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The Lobster NEWSLETTER

RESEARCH NEWS

The First Viral Disease Reported in Lobsters

From: Donald Behringer, Mark Butler and Jeffery Shields

In 1999, while sampling juvenile Caribbean spiny lobster (*Panulirus argus*) populations in the Florida Keys, we discovered lethargic, moribund animals whose hemolymph appeared chalky, rather than its normal transparent color. Hemolymph smears were negative for Gram-negative bacteria, but histopathology of lobster tissues showed viral inclusions in the nuclei of infected hemocytes. In heavily infected individuals, virtually all of the host's hyalinocytes and semigranulocytes were destroyed. Subsequent transmission electron microscopy (TEM) confirmed the disease to be an enveloped, icosahedral, Herpes-like DNA virus (HLV-PA) with a nucleocapsid approximately 187 nm in size (Fig. 1).

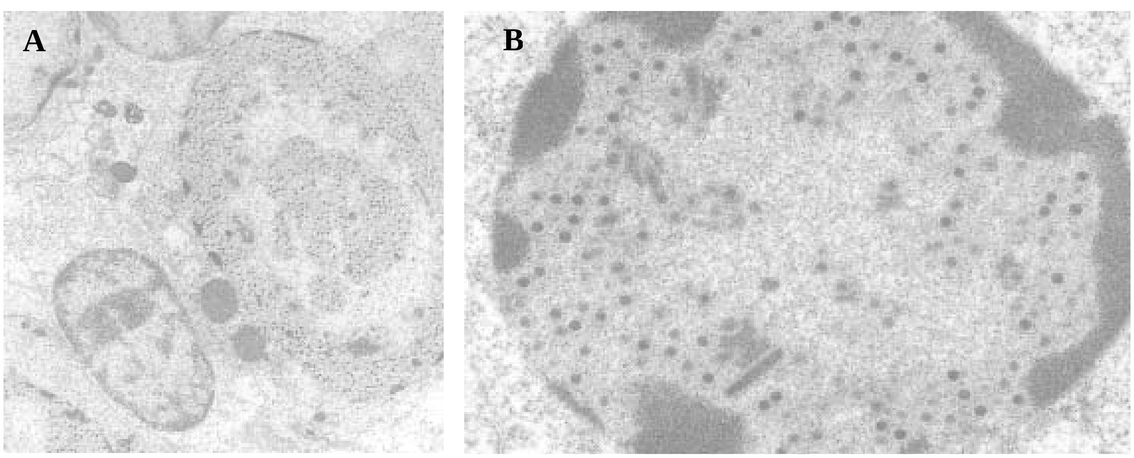

Figure 1: Electron micrographs showing Herpes-like virions in hemocytes of Caribbean spiny lobster. (A) Hypertrophied hemocyte nucleus with viral inclusions at right adjacent to an uninfected cell on the left. (B) Hemocyte nucleus with electron-dense circular virions budding

Evans et al. (2000) recently reviewed the few known diseases of spiny lobsters and until our discovery, naturally occurring pathogenic viral infections have never been conclusively demonstrated. Viral diseases have spread rapidly in other crustacean populations

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(e.g., king crabs, blue crabs, and shrimp) and have been attributed to declines in natural populations and aquaculture stocks. We do not know if this disease is new in south Florida, if it has been present for some time but simply has gone unrecorded, or whether it is an emergent pathogen of increasing prevalence. However, our preliminary findings suggest that this virus is highly pathogenic, widespread, and lethal.

Distribution and Prevalence: Infected juvenile lobsters occurred at 75% - 100% of the nursery habitat sites (n = 14 sites) that we have surveyed twice a year (summer and winter) in the middle and lower Florida Keys since 1999. The prevalence of diseased lobsters at each site averages 12% but can be as high as 40%. These are conservative estimates because they are based only on the presence of heavily infected individuals that are discernible by visual inspection of the hemolymph. Without histological analysis of tissues from every individual sampled we can not identify less heavily infected individuals. However, we are now working on an immunoassay to permit rapid identification of infected lobsters in the early stages of the disease progression.

Thus far, the disease appears limited to juvenile lobsters, which occur primarily in nursery areas 5 – 10 km from the coral reefs where adults reside. Our colleagues (John Hunt, Lynn Cox, Tom Matthews, William Sharp, Rodney Bertelsen) at the Florida Marine Research Institute, the state of Florida's fishery management and research agency, just completed (July 2001) an initial survey of disease within adult lobsters in the Florida Keys. They sampled 860 adult lobsters from reefs throughout the Florida Keys and only 4 individuals (< 1%) presented visual signs of HLV-PA infection. Nearly all of the infected animals were sub-legal sized individuals that may have recently migrated to the reef from the nursery. Why juvenile spiny lobsters are more susceptible to the disease than adults remains unknown. It may be a consequence of ontogenetic differences in viral resistance, or the physical separation of adults and juveniles in different habitats.

Transmission: The social behavior of *P. argus* could presumably hasten the transmission of disease, be it by water-borne particles, direct contact, or ingestion of infected tissue. In inoculation trials, we injected hemolymph from infected individuals into healthy juvenile lobsters (n = 20) and 90% of the inoculated lobsters acquired the HLV-PA infection and died within 30 – 90 days. All of the control lobsters (n = 10) injected with uninfected hemolymph survived. When we fed healthy lobsters (n = 32) diseased lobster tissue in

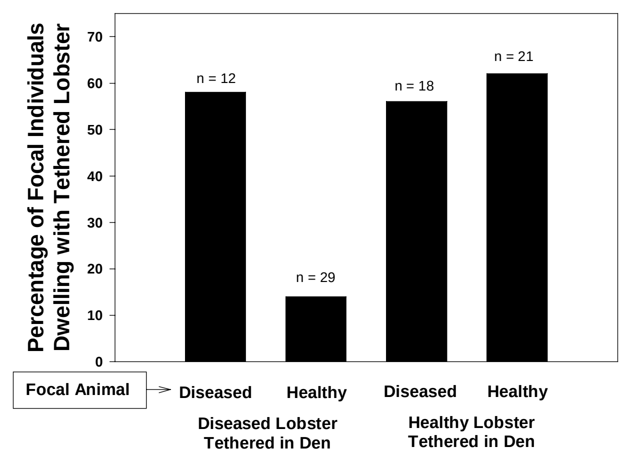

Figure 2: Results of preliminary laboratory trials testing patterns of den cohabitation among healthy and diseased juvenile spiny lobster. Healthy lobsters avoid cohabitation with diseased conspecifics.

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preliminary ingestion trials, 6% showed signs of infection and died within 45 days after having consumed diseased tissue on only three occasions. Tissue samples from the ingestion trials are currently being processed for histological analysis to ascertain true infection levels, which are likely to be higher than our estimates based on visually apparent symptoms.

Behavioral and Ecological Consequences of the Disease: Infected juveniles are found alone in dens (92% of individuals) more often than healthy juveniles (68% of individuals) and this phenomenon appears to be driven by changes in the behavior of healthy lobsters, not diseased ones. Preliminary laboratory experiments indicate that healthy juvenile lobsters avoid cohabitation with diseased conspecifics, presumably responding to alterations in the chemical cues produced by diseased individuals (Fig. 2). This remarkable change in the behavior of healthy lobsters could influence the spatial distribution of individuals in the population along with shelter availability, disease transmission, cooperative defensive behaviors, and ultimately survival.

Conclusions: We are in the process of expanding our research efforts on these extraordinary findings. In the next few years we plan to expand our field surveys and laboratory experiments to better determine the current distribution, local prevelance, and probable mode of transmission of the disease. Using laboratory experiments and field mark-recapture studies we will test the effect of the disease on pivotal aspects of lobster behavior, population dynamics, and spatial structure that may influence the spread of the disease. Finally, we hope to incorporate this new knowledge into our spatially-explicit, individual-based lobster recruitment model to explore whether lobster behavior or fishery practices alter the spread of the disease and the sustainability of this important resource.

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Survey of one of Namibia’s least fished lobster grounds

From: Kolette Grobler

Many of Namibia’s main commercial lobster (*Jasus lalandii*) fishing grounds have been surveyed annually by scientific divers since the early 1990’s. However, during last November and March our most northern commercial fishing grounds, off Sylvia Hill, were surveyed for the first time in more than 10 years. These grounds had not been commercially fished for more than 8 years, due to their remoteness and dangerous fishing conditions. The grounds

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consist of intertidal and shallow subtidal reefs within the breakers (Fig. 1) and are very difficult to reach from land due to their location on the inaccessible Namib desert coast. Historically lobster fishermen used small row boats and ring nets, and also hand collected lobsters at these grounds. Fishing is possible only during exceptional calm conditions and many fishers arriving from outside the area have capsized and drowned here over the years; those who reached shore could be trapped for days between the dune fields and the sea, without food, water, or shelter.

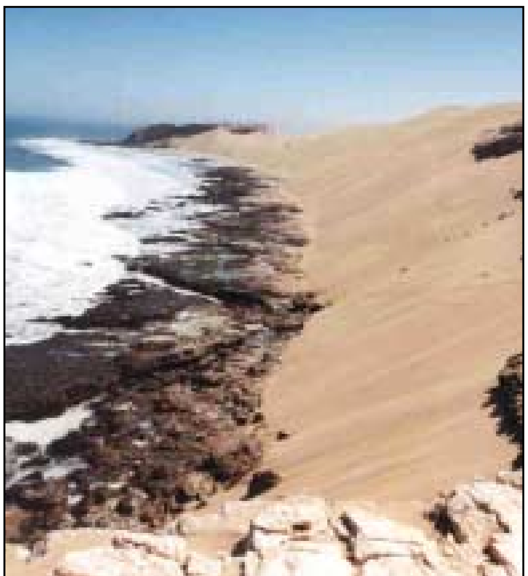

Figure 1: The Namib Desert meets the shore on the Sylvia Hill lobster fishing grounds. Our camp site was located well above this dune - in an attempt to avoid being sandblasted by the southerly winds! We drove to the top of the dune and then sledged the dive gear down to the beach below. The northern rocky point was inhabitated by about 3000 seals, and a cave at the south end of the beach has Namibia's most northern breeding colony of jackass penguins. Regular visitors to our campsite at night include black-backed jackals and brown hyenas.
(Photo: D. Louw)

We used 4WD vehicles to cross the Namib dune fields to reach Sylvia Hill, where a low dune was selected to gain access to the reef (Fig. 2). The beaches are short and narrow, with either the dunes or rocky hills spilling into the sea at high tide level.

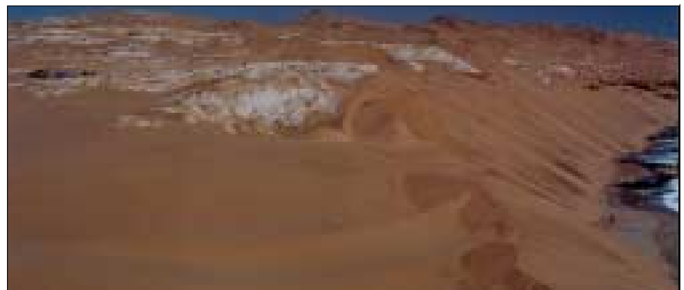

Figure 2: Our camp (upper left) consisted of seven tents and four vehicles. (Photo: J. Kemper)

The main aims of these dive surveys are to assess lobster recruitment, the benthic habitat (and food availability), and the depth distribution of lobsters. During March-April, lobsters along the Namibian coast are forced close inshore in response to low bottom dissolved oxygen levels (Grobler & Noli-Peard 1997). The November 2000 Sylvia Hill survey took place at a time of year when bottom dissolved oxygen levels further south are usually high, and the adult lobsters tend to occur at depths well below 30 m (lobsters were observed with an underwater video camera at depths exceeding 70 m). Off Sylvia Hill, however, young juvenile, older immature, and adult lobsters were all abundant in shallow waters. This could indicate either that the dissolved oxygen levels do not follow the same cycle as further south, or that the lack of subtidal rocky reefs (and thus food and shelter) limit the depth distribution of the lobsters. During the March 2001 survey, the Sylvia Hill lobster population was again well mixed and similar to those on the more southern grounds at that time of year.

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Our results indicate that both male and female lobsters on the Sylvia Hill grounds are on average much larger than in populations from the regularly fished grounds further south (Fig. 3). The March 2001 dive survey showed a virtual absence of legal size lobsters ($\geq$65 mm CL) on heavily fished grounds (e.g. Hottentot Point) and a relatively small proportion of legal size males on moderately fished grounds (e.g. SW Blinder). For adult males (>50 mm CL) the size distribution at Sylvia Hill was similar to that at the Ichaboe lobster sanctuary (although male lobsters above 100 mm CL were slightly more abundant at Sylvia Hill). Of particular interest was the high abundance of large females on the Sylvia Hill grounds compared with both the fishing grounds further south and the sanctuary (which is surrounded by fishing grounds). This has cast some doubt as to the effectiveness of the sanctuary in protecting adult females, even though, for unknown reasons, large males seem to be more abundant there. It also shows that, although females in Namibia seldom reach more than 65 mm CL on commercial grounds, they will become much larger if left undisturbed. This has significance for egg production and recruitment, because larger females produce more eggs (Beyers & Goosen 1987).

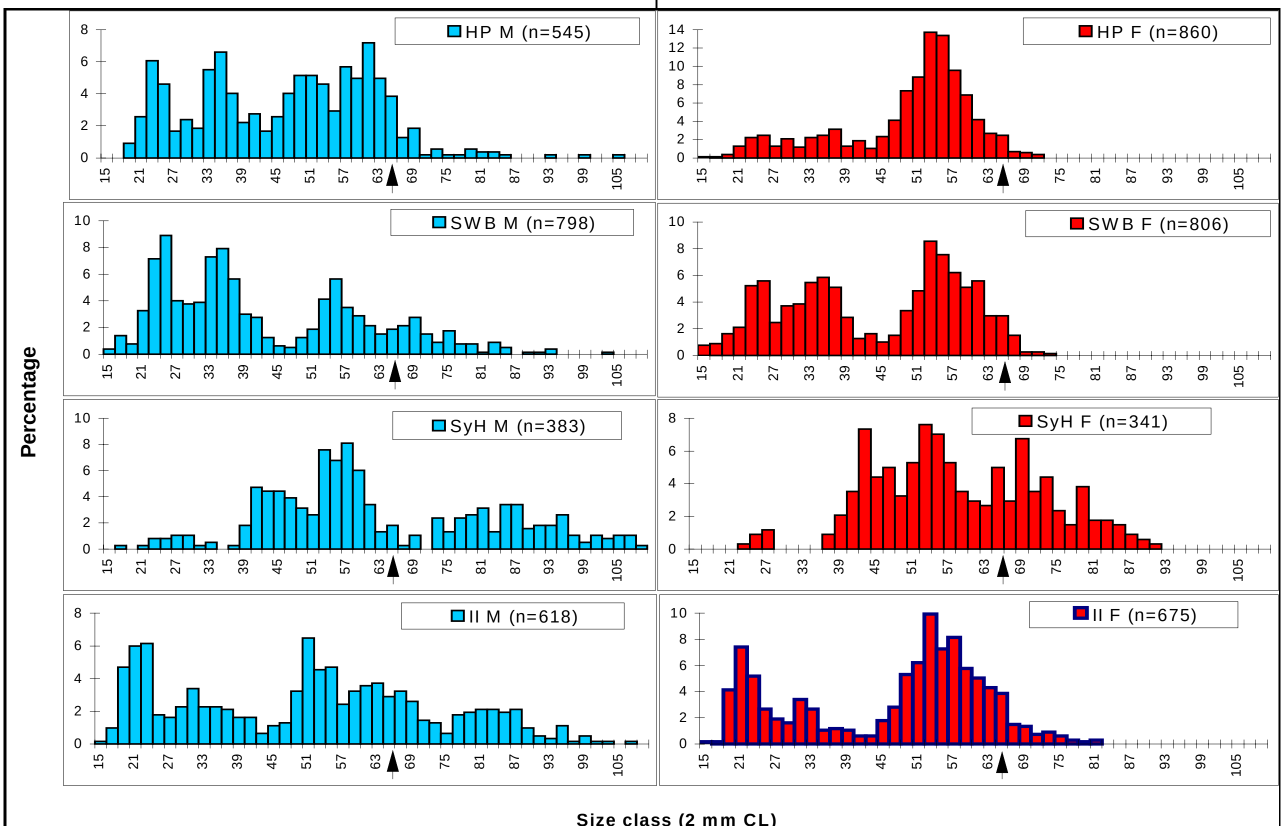

Figure 3: Size distributions of male (M) and female (F) lobsters caught at four Namibian lobster grounds: Hottentot Point (HP), South West Blinder (SWB), Sylvia Hill (SyH) and Ichaboe Island (II). The arrow indicates the minimum legal size limit of 65 mm CL.

Recruitment of the smaller year classes (<40 mm CL) was difficult to study at Sylvia Hill, due to the demanding dive conditions. Many more juvenile lobsters were seen than were caught. Thus our data on new recruits is inconclusive

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compared with those from the more southern grounds where results from the March 2001 survey showed the presence of two clear cohorts below 40 mm CL (Fig. 3).

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Shelter preferences of newly-settled Panulirus ornatus

From: Darren Dennis and Roland Pitcher

Surviving *Panulirus ornatus* pueruli from plankton samples collected in the north-west Coral Sea during May 1997 were released into an aquarium containing artificial shelters to examine the shelter preferences of newly-settled, and subsequently, first instar juvenile lobsters. The artificial shelters consisted of crevices, holes, and caves cut into two blocks ($400 \times 200 \times 40$ mm) of aerated concrete (Hebel ®), one laid horizontally and the other placed vertically; as well as bare sand. Two crevices, 6 mm wide by 15 mm deep, were cut across the top and bottom of each block. A total of 210 holes with diameters of 5 mm, 10 mm and 15 mm were drilled, in groups of three, into the horizontal and vertical blocks. Half of these were drilled to a depth of 15 mm and half to 30 mm. Horizontal cave shelters were created by drilling fifteen 25 mm holes into the front edge of the horizontal block. The sand on the bottom of the aquarium was level with the centre of, and filled the floor of, these caves. A further fifteen 25 mm holes were drilled into the top edge of the vertical block.

A total of 54 *P. ornatus* pueruli were placed in the aquarium during the 26 days of observation but 12 subsequently died and were removed. The locations of all pueruli and first instar juveniles were recorded each morning. The aquarium was supplied with running seawater at ambient temperature (generally 26-27° C) and aerated. Juveniles were fed by-catch from the plankton samples (principally mysids), each night. Shelter preferences were tested using Pearson Chi-square tests on one-way or two-way contingency tables of observation counts pooled over the 26 days. The shelters chosen by the pueruli and first instar juveniles were recorded on 297 and 600 occasions, respectively.

Both stages showed significant ($p<0.001$) preference for hole shelters over cave, crevice or sand shelters (Fig. 1). No lobsters sheltered in 5 mm holes. Pueruli showed no significant ($p=0.630$) preference for 10 or 15 mm hole shelters but juveniles significantly ($p<0.001$) preferred 15 mm over 10 mm holes. Both pueruli and juveniles showed significant preference ($p<0.001$ and $p=0.002$, respectively) for deeper hole shelters, although for both stages this preference was less obvious for the 10 mm diameter holes compared to the 15 mm hole shelters.

In the hole and crevice shelters, the pueruli and juveniles showed no significant preference ($p=0.319$ and 0.689 respectively) for vertical or horizontal orientation.

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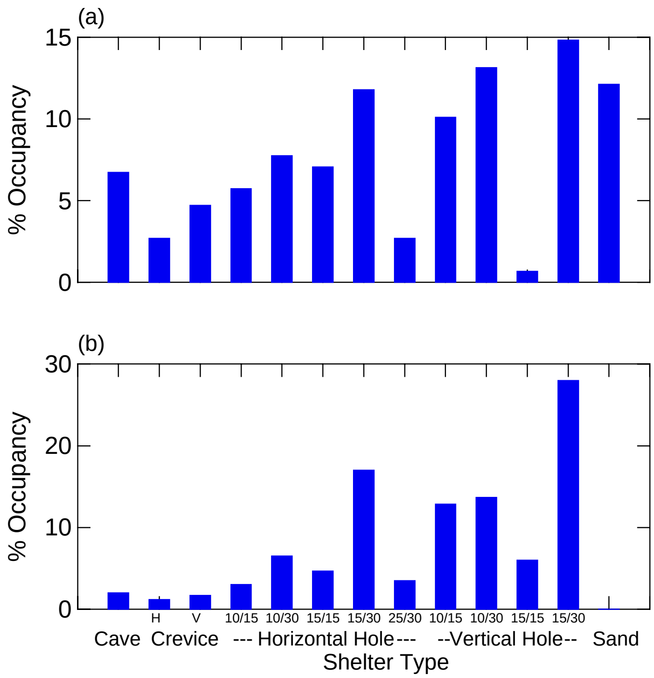

Figure 1. Percent occupancy by newly-settled (a) and first instar juvenile (b) *Panulirus ornatus* in several shelter types offered in an aquarium. Bar labels indicate horizontal (H) or vertical (V) orientation and the diameter and depth of hole shelters in millimetres (eg. 10/15 corresponds to 10 mm diameter and 15 mm depth).

On 36 occasions, pueruli were found buried in sand with their antennae lying on the sand surface, but no juveniles were seen to do this.

The preference for holes over sand or crevice and cave shelters shown by newly-settled juvenile *P. ornatus* compares well with shelter preferences shown by wild lobsters in Torres Strait (Dennis *et al.* 1997). However, the habitat of wild pueruli in Torres Strait was not documented and the current study provides new information, particularly the ability of pueruli to shelter in bare sand. Presumably this behaviour serves to reduce the risk of predation while pueruli are searching for more suitable habitat.

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Fisheries & Aquaculture Update

The sandwich collector, developed for commercial-scale harvesting of western rock lobster pueruli

From: Mark Rossbach, Bruce Phillips and Roy Melville-Smith

There is increasing interest worldwide in the commercial potential for on-growing juvenile spiny (rock) lobsters. In 1998, Fisheries Western Australia commenced a project, funded by the Fisheries Research and Development Corporation (FRDC) and managed by the Rock Lobster Enhancement and Aquaculture Subprogram, to examine the effect of harvesting large numbers of pueruli of the western rock lobster (*Panulirus cygnus*) on the wild fishery, and to develop large-scale harvesting techniques. We found that one type of collector stood out from all the others; this article describes this collector, its construction, deployment, method of servicing, and more. (See Phillips *et al.* (in press) for descriptions of all the collectors tried, and their catch rates.)

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The sandwich collector (Fig. 1) is a robust, relatively inexpensive (approximately $AU120) puerulus collector. It is based on the seaweed-type collector used by Montgomery and Craig (1996), that itself based on the Phillips collector (Phillips 1972). It consists of two rectangular, 4.5 mm thick sheets of grey industrial PVC (615 x 350 mm), instead of the three sheets used in the Phillips collector. Glued to the outer face of each sheet is a thin layer of woven polypropylene material. The tassels consist of polyethylene split fibre 125 tex (Kinnears Pty Ltd, Victoria, Australia) which comes in 1.5 m hanks weighing about 1 kg. Each hank is cut into 18 equal length tassels. Each tassel is bound tightly around its midpoint with a 20 cm strand of monel wire, and then attached to the PVC sheet by a 50 cm plastic tie passed through a hole in the sheet. A total of 25 evenly spaced tassels are used on each PVC sheet.

Figure 1: Sandwich collector

Two such sheets, secured back-to-back, make up the sandwich collector. We use two pieces of jarrah (47 mm x 45 mm x 38 mm), a hard wood grown in Western Australia, and stainless steel bolts to brace and secure the two PVC sheets (Fig. 2).

Two floats are attached to the jarrah braces at the top of the collector, while a bridle near the base secures the collector to the mooring block. The braces also allow a shaft to be inserted into the collector so that it can be spun when being serviced.

Figure 2: Internal side of the sandwich collector

Figure 3 shows the spinning shaft position in relation to the PVC sheets and braces. The floats are on short leads so as to avoid tangling the tassels. We use a figure eight knot to attach the floats, a knot that allows the floats to be easily removed when the collector is serviced.

Figure 3: Location of spinning shaft and spinning tub and holding brackets.

The main difference between the Montgomery and Craig (1996) collector and the sandwich collector is that theirs has a fixed aluminum center bar to which the floats and sheets are attached. We thought this cumbersome to use on our small research craft and it also made the

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collector more expensive. Furthermore, because we can remove our floats and use the one spinning shaft for all collectors, the size of the unit is minimized and we can service collectors more rapidly because there is no need to align the shaft to insert a pin before spinning the collector.

We use a 40 kg concrete block to moor each collector. About 1.5 m of 12 mm poly rope runs from the bridle at the base of the collector via a swivel to 12 mm galvanised chain, which is in turn shackled to the mooring block. The length of the mooring chain is generally about twice the water depth. Collectors set in this manner survived severe storms throughout last winter.

Recently we have had problems with the jarrah braces being attacked by shipworm (bivalve family Teredinidae), probably *Teredo navalis*. We need to look at chemical treatments to resolve this problem.

The collectors are positioned to float just below the surface and must be conditioned for at least two months. Our sampling was carried out over full moon. The collector is grappled from a small boat, pulled alongside and lifted onboard – which requires two people because of the weight. The floats and mooring bridle are then removed before the collector is serviced.

The spinning shaft slides into the central holes in the jarrah braces (Fig. 3). The whole unit is then placed inside a large tub (Fig. 4) with a plastic cover and the collector rotated both clockwise and counter-clockwise 20 times. For large-scale operations a device with an electric motor, like in a chicken rotisserie, would speed up servicing. The sample obtained is then poured into a sieve, sorted and the pueruli counted.

Figure 4: Spinning tub for sampling collectors.

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Doing Well Behind Bars

From: Andrew Jeffs and Phil James

The first experimental aquaculture of juvenile spiny lobsters in suspended sea cages has produced very promising results in New Zealand, the growth of *Jasus edwardsii* from pueruli being better than had previously been reported for land-based farming systems using ambient water temperatures (Jeffs & James 2001). On average lobsters reached 42.1mm CL and

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36.9g wet weight at the end of the first year. Mortality of lobsters was high (78%) at some experimental sites and low at others (14%), and on average below what has been recorded in land-based farming systems. Higher growth and mortality appears to have been associated with the higher water temperatures recorded at the sites in northern New Zealand, compared to the site in centre of the country. The lobsters were fed freshly opened green-lipped mussels (*Perna canaliculus*), but they also fed on fouling organisms on the inside of the plastic cages.

Farming lobsters in suspended sea cages has considerable potential for New Zealand, as it would be integrated with the extensive long-line aquaculture of green-lipped mussels (Holland & Jeffs 1999). This industry produces substantial amounts of waste mussels, which could be used to feed the lobsters. Economic analyses have indicated that land-based farming infrastructure and food costs were two of the biggest operating costs associated with farming spiny lobsters in tanks (Jeffs & Hooker 1999). Current work is focussed on scaling up sea cages to a commercial scale and assessing the effects of density and the provision of shelter on growth and survival.

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The Lobster NEWSLETTER

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Contact any Editor about submission of articles.

Comments on final editing and production should be sent to Mark Butler.

NEWS RELEASE

Crime does not pay!

The United States Attorney's Office for the Southern District of Alabama announced that three men, one from Honduras and three from the United States were each sentenced to 97 months in prison for their roles in conspiring to import into the United States numerous shipments of Caribbean spiny lobster tails harvested in Honduras in violation of Honduran and US laws. The men were convicted on November 3, 2000 for up to 37 offenses ranging from: importing lobster contrary to law, illegal monetary transactions, conspiracy, smuggling, and false labeling of fish. In addition to imprisonment, the men jointly forfeited $1,000,000US in proceeds from their illegal scheme and individually paid fines of $15,000 to $100,000US.

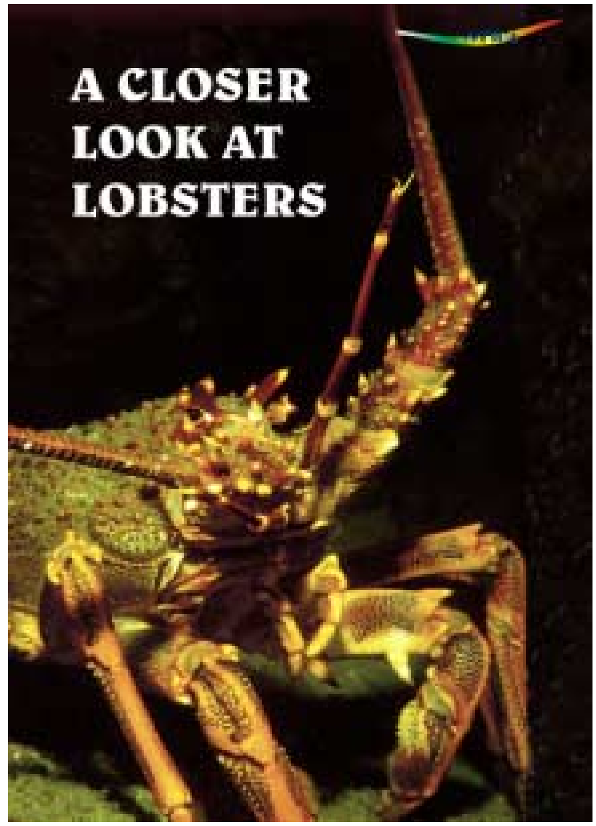
In the illegal scheme, one of the men, who owns the largest fleet of lobster-fishing vessels in Honduras, harvested egg-bearing lobster and lobster that were less than the legal size limit in Honduras. The lobster were then imported into the United States at Bayou la Batre, Alabama in bulk bags, in violation of Honduran law requirements that lobster be processed and sorted in Honduras before export. The lobsters were purchased by one of the other men through his US company, and then resold to U.S. seafood companies, including companies for which the other two men worked.

"*We will not tolerate those who flout environmental regulations as they harvest ocean resources, seeking short-term gains at the expense of law-abiding fishers and of future generations*," said John Cruden, the Acting Assistant Attorney General in charge of the Environment Division at the Justice Department. "*Managing natural resources for the next generations will require global cooperation in enforcement actions such as this*."

NOW AVAILABLE

A new film about rock lobsters

A Closer Look at Lobsters' is a 15 minute program that shows exciting new footage of the natural history and behavior of the New Zealand red rock lobster *Jasus edwardsii*. Filmed and produced by Chris Thomas of NIWA, the life history is shown with fascinating sequences of the animal's moulting and mating. The various larval stages from egg to puerulus are shown in detail and there is an underwater sequence of aggregations of migrating animals.



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