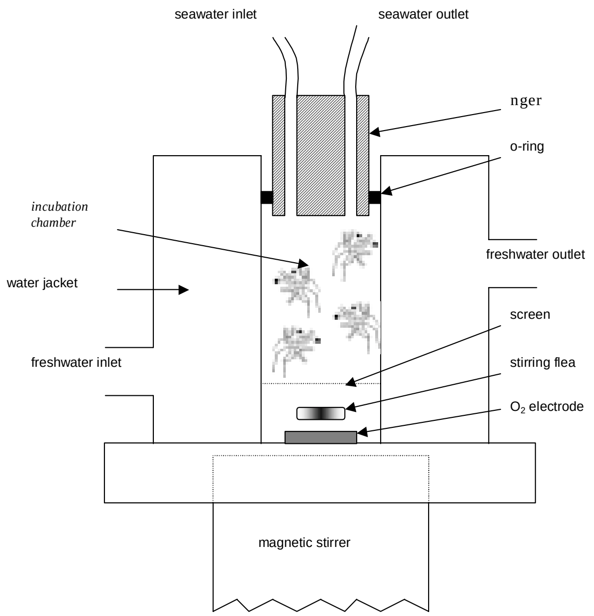

Figure 2. Schematic view of experimental apparatus used to measure the oxygen consumption (energy expenditure) of stage I larvae.

Not surprisingly, temperature was found to be an important factor controlling development in early phyllosomas (Fig. 3). Maximum growth rates were achieved at 18 - 19°C, the reduced performance at higher temperatures being due to the energetic imbalance between food intake and metabolic expenditure.

Light was the predominant cue controlling behaviour, as larvae were less active in the dark than under light. Low light intensities (~ full moon, dusk, dawn) may be used to optimise larval distribution in tanks and therefore maximise density. Greater activity of larvae under light caused higher energy expenditure than in the dark. However, larvae under light fed more than their counterparts in the dark, thus maximising energy use. Since the growth of phyllosomas was higher under a simulated natural photoperiod (18L:6D and 12L:12D) than under constant light and continuous darkness (Fig. 4), it is thought that rock lobster larvae use the light phase for feeding while the dark phase is used for food assimilation. It is therefore recommended that phyllosomas be fed at the start of the day, and uneaten food flushed out at night.

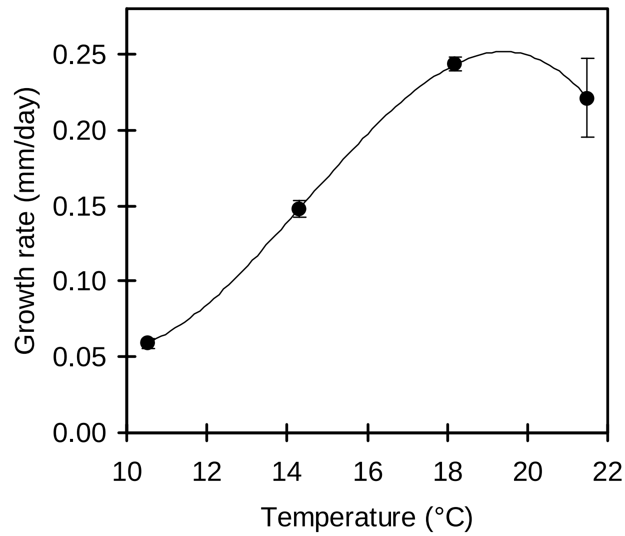

Figure 3: The effect of temperature on the growth rate of stage I larvae.

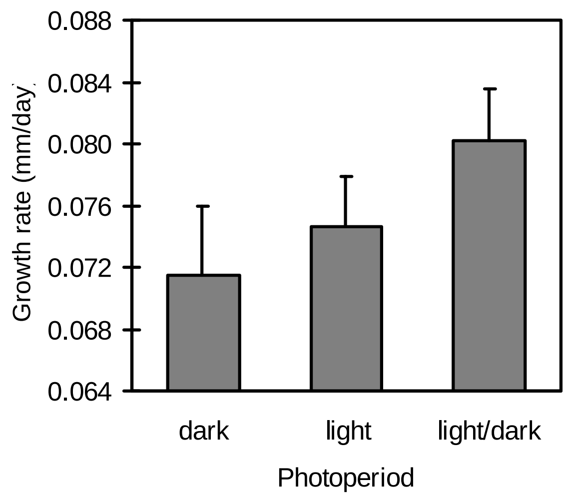

Figure 4: The effect of photoperiod on the growth rate of larvae reared from stage I to stage IV. The light/dark photoperiod was 18 h of daylight to 6 h of dark.

Part of this project addressed the water quality requirements of phyllosomas – a topic for which there is little information. As would be expected for a largely oceanic animal adapted to a clean and stable environment, phyllosomas require consistent water quality, particularly in terms of salinity (optimum around 34 - 35 psu) and dissolved oxygen (must be over 80% saturation). However, larvae appear well adapted to recirculation systems since they tolerate ammonia concentrations up to ~ 0.1 mg NH_3-N l^{-1}, and so are similar to molluscs and other crustaceans (Forteath 1990).

Research into rock lobster propagation is a step by step process

This study provided information on the environmental requirements of early stage phyllosomas. Similar work is now required for later stages. The methods developed in this project are powerful tools for defining larval culture conditions for these more advanced larval stages, and also for larvae of other lobster species currently being evaluated in Australia, Japan and New Zealand. Fine-tuning of the system design and culture techniques is a key to the successful propagation of the southern rock lobster, which will be achieved through the thorough understanding of the environmental requirements of phyllosomas.

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Mothers know best ! Artificial incubation of spiny lobster eggs

From: Phil James

As part of the spiny lobster broodstock programme, researchers at the NIWA Aquaculture Research Facility in Wellington tested the feasibility of removing fertilized eggs from females and hatching them in incubators. This is a technique that could give much greater control over when and at what rate eggs hatch. Currently, numerous eggs (up to 1.4 million) are hatched over a very short period (2 – 4 d) from each female to supply phyllosomas for research. If it were possible to detach the eggs and keep them in incubators, a more constant supply could be available by controlling temperature and consequent egg development (Tong *et al* 2000). Our previous research has shown that egg hatch times can be spread over four months by manipulating the temperature in the holding tanks – and with little loss of viability.

There were two experiments. For both, the eggs were removed by running a scalpel around the edge of the pleopod, severing the setae, and gently removing the eggs. The eggs remained attached to the setae throughout as there is no way to separate them without damage.

The first experiment used eggs at various stages of development from different gravid *Jasus edwardsii* (n = 42) in a recirculating system. There were 56 incubators (Fig. 1), each holding 74 ml of seawater and with 1.37 $l.m^{-1}$ of water upwelling through a 450 µm sieve. A 3 g egg sample from each lobster was soaked in a 1‰ formalin solution for 1 min prior to the experiment. The remaining eggs were left attached to the females as a control and the females returned to the holding tank. After 5 weeks, mass mortality of the eggs in all the incubators had occurred due to an infection by an invasive oomycete, later identified by DNA sequencing as *Haliphthoros* sp. An unidentified species of *Haliphthoros* had previously been found on samples taken from puerulus and juvenile *J. edwardsii*

(Diggles 2001). None of the control eggs were affected by fungi and they hatched normally.

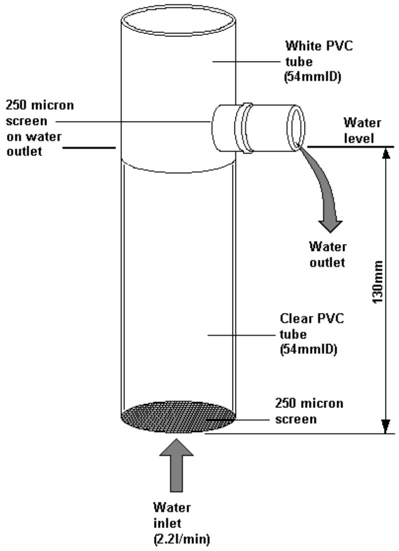

Figure 1: Detail of incubators used in the first spiny lobster egg experiment.

In the second experiment the flow-through system consisted of 18 glass salmon ova incubators (Fig. 2) placed in a 2 m x 0.8 m fiberglass trough. Each incubator was supplied with filtered (2 µm) seawater (1.6 l m^{-1}) through a vertical inlet pipe.

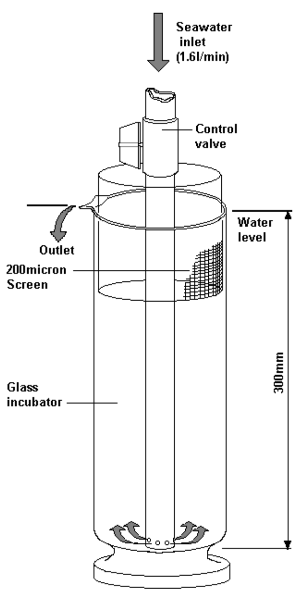

Figure 2: Glass salmon ova incubators used in the second spiny lobster egg experiment.

To test the effectiveness of chemical treatment for controlling pathogens, some eggs from three *Sagmariasus* (formerly *Jasus*) *verreauxi* were removed and treated with formalin, as above. A 10 g egg mass was placed in each of the incubators which were then randomly assigned one of two treatments: either the eggs were left in the incubators without any chemical treatment; or the eggs were given a 1 h bath, three times a week, using 0.5 ml l^{-1} of 'Malcon', a zinc-free malachite green oxalate. The egg masses on the females were again controls.

All eggs in the second experiment, regardless of treatment, became infected by a solid, white, blanketing layer of bacteria. Twelve species of bacteria were present but it was not possible to isolate those causing the egg mortality. Only 39% of the incubators had any phyllosomas hatch and in only 28% of these did more than 1% of the eggs hatch. Of this 28%, 11% hatched from incubators that were treated with Malcon and 17% from incubators that did not receive any chemical treatment. The eggs that were retained on two of the female lobsters as controls hatched normally without any bacterial problems whilst the third female stripped her remaining eggs.

Despite the upwelling motion, the eggs formed clumps in both incubators, an ideal breeding ground for both bacteria and fungi. It seems the grooming and fanning by the female is critical in maintaining the health of the egg mass and these actions cannot be replicated by the upwelling systems and chemical cleaning such as those used in the experiments. The results also indicate that there is a suite of infectious organisms present in the egg mass – once the eggs are removed from the female they opportunistically proliferate. When one organism is removed, the next dominates, as was the case in the second experiment when fungi were removed and bacteria took over.

Their small size and associated pathogenic fauna mean that spiny lobster eggs do not readily lend themselves to being removed and held in incubators. Mother lobsters know best!

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RESEARCH NEWS

Behavior of spiny lobsters inside communal shelters: the "Big Brother" approach

From: Enrique Lozano-Álvarez, Patricia Briones-Fourzán and Howard M. Weiss

Many species of spiny lobsters are gregarious and shelter communally. Most field or laboratory behavioral studies on spiny lobsters, including their social behavior, have been conducted outside their shelters, i.e., when the lobsters leave their shelters to carry out their daily activities (reviews in Atema & Cobb, 1980; Herrnkind, 1980). However, the behavior of spiny lobsters inside their communal shelters has seldom been reported. We recently started a series of short-term studies on the in-shelter behavior of two spiny lobster species, *Panulirus argus* and *P. guttatus*, using an approach akin to the "Big Brother" devised by George Orwell in his book "1984". We used artificial caves equipped with video cameras that "observe" and record the activity of lobsters within the cave. Our first attempts, conducted in artificial caves deployed in tanks, included the recording of a group of lobsters of both species and one predator (the triggerfish *Balistes vetula*) (Lozano-Álvarez & Briones-Fourzán, 2001), and of several groups of *P. argus* cohabiting with moray eels (unpublished). In 2000 we also began systematic studies on the behavior of *P. guttatus*, because this species is an obligate reef-dweller that spends long times within its shelters, in contrast to *P. argus*, which is highly mobile and has several ontogenetic habitat shifts.

First, we studied the shelter-related behavior of groups of six individually marked *P. guttatus* through several observational series. We focused on their daily activity rhythms and their behavioral patterns as related to shelter occupancy. Observations were conducted in outdoor circular tanks 3 m in diameter, provided with artificial shelters that resembled a triple-chambered reef cave. Each chamber was equipped with a closed-circuit video camera that recorded the activity of lobsters inside the shelters (Fig. 1). The tapes were later processed in the lab. One of ELA's students, Iris Segura-García (2001) reported on parts of this information in her thesis.

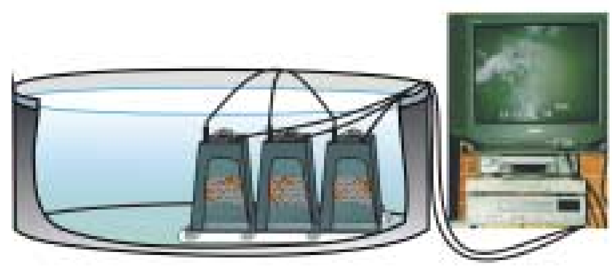

Figure 1: Diagram of the experimental system.

In-shelter activity of the groups of *P. guttatus* occurred both day and night, increasing at 05:00–06:00 h —prior to dawn— and decreasing during the day. Out-of-shelter activity occurred solely at night but peaked at 20:00–21:00 h, whereas shelter occupancy was 100% from 06:00 to 18:00 h. Lobsters tended to aggregate in the shelters and to climb to the walls rather than staying on the floor of the caves. Thirty-two different behavioral units (most of them described for other spiny lobster species by Atema & Cobb, 1980), grouped in six categories, were recorded and their frequency measured over one night. Results indicate that individuals of *P. guttatus* (a) are rather reclusive and do not leave their shelters during the day; (b) are more gregarious than solitary; and (c) maintain a high level of in-shelter activity, with evidence suggesting dominance by large males.

We are currently using one-chambered artificial caves deployed directly on a natural shallow seagrass meadow at Puerto Morelos, Mexico, designed for behavioral studies on large juvenile *P. argus*. We have used these shelters in two different series. In the first series, four individual *P. argus* were tethered so that they could roam the cave freely but could not escape from it. In the second series, the lobsters were untethered, but the cave was modified with funnel-shaped entrances that allowed other organisms to enter but precluded the four lobsters from leaving the shelter. Although both series were preliminary, they yielded interesting data. Despite the continuous presence of the lobsters, a suite of mobile organisms entered the artificial caves, in particular moray eels (*Gymnothorax moringa* and *G. vicinus*) and other lobsters. In our previous observations in tanks, lobsters and moray eels cohabited in the caves for up to 17 days without aggressive interactions. However, in one of the caves deployed on the seagrass meadow, one *G. moringa* readily fed on the corpse of a lobster that had been previously killed (presumably by a transient triggerfish). On a different occasion, a moray eel entered the cave several times, explored it, killed and consumed a live lobster, and left the cave. The whole sequence of events lasted a mere seven minutes.

Because lobsters other than the “forced residents” have also occupied the artificial caves on the seagrass meadow, we are considering the deployment of empty artificial caves and waiting for free lobsters to colonize them. This could yield less manipulated observations. The “Big Brother” approach could be a useful tool to analyze the in-shelter behavior of different species of lobsters, especially those which, as *P. guttatus*, remain in their shelters for long periods.

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In ovo embryonic development of the Mediterranean slipper lobster, *Scyllarides latus*

From: M.L. Bianchini and S. Ragonese

The Mediterranean slipper lobster, *Scyllarides latus* Latreille 1803, quite common until the 1970s, is now a rare occurrence in Italian water. Therefore, a feasibility study on stock enhancement was carried out a few years ago (Bianchini *et al*., 1998). While the complete larval development has been achieved under artifical conditions in various Scyllaridae species, only a few stages are known for the genus *Scyllarides* (Robertson, 1969). In *S. latus*, only the early free-swimming larvae have been described (Santucci, 1925; Santucci, 1928; al-Kholy, 1981; Glavic *et al*., 2001), and none for *in ovo* embryonic development.

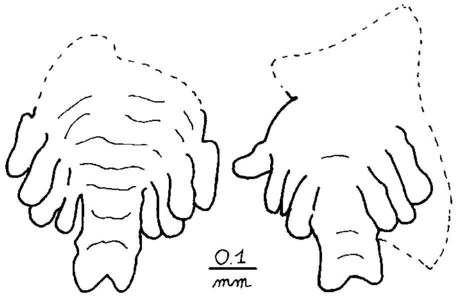
The Mediterranean slipper lobster (whose sex-ratio is 1:1) mature, copulate, spawn and brood easily in aquarium conditions, although fertilization of the roe mass is often incomplete. In our tanks, the smallest berried female was 491 g (mean 783 g). Of about 100 “appropriately-sized" females handled during the study, 40% of the specimens were captured already berried or matured in the laboratory tanks. This species does not necessarily molt prior to mating.

Because berried animals are sensitive to handling and lose almost all of their eggs when frequently manipulated, it is difficult to follow the embryo development in a single female: therefore, we took a “synthetic” picture from different females sampled independently at various stages of egg ripeness. The eggs were preserved in formaline, manually broken under a microscope, and the embryos sketched with the help of a tracing chamber or their picture taken under a light or scanning microscope.

The *in ovo* developmental stages can be also assessed by using a six-level macroscopic scale, based on the color of the egg (like in Martins, 1985). In this study, the scale was adapted (Appendix 1) to take into consideration the egg dimension, which seems a more objective, and consistent parameter (the C.V. is around 5%). Incidentally, the larval rearing, as well as the collection of wild nistos, was attempted during this study to limited avail.

In Southern Italy, the extrusion of eggs starts around the end of May. Eggs are spawned just after mating, and are thereafter carried for 4-6 weeks during which time the female actively grooms them. Egg masses are sometimes kept for longer periods of time even if not fertilized. During the incubation period, embryos do not develop in full synchrony and pass through several stages before becoming a viable naupliosoma larvae: a “naupliar” (without visible eyes), a pre-naupliosoma (well defined, eyed embryo, with feathered antennas and rounded limbs) and an early-naupliosoma phase (Fig. 1). The free-swimming naupliosoma stage (Fig. 2) lasts only few hours, to become a long-legged phyllosoma I (in our case, with a mean disk size of 1.82 mm). The phyllosoma eventually passes through multiple metamorphic events, maybe eleven, before reaching the final nisto form (Phillips and Sastry, 1980).

A



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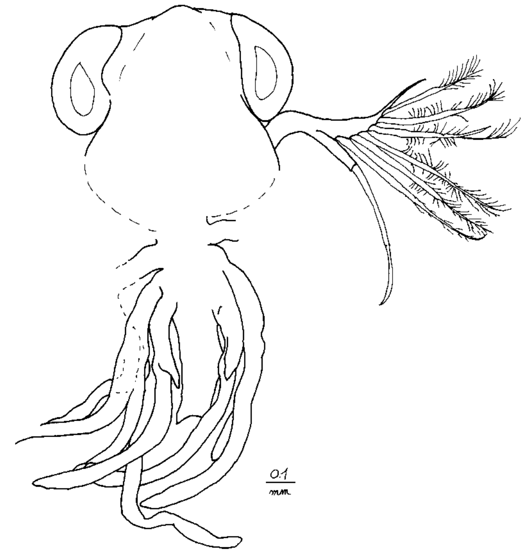

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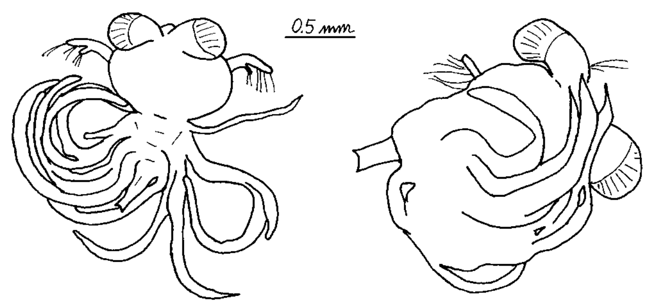

Figure 1: In ovo embryo stages of Scyllarides latus: a) two "nauplius"; b) pre-nauplosoma; and c) newly-hatched and "ready" naupliosomas.

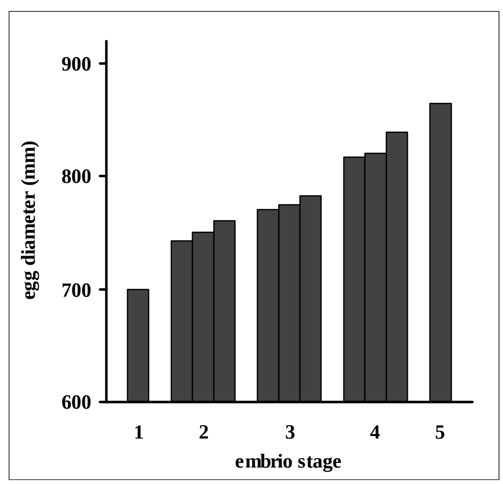

Figure 2: Embryo stage (see Appendix 1) vs. egg dimension in Scyllarides latus.

Appendix 1: In ovo embryo stages in Scyllarides latus.

stage	**description**	**corresponding to Martins (1985)**
0	light yellow egg, diameter 600-650 µm, weak and scarce filaments non-fecunded, or maybe at the beginning of segmentation	1
1	dark yellow egg, diameter 660-720 µm, well developed filaments no visible eyes at all, a darker embryonal "spot" can be seen at microscope	2
2	yellow-light orange egg, diameter 740-760 µm no visible eyes, embryo very difficult to see even at microscope; nauplius	2-3
3	yellow-orange egg, diameter 770-790 µm eyes visible macroscopically, embryo distinct from yolk and shell; pre-naupliosoma	3-4
4	orange egg, diameter 810-840 µm evident eyes, well defined larva, nailed extremities; naupliosoma	4-5
5	dark orange egg, diameter 865 µm ready to hatch, limbs visible thru the shell; advanced naupliosoma	6

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P. argus Photo by Jake Levinson

Aspects of the larval biology of Southern Rock Lobster in Tasmania: north vs. south

From: Michel Bermudes

Our knowledge of southern rock lobster (*Jasus edwardsii*) larval biology, ecology and dispersal remains patchy and too superficial for the needs of fisheries management and policy makers. Females carry eggs for 4 - 5 mo., hatching taking place during July to December depending on region (Winstanley 1977). After a 15-24 mo monumental journey that takes the pelagic larvae (phyllosomas; Fig. 1) tens to hundreds of kilometres offshore, they return to the reef as new recruit pueruli (Bruce *et al.* 2000). During my PhD, I was interested in the largely unknown environmental preferences (particularly temperature, light and water quality) of early-stage phyllosomas. While results were primarily intended for the improvement of hatchery propagation, the research also led to a better understanding of the behaviour and physiology of early-stage phyllosomas.

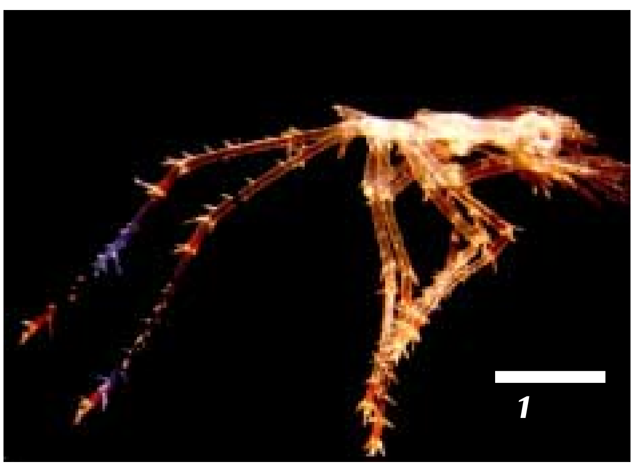

Figure 1: Side view of a stage I phyllosoma. The flattened morphology the phyllosoma (leaf-like body in Greek) is particularly well adapted for oceanic dispersal.

My research showed that rock lobster larvae undergo tremendous changes in behaviour within the first couple of days after hatching. While strongly attracted to light and therefore swimming on the surface upon hatching, phyllosomas display the opposite response only 2 d after hatching (Fig. 2). The early migration toward the light is likely to be linked to dispersal, allowing the larvae to ride offshore-moving, surface, wind-driven currents. Therefore, there appears to be only a short time frame for larvae to get offshore to continue their development. My observations suggested that the onset of this behavioural shift might be temperature dependent, being later at cooler temperatures. If this holds true in the field, we would expect larvae hatched in the cooler southern Tasmanian waters to remain longer at the surface than phyllosomas hatching in the warmer northern regions. The level of predatory pressure in the area of hatching and the time spent at the surface after hatching may be important factors dictating abundance of later stages.

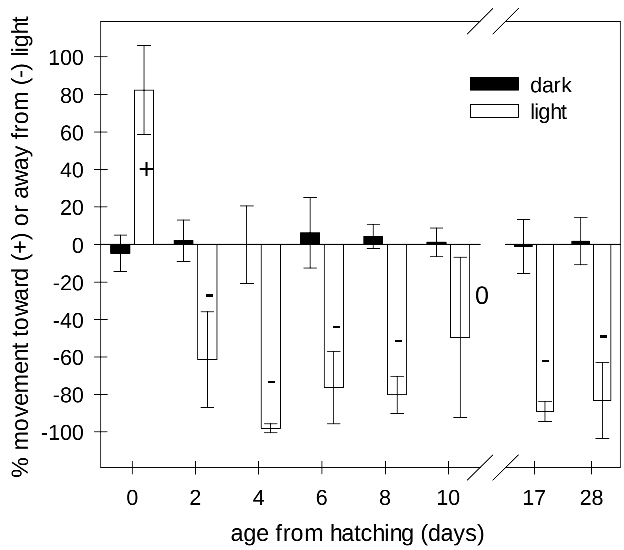

Figure 2: Changes in behavioural response to light during the early development of southern rock lobster larvae. The movement toward (+) or away from (-) the light is compared with the random distribution (0) of larvae in the dark.

Temperature is a primary parameter influencing larval fitness, with highest growth rate in phyllosomas cultured at around 18°C (Fig. 3). Interestingly, reduced size was observed in larvae cultured at lower temperatures – which may have important fisheries implications. My results would predict that larvae hatching off northern Tasmania between November and December (e.g. King Island) at sea surface temperatures ranging from 12.7°C to 17.4°C (records from 1989 to 1999, King Island; NOAA satellite AVHRR imagery) will grow larger and be fitter than their counterparts hatched from July to October in southern Tasmanian waters at temperatures ranging from 8.6°C to 14.1°C (Maatsuyker Island).

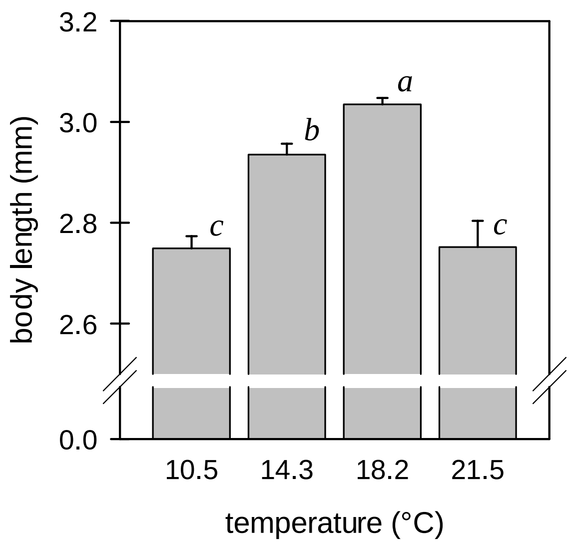

Figure 3. The effect of temperature on the growth of stage 1 southern rock lobster larvae. Treatments with different letters differed significantly (P <0.05).

While understanding the complete larval recruitment process of rock lobster in Tasmania remains a massive task, these results show that much can be gained from studying young phyllosomas in culture. The origin and successful transition from coastal to oceanic waters of these early stages may be critical in determining later pre-recruit abundance.

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HISTORICAL PERSPECTIVE

Two Hundred Years of Lobster Natural History and Research in Cuba Archipelago

From: Raúl Cruz

P*anulirus argus* (Latreille, 1804) is the basis of important fisheries in countries of the Western Central Atlantic. Considerable scientific study of this species has occurred in The United State of America (Florida), Cuba, Mexico and Brazil from which we have obtained considerable knowledge about history life and the effective management of stocks. Seventeen years before Latreille (1804) described the species *Panulirus argus* and *Panulirus guttatus* in the Atlantic, the Portuguese Manuel Antonio Parra (1787) in his book "Diferentes Piezas de Historia Natural, las Más del Ramo Marítimo, representadas en setenta y cinco láminas" (Fig. 1), made the first descriptions of spiny lobster off the Cuban coast (Fig.2). The morphological descriptions and drawings in that document are insufficient to discern between *P. argus* and *P. guttatus*, although it is possible that the sheet refers to *P. argus* when the author noted that its coloration is "pink, white and yellow." The coloration of *Panulirus laevicauda* (Latreille, 1817) does not coincide with the author's description. Parra (1787) described three more species of lobster: *Justitia longimanus* (Milne-Edwards, 1837) was reported with the vernacular name of "Camarón del alto" (Fig. 3) as were two species from the family Scyllaridae (Fig. 4) which were termed "langostino". Those descriptions of the external morphology and the drawings of both

Figure 1: The fishermen's engraving the Parra (1787) book. It represents two fishermen, one of them with a trident that lift a net of the sea, full with fish, next to a rock where there are distinguished several crustaceous (crabs and lobsters). In the superior part it is read "Labore , et Constantia".

individuals suggests that the species in question were *Scylarides aequinoctialis* and *Parribacus antarticus* reported by Lund in 1793. Other Scyllarid species in the region include *Scyllarus americanus* (Smith, 1869), *Scylarus faxoni* (Bouvier, 1917) and *Scylarus chacei* (Holtuis, 1960), but they are all very small lobsters (between 2 and 4 cm of total length) and not abundant in Cuban waters. Parra collected, described and studied in detail the fish and crustaceans of the Island of Cuba and his book opened the way for the study of the Natural Sciences in Cuba. Felipe Poey, Milne-Edwards, Cuvier , Valenciennes and other 19th century scientists noted the merits of the Parra monograph (García, 1989).

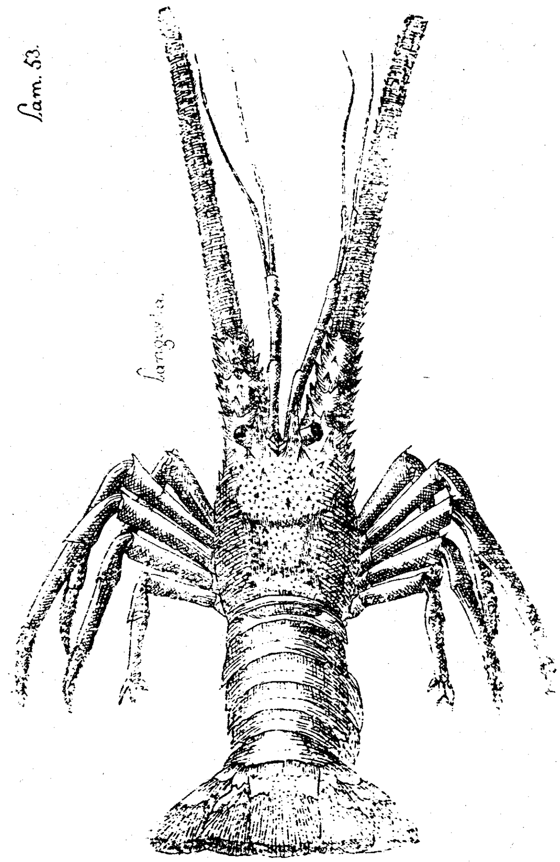

Figure 2: Lobster (Probably Panulirus argus). Sheet 53 in the original work. Parra (1787) only used vernacular name in the description of the species. He described the external morphology and color (between pink, white and yellow) of the lobster and suggested that it meat is very flavorful with oil and vinegar.

The initial studies whose purpose was to protect the marine fauna of Cuba, were carried out in the second half of the 19th century by the illustrious naturalists Don Felipe Poey, and Don Juan Vilaró, among others. In 1886, the first conservation measures were promulgated, primarily for mollusks in the Junta Central de Pesca del Apostadero de la Habana, and at that time were decreed the first regulation measures for spiny lobster, including closed seasons and minimum sizes for the Junta Nacional de Pesca, August 5 of 1915 (García, 1919). The legal minimum size of 210 mm (total length), which corresponds with a 150 mm measurement from the edge of the supraorbital spiny to the last abdominal ring or a 69 mm of carapace length, was thus adopted by the industry (Cruz et al, 1990).

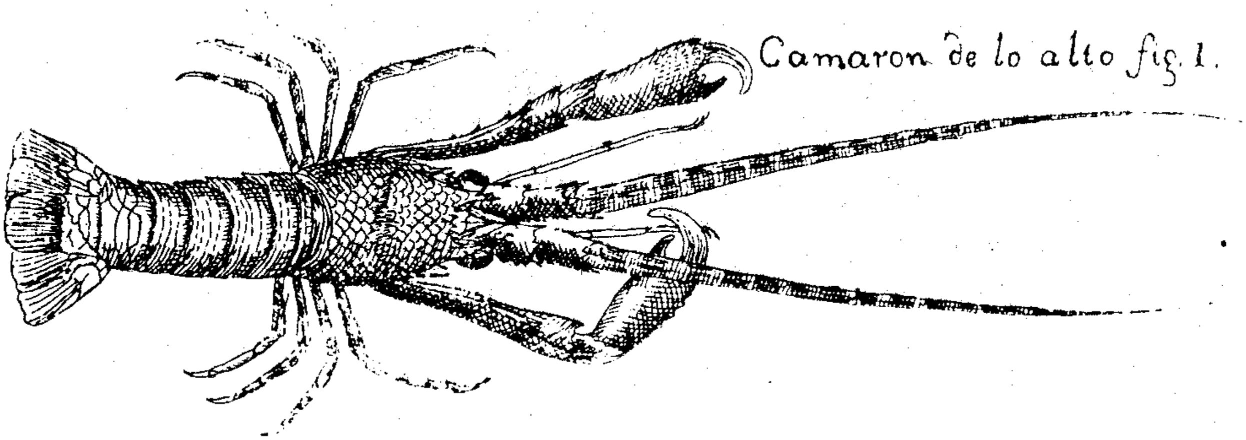

Figure 3: Camarón del alto (without doubts Justitia longimanus). Sheet 55, figure 1 in the original work. Parra (1787) described that this specie only live in bottom of one hundred fathoms. In Cuba, has being catched to this deep.

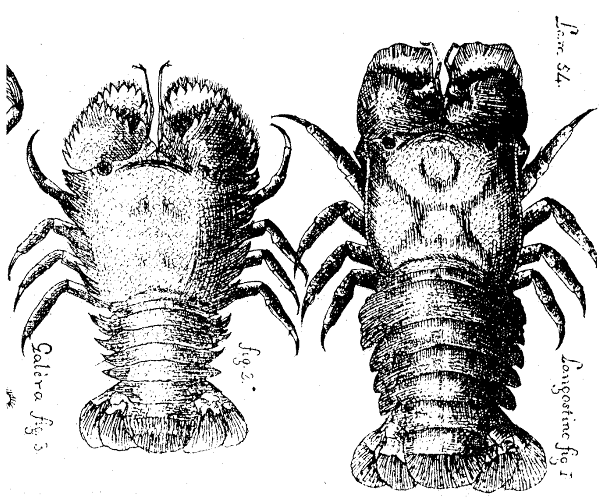

Figure 4: Langostinos (Probably Parribacus antarticus and Scylarides aequinoctialis). Sheet 54, figure 2 and 1 in the original work. Parra (1787) described the external morphology, color of these species, and probably made observations of egg bearing female when he described that the female has in the infer portion a "membranous fringes", more long and wide that the males, that allow carry out the eggs.

The study of Salvador de la Torre y Huerta (1914), " Contribución al Estudio de la langosta Panulirus argus, Latreille" (Contribution to the study of *Panulirus argus* lobster, Latreille)", was the first doctoral thesis about lobster biology in Cuba and in the Caribbean region. He produced a classification system for crustaceans and lobsters in the region and provided a very detailed description of external and internal anatomic structures and functions, including: sexual organs, sense organs, dermis, respiration, circulatory apparatus and circulation, digestive apparatus and digestion, excretory structures, and musculature. Finally, he carried out a brief description of the lobster fishing industry. Up through the middle of the 20th century, many papers referenced this common knowledge of the lobster *P. argus* (Anon, 1939; García, 1919; Gómez, 1935; Martínez, 1948; Sánchez-Roig, 1950, 1952; Sánchez-Roig, and Gómez, 1952, 1954). After some sixty decades of study, the number of scientific papers pertaining to spiny lobster in Cuba has increased, no doubt because of great economic importance of this species to Cuba.

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NEW METHODS & APPLICATIONS

Shell hardness made simple!

From: Josephine Walker, Caleb Gardner and Richard Musgrove

"Shell hardness" or "shell state" has been recorded for many years for lobsters collected in catch sampling conducted by both the Tasmanian Aquaculture and Fisheries Institute (TAFI) and the South Australian Research and Development Corporation (SARDI). This information is intended to provide a guide to the timing of moulting in the sampled populations, which helps in a range of analyses including those of growth and behavioural factors influencing CPUE.

Although potentially a valuable source of biological information, shell hardness and shell state are difficult to quantify. We currently record shell state based on the wear and fouling of the shell, while shell hardness is crudely categorised into "soft" or "hard" shell. These are subjective measures and classifications inevitably vary between individual observers. The issue has recently become of greater importance to the Tasmanian fishery as changes to the length of the season have resulted in increased landings of softer-shelled lobsters. The problem has affected researchers, fishers and processors alike. In particular, recently moulted lobsters are usually unsuitable for export, being easily damaged (reducing the beach price by up to $10/kg) and more likely to be cannibalised while in tanks prior to export.

The need to develop a shell hardness standard has prompted collaborative research between TAFI and SARDI, with funding support from the Rock Lobster Post Harvest Subprogram of the Australian Fisheries Research and Development Corporation. The main objectives of the study are to establish a method by which hardness can be accurately measured, identify the most appropriate position on the carapace to take this measurement, and to determine the minimum hardness acceptable for lobsters that are to be exported.

The recently commenced project will continue until mid 2003. Shell hardness is measured with a durometer (Fig. 1). This device was designed for measuring the hardness of plastic sheeting but also appears suited to quantifying the hardness of lobster shells. Different types of durometer are being tested, with the aim of providing researchers, fishers and processors with a tool that is practical, cost effective, durable, reliable and objective. Lobster processors are assisting in calibration of hardness results (Cape

Domby Seafoods, Skye Seafoods and A. Garth Seafoods). Russell Fraser Pty Ltd is assisting with engineering aspects of the Rex durometers.

Figure 1: Using a durometer to test the shell hardness of the abdomen of a male southern rock lobster, Jasus edwardsii.

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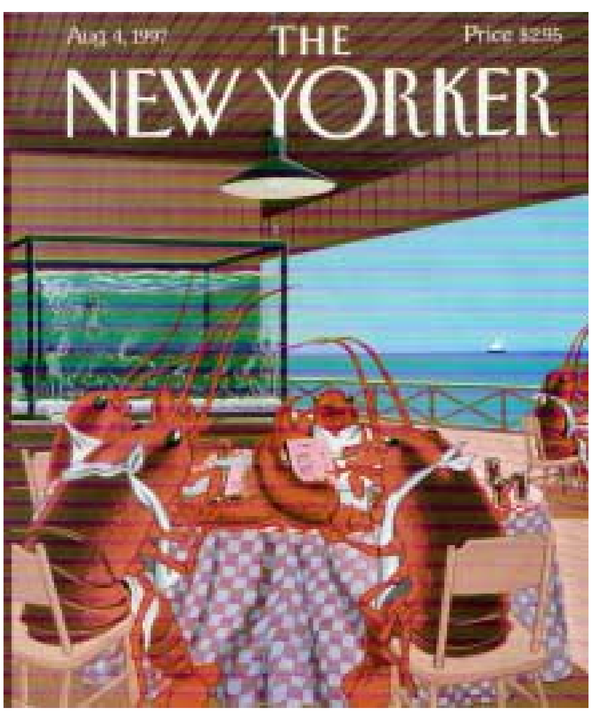

The Lobster NEWSLETTER

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