

Abstracts & publications

Management options for restocked trochus fisheries

S. Purcell

Source: K.M Leber, S. Kitada, H.L Blakenship, T. Svåsand (eds). 2004. Stock enhancement and sea ranching: developments, pitfalls and opportunities. 2nd Edition. Blackwell Pub., Oxford. p. 233–243.

Methods for restocking trochus fisheries have advanced greatly in recent years but restocking activities must link to sound management schemes to ensure sustainability of trochus fisheries. Management schemes generally have greater acceptance and persistence if these are community-based and enforced at a local level. Plans for seasonal or periodic closures, quotas and size limits need to be location-specific due to regional differences in trochus demography and traditional management approaches. Marine Protected Areas (MPAs) or No-Take Zones should be established at multiple sites for restocking trochus and preserving breeding populations. Fishing grounds should be protected for at least 5 years for recovery of sustainable stocks and fishing should commence on the basis of favourable stock assessment. Slot limits allow trochus 1–2 spawning years before reaching legal size and protect the very large individuals. Provided that fishers comply with size limits, MPAs and community-based management schemes should allow restocked trochus to replenish fisheries, leading to increased, sustained harvests.

Rapid recruitment of corals on top shell snail aquaculture structures

M. Omori, H. Kubo, K. Kajiwara, H. Matsumoto, A. Watanuki

Source: Coral Reefs 25(2): 280. May 2006.

No Abstract.

Using impact assessment methods to determine the effects of a marine reserve on abundances and sizes of valuable tropical invertebrates

M.P. Lincoln-Smith, K.A. Pitt, J.D. Bell, B.D. Mapstone

Source: Canadian Journal of Fisheries and Aquatic Sciences 63(6):1251–1266. June 2006.

Procedures for impact assessment, including “beyond-BACI” (before-after control-impact) and proportional differences (ratios between impact and control treatments) were used to test population replenishment of marine invertebrates at a marine conservation area (MCA) and three fished (control) areas in the Solomon Islands of the southwestern tropical Pacific. Within shallow reef terrace habitat, the MCA caused abundance and size of the topshell *Trochus niloticus* to increase but did not affect holothurians (sea cucumbers) or the giant clam *Tridacna maxima*. Abundance of the nonexploited topshell *Tectus pyramis* was unchanged at the MCA but increased at the controls, possibly because of changes in abundance of *T. niloticus*. Within deep slope habitat, the MCA caused increased abundance of the sea cucumber *Holothuria fuscogilva* and prevented possible declines in abundances of *Thelanota anax* and all holothurians combined but had no effect on abundances of *Holothuria atra* or *Holothuria fuscopunctata*. Power analysis comparing the MCA with controls indicated that further, relatively modest increases in abundance or size of some species would have a good chance of being detected statistically. The beyond-BACI procedure holds promise for enabling rigorous evaluation of marine reserves as management tools at different spatial scales; the use of proportional differences is simpler but has limited management value.

Diseases of pearl oysters and other molluscs: a western Australian perspective

J.B. Jones, J. Creeper

Source: Journal of Shellfish Research 25(1):233–238. April 2006.

Mollusc culture, particularly the cultivation of pearl oysters, is an important component of the aquaculture industry in Western Australia. As a result, there has been a long-term investment in surveys of commercial mollusc species for potential diseases of concern. A number of pathogens, particularly haplosporidians, identified within wild-stock shellfish have the potential to adversely affect mollusc populations. Others pose risks for translocations associated with aquaculture. The microsporidian *Steinhausia mytilovum* (Field),

found in ova of the blue mussel *Mytilus galloprovincialis* (Lamarck), poses intriguing questions about the origin and dispersal of its host.

New and little-known gastropods from the Albian of the Mahajanga basin, northwestern Madagascar

S. Kiel

Source: Journal of Paleontology 80(3):455–476. May 2006.

Thirty-one gastropod species and one type of isolated larval shell are described from a quarry near Ambatolafia in the Mahajanga Basin, northwestern Madagascar. The ammonite fauna indicates a lower Albian age of the fauna (*Cleoniceras besairiei* Zone). The taxonomic position of the species described earlier is reviewed, incorporating new data on shell structure and protoconch morphology. Twelve species and one genus are new, with four species described in open nomenclature. The oldest hitherto known representatives of *Cocculina* sensu lato, *Iphitus*, *Conjectura*, *Entomope*, *Tomura*, and possibly *Vatopsis* and *Paladmete*, are described. Nacre is documented in a species of *Semisolarium*, providing further evidence for the position of this genus within the Vetigastropoda. Eight of the species occur also in the Cretaceous of Europe or are tentatively assigned to European species. Three species have close relatives in the Aptian/Albian of Japan, one species may have relations to the Albian of Texas. The new genus is *Mahajangina* (family uncertain) for a species having a small, trochispiral teleoconch with spines on the periphery, and a conical, bicarinate larval shell. The new species are: *Cirsocerithium collignoni*, *Zardinistylus betsibokaensis*, *Pommerozygia mahajangensis*, *Conjectura minuta*, *Buvignieria berwaldi*, *Mahajangina weitschati*, *Entomope crassilabrum*, *Paladmete? rasoarinoroae*, *Tomura ambatolafiensis*, *Carinathilda parviruga*, *Carinathilda bandeli*, and *Gymnothilda pagodoidea*.

Virus-like particles associated with mass mortalities of the pen shell *Atrina pectinata* in Japan

Maeno Y., Yurimoto T., Nasu H., Ito S., Aishima N., Matsuyama T., Kamaishi T., Oseko N., Watanabe Y.

Source: Diseases of Aquatic Organisms 71(2):169–173. 2006.

Mass mortalities of the pen shell *Atrina pectinata* occurred in the fishing grounds of Ariake Bay, in southwestern Japan, during late spring and summer in 2003 and 2004. Histological examination revealed extensive necrosis in the epithelial cells of the kidney and gill, and impairment of the endothelial cells of the mantle arteria. Although cestode larvae belonging to the genus *Tylocephalum* were found in the mantle, adductor muscle, kidney, and digestive gland, their prevalence and the intensity of infection were low. Examinations of moribund pen shells for *Haplosporidium* spp. infection using PCR analysis and for *Perkinsus* spp. infection using Ray's fluid thioglycollate medium were negative. Unenveloped virus-like particles were detected by transmission electron microscopy in the cytoplasm of affected kidney and gill cells of moribund pen shells. They were icosahedral spherical and 50 to 55 nm in diameter. These virus-like particles found in moribund pen shells are different from those described in other marine mollusks, and may be the causative agent of the mass mortalities of pen shells.

The intersection of scientific and indigenous ecological knowledge in coastal Melanesia: implications for contemporary marine resource management

S. Foale

Source: International Social Science Journal 58(187):129–137. March 2006.

Fundamental differences in the worldviews of western marine scientists and coastal Melanesian fishers have resulted in very different conclusions being drawn from similar sets of observations. The same inductive logic may lead both scientists and indigenous fishers to conclude that, say, square-tail trout aggregate at a certain phase of the moon in a certain reef passage, but different assumptions derived from disparate worldviews may lead to very different conclusions about why the fish are there. In some cases these differences have significant implications for the way marine resources are (or are not) exploited and managed. Here I analyse examples of what I call empirical gaps in both scientific and indigenous knowledge concerning the biology and ecology of fished organisms that in some cases have led to the poor management of stocks of these species. I argue that scientific education can complement indigenous knowledge systems and thus lead to improved resource management, despite some claims that scientific and indigenous knowledge systems are incommensurable.

Factors regulating the breeding and foraging activity of a tropical opisthobranch

J.-F. Hamel, A. Mercier

Source: Hydrobiologia 571:225–236. 2006

This study investigated the influence of environmental factors on the foraging cycle, breeding activity, settlement and growth of the opisthobranch *Hydatina physis* using laboratory trials and field observations.

Results showed that *H. physis* follows a nocturnal circadian rhythm mediated by photic intensity and modulated by food availability. The adults foraged between 1900 and 0530 h, with an activity peak between 2000 and 2200 h, and remained inactive and burrowed in the sand during the day. This pattern was clearly influenced by cloud cover, rain and laboratory manipulated light:dark cycle. The reproduction of *H. physis* was primarily influenced by the lunar cycle. For 4 consecutive months, hermaphroditic reciprocal copulation, preceded by pre-copulatory courtship behaviour, occurred at night 5–7 d before the full moon. Spawning occurred 3–5 d later for up to 5 consecutive nights, the egg mass gradually decreasing in size with each spawning. An overcast sky or rain prevented or delayed both copulation and egg release. Settlement of veligers was largely influenced by the nature of the substrate. In multiple-choice experiments, settlement occurred predominantly on sand containing cirratulid polychaetes. The juveniles reached ca. 3.9 mm in shell length after 5.5 months growth.

Manual for the monitoring and management of queen conch

P. Medley

Source: 2005. FAO Fisheries Circular No 1012, Rome, FAO, 58 p.

The Caribbean queen conch *Strombus gigas* is listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). A Listing on Appendix II requires that any specimen of the species included in Appendix II can only be exported if a permit has been issued to allow the export. Further, CITES states that export permits should only be issued when the responsible authority has deemed that the export will not be detrimental to the survival of that species. This manual presents guidelines on the requirements for responsible management of the fisheries exploiting queen conch, with particular emphasis on the requirements to comply with the relevant CITES regulations.

The manual describes the basic fisheries management cycle which includes: development and interpretation of policy; the need for management controls to regulate fishing activities; data collection and analysis; decision-making; enforcement of and compliance with the management controls; and regular feedback and review of the management system. It provides general guidance on each of those steps for the queen conch fisheries of the Caribbean. It also provides two case studies of management systems currently being applied: the Turks and Cairns Islands and Jamaica.

Sections 2 to 6 (Part 1) cover the main issues and examples in a relatively non-technical manner and Sections 7 to 16 (Part 2) cover similar issues in a more technical manner.

Why won't they grow? Inhibitory substances and mollusc hatcheries

J. Jones

Source: Aquaculture International 14(4):395–403. August 2006.

Molluscs are known to be seriously affected by trace amounts of environmental pollutants such as tributyltin at concentrations in seawater that are below the level of detection by all but the most sensitive chemical analytical techniques. This extreme sensitivity by molluscs has led to use of both adults and larvae as biomonitors for environmental pollution. Mollusc aquaculture has led to an increasing demand for commercial hatcheries to supply seed stock, including selected genetic lines of spat and juveniles. It is becoming apparent that many of the unexplained “crashes”, ill thrift or failures of larvae to metamorphose in such hatcheries are primarily due to their being compromised for a range of reasons including traces of inhibitory or toxic substances in the water supply. Because dead and dying larvae are ideal substrates for bacterial and ciliate growth, such invaders are often assumed to be the primary cause of the problem and this hinders finding a solution. In addition, many of the toxins which may be implicated in crashes are sporadic in occurrence and are both difficult to detect and hard to remove from the water supply. This paper provides evidence for these toxic effects and suggests ways of reducing the problems.

Population dynamics of the green mussel *Perna viridis* from the high spat-fall coastal water of Malacca, Peninsular Malaysia

S.M. Al-Barwani, A. Arshad, S.M. Nurul Amin, S.B. Japar, S.S. Siraj, C.K. Yap

Source: Fisheries Research 84(2):147–152. April 2007.

Population parameters such as asymptotic length (L_{∞}), growth coefficient (K), mortality rates (Z , F and M), exploitation level (E) and recruitment pattern of green mussel *Perna viridis* were estimated using length–frequency data from the coast of Malacca, Peninsular Malaysia. Asymptotic length (L_{∞}) was 102.38 mm and growth coefficient (K) was estimated at 1.50 year⁻¹. Total mortality (Z) for *P. viridis* was 2.48 year⁻¹, while natural mortality (M) and fishing mortality (F) were 1.69 and 0.79 year⁻¹, respectively. The growth

performance index was (ϕ') 4.197 and the exponent “ b ” of the length–weight relationship was 2.602 (± 0.02) during the study period. The asymptotic wet weight estimated from length–weight relationship was 40.81 g. Exploitation level (E) of *P. viridis* was 0.32 while the maximum allowable limit of exploitation (E_{\max}) was 0.43. The recruitment pattern was continuous with one major peak in the months of July–August. The exploitation level (0.32) and lower fishing mortality (0.79 year^{-1}) indicate that the green mussel is under-exploited from Malacca coastal waters.

The hatchery culture of bivalves: a practical manual

Helm M.M., Bourne N., Lovatelli A. (Ed.)

Source: FAO Fisheries Technical Paper 471. FAO, Rome, Italy. 184 p. 2004.

Bivalve mollusc culture is an important and rapidly expanding area of world aquaculture production, representing approximately 20 percent of the sector’s output at 14 million tonnes in 2000. The majority of production is from natural populations although increasingly stocks are approaching or have exceeded maximum sustainable yields. Stock enhancement through the capture and relaying of natural seed in both extensive and intensive forms of culture is common practice worldwide but the reliability of natural recruitment can never be guaranteed, and conflicts over the use of the coastal zone are becoming ever more pressing. A solution to meeting the seed requirements of the bivalve industry, applicable to the production of high unit value species such as clams, oysters and scallops, is hatchery culture. The production of seed through hatchery propagation accounts at the present time for only a small percentage of the total seed requirement but it is likely to become increasingly important as work continues to produce genetically-selected strains with desirable characteristics suited to particular conditions.

The advent of bivalve hatcheries was in Europe and the United States in the 1960s. Since those early pioneering days, knowledge of the biological requirements of the various species that predominate in worldwide aquaculture production and the technology used to produce them has grown and continues to improve. This manual brings together the current state of knowledge in describing the various aspects of hatchery culture and production from acquisition of broodstock to the stage at which the seed are of sufficient size to transfer to sea-based growout. Focus is on intensive methodology in purpose-built hatchery facilities rather than on more extensive methods of seed production in land-based pond systems. For a complete view, the intermediate nursery phase of production, which is the interface between the hatchery and sea-based growout, and the concept of remote setting are also described and discussed in some depth.

This manual is not intended as a scientific treatise on the subject. Rather, it provides the reader with a practical insight as to what is required in the way of resources and details of how to handle and manage the various life history stages of bivalves in the hatchery production cycle. Examples are largely drawn from the more commonly cultured temperate climate species including the Pacific oyster, *Crassostrea gigas*, the American (Eastern) oyster, *Crassostrea virginica*, the European flat oyster, *Ostrea edulis*, the Manila clam, *Tapes philippinarum* and a range of scallop species. Consideration is also given to the culture of tropical bivalves. Methods described are equally as applicable to bivalves of lesser significance in terms of worldwide production.

The authors recognize that bivalve hatchery production is as much an art founded on science as it is a science per se. There are as many ways of operating and managing a hatchery as there are hatcheries in terms of the sophistication of the facility and the precision with which each part of production is approached. In this respect, many experienced hatchery managers will consider much of the detailed information as “overkill.” However, the authors have considered the need for a thorough grounding for new entrants in this field, not just how the various procedures are done but the biological basis of why they are done in that way. Thus, the content is equally as appropriate to the operation of a closely controlled experimental hatchery as it is to a commercial-scale hatchery.

In addition to explanations of culture technology and methodology, the manual includes a brief discussion of the processes of identifying a suitable site for locating a hatchery and considerations in planning and designing the hatchery. It also includes advances that are likely to improve the reliability and economic viability of the hatchery industry in the near future, featuring topics such as polyploidy, the development of selected strains, cryopreservation of gametes and the need for novel, non-living foods.

Managing Jamaica’s queen conch resources

K. Aiken, A. Kong, S. Smikle, R. Appeldoorn, G. Warner

Source: Ocean & Coastal Management 49(5-6):332–341. 2006.

Jamaica’s industrial fishery for queen conch (*Strombus gigas*) has produced a substantial amount of much-needed foreign exchange and for at least 10 years has been the most valuable component of all commercial

marine fisheries activities. Since its inception in 1990 it has grown tremendously and may now be at some risk of collapse, due to problems including, among other factors, overfishing, poor enforcement, foreign poaching and under-reporting of catches. This paper examines and analyzes the problems relating to management of the conch fishery and speculates on its future. The main problems are overfishing by licensed fishers who take more than permitted, and serious poaching by industrial vessels mainly from Honduras, which exploit poor high seas enforcement by Jamaican authorities. For nearly two years the official fishery was closed due to legal issues. During closures, considerable foreign poaching occurred. The paper suggests that increased roles for the coast guard, continued quota reductions, and the Convention on International Trade in Endangered Species of Fauna and Flora (CITES), could be the best options for sustainability.

Inducing relaxation in the queen conch *Strombus gigas* (L.) for cultured pearl production

H. Acosta-Salmón, M. Davis

Source: Aquaculture 262(1):73–77. February 2007.

Five potential relaxant chemicals were evaluated: 2-phenoxyethanol, menthol crystals, benzocaine, MS-222, and magnesium chloride to induce relaxation in the queen conch for cultured pearl production. *S. gigas* were exposed to each chemical and were observed continuously for 30 min. Conch were placed on the bottom of the container with the aperture facing upwards (i.e., in an inverted position). When conch returned to their 'normal' position, they were turned facing upwards again. This process continued until conch were unable to return to their normal position. Only 30 g L⁻¹ magnesium chloride induced adequate relaxation in *S. gigas* to attempt pearl seeding. Conch exposed to all other treatments, except 0.25 g L⁻¹ menthol, showed a strong 'kicking' (escape) reaction during the initial 2 min to 7 min of exposure. After such reaction, conch retracted into their shells and within the 30 min exposure period they showed no signs of relaxation. Conch exposed to 0.25 g L⁻¹ menthol did not attempt to right but slowly retracted into their shells and did not show signs of relaxation. Conch can be relaxed in 20 min with magnesium chloride. They showed an extended mantle, a relaxed foot and a slow response to physical manipulation.

Distribution, density, and abundance of the queen conch, *Strombus gigas*, in Los Roques Archipelago National Park, Venezuela

D. Schweizer, J.M. Posada

Source: Bulletin of Marine Science 79(2):243–257. September 2006.

Due to decades-long high levels of exploitation, in 1991 Venezuela closed the fishing of queen conch, *Strombus gigas* (Linnaeus, 1758). A visual assessment was carried out between July and September 1999 providing the most current data on distribution, density, and abundance of queen conch for Los Roques Archipelago National park. The assessment involved two random surveys. The overall estimated mean density and abundance were 18.8 conchs ha⁻¹ (SD = 44.5), and 1,374,640 conchs (95% bootstrapped C.L.: 640,474–2,023,897) for the 73,197 ha of the platform, < 40 m depth. Overall density values were close to those obtained in overfished areas of Belize and St. Thomas/St. John, U.S. Virgin Islands. The survey revealed zones with potential nursery areas and the largest aggregations of adults on sand plains at depths > 16 m, actively mating. Given the relatively low densities found, the susceptibility of the species to overfishing, the current economic alternatives in the area, the precarious enforcement of fishing regulations, and the presence of important breeding aggregations, we recommend that Los Roques Archipelago be kept as a sanctuary for this species, thus prohibiting the re-opening of the fishery.

Growth and mortality of Mediterranean mussel *Mytilus galloprovincialis* Lam., 1819, in relation to size on longline in Mersin Bay, Izmir (Turkey – Aegean Sea)

A. Lök, S. Acarli, S. Serdar, A. Köse, H. Yildiz

Source: Aquaculture Research 38(8):819–826. June 2007.

The growth and mortality rate of different size of mussels, *Mytilus galloprovincialis*, were compared in Mersin Bay, Izmir. Mussel sampling was performed on a monthly basis over 1 year, together with hydrobiological parameters. Water temperature, salinity, chlorophyll *a*, total particulate matter (TPM) and particulate organic carbon (POC) were determined. Average chlorophyll *a*, TPM and POC values were 3.88 ± 1.62 µg L⁻¹, 13.12 ± 3.68 mg L⁻¹ and 252 ± 121.89 µg L⁻¹ respectively. Initial mean lengths of mussels for each size group were 10 mm (9.91 ± 0.25 mm), 20 mm (20.14 ± 0.29 mm), 30 mm (30.66 ± 0.21 mm), 40 mm (40.14 ± 0.21 mm), 50 mm (50.62 ± 0.21 mm), 60 mm (59.77 ± 0.21 mm) and 70 mm (69.47 ± 0.62 mm). Maximum growth in length occurred during the spring–summer months. The annual length increments of mussel size groups were 46.22, 41.42, 30.3, 28.03, 20.63, 16.34 and 12.03 mm from small to large size groups respectively. Small

mussels grew faster than large mussels and reached commercial size at the same time. Mortality was <5% for all groups at the end of the experiment.

Spawning induction and early development of the Caribbean scallops *Argopecten nucleus* and *Nodipecten nodosus*

L.A. Velasco, J. Barros, E. Acosta

Source: Aquaculture 266(1–4):153–165. June 2007.

Argopecten nucleus and *Nodipecten nodosus* are two commercially valuable bivalve species from the Caribbean region, and are interesting candidates for mass culture in the sea based on laboratory production of juvenile “spat” organisms. An experiment of artificial spawning was performed with the two species as the initial part of a study on the feasibility of producing their spat. Stimulation of spawning was carried out, determining the percentages of individuals spawning, response time, numbers of gametes produced, and fertilization of the oocytes. Five external stimuli and eight combinations of those were tested: slow changes in temperature (ST), fast changes in temperature (FT), desiccation (D), high concentrations of microalgae (M), exposure to water currents (C), ST + D, ST + M, ST + C, FT + D, FT + M, FT + C, D + M and D + C. Four internal stimuli were applied, including intragonadal injection of serotonin (Se), dopamine (Da), Da + prostaglandin E₂ (Da + PE₂) and Se + PE₂. The results showed that *A. nucleus* spawned in response to all 17 stimuli tested, while *N. nodosus* responded to only eight of these (47%), suggesting that spawning in the first species was more sensitive to both external and internal stimuli. Larger percentages of individuals of *A. nucleus* spawned, with specially high values (100%) obtained with the ST + M, ST + D and Da stimuli; in *N. nodosus*, the Da stimulus was the most effective. *N. nodosus* gave shorter response times to stimuli than *A. nucleus*, with the shortest times in both scallop species (16 to 32 min) obtained using the internal stimuli. The production of gametes was similar between the two species, with about 5×10^9 spermatozoa, and 1.9×10^6 oocytes released per individual. *A. nucleus* produced higher numbers of spermatozoa using the ST + M stimulus, and higher numbers of oocytes using the FT + M, ST + D and Se stimuli; these values did not differ among treatments in *N. nodosus*. Abnormal spawning was observed in some of the internal stimuli tested, including release of immature gametes, simultaneous release of both male and female gametes, or sole production of male gametes. Fertilization was about 63% for both species, and was not influenced by the type of stimulation used to obtain the gametes. In summary, the most efficient stimuli for inducing the normal spawning of viable gametes in *A. nucleus* were ST + M and ST + D, and Se + PE₂ in *N. nodosus*. Early embryonic and larval development in *A. nucleus* were significantly more rapid than in *N. nodosus*, while the sizes of early embryos and larvae were similar in both species, and comparable to previous descriptions of scallops' early development.

Seasonal variation in weight and biochemical composition of the Pacific oyster, *Crassostrea gigas* in relation to the gametogenic cycle and environmental conditions of the Bizert lagoon, Tunisia

S. Dridi, M. Salah Romdhane, M. Elcafsi

Source: Aquaculture 263(1–4):238–248. March 2007.

Seasonal variations in biochemical composition of the bivalve *Crassostrea gigas* were studied from February 2002 until January 2003 in the Bizert lagoon in relation to environmental conditions and reproductive events. Separate analyses were made of gonad-visceral mass. The gametogenic cycle comprised two phases: gametogenesis including ripeness and spawning (March–September) and sexual repose during the rest of the year. The *C. gigas* in the Bizert lagoon showed a clear cycle of energy storage and utilization. Total biochemical composition was about $6.50\% \pm 3.01$ of dry weight in glycogen, $14.34\% \pm 3.60$ of dry weight in protein and $6.67\% \pm 1.34$ of dry weight in lipids. Lipid and glycogen concentrations in the gonad-visceral mass were inversely related: maximum concentrations of glycogen occurred between December and February and corresponded with minimum concentrations of lipids. High glycogen contents recorded in winter supported the processes of gametogenesis and then decreased progressively to attain low values at maturity and during summer corresponded to the first emission of gametes (June) and the beginning of total spawning, however lipids are accumulated in gonads during the period of maximum ripeness (spring) and decrease in summer. During autumn, the increase of total fatty acids values appeared to be related to the available food in association with an increase in the chlorophyll *a* concentrations. Protein contents show many variations throughout the year. High protein levels occurred in May and in July, which corresponded to oocyte maturation and then decreased in late summer (beginning of total spawning). At the expense of the available food in autumn, protein concentrations increase again to assure recovery of the tissue weight of the bivalve, which induced an increase in the condition indices values.

Density-dependent mortality of the scallop *Chlamys farreri* (Jones & Preston) in grow-out culture

X. Zhang, M. Zhu, R. Li, Z. Wang, L. Zhang

Source: Aquaculture Research 37(8):842–844. June 2006.

No Abstract.

Problems associated with shellfish farming

S. Chinabut, T. Somsiri, C. Limsuwan, S. Lewis

Source: Revue scientifique et technique - Office international des épizooties 25(2):627–635. 2006.

Shellfish culture is a major sector of aquaculture production worldwide, and zoonoses and drug residues associated with shellfish farm practice are of concern to public health. This paper focuses on three of the most important shellfish species: molluscs, crabs and shrimp. Although many diseases can affect shellfish, they do not appear to be transmittable to humans. Rather, the main hazards are associated with the methods used to farm the different species. The risk to human health from shellfish most commonly relates to contamination by biotoxins produced by marine algae. Another well-recognised problem associated with shellfish culture is the contamination of shellfish with domestic sewage that contains human pathogenic bacteria and viruses, which causes diseases such as typhoid fever and hepatitis. In shrimp farming, the main potential food safety hazards are zoonoses, chemical contamination and veterinary drug residues. Untreated effluent from shrimp farms is a major concern to the environmental sector as it is known to promote plankton blooms if directly discharged into natural water sources.

Use of single cell detritus (SCD) produced from *Laminaria saccharina* in the feeding of the clam *Ruditapes decussatus* (Linnaeus, 1758)

A. Pérez Camacho, J.M. Salinas, M. Delgado, C. Fuertes

Source: Aquaculture 266(1–4):211–218. June 2007.

This study analyses the food value for bivalve mollusc seed of single cell detritus (SCD) from *Laminaria saccharina*, produced in accordance with the technique developed by Pérez Camacho et al. [Pérez Camacho A., Salinas J.M., Fuertes C., Delgado M., 2005. Preparation of single cell detritus from *L. saccharina* as a hatchery diet for bivalve mollusks. Mar. Biotechnol. 6, 642–649], which is based on the sequential action of two enzymes: endoglucanases and cellulases and two bacteria isolated in our laboratories: CECT 5255 and CECT 5256, which have high cellobiosic, proteolytic and alginolytic activities. Using this technique, *L. saccharina* meal is transformed in a suspension of algal cells and detritus of less than 20 µm in diameter, which can easily be filtered and digested by the bivalve molluscs.

SCD from *L. saccharina* can replace between 80% and 90% of the live phytoplankton content in the feeding of *R. decussatus*, with growth rates equalling, and even surpassing, those resulting from live phytoplankton diets. If we then factor in the low sedimentation of this product, the lack of proliferation of pathogenic bacteria in the culture vessels (possibly as a consequence of the control exercised by the bacteria used in the SCE production process), and the high survival rates of the individuals used in our experiments, we can well conclude that SCD from *L. saccharina* is an effective complement to live phytoplankton diets for *R. decussatus*, its use reducing the need to produce phytoplankton in industrial bivalve mollusc hatcheries by up to 90%. Similarly, the introduction of this food would also appreciably diminish operating costs in this kind of industry, where phytoplankton culture accounts for some 30% of total production costs.

Experimental trials on the feasibility of offshore seed production of the mussel *Mytilus edulis* in the German Bight: installation, technical requirements and environmental conditions

B.H. Buck

Source: Helgoland Marine Research 61(2):87–101. June 2007.

This study summarizes the activities and findings during a 2-year investigation on the grow-out of blue mussels (*Mytilus edulis*) and the technical requirements to withstand harsh weather conditions at an offshore location. The experimental sites were two different test areas, each 5 ha in size, 12–15 m in depth, in the vicinity of the offshore lighthouse “Roter Sand” located 15–17 nautical miles northwest of the city of Bremerhaven (Germany). Two versions of submerged longline systems were deployed: a conventional polypropylene longline in 2002 as well as a steel hawser longline in 2003, both featuring different versions of buoyancy modes. The spat collectors and grow-out ropes were suspended perpendicular from the horizontal longline for several months beginning in March of each respective year. The test sites were visited and sampled on a monthly basis using research vessels. Larval abundances in the surrounding water column

reached numbers of up to 1,467 individuals m^{-3} . Post-larval settlement success varied through the entire experimental period, ranging from 29 to 796 individuals of spat per meter of collector. Settled mussels reached a shell length of up to 28 mm 6 months after settlement. Based on the growth rates observed for the seed, it is projected that mussels would reach market size (50 mm) in 12–15 months post settlement, and at the observed densities, each meter of collector rope could yield 10.9 kg of harvestable mussels. The polypropylene line resisted storm conditions with wind waves of up to 6.4 m and current velocities of 1.52 m s^{-1} and was retrieved in autumn of 2002. In contrast, the steel hawser-based line did not withstand the harsh weather conditions. The steel-based line consisted of six twisted strands that were untwisted by the strong currents and turbulences and consequently the individual strands were torn. Additionally, the line was accidentally cut by a yacht in July 2003. The biological study revealed that the tested location near “Roter Sand” has the potential to become an offshore seed production site as well as being exploitable as a grow-out site for mussel production to market size. In light of the technical results, recommendations for mussel culture strategies using a polypropylene longline system are given.

Preliminary assessment of the potential for mangrove oyster cultivation in Piraquêçu river estuary (Aracruz, ES)

L. Alvarenga, R.C. Nalesso

Source: Brazilian Archives of Biology and Technology 49(1):163–169. January 2006.

At Piraquêçu river estuary, Aracruz, ES, the technical viability of *Crassostrea rhizophorae* cultivation was determined through monthly measures in shell length and weight. Seeds of *C. rhizophorae* were put in cages and suspended in rafts. Increase in height and weight (flesh and dry) of the oysters was measured. During ten months (July 98 to May 99), oyster shell reached an average of 37.6 mm in shell height and 3.0 g in flesh weight (the whole animal). High mortality rates were registered and could be related to the high salinity water and to high predation observed, especially by flatworms *Stylochophana divae* and snails *Cymatium parthenopeum*, as well as fouling organisms such as barnacles, Serpulidae polychaetes and seed of the same species.

Growth rate estimation of *Hexaplex (trunculariopsis) trunculus* (Gastropoda: Muricidae) based on mark/recapture experiments in the Ria Formosa lagoon (Algarve coast, southern Portugal)

P. Vasconcelos, M.B. Gaspar, A.M. Pereira, M. Castro

Source: Journal of Shellfish Research 25(1):249–256. April 2006.

This study reports growth rates estimates for *Hexaplex (Trunculariopsis) trunculus* (Gastropoda: Muricidae) from mark/recapture experiments carried out in the Ria Formosa lagoon (Algarve coast, southern Portugal). A total of 726 specimens (shell length and total weight ranging between 20.65–58.36 mm and 0.86–19.89 g, respectively) were marked with Dymo tape tags and released into a fish culture earth pond. During the marking process, no adverse effects on the whelks' health and behavior or immediate postmarking mortality were detected. Periodical recapture operations were undertaken using a traditional fishing gear designated locally as “wallet-line” and by hand gathering by scuba divers. A total of 170 whelks were caught, with a total of 216 recaptures (shell length and total weight ranging between 36.22–65.97 mm and 4.42–27.35 g, respectively), thus corresponding to a recapture rate of 29.8%. Despite the loss of one tag, all remaining tags were intact and easily readable. Marked individuals presented low monthly growth rates, in terms of shell length ($1.0 \text{ mm month}^{-1}$ or $2.3\% \text{ month}^{-1}$), shell perimeter ($2.0 \text{ mm month}^{-1}$ or $3.1\% \text{ month}^{-1}$) and total weight (0.7 g month^{-1} or $10.8\% \text{ month}^{-1}$), which were highly variable between individuals and higher in smaller specimens. Data were used to estimate the von Bertalanffy growth parameters (length and weight) ($K = 0.41$, $L_{\infty} = 82.76$, $W_{\infty} = 49.97$ and $t_0 = 0.05$). The growth rate of *T. trunculus* was compared with results obtained in similar studies with other gastropod species to evaluate its potential for molluscan aquaculture.

Mechanical properties and structure of *Strombus gigas*, *Tridacna gigas*, and *Haliotis rufescens* sea shells: A comparative study

A.Y.M. Lin, M.A. Meyers, K.S. Vecchio

Source: Materials Science & Engineering C 26(8):1380–1389. 2006.

Sea shells are composed of calcium carbonate crystals interleaved with layers of viscoelastic proteins, having dense, tailored structures that yield excellent mechanical properties. Shells such as conch (*Strombus gigas*), giant clam (*Tridacna gigas*), and red abalone (*Haliotis rufescens*) have hierarchical architectures that differ depending on growth requirements and shell formation of the particular mollusk. Mechanical tests have been carried out on these shells for a comparison of strength with respect to the microstructural architecture

and sample orientation. The mechanical response is found to vary significantly from specimen to specimen and requires the application of Weibull statistics in order to be quantitatively evaluated. The complex micro-laminate structure of these biocomposite materials is characterized and related to their mechanical properties. The red abalone has the highest compressive (233–540 MPa) and flexure strengths of the three shells. The giant clam has the lowest strength (87–123 MPa) and the conch has an intermediate value (166–218 MPa) in compression. The high compressive strength observed in the abalone is attributed to an optimization of microstructural architecture in the form of 2-D laminates, enhancing the fracture toughness of this shell material and enabling higher stresses to develop before fracture.

Reproductive cycle of the purple snail *Plicopurpura pansa* (Gould 1853) from two locations at Baja California Sur, Mexico

L.C.A. Naegel, F.A. García-Domínguez

Source: Journal of Shellfish Research 25(3):925–933. December 2006.

The reproductive cycle of purple snail, *Plicopurpura pansa* (Gould 1853), sampled randomly monthly over a period of 20 months at Playa Cerritos at the Pacific, and Punta Perico at the Gulf of California, Baja California Sur, Mexico, was examined by histological observations of the gonadal development. At both sites year-round copulations were observed, whereas egg capsules could be found only during February to May. During nearly the whole period, male and female gonads were found in the developing stage. From January to July and August most female gonads were found in the ripe, and from January to June and August in the spawning stage. Male gonads in the spawning stage were observed from December to September. The recovering stage was found in male and female gonads between September and October. Synchronism of gonadal development between both sexes was evident. Spawning could be observed in females with a total shell length of more than 18 mm, whereas smaller animals had gonads in the developing stage. In gonads of males signs of spawning could be observed in animals larger than 18 mm. No relationship was found between the water temperature and the spawning period. The sex ratio was 1:1 at Playa Cerritos, whereas at Punta Perico more males than females were counted.

Molluscan natural products as biological models: chemical ecology, histology and laboratory culture

C. Avila

Source: Molluscs. G. Cimino, M. Gavagnin (Eds.), Springer-Verlag Berlin Heidelberg 2006

The utility of some natural products from molluscs has been known for centuries. However, only recently have modern technologies and advances in the fields of chemistry, chemical ecology, anatomy, histology, and laboratory culture allowed the exploitation of new, unprecedented applications of natural products. Recent studies have dealt with (a) the role that these compounds have in the sea in protecting the animals (e.g., chemical defense), or in mediating their intraspecific communication (e.g., pheromones), (b) the geographical differences in similar or related species (and the implications of this in chemical ecology and phylogeny), and (c) the localization of these metabolites in molluscan tissues (by means of the most modern technologies), among others. The methodology for the laboratory culture of some species has also been established, thus offering new insights into this interesting field. Further applications of all these challenging studies are currently being developed.

Endocrine disruption in prosobranch molluscs: evidence and ecological relevance

J. Oehlmann, P. Di Benedetto, M. Tillmann, M. Duft, M. Oetken, U. Schulte-Oehlmann

Source: Ecotoxicology 16(1):29–43. February 2007.

Prosobranch snails represent almost 50% of all recent molluscs, are ubiquitously distributed, play important roles in various ecosystems and exhibit a variety of reproductive modes and life-cycle-strategies. Many of them attain life spans of several years, which in combination with their limited ability to metabolize organic chemicals, may contribute to the fact that prosobranchs constitute one of the most endangered taxonomic groups in aquatic ecosystems. Although it is not yet known to what extent endocrine disrupting chemicals (EDCs) contribute to this situation, the case of tributyltin (TBT) and its population-level impact on prosobranchs demonstrates the general susceptibility of these invertebrates. The existing evidence for comparable population-level effects in prosobranch snails by other androgens, antiandrogens, and estrogens is critically reviewed. The example of TBT demonstrates the difficulty to prove an endocrine mode of action for a given chemical. Although it is generally accepted that TBT causes imposex and intersex in prosobranch snails as a result of endocrine disruption, the detailed biochemical mechanism is still a matter of debate.

The strengths and weaknesses of the five competing hypotheses are discussed, together with previously unpublished data. Finally, the ecological relevance of EDC effects on the population and community level and the application of prosobranchs for the assessment of EDCs are addressed.

Sex and genetic structure across age groups in populations of the European marine invasive mollusc, *Crepidula fornicata* L. (Gastropoda)

L. Dupont, D. Bernas, F. Viard

Source: Biological Journal of the Linnean Society 90(2):365–374. February 2007.

In long-lived species, variance in allele frequencies over time may vary according to the number of generations contributing to progeny. Here, we investigate the temporal stability of genetic diversity and structure in relation to sex and age in introduced populations of *Crepidula fornicata*, an exotic gastropod that successfully invaded Europe. This protandrous species has the potential to change sex from male to female according not only to age, but also to local sex ratio (social environment). This mechanism may adjust the reproduction efficiency across different cohorts and thus decrease the likelihood of genetic drift in the following generations. Based on crude demographic structure analysis in two spatially closed introduced French populations, we demonstrate that recruitment is discontinuous. Although timing of sex change is different across populations, both populations have a similar age structure characterized by distributions of males and females changing across generations. Using five microsatellite loci, we show that both populations display a temporal genetic homogeneity and a stability in genetic diversity indices across age groups examined. Our results highlight that the social control of sex change in *C. fornicata* has strong implications to the maintenance of high genetic diversity by enhancing breeding across several generations at each reproductive season.

Biology and fishery of the whelk *Buccinanops globulosum* (Kiener, 1834) in northern coastal waters of the San Matías Gulf (Patagonia, Argentina)

M.A. Navarte

Source: Fisheries Research 77(2):131–137. 2006.

The whelk *Buccinanops globulosum*, a very common prosobranch mollusk in northern Patagonian, is the target of a new fishery in San Matías Gulf. Given certain biological characteristics making this species susceptible to overfishing, a study started in 2000 in order to collect data on demography and growth at age of this species, with the aim to design and to implement a provisional management plan. Mean density was estimated at 111 individuals m⁻² (S.D. = 16.77). Females outnumbered males in most of the months ($P < 0.05$) and appeared laying egg capsules from November to January. The smallest female carrying egg capsules was 45.2 mm total conch length ($n = 36$). Recruitment peak was identified in January 2002 and January–February 2003. Early crawling juveniles had a mean size of 4.2 mm conch length (S.D. = 0.51, $n = 60$). A total of 450 individuals (263 females and 187 males) were examined for growth at age. Significant differences were found in the growth parameters between sexes (maximum likelihood method; $X = 92.34$; $g_1 = 3$; $P < 0.001$). Growth of males was lower than growth of females. Commercial capture of whelks is done by diving using a bait of fish discarded or open living purple clams. Only adults up 4 cm are retained during the fishing operations in a net bag. During 2000–2004 the annual catch varied from 20 to 9200 kg. Fluctuations in landings have more often reflected market prices rather than changes in the abundance of the resource. If effort for this whelk increases it should be necessary to consider a period of no fishery at all in the reproductive/recruitment period in order to ensure the sustainability of the stock.

Site- and species-specific distribution patterns of molluscs at five intertidal soft-sediment areas in northwest Europe during a single winter

P. Bocher, T. Piersma, A. Dekinga, C. Kraan, M.G. Yates, T. Guyot, E.O. Folmer G. Radenac

Source: Marine Biology 151(2):577–594. April 2007.

In this study we aim to provide a basic description and comparison of the spatial distribution and population structure of the common intertidal mollusc species, sampled within a single winter along a latitudinal gradient of different soft-sediment areas spanning 8° of latitude (46°–54°N) and 900 km of distance in northwest Europe. Sediment samples were collected from December 2003 to early March 2004 in the Wadden Sea (The Netherlands), the Wash (United Kingdom), Mont Saint-Michel Bay (France) and two bays on the central French Atlantic coast in south of Brittany. Core-sampling over 250 m grids allowed us to cover 3–30 km² at nine separate intertidal subsites, with a grand total of 2,103 points visited. Among the 15 bivalve and 8 gastropod species collected, we focused on the four most common and abundant bivalve

species (*Cerastoderma edule*, *Macoma balthica*, *Scrobicularia plana* and *Abra tenuis*) that together represented 96% of all collected bivalves, and on the mudsnail *Hydrobia ulvae* that comprised 99% of all collected gastropods. *C. edule* and *M. balthica* were the most widespread bivalves, with higher densities occurring at higher latitudes. *S. plana* and *A. tenuis* were more abundant at southern sites, both with a clear preference for muddy sediments. The mudsnail *H. ulvae* occurred commonly and in comparable densities at all study sites, except in Mont Saint-Michel Bay where it was very rare. Mean sizes of the common molluscs were highly variable between sites, without clear north-south gradients. The mollusc distribution patterns at the five intertidal areas and nine subsites were predominantly site-specific. Mollusc community composition showed greater similarity within than between the regions north and south of the Brittany peninsula.

Seasonal variations of immune parameters in diploid and triploid Pacific oysters, *Crassostrea gigas* (Thunberg)

M.B. Duchemin, M. Fournier, M. Auffret

Source: Aquaculture 264(1–4):73–81. April 2007.

During the last two decades, knowledge of shellfish immunology has been largely improved and the immune status of bivalves can be assessed by the measurement of both cellular and humoral parameters. Previous monitoring studies in which the immune status of bivalve molluscs has been assessed have demonstrated that many parameters may vary greatly among sites and seasons, suggesting that environmental and endogenous factors may affect this system. Reproduction may also interfere with the immune system. This study focuses on the seasonal variations of the immune parameters in two batches of Pacific oysters differing by their ploidy, diploid's and triploid's. The oysters were sampled from a French oyster farm over two reproductive periods. Selected immune parameters investigating haemocyte integrity and immunocompetency were analysed monthly by flow cytometry. Histological observations were made in gonads to discriminate gender and gametogenesis stages. Results indicate that immune parameters in both diploid and triploid oysters exhibited marked seasonal variations. Phagocytosis index was significantly low during spawning before reaching a maximum in autumn. Triploids also appeared to be less sensitive to environmental cues than diploids. Taken as a whole, alterations observed in maturing individuals corresponded to a depressed immune status in late spring, at a time corresponding to the spawning period. Furthermore, grouping by sex of ongoing gametogenesis individuals revealed uneven immune alterations among males and females. Finally, grouping sexual maturation stages showed evidence of a peculiar stressful event during early gametogenesis, perhaps under endogenous control.

Mussels flexing their muscles: a new method for quantifying bivalve behaviour

A. Robson, R. Wilson, C. Garcia de Leaniz

Source: Marine Biology 151(3):1195–1204. May 2007.

We employed a novel technique to quantify how blue mussels *Mytilus edulis* react to predation risk in their environment by quantifying mussel gape using a Hall sensor attached to one shell valve reacting to a magnet attached to the other. Change in gape angle per second (CHIGA) versus gape angle plots resulted in a distribution with a boundary, which defined the maximum CHIGA of a mussel at all gape angles. CHIGA boundary plots for all individual mussels were similar in form. However, the CHIGA boundary increased in extent with mussel length (maximum CHIGA for mussel valve closures for mussels 2.98 and 79.6 mm long were -1.5 and -11° s^{-1} , respectively), showing that larger mussels opened and closed most rapidly. Mussel extract added to the seawater, a factor believed to signal predation, caused mussels to close significantly faster than otherwise ($P < 0.001$). This approach for assessing how mussels react to their environment indicates that mussel response to predation is graded and complex and may well indicate animal-based assessments of the trade-off between effective feeding and the likelihood of predation.

Isolation and characterization of eight polymorphic microsatellite markers from pink conch (*Strombus gigas*)

R. Zamora-Bustillos, R. Rodríguez-Canul, F.J. García De León

Source: Molecular Ecology Notes. 2007. doi: 10.1111/j.1471-8286.2007.01687.x

Many marine organisms have pelagic larvae, and these are often important agents of dispersal. The larval phase and the multiple paternity that occur in marine gastropods such as *Strombus gigas* are crucial for the success of this species throughout the Caribbean Sea. To analyse these factors, we developed eight microsatellite loci specific to *S. gigas*. On the same set of individuals, the microsatellite loci exhibited a greater level of polymorphism than previously studied allozyme markers and thus, will permit fine-scale analysis and larval pool studies.

Mechanism of a plastic phenotypic response: predator-induced shell thickening in the intertidal gastropod *Littorina obtusata**J. I. Brookes, R. Rochette***Source:** Journal of Evolutionary Biology 20(3):1015–1027. May 2007.

Phenotypic plasticity has been the object of considerable interest over the past several decades, but in few cases are mechanisms underlying plastic responses well understood. For example, it is unclear whether predator-induced changes in gastropod shell morphology represent an active physiological response or a by-product of reduced feeding. We address this question by manipulating feeding and growth of intertidal snails, *Littorina obtusata*, using two approaches: (i) exposure to predation cues from green crabs *Carcinus maenas* and (ii) reduced food availability, and quantifying growth in shell length, shell mass, and body mass, as well as production of faecal material and shell micro-structural characteristics (mineralogy and organic fraction) after 96 days. We demonstrate that *L. obtusata* actively increases calcification rate in response to predation threat, and that this response entails energetic and developmental costs. That this induced response is not strictly tied to the animal's behaviour should enhance its evolutionary potential.

Bivalve genomics*C. Saavedra and E. Bachère***Source:** Aquaculture 256(1–4):1–14. June 2006.

Interest in bivalve genomics has emerged during the last decade, owing to the importance of these organisms in aquaculture and fisheries and to their role in marine environmental science. Knowledge of bivalve genome structure, function and evolution resulting from 20th century “single gene” approaches is limited, but genomic technologies are called to dramatically increase it. Research based on linkage maps, transcriptomics and proteomics is being carried out to study the genetic and molecular bases of traits of interest in bivalve farming industry, mainly disease susceptibility, tolerance to environmental stress, and growth. The Pacific oyster (*Crassostrea gigas*) is now the focus of an international genome-sequencing consortium. The use of bivalves in pollution monitoring has prompted the genomic study of the cell and organism responses to xenobiotics, which should expand into the field of phytoplankton toxins. Future work should also pay more attention to the larval stages, and to basic processes such as growth, sex-determination, and gonad development.

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Secretariat of the Pacific Community, Marine Resources Division, Information Section

BP D5, 98848 Noumea Cedex, New Caledonia

Telephone: +687 262000; Fax: +687 263818; cfpinfo@spc.int; <http://www.spc.int/coastfish>