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The Lobster NEWSLETTER

ANNOUNCEMENTS

The 9th International Conference and Workshop on Lobster Biology and Management 19-24 June 2011,

Bergen, Norway http://www.imr.no/icwl_bergen

- is open for registration until June 19th 2011.

Deadline for Abstract Submission is March 15th.

Submissions before March 31 may be considered.

The largest international event for lobster research and management arranged every 4 years. More than 300 participants from all over the world.

This is the top international event to network with the world's leading experts on all kinds of lobster species. All disciplines of lobster research and management are welcome.

Venue: Radisson Blu, Hotel Norge, Bergen

Host and organizer: Institute of Marine Research

For students: The Paul Kanciruk Student Travel Award. Application deadline 15 March 2011.

All interested in lobsters are welcome, whether or not they are giving a presentation.

Keep an eye on the conference web-site for more and new information

about the scientific and social programme! It will be constantly renewed

Scope of the conference and workshops

Theme 1: Management, Fisheries and Aquaculture

Fisheries, Management, Conservation, etc.

Subtheme: 'Innovations and Updates for Larval Culture of Lobsters'

Including the Seminar: Lobster and crab aquaculture: parallel innovations and shared discoveries for future development. Chaired by ***Dr. Jason Goldstein****, USA and* ***Dr. Ann-Lisbeth Agnalt****, Norway*

Theme 2: Ecology

Behavioral Ecology, Ecosystem- and climate-related research

Theme 3: Neurobiology, Sensory Biology and Behaviour

Including the Workshop, chaired by ***Dr. Thomas Breithaupt****, UK*

Theme 4: Disease

Including the workshop: Lobster Diseases: Emerging pathogens, chronic diseases, and their effects on lobster ecology and fisheries, chaired by ***Dr. Donald C. Behringer*** *, USA*

Theme 5: All other lobster-related topics

Evolution, Taxonomy, Genetics, Physiology, Endocrinology, Introduced species, Environmental research, Life-cycle-related research: Reproductive biology, Larval biology, Young life stages, etc. Also marked and Society-related studies are welcome.

Invited speakers

Dr. Steven Montgomery*, Australia (Special lecture)*

Mr. Knut E. Jørstad*, Norway (Special lecture)*

Ms. Nici Gibbs, *New Zealand (Special lecture)*

Dr. Andrew Jeffs, *New Zealand (Theme 1)*

Dr. M.Vijayakumaran, *India (Theme 1)*

Dr. Raquel Goñi*, Spain (Theme 1)*

Prof. Bruce Phillips, *Australia (Theme 2)*

Prof. Ehud Spanier, *Israel (Theme 2)*

Dr. Kari L. Lavalli *USA (Theme 2)*

Prof. Steffen Harszch, G*ermany (Theme 3)*

Dr. Kathy Castro*, USA (Theme 4)*

Prof. Mark Butler*, USA (Theme 4)*

Student Travel Award for ICWL

The Paul Kanciruk Student Travel Award for the International Lobster Conference and Workshop

A newly established student travel assistance award is now available to promising graduate students or recent doctoral degree recipients who are without sufficient financial support to attend the International Conference and Workshop on Lobsters (ICWL). The award honors the late Paul Kanciruk (1947-2006), who received his Ph.D. in 1976 under the directorship of Professor William Herrnkind, and from whose estate funds were made available to found this award. Dr. Kanciruk spent most of his professional career as a respected scientist in the area of climate change research and large database management, yet his doctoral research in lobster biology contributed substantially to our understanding of lobster behavior. Paul was unable to present his novel research results at the first ICWL held in 1977 in Perth, Australia because of lack of funding for student travel. Thus, it is most fitting that this award be used for this purpose and in his memory.

To apply: Students who wish to apply for the award to attend the upcoming ICWL in Bergen, Norway in June 2011 should complete the application form available on the ICWL conference website. The form is also available by email from the Chair of the award committee: Dr. Mark Butler (mbutler@odu.edu). **The completed application form must be emailed to the Chair of the award committee by March 15, 2011. Recipients of the award will be announced by March 31, 2011.**

The Award Committee:
Dr. Mark Butler (Chair), Old Dominion University (USA)
Dr. Alison MacDiarmid, National Institute for Water & Atmospheric Research (New Zealand)
Dr. Raquel Goni, Instituto Español de Oceanografía, (Spain)

Contributions: Members of the international community with interests in lobster fisheries, management, and science who would like to contribute to this award fund to ensure its existence for future conferences should contact Mark Butler (mbutler@odu.edu).

RESEARCH NEWS

Puerulus settlement patterns and growth of juvenile *Jasus lalandii* at an oyster farm in South Africa

From: Johan Groeneveld

The settlement patterns of rock lobster *Jasus lalandii* pueruli and their early life-history as juveniles off the west coast of South Africa remain poorly understood. Early studies during the 1970s showed that the metamorphosis from drifting phyllosoma larvae to the puerulus settlement stage takes place near the shelf break, and that the pueruli settle in shallow kelp beds and amongst benthic organisms such as sponges, mussels, and red algae. From blanket-net catches, Pollock (1973) found *J. lalandii* pueruli most abundant from December to April, and that moulting of the puerulus to the first juvenile instar took place within a few days after settlement. *Jasus lalandii* was the first rock lobster species to be cultured from egg to puerulus under laboratory conditions (Kittaka 1988).

In 1999, *J. lalandii* pueruli and young juveniles were found in high numbers on the structures of an oyster farm in Luderitz Bay, southern Namibia (Grobler and Ndjaula 2001) (Fig. 1). Reports of the presence of pueruli on an oyster farm in Saldanha Bay in western South Africa (approx. 500 km south of Luderitz Bay) led to a research project to assess the numbers of pueruli and juvenile rock lobsters potentially available for harvesting on the farm, their seasonal settlement patterns, abundance trends, size and growth (Groeneveld *et al.* 2010). The mesh bags used for oyster mariculture (see Fig. 2) were sampled monthly between August 2005 and June 2006, and totals of 3,842 lobster pueruli and 10,158 juveniles were captured.

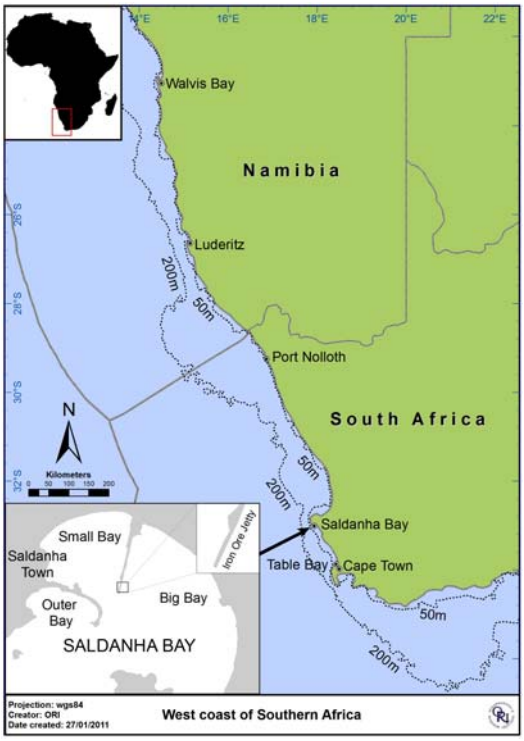

Figure 1: Locator map of the West Coast of South Africa and Namibia, showing Saldanha Bay, Luderitz Bay in Namibia and Table Bay. The oyster farm in Saldanha Bay is situated next to the Iron Ore Jetty, in the Big Bay. The region is dominated by the temperate waters of the Benguela Current ecosystem, with seasonal upwelling and high primary productivity.

Figure 2: Mesh bags containing cultured oysters, on which lobster pueruli settled in Saldanha Bay. The mesh bags were suspended from buoyed surface lines approximately 1 m below the sea surface, in sets of five. The oyster farm is a commercial operation, and sampling periodicity depended on the availability of the vessel.

Distinct puerulus settlement events were identified in November and January, and juvenile abundance peaked during the same months but also in March (Fig. 3). The size of newly settled pueruli increased significantly between October and March, and the carapace length of pueruli and juveniles overlapped larger individuals in February and March reflecting an accumulation of juveniles on the oyster stacks from the earlier settlement The size of newly settled pueruli increased significantly between October and March, and the carapace length of pueruli and juveniles overlapped between 8.5 mm (smallest juvenile) and 10.4 mm (largest puerulus). Monthly histograms showed a size progression of juveniles, with larger individuals in February and March reflecting an accumulation of juveniles on the oyster stacks from the earlier settlement events. The estimated growth increment from puerulus to first juvenile instar was 0.5–1.5 mm carapace length (4.9–16.1%), increasing to 1.4–2.5 mm (14.4–23.3%) for the second instar.

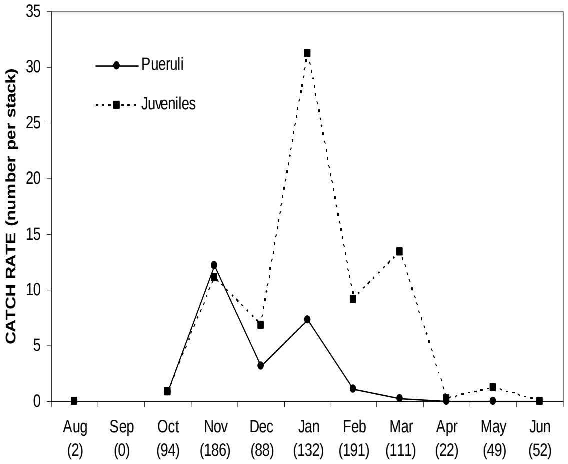

Figure 3: Average monthly catch rates of J. lalandii pueruli and juveniles between August 2005 and June 2006. The numbers shown in parenthesis denote the number of oyster stacks sampled per month.

The recruitment of lobster pueruli to the oyster farm in Saldanha Bay occurred during a period in which strong southerly winds prevailed, giving rise to a general offshore movement of surface waters along the west coast and upwelling of cold nutrient rich bottom waters. However, specific settlement events appear to coincide with a change in wind direction, reduction in upwelling strength, and increase in surface water temperatures. This implies that larvae may take advantage of landward movements of surface waters during downwelling or reversal of upwelling to return them to shallow coastal waters.

A novel finding of this study was that there is latitudinal gradient, between Luderitz Bay in the north and Table Bay (Cape Peninsula, 600 km due south), in the timing of puerulus settlement events (see Fig. 1). At Luderitz Bay, peak puerulus settlement occurred during August and September (Keulder 2005); at Saldanha and St Helena Bay (in-between) the peak settlement was in December to February; and at Table Bay in the south, it was in March and April. This pattern concurs with field observations that moulting and egg-bearing of *J. lalandii* varies with latitude, occurring progressively later towards the south.

The study showed that significant numbers of puerulus and small juvenile *Jasus lalandii* can be captured in Saldanha Bay on a seasonal basis, thus opening up the possibility of ongrowing of juvenile lobsters to a size that can be marketed as seafood. There remain some hurdles to ongrowing, such as relatively slow growth rates of *J. lalandii* (a cooler water, slow-growing species), the impact of removal of early juveniles on a heavily fished adult population, aquaculture legislation in South Africa, high initial costs, and economic risk.

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Johan C. Groeneveld
Oceanographic Research Institute,
PO Box 10712, Marine Parade,
Durban 4056, South Africa.
E-mail address: jgroeneveld@ori.org.za

Current understanding of the factors affecting puerulus recruitment in the West Australian rock lobster fishery.

From: Simon de Lestang and Nick Caputi

Background

Puerulus recruitment is monitored at 10 sites along the Western Australian coast, and has been shown to be an accurate predictor of catches three and four years later. Settlement has historically varied in relation to ENSO events, being highest during warm water La Niña conditions associated with a strong Leeuwin Current (Fig. 1). In 2007/08 puerulus settlement was slightly below the range expected by this historical relationship. The following year warm water temperatures indicated that 2008/09 settlement should be far better than 2007/08. However the 2008/09 settlement was the lowest on record, with subsequent 2009/10 settlement being the second lowest. In 2010/11 there was a significant increase in settlement, still below the long term average, but again in agreement with the historical environmental relationship.

An independent risk assessment was undertaken in 2009 to examine potential causes of these low puerulus settlements. This identified either a shift in environmental conditions or a combination of environmental conditions and localised depletion of lobsters (in the northern part of the fishery) as likely causes. A number of research projects were developed during the risk assessment, many of which have now been either completed or are well underway.

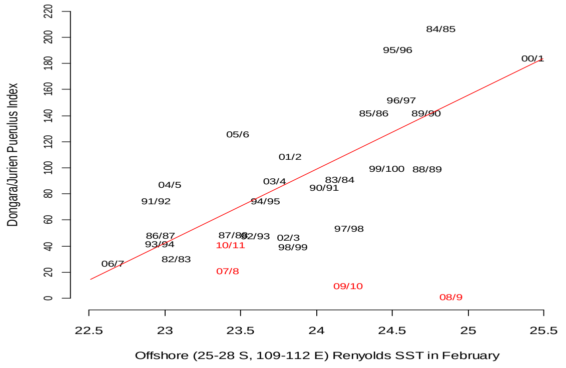

Fig. 1. Relationship between puerulus settlement in the centre of the Western Rock Lobster Fishery (Jurien and Dongara) and offshore water temperatures during the preceding February. The values represent the season of settlement, with red values highlighting the past four seasons. *10/11 is a preliminary figure.

Studies Completed/Underway

The set of collaborative research programs (Department of Fisheries (DoF) with CSIRO, University of Western Australia (UWA) etc.) initiated to unravel the potential cause of the low settlement is showing that the recruitment process is more complex than was previously considered. In addition to the Leeuwin Current, a number of additional environmental and biological factors have been found to be affecting the variations in recruitment. Preliminary results from these studies include:

- Anomalies in the Indian Ocean Dipole (IOD). There were three consecutive positive IOD over 2006-2008 which is unusual and for the first time in 30 years there was a positive IOD associated with the La Nińa conditions in 2008. The effect of the IOD appears to be associated with the strength of the westerly winds in winter/spring near the period that settlement is occurring.
- The larval oceanographic larval project with CSIRO showed that eggs released towards the very northern part of the fishery (e.g. Northern Abrolhos Islands & Big Bank) and in deeper waters (80-100 m) have much higher chance of successfully recruiting as puerulus. While the overall breeding stock was within historic ranges, in the far north of the fishery (Big Bank and the northern Abrolhos) the abundance had declined. See: http://www.fish.wa.gov.au/docs/frr/frr209/index.php?0401.
- The breeding stocks in the northern areas and deep water are replenished by the annual 'whites' migration. The amount of replenishment appears to be associated with two main factors, the number of migrating lobsters (i.e. based on the puerulus settlement four years previously and the level of capture before they reach the 100 m depth) and the strength of the southward flowing current during the time of the migration. The current strength has been above average in six of the last eight years, which will have reduced replenishment of the north area.
- The effect of temperature on the growth and survival of larvae was identified as an important component affecting settlement success. Higher success was associated with early larval release (Nov-Dec) compared with late releases (Feb.) and the proportion of early release larvae was affected by the water temperature leading up to spawning.

There has also been a collaborative (UWA, Murdoch University, CSIRO, DoF) project looking at the phyllosoma larvae off the WA coast in mid 2010 and their food sources.

Management response

As a result of the low puerulus settlement, proactive management measures were introduced in 2008/09 and 2009/10, resulting in nominal fishing effort reductions of 44 and 72% to ensure a carryover of legal size from these reasonable catch years into the low catch years and protect the breeding stock. This resulted in catches of 7,600 and 5,900 t in 2008/09 and 2009/10, respectively, compared to the catch predictions based on historic

(2007/08) levels of fishing of 9,200 and 8,700 t, respectively. This large reduction in catch (4,400 t) represents a significant increase in residual biomass that has been achieved over the last two years which has flowed into the predicted low recruitment years that are expected to commence in 2010/11. The fishery has also moved to an individual transferable quota (ITQ) in 2010/11 with a quota of 5,500 t.

Most Likely Scenario

The most likely scenario for the low settlement is still that the set of unusual environmental and oceanographic conditions during the past few years, but especially during 2008, possibly combined with the reduced level of egg production in the extreme north of the fishery (due in part to unusual currents) resulting in the low settlement levels.

Based on this scenario, the management actions available to influence future recruitment levels are to increase the egg production in these northern areas, both through a reduction in the harvest rate of animals moving into these areas (e.g. reduce exploitation on the migrating whites) and by increasing protection of animals that do move into this area or are already resident there (e.g. through closed areas). Both of these actions have been put in place in the last two years, however, it may be worth considering extending the Big-Bank closure south to encompass the northern section of the Abrolhos Islands.

Outlook

The environmental conditions for the 2011/12 settlement year (peak settlement August to January) are currently very conducive for settlement with water temperature in early 2011 being far above average. If the breeding stock in the northern area is a contributing factor then a survey of the closed area indicated that there has been an improvement which should aid the recovery.

Using our current understanding of the environmental correlations and the breeding stock, we are looking for the settlement to continue to improve this coming season.

Simon de Lestang
Western Australian Fisheries and Marine Research Laboratories, Department of Fisheries, Western Australia, PO Box 20 North Beach WA 6920, Australia
Simon.delestang@fish.wa.gov.au

Nick Caputi
Nick.Caputi@fish.wa.gov.au

Evidence of declining recruitment in the southern rock lobster (*Jasus edwardsii*) fisheries of south-eastern Australia.

From: Adrian Linnane, Caleb Gardner, David Hobday, André Punt, Richard McGarvey, John Feenstra, Janet Matthews and Bridget Green

Southern rock lobster *Jasus edwardsii* are distributed around southern mainland Australia, Tasmania and New Zealand where they support important regional fisheries. In the south-eastern States of South Australia, Victoria and Tasmania (Fig. 1) the annual catch ranges from 3,500-4,000 tonnes with an estimated gross commercial value of ~AUS$200 million. All three fisheries are managed under total allowable commercial catches (TACCs) that reply heavily on annual stock assessment reports produced independently in each jurisdiction. Typical performance indicators include catch rate of both legal and undersized (pre-recruit) lobsters as well as regional estimates of biomass, exploitation rate and recruitment as determined from a common length frequency based model (Punt and Kennedy, 1997).

This study stems from growing concerns among scientists, fishery managers and members of the commercial fishing industry as to the status of rock lobster fisheries across south-eastern Australia. Specifically, recent stock assessment reports from South Australia, Victoria and Tasmania have highlighted declines in fishery performance indices across the region over recent seasons (Gardner and Ziegler 2010; Hobday and Morison, 2006; Linnane *et al.*, 2009a, 2009b). Thus, the aim was to compare temporal and spatial trends in model-estimated recruitment and fishery-dependent commercial catch rates across all three States with a view towards a large-scale spatial analysis of the *J. edwardsii* resource across south-eastern Australia.

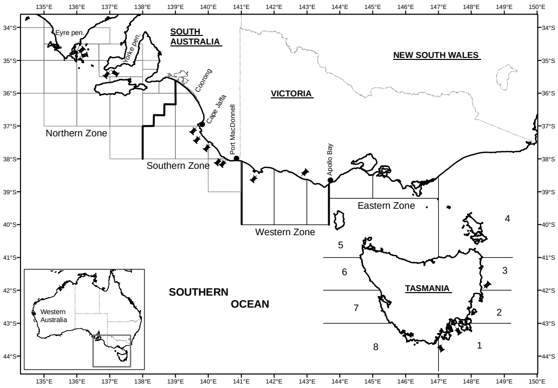

Figure 1: Rock lobster management regions of South Australia, Victoria and Tasmania. Reproduced from Linnane *et al.* (2010) with permission.

Trends in recruitment indicate large-scale spatial declines across almost all regions (Fig. 2). In South Australia and Victoria, highest levels of recruitment were observed in the Southern Zone fishery where levels of recruitment increased from 1996 to 1999. Over the next eight seasons recruitment declined to pre-1997 levels. However, the estimate of ~2 million lobsters in 2007 was the lowest on record and represents a 49% decrease in overall recruitment since 1999 (3.9 million). Similar declining trends over the same time period were observed in the Northern Zone of South Australia and the Western Zone of Victoria. Recruitment had also decreased in Tasmania since the late 1990s, with the exception of two spikes in 2001 and 2005 in the southern region. Recruitment in northern Tasmania decreased from 1.9 million lobsters in 1997 to 0.61 million in 2007, an overall reduction of 68%. The estimates of recruitment for 2007 in both regions of Tasmania are the lowest on record.

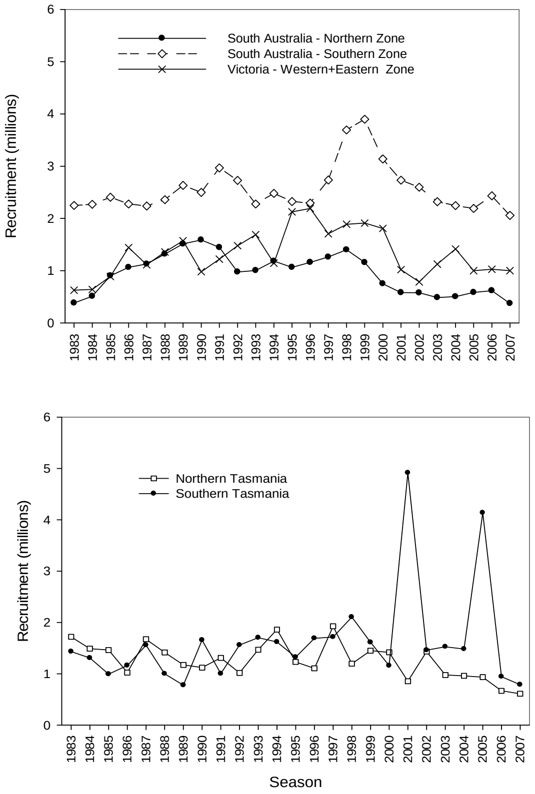

Figure 2: Trends in maximum likelihood estimates of recruitment across South Australia, Victoria (top) and Tasmania bottom from 1983 to 2007. Reproduced from Linnane *et al.* (2010) with permission.

Recent decreases in recruitment levels have translated to declines in commercial catch across south-eastern Australia (Fig. 3). In some regions, these declines have been rapid. For example, catch per unit effort (CPUE) in the Southern Zone fishery of South Australia increased from 0.93 kg/potlift in 1996 to 2.1 kg/potlift in 2002. However, over the next six seasons catch rate decreased by 65% to 0.73 kg/potlift, the lowest on record since 1978. Similar rates of decline were observed over the same time-scale in the Northern Zone fishery of South Australia and the Western Zone of Victoria.

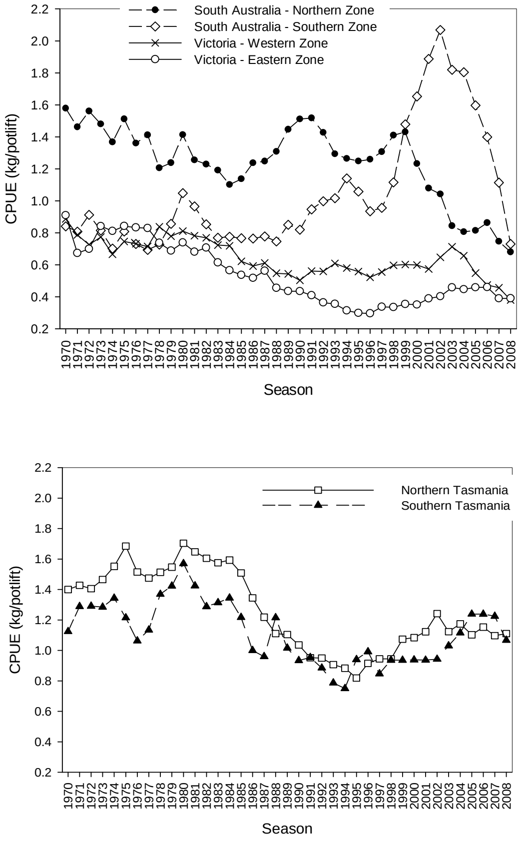

Figure 3: Trends in catch per unit effort (CPUE) across South Australia, Victoria (top) and Tasmania (bottom) from 1970 to 2008. Reproduced from Linnane *et al.* (2010) with permission.

Declines in CPUE in recent seasons in Tasmania have not been as rapid as in other regions. CPUE in southern Tasmania generally increased between the mid 1990s, with the 2008 estimate of 1.0 kg/potlift representing a 25% increase from 1994 (0.75 kg/potlift). Similarly, CPUE in northern Tasmania increased from 0.82 kg/potlift in 1995 to 1.24 kg/potlift in 2002. Since then however, CPUE has decreased in this region and in 2008 it was 1.1 kg/potlift, a decrease of 11% from 2002. Despite not experiencing the rapid declines in CPUE observed in South Australia and Victoria, current catch rates in both regions of Tasmania are low in relation to the last 1990s, early 2000s.

Declines in commercial catch rate trends have led to significant TACC cuts in all of the fisheries across south-eastern Australia. For example, in the Northern Zone of South Australia, the 625 tonne TACC introduced in 2003/04 has been gradually cut to 310 tonnes for the 2010/11 season. Similarly, the Southern Zone TACC has been reduced from 1,900 tonnes to 1,250 tonnes over the same period. In Victoria, the Western Zone TACC has been gradually reduced from 450 tonnes in 2006/07 to 240 tonnes for the 20010/11 season. The Eastern zone has had a marginal increase from 60 tonnes set in 2006/07 to 66 tonnes. In Tasmania, the TACC has been cut from 1,523 tonnes in 2008/09 to 1,323 tonnes for the 2010/11 season. It is envisaged that further reductions will see the Tasmanian TACC gradually reduced to 1,193 tonnes by 2012/13.

The factors driving the declines in fishery performance across south-eastern Australia have been the focus of much debate. The widespread nature of the decline suggests possible large-scale environmental factors, but studies on the impacts of oceanographic or environmental conditions on *J. edwardsii* recruitment remain limited. One feature that has been identified as a possible source of influence is the Bonney upwelling system of South Australia which is part of a larger upwelling system that extends from the western Bass Strait to the eastern Great Australian Bight. There is some evidence to suggest that, in recent seasons, this coldwater upwelling event has been more extreme in terms of its intensity and duration. However, what impacts this may have in terms of fishery performance remains largely unknown. It is recommended that future research focuses on the physiological impacts of extreme coldwater events on all life stages of *J. edwardsii* in order to determine possible implications for annual recruitment estimates. Further detailed discussion of the issues related to declines in recruitment of rock lobster across south-eastern Australia are given in Linnane *et al.* (2010).

Acknowledgements

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Adrian Linnane, Richard McGarvey, John Feenstra, Janet Matthews. South Australian Research and Development Institute (Aquatic Sciences), PO Box 120, Henley Beach, South Australia 5022. adrian.linnane@sa.gov.au

Caleb Gardner, Bridget Green. University of Tasmania.

David Hobday. Primary Industries Research Victoria, Department of Primary Industries.

André Punt. School of Aquatic and Fishery Sciences, University of Washington.

The artisanal lobster fishery in Mexico

From: Monica Perez-Ramirez

Of the six species of lobster (*Panulirus* sp.) located in Mexican waters, two are found in commercial quantities: the red rock lobster (*P. interruptus* Randall, 1842) and the Caribbean spiny lobster (*P. argus* Latreille, 1804). The red rock lobster is distributed along the coast of Baja California in the Mexican Pacific and is generally found at very shallow depths near the coastline. The Caribbean spiny lobster lives in the Mexican Caribbean, mainly in the States of Yucatan and Quintana Roo (Fig. 1). It usually prefers habitats with some type of coverage like coral reefs and mangroves. Water depth influences its size distribution and fishing location influences the size composition of the catch (Padilla-Ramos and Briones-Fourzán 1997). Fecundity also follows a latitudinal trend, with females producing fewer eggs per brood in the North than in the South.

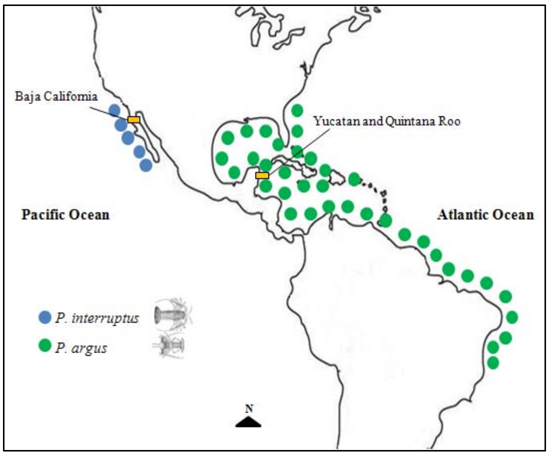

Figure 1. Geographical distribution of red rock lobster and Caribbean spiny lobster

The importance of artisanal lobster fishery in Mexico is fundamentally based on their economic value and not much on their amount captured. In the Mexican Pacific Coast, red rock lobster catches have been stable in recent years (980-1,800 tonnes/year), but the biomass varies due to large-scale climate phenomena. On the other hand, Caribbean spiny lobster catches show an up-and-down pattern, caused principally by the variations in the catch off the State of Yucatan. These variations have been produced by occurrence of hurricanes. In the last 10 years the average catch was 1,000 tonnes for both States.

Fishery management

The management structure of the lobster fisheries is based on Federal legislation: the Federal Fisheries Law that gives general guidelines to regulate fisheries; the General Law of Ecology and Environmental Protection that provides guidelines to carry out species protection and Mexican Official Standards (NOM) that deal with aspects such as regulating types of fishing gear used, mesh sizes, and spatial restrictions. The government agency responsible for fishery management and enforcement is the National Commission of Aquaculture and Fisheries (CONAPESCA) and the National Fisheries Institute (INP) assesses the national fisheries and the fishing gear. In addition, there is a recently implemented instrument called the National Fisheries Chart (NFC), which was elaborated by the INP in 2000. The NFC defines levels of fishing effort and it bears strategies for restoration and management of aquatic resources. Fishing method are traps (Fig. 2).

Figure 2. Fishermen measuring caught lobsters in traps (Photo credit: G. Ponce-Díaz)

Lobsters are exploited by fishermen's cooperatives, which are associations with the principle of mutual assistance aimed at improving the living conditions of their members. The cooperatives have fishing rights or concessions within a delimited fishing territory that are granted by the Mexican government for up to 20 years. Each cooperative hold processes and internal rules that govern how many people can fish and under what conditions fishermen must fish. This structure ensures a limitation on fishing effort within concessions as well as prevention of illegal fishing by poachers (Vega *et al*. 1997).

The following are data on some biological characteristics from four different studies of Mexican lobsters (Briones-Fourzán *et al*. 2003; Castañeda-Fernández *et al*. 2005):

	Red rock lobster	**Caribbean spiny lobster**
Body length	Cephalothoraxes: 82-114 mm	Abdominal: 140-160 mm
Spawning	June-August	March-October
Sex ratio (males:females)	Not available. Females are usually more abundant in the catch	1:1 (x^2=1.44; P>0.10)
Migration	Specific movements in each stage life	Specific movements in each stage life
Diet	Gastropods, decapods, red and brown algae	Gastropods, decapods

Management regulations included in the NOM and the NFC:

	Red rock lobster	**Caribbean spiny lobster**
Minimal legal size	82 mm (cephalothoraxes length)	135 mm (tail length) or 223 mm (total length)
Closed season	February 16th to September 15th	March 1st to June 30th
Female protection	prohibition of taking berried females	prohibition of taking berried females
Fishing effort	3 million traps/fishing season 1,000 boats	870 boats

Sustainable fisheries

Red rock lobster - Baja California coast involving 27 cooperatives and 30,000 people working in several activities of the fishery. Catches of individual cooperatives could vary considerably with lobster availability and oceanographic conditions. Approximately 90% of red rock lobster production is exported to Asian markets and 10% is sold in the local market. In 2004, a group of cooperatives (Baja California Regional Federation of the Fishing co-operative Societies, FEDECOOP) obtained the MSC certification. MSC certification program evaluates and recognizes sustainable fisheries through three Principles: 1) Sustainable fish stocks, 2) Minimizing environmental impact, and 3) Effective management. This certification is a voluntary, scientifically based, third-party assessment process and applies to wild-capture fisheries only (MSC, 2010). This fishery was the first community-based fishery to be certified in developing countries, this positively impacted FEDECOOP's national prestige.

Caribbean spiny lobster - There are 37 cooperatives and about 1,700 partners. The fishery generates employment for more than 8,000 people in States of Yucatan and Quintana Roo. Catches vary between cooperatives. Most Caribbean spiny lobster production is sold in the local market (Tourist sector). Currently, a group of cooperatives (Regional Federation of Fishing Cooperatives in Quintana Roo, RFCSIFQR) is seeking the MSC certification. If RFCSIFQR obtains the MSC certification, it would differentiate their products from other lobster cooperatives. Moreover, the two major lobster fisheries in Mexico would benefit from international recognition for sustainable management. This could promote the MSC program as achievable in terms of cost and time for local fisheries in developing nations.

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Monica Perez-Ramirez
Centro de Investigaciones Biológicas del Noroeste (CIBNOR)
Mar Bermejo 195, La Paz BCS 23090, Mexico
yperez@cibnor.mx
www.cibnor.mx

Drivers of fishers' behavior in the Northumberland lobster fishery

From: Rachel Turner

The current trend towards marine spatial planning (MSP) worldwide impacts marine resource users, particularly in inshore fisheries. Shellfisheries, including lobster fisheries, form an important component of the UK's inshore fishing fleet, with the contribution of shellfish to the total value of UK vessel landings having risen from 31% in 1999 to 42% in 2008 (MFA 2008). Understanding the spatial distribution of fishing activity and the complex social, economic and environmental drivers of human behaviour may help predict responses of fishers to changes in the management of marine resource use. A study carried out over the last three years explored the characteristics of fishers' spatial behaviour and decision-making in the European lobster (*Homarus gammarus*) fishery in Northumberland (UK).

With landings of 204 tonnes of lobsters in 2008, valued at an estimated £2.9 million, lobster fishing in the Northumberland district (Fig. 1) forms the most economically valuable part of the catch for the 132 shellfish permit holders. The pot fishery targets four main species: European lobster (*Homarus gammarus*), brown crab (*Cancer pagurus*), velvet swimming crab (*Necora puber*) and prawns (*Nephrops norvegicus*). While landings of lobster are lower in volume that those of brown crab, lobster is the most economically valuable target species in the Northumberland potting fishery, fetching prices at over £10 per kilo, compared to under £3 per kilo for brown crab (Bannister 2006). The Northumberland Sea Fisheries Committee (NSFC), a local management body, is working to improve the basis for managing local lobster stocks, but there remains a need to understand how fishing effort is distributed by the fleet.

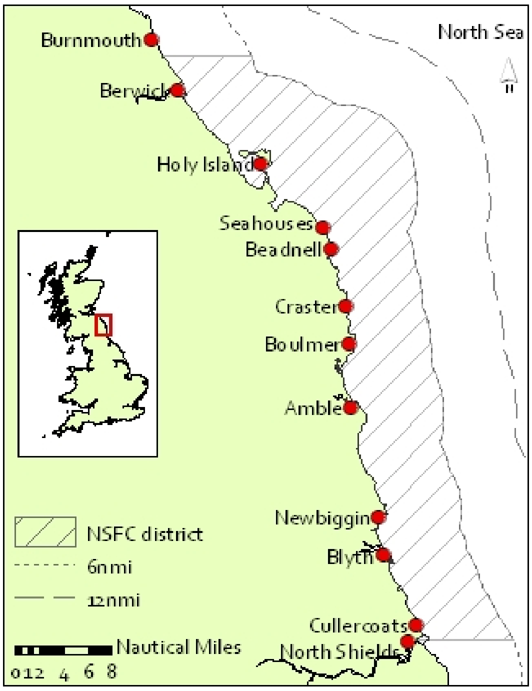

Fig. 1. Map of Northumberland Sea Fisheries Committee district and local fishing ports

Information on the distribution of UK inshore fisheries activity is scarce, but arguably is critical to the success of future MSP and fisheries management. The first component of the study used GIS to compare two data sources describing the distribution of inshore lobster potting activity: 1) perceptions of local potting grounds collected through map-based interviews with local fishers at four Northumberland ports during 2008-2009, and 2) sightings of potting vessels at sea recorded during routine enforcement patrols by the NSFC vessel over the period 2004-2008. The comparison found that data based on fishers' perceptions (Fig. 2) produced maps of potting distribution that were statistically similar to those based on vessel sightings data. However, strengths and weaknesses of both data sources were identified, suggesting that a combination of both is needed to inform decisions about spatial management measures.

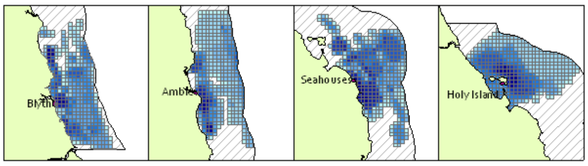

Fig. 2. Maps show local fishers' perceptions of fishing activity at four ports. Darker blue indicates higher fishing activity

Variability in catch rates across fishing grounds can influence the decision-making of fishers and be altered by responses in fishers' behaviour. The second component of the study analysed monthly data on lobster landings and fishing effort during 2001-2007, which represent the most extensive source of information available to manage the Northumberland lobster fishery. Lobster landings were found to vary among fishing ports, and this variation was not explained by fishing effort, season or weather, suggesting that there were different catch rates among ports. However, differences among ports were minor compared to those among individual fishing vessels. Differences among vessels were only weakly correlated with vessel length and engine size, suggesting further research is necessary to understand the way in which vessel characteristics and fishing behaviour, including individual fishers' spatial strategies, are related to catch rates.

The third component of the study looked at factors affecting decisions about where to fish. Wind, weather, personal experience, season and gear congestion were the factors most often prioritised by fishers. Other factors, such as risk of conflict with other vessels, and information shared by other fishers, highlighted the importance of social factors affecting behaviour. The study found that conflict over fishing grounds between ports could be linked to differences in perceptions about rights of access to fishing grounds, as the social norm of fishing 'territories' was stronger in some ports than others. European fisheries management has tended to overlook informal rules for resource management, yet understanding social norms that influence fishers' behavior may help develop management measures suited to the local context. For instance, in the Maine lobster fishery, territoriality among fishers has led to economic and ecological benefits (Acheson 1990) and helped facilitate voluntary fisheries management measures (Acheson 1998). Furthermore, identifying the relationship between fishing grounds at sea and fishing communities on land may help predict the potential impact of marine spatial management measures (Jones 2008).

Communication among fishers was also found to be important in fishers' decision-making and behaviour. Social network analysis, which looks at relationships among a set of actors (Wasserman and Faust 1994), was used to explore the relationship between the fishers' behaviour, and their position in communication and information-sharing networks in their home port (Fig.3). The findings suggested that strong communication ties among fishers were associated with similarity in their choice of fishing grounds. Social relationships were also related to fishing success, with the most successful fishers identified as those who received information from many sources, but shared information with few others. The study demonstrates that an insight into the social context shaping fishers' decisions is important for developing appropriate management measures to ensure the future sustainability of the Northumberland lobster fishery and associated fishing communities.

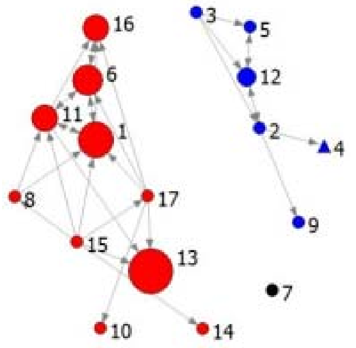

Fig. 3. This network diagram shows links between fishers in one port who share information about fishing locations and catches. Circles represent fishers, and their size indicates their "fishing success". Arrows between fishers show the direction of information flow (i.e. arrow from node 8 to node 1 means fisher 8 shares information with fisher 1). Different colours indicate groups within the port that are not connected through information-sharing.

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Dr Rachel Turner
Research Associate, Future of Reefs in a Changing Environment (FORCE)
Centre for Resource Management and Environmental Studies (CERMES)
University of the West Indies: Cave Hill Campus
St Michael, Barbados, BB11000
t: +1 246 417-4830
e: rachel.turner@cavehill.uwi.edu

American lobster lore in 1881 and today

From: Robert J. Miller

Some of what we have learned:

My wife, Beverly, and I were enjoying dinner at the Blomidon Inn in Wolfville, Nova Scotia, Canada when Beverly noticed an 1881 edition of the Schribners Monthly on a nearby shelf and began thumbing through it. This may have been in response to the quality of conversation provided by her dinner partner. She found an article with nice prose and hand-drawn illustrations titled "The Lobster at Home" by William H. Bishop. It discussed the biology and the fishery for the American lobster in Maine, U.S.A. The opening lines were, "In the spring, the lobster, who has passed the winter months in deep water, returns again inshore. He has found the deep water both tranquil and warm, while the shallower expanses near land have been troubled to the bottom by furious gales and chilled by drifting ice."

Bishop's references to lobster biology reveal we have learned something in the past 130 years. Based on fishing locations he concluded that lobsters spend winters at 30 fathoms and summers at 5 fathoms or less. He gave a colourful description of seasonal migration, "The migratory impulse seizes upon all about the same moment and they come in regular columns, the stronger members in the front and the weaker in the rear." Herrick (1909) agrees with winter-summer migration although, based on a diving study in central Maine, Cooper *et al.* (1975) do not. We have well documented examples of seasonal movement into and out of estuaries, shallow embayments, and the Bay of Fundy (Lawton and Lavalli 1995), but lack generalizations for large sections of coast. In the 1870s any information on migration would have been tainted by trap selectivity and lobster catchability.

The trap design was similar to that used today, but lacking internal partitions (Knight 1917) to reduce escapement. Hoop traps were also used in the 19th century but are prohibited in all commercial American lobster fisheries today.

We learn that variation in stock size and fishermen's incomes are not new. Increased effort before 1881 reduced earnings from $4-5 per day to $1 per day. Even after allowing for inflation and increased operating costs we can surmise that lobster fishermen enjoy a higher standard of living today.

Bishop was correct that shedding of the shell permitted lobster growth, but curiously concluded that the first shedding occurred at age 5, at 8-10 inches total length. The size at age was not unreasonable (Fogarty 1995).

The literature does not support an interesting assertion by Bishop that mature females are surrounded by baby lobsters a few inches long that take refuge under her tail at the first sign of danger.

Bishop states that lobster odour reception occurs at the base of one antenna and sound reception at the base of another. Chemoreception occurs primarily on the antennules and walking legs and mechanoreception at the base of antennules and internally in muscle receptor organs (Atema and Voigt 1995; Beltz 1995).

Bishop lists food as barnacles, seaweeds, and mud. Decapods, bivalves, seaweeds and echinoderms have since been found to dominate stomach contents (Scarratt 1980; Elner and Campbell 1987; Sainte-Marie and Chabot 2002).

The only mention of regulations was a minimum size of 27 cm total length and a season for canning from to March through July. Although the latter was said to avoid p'is'n meat (presumably watery from recent molting), sceptics thought it was to release tradesmen who soldered cans to work in the factories that canned sweet corn. Although ovigerous females have been protected for most of the history of the fishery the prohibition was lifted from 1874-1883 (Kelly 1992).

Some useful additions to lobster fishery management

Although we have made a lot of progress, we are not done yet. Fishery management is of course a large topic; but I will grind a few of my favourite axes.

1. Management targets (reference points) are necessary to give scientists, fishery managers, fishermen, and lobster buyers a common purpose. If targets are simple enough for stakeholders to understand, and stakeholders all participate in the development of targets and in stock monitoring (Miller and Breen 2010), the chance that they will share ownership of the objectives will be much improved.

2. Stakeholders should be flexible in choosing targets and the regulatory means of achieving them. Stock production, fishing technology, and markets change constantly. Management of the fishery should respond to at least the large changes. With humility, stakeholders should accept that the ideal target is unknown and moving, and that stock management should adapt while chasing an unreachable goal.

3. Experimental management areas, the analogue of experimental farms, would give scientists the opportunity to experiment with exploitation regimes. A no-take regime could help define habitat carrying capacity as demonstrated for spiny lobsters by MacDiarmid and Breen 1992, Acosta 2002, and Babcock *et al*. 2007.

4. We could use better definitions of optimum and marginal habitats for each benthic life history stage. With this information stock production measured per unit area could be expanded to the entire lobster habitat and give us a measure of how far we are from potential yield.

5. We could use a thorough review of lobster migration. We have creditable studies showing migration changes with location, age, sex, and stage of maturity (reviewed by Lawton and Lavalli 1995). Pattern generalizations would be useful in defining management areas and MPAs.

6. We have had several ambitious attempts to measure larval drift (e.g. Incze and Naime 2000; Harding *et al*. 2005; Xue *et al*. 2008; Chasse and Miller 2010). However, if we wish to continue this masochistic line of work, in my opinion, better measures of model inputs are needed to predict larval drift and retention. Biologists cannot adequately describe larval swimming behavior or variable larval mortality and physicists are challenged to model circulation near-shore, especially in areas with complex topography.

Prediction is overrated in stock management

This paragraph will cement my reputation as a loose cannon among lobster biologists. In heavily exploited American lobster stocks, the usual case, annual landings are an approximate index of stock size. If we observe that a stock is depleted this can be caused by several environmental causes. In the unlikely event that we are able to establish a good correlation between fishery yield and any of temperature, wind, river runoff, predators, or prey, what are our management options? It is improbable that we can modify any of the natural causes. Alternatively, if we suspect recruit overfishing is the cause of depletion what are our management options? For any of these we can choose to do nothing or choose to increase reproduction by reducing fishing mortality. (Minimum size, maximum size, closed window size, protecting ovigerous females, and reducing total fishing effort are the usual methods.) Knowing cause-effect doesn't change our choice of cure.

Habitat destruction or bycatch by another fishery are special cases. If these causes can be identified with some certainty and governance can force change, then treating the cause can be useful. If disease is destroying the stock, then a change in career is worth considering.

You newbies should be pleased that us old geezers have left you with problems to solve.

John Tremblay and Robt. Elner are thanked for their comments on this piece.

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Dr. Robert Miller, Emeritus Scientist
Canada Dept. Fisheries and Oceans
Bedford Inst. Oceanography
Dartmouth, Nova Scotia, Canada B2Y 4A2
Phone (902) 426-8108; Fax (902)426-1862
e-mail millerr@mar.dfo-mpo.gc.ca

Classification of the marine clawed lobsters – a crash course

From: Dale Tshudy

A biologically meaningful taxonomy, one that reflects evolutionary relationships, is a prerequisite to studies of species diversity, biogeography, ecology, etc. The current classification of marine clawed lobsters includes 288 species, most of them extinct. Family level and higher groupings of most species are now based on cladistic analyses of morphological and, whenever possible, molecular data.

This informal orientation to classification of living and fossil lobsters is geared especially for the non-taxonomist and anyone unfamiliar with the fossil record. It orients the reader to the position of the better known, commercially important species in the taxonomic big picture. For brevity and readability, this summary excludes taxon authorship and, whenever possible, references in text. A list of key references is given at the end for anyone seeking greater detail. The classification herein follows closely that given in De Grave *et al*. 2009, although I use my own tallies of fossil species. Chan (2010) produced a checklist of modern species and reviewed higher taxonomy. Schweitzer *et al.* (2009) produced a checklist of fossil species as part of a larger work on decapod crustaceans.

GENERAL

The "marine clawed lobsters" (to distinguish them from the *spiny* and *slipper* lobsters, and many other extinct, non-clawed lobsters) include a total of 12 families (9 truly clawed; others subchelate) within two decapod crustacean infraorders: Infraorder Astacidea, which includes the 6 families of the commonly known marine clawed lobsters (as well as all freshwater crayfish), and the almost entirely extinct infraorder Glypheidea, which includes 6 families of clawed and non-clawed lobsters. Only three of these 12 families are extant (the astacidean Nephropidae and Enoplometopidae, and the Glypheidae). The nine extinct families, including four astacids (Uncinidae, Chilenophoberidae, Protoastacidae, Stenochiridae) and five glypheids (Chimaerastacidae, Erymidae, Mecochiridae, Pemphicidae, Platychelidae), are known from a fossil record ranging from the Lower Triassic to the Upper Cretaceous.

"Marine clawed lobsters" is a paraphyletic group; that is, one containing only some (not all) of the descendants of a common ancestor. Following recent phylogenetic analyses (Ahyong and O'Meally 2004) and classifications (De Grave *et al.* 2009), "marine clawed lobsters" notably excludes the *freshwater* crayfish and the marine *non-clawed* lobsters (mostly extinct) in Glypheoidea. Thus, the group of organisms we call "marine clawed lobsters" is a group of convenience, rather than a natural, monophyletic group. It should be emphasized, though, that the Infraorder Astacidea is monophyletic (Tsang *et al*. 2008).

Of the 288 species of marine clawed lobsters known, only 70 are extant; all of these are in the Infraorder Astacidea; most in family Nephropidae. Of the 218 extinct species, roughly half are in Infraorder Astacidea and half are in Infraorder Glypheidea.

CLASSIFICATION OF THE 9 FAMILIES OF MARINE CLAWED LOBSTERS

Infraorder Astacidea - includes the commonly known marine clawed lobsters and all freshwater crayfish; 661 extant species, mostly (592) freshwater crayfish, but also well represented in the fossil record with 113 species, mostly marine lobsters. Contains two superfamilies, Enoplometopoidea and Nephropoidea. Enoplometopoidea is a small group of shallow reef dwellers that are small-bodied and cryptic. Enoplometopids are not fished commercially but have recently become important in the aquarium trade as "reef lobsters." Nephropoidea is a much larger group; includes the more familiar and commercially important species. Among Nephropidae, only two genera, *Homarus* and *Nephrops*, are abundant and ecologically important in shallow coastal waters, where they comprise important commercial fisheries. The remaining nephropids are primarily found in deeper water.

SF Enoplometopoidea

F Enoplometopidae – Plain-looking morphology overall, although brightly colored. Body small, subcylindrical; carapace spiny anterodorsally but elsewhere lacking grooves and spines; pleon unsculpted; chelipeds equal. Recent. 1 genus, 12 species.

F Uncinidae – extinct relatives of Enoplometopidae. Lower-Upper Jurassic. 2 genera, 5 species.

SF Nephropoidea

F Chilenophoberidae – Carapace groove pattern appearing (intuitively) intermediate between that of extinct Erymidae and extant Nephropidae (Tshudy and Babcock 1997). Middle Jurassic – Lower Cretaceous. 4 genera, 12 species.

F Protastacidae – Sigmoidal cervical-antennal groove extends from dorsomedian. Upper Jurassic – Upper Cretaceous. 1 genus, 2 species.

F Stenochiridae – Cervical groove extends from dorsomedian; postcervical groove short. Upper Jurassic – Upper Cretaceous. 1 genus, 3 species.

F Nephropidae – Defined/united mostly by carapace groove pattern. Includes commercially important *Homarus* and *Nephrops*. Now also includes the former Thaumastochelidae. 20 genera (6 extinct, 4 extant but with fossil record, 10 recent only). 137 species (79 extinct, 1 extant with fossil record, 57 recent only).

Infraorder Glypheidea - includes both clawed and non-clawed lobsters (three families each). Almost entirely extinct; only two living species but 256 fossil species are known. Includes the extinct superfamily Erymoidea (all clawed) and the almost entirely extinct superfamily Glypheoidea (mostly non-clawed). The largest of the glypheoid families, the extant but mostly extinct Glypheidae, is comprised of "subchelate" lobsters. Similarly, the extinct glypheoid families Mecochiridae and Pemphicidae have only subchelate first pereiopods. That leaves two families, the Chimaerastacidae and Platychelidae, as clawed glypheoids.

SF Erymoidea

F Erymidae – short rostrum, cervical groove extends from dorsomedian; branchiocardiac and postcervical grooves almost parallel. Robust chelae. Lower Triassic - Upper Cretaceous. 11 genera, 113 species.

SF Glypheoidea

F Chimaerastacidae – Carapace subcylindrical; cervical groove extends from dorsomedian; distinct ridges on anterior of carapace. Middle Triassic. 1 genus, 1 species.

F Platychelidae – Carapace dorsoventrally compressed; cervical groove extends from dorsomedian; postcervical and branchiocardiac grooves extend in parallel from (or near) dorsomedian. Upper Triassic. 3 genera, 4 species.

PHYLOGENY

Relationship of Marine Clawed Lobsters to Other Groups

Morphological cladistic analyses of higher decapod groups began with Scholtz and Richter's (1995) non-computerized analysis of extant reptantian decapods. Molecular cladistic analyses began with Crandall *et al*. (2000). A number of morphological and molecular studies have followed. Relationships of higher groups were reviewed most recently by Chan (2010). The freshwater crayfish (Astacidae, Cambaridae, and Parastacidae) form a sister group to the marine lobsters (Ahyong and O'Meally 2004; Tsang *et al*. 2008; others). Glypheidae are the sister group to the clawed lobster + crayfish clade (Ahyong and O'Meally 2004). The Achelata ("spiny" and "slipper" lobsters) are more distantly related. Relationships will continue to be tested and refined by still larger morphological and molecular cladistic analyses. The work by Tsang *et al*. (2008), for example, demonstrates the utility of nuclear protein-coding genes in phylogenetic inference regarding higher decapod taxa.

Relationship Between Families of Marine Clawed Lobsters

The relationships of only a few of the clawed lobster families have been analyzed cladistically. As a result, the relationships between most of these groups are poorly known. What we badly need are cladistic analyses simultaneously incorporating all of these families. Ahyong (2006), using Erymidae and Glypheidae for an out-group, morphologically analyzed genera representing the freshwater crayfish, Chilenophoberidae, Enoplometopidae + Uncinidae, and Nephropidae, finding them more derived in that order. Protastacidae, Stenochiridae, Mecochiridae, Pemphicidae, and Platychelidae have been little studied in cladistic analyses. Their superfamily placements herein are based on non-cladistic judgments adopted in De Grave *et al*. (2009).

The relationship of the enoplometopids to other decapods has been a problem over the years. They were placed with Nephropidae (Barnard 1950) until Holthuis (1974) removed them and suggested a relationship to Axiidae. More recently, they have been placed in their own superfamily (Saint Laurent 1988; Ahyong 2006; Tsang *et al* 2008; Chu *et al*. 2009; De Grave *et al*. 2009). Among extant taxa, Enoplometopidae and Nephropidae form a sister group in molecular analyses (Ahyong and O'Meally 2004; Tsang *et al*. 2008). Until 2006, the superfamily Enoplometopoidea was thought to have no fossil record, but morphological cladistic analyses (Ahyong 2006) indicate that the sister taxon to Enoplometopidae is the extinct Uncinidae.

Herein, Nephropidae includes the formerly recognized family Thaumastochelidae Bate, 1888 (Upper Cretaceous – Recent). The extant *Thaumastocheles*, *Thaumastochelopsis* and *Dinochelus*, along with the extinct fossil genus *Oncopareia* – all best known by their unusual major claw (a bulb-like palm with very long, slender fingers bearing acicular dentition) - form a sister group in both morphological and molecular studies. The close relationship between these four genera is undisputed, but, because they are nested within Nephropidae (are paraphyletic) in recent molecular analyses of Tshudy *et al*. (2005), Tsang *et al*. (2008), Chu *et al*. (2009), and Tshudy *et al*. (2009), they are no longer given family-level status as Thaumastochelidae.

Relationships of Genera Within Extant Families

As is true for the phylogenetic relationships between families and higher groups, two lines of evidence, morphology and DNA, have been applied in determining evolutionary relationships between lobster genera. Traditional systematic, i.e., non-cladistic, analyses of morphology were conducted throughout the last century [see Mertin's (1941) and Glaessner's (1969) works on fossil lobsters, or Holthuis' extensive works (1974, 1991; many others) on recent nephropids]. Cladistic analyses of lobster morphology appeared in the 1990's (Tshudy and Babcock 1997). Ahyong's (2006) cladogram is the morphological state of the art.

Ahyong (2006) found, within the Nephropidae, a group of three *Homarus*-like genera emerged as sister to a clade that includes the five *Nephrops*-like genera in a clade of their own and another unresolved clade of 7 other genera. The situation is a bit more resolved among the nephropid genera when only the extant genera were analyzed.

Tshudy *et al*. (2009) analyzed 12 lobster (nephropid and thaumastochelid) genera, using 12S and 16S DNA and four species of *Enoplometopus*_as an out-group. Their results show *Acanthacaris* to be the sister taxon to the remaining nephropids, with three clades recovered within the latter.

There are major differences and few similarities between the state-of-the-art morphological phylogeny (Ahyong 2006) and the state-of-the-art molecular phylogeny (Tshudy *et al*. 2009). Some of these might be attributable to the use of different out-groups, and a reanalysis with common out-groups is currently under way. Other differences seem attributable to morphological convergence. *Homarus* and *Homarinus*, for example, are two lobsters that form a sister group in morphological analyses but are well separated in molecular analyses. Likewise, *Nephrops* and *Metanephrops* form a sister group in morphological analyses but are widely separated in DNA-based trees. It appears that, in the clawed lobsters, convergent evolution is manifested at all taxonomic levels, and in many anatomical regions (see, for example, the repeated evolution of an elongate major cheliped bearing acicular dentition (Tshudy and Sorhannus 2000)].

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Dale Tshudy
Department of Geosciences
Edinboro University of Pennsylvania
dtshudy@edinboro.edu

An updated list of world's marine lobsters known to date

From: Tin-Yam Chan

After the monumental work of Holthuis in 1991 on a catalogue of marine lobster of the world, there have been new discoveries and taxonomic revisions on lobsters in the last two decades. Particularly, there are many recent works on the phylogeny of lobsters. Some of them suggest a change in the higher classification of lobsters. At the request of the Tree of Life project, Biodiversity Synthesis Center of the Encyclopedia of Life and the IUCN Red Listing of marine lobsters, a revised checklist and classification scheme for all the extant marine lobsters in the world was recently published: Chan, T.Y. 2010. Annotated checklist of the world's marine lobsters (Crustacea: Decapoda: Astacidea, Glypheidea, Achelata, Polychelida). *Raffles Bull. Zool.* suppl. **23**: 153-181. [pdf downloadable at http://rmbr.nus.edu.sg/rbz/biblio/s23/s23rbz153-181.pdf].

The traditional concept of marine lobsters includes the superfamilies Nephropoidea (clawed lobsters), Palinuroidea (spiny and slipper lobsters), Eryonoidea (blind lobsters) and the living fossil Glypheoidea contained within the suborder Macrura Reptantia. Previous checklists of marine lobsters did not list the Polychelidae (the only living family of blind lobsters) because of the extremely confusing taxonomy of this group. Furthermore, the reef lobsters, genus *Enoplometopus,* were not considered to be lobsters by some workers. On the other hand, the mud lobsters (or mud shrimps) Thalassinidea (or now Axiidea and Gebiidea in the newest classification scheme of decapod crustaceans) have sometimes been considered lobsters. Recent advances in morphological and molecular phylogeny studies have fundamentally impacted our understanding of the evolutionary relationships of marine lobsters and other Decapoda. Most recent analyses suggest that marine lobsters do not comprise a monophyletic group, and rather suggest that the relationships of the superfamilies and families of marine lobsters are mostly different from previously well-established schemes, such as that used by Holthuis (1991). However, recent phylogenetic studies have yielded significantly contrasting results. The latest and by far most robust phylogenetic analysis utilises newly developed molecular markers, concludes that lobsters are indeed a monophyletic group, if the thalassinideans (or some of the thalassinideans) are excluded. Thus, the suborder Macrura Reptantia is revived containing the lobsters and freshwater crayfishes. Thalassinidea (or now Axiidea and Gebiidea) is excluded from this suborder, partly because they are traditionally not considered true lobsters (e.g. the squat lobsters Galatheidae and Chirostylidae were never considered true lobsters), and partly because the most robust phylogenic study strongly suggested that only some clades of thalassinideans are allied to the "traditional" lobsters (i.e. Thalassinidea is a polyphyletic group). Thus, marine lobsters are now defined as consisting of four infraorders of decapod crustaceans: Astacidea, Glypheidea, Achelata and Polychelida. Together they form the suborder Macrura Reptantia. Altogether six families, 54 genera and 247 species (with four subspecies) of living marine lobsters are currently recognized as valid. Their synonyms in recent literature and information on the type locality of the valid taxa are provided in the new checklist. Notes on alternative taxonomies and justifications for the choice of taxonomy are also given. To show the morphological diversity in marine lobsters, color photographs of fresh specimens of 40 genera are illustrated (some examples showed in Fig. 1).

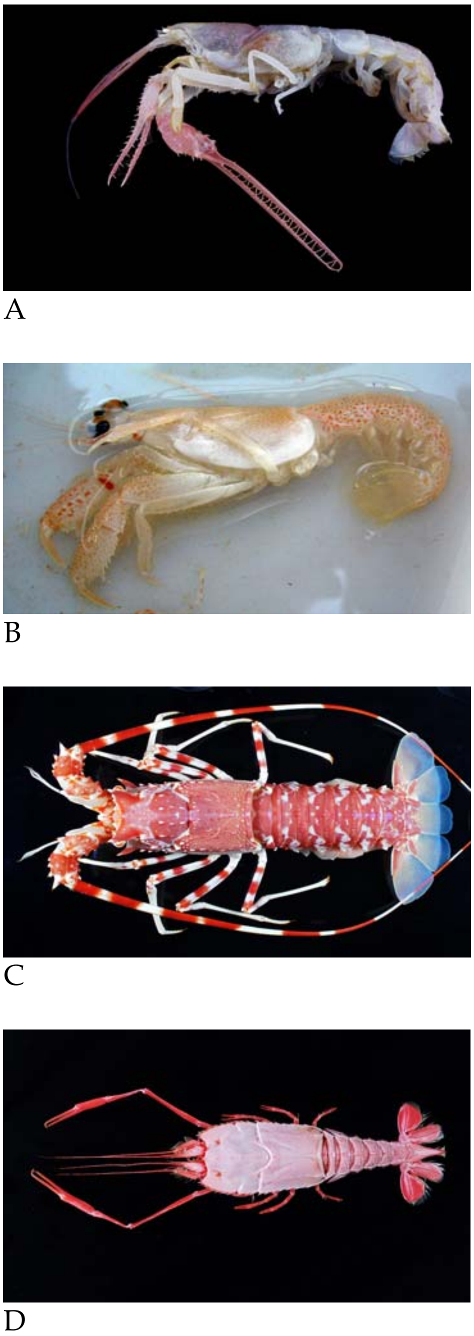

Fig. 1. A, *Dinochelus ausubeli* Ahyong, Chan & Bouchet, 2010 (Nephropidae), Philippines. B, *Laurentaeglyphea neocaledonica* (Richer de Forges, 2006) (Glyphaediae), New Caledonia (photographed by J.C.Y. Lai); C, *Palinurus delagoae* Barnard, 1926 (Palinuridae), Mozambique; D, *Stereomastis panglao* Ahyong & Chan, 2008 (Polychelidae), Philippines.

Although Carolus Linnaeus himself described the first marine lobster in 1758, the discovery rate of marine lobsters remains high to this day (Fig. 2). For example, nearly 11.3% (28 species) of marine lobsters were only described since 2000. Even to the most common and commercially important genera such as *Palinurus* and *Panulirus*, new species have been added in the last few years. Recent employment of molecular tools in separating cryptic and very similar species has contributed to the discovery of more lobster species as in other decapod crustaceans under this modern trend. Nevertheless, the high discovery rate of lobsters is no doubt more related to the revival of large scale expeditions in the Indo-West Pacific. It is believed that many more marine lobsters with novel morphological diversity are still awaiting discovery. Only a few years ago the new genus of living fossil *Laurentaeglyphea neocaledonica* was discovered (Richer de Forges 2006). And a month after the publication of the annotated checklist of world's marine lobsters, one new species of slipper lobster was formally described (Yang and Chan 2010). It is hoped that the updated checklist will enhance the discovery of marine lobsters and eventually contribute to a better understanding of the exact diversity of this group.

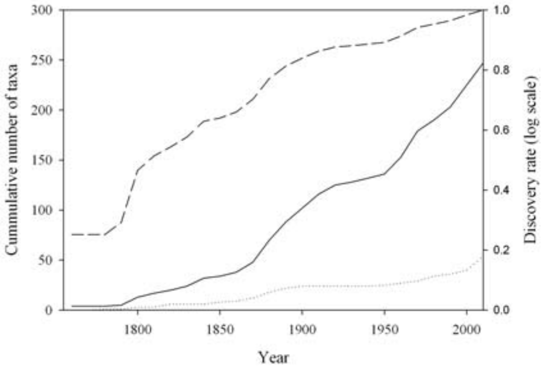

Fig. 2. Cumulative number of genus (dotted) and species (solid) described in marine lobsters by decade (from year 1 to 10), and their discovery rate (dash line, expressed as a fraction of those known to date on a logarithmic scale).

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Tin-Yam Chan
Institute of Marine Biology, National Taiwan Ocean University,
Keelung 20224,
TAIWAN, R.O.C.
E-mail:tychan@mail.ntou.edu.tw

FISHERIES & AQUACULTURE UPDATES

Research Results: Answers from the Baird Symposium on lobster shell disease

From: Kathy Castro, Rhode Island Sea Grant Extension Co-leader for Fisheries Programs,

This article appeared in the November 2010 issue of *Commercial Fisheries News.*

The ninth annual Ronald C. Baird Sea Grant Science Symposium, "*New Approaches to Understanding Emerging Marine Diseases: From Science to Management*" (August 10–11, 2010) focused on lobster shell disease. Results presented by the scientists on their collaborative research—funded by the New

England Lobster Research Initiative—show that there are significant differences between lobsters with shell disease and those with no symptoms of the disease.

Experts in a variety of fields—crustacean endocrinology, genetics, veterinary medicine, behavior, microbiology, lobster biology, chemistry, environmental science, and epidemiology—worked together with fishermen and fisheries managers. They studied lobsters from every possible approach—looking at the animals and what is happening in their shells, in their internal tissues, and in their environments.

The Culprit: Bacteria

Some researchers discovered that the microbes that live on the shells of all lobsters differ somewhat between healthy and diseased shells. While the same bacteria exist on both, diseased lobsters showed more of one species—*Aquimarina homaria*—than healthy lobsters did. This species is relatively new to local waters, though it has been known to be present in the Pacific for many years. *A. homaria* is believed to be responsible for causing the first entry into the shell. Lesions are quickly invaded by the other bacteria in the environment.

The Shell

Other researchers looked at chemicals in the environment and how they affect the hardening of the shell. One researcher looked at alkylphenols, which are found in differing amounts in sediments of many sites where shell disease occurs. He discovered that alkylphenols in the lobsters' environment were taken up by the lobsters and were present in the shells. These chemicals lengthened the time it took for the shells to harden and delayed molting (shedding of the shell). Alkylphenols are also toxic to lobster larvae. Concentrations of trace metals were also higher in lobsters with shell disease—particularly chromium, copper and mercury. (Those concerned with consuming alkylphenols or metals should avoid eating the tamale, or hepatopancreas, where these were most present.)

One researcher discovered that a type of chitin, a compound that makes up part of the outer portion of the lobster shell, was most present in the pores of the shell, presumably offering more protection to an area that might otherwise be a weak spot in allowing bacteria to enter the lobster. The area around the pores, protected by this chitin, appeared to be the least affected in shell diseased lobsters. However, there are concerns that changes in pH of the oceans caused by acidification will weaken these shell areas. Also, shells that were breached in some way in laboratory testing—abraded by sandpaper for instance—were subject to shell disease, while shells that were not abraded were not susceptible (barring other contributing factors, such as malnutrition). Lobsters with bands around their claws showed no signs of disease underneath the bands.

Other Tissue

Researchers discovered that lobsters with shell disease had compromised immune systems and a decrease in a hormone found in muscle tissue, indicating lobsters may be energetically compromised. Shell disease also affected other hormones in lobsters disrupting their growth and reproduction.

Stress

Other researchers found that stressors—such as poor nutrition or temperatures warmer than ideal for lobsters (but below temperatures that would kill the bacteria) contributed to lobsters coming down with shell disease. Shell diseased lobsters are also subject to higher mortality rates than non-symptomatic lobsters.

New Population Structure

Genetic and morphometric information reveals a complex population structure of lobsters in Rhode Island waters. Several "tribes" of lobster exist that recognize their own kind and prefer to spend time with them. The tribe did not influence susceptibility to disease but further work is being done to explore these possibilities.

100 Lobster Project

Research continues to analyze the results of the RI 100—the approximately 100 lobsters that were each divided up among researchers. Each of these lobsters was dissected and pieces sent to researchers using a new approach to study the whole animal. This database will be available as a public resource to further understanding of the complex effects of a marine disease.

Unclear

What the initiative was not able to determine was the issue of cause versus effect. In other words, did lobsters have all these changes as a result of shell disease? Or did they get shell disease because they were already compromised? The only way to clarify this is a longer term study where researchers induce shell disease in healthy lobsters and have before-and-after data. However, researchers pondered whether there were any lobsters that could be deemed “healthy” even if they did not show symptoms of the disease. It might not be valid to compare Maine (apparently healthy—lobsters there have a low incidence of shell disease) to Rhode Island lobsters since they are different genetically.

For more information about the results of the symposium, please see the “New Information on Shell Disease” fact sheet online at **seagrant.gso.uri.edu/z_downloads/baird_2010_toolsandinfo.pdf**

About the Initiative: The US Congress appropriated $3 million to establish a cooperative research program—the New England Lobster Research Initiative—to study the causes and consequences of lobster shell disease. $300,000 of this was allocated for sea sampling in MA, NH and ME; $500,000 for ventless trap surveys in ME and RI. $2.1 million was used to fund research and outreach for the Initiative. This funding was jointly managed by the National Oceanic and Atmospheric Administration’s National Marine Fisheries Service, URI, and Rhode Island Sea Grant. The goal of this project was to describe the disease agent and how it works, and to determine the extent and severity of the disease in New England waters. The initiative tapped into expertise from two state agencies and over 35 scientists and graduate students from 16 institutions:

- Stony Brook University
- Boston University
- University of Louisiana
- Marine Biological Laboratory
- R.I. Department of Environmental Management
- George Mason University
- University of Massachusetts
- University of Connecticut
- University of Maine
- Virginia Institute of Marine Science
- New England Aquarium
- Roger Williams University
- Georgia Aquarium
- Woods Hole Oceanographic Institution
- Maine Department of Marine Resources
- New York Sea Grant
- Ludwig Maximillian University, Germany
- Carl von Ossietzky University of Oldenburg, Germany

For more information visit

seagrant.gso.uri.edu/lobster_initiative.

The Lobster NEWSLETTER

Editors:

Roy Melville-Smith
Department of Environment and Agriculture
School of Science
Curtin University of Technology
GPO Box U1987
Perth WA 6845 AUSTRALIA
FAX: (618) 9266 2495
roy.smith@curtin.edu.au

Richard A. Wahle, Ph.D.
Research Associate Professor
School of Marine Sciences
University of Maine
Darling Marine Center
193 Clark's Cove Road
Walpole, Maine 04573
USA
Tel: 207 563 3146 ext249
FAX: 207 563 3119
richard.wahle@maine.edu

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Contact Roy Melville-Smith (southern hemisphere) or Rick Wahle (northern hemisphere) about article submissions.