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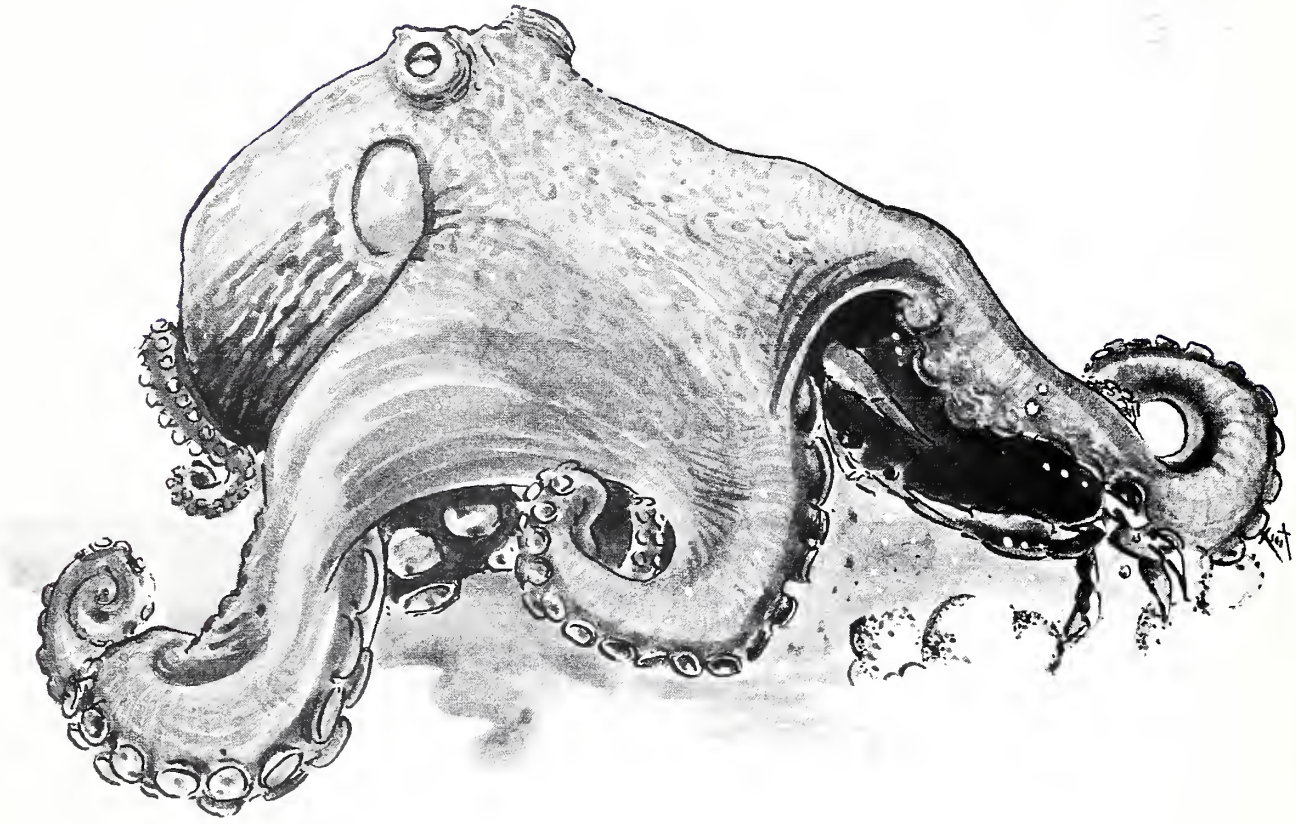

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Information Resources on the Care and Use of Molluscs

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Information Resources on the Care and Use of Molluscs

Contents

How to Use This Guide*

Invertebrates are playing an increasingly important role in biomedical research. Because many of their biological processes are temperature dependant, they have allowed us to view biochemical pathways and intermediate steps in ways that would be impossible with birds or mammals. Some have cells or organs similar to those found in man but greatly enlarged. The giant axon in the squid and the muscle cells in barnacles are the largest in the animal kingdom. Octopuses have the most complex brain of all invertebrates; which include long and short-term memories. Aplysia are used in many different types of nervous system studies. Sea squirts have been used to study kidney stones and squid are used in multiple sclerosis research. From scallop to sea slug, invertebrates have served as models of human and animal disease.

Invertebrates are relatively easy to maintain, less expensive, and less labor intensive than more traditional laboratory animals. From a societal standpoint, invertebrates may be more acceptable as laboratory animals than vertebrates. Many researchers, either by law or policy, are required to consider ways to reduce the number of animals proposed for an experiment, refine their techniques to minimize pain and distress to the animals, and replace the animal model with a non-animal model or a taxonomically lower species. Use of the invertebrate is considered a replacement alternative to the use of vertebrates. Since research has not yet shown invertebrate cognition of what would be considered pain in mammals and birds, their use is also a refinement alternative.

This guide, *Information Resources on the Care and Use of Molluscs*, provides a snap shot of how Molluscs are being used in research and, just as important, how they are cultured, reared, and housed in the laboratory and elsewhere. The bibliographic citations cover the publication years 2002 to approximately 1973. The bibliographic citations resulted from searching numerous scientific and technical databases. The call number is included for materials in the National Agricultural Library's (NAL)collection. NAL's document delivery policies can be found at http:/www.nal.usda.gov/ddsb/.

The websites and organizations at the end of some sections are current through April 2003. They were found by running general searches on the World Wide Web. As sites can become outdated or relocated and new sites emerge, a general search on one of the commercial search engines should help locate address changes or new sites if the addresses included in this document no longer function.

* Information included in this portion of this publication and other web-resources sections were adapted from *Information Resources for the Care and Use of Invertebrates* (published previously in AWIC by Michael D. Kreger, Ph.D.) and included with his permission.

Laboratory Care/ Research

Bivalves

2002

Kreeger, D.A.; Gatenby, C.M.; Raksany, D. (2002) **Variability in condition index and tissue biochemistry of Elliptio complanata held in the field and laboratory.** *Journal of Shellfish Research* 21 (1): 378-379, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: freshwater ecology, environmental sciences, nutrition, Elliptio complanata, freshwater mussel, adult, microalgae, food, lab cultured, animals, nonvascular plants, tissue, biochemistry, carbohydrate, lipid, protein, continuous flow chambers, laboratory equipment, ash, environmental conditions, field conditions, food quality, laboratory conditions, natural seston, physiological condition index, reproductive cycling, seasonal variation, sediment conditions, water quality.

Piano, A.; Asirelli, C.; Caselli, F.; Fabbri, E. (2002) **Hsp70 expression in thermally stressed Ostrea edulis, a commercially important oyster in Europe.** *Cell Stress and Chaperones* 7 (3): 250-257, ISSN: 1355-8145.
DESCRIPTORS: Ostrea edulis, animal model, commercial importance, thermal stress, Heat shock protein-70, heat induced thermally stressed oyster gill, expression, heat induced thermally stressed oyster mantle expression, Europe.

2001

Barfield, M.L.; Farris, J.L.; Black, M.C. (2001) **Biomarker and bioaccumulation responses of Asian clams exposed to aqueous cadmium.** *J Toxicol Environ Health A* 63(7): 495-510, ISSN: 1528-7394.
NAL CALL NUMBER: RA565 A1J6
ABSTRACT: Measured responses of biochemical or physiological indicators have been suggested to reflect thresholds where pollutants exert their initial effect. Responses in cellulolytic enzyme activity and DNA strand breakage of the Asian clam Corbicula fluminea exposed to cadmium in the laboratory were measured and metal body burdens were determined concurrently. Clams were exposed to aqueous cadmium concentrations of 3, 6, 12, or 25 ppb for 23 and 28 d. Cadmium concentrations in clam tissue were highest in lower cadmium treatments, and body burdens increased with length of exposure in only the 28-d experiment. Cellulolytic enzyme activity decreased with increasing cadmium concentrations for clams in the 28-d experiment. Induced enzyme activities were observed in cadmium treatments for both experiments and are thought to precede declines in activity through the length of exposure. Significant reductions in DNA strand lengths of cadmium exposed clams were observed by wk 3 in the 23-d exposure and by wk 2 in the 28-d exposure. Reduced DNA strand lengths in these cadmium treatments for the 28-d exposure precede significant declines in cellulolytic activity at subsequent sampling events. Combining these data with observations of mortality in higher cadmium treatments suggests that impairment of DNA structural integrity and reduced digestive enzyme activity may indicate metal-induced stress in clams.
DESCRIPTORS: cadmium pharmacokinetics, cellulose metabolism, water pollutants, chemical pharmacokinetics, analysis of variance, biological markers, body burden, cadmium toxicity,

clams, DNA, single stranded drug effects, dose response relationship, drug, tissue distribution, water pollutants, chemical toxicity, biological markers, DNA, single stranded, chemical, cadmium.

Borcherding, J.; Wolf, J. (2001) **The influence of suspended particles on the acute toxicity of 2-chloro-4-nitro-aniline, cadmium, and pentachlorophenol on the valve movement response of the zebra mussel (Dreissena polymorpha).** *Arch Environ Contam Toxicol* 40(4): 497-504, ISSN: 0090-4341.
NAL CALL NUMBER: TD172 A7
ABSTRACT: The Dreissena-Monitor is a biological early warning system for the continuous monitoring of river water quality, based on the valve movements of two groups of 42 zebra mussels (Dreissena polymorpha). Laboratory experiments with Cd, PCP, and 2-chloro-4-nitro-aniline were conducted in combination with suspended particles (a mixture of stinging nettle powder, bentonite, and quartz powder). An increase of suspended particles up to a nominal concentration of 540 mg/L within 5 min did not evoke any reactions by the mussels significantly different from normal. The distribution between water and solids was analyzed for Cd and 2-chloro-4-nitroaniline, with the result that the former quickly adsorbed to the particles, whereas the latter did not bind to the particles at all. The behavior of the zebra mussels revealed that the detection of 2-chloro-4-nitro-aniline was not affected by the presence of suspended matter. In the cases of Cd and PCP, D. polymorpha was able to detect these substances when they were particle-associated at least as well or better as when they were dissolved in the water. The results are discussed with respect to the physiology of the organisms and the bioavailability of toxicants, as well as to the consequences these results may have under field conditions.
DESCRIPTORS: aniline compounds toxicity, cadmium toxicity, environmental pollutants toxicity, mussels, mutagens toxicity, pentachlorophenol toxicity, adsorption, aniline compounds pharmacokinetics, behavior, animal, biological availability, cadmium pharmacokinetics, environmental monitoring, environmental pollutants, pharmacokinetics, particle size, pentachlorophenol pharmacokinetics, aniline compounds, environmental pollutants, mutagens, 2-chloro-4-nitroaniline, cadmium, pentachlorophenol, environmental health, toxicology.

Brichette, I.; M. I. Reyero; C. Garcia. **A genetic analysis of intraspecific competition for growth in mussel cultures.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. Jan 15, 2001. v. 192 (2/4) p. 155-169. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
ABSTRACT: In domestic organisms that are cultured in situations where competition for resources exists, the effect of an individual on the overall yield of the population depends not only on its own growth in the face of competition, but also on its competitive influence on its neighbours' growth. The genetic variability of this influence may be very important and therefore useful in a breeding plan, but is seldom estimated in practice. In this study, we carried out a genetic analysis of the intraspecific competition for growth in cultured mussels, and found that the family genotype had a clear effect on both the competitive influence of each individual on its neighbours, and its response to the competition from them. The limited number of male and female parents available for the experiment prevented a very precise partition of this genetic variability in additive and dominant variances, but in any case the heritability estimates obtained tended to be low (about 10% overall). These low heritabilities could still result in significant responses to artificial selection, given the high selection pressures that can be applied in bivalve molluscs. In addition, and in contrast with what usually happens in plants, the correlation between both kinds of effects in our mussel population was clearly greater than -1, which could allow the use of artificial selection to increase the ability to grow at high population densities and simultaneously to reduce the competitive interference between neighbours.

DESCRIPTORS: Mytilus galloprovincialis, genetic analysis, intraspecific competition, mussel culture, heritability, yields, competitive ability, growth, genetic variation, animal breeding, breeding programs, genotypes, genetic variance, artificial selection, selection pressure.

Butler, R.A.; Roesijadi, G. (2001) **Quantitative reverse transcription polymerase chain reaction of a molluscan metallothionein mRNA.** *Aquat Toxicol* 54(1-2): 59-67, ISSN: 0166-445X.
NAL CALL NUMBER: QH541.5.W3A6
ABSTRACT: A quantitative assay based on competitive reverse transcription polymerase chain reaction (RT-PCR) was developed for metallothionein (MT) mRNA of the mollusc Crassostrea virginica and applied to analysis of MT mRNA of hemocytes. The assay was based on titration of a competitive external standard cRNA derived from the coding region of the oyster MT mRNA. Serial dilutions of the cRNA standard were coamplified with a constant amount of total RNA using biotinylated primers common to both target and standard sequences. Amplified products were bound to streptavidin-coated plates and hybridized to sequence-specific fluorescein-labeled probes. Detection was based on single photon counting of chemiluminescence generated by an alkaline phosphatase-conjugated antifluorescein antibody. For quantification, the target chemiluminescence was normalized to that of the standard, and the amount of target MT mRNA in the sample was derived from the titration. Cadmium-induced MT mRNA equivalent to that in 180 hemocytes was easily detected, and, for routine quantitative analysis, was sufficiently sensitive to quantify basal and induced MT mRNA. Basal hemocyte MT mRNA of 133+/-8 (1 S.E.) amol per microgram total RNA was induced 5-fold to 573+/-14 amol per microgram total RNA by in vitro exposure to 15 microM CdCl(2) for 20 h.
DESCRIPTORS: metallothionein genetics, oysters metabolism, RNA messenger analysis, reverse transcriptase polymerase chain reaction, cadmium pharmacology, pharmacology, genetics, metabolism, analysis, messenger RNA, cadmium, metallothionein.

Kelley, M.L.; Winge, P.; Heaney, J.D.; Stephens, R.E.; Farell, J.H.; Van Beneden, R.J.; Reinisch, C.L.; Lesser, M.P.; Walker, C.W. (2001) **Expression of homologues for p53 and p73 in the softshell clam (Mya arenaria), a naturally-occurring model for human cancer.** *Oncogene* 20 (6): 748-758, ISSN: 0950-9232.
DESCRIPTORS: molecular genetics, biochemistry and molecular biophysics, tumor biology, Mollusca, Mya arenaria, animal model, Mollusks, leukemia, blood and lymphatic disease, neoplastic disease, tumor development.

Lares, M.L.; Orians, K.J. (2001) **Differences in Cd elimination from Mytilus californianus and Mytilus trossulus soft tissues.** *Environ Pollut* 112(2): 201-7, ISSN: 0269-7491.
NAL CALL NUMBER: QH545.A1E52
ABSTRACT: Field results have shown that Mytilus californianus is able to release its Cd concentrations significantly in just a few days. The existing paradigm states that Cd elimination from Mytilus soft tissues is a very slow process. This discrepancy was investigated in the laboratory, testing the effect of two Cd levels (10 and 1 microgram l-1) on its release from Mytilus trossulus and M. californianus soft tissues. After exposure to 10 micrograms l-1, both species showed a significant uptake with no elimination after several days of depuration. After exposure to 1 microgram l-1, the responses were different. No significant Cd uptake was seen in M. trossulus while in M. californianus uptake was significant but returned to the background level after just 1 day of depuration. This response of M. californianus is consistent with that reported from field studies. These results are important for environmental monitoring programs since M. californianus has been used as equivalent to other Mytilus species in the assessment of Cd pollution.

DESCRIPTORS: cadmium pharmacokinetics, environmental pollutants pharmacokinetics, mussels physiology, environmental monitoring, reference values, cadmium, pharmacokinetics, physiology.

Longsha, M.; Feist, S.W.; Matthews, R.A.; Figueras, A. (2001) **Ultrastructural characterisation of Marteilia species (Paramyxea) from Ostrea edulis, Mytilus edulis and Mytilus galloprovincialis in Europe.** *Dis Aquat Organ* 44(2): 137-42, ISSN: 0177-5103.
ABSTRACT: A focused ultrastructural study of Marteilia spp. found in cultured Ostrea edulis, Mytilus edulis and Mytilus galloprovincialis from France and Spain was conducted with emphasis placed on haplosporosomes, striated plate-like inclusions and spore wall morphology. Two types of haplosporosome were identified, sphaeroid and oblate, which were common to the parasite in all 3 host species. A total of 492 haplosporosomes were measured; those from the Marteilia sp. in Mytilus spp. were marginally smaller than those in Ostrea edulis. Spore wall morphology was found to vary depending on the state of maturity of the parasite--the more mature the parasite, the thicker the wall surrounding it. It is suggested that the current criteria used to distinguish M. maurini from M. refringens are invalid and that M. maurini was relegated to a junior synonym of M. refringens.
DESCRIPTORS: eukaryotic cells ultrastructure, mussels parasitology, oysters parasitology, parasites ultrastructure, aquaculture, eukaryotic cells classification, France, microscopy, electron veterinary, parasites classification, Spain, classification, ultrastructure, veterinary, parasitology, microbiology, biology.

Mullendore, J.L.; Sobsey, M.D.; Carol Shieh, Y. (2001) **Improved method for the recovery of hepatitis A virus from oysters.** *J Virol Methods* 94(1-2): 25-35, ISSN: 0166-0934.
NAL CALL NUMBER: QR355.J6
ABSTRACT: Hepatitis A is one of the major infectious diseases epidemiologically associated with worldwide shellfish consumption. Molecular detection using polymerase chain reaction (PCR) to detect hepatitis A virus (HAV) in contaminated shellfish can be hindered by low virus recoveries during the concentration process and by natural PCR inhibitors in shellfish. This study evaluated and modified two major steps of a processing procedure for virus concentration from oysters: acid adsorption-elution and solvent extraction. With the addition of second and third elutions, the acid adsorption-elution step doubled the recovery to 46% of HAV seeded initially. Extraction with chloroform or chloroform-butanol resulted in lower HAV detection limits by reverse transcription-PCR (RT-PCR)-oligoprobing than extraction with the fluorocarbon, Freon. These results led to the following modified procedure: HAV was acid adsorbed at pH 4.8, eluted first with 0.05 M glycine, second with 0.5 M threonine, PEG-precipitated twice, chloroform-extracted twice, RNA-extracted, and RT-PCR (single round) amplified. Using the modified procedure, HAV was detected by RT-PCR in all trials with a seeding density of > or = 1 plaque forming unit (PFU)/g of oyster, and in which the equivalent detection limit was 0.33 PFU of HAV seeded per RT-PCR reaction (corresponding to 111 PCR units). The method developed is capable of detecting low levels of HAV in oysters environmentally contaminated.
DESCRIPTORS: hepatovirus isolation and purification, oysters virology, cell line, DNA probes, hepatovirus genetics, Macaca mulatto, oligodeoxyribonucleotides, solvents, water, genetics, isolation and purification, virology DNA probes, oligodeoxyribonucleotides, solvents, water.

Pfeiffer, T. J.; K. A. Rusch. **Comparison of three culture methods for the intensive culture of northern quahog seed, Mercenaria mercenaria.** *J World Aquac Soc.* Baton Rouge, La. : World Aquaculture Society, c1987. Mar 2001. v. 32 (1) p. 11-20. ISSN: 0893-8849.
NAL CALL NUMBER: SH138.W62

DESCRIPTORS: Mercenaria mercenaria, Mollusc culture, techniques, intensive production, population density, hatcheries, populations, survival, rearing techniques, larvae, evaluation, feed rations, Bacillariophyta, water flow, growth rate, length.

Stuart, K. R.; A. G. Eversole; D. E. Brune. **Filtration of green algae and cyanobacteria by freshwater mussels in the partitioned aquaculture system.** *J World Aquac Soc.* Baton Rouge, La. : World Aquaculture Society, c1987. Mar 2001. v. 32 (1) p. 105-111. ISSN: 0893-8849.
NAL CALL NUMBER: SH138.W62
DESCRIPTORS: freshwater Molluscs, algae, cyanobacteria, Mollusc culture, filtration, water flow, organic matter, Microcystis, Scenedesmus, Ankistrodesmus, population density, Mussels.

Uriarte, I.; A. Farias; J. C. Castilla. **Effect of antibiotic treatment during larval development of the Chilean scallop Argopecten purpuratus.** *Aquac Eng.* Amsterdam, The Netherlands : Elsevier Science. Oct 2001. v. 25 (3) p. 139-147. ISSN: 0144-8609.
NAL CALL NUMBER: SH1.A66
ABSTRACT: The requirement for antibiotic use in a culture depends principally on the quality of water available and on the use of strict husbandry of the materials closely related with the culture. The purpose of the present study was to determine the dose of chloramphenicol resulting in better survival and growth rates of Chilean scallops between the early larvae and pediveliger stages cultured in closed systems with manual dosing of food two times per day. Two experiments with antibiotic application during larval development of the Chilean scallop (Argopecten purpuratus) were conducted. The experiments were carried out at the early larval stage (86 micrometer) and at the eyed stage (213 micrometer). The antibiotic concentration ranged between 0 and 8 mg l(-1) chloramphenicol (CHL) per day. The survival and growth rates of the larvae were monitored for 10 days at each stage. In the experiment with eyed larvae, larval settlement and percent metamorphosis were measured. Use of an antibiotic on the early larvae resulted in significantly better growth and survival. Growth rates were 2.3 +/- 0.3 and 2.6 +/- 0.2% per day when using 2 and 8 mg l(-1) CHL per day, respectively, compared with 1.3% +/- 0.2 per day for the larvae without antibiotic. Survival was also better with antibiotic treatment reaching 50% compared with 35% without antibiotic. The metamorphosis was highest using of 8 mg l(-1) CHL day(-1), compared with treatment without antibiotic. Between 75 and 79% of the metamorphosed larvae were found settled on the nets in the treatments using 2 and 8 mg l(-1), while only 55.5% were settled in the nets in the treatment without antibiotic. The results of the experiments indicate that concentrations of 2 and 8 mg l(-1) CHL demonstrated effective control of larval contamination. Moreover, the condition of the postlarvae was improved by the addition of 8 mg l(-1) CHL from eyed larvae to postlarvae.
DESCRIPTORS: Argopecten, larvae, biological development, water quality, Mollusc culture, chloramphenicol, survival, growth rate, application rates.

Uthaiwan, K.; N. Noparatnaraporn; J. Machado. **Culture of glochidia of the freshwater pearl mussel Hyriopsis myersiana (Lea, 1856) in artificial media.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. Apr 2, 2001. v. 195 (1/2) p. 61-69. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
ABSTRACT: The freshwater pearl mussel, Hyriopsis myersiana (Limnoscapha) (Lea, 1856) was cultured in two artificial media at 23 +/- 2 degrees C. Each artificial medium contained a mixture of M199, (Life Technologies, No. 71N0262) horse serum or fish (Oreochromis niloticus) artificial medium plasma as a protein source, and antibiotics/antimycotics at a ratio of 2:1:0.5. Glochidia were reared until they became juveniles, i.e. until the mantle and foot could be observed under a light microscope. The duration of glochidia development until the juvenile stage was 9-10 days in both media. After 1 month of controlled feeding with phytoplankton, the

juveniles showed an elongate of shell with several growth lines. The more suitable artificial culture formula for the transformation from glochidia to juvenile stage was the medium containing protein from fish plasma. Survival from glochidia to juvenile stage was up to 85.3 +/- 3.9% in fish plasma, while it was equal to 46.2 +/- 12.7% in horse serum. The transformation from glochidia to juvenile stage was up to 84.3 +/- 2.3% in fish plasma, while it was equal to 44.3 +/- 8.9% in horse serum. Percentage survival and transformation from glochidia to juvenile stage were significantly higher in fish plasma than in horse serum ($P < 0.01$).
DESCRIPTORS: Mollusca, mollusc culture, culture media, blood serum, blood plasma, horses, fish, antibiotics, rearing techniques, developmental stages, duration, phytoplankton, growth, survival.

Wang, Y.P.; Guo, X.M. (2001) **Chromosomal mapping of the vertebrate telomeric sequence (TTAGGG)N in four bivalve molluscs by fluorescence in situ hybridization.** *Journal of Shellfish Research* 20 , N3 (DEC) , P. 1187-1190, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: FISH, chromosome, telomeric sequence, mapping, evolution, Mollusca.

Weinstein, J.E. (2001) **Characterization of the acute toxicity of photoactivated fluoranthene to glochidia of the freshwater mussel, Utterbackia imbecillis.** *Environ Toxicol Chem* 20(2): 412-9, ISSN: 0730-7268.
NAL CALL NUMBER: QH545.A1E58
ABSTRACT: The acute photoactivated toxicity of fluoranthene to the glochidial larvae of the paper pondshell, Utterbackia imbecillis, was characterized in the laboratory using three sets of experiments. Toxicokinetic studies revealed that glochidia rapidly bioaccumulated fluoranthene, reaching an apparent steady state in 4 h. Based on a two-compartment model, uptake (Ku) and depuration (Kd) rate constants were 1394 ml/g/h and 0.769/h, respectively. However, experimental data suggested the presence of a fast and slow depuration compartment with a Kd of 0.290 and 0.031/h, respectively. Replicate 24-h acute toxicity tests designed to determine the overall sensitivity of glochidia to photoactivated fluoranthene were conducted under simulated sunlight (ultraviolet [UV]-A = 69.0 +/- 1.0 microW/cm2) (mean +/- standard deviation [SD]). Mean median lethal concentrations (LC50) of fluoranthene at 8, 16, and 24 h were 5.59 +/- 0.59, 4.09 +/- 0.57, and 2.45 +/- 0.45 micrograms/L, respectively. Mean median lethal doses (LD50) at the same time periods were 14.76 +/- 2.17, 11.66 +/- 2.82, and 6.98 +/- 1.31 micrograms/g dry weight, respectively. Acute toxicity tests designed to elucidate the relationship between the rate of mortality and UV intensity were conducted under one of four different UV intensities (UV-A = 15, 31, 50, and 68 microW/cm2). Regression analysis revealed that the time-dependent mortality of glochidia was inversely related to the product of initial tissue residue of fluoranthene and UV intensity. These findings suggest that glochidia of freshwater mussels are among the most sensitive organisms tested to date to photoactivated fluoranthene and the time-dependent mortality of glochidia can accurately be predicted through evaluation of the product of fluoranthene tissue residue and the light intensity to which the glochidia is exposed.
DESCRIPTORS: fluorenes toxicity, larva drug effects, ultraviolet rays, water pollutants, chemical toxicity, fluorenes pharmacokinetics, mussels, water pollutants, chemical pharmacokinetics.

2000

Barbariol, V.; Razouls, S. (2000) **Experimental studies on the respiratory metabolism of Mytilus galloprovincialis Mollusca bivalvia) from the Mediterranean sea (Gulf of Lion).** *Vie et Milieu* 50(2) p. 87-92, ISSN: 0240-8759.
NAL CALL NUMBER: QH91.A1V5
DESCRIPTORS: Mytilus galloprovincialis, metabolism, respiration, environmental factors, Languedoc roussillon, Mediterranean sea, Bivalvia, Europe, France, marine areas, Mollusca, Mytilus, physiological functions, western Europe, animal physiology nutrition.

Boettcher, K.J.; Barber, B.J.; Singer, J.T. (2000) **Additional evidence that juvenile oyster disease is caused by a member of the Roseobacter group and colonization of nonaffected animals by Stappia stellulata-like strains.** *Appl Environ Microbiol* 66(9): 3924-30, ISSN: 0099-2240.
NAL CALL NUMBER: 448.3 AP5
ABSTRACT: Juvenile oyster disease (JOD) causes significant annual mortalities of hatchery-produced Eastern oysters, Crassostrea virginica, cultured in the Northeast. We have reported that a novel species of the alpha-proteobacteria Roseobacter group (designated CVSP) was numerically dominant in JOD-affected animals sampled during the 1997 epizootic on the Damariscotta River, Maine. In this study we report the isolation of CVSP bacteria from JOD-affected oysters during three separate epizootics in 1998. These bacteria were not detected in nonaffected oysters at the enzootic site, nor in animals raised at a JOD-free site. Animals raised at the JOD enzootic site that were unaffected by JOD were stably and persistently colonized by Stappia stellulata-like strains. These isolates (designated M1) inhibited the growth of CVSP bacteria in a disk-diffusion assay and thus may have prevented colonization of these animals by CVSP bacteria in situ. Laboratory-maintained C. virginica injected with CVSP bacteria experienced statistically significant elevated mortalities compared to controls, and CVSP bacteria were recovered from these animals during the mortality events. Together, these results provide additional evidence that CVSP bacteria are the etiological agent of JOD. Further, there are no other descriptions of specific marine alpha-proteobacteria that have been successfully cultivated from a defined animal host. Thus, this system presents an opportunity to investigate both bacterial and host factors involved in the establishment of such associations and the role of the invertebrate host in the ecology of these marine alpha-proteobacteria.
DESCRIPTORS: oysters microbiology, alpha proteobacteria growth and development, alpha proteobacteria pathogenicity, culture media, genes, rRNA, molecular sequence data, phenotype, RNA, ribosomal, 16S genetics, seawater, sequence analysis, DNA, alpha proteobacteria classification, alpha proteobacteria isolation and purification.

Ciarelli, A.; Tiscar, P.G.; Dainese, E.; Montauti, A.E. (2000) **In vitro activation of prophenoloxidase system in the hemolymph and hemocytes of Mytilus galloprovincialis (Lmk - 1819) in consequence of bacteria exposure.** *Atti della Societa' Italiana delle Scienze Veterinarie* v. 54 p. 177-178.
NAL CALL NUMBER: 41.9 SO17
ABSTRACT: In the present study we investigated the response of the marine bivalve Mytilus galloprovincialis serum and hemocytes to different species and concentrations of bacteria, as far as the functional modification of the prophenoloxidase-activating system (proPO-AS) is concerned. The results indicate that the proPO activity, recovered in the serum only, is affected by the type of bacteria species, being more enhanced by Vibrio alginolyticus than by Escherichia coli. Different bacteria concentrations does not yield a dose-dependent response.
DESCRIPTORS: Mytilus galloprovincialis, mussels, haemolymph, immunity, Escherichia coli, Vibrio, oxidoreductases, laboratory diagnosis, immune response, biological contamination,

bacteria, Bivalvia, body fluids, body parts, contamination, diagnosis, Enterobacteriaceae, enzymes, immunity, Mollusca, Mytilus, shellfish.

Genthner, F.J.; Fisher, W.S.; Volety, A.K.; Tall, B.D.; Curtis, S.K.; McCarthy, S.A. (2000) **Responses of oysters and their hemocytes to clinical and environmental isolates of Vibrio parahaemolyticus.** *Journal of Shellfish Research* 19 (1): 598-599, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: molecular genetics (biochemistry and molecular biophysics), infection, Pelecypoda, Vibrionaceae, facultatively anaerobic gram negative rods, Eubacteria, bacteria, microorganisms, Vibrio parahaemolyticus, clinical isolate 2030, clinical isolate 2062, clinical isolate 2107, isolate 1094, isolate 1163, isolate ATCC 17802, pathogen, oyster, fisheries species, host, animals, hemocyte, blood and lymphatics, immune system, Vibrio parahaemolyticus tdh gene, thermostable direct hemolysin.

Hauton, C.; Hawkins, L.E.; Hutchinson, S. (2000) **The effects of salinity on the interaction between a pathogen (Listonella anguillarum) and components of a host (Ostrea edulis) immune system.** *Comp Biochem Physiol B Biochem Mol Biol* 127(2): 203-12, ISSN: 1096-4959.
NAL CALL NUMBER: QP501.C6
ABSTRACT: Data are presented from a study to determine how salinity may modulate the interactions between an opportunistic bacterial pathogen Listonella anguillarum and the immune system of a bivalve host, the European flat oyster Ostrea edulis. Oysters were acclimated to three salinity regimes (32, 25 and 16%, at 15 degrees C) for 7 days within the laboratory and were then inoculated with a sub-lethal dose of live L. anguillarum. Forty-eight hours after inoculation measurements were made of the changes in haemocyte composition, haemolymph hydrogen peroxide concentration and haemolymph lysozyme activity to provide information on both the cellular and humoral components of the immune system. The data indicated that in the majority of cases the effects on the immune system were dose dependent. At 32%, a salinity which promoted the growth of the bacterial inoculate, there was a significant increase in the number of circulating large granulocytes and a significant decrease in the haemolymph hydrogen peroxide concentration. At lower salinities, which were less favourable to the growth of L. anguillarum, there were no significant immune system effects. The data highlight the potential for environment management as a tool in controlling opportunistic pathogens and subsequently disease in commercially important bivalve species.
DESCRIPTORS: Mollusca immunology and microbiology, salts metabolism, gamma Proteobacteria pathogenicity, dose response relationship, drug, hemolymph metabolism, hydrogen peroxide metabolism, immune system drug effects, muramidase metabolism.

Hawkins, A.J.; Magoulas, A.; Heral, M.; Bougrier, S.; Naciri-Graven, Y.; Day, A.J.; Kotoulas, G. (2000) **Separate effects of triploidy, parentage and genomic diversity upon feeding behaviour, metabolic efficiency and net energy balance in the Pacific oyster Crassostrea gigas.** *Genet Res* 76(3): 273-84, ISSN: 0016-6723.
NAL CALL NUMBER: 443.8 G283
ABSTRACT: Triploid oysters were induced using cytochalasin B upon retention of either the first (meiosis I triploids) or the second (meiosis II triploids) polar body in embryos from a single cohort derived from mixed parentage. Allozyme and microsatellite assays enabled the confirmation of both parentage and triploidy status in each oyster. Comparison of meiosis I triploids, meiosis II triploids and diploid siblings established that improved physiological performance in triploids was associated with increased allelic variation, rather than with the quantitative dosage effects of ploidy status. An unidentified maternal influence also interacted with genotype. Among full sibs, allelic variation measured as multi-locus enzyme heterozygosity

accounted for up to 42% of the variance in physiological performance; significant positive influences were identified upon feeding rate, absorption efficiency, net energy balance and growth efficiency (= net energy balance divided by energy absorbed). Whilst allelic variation was greater in both meiosis I and meiosis II triploids than in diploid siblings, both allelic variation and net energy balance were highest in triploids induced at meiosis I. This suggests that it may be preferable to induce triploidy by blocking meiosis I, rather than meiosis II as has traditionally been undertaken during commercial breeding programmes.
DESCRIPTORS: energy metabolism genetics, oysters genetics, oysters physiology, variation genetics, animals laboratory, biopsy, breeding, cytochalasin B administration and dosage, feeding behavior, genotype, heterozygote, image processing, computer assisted, meiosis drug effects, meiosis genetics, metabolism, microsatellite repeats genetics, oxygen consumption physiology, ploidies, quantitative trait.

Kelley, M.L.; Van Beneden, R.J. (2000) **Identification of an E3 ubiquitin-protein ligase in the softshell clam (Mya arenaria).** *Mar Environ Res* 50(1-5): 289-93, ISSN: 0141-1136.
NAL CALL NUMBER: QH545.W3M36
ABSTRACT: Softshell clams (Mya arenaria) were exposed to dioxin in controlled laboratory experiments in order to study their molecular response to dioxin exposure. A complementary DNA (cDNA) fragment with sequence similarity to E3 ubiquitin-protein ligase appeared to be upregulated in dioxin-exposed clams compared to controls. E3 covalently ligates ubiquitin onto a protein, targeting it for degradation. Our findings suggest that the ubiquitin-mediated proteolytic pathway in the softshell clam may be activated by dioxin exposure. Because the clam E3-predicted amino acid sequence is most similar to a specific vertebrate E3 protein (E6-AP), we hypothesize that dioxin may stimulate ubiquitin-mediated degradation of cell-cycle regulatory proteins, such as the tumor suppressor p53, which promotes cell proliferation. This pathway has been observed in human cervical cancer. Partial cDNA sequence of the clam E3 has been identified using the differential display polymerase chain reaction (ddPCR) and RACE (Rapid Amplification of cDNA Ends) PCR; the full-length sequence is currently being determined. Discovering the molecular mechanism(s) stimulated by dioxin exposure in this invertebrate model may contribute to a better understanding of the effects of dioxin on marine organisms.
DESCRIPTORS: clams enzymology, ligases metabolism, amino acid sequence, clams drug effects, dioxins toxicity, mice, molecular sequence data, random amplified polymorphic DNA technique veterinary, water pollutants, chemical toxicity.

Kono, M.; Hayashi, N.; Samata, T. (2000) **Molecular mechanism of the nacreous layer formation in Pinctada maxima.** *Biochem Biophys Res Commun* 269(1): 213-8, ISSN: 0006-291X.
NAL CALL NUMBER: 442.8 B5236
ABSTRACT: We have cloned the cDNAs that encode two kinds of molluscan shell matrix proteins, namely N66 and N14, in the nacreous layer of Pinctada maxima. N66 is composed of carbonic anhydrase-like and repeat domains, as described for nacrein (1) in the pearls of P. fucata. N14 is homologous to N16, recently found in the nacreous layer of P. fucata (2) and is characterized by high proportions of Gly, Tyr, and Asn together with NG repeat sequences. The molecular weights of these proteins were estimated as 59,814 and 13,734 Da, respectively. Structural differences were clearly indicated in the alignment and length of the repeat sequences of the sets of the homogeneous proteins (N66/nacrein and N14/N16). The longer repeat sequences of N66 and N14 may be responsible for P. maxima's excellent property of calcification. The in vitro crystallization experiments revealed that the mixture of N66 and N14

could induce platy aragonite layers highly similar to the nacreous layer, once adsorbed onto the membrane of the water-insoluble matrix.
DESCRIPTORS: oysters genetics, oysters metabolism, proteins genetics, proteins metabolism, base sequence, carbonic anhydrases chemistry, carbonic anhydrases genetics, carbonic anhydrases metabolism, cloning, molecular, crystallization, DNA, complementary genetics, molecular sequence data, molecular weight, proteins chemistry, repetitive sequences, amino acid, sequence homology, amino acid, chemistry, genetics, metabolism, complementary DNA, proteins, nacrein, carbonic anhydrases.

Lees, D. (2000) **Viruses and bivalve shellfish.** *Int J Food Microbiol* 59(1-2): 81-116, ISSN: 0168-1605.
NAL CALL NUMBER: QR115.I57
ABSTRACT: The epidemiological data clearly demonstrates that filter feeding bivalve shellfish can, and do, act as efficient vehicles for the transmission of enteric viruses transmitted by the faecal-oral route. This identified hazard has been documented as a cause for concern by various international agencies and has a long history. Disease outbreaks can occur on an epidemic scale as graphically illustrated by an outbreak of Hepatitis A in Shanghai, China in 1988 involving about 300,000 cases. Improvement of harvesting area water quality offers the most sustainable route to improvement in the virological quality of bivalve shellfish sold live. However there is growing awareness, and concern, that current regulatory standards based on faecal coliform monitoring do not fully protect the shellfish consumer from viral infection. New viral test methods based on PCR, and the development of alternative more reliable faecal pollution indicators, offer new approaches for the further development of public health controls. However, further work is required to build a scientific consensus and to understand the implications of their introduction into legislation.
DESCRIPTORS: food microbiology standards, shellfish virology, viruses isolation and purification, Adenoviridae, Astrovirus, Caliciviridae, Enterovirus, Gastroenteritis epidemiology and virology, Great Britain, Hepatitis A epidemiology, Hepatitis A virology, Rotavirus.

Marin, F.; Corstjens, P.; De Gaulejac, B.; De Vrind De Jong, E.; Westbroek, P. (2000) **Mucins and molluscan calcification. Molecular characterization of mucoperlin, a novel mucin-like protein from the nacreous shell layer of the fan mussel Pinna nobilis (Bivalvia, pteriomorphia).** *J Biol Chem* 275(27): 20667-75, ISSN: 0021-9258.
NAL CALL NUMBER: 381 J824
ABSTRACT: A cDNA expression library constructed from mantle tissue mRNA of the Mediterranean fan mussel Pinna nobilis was screened with antibodies raised against the acetic acid-soluble shell matrix of the same species. This resulted in the isolation of a 2138-base pair cDNA, containing 13 tandem repeats of 93 base pairs. The deduced protein has a molecular mass of 66.7 kDa and a isoelectric point of 4.8. This protein, which is enriched in serine and proline residues, was overexpressed, purified, and used for producing polyclonal antibodies. Immunological in situ and in vitro tests showed that the protein is localized in the nacreous aragonitic layer of P. nobilis, but not in the calcitic prisms. Because this protein of the nacre of P. nobilis exhibits some mucin-like characteristics, we propose the name mucoperlin. This is the first paper reporting the cloning of a molluscan mucin and the first molecular evidence for the involvement of a mucin in molluscan calcification. This finding corroborates our previous hypothesis that some of the proteinaceous constituents of the molluscan shell matrix would derive from mucins, common to many metazoan lineages of the late Precambrian (Marin, F., Smith, M., Isa, Y., Muyzer, G. and Westbroek, P. (1996) Proc. Natl. Acad. Sci. U. S. A. 93, 1554-1559). The adaptation of an ancestral mucin to a new function, the regulation of the mineralization process, may be one of the molecular events, among others, that would explain

the simultaneous emergence of organized calcification in many metazoan lineages during the Cambrian explosion.
DESCRIPTORS: Mollusca genetics, mucins genetics, amino acid sequence, amino acids analysis, calcification, physiologic, calcium metabolism, calcium carbonate metabolism, calcium binding proteins chemistry, cloning, molecular, evolution, glycosylation, immunohistochemistry, Mediterranean Sea, molecular sequence data, Mollusca metabolism, mucins chemistry, recombinant proteins chemistry, sequence alignment, tandem repeat sequences.

Martinez, G.; Olivares, A.Z.; Mettifogo, L. (2000) **In vitro effects of monoamines and prostaglandins on meiosis reinitiation and oocyte release in Argopecten purpuratus Lamarck.** *Invertebrate Reproduction & Development*, V. 38, N1 (OCT), P. 61-69, ISSN: 0168-8170.
NAL CALL NUMBER: QP251.I628
DESCRIPTORS: Argopecten purpuratus, scallops, reproduction, spawning, meiosis, mussel, Dreissena polymorpha, zebra mussel, Patinopecten yessoensis, bivalve Mollusks, reproductive process, arachidonic acid, serotonin, maturation, scallop, induction.

McFadzen, I.; Eufemia, N.; Heath, C.; Epel, D.; Moore, M.; Lowe, D. (2000) **Multidrug resistance in the embryos and larvae of the mussel Mytilus edulis.** *Mar Environ Res* 50(1-5): 319-23, ISSN: 0141-1136.
NAL CALL NUMBER: QH545.W3M36
ABSTRACT: Cells exhibiting the multidrug resistance (MDR) phenotype demonstrate a decreased intracellular drug accumulation due to an active outward transport and decreased intracellular flux. This study demonstrates the inhibition of MDR in mussel (Mytilus edulis) embryos and larvae based on a simple bioassay. The development of embryos was assessed and abnormalities identified at key stages of development, including gastrulation, trochophore and prodissoconch stages. The incidence of developmental abnormalities was significantly increased in the presence of vinblastine, MMS, chloroquine, mitomycin-C, cadmium chloride and colchicine, compared to clean seawater. Consistently, there was a further increase in the number and severity of deformities observed when each toxin was added in the presence of verapamil. Larval growth was also significantly impaired in the presence of verapamil. Increased accumulation of fluorescent MDR dyes, such as rhodamine B, has been measured and shown to be verapamil sensitive. This bioassay encompasses a period of intense cellular activity during which the impairment of a number of critical processes results in abnormal growth and development.
DESCRIPTORS: mussels drug effects, mussels embryology, water pollutants, chemical toxicity, biological assay methods, biological assay veterinary, cadmium chloride toxicity, chloroquine toxicity, colchicine toxicity, drug resistance, multiple, drug synergism, larva drug effects, methyl methanesulfonate toxicity, mitomycin toxicity, phenotype, seawater, verapamil toxicity, vinblastine toxicity.

Moura, G.; Vilarinho, L.; Machado, J. (2000) **The action of Cd, Cu, Cr, Zn, and Pb on fluid composition of Anodonta cygnea (L.): organic components.** *Comp Biochem Physiol B Biochem Mol Biol* 127(1): 105-12, ISSN: 1096-4959.
NAL CALL NUMBER: QP501.C6
ABSTRACT: The heavy metals, Cd, Cu, Cr, Zn, and Pb, were used to incubate healthy specimens of the freshwater mussel species, Anodonta cygnea. Afterwards, their biological fluids, either haemolymph or extrapallial fluid were analyzed for the presence of several organic constituents, known to be important for biomineralization, such as proteins, glycosaminoglycans (GAGs) and glucosamine. Proteins were subjected to further study, namely through the total amino acid

determination after acid hydrolysis. The most disturbing pollutants tested seem to be Pb, Zn, and Cr, which caused highly decreased overall compositions, namely with respect to protein, and glucosamine, in comparison to the control group. This suggests that this group contributes to a decrease of the metabolic activity, and thus mineralization, in the exposed animals.
DESCRIPTORS: cadmium pharmacology, chromium pharmacology, copper pharmacology, lead pharmacology, mussels metabolism, zinc pharmacology, glucosamine metabolism, glycosaminoglycans metabolism, hemolymph drug effects, hydrolysis, proteins drug effects, time factors.

Pavlica, M.; Klobucar, G.I.; Vetma, N.; Erben, R.; Papes, D. (2000) **Detection of micronuclei in haemocytes of zebra mussel and great ramshorn snail exposed to pentachlorophenol.** *Mutat Res* 465(1-2): 145-50, ISSN: 0027-5107.
NAL CALL NUMBER: QH431.M8
ABSTRACT: The frequency of micronuclei (MN) induced by pentachlorophenol (PCP) in haemocytes of zebra mussel, Dreissena polymorpha Pall. and great ramshorn snail, Planorbarius corneus L. was determined over a 14 days of exposure (sampling after 4, 7 and 14 days) under laboratory conditions. PCP doses for zebra mussel ranged from 10 to 150 microg/l, and for ramshorn snail from 10 to 450 microg/l. Micronuclei were detected after bisbenzimide fluorescent staining. Positive responses were observed in both species. The mean MN frequencies in treated mussels ranged between 0.69 and 7.50 per thousand, and between 2.07 and 13.80 per thousand in treated snails. The spontaneous MN levels in mussels averaged from 0.5 to 2.75 per thousand, and in snails from 1.56 to 2.00 per thousand. Our results suggest that haemolymph of both species represent an appropriate test tissue in environmental genotoxicity assessment.
DESCRIPTORS: hemocytes drug effects, micronuclei drug effects, mutagens toxicity, pentachlorophenol toxicity, hemocytes ultrastructure, micronucleus tests methods, mussels, snails, species specificity, drug effects, ultrastructure, methods, toxicity, mutagens, pentachlorophenol, cytogenetics.

Ringwood, A.H.; Conners, D.E. (2000) **The effects of glutathione depletion on reproductive success in oysters, Crassostrea virginica.** *Mar Environ Res* 50(1-5): 207-11, ISSN: 0141-1136.
NAL CALL NUMBER: QH545.W3M36
ABSTRACT: Glutathione (GSH) is a ubiquitous tripeptide that functions as a very important modulator of cellular homeostasis, including detoxification of metals and oxyradicals. Therefore, depletion of GSH may predispose organisms to pollutant stress. Reproductively active oysters (Crassostrea virginica) were exposed to buthionine sulfoximine in the laboratory to deplete gonadal GSH. The effects of metal exposures (Cd and Cu) on fertilization and developmental assays were evaluated using gametes from control and GSH-depleted adults. Fertilization success was not affected by GSH status, i.e. the fertilization rates of gametes derived from GSH-depleted adults were the same or slightly higher. However, GSH depletion did increase the susceptibility of developing embryos to metal toxicity, i.e. adverse effects on embryonic development were observed at lower metal concentrations with gametes derived from GSH-depleted adults. These effects may be related to diminished removal of free radicals or increased availability of metals. Whereas sperm penetration of embryonic membranes and fertilization success may be facilitated by free radicals, the persistence of free radicals during subsequent developmental periods may adversely affect differentiation and normal development. GSH probably also plays an important role in scavenging toxic metals and reducing metal interactions with essential developmental processes. These results suggest that parental depletion of GSH may increase the susceptibility of embryos to metal toxicity.

DESCRIPTORS: glutathione physiology, oysters physiology, reproduction physiology, cadmium toxicity, copper toxicity, free radicals, oysters embryology, sperm ovum interactions, water pollution, animal, female, male.

Shepard, J.L.; Olsson, B.; Tedengren, M.; Bradley, B.P. (2000) **Protein expression signatures identified in Mytilus edulis exposed to PCBs, copper and salinity stress.** *Mar Environ Res* 50(1-5): 337-40, ISSN: 0141-1136.
NAL CALL NUMBER: QH545.W3M36
ABSTRACT: Applied to environmental toxicology, proteome analysis may be used to isolate chemical-specific protein expression signatures (PES). In this project specific PES were isolated in mussels, Mytilus edulis, from the Baltic Sea subjected in the laboratory to treatment with copper (70 ppb), Aroclor 1248 (1 ppb), and to lowered salinity. Four mussels in each treatment group were acclimated in the laboratory for 24 h before beginning the 7-day exposure. Whole body tissue was homogenized and separated using two-dimensional gel electrophoresis. The protein gels were scanned to TIFF files and compared using MELANIE II 2D gel analysis software (BioRad). Protein expression signatures including proteins induced and repressed by exposure were isolated for each treatment group. The specificity of PES due to environmental changes shows promise in bioindication, toxicity testing and in helping identify possible toxicity mechanisms.
DESCRIPTORS: copper toxicity, mussels drug effects, polychlorinated biphenyls toxicity, proteins biosynthesis, sodium chloride toxicity, toxicology methods, aroclors toxicity, electrophoresis, gel, two dimensional, sodium chloride administration and dosage.

Shieh, Y.; Monroe, S.S.; Fankhauser, R.L.; Langlois, G.W.; Burkhardt, W. 3rd; Baric, R.S. (2000) **Detection of norwalk-like virus in shellfish implicated in illness.** *J Infect Dis* 181 Suppl 2: S360-6, ISSN: 0022-1899.
NAL CALL NUMBER: 448.8 J821
ABSTRACT: In the 1990s, Norwalk-like viruses (NLVs) were identified in patient specimens as the primary pathogen associated with shellfish-borne gastroenteritis in the United States. Identification of these viruses from implicated shellfish has been difficult due to inefficient recovery of viruses, natural polymerase chain reaction (PCR) inhibitors in shellfish, and low virus contamination. Recent improvements to the method of detecting NLVs in shellfish include enhanced processing of virus and shellfish samples, application of nested PCR and nucleotide sequencing, and increased knowledge of NLV genetic diversity. Using a newly developed and sensitive method, an NLV G2 strain was identified in 2 oyster samples implicated in a 1998 California outbreak involving 171 cases. NLV capsid primers demonstrated a greater specificity of PCR detection than did polymerase primers. The 175-base viral capsid nucleotide sequences derived from oysters were 100% identical to those derived from a patient stool sample. This finding supports the epidemiologic associations indicating that contaminated shellfish serve as the vehicle for NLV transmission.
DESCRIPTORS: Norwalk Virus isolation and purification, shellfish virology, disease outbreaks, gastroenteritis epidemiology, gastroenteritis etiology, gastroenteritis prevention and control, oysters virology, polymerase chain reaction, epidemiology, etiology, prevention and control, isolation and purification, virology, communicable diseases.

Teh, S.J.; Werner, I.; Hinton, D.E. (2000) **Sublethal effects of chromium-VI in the Asian clam (Potamocorbula amurensis).** *Mar Environ Res* 50(1-5): 295-300, ISSN: 0141-1136.
NAL CALL NUMBER: QH545.W3M36
ABSTRACT: Previously, we have shown that Asian clams (Potamocorbula amurensis) with highest metallic body burdens have highest prevalence of disease and lowest reproduction. The

present study was designed to assess and validate potential sublethal toxicity of hexavalent chromium (Cr-VI) in clams under controlled laboratory exposure. For 7 days, three replicates of clam (n = 10 per replicate) were exposed to aqueous solution containing 0.00, 0.92, 8.40, or 25.6 mg l-1 of Cr-VI at 15 degrees C and 15 g l-1 salinity. Mortality reached 100% in the 25.6 mg l-1 group within 7 days. There was no significant difference in mortality among the control, 0.92, and 8.40 mg l-1 groups. Western blot analyses revealed significantly elevated stress protein hsp70 levels in the 8.40 mg l-1 treatment group. Histopathologic analyses revealed mild digestive gland (DG) atrophy in the control group. Clams exposed to 0.92 mg l-1 Cr-VI showed moderate DG atrophy, moderate granulomatous inflammation and necrosis in DG, ovary and testis. Lesions observed in the 8.40 mg l-1 treatment group included severe DG atrophy, severe granulomatous inflammation and necrosis in byssal gland, DG, gill, kidney, ovary and testis. In gills and testes of treated groups, apoptotic cells outnumbered mitotic cells. In addition, gills from clams in the 8.40 mg l-1 group showed enhanced hsp70 staining. Our studies support a cause-effect relationship between contaminants and reduced health in Asian clams and indicate the DGs, gills, and reproductive organs are principal targets of Cr-VI toxicity at sublethal concentrations. Results from this study suggest that Cr-VI may have played a role in the increased incidence of diseased clams seen in previous studies and these adverse effects may be working to decrease clam populations at sites with highest metallic contamination in the San Francisco Bay Estuary.
DESCRIPTORS: carcinogens, chromium toxicity, clams drug effects, chemical toxicity, carcinogens, environmental administration and dosage, chromium administration and dosage, dose response relationship, drug, chemical administration and dosage.

Werner, I.; Hinton, D.E. (2000) **Spatial profiles of hsp70 proteins in Asian clam (Potamocorbula amurensis) in northern San Francisco Bay may be linked to natural rather than anthropogenic stressors.** *Mar Environ Res* 50(1-5): 379-84, ISSN: 0141-1136.
NAL CALL NUMBER: QH545.W3M36
ABSTRACT: Multi-year investigations in northern San Francisco Bay by United States Geological Survey have linked reduced condition indices in populations of Asian clam (Potamocorbula amurensis) with elevated cadmium tissue concentrations. Our study seeks to determine whether levels of hsp70 proteins in P. amurensis can be correlated with these findings, and/or are related to histopathologic alterations and concentrations of metallothionein-like proteins. Here we present our results on stress proteins in clams collected monthly from four field stations between July 1996 and January 1998. In addition, animals were exposed in the laboratory to a range of salinities. Stress proteins were analyzed by Western blotting using monoclonal antibodies. Hsp70 protein levels in field-collected clams were significantly higher at the seaward (high salinity/low cadmium) stations (12.5, 8.1) than at the landward (low salinity/high cadmium) stations (6.1, 4.1). Laboratory studies showed that clams exposed to 0.1 ppt salinity had markedly lower hsp70 levels than clams exposed to higher salinities. In view of our previous laboratory studies showing that cadmium induces hsp70 in P. amurensis, our present results indicate that reduced hsp70 protein levels in field-collected clams may be linked to salinity effects rather than cadmium tissue concentrations.
DESCRIPTORS: clams metabolism, heat shock proteins 70 chemistry, antibodies, monoclonal, blotting, western veterinary, cadmium analysis, geology, San Francisco.

Yamada, A.; Yoshio, M.; Kojima, H.; Oiwa, K. (2000) **In vitro reconstruction of 'catch' state of molluscan smooth muscle.** *Biophysical Journal* 78 (1 Part 2): 114A, ISSN: 0006-3495.
NAL CALL NUMBER: 442.8 B5238
DESCRIPTORS: muscular system (movement and support), Pelecypoda, Mytilus byssus, animal model, retractor muscle, in vitro catch state reconstruction, muscular system.

1999

Anderson, R.S. (1999) **Perkinsus marinus secretory products modulate superoxide anion production by oyster (Crassostrea virginica) haemocytes.** *Fish and Shellfish Immunology* 9(1) p. 51-60.
NAL CALL NUMBER: QL638.97 F55
DESCRIPTORS: sporozoa, Bivalvia, oysters, Crassostrea virginica, blood cells, phagocytes, optical properties, immunosuppression, chemicophysical properties, immunotherapy, Protozoa, shellfish, therapy.

Anderson, R.S.; Patel, K.M.; Roesijadi, G. (1999) **Oyster metallothionein as an oxyradical scavenger: implications for hemocyte defense responses.** *Dev Comp Immunol* 23(6): 443-9, ISSN: 0145-305X.
NAL CALL NUMBER: QR180.D4
ABSTRACT: In order to better understand the interplay between metallothionein (MT) and reactive oxygen species (ROS) in oyster hemocytes, studies of the hydrogen peroxide (H2O2) scavenging properties of MT were carried out in a cell-free system. Mammalian MT is involved in protection against oxidative stress by virtue of its ability to scavenge free radicals; therefore, the H2O2 scavenging potentials of Crassostrea virginica and rabbit MTS were compared. Oyster and rabbit MTs showed similar dose-dependent suppression of H2O2-stimulated, luminol-augmented chemiluminescence (CL); the EC50 for CL (25 microM H2O2) was approximately 1.0 microM MT for both species. The interaction of ROS with MT in hemocytes could play a role in protection of the cells and surrounding tissues from oxidants associated with antimicrobial responses. Mobilization of bound zinc from MT by hemocyte-derived ROS may produce aberrant regulatory effects on various cellular processes. The data suggest that MT may be involved in immunoregulatory pathways in oyster hemocytes as a result of its ability to scavenge antimicrobial ROS.
DESCRIPTORS: free radical scavengers metabolism, hemocytes physiology, metallothionein physiology, oysters metabolism, reactive oxygen species metabolism, liver metabolism, rabbits.

Bramble, L.H.; Anderson, R.S. (1999) **Lack of involvement of reactive oxygen species in the bactericidal activity of Crassostrea virginica haemocytes in contrast to Morone saxatilis phagocytes.** *Fish and Shellfish Immunology* 9(2) p. 109-123.
NAL CALL NUMBER: QL638.97 F55
DESCRIPTORS: oxygen, antimicrobial properties, morone, Crassostrea virginica, Bivalvia, oysters, Percoidei, macrophages, optical properties, blood cells, nonspecific immunostimulation, phagocytes, antibiotic properties, Bivalvia, blood, bony fishes, cells, chemicophysical properties, elements, fishes, immunostimulation, immunotherapy, Mollusca, nonmetals, Percoidei, phagocytes, shellfish, therapy, animal diseases, aquaculture production.

Cadet, P.; Stefano, G.B. (1999) **Mytilus edulis pedal ganglia express mu opiate receptor transcripts exhibiting high sequence identity with human neuronal mu1.** *Molecular Brain Research* 74 (1-2): 242-246, ISSN: 0169-328X.
DESCRIPTORS: cell biology, nervous system (neural coordination), Pelecypoda, Mytilus edulis, animal model, human neuronal mu 1 receptor, pedal ganglia, nervous system, mu opiate receptor transcripts, expression, high sequence identity.

Canesi, L.; Ciacci, C.; Betti, M.; Malatesta, M.; Gazzanelli, G.; Gallo, G. (1999) **Growth factors stimulate the activity of key glycolytic enzymes in isolated digestive gland cells from**

mussels (Mytilus galloprovincialis Lam.) through tyrosine kinase mediated signal transduction. *General and Comparative Endocrinology* 116 (2): 241-248, ISSN: 0016-6480.
NAL CALL NUMBER: 444.8 G28
DESCRIPTORS: endocrine system (chemical coordination and homeostasis), digestive system (ingestion and assimilation), Pelecypoda, Mytilus galloprovincialis, animal model, animals, Invertebrates, Mollusks, digestive gland cells, digestive system, growth factors, key glycolytic enzymes, activity stimulation, signal transduction, tyrosine kinase mediated.

Denardou-Queneherve, A.; Grzebyk, D.; Pouchus, Y.F.; Sauviat, M.P.; Alliot, E.; Biard, J.F.; Berland, B.; Verbist, J.F. (1999) **Toxicity of French strains of the dinoflagellate Prorocentrum minimum experimental and natural contaminations of mussels.** *Toxicon* 37(12): 1711-9, ISSN: 0041-0101.
NAL CALL NUMBER: 391.8 T66
ABSTRACT: Mediterranean strains of Prorocentrum minimum do not appear to have the same toxic component as Japanese strains since they showed no cytotoxicity for hepatocytes in culture. However, their toxic components, which appear to block calcium channels, were detectable by the immobilisation test on Diptera larvae. A bio-accumulation experiment in the laboratory showed that the toxins could accumulate in nearly equivalent amounts in the hepatopancreas and meat of cultured mussels. The same toxicity was found in natural samples collected in a period of bloom of P. minimum. These results suggest that P. minimum could be responsible for shellfish toxicity in the natural environment and thus present a risk for human health.
DESCRIPTORS: Dinoflagellida, marine toxins toxicity, mussels drug effects, brain drug effects, brain metabolism, cells cultured, digestive system drug effects, digestive system metabolism, Diptera drug effects, heart drug effects, liver drug effects, marine toxins isolation and purification, marine toxins pharmacokinetics, mice, mussels metabolism, neurotoxins toxicity, Rana esculenta, rats, toxicity tests.

De Voogt, P.; Bleeker, E.A.; van Vlaardingen, P.L.; Fernandez, A.; Slobodnik, J.; Wever, H.; Kraak, M.H. (1999) **Formation and identification of azaarene transformation products from aquatic invertebrate and algal metabolism.** *J Chromatogr B Biomed Sci Appl* 724(2): 265-74, ISSN: 1387-2273.
NAL CALL NUMBER: QD272.C4J682
ABSTRACT: The metabolism of two azaarenes, viz. acridine and phenanthridine, by aquatic organisms was studied in short-term and chronic laboratory tests. The identity of metabolites observed in the test waters was investigated with different analytical methods, including HPLC, GC and hyphenated LC- or GC-MS. The Zebra mussel (Dreissena polymorpha), one green alga species (Selenastrum capricornutum) and periphyton or bacteria transformed acridine into 9[10H]-acridinone. Phenanthridine was transformed into 5[6H]-phenanthridinone by midge (Chironomus riparius) larvae. The findings indicate that closely related isomers may undergo species-specific biotransformation. It was concluded that keto-metabolites are major products in the aquatic fate of benzoquinolines, which may be overlooked in the risk assessment of parent compounds. This study illustrates the typical problems with, as well as the potency of, chromatographic methods in the elucidation of metabolic routes of organic contaminants.
DESCRIPTORS: acridines pharmacokinetics, algae green metabolism, mussels metabolism, phenanthridines pharmacokinetics, biotransformation, chromatography, high pressure liquid, mass fragmentography, species specificity, spectrophotometry, ultraviolet.

Inoue, T.; Yoshiya, M.; Itani, M.; Douke, A. (1999) **Feeding behavior of the starfishes to the manila clam [Ruditapes philippinarum].** *Bulletin of the Kyoto Institute of Oceanic and Fishery Science* (no.21) p. 8-13, ISSN 0386-5290.
DESCRIPTORS: Ruditapes philippinarum, predator prey relations, Asteroidea, feeding habits, benthic environment, sand, laboratory experimentation, aquatic environment, behaviour, Bivalvia, Echinodermata, environment, experimentation, Mollusca, predation, rock, ruditapes, aquatic ecology.

Jorquera, M.A.; C. E. Riquelme; L. A. Loyola; L. F. Munoz. **Production of bactericidal substances by a marine vibrio isolated from cultures of the scallop Agropecten purpuratus.** *Aquac Int.* Dordrecht, The Netherlands : Kluwer Academic Publishers. 1999. v. 7 (6) p. 433-448. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: Vibrio, Argopecten, Listonella anguillarum, growth, inhibition, antibacterial properties, strain differences, sea water, Mollusc culture, chemical composition, bioassays, ethers, Vibrio parahaemolyticus.

Sallenave, C.; Pouchus, Y.F.; Bardouil, M.; Lassus, P.; Roquebert, M.F.; Verbist, J.F. (1999) **Bioaccumulation of mycotoxins by shellfish: contamination of mussels by metabolites of a Trichoderma koningii strain isolated in the marine environment.** *Toxicon* 37(1): 77-83, ISSN: 0041-0101.
NAL CALL NUMBER: 391.8 T66
ABSTRACT: To determine whether toxic metabolites produced by fungi could cause shellfish toxicities, mussels were contaminated in laboratory conditions by sterile filtrates of a liquid culture of a strain of the fungus Trichoderma koningii previously isolated from a shellfish, the cockle (Cerastoderma edule). Mussels were kept in aerated natural seawater and fed with a culture of the microalga Isochrysis galbana, to which a filtrate of liquid fungal culture was added. Mussels were exposed to contamination for 7 days at 16 or 20 degrees C and extractions were then performed and their activity tested on blowfly larvae. The same toxicity was found in the fungal filtrate and the shellfish, indicating bioaccumulation. The digestive gland was the most toxic part of the mussel, confirming contamination by filtration. Treated mussels produced a mucus which appeared to be a means of eliminating toxic metabolites.
DESCRIPTORS: food contamination analysis, marine toxins metabolism, mussels metabolism, mycotoxins metabolism, shellfish analysis, Trichoderma metabolism, algae metabolism, Cnidaria, larva, mucus metabolism, temperature.

Shieh, Y.C.; Calci, K.R.; Baric, R.S. (1999) **A method to detect low levels of enteric viruses in contaminated oysters.** *Appl Environ Microbiol* 65(11): 4709-14, ISSN: 0099-2240.
NAL CALL NUMBER: 448.3 AP5
ABSTRACT: Direct isolation and identification of pathogenic viruses from oysters implicated in gastroenteritis outbreaks are hampered by inefficient methods for recovering viruses, naturally occurring PCR inhibitors, and low levels of virus contamination. In this study we focused on developing rapid and efficient oyster-processing procedures that can be used for sensitive PCR detection of viruses in raw oysters. Poliovirus type 3 (PV3) Sabin strain was used to evaluate the efficacy of virus recovery and the removal of PCR inhibitors during oyster-processing procedures. These procedures included elution, polyethylene glycol precipitation, solvent extraction, and RNA extraction. Acid adsorption-elution in which glycine buffer (pH 7.5) was used was found to retain fewer inhibitors than direct elution in which glycine buffer (pH 9.5) was used. RNA extraction in which a silica gel membrane was used was more effective than single-step RNA precipitation for removing additional nonspecific PCR inhibitors. The final

10-microl volume of RNA concentrates obtained from 2 g of oyster tissue (concentration factor, 200-fold) was satisfactory for efficient reverse transcription-PCR detection of virus. The overall detection sensitivity of our method was 1 PFU/g of oyster tissue initially seeded with PV3. The method was utilized to investigate a 1998 gastroenteritis outbreak in California in which contaminated oysters were the suspected disease transmission vehicle. A genogroup II Norwalk-like virus was found in two of three recalled oyster samples linked by tags to the harvest dates and areas associated with the majority of cases. The method described here improves the response to outbreaks and can be used for rapid and sensitive detection of viral agents in outbreak-implicated oysters.
DESCRIPTORS: Enterovirus isolation and purification, oysters virology, shellfish virology, Enterovirus genetics, polymerase chain reaction methods, RNA, viral isolation and purification, reverse transcriptase polymerase chain reaction methods, rhabdomyosarcoma, seasons, sensitivity and specificity, tumor cells, cultured, United States.

Steffen, W.; Kuznetsov, S.A.; Holzbaur, E.L.F.; Langford, G.M.; Weiss, D.G.; Palazzo, R.E. (1999) **The dynein-dynactin complex is required for cytaster assembly but not for centrosome-dependent aster formation in vitro.** *Molecular Biology of the Cell* 10 (SUPPL.): 17a, ISSN: 1059-1524.
NAL CALL NUMBER: QH604.C452
DESCRIPTORS: Pelecypoda, Spisula, animal model, female, dynein-dynactin complex, cytaster assembly requirement, in-vitro study, negative centrosome dependent aster formation requirement, oocyte expression.

Walker, C.W. (1999) **Apoptosis following treatment of clam leukemia cells with etoposide: A p53-dependent mechanism?** *Molecular Biology of the Cell* 10 (SUPPL.): 431a, ISSN: 1059-1524.
NAL CALL NUMBER: QH604.C452
DESCRIPTORS: biochemistry and molecular biophysics, blood and lymphatics (transport and circulation), tumor biology, Pelecypoda, Mya arenaria [soft-shell-clam], animal model, DNA, etoposide, topoisomerase II inhibitor, p53, Mya arenaria p53 gene, acute myelocytic leukemia, blood and lymphatic disease, immune system, disease, neoplastic disease.

Won, S.J.; Flynn, A.; Ammerman, M.; Callard, I. (1999) **Putative vitellogenins in the fresh water mussel, Elliptio complanata.** *Biology of Reproduction* 60 (SUPPL. 1): 184, ISSN: 0006-3363.
NAL CALL NUMBER: QL876.B5
DESCRIPTORS: reproductive system, Pelecypoda, Elliptio complanata, fresh water mussel, animal model, female, Patinopecten yessoensis, scallop, animals, putative vitellogenins, ovarian yolk proteins, fresh water mussel synthesis.

1998

Bramble, L.H.; Anderson, R.S. (1998) **A comparison of the chemiluminescent response of Crassostrea virginica and Morone saxatilis phagocytes to zymosan and viable Listonella anguillarum.** *Dev Comp Immunol* 22(1): 55-61, ISSN: 0145-305X.
NAL CALL NUMBER: QR180.D4
ABSTRACT: If reactive oxygen species (ROS) produced by hemocytes of the eastern oyster, Crassostrea virginica, impart bactericidal activity, exposure of hemocytes to bacteria should result in increased ROS generation. In an earlier study, this hypothesis was tested using luminol-

and lucigenin-augmented chemiluminescence (CL) to measure ROS production. The bacterium Listonella anguillarum did not stimulate a net increase in hemocyte-derived CL, and it was suggested that bacterial antioxidants might suppress hemocyte CL. In the present study a comparison was made, under identical assay conditions, of the zymosan- and bacteria-enhanced luminol CL produced by eastern oyster hemocytes and by striped bass (Morone saxatilis) macrophages, for which L. anguillarum has been shown to be a stimulus in CL reactions. The response to zymosan produced by bass phagocytes was two orders of magnitude greater than that generated by eastern oyster hemocytes. Whereas an increase in net ROS production was not evident when oyster hemocytes were exposed to L. anguillarum, significant stimulation of striped bass macrophage-derived CL occurred. These data suggest that striped bass macrophages have a greater capacity to generate ROS than oyster hemocytes, enabling them to surpass the antioxidant capability of L. anguillarum and produce a luminol CL response.
DESCRIPTORS: bass immunology, oysters immunology, phagocytes immunology, reactive oxygen species metabolism, chemiluminescence, hemocytes immunology, macrophages immunology, vibrio immunology, zymosan immunology.

Donovan, T.J.; Gallacher, S.; Andrews, N.J.; Greenwood, M.H.; Graham, J.; Russell, J.E.; Roberts, D.; Lee, R. (1998) **Modification of the standard method used in the United Kingdom for counting Escherichia coli in live bivalve molluscs.** *Commun Dis Public Health* 1(3): 188-96.
ABSTRACT: The standard method for counting Escherichia coli in live bivalve molluscs is labour intensive and takes three days to obtain a result. Modifications to the standard method were investigated in a collaborative trial conducted in five centres. No significant difference was found between results based on the presence of acid at 24 hours (h) in first stage tests and those based on the presence of acid and gas after 48 h (standard method). The use of the chromogenic medium BCIG (5-bromo-4-chloro-3-indolyl-beta-D glucuronide) agar incubated at 44 degrees C to confirm first stage tests was also found to give equivalent results to conventional confirmation tests. The preferred, modified method removes the presence of gas as a criterion of detection, uses a chromogenic agar medium to confirm the presence of E. coli, and gives results within 48 h. A distribution of simulated samples and selected strains of E. coli to other laboratories using the PHLS external quality assurance scheme for shellfish found no significant difference between results obtained by the standard and modified methods.
DESCRIPTORS: colony count, microbial methods, Escherichia coli isolation and purification, microbiology, shellfish microbiology, bacteriological techniques, Great Britain, reproducibility of results.

Ford, S.E.; Ashton-Alcox, K.A. (1998) **Altered response of oyster hemocytes to Haplosporidium nelsoni (MSX) plasmodia treated with enzymes or metabolic inhibitors.** *J Invertebr Pathol* 72(2): 160-6, ISSN: 0022-2011.
NAL CALL NUMBER: 421 J826
ABSTRACT: To avoid phagocytosis, parasites may mask themselves with host-like molecules that prevent recognition as nonself or they may produce substances that interfere with host cellular defenses. The protozoan parasite Haplosporidium nelsoni, which causes MSX disease in the eastern oyster Crassostrea virginica, is not ingested by host hemocytes. To assess potential avoidance mechanisms, oyster hemocytes were incubated with plasmodial stages of the parasite that had been pretreated with one of a variety of enzymes (proteases and carbohydrases) to alter surface molecules or with metabolic inhibitors to prevent the synthesis or active uptake of "masking" molecules, as well as the production and discharge of inhibitory substances. The maximum increase in phagocytosis resulting from treatment with carbohydrases was 12.5% (beta-galactosidase) and with proteases was 18% (Proteinase K). Inhibitors of aerobic

metabolism resulted in a similar level of enhancement. In contrast, treatment of parasites with the glycolysis inhibitor iodoacetate enhanced phagocytosis by up to 66%. Thus, the process that obstructs phagocytosis involves aerobic and, especially, anaerobic pathways. The greater effect of a metabolic inhibitor compared to enzymes suggests that the mechanism involves more than just surface modification and may include the production of interference molecules.
DESCRIPTORS: enzyme inhibitors, hemocytes immunology, hydrolases, iodoacetates, oysters immunology, phagocytosis immunology, Protozoa immunology, hemocytes parasitology.

House, M.L.; Kim, C.H.; Reno, P.W. (1998) **Soft shell clams Mya arenaria with disseminated neoplasia demonstrate reverse transcriptase activity.** *Dis Aquat Organ* 34(3): 187-92, ISSN: 0177-5103.
ABSTRACT: Disseminated neoplasia (DN), a proliferative cell disorder of the circulatory system of bivalves, was first reported in oysters in 1969. Since that time, the disease has been determined to be transmissible through water-borne exposure, but the etiological agent has not been unequivocally identified. In order to determine if a viral agent, possibly a retrovirus, could be the causative agent of DN, transmission experiments were performed, using both a cell-free filtrate and a sucrose gradient-purified preparation of a cell-free filtrate of DN positive materials. Additionally, a PCR-enhanced reverse transcriptase assay was used to determine if reverse transcriptase was present in tissues or hemolymph from DN positive soft shell clams Mya arenaria. DN was transmitted to healthy clams by injection with whole DN cells, but not with cell-free filtrates prepared from either tissues from DN positive clams, or DN cells. The cell-free preparations from DN-positive tissues and hemolymph having high levels of DN cells in circulation exhibited positive reactions in the PCR-enhanced reverse transcriptase assay. Cell-free preparations of of hemolymph from clams having low levels of DN (<0.1% of cells abnormal), hemocytes from normal soft shell clams, and normal soft shell clam tissues did not produce a positive reaction in the PCR enhanced reverse transcriptase assay.
DESCRIPTORS: clams virology, RNA directed DNA polymerase analysis, Retroviridae isolation and purification, clams enzymology, hemolymph enzymology, neoplasms virology, polymerase chain reaction, Retroviridae enzymology, tumor virus infections transmission, tumor virus infections virology.

Konishi, K.; Kawamura, K.; Furuita, H.; Komaru, A. (1998) **Spermatogenesis of the freshwater clam Corbicula aff. fluminea Muller (Bivalvia: Corbiculidae).** *Journal of Shellfish Research* V 17 , N1 (JUN) p. 185-189, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: spermatogenesis, ultrastructure, flagella, hermaphrodite, Corbicula, ultrastructure, sperm, spermatozoa, Unionidae.

Madon, S.P.; Schneider, D.W.; Stoeckel, J.A. (1998) **In situ estimation of zebra mussel metabolic rates using the electron transport system (ETS) assay.** *Journal of Shellfish Research* V. 17, N1 (JUN), P. 195-203, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: zebra mussels, ETS assay, in-situ metabolic rates, Dreissena polymorpha, bioenergetics model, oxygen consumption, marine zooplankton, great lakes, impact, respiration, region, river, populations.

Martinez, G.; Mettifogo, L. (1998) **Mobilization of energy from adductor muscle for gametogenesis of the scallop, Argopecten purpuratus Lamarck.** *Journal of Shellfish Research* V 17, N1 (JUN), P. 113-116, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6

DESCRIPTORS: scallops, gametogenesis, Argopecten purpuratus, reproduction, adductor muscle, clyde sea area, biochemical composition, bay scallop, Placopecten magellanicus, Irradians concentricus, seasonal variation, Pecten maximus, cyclic AMP, reproduction, Yessoensis.

OConnor, W.A.; Heasman, M.P. (1998) **Ontogenetic changes in salinity and temperature tolerance in the doughboy scallop, Mimachlamys asperrima.** *Journal of Shellfish Research* V. 17, N1 (JUN), P. 89-95, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: salinity, temperature, tolerance, ontogeny, byssogenesis, scallops, commercial scallop, iceland scallop, Pecten fumatus, growth, settlement, pectinidae, bay.

Serrano, F.S.; Alonso, P.S.; Lopez, S.L.; Martin, L.O. (1998) **Regulation of Mytilus galloprovincialis glycogen phosphorylase by glucose and glucose-6-phosphate.** *Journal of Shellfish Research*, V. 17, N1 (JUN), P. 159-163, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: Mytilus galloprovincialis, glycogen phosphorylase, regulation glucose, glucose-6-phosphate, inorganic phosphate, liver, site, dephosphorylation, gametogenesis, purification, metabolism, binding, edulis, mantle.

Trotta, P.; Cordisco, C.A. (1998) **Gonadal maturation, conditioning, and spawning in the laboratory and maturation cycle in the wild of Cerastoderma glaucum Bruguiere.** *Journal of Shellfish Research* 17 (4) 919-923, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: aquaculture, marine ecology, environmental sciences, reproduction, Pelecypoda, Cerastoderma glaucum, egg, fisheries species, gamete, reproductive system, Europe, Palearctic region, Lesina Lagoon, Italy, Europe, Palearctic region, mariculture industry, adaptability, aquatic conditions, chemical, biomass, coastal embayments, habitat, eutrophic lagoons, gametogenesis, gonadal maturation, latitudinal variation, mariculture, maturation cycle, muddy soft bottom, organic load, population density, reproductive behavior, salinity, temperature, Isochrysis aff. galbana.

Walker, R.L.; Hurley, D.H.; Kupfer, R. (1998) **Growth and survival of Atlantic surfclam, Spisula solidissima, larvae and juveniles fed various microalga diets.** *Journal of Shellfish Research*, V. 17, N1 (JUN), P. 211-214, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: Spisula, diets, growth, larvae, survival, upweller, Crassostrea virginica gmelin, Mercenaria mercenaria.

1997

Afanasjev, S.A.; Szatochina, A.V.; Zdanowski, B. (1997) **Some aspects of thermal tolerance of Anodonta from heated koninskie lakes.** *Archives of Polish Fisheries* (1997). v. 5(1) p. 5-11, ISSN 1230-6428.
NAL CALL NUMBER: SH293.P7A73
ABSTRACT: Thermal tolerance of Anodonta and Unio was studied under experimental conditions. Most tolerant to a gradual and stepwise temperature increase to 35 deg C were Chinese Anodonta, very numerous in Koninskie lakes, and among them - individuals up to 5 cm. Critical water temperature, at a gradual daily increase, was 39 deg C.

DESCRIPTORS: freshwater Molluscs, invertebrates, temperature resistance, heating, laboratory experimentation, electrical energy, water power, environmental impact, Poland, lakes, aquatic animals, aquatic organisms, eastern Europe, energy, energy sources, environmental control, Europe, experimentation, inland waters, natural resources, nonrenewable resources, physiographic features, renewable energy, renewable resources, resistance to injurious factors, surface water, water resources.

DePaola, A.; McLeroy, S.; McManus, G. (1997) **Distribution of Vibrio vulnificus phage in oyster tissues and other estuarine habitats.** *Appl Environ Microbiol* 63(6): 2464-7, ISSN: 0099-2240.
NAL CALL NUMBER: 448.3 AP5
ABSTRACT: Phages lytic to Vibrio vulnificus were found in estuarine waters, sediments, plankton, crustacea, molluscan shellfish, and the intestines of finfish of the U.S. Gulf Coast, but no apparent relationship between densities of V. vulnificus and its phages was observed. Phage diversity and abundance in molluscan shellfish were much greater than in other habitats. V. vulnificus phages isolated from oysters did not lyse other mesophilic bacteria also isolated from oysters. Both V. vulnificus and its phages were found in a variety of oyster tissues and fluids with lowest densities in the hemolymph and mantle fluid. These findings suggest a close ecological relationship between V. vulnificus phages and molluscan shellfish.
DESCRIPTORS: bacteriophages isolation and purification, oysters microbiology, oysters virology, shellfish microbiology, shellfish virology, Vibrio virology, water microbiology, ecosystem, fresh water microbiology, fresh water virology, seawater microbiology, seawater virology, United States, Vibrio isolation and purification.

Elston, R. (1997) **Special topic review: Bivalve mollusc viruses.** *World Journal of Microbiology and Biotechnology* 13 (4) 393-403, ISSN: 0959-3993.
NAL CALL NUMBER: QR1.M562
DESCRIPTORS: cell biology, infection, marine ecology (ecology, environmental sciences), methods and techniques, microbiology, Pathology, Physiology, wildlife management (conservation), Birnaviridae, viruses, Herpesviridae, Invertebrata unspecified, Reoviridae animal host only, bivalves, herpesviruses, microorganism, oyster, Pelecypoda, Birnaviridae, Reoviridae, Reoviridae Animal Host Only.

Fayer, R.; Farley, C.A.; Lewis, E.J.; Trout, J.M.; Graczyk, T.K. (1997) **Potential role of the Eastern oyster, Crassostrea virginica, in the epidemiology of Cryptosporidium parvum.** *Applied and environmental microbiology* v. 63(5) p. 2086-2088, ISSN: 0099-2240.
NAL CALL NUMBER: 448.3 AP5
ABSTRACT: Oysters were placed in an aquarium containing artificial seawater, and Cryptosporidium parvum oocysts were added. Oocysts were later found in the gill washings, hemocytes, and gut contents of the oysters. Hemocytes containing oocysts were intubated into four mice. C. parvum stages developed in the ileal epithelia of all of the mice, indicating that the oocysts in the hemocytes remained infective.
DESCRIPTORS: Crassostrea virginica, epidemiology, Cryptosporidium parvum, Bivalvia, Coccidia, Crassostrea, Cryptosporidium, Protozoa, Sporozoa.

Gjetvaj, B.; Ball, R.M.; Burbridge, S.; Bird, C.J.; Kenchington, E.; Zouros, E. (1997) **Amounts of polymorphism at microsatellite loci in the sea scallop Placopecten magellanicus.** *Journal Of Shellfish Research*, V. 16, N2 (DEC), P. 547-553, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6

DESCRIPTORS: microsatellites, scallops, Placopecten magellanicus, stepwise mutation model, mitochondrial DNA, distributions, populations.

Shamseldin, A.A.; Clegg, J.S.; Friedman, C.S.; Cherr, G.N.; Pillai, M.C. (1997) **Induced thermotolerance in the Pacific oyster, Crassostrea gigas.** *Journal Of Shellfish Research* V 16 , N2 (DEC), P. 487-491, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: oyster, thermotolerance, heat shock protein, summer mortality, heat-shock proteins, molecular chaperones, Perkinsus marinus, stress proteins.

1996

Mersch, J.; Beauvais, M.N.; Nagel, P. (1996) **Induction of micronuclei in haemocytes and gill cells of zebra mussels, Dreissena polymorpha, exposed to clastogens.** *Mutat Res* 371(1-2): 47-55, ISSN: 0027-5107.
NAL CALL NUMBER: QH431.M8
ABSTRACT: Zebra mussels, Dreissena polymorpha, were exposed to four directly acting reference clastogens (mitomycin C, bleomycin, dimethylarsinic acid and potassium chromate) under laboratory conditions. The aim was to examine the inducibility of micronuclei (MN) in haemocytes and gill cells. Positive responses were observed in both tissues for all four substances used under the given test conditions. The mean MN frequencies in treated mussels ranged between 3.2 and 6.9/1000 in haemocytes and between 5.4 and 6.7/1000 in gill cells. The spontaneous MN levels averaged 1.2 and 2.8/1000 in haemocytes and gill cells, respectively. The MN induction capacity of the different chemicals was equivalent in both tissues, except for the treatment with dimethylarsinic acid which generated a significantly higher MN rate in gill cells than in haemocytes. Several characteristics suggest that haemolymph is the more appropriate test tissue for environmental genotoxicity assessment: (1) a shorter preparation time of slides, (2) a more accurate identification of unambiguous MN, (3) a lower baseline MN frequency and a higher induction factor.
DESCRIPTORS: gills drug effects, hemocytes drug effects, micronucleus tests, mutagens toxicity, bleomycin toxicity, cacodylic acid pharmacology, chromates pharmacology, gills cytology, mitomycin toxicity, mussels, potassium compounds pharmacology.

Mortensen, S.H.; Glette, J. (1996) **Phagocytic activity of scallop (Pecten maximus) haemocytes maintained in vitro.** *Fish and Shellfish Immunology* 6 (2) 111-121, ISSN: 1050-4648.
NAL CALL NUMBER: QL638.97 F55
DESCRIPTORS: blood and lymphatics, transport and circulation, immune system, chemical coordination and homeostasis, marine ecology, environmental sciences, physiology, Pelecypoda, Pecten maximus, Hemocyte, Morphology.

Vanderploeg, H.A.; Liebig, J.R.; Gluck, A.A. (1996) **Evaluation of different phytoplankton for supporting development of Zebra mussel larvae (Dreissena polymorpha): The importance of size and polyunsaturated fatty acid content.** *Journal of Great Lakes Research* 22 (1) 36-45, ISSN: 0380-1330.
NAL CALL NUMBER: GB1627.G8J6
DESCRIPTORS: biochemistry and molecular biophysics, development, ecology, environmental sciences, freshwater ecology, metabolism, physiology, algae unspecified, plantae, Pelecypoda, Mollusca, algae, Dreissena polymorpha, microorganisms, Mollusks, nonvascular plants.

Wright, D.A.; Setzler, H.E.M.; Magee, J.A.; Harvey, H.R. (1996) **Laboratory culture of Zebra (Dreissena polymorpha) and Quagga (D. bugensis) Mussel larvae using estuarine algae.** *Journal of Great Lakes Research* 22 (1) 46-54, ISSN: 0380-1330.
NAL CALL NUMBER: GB1627.G8J6
DESCRIPTORS: biochemistry and molecular biophysics, estuarine ecology, environmental sciences, nutrition, physiology, systematics and taxonomy, wildlife management, conservation, Algae unspecified, Plantae, Pelecypoda, Dreissena bugensis, Dreissena polymorpha, microorganisms, Mollusks, nonvascular plants.

1995

Greger, E.A.; Drum, A.S.; Elston, R.A. (1995) **Measurement of oxidative activity in hemocytes of the Pacific razor clam, Siliqua patula, and the oyster, Crassostrea gigas, using lucigenin- and luminol-dependent chemiluminescence.** *Journal of invertebrate pathology* 65(1): 48-60, ISSN: 0022-2011.
NAL CALL NUMBER: 421 J826
ABSTRACT: In a manner resembling the respiratory burst of activated mammalian polymorphonuclear leukocytes, hemocytes of the Pacific razor clam, Siliqua patula, produced reactive oxygen intermediates during in vitro phagocytosis of zymosan particles. The acridinium salt lucigenin is oxidized by superoxide anion, creating photon emissions at levels measurable on a liquid scintillation counter calibrated to detect blood cell chemiluminescence (CL). Production of the superoxide anion by activated razor clam hemocytes was indicated by superoxide dismutase-mediated inhibition of both lucigenin-dependent CL and the histochemical reduction of nitroblue tetrazolium. Reduced zymosan-stimulated myeloperoxidase activity was suggested by minimal luminol-dependent CL compared to hemocytes of the oyster, Crassostrea gigas, and enhancement of lucigenin-dependent CL with exogenous sodium azide and potassium cyanide. CL analysis of individual hemolymph samples revealed a high degree of variability in lucigenin-enhanced CL, suggesting large variation in hemocyte oxidative activity. Comparison of the lucigenin-and luminol-dependent CL of razor clam versus that of oyster hemocytes revealed significant interspecific dissimilarities and indicated that lucigenin offers an alternative to luminol for measurement of the bivalve hemocyte oxidative metabolism.
DESCRIPTORS: Siliqua genus, Crassostrea gigas, blood cells, phagocytes, polysaccharides, oxygen, oxidation, anions, optical properties, organic nitrogen compounds, Bivalvia, blood, carbohydrates, cells, chemical reactions, chemicophysical properties, Crassostrea, elements, ions, Mollusca, nonmetals.

Lewis, E.J.; Farley, C.A.; Small, E.B.; Baya, A.M. (1995) **A synopsis of juvenile oyster disease (JOD) experimental studies in Crassostrea virginica.** *Aquatic Living Resources* v. 9(2) p. 169-178, ISSN 0990-7440.
NAL CALL NUMBER: SH1.A8
DESCRIPTORS: Crassostrea virginica, young animals, pathology, mortality, aetiology, New England, America, Bivalvia, Mollusca, North America, North Eastern States USA.

Makela, T.P.; Oikari, A.O. (1995) **Pentachlorophenol accumulation in the freshwater mussels Anodonta anatina and Pseudanodonta complanata, and some physiological consequences of laboratory maintenance.** *Chemosphere* 31(7): 3651-62, ISSN: 0045-6535.
NAL CALL NUMBER: TD172.C54
ABSTRACT: Freshwater mussels Anodanta anatina and Pseudanodonta complanata were exposed to (14C)-pentachlorophenol. The wet weight based bioconcentration factor (BCF =

activity in animal per activity in water) at steady state varied from 80 to 120 for A. anatina and from 61 to 85 for P. complanata. The species did not differ significantly in their wet weight or lipid based BCFs but dry weight based values were significantly higher (40-50%) for A. anatina. The soft tissue dry weight and dry weight based condition index of A. anatina (Cl4 = soft tissue dry weight per shell length) differed significantly between natural mussel populations. In animals kept from 4 to 8 months in laboratory conditions, the soft tissue dry weight and glycogen content decreased more rapidly when mussels were maintained at 15 than at 5 degrees C. However, glycogen content in the digestive gland or adductor muscle did not differ in mussels maintained in the laboratory (5 degrees C) when compared to the natural population. The adductor muscle protein content differed between laboratory maintained animals and the natural population in Lake Hoytianen but there was no difference in the soft tissue lipid content. Trace metal concentrations and calcium in the soft tissue were in general higher in laboratory maintained mussels. In addition, laboratory maintenance affected the reproductive cycle of A. anatina.
DESCRIPTORS: animals, laboratory physiology, environmental pollutants metabolism, mussels physiology, pentachlorophenol metabolism, body weight drug effects, calcium analysis, environmental pollutants pharmacology, mussels chemistry, mussels drug effects, pentachlorophenol pharmacology, reproduction drug effects, seasons, trace elements analysis, xenobiotics metabolism, xenobiotics pharmacology.

1994

Alcutt, F.; Pinto, J.T. (1994) **Glutathione concentrations in the hard clam, Mercenaria mercenaria, following laboratory exposure to lead (a potential model system for evaluating exposure to carcinogens and toxins).** *Comp Biochem Physiol Pharmacol Toxicol Endocrinol* 1994 Mar; 107(3): 347-52.
NAL CALL NUMBER: QP901.C6
ABSTRACT: This study determined whether M. mercenaria retain Pb from sea water and whether endogenous GSH acts as an important primary response modulator of heavy metal detoxification. Lead accumulation in M. mercenaria may be related to the rate of endogenous formation of GSH. Glutathione concentrations decrease with increasing early exposure to Pb and increase after continued acute exposure. M. mercenaria do not accumulate Pb but appear to reach an equilibrium with their environment. GSH formation may protect the hard clam from accumulating excess Pb by forming insoluble sulfide adducts with Pb and excreting these complexes.
DESCRIPTORS: carcinogens toxicity, clams metabolism, glutathione metabolism, lead toxicity, toxins toxicity, water pollutants, chemical toxicity, environmental monitoring, metabolic detoxication, drug, models biological.

Anderson, R.S. (1994) **Hemocyte-derived reactive oxygen intermediate production in four bivalve mollusks.** *Dev Comp Immunol* 18(2): 89-96, ISSN: 0145-305X.
NAL CALL NUMBER: QR180.D4
ABSTRACT: Luminol-dependent chemiluminescence (LDCL) and nitroblue tetrazolium (NBT) reduction assays have been used to measure reactive oxygen intermediate (ROI) production by oyster (Crassostrea virginica) hemocytes, as well as ROI modulation caused by disease or exposure to environmental toxicants. However, ROI responses measured by these tests apparently vary considerably among other bivalve species. In all species tested, unstimulated hemocytes produced small quantities of ROIs. In C. virginica and Geukensia demissa phagocytosis or treatment with phorbol myristate acetate triggered significantly augmented, but

kinetically dissimilar, ROI responses; however, no induction was recorded in two clam species (Mya arenaria and Mercenaria mercenaria). This was supported by both LDCL and NBT assays, measuring activity of the myeloperoxidase/hydrogen peroxide system and production of intracellular superoxide anion, respectively. The failure of the clams to respond to standard ROI-eliciting procedures is possibly indicative of interspecies differences in hemocyte-mediated antimicrobial defense mechanisms.
DESCRIPTORS: hemocytes metabolism, Mollusca metabolism, reactive oxygen species metabolism, chemiluminescence, nitroblue tetrazolium metabolism.

Duncan, J.; Ram, J.L.; Fong, P.P.; Snow, V. (1994) **Zebra mussel gills: Long term culture and contractile responses.** *American Zoologist* 34 (5) 35A, ISSN: 0003-1569.
NAL CALL NUMBER: 410 AM3
DESCRIPTORS: biochemistry and molecular biophysics, cell biology, freshwater ecology, environmental sciences, membranes, cell biology, metabolism, physiology, Carunculina texasensis, Corbicula fluminea, Pelecypoda.

Juneja, R.; Ito, E.; Koide, S.S. (1994) **Effect of Serotonin and Tricyclic Antidepressants on Intracellular Calcium Concentrations in Spisula Oocytes.** *Cell Calcium* V 15, N1 (JAN), P. 1-6, ISSN: 0143-4160.
NAL CALL NUMBER: QP772.V53C4
DESCRIPTORS: affinity binding sites, human platelets, H-3 Imipramine, rat brain, maturation, effects of Imipramine, antidepressants inhibit spontaneous oscillations, cardiac assist devices.

MacMillan, R.J.; Cawthorn, R.J.; Whyte, S.K.; Lyon, P.R. (1994) **Design and maintenance of a closed artificial seawater system for long-term holding of bivalve shellfish.** *Aquacultural Engineering* 13 (4) 241-250, ISSN: 0144-8609.
NAL CALL NUMBER: SH1.A66
DESCRIPTORS: biochemistry and molecular biophysics, development, marine ecology, environmental sciences, metabolism, nutrition, physiology, wildlife management, conservation, Pelecypoda, Sporozoa, Protozoa, Argopecten irradians, Crassostrea virginica, Mercenaria mercenaria, Mya arenaria, Mytilus edulis, Ostrea edulis, Perkinsus karlssoni, Placopecten magellanicus.

Shi, A.J.; Wang, X.Z.; Zhang, H.Y. (1994) **On the nature of nacre secreted by the cultured mantle cells of freshwater mussel.** *Acta Zoologica Sinica* 40 (2) 191-197, ISSN: 0001-7302.
Note: In Chinese.
NAL CALL NUMBER: 410 AC87
DESCRIPTORS: biochemistry and molecular biophysics, cell biology, marine ecology, environmental sciences, metabolism, methods and techniques, morphology, pharmacognosy, pharmacology, physiology, wildlife management, conservation, Malvaceae, Dicotyledones, Angiospermae, Spermatophyta, Plantae, Pelecypoda.

Tessier, L.; G. Vaillancourt; L. Pazdernik. (1994) **Temperature effects on cadmium and mercury kinetics in freshwater molluscs under laboratory conditions.** *Arch Environ Contam Toxicol.* New York, Springer-Verlag. Feb 1994. v. 26 (2) p. 179-184. ISSN: 0090-4341.
NAL CALL NUMBER: TD172.A7
DESCRIPTORS: freshwater Molluscs, exposure, temperature, effects, cadmium, mercury, kinetics, laboratory tests.

1993

Marsh, J.W.; Chipman, J.K.; Livingstone, D.R. (1993) **Formation of DNA adducts following laboratory exposure of the mussel, Mytilus edulis, to xenobiotics.** *Science of the Total Environment Suppl.* 1993(part 1) p. 567-572, ISSN 0048-9697.
NAL CALL NUMBER: RA565.S365
DESCRIPTORS: Mytilus edulis, xenobiotics, DNA, toxicity, tracer techniques, acids, Bivalvia, Mytilus, nucleic acids, nucleic compounds, organic acids, miscellaneous animal disorders.

Tamai, K. (1993) **Tolerance of Theora fragilis (Bivalvia: Semelidae) to low concentrations of dissolved oxygen.** *Bulletin of the Japanese Society of Scientific Fisheries* 59(4): 615-620, ISSN 0021-5392. Note: In Japanese.
NAL CALL NUMBER: 414.9 J274
DESCRIPTORS: Bivalvia, anoxia, resistance to injurious factors, laboratory experimentation, dissolving, oxygen, environmental temperature, survival, duration, elements, environmental factors, nonmetals, physical phenomena, temperature, time, miscellaneous animal disorders.

1992

Borsa, P.; Jousselin, Y.; Delay, B. (1992) **Relationships between Allozymic Heterozygosity, Body Size, and Survival to Natural Anoxic Stress in the Palourde ruditapes decussatus (Bivalvia, Veneridae).** *Journal of Experimental Marine Biology and Ecology* V 155, N2, P. 169-181.
NAL CALL NUMBER: QH91.A1J6
DESCRIPTORS: anoxic stress, bivalve, heterozygosity, malaigue, Ruditapes decussates, survival, oyster Crassostrea virginica, mussel Mytilus edulis, growth rate, marine bivalves, Mulinia lateralis, blue mussel, coot clam, populations, energetics, lagoon.

Gosling, E (1992) *Developments in Aquaculture and Fisheries Science; The mussel Mytilus: Ecology, physiology, genetics and culture.*25: xiii+589p, ISSN: 0167-9309.
NAL CALL NUMBER: SH1 D43 v.25
DESCRIPTORS: infection, marine ecology, environmental sciences, parasitology, physiology, wildlife management, conservation, animal viruses general, viruses, Pelecypoda, microorganisms, viruses, epizootic diseases, mortality, parasite.

Jones, H.D.; Richards, O.G.; Southern, T.A. (1992) **Gill Dimensions, Water Pumping Rate and Body Size in the Mussel Mytilus edulis** *Journal of Experimental Marine Biology and Ecology* V 155, N2, P. 213-237.
NAL CALL NUMBER: QH91.A1J6
DESCRIPTORS: filter feeding, filtration rate, gill area, Mytilus, ostial area, size, suspension feeding bivalves, filtration rate, growth, temperature, oyster crassostrea gigas, mussel culture, growth of juvenile bay scallops Argopecten irradians concentricus.

Novelli, A.; Kispert, J.; Fernandezsanchez, M.T.; Torreblanca, A.; Zitko, V. (1992) **Domoic Acid-Containing Toxic Mussels Produce Neurotoxicity in Neuronal Cultures through a Synergism between Excitatory Amino Acids.** *Brain Research* V 577, N1 (APR 10), P. 41-48.
DESCRIPTORS: domoic acid, toxic mussel, synergism between excitatory amino acids, biotoxin, environmental neurotoxin, cerebellar granule cells, nervous system, receptors, glutamate, metabolism, model.

1991

Beaumont, A.R. (1991) **Genetic Studies of Laboratory Reared Mussels, Mytilus-edulis-Heterozygote Deficiencies, Heterozygosity and Growth.** *Biological Journal of the Linnean Society* V 44, N3, P. 273-285.
NAL CALL NUMBER: QH301.B56
DESCRIPTORS: Mytilus edulis, culture, genetics, electrophoresis, heterozygosity, growth, enzyme heterozygosity, Mulinia lateralis, marine bivalves, coot clam, Mercenaria mercenaria, Crassostrea virginica, possible explanations, environmental stress, population genetics, blue mussel.

Fujii, T.; Sugiyama, M. (1991) **The effect of water pressure change on the scallop appeared in periodic expansion-contraction movement of its adductor muscle.** *Bulletin of National Research Institute of Aquaculture* (no.19) p. 27-30, ISSN 0389-5858. Note: In Japanese.
NAL CALL NUMBER: SH109.Y67
ABSTRACT: Effects of periodical changes of water pressure and light-dark conditions on the movement of adductor muscle of a scallop, Patinopecten yessoensis (Jay), were investigated in the laboratory. The expansion-contraction movement of adductor muscle was measured (recorded) by straingauge method under the conditions of 12h water-level cycle with continuous dark and of 16h water-level cycle with 12h-12h light-dark alternation respectively. FFT spectral analysis showed that periodic elements corresponding to each periodic factor of the environmental conditions given to the shell were present in the adductor muscle movement, which suggested that the movement might be affected by tidal change as well as day-night change in natural environment.
DESCRIPTORS: Scallops, muscles, biological rhythms, pressure, sea water, movement, periodicity, light regimes, body parts, chemicophysical properties, environmental factors, lighting, musculoskeletal system, physiological functions, saline water, shellfish, time, water.

Jenner, H.A.; Hemelraad, J.; Marquenie, J.M.; Noppert, F. (1991) **Cadmium kinetics in freshwater clams (Unionidae) under field and laboratory conditions.** *Science of the Total Environment* 108(3): 205-214, ISSN: 0048-9697.
NAL CALL NUMBER: RA565.S365
DESCRIPTORS: clams, cadmium, kidneys, animal morphology, elements, heavy metals, metallic elements, shellfish, urinary tract, urogenital system.

1984

Tanaka, Y. (1984) **Morphological and physiological characteristics of the post larval stages in Corbicula japonica Prime, reared in the laboratory.** *Bulletin of National Research Institute of Aquaculture* (Japan) (no.6) p. 23-27, ISSN: 0389-5858.
NAL CALL NUMBER: SH109.Y67
DESCRIPTORS: clams, animal anatomy, physiology, larvae, life cycle, salinity, brackishwater environment, anatomy, animal developmental stages, aquatic environment, biological rhythms, chemicophysical properties, composition, developmental stages, environment, foods, seafoods, shellfish, time, timing.

1982

Fujii, T.; Mizuno, K.; Ishikawa, K. (1982) **The study for periodic behaviour of bivalves, 4: A characteristic of shell movement of mussels [Mytilus edulis].** *Bulletin of Tohoku Regional Fisheries Research Laboratory* (no.45) p. 69-75. Note: In Japanese.
NAL CALL NUMBER: SH301.S852
DESCRIPTORS: Mytilus, shell, movement, periodicity, environmental conditions, anatomy, animal anatomy, animals, aquatic animals, aquatic organisms, bivalves, body parts, environment, integument, physiological functions, time, timing, tissues.

1980

Mackie, G.L.; Zdeba, T.W. (1980) *A guide to freshwater mollusks of the Laurentian Great Lakes, with special emphasis on the genus Pisidium* Environmental Research Laboratory, Office of Research and Development, U. S. Environmental Protection Agency. 1980. 144 p.
NAL CALL NUMBER: TD1.E2 no. 80-068
DESCRIPTORS: auxiliary disciplines, Molluscs other, north central states USA, Ontario, lakes and ponds.

Palmer, R.E. (1980) **Behavioural and rhythmic aspects of filtration in the Bay scallop, Argopecten irradians concentricus (Say), and the oyster, Crassostrea virginica (Gmelin).** *Journal of Experimental Marine Biology and Ecology* 45(2): 273-295.
NAL CALL NUMBER: QH91.A1J6
ABSTRACT: Hourly measurements, for periods of 24 to 33 h, were made in the laboratory of filtration rate and cell clearance rate of 39 individual Argopecten irradians concentricus (Say) and Crassostrea virginica (Gmelin). Bivalves fed on suspensions of algea (Dunaliella tertiolecta Butcher, Ispchrysis galabna Parke, or Thalassiosira pseudonana (Hustedt)) whose concentration was maintained at a nearly constant level throughout each experiment. Neither local tidal sequence nor laboratory day: night cycles exerted a significant influence on scallop or oyster filtration behaviour. In Argopecten irradians filtration activity either remained relatively constant throughout the experimental period or stabilized at a constant level after an initial period of steady decline. There was an inverse relationship between suspended algal concentration (0.94 9.66mg l('1)) and filtration rate of A. irradians, so that the average amount of algae cleared hourly was similar throughout this range of concentrations. Mean filtration rate for all experiments with scallops was 4.7l.h('1)g dry wt ('1), but averaged 5.7l.h ('1) g dry wt ('1) when ambient concentration was <1.5mg.l('1). Filtration behaviour of Crassostrea virginica was generally characterized by alternating periods of high and low activity. Peaks of oyster filtration activity occurred two or three times per day, and the period between peaks did not vary with experimental algal concentration (1.7 6.7mg.l('1)). Oysters filtered actively for 80 per cent of all hourly periods in suspensions of Thalassiosira pseudonana and 91 per cent in suspensions of Isochrysis galbana: mean filtration rate for Crassostrea virginica was 1.5l.h('1)g dry wt ('1) for all measurements and 1.9l.h('1)g dry wt ('1) during hourly periods of active filtration. These results indicate that scallops can collect food continuously, and, in the range of concentrations of suspended matter typical of coastal environments, can respond to environmental variations quickly enough to collect a relatively constant supply of food over time. In similar concentrations filtration of oysters is much more variable. Fluctuations in filtration of oysters in the laboratory could not be related to tidal or diurnal cycles or to food availbility. Although their frequency does suggest a tidal component in filtration, the most probable explanation for variations in cell clearance rate is that they serve to regulate food levels in the stomach to permit a relatively constant level of intracellular digestion.
DESCRIPTORS: Aquatic ecology; Oysters.

1977

Nakanishi, T. (1977) **Studies of the effect of the environment on the heart rate of shellfishes, 1: Effect of temperature, salinity and hypoxia on the heart rate of scallop.** *Bulletin of the Hokkaido Regional Fisheries Research Laboratory.* (no.42) p. 65-73, ISSN: 0513-2541. Note: In Japanese.
NAL CALL NUMBER: 414.9 H683
DESCRIPTORS: aquatic ecology, clam.

Cephalopods

2002

Ikeda, Y.; Okazaki, J.; Sakurai, Y.; Sakamoto, W. (2002) **Periodic variation in Sr/Ca ratios in statoliths of the Japanese Common Squid Todarodes pacificus Steenstrup, 1880 (Cephalopoda: Ommastrephidae) maintained under constant water temperature.** *Journal of Experimental Marine Biology and Ecology* 273 (2): 161-170, ISSN: 0022-0981.
NAL CALL NUMBER: QH91.A1J6
DESCRIPTORS: marine ecology (ecology, environmental sciences), Todarodes pacificus, Japanese common squid, animals, Invertebrates, Mollusks, strontium/calcium ratio, periodic feeding activity, periodic variation, vertical movements, water temperature.

2001

Domingues, P. M.; A. Sykes; J. P. Andrade. **Pilot-scale culture of the cuttlefish S. Officinalis at the University of the Algarve (South Portugal).** *World Aquac.* Baton Rouge, La. : World Aquaculture Society,. June 2001. v. 32 (2) p. 3-5. ISSN: 1041-5602.
NAL CALL NUMBER: SH1.W62
DESCRIPTORS: Sepia, Mollusc culture, evaluation, growth rate, life cycle, liveweight, ova, prey, feeding, rearing techniques, larvae, survival, stocking density, handling, Portugal.

Jaffe, H.; Sharma, P.; Grant, P.; Pant, H. (2001) **Characterization of the phosphorylation sites of the squid (Loligo pealei) high-molecular-weight neurofilament protein from giant axon axoplasm.** *J Neurochem* 76(4): 1022-31, ISSN: 0022-3042.
NAL CALL NUMBER: QP351.J6
ABSTRACT: Axonal caliber in vertebrates is attributed, in part, to the extensive phosphorylation of NFM and NFH C-terminal tail domain KSP repeats by proline-directed kinases. The squid giant axon, primarily involved in rapid impulse conduction during jet propulsion motility, is enriched in squid-specific neurofilaments, particularly the highly phosphorylated NF-220. Of the 228 serine-threonine candidate phosphate acceptor sites in the NF-220 tail domain (residues 401-1220), 82 are found in numerous repeats of three different motifs SAR/K, SEK/R, K/RSP, with 62 of these tightly clustered in the C-terminal repeat segment (residues 840-1160). Characterization of the in vivo NF-220 phosphorylated sites should provide clues as to the relevant kinases. To characterize these sites, proteolytic digests of NF-220 were analyzed by a combination of HPLC, electrospray tandem mass spectrometry and database searching. A total of 53 phosphorylation sites were characterized, with 47 clustered in the C-terminal repeat segment (residues 840-1160), representing 76% (47/62) of the total acceptor sites in the region. As in mammalian NFH, approximately 64% of the K/RSP sites (14/22) in this region were found

to be phosphorylated implicating proline-directed kinases. Significantly, 78% of serines (31/40) in the KAES*EK and EKS*ARSP motifs were also phosphorylated suggesting that non proline-directed kinases such as CKI may also be involved. This is consistent with previous studies showing that CKI is the principal kinase associated with axoplasmic NF preparations. It also suggests that phosphorylation of large macromolecules with multiple phospho-sites requires sequential phosphorylation by several kinases.
DESCRIPTORS: axons chemistry, cytoplasm chemistry, neurofilament proteins chemistry, amino acid sequence, binding sites physiology, chromatography, liquid, molecular sequence data, neurofilament proteins isolation and purification, peptide fragments analysis, peptide hydrolases metabolism, phosphorylation, protein structure, tertiary, sequence analysis, protein, spectrum analysis, squid, peptide fragments, neurofilament protein NF 220.

Mather, J.A. **Animal suffering: an invertebrate perspective.** *J Appl Anim Welf Sci.* Mahwah, N.J. : Lawrence Erlbaum Associates, Inc. 2001. v.4 (2) p. 151-156. ISSN: 1088-8705.
NAL CALL NUMBER: HV4701.J68
DESCRIPTORS: laboratory animals, invertebrates, Cephalopoda, pain, animal welfare, octopus, animal behavior,. conditioned reflexes, nervous system, ethics.

Zheng, X.D.; Wang, R.C.; Wang, X.F.; Xiao, S.; Chen, B. (2001) **Genetic variation in populations of the common Chinese cuttlefish Sepiella maindroni (Mollusca : Cephalopoda) using allozymes and mitochondrial DNA sequence analysis.** *Journal of Shellfish Research* V 20, N3 (DEC) , P. 1159-1165, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: genetic variation, Sepiella maindroni, allozyme, cytochrome oxidase I gene, DNA sequencing.

2000

Boutilier, R.G.; West, T.G.; Webber, D.M.; Pogson, G.H.; Mesa, K.A.; Wells, J.; Wells, M.J. (2000) **The protective effects of hypoxia-induced hypometabolism in the Nautilus.** *J Comp Physiol [B]* 170(4): 261-8, ISSN: 0174-1578.
NAL CALL NUMBER: QP33.J681
ABSTRACT: Specimens of Nautilus pompilius were trapped at depths of 225-300 m off the sunken barrier reef southeast of Port Moresby, Papua New Guinea. Animals transported to the Motupore Island laboratory were acclimated to normal habitat temperatures of 18 degrees C and then cannulated for arterial and venous blood sampling. When animals were forced to undergo a period of progressive hypoxia eventually to encounter ambient partial pressure of oxygen (PO2) levels of approximately 10 mmHg (and corresponding arterial PO2's of approximately 5 mmHg), they responded by lowering their aerobic metabolic rates to 5-10% of those seen in resting normoxic animals. Coincident with this profound metabolic suppression was an overall decrease in activity, with brief periods of jet propulsion punctuating long periods of rest. Below ambient PO2 levels of 30-40 mmHg, ventilatory movements became highly periodic and at the lowest PO2 levels encountered, ventilation occasionally ceased altogether. Cardiac output estimated by the Fick equation decreased during progressive hypoxia by as much as 75 80%, and in the deepest hypometabolic states heart rates slowed to one to two cycles of very low amplitude per minute. By the end of 500 min exposure to ambient PO2 levels of 10 mmHg or less, the anaerobic end products octopine and succinate had increased significantly in adductor muscle and heart, respectively. Increased concentrations of octopine in adductor muscle apparently contributed to a small intracellular acidosis and to the development of a combined respiratory

and metabolic acidosis in the extracellular compartment. On the other hand, increases in succinate in heart muscle occurred in the absence of any change in cardiac pHi. Taken together, we estimate that these anaerobic end products would make up less than 2% of the energy deficit arising from the decrease in aerobic metabolism. Thus, metabolic suppression is combined with a massive downregulation of systemic O2 delivery to match metabolic supply to demand.
DESCRIPTORS: adaptation, physiological physiology, anoxia metabolism, arginine analogs and derivatives, basal metabolism physiology, Mollusca metabolism, acid base equilibrium physiology, arginine metabolism, carbon dioxide metabolism, heart rate, hydrogen ion concentration, muscles metabolism, myocardium metabolism, oxygen metabolism, respiration, succinic acid metabolism.

Dickel, L.; Boal, J.G.; Budelmann, B.U. (2000) **The effect of early experience on learning and memory in cuttlefish.** *Developmental Psychobiology* 36 (2): 101-110, ISSN: 0012-1630.
NAL CALL NUMBER: QP351.D4
DESCRIPTORS: behavior, development, Cephalopoda, Mollusca, Invertebrata, Animalia, Sepia officinalis ,cuttlefish, juvenile, animals, Invertebrates, learning, acquisition, early experience effect, retention, memory, early experience effect, growth, maturation rate, ontogeny, rearing environment, enriched, impoverished.

Nyholm, S.V.; Stabb, E.V.; Ruby, E.G.; McFall-Ngai, M.J. (2000) **Establishment of an animal-bacterial association: recruiting symbiotic vibrios from the environment.** *Proc Natl Acad Sci USA* 97(18): 10231-5, ISSN: 0027-8424.
NAL CALL NUMBER: 500 N21P
ABSTRACT: While most animal-bacterial symbioses are reestablished each successive generation, the mechanisms by which the host and its potential microbial partners ensure tissue colonization remain largely undescribed. We used the model association between the squid Euprymna scolopes and Vibrio fischeri to examine this process. This light organ symbiosis is initiated when V. fischeri cells present in the surrounding seawater enter pores on the surface of the nascent organ and colonize deep epithelia-lined crypts. We discovered that when newly hatched squid were experimentally exposed to natural seawater, the animals responded by secreting a viscous material from the pores of the organ. Animals maintained in filtered seawater produced no secretions unless Gram-negative bacteria, either living or dead, were reintroduced. The viscous material bound only lectins that are specific for either N-acetylneuraminic acid or N-acetylgalactosamine, suggesting that it was composed of a mucus-containing matrix. Complex ciliated fields on the surface of the organ produced water currents that focused the matrix into a mass that was tethered to, and suspended above, the light organ pores. When V. fischeri cells were introduced into the seawater surrounding the squid, the bacteria were drawn into its fluid-filled body cavity during ventilation and were captured in the matrix. After residing as an aggregate for several hours, the symbionts migrated into the pores and colonized the crypt epithelia. This mode of infection may be an example of a widespread strategy by which aquatic hosts increase the likelihood of successful colonization by rarely encountered symbionts.
DESCRIPTORS: gram negative bacteria physiology, gram positive bacteria physiology, squid microbiology, squid physiology, symbiosis, Vibrio physiology, cloning, molecular, epithelium microbiology, epithelium physiology, lectins, luminescent proteins analysis, luminescent proteins genetics, recombinant proteins analysis, seawater microbiology.

1999

Grant, P; Diggins, M; Pant, H.C. (1999) **Topographic regulation of cytoskeletal protein phosphorylation by multimeric complexes in the squid giant fiber system.** *J Neurobiol* 40(1): 89-102, ISSN: 0022-3034.
NAL CALL NUMBER: QP351.J55
ABSTRACT: In mammalian and squid nervous systems, the phosphorylation of neurofilament proteins (NFs) seems to be topographically regulated. Although NFs and relevant kinases are synthesized in cell bodies, phosphorylation of NFs, particularly in the lys-ser-pro (KSP) repeats in NF-M and NF-H tail domains, seem to be restricted to axons. To explore the factors regulating the cellular compartmentalization of NF phosphorylation, we separated cell bodies (GFL) from axons in the squid stellate ganglion and compared the kinase activity in the respective lysates. Although total kinase activity was similar in each lysate, the profile of endogenous phosphorylated substrates was strikingly different. Neurofilament protein 220 (NF220), high-molecular-weight NF protein (HMW), and tubulin were the principal phosphorylated substrates in axoplasm, while tubulin was the principal GFL phosphorylated substrate, in addition to highly phosphorylated low-molecular-weight proteins. Western blot analysis showed that whereas both lysates contained similar kinases and cytoskeletal proteins, phosphorylated NF220 and HMW were completely absent from the GFL lysate. These differences were highlighted by P13(suc1) affinity chromatography, which revealed in axoplasm an active multimeric phosphorylation complex(es), enriched in cytoskeletal proteins and kinases; the equivalent P13 GFL complex exhibited six to 20 times less endogenous and exogenous phosphorylation activity, respectively, contained fewer cytoskeletal proteins and kinases, and expressed a qualitatively different cdc2-like kinase epitope, 34 kDa rather than 49 kDa. Cell bodies and axons share a similar repertoire of molecular consitutents; however, the data suggest that the cytoskeletal/kinase phosphorylation complexes extracted from each cellular compartment by P13 are fundamentally different.
DESCRIPTORS: cytoskeletal proteins metabolism, nerve fibers metabolism, nerve fibers ultrastructure, protein kinases metabolism, chromatography, affinity, cytoskeletal proteins chemistry, electrophoresis, polyacrylamide gel, neurofilament proteins chemistry, neurofilament proteins isolation and purification, neurofilament proteins metabolism, phosphorylation, repetitive sequences, amino acid, squid.

1998

Boal, J. G.; S. A. Gonzalez. **Social behavior of individual oval squids (Cephalopoda, Teuthoidea, Loliginidae, Sepioteuthis lessoniana) within a captive school.** *Ethology.* Berlin : Paul Parey, 1986. Feb 1998. v. 104 (2) p. 161-178. ISSN: 0179-1613.
NAL CALL NUMBER: QL750.E74
DESCRIPTORS: Loliginidae, social behavior, behavior patterns.

Houlihan, D.F.; Kelly, K.; Boyle, P.R. (1998) **Correlates of growth and feeding in laboratory-maintained Eledone cirrhosa (Cephalopoda: Octopoda).** *Journal of the Marine Biological Association of the United Kingdom* 78 (3) 919-932, ISSN: 0025-3154.
NAL CALL NUMBER: 442.9 M331
DESCRIPTORS: marine ecology (ecology, environmental sciences), Cephalopoda, Eledone cirrhosa, body mass, digestive gland index, feeding, growth.

Nishiguchi, M.K.; Ruby, E.G.; McFall-Ngai, M.J. (1998) **Competitive dominance among strains of luminous bacteria provides an unusual form of evidence for parallel evolution in Sepiolid squid-vibrio symbioses.** *Appl Environ Microbiol* 64(9): 3209-13, ISSN: 0099-2240.

NAL CALL NUMBER: 448.3 AP5
ABSTRACT: One of the principal assumptions in symbiosis research is that associated partners have evolved in parallel. We report here experimental evidence for parallel speciation patterns among several partners of the sepiolid squid-luminous bacterial symbioses. Molecular phylogenies for 14 species of host squids were derived from sequences of both the nuclear internal transcribed spacer region and the mitochondrial cytochrome oxidase subunit I; the glyceraldehyde phosphate dehydrogenase locus was sequenced for phylogenetic determinations of 7 strains of bacterial symbionts. Comparisons of trees constructed for each of the three loci revealed a parallel phylogeny between the sepiolids and their respective symbionts. Because both the squids and their bacterial partners can be easily cultured independently in the laboratory, we were able to couple these phylogenetic analyses with experiments to examine the ability of the different symbiont strains to compete with each other during the colonization of one of the host species. Our results not only indicate a pronounced dominance of native symbiont strains over nonnative strains, but also reveal a hierarchy of symbiont competency that reflects the phylogenetic relationships of the partners. For the first time, molecular systematics has been coupled with experimental colonization assays to provide evidence for the existence of parallel speciation among a set of animal-bacterial associations.
DESCRIPTORS: phylogeny, squid microbiology, symbiosis, Vibrio genetics, Vibrio growth and development, cytochrome c oxidase genetics, DNA, bacterial, evolution, glyceraldehydes 3 phosphate dehydrogenases genetics, luminescence bacterial, molecular sequence data, sequence analysis, DNA, species specificity, squid genetics.

1997

Hanlon, R.T.; Claes, M.F.; Ashcraft, S.E.; Dunlap, P.V. (1997) **Laboratory culture of the sepiolid squid Euprymna scolopes: A model system for bacteria-animal symbiosis.** *Biological Bulletin Woods Hole* 192 (3) 364-374, ISSN: 0006-3185.
NAL CALL NUMBER: 442.8 B52
DESCRIPTORS: development, ecology (environmental sciences), physiology, reproductive system (reproduction), systematics and taxonomy, Cephalopoda, Vibrionaceae, Eubacteria, bacteria, Euprymna scolopes, Vibrio fischeri (Vibrionaceae), microorganisms, bacterial animal symbiosis, growth, laboratory culture, model, oviposition, sepiolid squid, settlement, sexual maturity, survival , symbiont.

Oestmann, D. J.; J. M. Scimeca; J. Forsythe; R. Hanlon; P. Lee. **Special considerations for keeping cephalopods in laboratory facilities.** *Contem Top Lab Anim Sci.* Cordova, TN : The Association, 1992. Mar 1997. v. 36 (2) p. 89-93. ISSN: 1060-0558.
NAL CALL NUMBER: SF405.5.A23
DESCRIPTORS: Cephalopoda, culture techniques, laboratory rearing, aquaria, animal models, laboratory animals.

1996

Boutilier, R.G.; West, T.G.; Pogson, G.H.; Mesa, K.A.; Wells, J.; Wells, M.J. (1996) **Nautilus and the art of metabolic maintenance.** *Nature* London 382 (6591) 534-536, ISSN: 0028-0836.
NAL CALL NUMBER: 472 N21
DESCRIPTORS: biochemistry and molecular biophysics, blood and lymphatics, transport and circulation, marine ecology, environmental sciences, metabolism, physiology, Nautilus pompilius, Cephalopoda.

Clay, J.R. (1996) **Effects of permeant cations on K+ channel gating in nerve axons revisited.** *J Membr Biol* 153(3): 195-201, ISSN: 0022-2631.
NAL CALL NUMBER: QH573.J6
ABSTRACT: An increase in extracellular potassium ion concentration, Ko, significantly slows the potassium channel deactivation rate in squid giant axons, as previously shown. Surprisingly, the effect does not occur in all preparations which, coupled with the voltage independence of this result in preparations in which it does occur, suggests that it is mediated at a site outside of the electric field of the channel, and that this site is accessible to potassium ions in some preparations, but not in others. In other words, the effect does not appear to be related to occupancy of the channel by potassium ions. This conclusion is supported by a four-barrier, three-binding site model of single file diffusion through the channel in which one site, at most, is unoccupied by a potassium ion (single-vacancy model). The model is consistent with current-voltage relations with various levels of Ko, and, by definition, with multiple occupancy by K+. The model predicts that occupancy of any given site is essentially independent of Ko (or Ki). The effects of extracellular Rb+ and Cs+ on gating are strongly voltage dependent, and they were observed in all preparations investigated. Consequently, the mechanism underlying these results would appear to be different from that which underlies the effect of K+ on gating. In particular, the effect of Rb+ on gating is reduced by strong hyperpolarization, which in the context of the occupancy hypothesis, is consistent with the voltage dependence of the current-voltage relation in the presence of Rb+. The primary, novel, finding in this study is that the effects of Cs+ are counterintuitive in this regard. Specifically, the slowing of channel deactivation rate by Cs+ is also reduced by hyperpolarization, similar to the Rb+ results, whereas blockade is enhanced, which is seemingly inconsistent with the concept that occupancy of the channel by Cs+ underlies the effect of this ion on gating. This result is further elucidated by barrier modeling of the current-voltage relation in the presence of Cs+.
DESCRIPTORS: axons physiology, ion channel gating, potassium channels metabolism, calcium metabolism, electrophysiology.

Robertson, J.D.; Bonaventura, J.; Kohm, A.; Hiscat, M. (1996) **Nitric oxide is necessary for visual learning in Octopus vulgaris.** *Proc R Soc Lond B Biol Sci* 263(1377): 1739-43, ISSN: 0962-8452.
NAL CALL NUMBER: 501 L84B
ABSTRACT: We recently reported that inhibition of nitric oxide synthase (NOS) in Octopus vulgaris by intramuscular injections of an analog of L-arginine, N-omega-nitro-L-arginine methyl ester (L-NAME), blocked touch learning in Octopus vulgaris. The inactive enantiomorph (D-NAME), which had no effect on learning, was used for control. We now report that essentially the same procedures block visual learning in this animal. We used a visual paradigm in which the octopus was trained to respond positively to a smooth black plastic ball 2.5 cm diameter and negatively to a similar white ball, or vice versa. One set of eight animals was trained to the black ball positive, and another set of six to the white ball positive. Each set was trained at different times by two different trainers. We found that a 1 h pretreatment with the nitric oxide synthase inhibitor L-NAME blocks visual learning in Octopus vulgaris in both sets of animals.
DESCRIPTORS: learning physiology, nitric oxide physiology, Octopus physiology, enzyme inhibitors pharmacology, learning drug effects, nitroarginine methyl ester pharmacology, nitric oxide synthase antagonists and inhibitors, photic stimulation.

Siriraksophon, S.; Morinaga, T. (1996) **Effect of background brightness on the visual contrast threshold of the Japanese common squid [Todarodes pacificus].** *Fisheries Science* 62(4): 534-537, ISSN 0919-9268.

NAL CALL NUMBER: SH1.F8195
DESCRIPTORS: Todarodes pacificus, vision, performance testing, behaviour, lighting, light regimes, darkness, laboratory experimentation, laboratory equipment, Cephalopoda, environmental control, environmental factors, equipment, experimentation, lighting, Mollusca, physiological functions, senses, testing, animal physiology and biochemistry.

1995

Clay, J.R. (1995) **A simple model of K+ channel activation in nerve membrane.** *J Theor Biol* 175(2): 257-62, ISSN: 0022-5193.
NAL CALL NUMBER: 442.8 J8223
ABSTRACT: A model is proposed for activation of potassium ion channel current, IK, in squid giant axons, which consists of two closed states and one open state. The rate parameter in the forward direction between the two closed states depends upon previous history. That is, it relaxes exponentially to its steady-state value appropriate to the membrane potential of a voltage clamp step rather than change instantaneously as in traditional models of channel gating. The model successfully describes both the enhancement of the delay in activation of IK with relatively negative prepulse potentials, i.e. the Cole-Moore effect, and the time-dependent rising phase of "on" gating current, which has been reported recently for several types of potassium channels.
DESCRIPTORS: axons metabolism, ion channel gating physiology, potassium channels physiology, models biological, squid.

Rivera, D.T.; Langford, G.M.; Weiss, D.G.; Nelson, D.J. (1995) **Calmodulin regulates fast axonal transport of squid axoplasm organelles.** *Brain Res Bull* 37(1): 47-52, ISSN: 0361-9230.
ABSTRACT: The role of calmodulin (CaM) in organelle motility (fast axonal transport) in the axoplasm of the squid giant axon was evaluated directly using video-enhanced microscopy. Addition of 6 microM CaM to extruded squid axoplasm produced a 2.6-fold increase in the number of organelles moving per minute per unit area of axoplasm. When lower concentrations of CaM, including physiological concentration (2 micrograms/ml), were added to extruded axoplasm, the number of organelles moving was equally increased. CaM had no significant effect on the mean velocity of organelle translocations. The stimulatory effect of CaM was reduced significantly by the CaM inhibitors melittin (36 microM) and trifluoperazine (50 microM). Parvalbumin, a high-affinity calcium binding protein, did not stimulate motile activity. These results suggest that CaM is a positive regulator of fast axonal transport. At the molecular level, this regulation may involve microtubule-and/or actin-based motor proteins. Several possible molecular mechanisms are proposed.
DESCRIPTORS: axonal transport physiology, axons metabolism, calmodulin physiology, organelles physiology, axonal transport drug effects, axons drug effects, biological transport drug effects, biological transport physiology, calmodulin antagonists and inhibitors, melitten pharmacology, microscopy, video, organelles drug effects, squid, time factors, trifluoperazine pharmacology.

Segawa, S. (1995) **Effect of temperature on oxygen consumption of juvenile oval squid Sepioteuthis lessoniana.** *Fisheries Science* 61(5): 743-746, ISSN 0919-9268.
NAL CALL NUMBER: SH1.F8195
DESCRIPTORS: Sepioteuthis, growth period, oxygen consumption, environmental temperature, weight, laboratory experimentation, Cephalopoda, developmental stages, environmental factors,

experimentation, gas exchange, physiological functions, temperature, animal physiology and biochemistry, aquatic ecology.

Siriraksophon, S.; Nakamura, Y.; Matsuike, K. (1995) **Visual contrast threshold of Japanese common squid Todarodes pacificus Steenstrup.** *Fisheries Science* 61(4): 574-577, ISSN 0919-9268.
NAL CALL NUMBER: SH1.F8195
DESCRIPTORS: Todarodes pacificus, vision, identification, senses, laboratory experimentation, behaviour, testing, darkness, light, Cephalopoda, environmental factors, experimentation, physiological functions, radiation, senses, aquatic ecology, animal physiology and biochemistry.

Villanueva, R. (1995) **Experimental rearing and growth of planktonic Octopus vulgaris from hatching to settlement.** *Canadian Journal of Fisheries and Aquatic Sciences* 52 (12) 2639-2650, ISSN: 0706-652X.
NAL CALL NUMBER: 442.9 C16J
DESCRIPTORS: behavior, development, ecology, environmental sciences, marine ecology, physiology, Cephalopoda, Octopus vulgaris, Mediterranean Sea, North Atlantic, Atlantic Ocean, behavior, dispersal, negative phototaxis, survival, temperature, weight gain.

Wada, Y.; Kobayashi, T. (1995) **On an iteroparity of the oval squid Sepioteuthis lessoniana.** *Bulletin of the Japanese Society of Scientific Fisheries* v. 61(2) p. 151-158, ISSN 0021-5392.
NAL CALL NUMBER: 414.9 J274
DESCRIPTORS: Sepioteuthis, oviposition, reproductive performance, environmental temperature, laboratory experimentation, aquaculture equipment, copulation, egg hatchability, fertility, animal performance, biological properties, Cephalopoda, environmental factors, equipment, experimentation, fertilization, physiological functions, reproduction, sexual reproduction, temperature, animal physiology, reproduction, aquatic ecology.

1994

Boletzky, S.V. (1994) **Embryonic Development of Cephalopods at Low-Temperatures.** *Antarctic Science* V. 6, N2 (JUN), P. 139-142, ISSN: 0954-1020.
DESCRIPTORS: environmental sciences, multidisciplinary sciences, Cephalopoda, spawning, development, embryos, hatching, coldwater.

Brierley, A.S.; Thorpe, J.P. (1994) **Biochemical-Genetic Evidence Supporting the Taxonomic Separation of Loligo gahi from the genus Loligo.** *Antarctic Science* V. 6, N2 (JUN), P. 143-148, ISSN: 0954-1020.
DESCRIPTORS: environmental sciences, multidisciplinary sciences, Loligo gahi, electrophoresis, genetics, systematics.

Ivanovic, M.L.; Brunetti, N.E. (1994) **Food and Feeding of Illex argentinus.** *Antarctic Science* V. 6 , N2 (JUN), p. 185-193, ISSN: 0954-1020.
DESCRIPTORS: Illex argentinus, food, feeding, crustaceans, fish, cannibalism.

Lee, P.G.; Turk, P.E.; Yang, W.T.; Hanlon, R.T. (1994) **Biological characteristics and biomedical applications of the squid Sepioteuthis lessoniana cultured through multiple generations.** *Biol Bull* 186(3): 328-41, ISSN: 0006-3185.
NAL CALL NUMBER: 442.8 B52

ABSTRACT: Providing squids--especially their giant axons--for biomedical research has now been achieved in 10 mariculture trials extending through multiple generations. The noteworthy biological characteristics of Sepioteuthis lessoniana are (1) this species is behaviorally and morphologically well suited to the laboratory environment; (2) the life cycle is completed in 4-6 months; (3) growth is rapid (12% and 5% wet body weight d-1 for 100 d and for the life span, respectively), with adult size ranging from 0.4-2.2 kg; (4) feeding rates are high (30% wet body weight d-1), and a variety of live crustaceans and fishes are eaten; (5) crowding is tolerated (about 4 squids m-3); (6) the incidence of disease and cannibalism is low; and (7) reproduction in captivity allows culture through three successive generations. Engineering factors contributed to culture success: (1) physical design (i.e., size, shape, and painted pattern) of the culture tanks; (2) patterns of water flow in the culture tanks; (3) water filtration systems; and (4) spawning substrates. Initial production (a few hundred squids per year) suggests that large-scale culture will be able to supply the needs of the biomedical research community. The size (> 400 microns in diameter) and characteristics of the giant axons of Sepioteuthis are appropriate for experimentation, and other studies indicate that the eye, oculomotor/equilibrium system, olfactory system, blood, and ink are equally suitable for research.
DESCRIPTORS: squid growth and development, axons, behavior animal, eating, feeding behavior, light, ovum physiology, reproduction, research, seawater, squid embryology, tissue culture.

Yokawa, K. (1994) **Allozyme Differentiation of 16 Species of Ommastrephid Squid (Mollusca, Cephalopoda).** *Antarctic Science* V 6, N2 (JUN), p. 201-204, ISSN: 0954-1020.
DESCRIPTORS: Squid, Ommastrephidae, allozyme, electrophoresis.

1993

Dimarco, F.P.; Turk, P.E.; Scimeca, J.M. Jr.; Browning, W.J.; Lee, P.G. (1993) **Laboratory survival, growth, and digestive gland histologic features of squids reared on living and non-living fish diets.** *Laboratory Animal Science* 43 (3) 226-231, ISSN: 0023-6764.
NAL CALL NUMBER: 410.9 P94
DESCRIPTORS:animal care, cell biology, development, digestive system, ingestion and assimilation, estuarine ecology, environmental sciences, methods and techniques, nutrition, pathology, physiology, Cephalopoda.

1991

Boyle, P. R. *The UFAW handbook on the care and management of cephalopods in the laboratory.* Potters Bar, Herts. [England] : Universities Federation for Animal Welfare, c1991. 63 p. : ill. ISBN: 0900767723.
NAL CALL NUMBER: SF407.M37B68
DESCRIPTORS: Marine invertebrates as laboratory animals, Cephalopoda.

1990

Gilbert, D. L.; W. J. Adelman; J. M. Arnold. *Squid as experimental animals.* New York : Plenum Press, c1990. xxxi, 516 p. : ill. ISBN: 0306435136.
NAL CALL NUMBER: QL430.2.S66

DESCRIPTORS: Squids as laboratory animals, Nervous system Mollusks, Squids Cytology, Animal welfare.

1989

Arnaya, I.N.; Sano, N.; Iida, K. (1989) **Studies on acoustic target strength of squid, 2: Effect of behaviour on averaged dorsal aspect target strength [of Todarodes pacificus and Ommastrephes bartrami].** *Bulletin of the Faculty of Fisheries Hokkaido University* 40(2): 83-99, ISSN 0018-3458.
NAL CALL NUMBER: 414.9 H682
DESCRIPTORS: squids, acoustic properties, echosounding, strength, todarodes, ommastrephes, behaviour, orientation, laboratory experiments, measurement, Cephalopoda, chemicophysical properties, environmental factors, experiments, foods, measurement, mechanical properties.

DeRusha, R.H.; Forsythe, J.W.; DiMarco, F.P.; Hanlon, R.T. (1989) **Alternative diets for maintaining and rearing cephalopods in captivity.** *Lab Anim Sci* v. 39 (4) p. 306-312.
NAL CALL NUMBER: 410.9 P94
ABSTRACT: The requirement of live marine prey for cephalopod mariculture has restricted its practicality for inland research laboratories, commerical enterprises and home aquarists. We evaluated acceptability and resultant growth on: (a) frozen marine shrimps, (b) live and frozen marine polychaete worms, (c) live and frozen marine crabs, (d) frozen marine fishes, (e) live adult brine shrimp, (f) live freshwater fish and (g) live freshwater crayfish. The diets were presented for periods of 2 to 11 weeks to octopuses, cuttlefishes or squids and in most trials the results were compared to animals fed control diets of live marine shrimps, crabs or fish. Overall, frozen marine shrimp proved to be the best alternative diet tested. Adult Octopus maya on frozen marine shrimp diets grew as well as those on control diets at 2.8% body weight per day (%/d) compared to 2.0 %/d on live freshwater crayfish, 1.4%/d on live marine polychaete worms and 0.8 %/d on live freshwater fish (Tilapia sp.). Juvenile Octopus maya and Octopus bimaculoides also grew comparably to controls when fed frozen marine shrimps; growth rates ranged from near 3.0 %/d at 3 months of age to nearly 2.5 %/d at 6 months of age. Thus, these alternatives are acceptable as the octopuses end their exponential growth phase at an age of 3-5 months. Attempts to rear O. maya hatchlings and juveniles (up to 1 month of age) on dead foods resulted in high mortality and slow or negative growth. No live or dead alternative diet has been found yet that will promote good growth and survival in hatchling octopuses. Hatchling F3 generation Sepia officinalis (the European cuttlefish) were reared for 6 weeks exclusively on adult brine shrimp (Artemia salina). Survival, feeding rate and growth were excellent. This experiment marks the first time that brine shrimp have been readily accepted frozen marine shrimp at 3 months of age, and growth over 2 months was 3.3 %/d versus 3.9 %/d on live shrimp. Gross Growth Efficiency (GGE) was 39% and 43%, respectively. Twenty-five slightly older cuttlefish, group-reared for 69 days on a diet of frozen marine fishes, grew at 2.5 %/d with a mean GGE of 38%. These data compare well to published data from live diets. The bay squid Lolligucula brevis was trained over an 8-day period to accept frozen marine shrimps. Over 41 days, growth was 1.3%/d versus 1.8 %/d on live shrimp. These results provide researchers and others some viable alternative foods for maintaining or rearing cephalopods through a substantial portion of their life cycle.
DESCRIPTORS: Cephalopoda, laboratory rearing, diet, animal feeding, experimental design.

1985

Balch, N.; O'Dor, R.K.; Helm, P. (1985) **Laboratory rearing of rhynchoteuthions of the ommastrephid squid Illex illecebrosus (Mollusca: Cephalopoda).** *Vie et Milieu* 35 (3-4): 243-246, ISSN 0240-8759.
NAL CALL NUMBER: QH91.A1V5
DESCRIPTORS: Cephalopods, animal husbandry methods, viability, diet, environmental control, animals, aquatic animals, aquatic organisms, dietetics, health, invertebrates, isscaap group b 57, isscaap groups of species, methods, nutrition, zootechny.

1980

Matsumoto, G.; J. Shimada. **Further improvement upon maintenance of adult squid (Doryteuthis bleekeri) in a small circular and closed-system aquarium tank.** *Bio Bull.* Woods Hole, Mass., Marine Biological Laboratory. Oct 1980. v. 159 (2) p. 319-324. ill. ISSN: 0006-3185.
NAL CALL NUMBER: 442.8 B52
DESCRIPTORS: Doryteuthis bleekeri, adult squid, maintenance, aquarium tanks- small circular and closed-system, susceptibility hazards, filtering, zeolite, feeding, short and long-term culture, housing, food sources.

1977

Van Heukelem, W. F. **Laboratory maintenance, breeding, rearing, and biomedical research potential of the Yucatan octopus (Octopus maya).** *Lab Anim Sci*, Oct 1977, 27 (5, pt. 2): 852-859. Ref.
NAL CALL NUMBER: 410.9 P94
DESCRIPTORS: Yucatan octopus, Octopus maya, laboratory maintenance, breeding, rearing, animal model, neurobiology, behavior, endocrinology, immunology, aging, reproduction, animal husbandry.

1973

LaRoe, E.T. (1973) **Laboratory culture of squid.** *Fed Proc* 32(12): 2212-4, ISSN: 0014-9446.
NAL CALL NUMBER: 442.9 F31P
DESCRIPTORS: animals laboratory growth and development, squid growth and development, behavior animal, environment controlled, feeding behavior, lighting, ultraviolet rays.

Gastropods

2002

Montgomery, M.; Messner, M.C.; Kirk, M.D. (2002) **Arterial cells and CNS sheath cells from Aplysia californica produce factors that enhance neurite outgrowth in co-cultured neurons.** *Invertebrate Neuroscience* 4 (3): 141-155, ISSN: 1354-2516.
DESCRIPTORS: nervous system, neural coordination, Aplysia californica (Gastropoda), amoebocyte, nervous system, aorta, circulatory system, central nervous system sheath cells, nervous system, fibrocyte, nervous system, hemolymph, blood and lymphatics, myocyte,

nervous system, neuron, nervous system, growth, neural plasticity, neurite outgrowth, synapse formation.

2001

Hickman, C.S. (2001) **Evolution and development of gastropod larval shell morphology: experimental evidence for mechanical defense and repair.** *Evol Dev* 3(1): 18-23, ISSN: 1520-541X.
ABSTRACT: The structural diversity of gastropod veliger larvae offers an instructive counterpoint to the view of larval forms as conservative archetypes. Larval structure, function, and development are fine-tuned for survival in the plankton. Accordingly, the study of larval adaptation provides an important perspective for evolutionary-developmental biology as an integrated science. Patterns of breakage and repair in the field, as well as patterns of breakage in arranged encounters with zooplankton under laboratory conditions, are two powerful sources of data on the adaptive significance of morphological and microsculptural features of the gastropod larval shell. Shells of the planktonic veliger larvae of the caenogastropod Nassarius paupertus [GOULD] preserve multiple repaired breaks, attributed to unsuccessful zooplankton predators. In culture, larvae isolated from concentrated zooplankton samples rapidly repaired broken apertural margins and restored the "ideal" apertural form, in which an elaborate projection or "beak" covers the head of the swimming veliger. When individuals with repaired apertures were reintroduced to a concentrated mixture of potential zooplankton predators, the repaired margins were rapidly chipped and broken back. The projecting beak of the larval shell is the first line of mechanical defense, covering the larval head and mouth and potentially the most vulnerable part of the shell to breakage. Patterns of mechanical failure show that spiral ridges do reinforce the beak and retard breakage. The capacity for rapid shell repair and regeneration, and the evolution of features that resist or retard mechanical damage, may play a more prominent role than previously thought in enhancing the ability of larvae to survive in the plankton.
DESCRIPTORS: evolution, larva growth and development, snails' growth and development, wound healing/repair, biomechanics, food chain, marine biology, predatory behavior, snails anatomy and histology, growth and development, anatomy and histology, developmental biology.

Inoue, T.; Watanabe, S.; Kirino, Y. (2001) **Serotonin and NO complementarily regulate generation of oscillatory activity in the olfactory CNS of a terrestrial mollusk.** *J Neurophysiol* 85(6): 2634-8, ISSN: 0022-3077.
ABSTRACT: Synchronous oscillation of membrane potentials, generated by assemblies of neurons, is a prominent feature in the olfactory systems of many vertebrate and invertebrate species. However, its generation mechanism is still controversial. Biogenic amines play important roles for mammalian olfactory learning and are also implicated in molluscan olfactory learning. Here, we investigated the role of serotonin, a biogenic amine, in the oscillatory dynamics in the procerebrum (PC), the molluscan olfactory center. Serotonin receptor blockers inhibited the spontaneous synchronous oscillatory activity of low frequency (approximately 0.5 Hz) in the PC. This was due to diminishing the periodic slow oscillation of membrane potential in bursting (B) neurons, which are essential neuronal elements for the synchronous oscillation in the PC. On the other hand, serotonin enhanced the amplitude of the slow oscillation in B neurons and subsequently increased the number of spikes in each oscillatory cycle. These results show that the extracellular serotonin level regulates the oscillation amplitude in B neurons and thus serotonin may be called an oscillation generator in the PC. Although nitric oxide (NO) is known to also be a crucial factor for generating the PC oscillatory activity and setting the PC oscillation

frequency, the present study showed that NO only regulates the oscillation frequency in B neurons but could not increase the spikes in each oscillatory cycle. These results suggest complementary regulation of the PC oscillatory activity: NO determines the probability of occurrence of slow potentials in B neurons, whereas serotonin regulates the amplitude in each cycle of the oscillatory activity in B neurons.
DESCRIPTORS: nitric oxide metabolism, olfactory receptor neurons metabolism, periodicity, serotonin metabolism, action potentials drug effects, action potentials physiology, cinanserin pharmacology, electrophysiology, invertebrate cytology, ganglia, invertebrate physiology, Mollusca, serotonin antagonists pharmacology, tropanes pharmacology, serotonin antagonists, tropanes, nitric oxide, cinanserin, bemesetron, serotonin, physiology, neurosciences.

Murphy, A.D. (2001) **The neuronal basis of feeding in the snail, Helisoma, with comparisons to selected gastropods.** *Prog Neurobiol* 63(4): 383-408.
ABSTRACT: Research on identified neurons during the last quarter century was forecast at a conference in 1973 that discussed "neuronal mechanisms of coordination in simple systems." The focus of the conference was on the neuronal control of simple stereotyped behavioral acts. Participants discussing the future of such research called for a comparative approach; emphasis on structure-function interactions; attention to environmental and behavioral context; and the development of new techniques. Significantly, in some cases amazing progress has been made in these areas. Major conclusions of the last quarter century are that so-called simple behaviors and the neural circuitry underlying them tend to be less simple, more flexible, and more highly modulated than originally imagined. However, the comparative approach has, as yet, failed to reach its potential. Molluscan preparations, along with arthropods and annelids, have always been at the forefront of neuroethological studies. Circuitry underlying feeding has been studied in a handful of species of gastropod molluscs. These studies have contributed substantially to our understanding of sensorimotor organization, the hierarchical control of behavior and coordination of multiple behaviors, and the organization and modulation of central pattern generators. However, direct interspecific comparisons of feeding circuitry and potentially homologous neurons have been lacking. This is unfortunate because much of the vast radiation of the class Gastropoda is associated with variations in feeding behaviors and feeding apparatuses, providing ample substrates for comparative studies including the evolution of defined circuitry. Here, the neural organization of feeding in the snail, Helisoma, is examined critically. Possible direct interspecific comparisons of neural circuitry and potentially homologous neurons are made. A universal model for central pattern generators underlying rasping feeding is proposed. Future comparative studies can be expected to combine behavioral, morphological, electrophysiological, molecular and genetic techniques to identify neurons and define neural circuitry. Digital resources will undoubtedly be exploited to organize and interface databases allowing illumination of the evolution of homologous identified neurons and defined neural circuitry in the context of behavioral change.
DESCRIPTORS: central nervous system cytology, feeding behavior physiology, interneurons cytology, motor neurons cytology, snails cytology, action potentials physiology, central nervous system physiology, ganglia, invertebrate cytology, ganglia, invertebrate physiology, interneurons physiology, motor neurons physiology, nerve net cytology, nerve net physiology, snails physiology.

Schofield, J.C.; Grindley, R.M.; Keogh, J.A. (2001) **The use of diagnostic radiology to detect shell irregularities in the New Zealand paua (abalone) Haliotis iris.** *Laboratory Animals* 35 (2): 167-171, ISSN: 0023-6772.
NAL CALL NUMBER: QL55.A1L3

DESCRIPTORS: animal care, aquaculture, marine ecology (ecology, environmental sciences), radiology (medical sciences), Gastropoda, Mollusca, Invertebrata, Animalia, Haliotis iris, [abalone, paua], animals, Invertebrates, Mollusks, New Zealand (Australasian region), shell lesions, integumentary system disease, diagnostic radiology, detection method, diagnostic method, imaging method, non-destructive, non-invasive, radiologic method, video display unit equipment, aquaculture, fisheries, laboratory animal science, laboratory animal welfare.

2000

Aquilina, B.; R. Roberts. **A method for inducing muscle relaxation in the abalone, Haliotis iris.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. Nov 1, 2000. v. 190 (3/4) p. 403-408. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
DESCRIPTORS: muscles, Haliotis, techniques, Mollusc culture, stress, mortality, dosage, benzocaine, muscle contraction, water temperature, air, survival.

Chang, D.J.; Li, X.C.; Lee, Y.S.; Kim, H.K.; Kim, U.S.; Cho, N.J.; Lo, X.; Weiss, K.R.; Kandel, E.R.; Kaang, B.K. (2000) **Activation of a heterologously expressed octopamine receptor coupled only to adenylyl cyclase produces all the features of presynaptic facilitation in aplysia sensory neurons.** *Proc Natl Acad Sci USA* 97(4): 1829-34, ISSN: 0027-8424.
NAL CALL NUMBER: 500 N21P
ABSTRACT: Short-term behavioral sensitization of the gill-withdrawal reflex after tail stimuli in Aplysia leads to an enhancement of the connections between sensory and motor neurons of this reflex. Both behavioral sensitization and enhancement of the connection between sensory and motor neurons are importantly mediated by serotonin. Serotonin activates two types of receptors in the sensory neurons, one of which is coupled to the cAMP/protein kinase A (PKA) pathway and the other to the inositol triphosphate/protein kinase C (PKC) pathway. Here we describe a genetic approach to assessing the isolated contribution of the PKA pathway to short-term facilitation. We have cloned from Aplysia an octopamine receptor gene, Ap oa(1), that couples selectively to the cAMP/PKA pathway. We have ectopically expressed this receptor in Aplysia sensory neurons of the pleural ganglia, where it is not normally expressed. Activation of this receptor by octopamine stimulates all four presynaptic events involved in short-term synaptic facilitation that are normally produced by serotonin: (i) membrane depolarization; (ii) increased membrane excitability; (iii) increased spike duration; and (iv) presynaptic facilitation. These results indicate that the cAMP/PKA pathway alone is sufficient to produce all the features of presynaptic facilitation.
DESCRIPTORS: adenylate cyclase metabolism, Aplysia metabolism, neurons, afferent metabolism, receptors, biogenic amine genetics, synaptic transmission drug effects, action potentials drug effects, amino acid sequence, cell line, cell membrane metabolism, cloning, molecular, cyclic AMP metabolism, gene expression, molecular sequence data, octopamine pharmacology, oocytes, patch clamp techniques, psychomotor performance, receptors, biogenic amine chemistry, sequence homology, amino acid, serotonin pharmacology, transfection, Xenopus, drug effects, metabolism, pharmacology, chemistry, genetics, receptors, biogenic amine, norsynephrine receptor, octopamine, serotonin, cyclic-AMP, adenylate cyclase.

Chitwood, R.A.; Li, Q.; Glanzman, D.L. (2000) **Serotonin enhances the glutamate response in isolated Aplysia motor neurons in culture.** *Society for Neuroscience Abstracts* 26 (1-2): Abstract No.-568.19, ISSN: 0190-5295.
NAL CALL NUMBER: QP351.S56716

DESCRIPTORS: nervous system (neural coordination), Gastropoda, motor neuron, cultured, nervous system, sensory neuron, nervous system, BAPTA, calcium, glutamate, serotonin, 5-HT, 5-hydroxytryptamine, hht, bathing medium, equipment, glutamate stimulated potential, learning, postsynaptic AMPA type response.

Gandhi, C.C.; Matzel, L.D. (2000) **Modulation of presynaptic action potential kinetics underlies synaptic facilitation of type B photoreceptors after associative conditioning in Hermissenda.** *J Neurosci* 20(5): 2022-35, ISSN: 1529-2401.
ABSTRACT: Descriptions of conditioned response generation in Hermissenda stipulate that the synaptic interaction between type B and A photoreceptors should be enhanced after associative pairings of light and rotation. Although evidence from several laboratories has confirmed this assumption, the mechanism underlying this synaptic facilitation has not been elucidated. Here we report that in vitro conditioning (i.e., light paired with stimulation of vestibular hair cells) modifies the kinetics of presynaptic action potentials in the B photoreceptor in a manner sufficient to account for this synaptic facilitation. After paired training, we observed an increase in the duration of evoked action potentials and a decrease in the amplitude of the spike afterhyperpolarization in the B-cell. As previously reported, paired training also enhanced the excitability (i.e., input resistance and evoked spike rate) of the B photoreceptor. In a second experiment, simultaneous recordings were made in type B and A photoreceptors, and paired training was found to produce an increase in the amplitude of the IPSP in the A photoreceptor in response to an evoked spike in the B-cell. Importantly, there was no change in the initial slope of the postsynaptic IPSP in the A photoreceptor, suggesting that spike duration-independent mechanisms of neurotransmitter exocytosis or postsynaptic receptor sensitivity did not contribute to the observed synaptic facilitation. Perfusion of 4-aminopyridine (4-AP) mimicked a known effect of behavioral conditioning in that it specifically reduced the amplitude of the transient voltage-dependent K(+) current (I(A)) in the B-cell, but in addition, produced action potential broadening and synaptic facilitation that was analogous to that observed after in vitro conditioning. Finally, the effect of 4-AP on B-cell action potentials and on the postsynaptic IPSP in the A-cell was occluded by previous paired (but not unpaired) training, suggesting that the prolongation of the B-cell action potential by a reduction of I(A) was sufficient to account for the observed synaptic facilitation. The occlusion of the effects of 4-AP by paired training was not attributable to a saturation of the capacity of the B-cell for transmitter exocytosis, because it was observed that tetraethylammonium (TEA)-induced inhibition of the delayed voltage-dependent K(+) current induced both spike broadening and synaptic facilitation regardless of training history. Collectively, these results demonstrate that training-induced facilitation at B-cell synapses is attributable to the effects of a reduction of a presynaptic K(+) conductance on action potential kinetics and suggest another critical similarity between the cellular basis for learning in Hermissenda and other invertebrate systems.
DESCRIPTORS: action potentials physiology, association learning physiology, photoreceptors, invertebrate physiology, presynaptic terminals physiology, 4-aminopyridine pharmacology, action potentials drug effects, conditioning psychology physiology, dose response relationship, drug, exocytosis physiology, kinetics, Mollusca, neural inhibition physiology, patch clamp techniques, photic stimulation, photoreceptors, invertebrate chemistry, potassium channels physiology, presynaptic terminals chemistry, synaptic transmission drug effects, synaptic transmission physiology, pharmacology, drug effects, physiology, chemistry, potassium channels, 4-Aminopyridine.

Green, B.J.; Li, W.Y.; Manhart, J.R.; Fox, T.C.; Summer, E.J.; Kennedy, R.A.; Pierce, S.K.; Rumpho, M.E. (2000) **Mollusc-algal chloroplast endosymbiosis. Photosynthesis, thylakoid**

protein maintenance, and chloroplast gene expression continue for many months in the absence of the algal nucleus. *Plant Physiology* 124 (1): 331-342, ISSN: 0032-0889.
NAL CALL NUMBER: 450 P692
DESCRIPTORS: bioenergetics (biochemistry and molecular biophysics), molecular genetics (biochemistry and molecular biophysics), marine ecology, infection, Chrysophyta, Algae, Plantae, Gastropoda, Elysia chlorotica, marine species, Vaucheria litorea, microorganisms, nonvascular plants, algal nucleus, absence effect, chloroplast, Vaucheria chloroplast gene, expression, animal nuclear genome, animal algal symbiosis, Mollusc algal chloroplast endosymbiosis, photosynthesis.

Kirby, R.R. (2000) **An ancient transpecific polymorphism shows extreme divergence in a multitrait cline in an intertidal snail (Nucella lapillus (L.)).** *Mol Biol Evol* 17(12): 1816-25, ISSN: 0737-4038.
NAL CALL NUMBER: QH506.M642
ABSTRACT: Clines in intraspecific genetic variation are frequently associated with an environmental transition. Here, divergence among nucleotide sequences of two nuclear loci, cytosolic and mitochondrial malate dehydrogenase (cMDH and mMDH, respectively), is described, in a multitrait cline over a distance of ca. 3 km where shell phenotype, allozyme, mitochondrial DNA haplotype, and centric fusion (Robertsonian translocations) frequencies covary with temperature and humidity and change abruptly in a continuous population of the dog-whelk (Nucella lapillus), a common intertidal snail of the north temperate Atlantic. Protein electrophoresis has already shown two alleles of mMDH varying from fixation of one allele to near fixation of the other, whereas cMDH appears to be monomorphic. The results of this study show a striking disparity in nucleotide sequence divergence among alleles at the two loci, with extreme molecular differentiation in one of them. Four alleles of cMDH were found to have nucleotide and amino acid sequence divergences of 0.4% and 0.3%, respectively. In contrast, the two mMDH cDNA alleles differed by 23% and 20% at the nucleotide and amino acid levels, respectively. Analysis of a 91-bp partial nucleotide sequence of mMDH from Nucella freycineti, the closest relative of N. lapillus, revealed two similar alleles and indicated that the divergence in mMDH in N. lapillus represents an ancient transpecific polymorphism in these Nucella. Together with earlier studies on variation in N. lapillus, it is argued that the polymorphism in mMDH and the clines in N. lapillus represent the presence of two persistent coadapted gene complexes, multitrait coevolving genetic solutions to environmental variation, which may presently enable this snail to exploit a diverse environment successfully.
DESCRIPTORS: environment, evolution molecular, malate dehydrogenase genetics, polymorphism genetics, snails genetics, alleles, amino acid sequence, cell nucleus genetics, DNA, mitochondrial genetics, molecular sequence data, phylogeny, seawater, sequence homology, snails enzymology, variation genetics.

Lee, Y.S.; Lee, J.A.; Jung, J.; Oh, U.; Kaang, B.K. (2000) **The cAMP-dependent kinase pathway does not sensitize the cloned vanilloid receptor type 1 expressed in xenopus oocytes or Aplysia neurons.** *Neurosci Lett* 288(1): 57-60, ISSN: 0304-3940.
NAL CALL NUMBER: QP351.N3
ABSTRACT: Capsaicin-activated channels present in sensory neurons are ligand-gated cation channels that largely account for mediating some types of pain. The cAMP-dependent protein kinase (PKA) signal pathway was suggested to mediate the prostaglandin-induced enhancement of capsaicin-evoked inward current (I(CAP)) in rat sensory neurons. It is not clear, however, whether PKA acts directly on the capsaicin-sensitive channel that is responsible for I(CAP). To address this issue, we overexpressed the cloned capsaicin receptor, VR1, in heterologous expression systems such as Xenopus oocytes or Aplysia R2 neuron and stimulated PKA

pathways. As a result, activation of PKA by applying either 8-bromo-cAMP or forskolin with 3-isobutyl-1-methylxanthine or through activation of beta(2) adrenergic receptors failed to enhance I(CAP) in oocytes or R2 neurons expressing VR1. Our results raise two possibilities. (1) Direct phosphorylation of VR1 by PKA may not be responsible for the sensitization; instead, phosphorylation of regulatory proteins associated with VR1 would account for the sensitization of I(CAP) evoked by prostaglandin E(2) in dorsal root ganglion (DRG) neurons. (2) DRG neurons may have a different PKA signaling mechanism that is not replicable in Xenopus oocytes or Aplysia R2 neurons.
DESCRIPTORS: cyclic AMP dependent protein kinases metabolism, neurons enzymology, receptors, drug genetics, signal transduction physiology, 1-methyl-3-isobutylxanthine pharmacology, 8-bromo cyclic adenosine monophosphate pharmacology, Aplysia, capsaicin pharmacology, cloning, molecular, forskolin pharmacology, gene expression physiology, membrane potentials drug effects, membrane potentials physiology, neurons chemistry, oocytes cytology, patch clamp techniques, phosphodiesterase inhibitors pharmacology, receptors, adrenergic, beta 2 physiology, signal transduction drug effects, transfection, Xenopus.

Oehlmann, J.; Schulte-Oehlmann, U.; Tillmann, M.; Markert, B. (2000) **Effects of endocrine disruptors on prosobranch snails (Mollusca: Gastropoda) in the laboratory. Part I: Bisphenol A and octylphenol as xeno-estrogens.** *Ecotoxicology* 9(6): 383-97, ISSN: 0963-9292.
NAL CALL NUMBER: RA565.A1E27
ABSTRACT: The effects of suspected endocrine disrupting chemicals on freshwater and marine prosobranch species were analysed in laboratory experiments. In this first publication, the responses of the freshwater snail Marisa cornuarietis and of the marine prosobranch Nucella lapillus to the xeno-estrogenic model compounds bisphenol A (BPA) and octylphenol (OP) are presented at nominal concentration ranges between 1 and 100 micrograms/L. Marisa was exposed during 5 months using adult specimens and in a complete life-cycle test for 12 months. In both experiments, the xeno-estrogens induced a complex syndrome of alterations in female Marisa referred to as "superfemales" at the lowest concentrations. Affected specimens were characterised by the formation of additional female organs, an enlargement of the accessory pallial sex glands, gross malformations of the pallial oviduct section resulting in an increased female mortality, and a massive stimulation of oocyte and spawning mass production. The effects of BPA and OP were comparable at the same nominal concentrations. An exposure to OP resulted in inverted U-type concentration response relationships for egg and spawning mass production. Adult Nucella from the field were tested for three months in the laboratory. As in Marisa, superfemales with enlarged accessory pallial sex glands and an enhancement of oocyte production were observed. No oviduct malformations were found probably due to species differences in the gross anatomical structure of the pallial oviduct. A lower percentage of exposed specimens had ripe sperm stored in their vesicula seminalis and additionally male Nucella exhibited a reduced length of penis and prostate gland when compared to the control. Because statistically significant effects were observed at the lowest nominal test concentrations (1 microgram BPA or OP/L), it can be assumed that even lower concentrations may have a negative impact on the snails. The results show that prosobranchs are sensitive to endocrine disruption at environmentally relevant concentrations and that especially M. cornuarietis is a promising candidate for a future organismic invertebrate model to identify endocrine-mimetic test compounds.
DESCRIPTORS: estrogens, non steroidal pharmacology, phenols pharmacology, snails drug effects, water pollutants, chemical pharmacology, fresh water, seawater.

Rogers, C. N.; R. De Nys; T. S. Charlton; P. D. Steinberg. **Dynamics of algal secondary metabolites in two species of sea hare.** *J Chem Ecol.* New York, N.Y. : Plenum Publishing Corporation. Mar 2000. v. 26 (3) p. 721-744. ISSN: 0098-0331.
NAL CALL NUMBER: QD415.A1J6
ABSTRACT: The function of acquired algal secondary metabolites in sea hares is the subject of debate, in part because the dynamics/processing of metabolites by sea hares is poorly understood. This study investigates the dynamics of red algal secondary metabolites in two sea hares, Aplysia parvula and Aplysia dactylomela. Secondary metabolite levels were quantified for the dietary red algae Laurencia obtusa and Delisea pulchra and for sea hares collected from these seaweeds in the field. The patterns and dynamics of algal secondary metabolites were further investigated in the laboratory by quantitative analysis of secondary metabolites in sea hares grown on diets of L. obtusa, D. pulchra, or the green alga Ulva sp. Sea hares accumulated the most abundant metabolites from each red alga, the terpene palisadin A from L. obtusa, and the halogenated furanone 3 from D. pulchra, and stored a greater proportion of these metabolites than other algal metabolites. A. parvula accumulated D. pulchra metabolites at much higher levels than L. obtusa metabolites. A. dactylomela accumulated similar concentrations of L. obtusa metabolites to A. parvula. The loss of L. obtusa metabolites by A. dactylomela matched that expected for dilution of metabolites via growth of the sea hares. However, the loss of L. obtusa metabolites by A. parvula was faster than predicted for growth alone, suggesting that metabolites were actively metabolized or excreted. Data for the loss of D. pulchra metabolites by A. parvula was equivocal. The secretions of A. parvula fed D. pulchra or L. obtusa were analyzed for the presence of algal secondary metabolites to investigate one possible path of excretion. L. obtusa secondary metabolites were detected in the mucous and opaline secretions of A. parvula, but D. pulchra metabolites were not detected in any secretions. The deployment of L. obtusa secondary metabolites in secretions by A. parvula may explain the more rapid rate of loss of these compounds and is consistent with a possible defensive role for acquired metabolites.
DESCRIPTORS: algae, secondary metabolites, defense mechanisms, excretion.

Schulte-Oehlmann, U.; Tillmann, M.; Markert, B.; Oehlmann, J.; Watermann, B.; Scherf, S. (2000) **Effects of endocrine disruptors on prosobranch snails (Mollusca: Gastropoda) in the laboratory. Part II: Triphenyltin as a xeno-androgen.** *Ecotoxicology* 9(6): 399-412, ISSN: 0963-9292.
NAL CALL NUMBER: RA565.A1E27
ABSTRACT: In laboratory experiments the effects of suspected endocrine disrupting chemicals on freshwater and marine prosobranch species were analysed. In this second of three publications the responses of the freshwater ramshorn snail Marisa cornuarietis and of two marine prosobranchs (the dogwhelk Nucella lapillus and the netted whelk Hinia reticulata) to the xeno-androgenic model compound triphenyltin (TPT) are presented. Marisa and Nucella were exposed via water (nominal concentrations 5-500 ng TPT-Sn/L) and Hinia via sediments (nominal concentrations 50-500 micrograms TPT-Sn/kg dry wt.) for up to 4 months. Female ramshorn snails but not the two marine species developed imposex in a time and concentration dependent manner (EC10 4 months: 12.3 ng TPT-Sn/L) with a comparable intensity as described for tributyltin. TPT reduced furthermore the fecundity of Marisa at lower concentrations (EC10 4 months: 5.59 ng TPT-Sn/L) with a complete inhibition of spawning at nominal concentrations > or = 250 ng TPT-Sn/L (mean measured +/- SD: > or = 163 +/- 97.0 ng TPT-Sn/L). The extension of the pallial sex organs (penis with accessory structures and prostate gland) of male ramshorn snails and dogwhelks were reduced by up to 25% compared to the control but not in netted whelks. Histopathological analyses for M. cornuarietis and H. reticulata provide evidence for a marked impairment of spermatogenesis (both species) and oogenesis (only netted whelks).

The test compound induced a highly significant and concentration independent increase in the incidence of hyperplasia on gills, osphradia and other organs in the mantle cavity of N. lapillus indicating a carcinogenic potential of TPT. The results show that prosobranchs are sensitive to endocrine disruption at environmentally relevant concentrations of TPT. Also, M. cornuarietis is a promising candidate for a future organismic invertebrate system to identify endocrine-mimetic test compounds.
DESCRIPTORS: androgens pharmacology, organotin compounds pharmacology, pesticides pharmacology, snails drug effects, water pollutants, chemical pharmacology, fresh water, seawater.

Tomsic, D.; Alkon, D.L. (2000) **Background illumination effects upon in vitro conditioning in Hermissenda.** *Neurobiol Learn Mem* 74(1): 56-64, ISSN: 1074-7427.
NAL CALL NUMBER: QH301.C63
ABSTRACT: In the marine snail Hermissenda, associative learning can be accomplished by paired presentations of light and vestibular stimulation. It is generally assumed that associative learning depends upon the intensity or salience of the conditioned or unconditioned stimulus (CS and US, respectively). Accordingly, during Hermissenda conditioning a stronger dark adaptation is expected to render the CS (the light) more salient and hence facilitate association. We studied the influence of background illumination level using an in vitro pairing procedure in Hermissenda. This procedure allows one to assess the effect of conditioning upon a single cell, the B photoreceptor, which is implicated in this learning process. After 15 min of adaptation to a dim background light, B photoreceptors maintained a basal rate of firing, while after adaptation to complete darkness, they stopped firing. Paired and unpaired groups received 10 training trials in either a completely dark or a dim light environment. Although a trial to trial cumulative increase in excitability was found in the paired group trained in darkness, only the paired group trained under dim background light showed a higher input resistance and cell excitability 10 min after training. These results suggest that the background dim illumination was not needed for the induction but played a role in the maintenance of the pairing effect. Possible mechanisms for such a modulatory effect are discussed.
DESCRIPTORS: association learning, conditioning, classical physiology, light, adaptation, physiological physiology, photoreceptors physiology, snails, vestibule physiology.

1999

Adriaens, E.; Remon, J.P. (1999) **Gastropods as an evaluation tool for screening the irritating potency of absorption enhancers and drugs.** *Pharm Res* 16(8): 1240-4, ISSN: 0724-8741.
ABSTRACT: PURPOSE: The objective of this study was to develop a simple alternative test using naked snails (slugs) for screening the irritating potency of chemicals on mucosal surfaces. METHODS: The effect of various absorption enhancers and two beta-blocking agents on the mucosal tissue was determined from the total protein and lactate dehydrogenase released from the foot mucosa after treatment. Additionally, mucus production and reduction in body weight of the slugs caused by the treatment were measured. RESULTS: According to the effects on the mucosal epithelium of the slugs the following rank order of increasing toxicity was established: PBS, HP-beta-CD (5%), beta-CD (1.8%) and oxprenolol hydrochloride (1%) < DDPC (1%) < STDHF (1%) < BAC (1%), SDC (1%) and propranolol hydrochloride (1%). The results of the present study are in agreement with other studies using the same compounds on other models. CONCLUSIONS: The results of this study indicated the mucosa of slugs can serve as a primary screening tool for the evaluation of chemicals on mucosal surfaces. By simply measuring mucus

production and weight loss reliable toxicity information can be obtained. This demonstrates rapid screening tests can be carried out using simple toxicity endpoints.
DESCRIPTORS: adrenergic beta antagonists toxicity, drug evaluation, preclinical methods, irritants toxicity, mucous membrane drug effects, absorption drug effects, adrenergic beta antagonists pharmacology, lactate dehydrogenase metabolism, mucous membrane metabolism, mucus metabolism, oxprenolol pharmacology, oxprenolol toxicity, propranolol pharmacology, propranolol toxicity, proteins metabolism, snails.

Albrecht, E.A.; Carreno, N.B.; Castro-Vazquez, A. (1999) **A quantitative study of environmental factors influencing the seasonal onset of reproductive behaviour in the South American apple-snail Pomacea canaliculata (Gastropoda: Ampullariidae).** *Journal of Molluscan Studies* v. 65(2) p. 241-250.
DESCRIPTORS: Pomacea canaliculata, water temperature, temperature, photoperiodicity, copulation, oviposition, reproduction, biology, environmental factors, feeding, fertilization, Gastropoda, periodicity, physiological functions, reproduction, sexual reproduction, temperature.

Leung, K.M.; Furness, R.W. (1999) **Induction of metallothionein in dogwhelk Nucella lapillus during and after exposure to cadmium.** *Ecotoxicol Environ Saf* 43(2): 156-64, ISSN: 0147-6513.
NAL CALL NUMBER: QH545.A1E29
ABSTRACT: Induction of metallothionein (MT) was investigated in a common biomonitor, the dogwhelk Nucella lapillus (shell length: 27.7+/-1.4 mm; wet tissue weight: 667+/-196 mg), during and after exposure to cadmium (Cd) under controlled laboratory conditions (10+/-1 degrees C and 34+/-1 per thousand salinity). The dogwhelks were exposed to 500 microg Cd l-1 (2.2% of 96 h LC50) for 60 days and then placed into clean seawater for 110 days. MT concentration in whole animal increased during the exposure period, peaked at Day 70, and then declined gradually. Half-life of MT was ca. 40 days. MT concentration increased very significantly with increasing Cd concentration ($r=0.74$, $n=24$, $P<0.001$). Nevertheless, Cd concentration increased throughout the period of exposure and while in clean seawater, leveling off only after Day 120, indicating that Cd concentration could not be regulated by N. lapillus. Throughout the study, MT and Cd concentrations in gills, Leiblein gland, kidney, digestive gland, and gonad tissues increased gradually. Highest concentrations of MT and Cd were found in the Leiblein gland. Measurement of MT induction in the Leiblein gland of N. lapillus may therefore prove useful as a sublethal biological response to Cd contamination.
DESCRIPTORS: cadmium toxicity, metallothionein biosynthesis, snails drug effects, copper metabolism, iron metabolism, lethal dose 50, snails metabolism, tissue distribution, zinc metabolism.

Lin, M. C.; C. M. Liao. **65Zn(II) accumulation in the soft tissue and shell of abalone Haliotis diversicolor supertexta via the alga Gracilaria tenuistipitata var. liui and the ambient water.** *Aquaculture.* Amsterdam, Elsevier. July 15, 1999. v. 178 (1/2) p. 89-101. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: This investigation analyzed the Zn-bioaccumulation kinetics in the abalone Haliotis diversicolor supertexta and in the red alga Gracilaria tenuistipitata var. liui for assessing bioconcentration and biomagnification in an aquacultural system. Laboratory exposure experiments estimated uptake and depuration rate constants (i.e., k(1) and k(2), respectively) of H. diversicolor supertexta via nondietary and dietary processes. Bioconcentration factor (BCF) and biomagnification factor (BMF) of H. diversicolor supertexta as well as BCF of G. tenuistipitata var. liui were determined. A simple first-order one-compartment model fitted the

uptake and depuration characteristics of Zn-bioaccumulation and successfully determined k(1) and k(2). The resulting values of k(1) and k(2) of H. diversicolor supertexta were 101.4 ml g(-1) d(-1) and 0.611 d(-1), respectively, when the abalone were exposed to 1 microgram ml(-1) Zn seawater without the presence of G. tenuistipitata var. liui. When the abalone were fed with the algae, k(1) and k(2) values were estimated to be 114.5 g g(-1) d(-1) and 0.636 d(-1), respectively. BCF values for the alga and abalone were determined to be 170 and 180, respectively; and the BMF value was 1.06 for the abalone. Both field and laboratory data show that BMF values for Zn were about 1. Further more, the abalone in the tank without algae absorbed the same quantity of Zn as the abalone in the tank with alga. From these two findings we conclude that Zn in the abalone comes from the ambient water and not from the algae.
DESCRIPTORS: Haliotis, Rhodophyta, zinc, cations, water pollution, water quality, Mollusc culture, tanks.

Minchin, A.; Davies, I.M. (1999) **Effect of freezing on the length of the penis in Nucella lapillus (L.).** *J Environ Monit* 1(2): 203-5, ISSN: 1464-0325.
ABSTRACT: When quantifying imposex in Nucella lapillus, two indices are used: the Vas Deferens Sequence Index (VDSI) and the Relative Penis Size Index (RPSI). Freezing and thawing increase the length of the penis in both male and female Nucella lapillus. In the population studied, this had no significant effect on the RPSI, but was potentially an important source of additional variance in the estimation of the mean penis length.
DESCRIPTORS: hermaphroditism veterinary, penis anatomy and histology, snails anatomy and histology, biometry, cryopreservation, hermaphroditism etiology, reproducibility of results, specimen handling, animal, male.

Santini, G.; De-Pirro, M.; Chelazzi, G. (1999) **In situ and laboratory assessment of heart rate in a Mediterranean limpet using a noninvasive technique.** *Physiol Biochem Zool* 72(2): 198-204, ISSN: 1522-2152.
NAL CALL NUMBER: QL1.P52
ABSTRACT: Heart rate of the Mediterranean limpet Patella caerulea L. was investigated on the natural shore and in the laboratory by using a technique based on infrared phototransducers. Field recording occurred in the Gulf of Trieste (northern Adriatic) during March and June 1997. A consistent dependence of heart rate on temperature was observed in limpets both when submerged and when exposed to air in the two periods, but thermal acclimation was evident. During spontaneous activity at high tide, heart rate increased 1.5-1.7 times the values observed during resting in water at corresponding temperatures. The dependence of heart rate on temperature (10 degrees, 16 degrees, and 22 degrees C) and size (wet weight <1.25 and >1.30 g) in submerged limpets from different populations (northern Adriatic and Tyrrhenian) was tested in the laboratory by adopting a factorial design. The results showed a marked effect of temperature, body weight, and their interaction, independent from the site of origin. Smaller limpets showed a linear increase of heart rate in the whole range of temperature tests, while in the larger ones the increase between 10 degrees and 16 degrees C was greater than between 16 degrees and 22 degrees C. Heart rate decreased with increasing body size at control (16 degrees C) and high (22 degrees C) temperature, while at lower temperature (10 degrees C) no effect of body size was evident. When removed from their home scar, limpets increased heart rate to about 1.5 times the reference value. Finally, correlation of oxygen consumption with heart rate of submerged limpets maintained at a different temperature (10 degrees -22 degrees C) was statistically significant.
DESCRIPTORS: heart rate, Mollusca physiology, spectrophotometry, infrared veterinary, body weight, energy metabolism, environment, temperature.

Shpigel, M.; Ragg, N.L.; Lupatsch, I.; Neori, A. (1999) **Protein content determines the nutritional value of the seaweed Ulva lactuca L for the abalone Haliotis tuberculata L. and H. discus hannai Ino.** *Journal of Shellfish Research* vol. 18 (1): p.227-233, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: aquaculture, nutritive value, seaweeds, ammonia, crude protein, cultures, diet, diets, dry matter, enrichment, feed intake, feed, conversion efficiency, feeding, growth, intake, protein content, ratios, Ulva, abalones, Haliotis, algae, Haliotidae, Gastropoda, animals, plants, aquatic plants, aquatic organisms, feed composition and quality, animal nutrition, production responses.

Toledo, R.; Munoz-Antoli, C.; Perez, M.; Esteban, J.G. (1999) **Miracidial infectivity of Hypoderaeum conoideum (Trematoda: Echinostomatidae): differential susceptibility of two lymnaeid species.** *Parasitol Res* 85(3): 212-5, ISSN: 0932-0113.
NAL CALL NUMBER: QL757.P377
ABSTRACT: A study was made of the infectivity of Hypoderaeum conoideum miracidia to a range of laboratory-reared specimens of freshwater snail species (Lymnaea peregra, L. corvus, Physella acuta, and Gyraulus chinensis) that coexist with the parasite in the same natural habitat. L. peregra and L. corvus were found to be equally susceptible to the parasite when specimens of each snail species were singly exposed to miracidia. However, when miracidia could choose either lymnaeid species, they showed a high degree of specificity toward L. peregra. The results obtained suggest that H. conoideum miracidia are capable of distinguishing among these lymnaeids in their orientation to the host. This indicates that miracidia might achieve specificity before actually contacting the snail host and suggests that during the host-snail orientation process they respond to signals different from those generated upon snail contact and invasion. The specificity toward L. peregra observed in H. conoideum miracidia seems to indicate adaptation to the snail community in their natural habitat, resulting in enhancement of their transmission.
DESCRIPTORS: Echinostomatidae physiology, Lymnaea parasitology, snails parasitology, fresh water, host parasite relations, signal transduction, species specificity.

1998

Ategbo, J.M.; Zongo, D.; Aidara, D. (1998) **Behavioral states and mobility of the giant snail Achatina achatina.** *Cahiers d'Etudes et de Recherches Francophones Agricultures* 7(1): 72-74, ISSN 1166-7699.
NAL CALL NUMBER: S5.C34
ABSTRACT: Mobility and bebavioral states of the African giant snail Achatina achatina L. were studied both in the laboratory and the open field. Behavioral state scores (BSS), derived from animal stereotypic postures, provided a suitable scale of increasing activity. To test whether BSS was correlated with activity, 30 randomly chosen sexually mature snails were removed from a colony and placed on a large bare surface. BSS scores were obtained 5 min later, and the distance each snail moved over the next 5 min was recorded by measuring the length of a thread laid along the mucous trail. BSS can be used to measure Achatina achatina mobility . In the open field, without any stimulus, humidity was the most important factor affecting snail mobility.
DESCRIPTORS: Achatina, snails, behaviour, locomotion, field experimentation, laboratory experimentation, environmental factors, humidity, cote d' ivoire, Africa, Africa south of sahara, experimentation, Gastropoda, movement, physiological functions, West Africa.

Chambers, R.J.; McQuaid, C.D.; Kirby, R. (1998) **The use of randomly amplified polymorphic DNA to analyze the genetic diversity, the systematic relationships and the evolution of intertidal limpets, Siphonaria spp. (Pulmonata: Gastropoda), with different reproductive modes.** *Journal of Experimental Marine Biology and Ecology* V. 227, N1 (SEP 1), P. 49-66, ISSN: 0022-0981.
NAL CALL NUMBER: QH91.A1J6
DESCRIPTORS: marine and freshwater biology, ecology, polyacrylamide gel electrophoresis, total cellular proteins, Littorina saxatilis, larval development, arbitrary primers, family Littorinidae, markers, PCR, identification.

DeWitt, T.J. (1998) **Costs and limits of phenotypic plasticity: Tests with predator-induced morphology and life history in a freshwater snail.** *Journal of Evolutionary Biology* V 11, N4 (JUL), P. 465-480, ISSN: 1010-061X.
NAL CALL NUMBER: QH359.J68
DESCRIPTORS: costs of plasticity, evolution of plasticity, reaction norm, predator induced defense, genetics of plasticity, adaptive plasticity, water snail, body size, evolution, maintenance, environment, generalists, specialists, defenses, genetics.

Foster, G. G.; A. N. Hodgson. **Consumption and apparent dry matter digestibility of six intertidal macroalgae by Turbo sarmaticus (Mollusca: Vetigastropoda: Turbinidae).** *Aquaculture.* Amsterdam, Elsevier. Sept 1, 1998. v. 167 (3/4) p. 211-227. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: Laboratory experiments on feeding of Turbo sarmaticus have shown that this gastropod mollusc is capable of consuming and digesting algae from the Rhodophyta (Gelidium pristoides and Corallina spp.), Chlorophyta (Ulva rigida and Codium extricatum) and Phaeophyta (Ecklonia radiata and Iyengaria stellata). The consumption rates of animals feeding on these different algae at 20 degree C ranged from 1.45 to 9.5% body weight per day (juveniles) and 1.06 to 6.08% body weight per day (adults). Juvenile T. sarmaticus had significantly ($P < 0.05$) higher consumption rates (1.6-2.8 times higher) for each algal species (except E. radiata) than adults. In both juveniles and adults, consumption rates of three species of algae (G. pristoides, U. rigida and Corallina spp.) were 1.5 to 5.8 times higher at 20 degree C and 25 degree C than at 15 degree C. The apparent dry matter digestibility for the different algae at 20 degree C ranged from 9.1 to 74.8% (juveniles) and 7.3 to 77.1% (adults). Juvenile T. sarmaticus had significantly ($P < 0.01$) higher apparent dry matter digestibility values (12-24% higher) for each algal species, except G. pristoides where there was no significant difference ($P=0.444$). In both juvenile and adult T. sarmaticus, algal digestibility was not affected by temperature. Monthly comparisons of the energetic value and nutritional content (protein, soluble carbohydrate and lipid) of the algae indicated that, with the exception of U. rigida and C. extricatum, there was little seasonal variation.
DESCRIPTORS: Gastropoda, Rhodophyta, Chlorophyta, Phaeophyta, feeding, feed intake, dry matter, digestibility, liveweight, age, water temperature, species differences, energy content, nutrient content, protein content, dietary carbohydrate, lipids, seasonal variation.

Gilroy, A.; S. J. Edwards. **Optimum temperature for growth of Australian abalone: preferred temperature and critical thermal maximum for blacklip abalone, Haliotis rubra (Leach), and greenlip abalone, Haliotis laevigata (Leach).** *Aquac Res.* Oxford : Blackwell Science, c1995. July 1998. v. 29 (7) p. 481-485. ISSN: 1355-557X.
NAL CALL NUMBER: SH1.F8
ABSTRACT: The preferred temperature and critical thermal maximum of Australian blacklip abalone, Haliotis rubra (Leach), and greenlip abalone, Haliotis laevigata (Leach), were found to

differ only slightly; the blacklip abalone exhibited lower temperature tolerance and preference, as expected from its habitat distribution. Preferred temperatures were 16.9 and 18.9 degrees C, and 50% critical thermal maxima were 26.9 and 27.5 degrees C for blacklip and greenlip abalone, respectively. The optimum temperatures for growth calculated from each of these indices and averaged were 17.0 and 18.3 degrees C, respectively.
DESCRIPTORS: Haliotis, water temperature, growth, Mollusc culture, habitats, cold tolerance, Gastropoda.

Thomas, J.D.; Eaton, P. (1998) **The origins, fate, and ecological significance of free amino compounds released by freshwater pulmonate snails.** *Comp Biochem Physiol A Mol Integr Physiol* 119(1): 341-9, ISSN: 1095-6433.
NAL CALL NUMBER: QP1.C6
ABSTRACT: The mass-specific accumulation rates (MSAR) of both total (TFAC) and individual free amino compounds (FAC) in conditioned media were measured by HPLC, using the orthophthaldialdehyde (OPA) methods, in the following cases: (a) laboratory-reared freshwater snails (B. glabrata) with chemosterilized shells; (b) Biomphalaria glabrata with non-chemosterilized shells; (c) B. glabrata faeces; (d) isolated shells of B. glabrata; and (e) 10 other species of freshwater gastropods from the Lewes Brooks, East Sussex, U.K. The MSAR values for B. glabrata show that 95% of the TFAC's (predominantly ethanolamine, phosphoserine, and the amino acids leucine, isoleucine, valine, aspartic acid, and glycine/threonine) originated from the snails themselves as the faeces and shells contributed only 5.0 and 0%, respectively. In contrast, epizootic organisms on the shells of all 10 snail species from the Lewes Brooks released significant amounts of FAC with the two smallest species (Planorbis vortex and Planorbis contortus) having the highest MSAR values. The MSAR for isolated B. glabrata mucus was 42.45 micromol x g(-1)h(-1). As 500 mg snails can release 16.67 mg of mucus daily, this could potentially result in the daily loss of 707.5 micromol of FAC. The cost/benefits of mucus secretion and the various anatomical, physiological, biochemical, and ecological mechanisms which allow freshwater snails to recover FAC's lost as a result of a high rate of urine production in their hypotonic environment, are discussed.
DESCRIPTORS: amines metabolism, Biomphalaria metabolism, fresh water, chromatography high pressure liquid, culture media, conditioned metabolism, ecology, mucus metabolism, tissue culture.

1997

Gomot, A. (1997) **Effets des metaux lourds sur le developpement des escargots. Utilisation des escargots comme bio-indicateurs de pollution par les metaux lourds pour la preservation de la sante de l'homme [Effects of heavy metals on snail development. Use of snails as bio-indicators of heavy metal pollution for the preservation of human health.]** *Bull Acad Natl Med* 181(1): 59-74; discussion 74-5, ISSN: 0001-4079. Note: In French.
ABSTRACT: The use of snails as biological indicators is particularly appropriate for metals, which they accumulate in their organs. The aim of the present experiment was to carry out a rigorous experimentation in the laboratory and in the wild in order to develop a methodology for the use of snails at a known stage of growth that would give precise information on the toxicity of heavy metals for different concentrations and durations of exposure. We have developed a test of toxicity based on the effects of a noxious and carcinogenic element, cadmium, on the land-snail Helix aspersa aspersa (H.a.a) of one month of age. Five concentrations (50 to 800 micrograms/g), were selected to estimate the concentrations causing 50% inhibition of growth (EC 50) at 14 days: 190 micrograms/g and at 28 days: 180 micrograms/g. A soil matrix

contaminated with metals (soil including 800 micrograms/g Cr, 20 micrograms/g Cd, 800 micrograms/g Pb and 2000 micrograms/g Zn) was incorporated into the food at 50 and 75%, it too inhibited the growth of juvenile snails compared to incorporation of control soil. An accurate and rapid (2 to 4 weeks) method is therefore available for the evaluation of the toxicity of pollutants by ingestion. The first trials of this method in the wild consisted of placing batches of 2-month-old snails, identical to those used in the first lab tests, in locations that were either polluted or not. Differences in growth were observed depending on the locations; analysis of the levels of metal in the organs of the snails should enable us to check if there is a correlation between these levels and the growth rates. The results obtained with cadmium compared to those of other authors working with earthworms and soil arthropods show that snails give responses to concentrations comparable to those of earthworms and much more rapidly and with more sensitivity than those of collembolla for example. The ease of handling snails and the perfect control of their breeding are essential factors in carrying out reliable bioassays in toxicology and in ecotoxicology.
DESCRIPTORS: environmental health, environmental monitoring, helix snails drug effects, metals, heavy toxicity, soil pollutants toxicity.

Lim, C.S.; Chung, D.Y.; Kaang, B.K. (1997) **Partial anatomical and physiological characterization and dissociated cell culture of the nervous system of the marine mollusc Aplysia kurodai.** *Mol Cells* 7(3): 399-407, ISSN: 1016-8478.
ABSTRACT: Snail nervous systems are powerful tools for neurobiological studies as the biophysical properties of the giant neurons and their neural circuits can be examined in relation to specific behaviors of animals. The marine mollusc Aplysia californica is particularly useful for analyzing the components of learning and memory at the molecular and cellular levels. Here we partially examined the nervous systems of two species (A. kurodai and A. juliana) commonly found along the Korean coast in comparison with that of A. californica, one of the American marine snails. A. kurodai appeared to be identical to A. californica in both anatomical and physiological properties of the nervous system. A. juliana could be distinguished from A. californica in certain morphological aspects of the nervous system. The hemolymph either from A. kurodai or from A. juliana was required for effectively elongating neurite outgrowth of A. kurodai neurons in dissociated cell culture. The cultured cells retained neuronal properties such as neurite outgrowth, synapse formation, and generation of action potentials. The sensory cells of A. kurodai in dissociated cultures showed a response to serotonin (5-HT) of spike broadening and enhanced membrane excitability as in intact ganglia. Therefore, the nervous system and dissociated neuronal culture of A. kurodai may be useful for studying learning and memory in the context-of well-defined neural circuits of A. californica.
DESCRIPTORS: Aplysia anatomy and histology, Aplysia physiology, nervous system anatomy and histology, nervous system physiology, action potentials, Aplysia cytology, cells cultured, culture media, electrophysiology, ganglia, invertebrate anatomy and histology, ganglia, invertebrate cytology, ganglia, invertebrate physiology, hemolymph, nervous system cytology, neurites ultrastructure, neurons, afferent drug effects, neurons, afferent physiology, serotonin pharmacology, species specificity, synapses ultrastructure.

Nakamura, K.; Soh, T. (1997) **Mechanical memory hypothesized in the homing abalone Haliotis diversicolor supertexta under experimental conditions.** *Fisheries Science* 63(6): 854-861, ISSN 0919-9268.
NAL CALL NUMBER: SH1.F8195
DESCRIPTORS: Haliotis, behaviour, habitats, locomotion, mental ability, laboratory experimentation, darkness, taxis, physiological functions, orientation, ecosystems, environmental

factors, experimentation, Gastropoda, movement, physiological functions, animal physiology and biochemistry.

1995

Fleming, A.E. (1995) **Digestive efficiency of the australian abalone haliotis-rubra in relation to growth and feed preference.** *Aquaculture* v 134 , n3-4 (jul 15), p. 279-293, ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
DESCRIPTORS: Haliotis rubra, feeding and nutrition, Mollusks, algae, marine, herbivore, nitrogen, ecology, food, behavior, defenses, plants.

Nakano, D. (1995) **Availability of the embryo of Semisulcospira libertina (Prosobranchia: Pleuroceridae) as a laboratory animal.** *Japanese Journal of Malacology* 54(1): 77-82, ISSN 0042-3580. Note: In Japanese.
DESCRIPTORS: Gastropoda, animal embryos, laboratory animals, feasibility studies, summer, autumn, animal developmental stages, animal developmental stages, developmental stages, Mollusca, seasons, useful animals.

Plaut, I.; Borut, A.; Spira, M.E. (1995) **Growth and metamorphosis of Aplysia oculifera larvae in laboratory culture.** *Marine Biology Berlin* 122 (3) 425-430, ISSN: 0025-3162.
NAL CALL NUMBER: QH91.A1M35
DESCRIPTORS: development, ecology, environmental sciences, marine ecology, morphology, nutrition, physiology, reproductive system, Chlorophyta, Algae, Plantae, Gastropoda, Aplysia oculifera, Codium dichotomum, Colpomenia sinuosa (Phaeophyta), Cystoseira sp., Dasia sp., Enteromorpha intestinalis, Hydroclathrus clathratus, Hypnea sp., Jania sp., Liagora sp., Padina pavonia, microorganisms.

Takami, A. (1995) **Growth and number of newborns in Semisulcospira kurodai (Prosobranchia: Pleuroceridae) reared in the laboratory.** *Japanese Journal of Malacology* 54(2): 123-132, ISSN: 0042-3580.
DESCRIPTORS: Gastropoda, snail culture, growth rate, environmental temperature, shell, diameter, parturition, birth rate, laboratory experimentation, animal production, biological development, body parts, dimensions, environmental factors, experimentation, growth, integument, physiological functions, production, reproduction, sexual reproduction, temperature, vital statistics, aquatic ecology.

Wildering, W.C.; Lodder, J.C.; Kits, K.S.; Bulloch, A.G. (1995) **Nerve growth factor acutely enhances high-voltage activated Ca-2+ currents in adult molluscan neurons.** *Society for Neuroscience Abstracts* 21 (1-3) 1048, ISSN: 0190-5295.
NAL CALL NUMBER: QP351.S56716
DESCRIPTORS: biochemistry and molecular biophysics, cell biology, development, endocrine system, chemical coordination and homeostasis, membranes, cell biology, metabolism, nervous system, neural coordination, physiology, Gastropoda, Lymnaea.

1994

Abe, N. (1994) **Growth and prey preference of the two forms in Thais clavigera (Kuster) under rearing.** *Venus the Japanese Journal of Malacology* 53 (2) 113-118.

DESCRIPTORS: behavior, ecology, environmental sciences, genetics, nutrition, physiology, population genetics, population studies, Gastropoda, Thais clavigera.

Baur, B. (1994) **Parental care in terrestrial gastropods.** *Experientia Basel* 50 (1) 5-14, ISSN: 0014-4754.
NAL CALL NUMBER: 475 EX7
DESCRIPTORS: behavior, ecology, environmental sciences, physiology, reproductive system, reproduction, Gastropoda.

Fejtl, M.; Gyori, J.; Carpenter, D.O. (1994) **Mercuric(II) chloride modulates single-channel properties of carbachol-activated Cl- channels in cultured neurons of Aplysia californica.** *Cellular and Molecular Neurobiology* 14 (6) 665-674, ISSN: 0272-4340.
NAL CALL NUMBER: QP351.C4
DESCRIPTORS: biochemistry and molecular biophysics, cell biology, ecology, environmental sciences, endocrine system, chemical coordination and homeostasis, membranes, cell biology, metabolism, nervous system, neural coordination, pharmacology, physiology, pollution assessment control and management, toxicology, Gastropoda, Aplysia californica.

Mcshane, P.E.; Gorfine, H.K.; Knuckey, I.A. (1994) **Factors influencing food selection in the abalone haliotis-rubra (Mollusca, Gastropoda).** *Journal of Experimental Marine Biology and Ecology*, v 176, n1 (mar 15), p. 27-37, ISSN: 0022-0981.
NAL CALL NUMBER: QH91.A1J6
DESCRIPTORS: Abalone, Haliotis rubra, macroalgal diet, marine invertebrate herbivores, phenolic compounds, temperate Australasia, brown algae, defenses, growth, precipitation, surfactants, resistance, evolution.

Wang R.; Pang, P.K.T.; Wu, L.; Karpinski, E.; Harvey, S.; Berdan, R.C. (1994) **Enhanced Calcium Influx by Parathyroid-Hormone in Identified Helisoma-Trivolvis Snail Neurons.** *Cell Calcium*, V 15, N1 (JAN), p. 89-98, ISSN: 0143-4160.
NAL CALL NUMBER: QP772.V53C4
DESCRIPTORS: central nervous system, smooth muscle cells, neurotransmitter release, peptidergic neurons, brain synaptosomes, Lymnaea stagnalis, Molluscan neuron, organ culture, growth cones, fluorescence.

1993

Bianchi, F.; Bolognani, A.M.; Fratello, B.; Sabatini, M.A.; Sonetti, D. (1993) **Cell-specific effects of lead on cultured neurons of the freshwater snail Planorbarius corneus.** *Acta Biologica Hungarica* 44 (1) 15-19, ISSN: 0236-5383.
NAL CALL NUMBER: 475 AC85
DESCRIPTORS: cell biology, development, estuarine ecology, environmental sciences, metabolism, nervous system, neural coordination, physiology, skeletal system, movement and support, toxicology, Gastropoda, Planorbarius corneus.

Eliot, L.S.; Kandel, E.R.; Siegelbaum, S.A.; Blumenfeld, H. (1993) **Imaging terminals of Aplysia sensory neurons demonstrates role of enhanced calcium influx in presynaptic facilitation.** *Nature* 361 (6413) 634-637, ISSN: 0028-0836.
NAL CALL NUMBER: 472 N21

DESCRIPTORS: cell biology, endocrine system, chemical coordination and homeostasis, membranes, cell biology, metabolism, nervous system, neural coordination, physiology, Aplysia, Gastropoda, calcium, potassium ion, serotonin.

Harada, A.; Yoshida, M.; Minakata, H.; Nomoto, K.; Muneoka, Y.; Kobayashi, M. (1993) **Structure and function of the molluscan myoactive tetradecapeptides.** *Zoolog Sci* 10(2): 257-65, ISSN: 0289-0003.
ABSTRACT: Effects of myoactive tetradecapeptides, Achatina excitatory peptide 2 and 3 (AEP2 and AEP3) and Fusinus excitatory peptide 4 (FEP4), on several molluscan muscles and neurons were investigated. In the penis retractor and radula retractor muscles of Achatina fulica (pulmonate), the three peptides enhanced the tetanic contraction elicited by nerve stimulations. The order of potency was AEP2 > AEP3 > FEP4, although the effects of AEP3 and FEP4 on the radula retractor were somewhat irregular. AEP2 also induced rhythmic bursts of activity in the buccal ganglionic neuron B4 known as a cholinergic motoneuron of the radula retractor. In the radula protractor and retractor muscles of Fusinus ferrugineus (prosobranch), FEP4 was most potent in enhancing the contraction. The enhancement was greater in the protractor than in the retractor. It was suggested that myoactive tetradecapeptides modulate mainly the cholinergic transmission in molluscan muscles.
DESCRIPTORS: Mollusca physiology, muscle contraction physiology, proteins chemistry, snails physiology, amino acid sequence, dose response relationship drug, molecular sequence data, muscle contraction drug effects, neurons drug effects, proteins physiology, sequence homology, amino acid.

Pagulayan, I.F.; Salunga, T.L. (1993) *Reproductive biology of Achatina fulica Ferussac.* Diliman, Quezon City (Philippines). 1993. 1 leaf. Philippines Univ., Diliman, Quezon City (Philippines). Inst. of Biology. National Malacological Convention. Diliman, Quezon City (Philippines). 3-4 Dec 1993. AVAILABILITY: UPLB-National Crop Protection Center Library, College, Laguna.
ABSTRACT: Achatina fulica Ferussac or the African giant snail collected from the field were reared and maintained in the laboratory. They were fed with (Lactuca sativa L.), yeast and chalk particles and frequently supplied with water to moisten the soil. The gross morphology of the reproductive system was studied. A. fulica is hermaphroditic. The male and female gametes differentiate within a single gonad called hermaphroditic gland. They have an ambisexual hermaphroditic gland in which oocytes and spermatozoa are produced simultaneously in close proximity within each acinus. However, it takes two snails to produce eggs. It was observed that courtship and copulation are reciprocal, both animals acting as males and females at the same time. There are four stages of mating behaviour: the spiral phase, the upright phase, the down turning phase and the immobility phase. Sex pheromones released from the head wart and some environmental factors like temperature, moisture, photoperiod and food influences the activity of the snail in the breeding season. It takes 24 to 48 hours for the snail to lay eggs which hatch in 7 to 15 days. A mass of 27 to 155 eggs laid per snail were obtained from the cultures.
DESCRIPTORS: Achatina fulica, pests of plants, reproductive performance, copulation, pheromones, Philippines, Asia, biological properties, fertilization, Gastropoda, performance, pests, physiological functions, reproduction, semiochemicals, sexual reproduction, south east Asia.

Santarelli, L.; Ghirardi, M.; Casadio, A.; Montarolo, P.G. (1993) **Aplysia hemolymph enhances neurite outgrowth from identified Helix neurons in cell culture.** *Society for Neuroscience Abstracts* 19 (1-3) 1085, ISSN: 0190-5295.
NAL CALL NUMBER: QP351.S56716

DESCRIPTORS: cell biology, nervous system, neural coordination, physiology, toxicology, Gastropoda.

1992

Bedford, J.A.; Lutz, P.L. (1992) **Respiratory Physiology Of Aplysia-Californica (Morton, J.E. and Yonge, C.M., 1964) and Aplysia-Brasiliana Upon Aerial Exposure.** *Journal of Experimental Marine Biology and Ecology* v. 155, n2, p.239-248.
NAL CALL NUMBER: QH91.A1J6
DESCRIPTORS: aerial exposure, anaerobic, Aplysia, desiccation, metabolic depression, oxygen consumption, intertidal animals, energy metabolism, air, anaerobiosis, responses, behavior, hypoxia.

Buonomano, D.V.; Cleary, L.J.; Byrne, J.H. (1992) **Inhibitory Neuron Produces Heterosynaptic Inhibition of the Sensory-to-Motor Neuron Synapse in Aplysia.** *Brain Research* V. 577, N1 (APR 10), P. 147-150.
DESCRIPTORS: Aplysia, heterosynaptic inhibition, inhibitory neuron, synaptic plasticity, tail withdrawal reflex, siphon-withdrawal reflex, presynaptic inhibition, gill, camp, sensitization, modulation, serotonin, fmrfamide, tail.

Foster, M.C.; Castiglia, C.M.; Saubermann, A.J. (1992) **Effects of Serotonin and Carbachol on Glial and Neuronal Rubidium Uptake in Leech CNS.** *Brain Research* V 597, N2 (DEC 4), P. 181-188, ISSN: 0006-8993.
DESCRIPTORS: neurotransmitter, electron microprobe, potassium, serotonin, carbachol, leech, X-ray analysis, central nervous system, scanning electron microscopy, frozen hydrated sections, elemental composition, water content, cells, astrocytes, mechanism, K+.

Hughes, R.N.; Burrows, M.T.; Rogers, S.E. (1992) **Ontogenic Changes in Foraging Behavior of the Dogwhelk Nucella lapillus.** *Journal of Experimental Marine Biology and Ecology* V 155, N2, P. 199-212.
NAL CALL NUMBER: QH91.A1J6
DESCRIPTORS: foraging behavior, Nucella, ontogeny, prey selection, predator, history, mussels, rates.

Saubermann, A.J.; Castiglia, C.M.; Foster, M.C. (1992) **Preferential Uptake of Rubidium from Extracellular-Space by Glial-Cells Compared to Neurons in Leech Ganglia.** *Brain Research* V 577, N1 (APR 10), P. 64-72.
DESCRIPTORS: neuron, glial cell, elemental composition, potassium, electron probe x-ray microanalysis, X-ray analysis, scanning electron microscopy, frozen hydrated sections, central nervous system, potassium uptake, elemental composition, ion activities, water content, astrocytes, accumulation.

1991

Byrne, J.H.; Baxter, D.A.; Buonomano, D.V.; Cleary, L.J.; Eskin, A.; Goldsmith, J.R.; Mcclendon, E.; Nazif, F.A.; Noel, F.; Scholz, K.P. (1991) **Neural and Molecular-Bases of Nonassociative and Associative Learning in Aplysia.** *Annals of the New York Academy of Sciences* V 627, AUG, P. 124-149.
NAL CALL NUMBER: 500 N484

DESCRIPTORS: tail sensory neurons, long term facilitation, pre-synaptic facilitation, siphon-withdrawal reflex, presynaptic facilitation, protein synthesis, gill-withdrawal, transmitter release, cellular mechanism, adenosine 3'-5'-monophosphate, learning in aplysia, identified sensory neuron synapses during long-term sensitization, central nervous system, gill withdrawal reflex, c-fos messenger RNA induction, rat spinal cord, long term potentiation, Aplysia sensory neurons.

1990

Buonomano, D.V.; Byrne, J.H. (1990) **Long-Term Synaptic Changes Produced by a Cellular Analog of Classical-Conditioning in Aplysia.** *Science* V 249, N4967, P. 420-423.
NAL CALL NUMBER: 470 SC12
DESCRIPTORS: Aplysia model system, identified gill motor neurons, long term sensitization, neural networks, multiconnected memory models, associative theories.

Lacanilao, F. (1990) **Reproduction of the golden apple snail (Ampullaridae): egg mass, hatching, and incubation.** *Philippine Journal of Science* 119(2): 95-105.
NAL CALL NUMBER: 475 P53
ABSTRACT: Reproduction in the golden apple snail (Apullarius sp.) was studied to provide breeding information for laboratory and field culture. The influence of food quality and some environmental conditions on egg properties were studied in the laboratory at normal temperatures. Wandering jew produced the most numerous egg masses; combination of camote and papaya leaves and pechay, the largest egg masses; combination of wandering jew and kangkong, the shortest incubation period; and duckweed, the highest hatching rate and the best overall effects on egg properties. Water change affected number of egg masses at higher stocking density, but affected egg mass size at all stocking densities and sex ratios. Seasonal or natural temperature effects were only seen on incubation period-shortest in the warm months of April and May but longest in the cool months of December-February. Increasing age decreased the number and size of egg masses and hatching rate, but did not affect incubation period.
DESCRIPTORS: snails, snail culture, reproduction, hatching, egg incubation, animal developmental stages, animal husbandry methods, animal production, biological development, developmental stages, Mollusca, physiological functions, production, reproduction, sexual reproduction, animal husbandry.

1989

Madec, L. (1989) **Geographic variations in Helix aspersa Mueller shell size and form. Evolution of these characters in laboratory conditions.** *Bulletin de la Societe Zoologique de France* 114(1): 85-100, ISSN: 0037-962X.
NAL CALL NUMBER: 410.9 P214B
DESCRIPTORS: snails, shell, dimensions, environment, animals, aquatic animals, aquatic organisms, chemicophysical properties, integument, invertebrates, tissues.

1984

Spiridonov, N. A.; M. A. Kostenko; S. P. Volkova; A. G. Pogorelov; M. N. Kondrashova. **Influence of biologically active substances isolated from Galleria mellonella on neurons of**

Lymnaea stagnalis in culture. *Comp Biochem Physiol C Comp Pharmacol Toxic.* Oxford : Pergamon Press. 1984. v. 78 (1) p. 207-210. ill. ISSN: 0306-4492.
NAL CALL NUMBER: QP901.C6
DESCRIPTORS: Galleria mellonella, Lymnaea stagnalis, neurons, biologics, isolated giant neurons culture, test system, aggregation inhibition, freshwater snail, neurite activation, neuronal cells, chemical compositions.

1983

Nevo, E.; Lavie, E.; Ben-Shlomo, R. (1983) **Selection of allelic isozyme polymorphisms in marine organisms: pattern, theory, and application.** *Isozymes Curr Top Biol Med Res* 10: 69-92, ISSN: 0160-3787.
NAL CALL NUMBER: QP601.I74
ABSTRACT: The evolutionary significance of allelic isozyme polymorphisms in several Mediterranean marine organisms was tested initially by post-hoc gene frequency analyses at 11-15 gene loci in natural populations of barnacles, Balanus amphitrite, under thermal [Nevo et al, 1977] and chemical [Nevo et al, 1978] pollutions. We next carried out pre-hoc controlled laboratory experiments to test the effects of heavy metal pollution (Hg, Zn, Cd) on genotypic frequencies of 15 phosphoglucomutase (PGM) genotypes in thousands of individuals of the shrimp Palaemon elegans [Nevo et al, 1980, 1981a, and the present study]. Similarly, we tested the effects of Hg, Zn, Cd, Pb, Cu pollutions on the genotypic and allelic frequencies of five phosphoglucose isomerase (PGI) genotypes in the two close species of marine gastropods, Monodonta turbinata and M turbiformis [Lavie and Nevo, 1982, and the present study]. In both the thermal and chemical pollution studies, we established in repeated experiments statistically significant differences of allele frequencies at 8 out of 11 (73%) and 10 out of 15 (67%) gene loci, respectively, between the contrasting environments in each. While no specific function could be singled out in the post-hoc chemical study due to the complex nature of polluted marine water, temperature could be specified as the primary selective agent in the thermal study. The strongest direct and specific evidence for significant differential survivorship among allelic isozyme genotypes was obtained in the pre-hoc studies in Palaemon and Monodonta. Their differential viability was probably associated with the different degree of heavy metal inhibition uniquely related to each specific pollutant. Furthermore, we demonstrated in the two closely related Monodonta species parallel genotypic differentiation as a response to pollution. Our results are inconsistent with the neutral theory of allelic isozyme polymorphisms and appear to reflect the adaptive nature of the allelic isozyme polymorphisms studied. Allelic isozyme genotypes are sensitive to and vary with the quality and quantity of specific pollutants. Therefore, they can provide precise genetic indicators of the effects of pollution on the short- and long-term genetic changes of populations. Ideally, in different marine species specific genetic loci, either singly or in combination, may prove sensitive markers to different pollutants and could easily be assayed by quick electrophoretic tests and be used as genetic monitors. An extensive search for the appropriate enzymatic systems in various relatively sedentary marine species exposed to pollutants is therefore urgent.
DESCRIPTORS: isoenzymes genetics, polymorphism genetics, water pollution adverse effects, adaptation physiological, alleles, environment, evolution, glucose-6-Phosphate isomerase genetics, metals toxicity, Mollusca genetics, phosphoglucomutase genetics, shrimp genetics, Gastropoda.

Zelia, O. P.; S. A. Beer. **A technique of individual maintenance of molluscs infected with larvae of Schistosoma mansoni.** *Parazitologiia.* Leningrad : "Nauka". Sept-Oct 1983, v. 17 (5) p. 412-415. ISSN: 0031-1847. Note: In Russian with English summary.
NAL CALL NUMBER: QL757.A1P32
ABSTRACT: technique for individual maintenance of snail intermediate hosts in constant temperature water bath, effect on host growth, reproductive ability, and production of cercaria; technique used for study of compatibility between Malaysian strain of S. mansoni and Biomphalaria sudanica on basis of total cercaria production, Gastropoda.
DESCRIPTORS: Biomphalaria sudanica, freshwater snail, Schistosoma mansoni, maintenance, host- parasite relationship, snail intermediate host, water bath, reproduction, cercaria production, compatibility, model system, water bath, host growth, technique.

1982

Uki, N.; Kikuchi, S. (1982) **Influence of food levels on maturation and spawning of the abalone, Haliotis discus hannai related to effective accumulative temperature.** *Bulletin of Tohoku Regional Fisheries Research Laboratory* (no.45) p. 45-53, ISSN 0049-402X.
NAL CALL NUMBER: SH301.S852
DESCRIPTORS: abalones, maturation, oviposition, food intake, environmental temperature, biological development, consumption, environment, environmental conditions, food consumption, foods, isscaap group b 52, isscaap groups of species, physiological functions, reproduction, seafoods, shellfish, temperature, aquatic ecology, fisheries production, Gastropods, snail like molluscs.

1981

Bayne, C. J. **Gastropod cells in vitro.** *Adv Cell Cult.* New York : Academic Press. 1981, v. 1 p. 297-334. ISSN: 0275-6358.
NAL CALL NUMBER: QH585.A3
ABSTRACT: gastropod cells in vitro, establishment and maintenance of cultures, uses of cultures, includes adaptation for study of parasites and host/parasite systems and for synxenic cultivation of Schistosoma mansoni, review.
DESCRIPTORS: Biomphalaria glabrata, freshwater snail, neurobiology, Aplysia, sea hare, maintenance, culture uses, synxenic cultivation, karotyping, antigenicity, behavior, immunology, phagocytosis, Schistosoma mansoni, attachment, aggregation, degranulation, chemotaxis, primary cultures, snail cell culture, short-term culture, in vitro, review article, embryonic and adult tissues.

Levitan, I.B.; Adams, W.B. (1981) **Cyclic AMP modulation of a specific ion channel in an identified nerve cell: possible role for protein phosphorylation.** *Adv Cyclic Nucleotide Res* 14: 647-53, ISSN: 0084-5930.
NAL CALL NUMBER: QP801.N82A3
ABSTRACT: Multidisciplinary studies of the role of cAMP in synaptic transmission have been made possible by the favorable properties of the molluscan nervous system, and there is now evidence from several laboratories implicating cAMP in physiological responses in various Aplysia nerve and muscle cells (9,10,15,18,21). The results we have obtained satisfy all the criteria (8) necessary to establish that cAMP mediates the response to a neurotransmitter: a) the response is mimicked by intra- or extracellular application of cAMP derivatives, and by activation of adenylate cyclase within R15; b) a phosphodiesterase inhibitor enhances the

response to low concentrations of serotonin; c) serotonin causes cAMP to accumulate within R15, and stimulates adenylate cyclase activity in membranes prepared from R15 cell bodies; and d) the serotonin receptors mediating adenylate cyclase stimulation and R15 hyperpolarization are pharmacologically very similar. This is the first time all these criteria have been satisfied in a neuronal system, and thus we conclude that the serotonin-induced increase in potassium conductance in neuron R15 is mediated by cAMP.
DESCRIPTORS: cyclic AMP metabolism, ion channels metabolism, neurons metabolism, protein kinases metabolism, serotonin pharmacology, Aplysia, cyclic AMP analogs and derivatives, cyclic AMP pharmacology, ion channels drug effects, membrane potentials drug effects, neurons drug effects, phosphorylation.

Mulvey, M.; R. C. Vrijenhoek. **Genetic variation among laboratory strains of the planorbid snail Biomphalaria glabrata.** *Biochem Genet.* New York : Plenum Press. Dec 1981 v. 19 (11-12) p. 1169-1182. ISSN: 0006-2928.
NAL CALL NUMBER: QR73.B5
ABSTRACT: Biomphalaria glabrata (intermediate host of Schistosoma mansoni), genetic variation among laboratory strains.
DESCRIPTORS: Biomphalaria glabrata, freshwater snail, Schistosoma mansoni, intermediate host, polymorphism, genetics, genetic variation, laboratory strains.
Paris, C. G.; V. F. Castellucci; E. R. Kandel; J. H. Schwartz. *Protein phosphorylation* Protein phosphorylation, presynaptic facilitation, and behavioral sensitization in Aplysia Marine mollusc. Edited by Ora M. Rosen, Edwin G. Krebs. Cold Spring Harbor, N.Y.: Cold Spring Harbor Laboratory, 1981. p. 1361-1375. ill. ISBN: 0879691409.
NAL CALL NUMBER: QP606.P76P76
DESCRIPTORS: Aplysia, sea slug, protein phosphorylation, animal model, molecular pathway, learning, sensitization, gill-withdrawl reflex, biochemistry, neurons, serotonin receptor, adenylate cyclase, cyclic AMP regulatory subunit, presynaptic facilitation, behavioral sensitization, nervous system.

Uki, N.; Kikuchi, S.; Grant, J.F. (1981) **Juvenile growth of the abalone, Haliotis discus hannai, fed certain benthic micro algae related to temperature.** *Bulletin of Tohoku Regional Fisheries Research Laboratory* (no.43) p. 59-64, ISSN 0049-402X.
NAL CALL NUMBER: SH301.S852
DESCRIPTORS: abalones, Haliotis, young animals, benthic environment, feeds, algae, periphyton, growth, environmental temperature, animals, aquatic animals, aquatic communities, aquatic environment, aquatic organisms, biocoenosis, biological development, environment, environmental conditions, foods, gastropods, invertebrates, isscaap group b 52, isscaap groups of species, physiological functions, physiology, plants, seafoods, shellfish, temperature.

Uki, N. (1981) **Feeding behavior of experimental populations of the abalone, Haliotis discus hannai.** *Bulletin of Tohoku Regional Fisheries Research Laboratory* (no.43) p. 53-58, ISSN: 0049-402X.
NAL CALL NUMBER: SH301.S852
DESCRIPTORS: abalones, haliotis, feeding habits, phaeophyceae, biological rhythms, environmental temperature, algae, animals, aquatic animals, aquatic organisms, behaviour, environment, environmental conditions, foods, gastropods, invertebrates, isscaap group b 52, isscaap group b 91, isscaap groups of species, plants, seafoods, shellfish, temperature, time, timing, aquatic ecology, Gastropods, snail like Molluscs.

1980

Saitoh, Y.; H. Itagaki. **A new breeding system of Oncomelania hupensis nosophora in the laboratory.** *Jap J Parasitol.* Tokyo : Japanese Society of Parasitology. Oct 1980, v. 29 (5) p. 341-350 (p. 17-26). ISSN: 0021-5171.
ABSTRACT: new system for maintenance and mass breeding of Oncomelania hupensisnosophora (vector of Schistosoma japonicum) in the laboratory.
NAL CALL NUMBER: 436.8-J27
DESCRIPTORS: Oncomelania hupensisnosophora, freshwater snail, maintenance, breeding, Schistosoma japonicum, rearing, feeding, long-term culture, space requirements, aquaterrarium, aquarium, reproduction, artificial and natural lighting, moisture control.

1978

Nakanishi, T. (1978) **Studies on the effects of the environment on the heart rate of shellfishes, 2: Effects of temperature, low salinity and hypoxia on the heart rate of an abalone Haliotis (Nordotis) discus hannai Ino.** *Bulletin of the Hokkaido Regional Fisheries Research Laboratory.* (no.43) p. 59-68, ISSN: 0513-2541. Note: In Japanese.
NAL CALL NUMBER: 414.9 H683
DESCRIPTORS: aquatic ecology.

1975

Stephenson, J.W.; Dibley, G.C. (1975) **Electric fence for retaining slugs in outdoor enclosures.** *Lab Pract* 24(12): 815, ISSN: 0023-6853.
NAL CALL NUMBER: Q183.L3
DESCRIPTORS: Mollusca, electricity, environment design, laboratories.

Miscellaneous

2001

Galloway, T.S.; Depledge, M.H. (2001) **Immunotoxicity in invertebrates: measurement and ecotoxicological relevance.** *Ecotoxicology* 10(1):5-23, ISSN: 0963-9292.
NAL CALL NUMBER: RA565.A1E27
ABSTRACT: Concern is growing regarding the impact of chemicals suspected of altering the function of the immune system in humans and wildlife. There are numerous examples of links between pollution and increased susceptibility to disease in wildlife species, including immunosuppression in harbour seals feeding on fish from contaminated sites, altered immune function in riverine fish and decreased host resistance in birds exposed to pollutants. Laboratory tests have identified potential immunological hazards posed by a range of anthropogenic chemicals in mammals and higher vertebrates. However, few reports have considered the ecological relevance of pollution-induced immunosuppression in invertebrate phyla, which constitute around 95% of all animal species and occupy key structural and functional roles in ecosystems. In this paper effects of chemicals on immune function in invertebrates are briefly reviewed and biomarkers of immunotoxicity are identified. Examples of new approaches for the measurement of immunological inflammatory reactions and stress in molluscan haemocytes are

detailed. The relevance of defining the immune system as a target organ of toxicity in invertebrates is discussed and an integrated approach for the use of immunological biomarkers in environment management is proposed, combining measures of immune function and organismal viability at the biochemical, cellular and population level.
DESCRIPTORS: ecology, environmental pollutants toxicity, immunotoxins toxicity, Mollusca immunology, biological markers, environmental pollutants immunology, hemocytes immunology, hydrocarbons, halogenated immunology, hydrocarbons, halogenated toxicity, immunotoxins immunology, metals, heavy immunology, metals, heavy toxicity, organotin compounds immunology, organotin compounds toxicity, oxidants immunology, oxidants toxicity, pesticides immunology, pesticides toxicity, polycyclic hydrocarbons immunology, polycyclic hydrocarbons toxicity, biological markers, environmental pollutants, hydrocarbons halogenated, immunotoxins, metals heavy, organotin compounds, oxidants, pesticides, polycyclic hydrocarbons.

Snyder, M.J.; Girvetz, E.; Mulder, E.P. (2001) **Induction of marine mollusc stress proteins by chemical or physical stress.** *Arch Environ Contam Toxicol* 41(1): 22-9, ISSN: 0090-4341.
NAL CALL NUMBER: TD172 A7
ABSTRACT: The cellular stress responses of most organisms in part involve the induction of a class of proteins called heat shock or stress proteins (HSPs) as a result of damage to existing proteins. Cellular proteins can be damaged by chemical exposures known to induce various HSPs. In these experiments, we examine the HSP responses of mussel (Mytilus galloprovincialis) and abalone (Haliotis rufescens) tissues to both thermal and chemical exposures. HSP70 isoforms, HSP60, and HSP90 all show varying induction capabilities. The results demonstrate that the extent of stress exposure as both a time- and dose-dependent phenomena can be ascertained by examining changes in mollusc HSP protein levels. We also examined the relationship between HSP induction and levels of a mussel cytochrome P450 (CYP4Y1) mRNA in dose-response experiments with the products of biologically degraded weathered crude oil. The increases in HSP70 isoforms and HSP90 were correlated with decreases in CYP4Y1 expression levels in a dose-dependent manner. HSP responses may therefore be a valuable part of a suite of biomarkers in biomonitoring for hydrocarbon exposures in nearshore environments.
DESCRIPTORS: heat shock proteins biosynthesis, hydrocarbons adverse effects, Mollusca physiology, mussels physiology, water pollutants, chemical adverse effects, biological markers analysis, cytochrome P 450 metabolism, dose response relationship, drug, analysis, metabolism, biosynthesis, adverse effects, physiology, biological markers, heat shock proteins, hydrocarbons; messenger RNA, water pollutants chemical, cytochrome P450 CYP41, cytochrome P-450, environmental health, toxicology.

2000

Gomez, M.P.; Nasi, E. (2000) **Light transduction in invertebrate hyperpolarizing photoreceptors: possible involvement of a Go-regulated guanylate cyclase.** *J Neurosci* 20(14): 5254-63, ISSN: 0270-6474.
ABSTRACT: The hyperpolarizing receptor potential of scallop ciliary photoreceptors is attributable to light-induced opening of K(+)-selective channels. Having previously demonstrated the activation of this K(+) current by cGMP, we examined upstream events in the transduction cascade. GTP-gamma-S produced persistent excitation after a flash, accompanied by decreased sensitivity and acceleration of the photocurrent, whereas GDP-beta-S only inhibited responsiveness, consistent with the involvement of a G-protein. Because G(o) (but not

G(t) nor G(q)) recently has been detected in the ciliary retinal layer of a related species, we tested the effects of activators of G(o); mastoparan peptides induced an outward current suppressible by blockers of the light-sensitive conductance such as l-cis-diltiazem. In addition, intracellular dialysis with the A-protomer of pertussis toxin (PTX) depressed the photocurrent. The mechanisms that couple G-protein stimulation to changes in cGMP were investigated. Intracellular IBMX enhanced the photoresponse with little effect on the baseline current, a result that argues against regulation by light of phosphodiesterase activity. LY83583, an inhibitor of guanylate cyclase (GC), exerted a reversible, dose-dependent suppression of the photocurrent. By contrast, ODQ, an antagonist of NO-sensitive GC, and YC-1, an activator of NO-sensitive GC, failed to alter the light response or the holding current; furthermore, the NO synthase inhibitor N-methyl- l-arginine was inert, indicating that the NO signaling pathway is not implicated. Taken together, these results suggest a novel type of phototransduction cascade in which stimulation of a PTX-sensitive G(o) may activate a membrane GC to induce an increase in cGMP and the consequent opening of light-dependent channels.
DESCRIPTORS: GTP binding proteins metabolism, guanosine diphosphate analogs and derivatives, guanylate cyclase metabolism, photoreceptors, invertebrate metabolism, photoreceptors, invertebrate radiation effects, signal transduction drug effects, calcium channel blockers pharmacology, dose response relationship, drug, enzyme inhibitors pharmacology, guanosine-5'-O-3-thiotriphosphate pharmacology, guanosine diphosphate pharmacology, guanylate cyclase antagonists and inhibitors, Mollusca, nitric oxide synthase antagonists and inhibitors, patch clamp techniques, pertussis toxins pharmacology, phosphodiesterase inhibitors pharmacology, photic stimulation, photoreceptors, invertebrate cytology, retina cytology, signal transduction, radiation effects, thionucleotides pharmacology, wasp venoms pharmacology, metabolism, analogs and derivatives, antagonists and inhibitors, cytology, radiation effects, drug effects.

1997

Gonzalez-Lanza, C.; Manga-Gonzalez, M.Y.; Campo, R.; Del-Pozo, M.P. (1997) **Larval development of Dicrocoelium dendriticum in Cernuella (Xeromagna) cespitum arigonis under controlled laboratory conditions.** *J Helminthol* 71(4): 311-7, ISSN: 0022-149X.
NAL CALL NUMBER: 436.8 J82
ABSTRACT: The larval development of Dicrocoelium dendriticum (Digenea: Dicrocoeliidae) in experimentally infected Cernuella (Xeromagna) cespitum arigonis (Schmidt, 1853), a species of mollusc important in the epidemiology of dicrocoeliosis in Spain, has been studied. A total of 948 specimens of this mollusc, distributed in five batches, were tested with individual doses of 50 to 150 parasite eggs, obtained from sheep, after 4 days without food. After infection these molluscs and control specimens were kept in an environmental simulation chamber at 20 degrees C, 50% relative humidity and 7 h of light per day. To detect the parasite, a minimum of six molluscs were examined every 20 days from day 1 post-infection (p.i.). The eggs of D. dendriticum were eliminated in the molluscan faeces 48 h post infection. The percentages of molluscs harbouring the parasite ranged between 17.53% and 75%. Daughter sporocysts with undifferentiated germinal masses and occupying very reduced areas of the hepatopancreas were observed 50 days p.i. and in the period immediately following. After 110 days p.i. sporocysts with cercariae at different stages of development were found although slimeball emission was never observed.
DESCRIPTORS: Dicrocoeliasis parasitology, Dicrocoelium physiology, Mollusca parasitology, feces parasitology, larva, time factors.

1995

Anderson, I.G. (1995) *Queensland Department of Primary Industries Information Series, QI95011. The preparation and submission of cultured aquatic animals for veterinary laboratory examination.* Queensland Department of Primary Industries Information Series; The preparation and submission of cultured aquatic animals for veterinary laboratory examination. ii+34p. ISBN: 0727-6273.
DESCRIPTORS: ecology, environmental sciences, nutrition, pathology, physiology, systematics and taxonomy, veterinary medicine, medical sciences, wildlife management, conservation, Algae unspecified, Plantae, Arthropoda unspecified, Crustacea unspecified, Arthropoda, Mollusca unspecified, Osteichthyes, Pisces, Vertebrata, Chordata.

Kinne, S.E.; Kinne, R.K.H. (1995) **The contribution of marine biology to biomedical research: Past, present, future.** *Helgolaender Meeresuntersuchungen* 49 (1-4) 45-56, ISSN: 0174-3597.
NAL CALL NUMBER: QH91.A1H4
DESCRIPTORS: animal care, marine ecology, environmental sciences, nervous system, neural coordination, physiology, reproductive system, Cephalopoda, Chondrichthyes, Pisces, Vertebrata, Chordata, Hominidae, Primates, Mammalia, Vertebrata, Chordata, Animalia, dogfish (Chondrichthyes), human (Hominidae), squid, animals, chordates, fish, humans, Mammals, Mollusks, nonhuman vertebrates, Primates, Vertebrates.

1993

Pritchard, J.B. (1993) **Aquatic toxicology: past, present, and prospects.** *Environ Health Perspect* 100: 249-57, ISSN: 0091-6765.
NAL CALL NUMBER: RA565.A1E54
ABSTRACT: Aquatic organisms have played important roles as early warning and monitoring systems for pollutant burdens in our environment. However, they have significant potential to do even more, just as they have in basic biology where preparations like the squid axon have been essential tools in establishing physiological and biochemical mechanisms. This review provides a brief summary of the history of aquatic toxicology, focusing on the nature of aquatic contaminants, the levels of contamination in our waters, and the origins of these agents. It considers the features of the aquatic environment that determine the availability of xenobiotics to aquatic life and the fate of foreign chemicals within the organism. Finally, toxic effects are considered with primary emphasis on the potential of aquatic models to facilitate identification of the underlying mechanisms of toxicity.
DESCRIPTORS: forecasting, toxicology trends, water pollutants, chemical adverse effects, carcinogens environmental adverse effects, water pollutants chemical metabolism.

1992

Frye, F.L. (1992) *Captive invertebrates : a guide to their biology and husbandry / Fredric L. Frye.* Malabar, Fla. : Krieger Pub. Co., 135 p. : ill. (some col.) ; 29 cm.
NAL CALL NUMBER: SF407 I58F79 1991
DESCRIPTORS: Invertebrates as laboratory animals, Invertebrates as pets, captive wild animals.

Graham, M.; Wong, K. (1992) **Captive care of and research on Arctic fish and invertebrates.** *International Zoo Yearbook* 31 (0) 111-115, ISSN: 0074-9664.
NAL CALL NUMBER: QL76.I5
DESCRIPTORS: conservation, ecology, environmental sciences, general life studies, wildlife management, conservation, Echinodermata unspecified, Pisces unspecified.

1981

Hinegardner, R.T.; Atz, J.W.; Fay, R.C.; Fingerman, M.; Josephson, R.K.; Meinkoth, N.A.; Miller, J.W.; Rice, M.E.; Muckenhirn, N.A.; Pye, V.I. (1981) *Laboratory Animal Management Marine Invertebrates (Marine invertebrates as laboratory animals)* Institute of Laboratory Animal Resources, Assembly of Life Sciences, National Research Council (U.S.) Committee on Marine Invertebrates, National Academy Press, Washington, D.C., 382 pgs., ISBN: 0-309-03134-6.
NAL CALL NUMBER: SF407.M37M37
DESCRIPTORS: aquarium, transport, anesthesia, collection, housing, husbandry, rearing, bioassays, tissue culture, Molluscs.

Ray, S.; McLeese, D.W.; Peterson, M.R. (1981) **Accumulation of copper, zinc, cadmium and lead from two contaminated sediments by three marine invertebrates--a laboratory study.** *Bull Environ Contam Toxicol* 26(3): 315-22, ISSN: 0007-4861.
NAL CALL NUMBER: RA1270.P35A1
DESCRIPTORS: invertebrates metabolism, metals metabolism, cadmium metabolism, copper metabolism, lead metabolism, Mollusca metabolism, particle size, Polychaeta metabolism, shrimp metabolism, water pollutants, chemical metabolism, zinc metabolism.

1979

Ernst, W. (1979) **Factors affecting the evaluation of chemicals in laboratory experiments using marine organisms.** *Ecotoxicol Environ Saf* 3(1): 90-8, ISSN: 0147-6513.
NAL CALL NUMBER: QH545.A1E29
DESCRIPTORS: environmental pollutants toxicity, mussels drug effects, Polychaeta drug effects, half life, kinetics, lipids metabolism, methods, species specificity, temperature.

1976

Wright, C. A. **Land and freshwater molluscs .** *In UFAW (Univ Fed Anim Welfare) Handb Care Manage Lab Anim*, 1976, p. 610-615. Ref.
NAL CALL NUMBER: QL55.U5 1976
DESCRIPTORS: Laboratory animals.

Aquaculture-Related Resources

Bivalves

2001

Avault, J .W. Jr. **Seed production: prerequisite for farming a "new" species.** *Aquac Mag.* [Little Rock, Ark., Briggs Associates, inc.]. July/Aug 2001. v. 27 (4) p. 55-59. ISSN: 0199-1388.
NAL CALL NUMBER: SH1.C65
DESCRIPTORS: fishes, fry, larvae, embryos, biological development, embryonic development, spawning, shellfish culture, fish culture.

Hamada, T.; N. Yamashita; T. Watanabe; S. Natsume. **Drilling position of the ear affects growth and mortality of scallop (Patinopecten yessoensis, Jay) in ear-hanging culture.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. Feb 15, 2001. v. 193 (3/4) p. 249-256. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
ABSTRACT: We evaluated the effect of where the hole is drilled in the shell when using the ear-hanging or Nimai-ake method in scallop aquaculture. We examined its influence on growth and mortality during 8-month growth trials on the scallop Patinopecten yessoensis at Shikabe, Japan. Our observations showed: (1) no differences in growth and mortality between drilling the hole in the posterior compared to the anterior ear; (2) that drilling at positions next to the ligament causes increased mortality; (3) that the lowest increase in shell height and total weight is obtained when the hole is drilled next to the ligament on the anterior ear; and (4) that growth is greatest when the hole is drilled near the corners of the ears (either on the anterior or posterior ears).
DESCRIPTORS: scallops, mortality, Mollusc culture, growth, techniques, spatial variation, shells, liveweight gain, height, growth rate, survival.

Lee, C. S.; S. Ellis; K. L. Awaya. **Giant clam farming in the U.S. affiliated pacific islands.** *World Aquac.* Baton Rouge, La. : World Aquaculture Society,. Sept 2001. v. 32 (3) p. 21-22, 25-27, 62-63. ISSN: 1041-5602.
NAL CALL NUMBER: SH1.W62
DESCRIPTORS: Bivalvia, Mollusc culture, cages, rearing techniques, evaluation, trends, biology, larvae, spawning, sexual reproduction, fecundity, metamorphosis, intensive production, extensive production, stocking density, survival, food marketing, food products, American oceania.

Maguire, J. A.; G. M. Burnell. **The effect of stocking density in suspended culture on growth and carbohydrate content of the adductor muscle in two populations of the scallop (Pecten maximus L.) in Bantry Bay, Ireland.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. June 15, 2001. v. 198 (1/2) p. 95-108. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
ABSTRACT: The effect of stocking density of the scallop (Pecten maximus L.) in suspended culture using pearl and lantern nets on growth and carbohydrate content of the adductor muscle was assessed in two populations from Mulroy Bay and Bantry in Bantry Bay for 1 year. The results showed that in all treatments, the growth rate increased significantly from June to September. In general, the carbohydrate content in the striated muscle decreased from maximum

levels in September to a minimum in March. The carbohydrate content of the smooth muscle was lower than the striated and gradually increased throughout the experiment. The scallops from Bantry Bay had a significantly higher growth and carbohydrate content than the spat from Mulroy Bay. Spat cultured in lantern nets had a significantly higher growth rate than those cultured in pearl nets. In addition, spat cultured at low densities had a higher growth rate and carbohydrate content during the summer than those cultured at high densities.
DESCRIPTORS: Pecten maximus, stocking density, growth, Mollusc culture, carbohydrates, chemical composition, populations, nets, seasonal variation, Irish Republic.

Mazzola, A.; G. Sara. **The effect of fish farming organic waste on food availability for bivalve molluscs (Gaeta Gulf, Central Tyrrhenian, MED): stable carbon isotopic analysis.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. Jan 15, 2001. v. 192 (2/4) p. 361-379. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
ABSTRACT: Stable carbon isotope (delta13C) analysis was used in a fish-farming impacted Mediterranean area (the Gulf of Gaeta, Central Tyrrhenian) to determine the predominant carbon sources available to bivalve molluscs cultivated around fish cages. Whether the organic matter generated by fish farming was taken up by the bivalve molluscs was also investigated. Stable carbon isotope values were measured in the particulate organic carbon (POC) of samples from potential organic matter sources such as fish-pelleted feed, mollusc faecal waste and bivalve flesh. The sources of organic matter affecting the study area water column and benthic communities appeared to be terrigenous-continental, autochthonous (phytoplankton) and anthropogenic inputs due mainly to fish-farming and bivalve mollusc activities. The POC was dominated by organic waste isotopic signatures, while the bivalve mixed diet was composed of organic matter with different isotopic signatures (phytoplankton, waste material from the bivalves themselves and surplus uneaten pelletted feed). Organic waste appears to be the dominant trophic resource in the deeper-cultivated clam diet, while phytoplankton organic carbon plays a more important role in the diet of the mussel. We propose that bivalve organic matter uptake may play an effective role in reducing the environmental impact of fish organic waste. The organic matter produced by bivalves (faecal material) under these hydrodynamic conditions (low current velocities) can be recycled through the filtration activities of the bivalves themselves, together with most of the organic matter produced by fish-farming activities (uneaten feed and faecal material). Bivalve cultivation around cages may reduce the environmental impact of organic waste from fish-farming activities and increase the profitability of fish culture activities.
DESCRIPTORS: fish farming, organic wastes, nutrient availability, Bivalvia, foods, organic matter, cages, Mollusc culture, waste treatment, carbon, turbidity, feeds, feces, benthos, phytoplankton, environmental impact, filtration, water flow, latium, Mediterranean sea.

Power, A. J.; R. L. Walker. **Growth and survival of the blood ark Anadara ovalis (Bruguiere, 1789) cultured in mesh bags on soft-bottom sediments in the coastal waters of Georgia.** *J World Aquac Soc.* Baton Rouge, La. : World Aquaculture Society, c1987. 2001. v. 32 (3) p. 269-277. ISSN: 0893-8849.
NAL CALL NUMBER: SH138.W62
DESCRIPTORS: Arcidae, Mollusc culture, growth, survival, rearing techniques, evaluation, stocking density, fouling, size, growth rate, Georgia.

Selegean, J.P.; Kusserow, R.; Patel, R.; Heidtke, T.M.; Ram, J.L. (2001) **Using zebra mussels to monitor Escherichia coli in environmental waters.** *J Environ Qual* 30(1):171-9, ISSN: 0047-2425.

NAL CALL NUMBER: QH540 J6
ABSTRACT: Use of the zebra mussel (Dreissena polymorpha) as an indicator of previously elevated bacteria concentrations in a watershed was examined. The ability of the zebra mussel to accumulate and purge Escherichia coli over several days was investigated in both laboratory and field experiments. In laboratory experiments, periodic enumeration of E. coli in mussels that had been exposed to a dilute solution of raw sewage demonstrated that (i) maximum concentrations of E. coli are reached within a few hours of exposure to sewage, (ii) the tissue concentration attained is higher than the concentration in the ambient water, and (iii) the E. coli concentrations take several days to return to preexposure concentrations when mussels are subsequently placed in sterile water. In field experiments conducted in southeast Michigan in the Clinton River watershed, brief increases in E. coli concentrations in the water were accompanied by increases in mussel concentrations of E. coli that lasted 2 or 3 d. The ability of mussels to retain and to concentrate E. coli made it possible to detect E. coli in the environment under conditions that conventional monitoring may often miss. Sampling caged mussels in a river and its tributaries may enable watershed managers to reduce the sampling frequency normally required to identify critical E. coli sources, thereby providing a more cost-effective river monitoring strategy for bacterial contamination.
DESCRIPTORS: environmental monitoring methods, Escherichia coli, mussels microbiology, water pollutants analysis, specimen handling, tissue distribution, water microbiology, methods, microbiology, analysis.

2000

Arnold, W. S.; M. W. White; H. A. Norris; M. E. Berrigan. **Hard clam (Mercenaria spp.) aquaculture in Florida, USA: geographic information system applications to lease site selection.** *Aquac Eng.* Amsterdam, The Netherlands : Elsevier Science. Sept. 2000. v. 23 (1/3) p. 203-231. ISSN: 0144-8609.
NAL CALL NUMBER: SH1.A66
DESCRIPTORS: Mercenaria, Mollusc culture, geographical information systems, site selection, computer techniques, decision making, marketing, information, lagoons, estuaries, development, geographical variation, surveys, management, Florida.

Beaumont, A. **Genetic considerations in transfers and introductions of scallops.** *Aquac Int.* Dordrecht, The Netherlands : Kluwer Academic Publishers. 2000. v. 8 (6) p. 493-512. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: scallops, Argopecten irradians, Mollusc culture, introduced species, geographical variation, geographical distribution, gene flow, genetic variation, morphology, alloenzymes, DNA, populations, mitochondrial DNA, risk assessment, literature reviews.

Bourne, N. F. **The potential for scallop culture--the next millenium.** *Aquac Int.* Dordrecht, The Netherlands : Kluwer Academic Publishers. 2000. v. 8 (2/3) p. 113-122. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: scallops, Mollusc culture, yields, government policy, food industry, economic development, literature reviews, China, Japan, Chile, British Columbia.

Cano, J.; M. J. Campos; G. Roman. **Growth and mortality of the king scallop grown in suspended culture in Malaga, Southern Spain.** *Aquac Int.* Dordrecht, The Netherlands : Kluwer Academic Publishers. 2000. v. 8 (2/3) p. 207-225. ISSN: 0967-6120.

NAL CALL NUMBER: SH1.A627
DESCRIPTORS: Pecten maximus, growth, mortality, Mollusc culture, rearing techniques, cages, size, developmental stages, seasonal variation, balanus, Spain.

Christophersen, G. **Effects of air emersion on survival and growth of hatchery reared great scallop spat.** *Aquac Int.* Dordrecht, The Netherlands : Kluwer Academic Publishers. 2000. v. 8 (2/3) p. 159-168. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: Pecten maximus, scallops, rearing techniques, survival, growth, developmental stages, air exposure, seasonal variation, duration, height, dry matter, growth rate, Mollusc culture, hatcheries.

Cigarria, J.; J. M. Fernandez. **Management of Manila clam beds. I. Influence of seed size, type of substratum and protection on initial mortality.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. Feb 1, 2000. v. 182 (1/2) p. 173-182. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
DESCRIPTORS: clams, management, Mollusc culture, sediment, mortality, predation, larvae, size, nets, survival, length.

Fisher, G. R.; R. V. Dimock Jr.; R. E. Kuhn. **The symbiotic water mite Unionicola formosa (Acari: Unionicolidae) ingests mucus and tissue of its molluscan host.** *J Parasitol.* Lawrence, Kan. : American Society of Parasitologists, 1914. Dec 2000. v. 86 (6) p. 1254-1258. ISSN: 0022-3395.
NAL CALL NUMBER: 448.8 J824
DESCRIPTORS: Unionicola, water mites, feeding behavior, Bivalvia, freshwater Molluscs, mussels, mucus, gills, hemolymph, ingestion, host parasite relationships, symbionts.

Frechette, M.; M. Gaudet; S. Vigneau. **Estimating optimal population density for intermediate culture of scallops in spat collector bags.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. Mar 1, 2000. v. 183 (1/2) p. 105-124. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
DESCRIPTORS: scallops, Pectinidae, stocking density, Mollusc culture, larvae, growth, nets, depth, biomass, yields, feeds, availability, biological competition, water temperature, Quebec.

Goldberg, R.; J. Pereira; P. Clark. **Strategies for enhancement of natural bay scallop, Argopecten irradians irradians, populations; a case study in the Niantic River estuary, Connecticut, USA.** *Aquac Int.* Dordrecht, The Netherlands : Kluwer Academic Publishers. 2000. v. 8 (2/3) p. 139-158. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: Argopecten irradians, populations, scallops, Mollusc culture, fisheries, habitats, estuaries, spawning, spawning season, techniques, density, predation, survival, predators, gametogenesis, Connecticut.

Grecian, L. A.; G. J. Parsons; P. Dabinett; C. Couturier. **Influence of season, initial size, depth, gear type and stocking density on the growth rates and recovery of sea scallop, Placopecten magellanicus, on a farm-based nursery.** *Aquac Int.* Dordrecht, The Netherlands : Kluwer Academic Publishers. 2000. v. 8 (2/3) p. 183-206. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: scallops, seasonal variation, size, stocking density, growth rate, depth, equipment, monitoring, growth, mortality, fouling, Mollusc culture, Newfoundland.

Heasman, M.; J. Diemar; W. O'Connor; T. Sushames; L. Foulkes. **Development of extended shelf-life microalgae concentrate diets harvested by centrifugation for bivalve molluscs--a summary.** *Aquac Res.* Oxford : Blackwell Science, c1995. Aug/Sept 2000. v. 31 (8/9) p. 637-659. ISSN: 1355-557X.
NAL CALL NUMBER: SH1.F8
ABSTRACT: On the basis of initial harvesting efficiency trials and screening trials to evaluate apparent cell damage and viability, high-speed centrifugation was selected as the most appropriate microalgae harvesting method for developing extended shelf-life concentrates that would collectively meet the requirements of marine hatcheries and nurseries. Bioassay evaluation of stored microalgae concentrates revealed major discrepancies between closely related species of microalgae with regard to the impact of harvesting method on both short-term nutritional quality and shelf-life of stored concentrates. At one extreme, very good retention of nutritional quality was exhibited by high-speed-centrifuged concentrates of Tetraselmis spp. and Chaetoceros calcitrans beyond 8 weeks storage. In contrast, the naked flagellates Pavlova lutheri and Tahitian Isochrysis and the diatom Chaetoceros muelleri exhibited rapid and profound losses in nutritional quality as a consequence of supercentrifugation. Likewise, the impact of storage conditions and the effects of preservatives and other common food additives on the quality and extended shelf-life of stored concentrates was found to be unpredictable and highly species specific. Accordingly, optimum combinations of harvesting and storage, including optimum cell densities, presence or absence of food additives, temperature and, in some cases, gaseous atmosphere and light, had to be specifically tailored to individual species of microalgae in order to maximize the effective shelf-life of their concentrates. Data are presented demonstrating that the best binary concentrate diets developed during the course of this study could sustain growth and survival of larval and juvenile bivalves at rates similar to fresh microalgae culture even after storage periods of 6-8 weeks.
DESCRIPTORS: Bivalvia, feeds, storage life, efficiency, harvesting, mechanical damage, concentrates, species differences, nutritive value, water temperature, density, additives.

Lodeiros, C. J. M.; J. H. Himmelman. **Identification of factors affecting growth and survival of the tropical scallop Euvola (Pecten) ziczac in the Golfo de Cariaco, Venezuela.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. Feb 1, 2000. v. 182 (1/2) p. 91-114. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
DESCRIPTORS: Pecten, growth, survival, Mollusc culture, sexual development, depth, biological development, nets, fouling, colonization, developmental stages, gonads, phytoplankton, water temperature, stress, chlorophyll, prediction, seasonal variation, temporal variation, Venezuela.

Lopez, D. A.; V. A. Riquelme; M. L. Gonzalez. **The effects of epibionts and predators on the growth and mortality rates of Argopecten purpuratus cultures in southern Chile.** *Aquac Int.* Dordrecht, The Netherlands : Kluwer Academic Publishers. 2000. v. 8 (5) p. 431-442. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: Argopecten, Mollusc culture, mortality, growth, predation, algae, Hydrozoa, size, predators, Decapoda, nets, water temperature, parasites, marine animals, Chile.

Maeda Martinez, A. N.; P. Ormart; L. Mendez; B. Acosta; M. T. Sicard. **Scallop growout using a new bottom-culture system.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. Sept 25, 2000. v. 189 (1/2) p. 73-84. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6

ABSTRACT: A new bottom-culture system was tested at a commercial level to grow catarina scallops (Argopecten ventricosus) in the Rancho Bueno tidal channel in Bahia Magdalena, Mexico. The system consisted of a 50 X 1-m sleeve of 19-mm mesh polyethylene netting placed on the sea floor of selected growout areas. A total of 448 sleeves were deployed at various times from October 1994 to April 1995 in four zones from the mouth to the head of the tidal channel. Each sleeve contained 10,000 scallops (initially 32 mm shell height) at a density of 200 scallops/m2. Fifty-four percent of the spat were produced in a hatchery and the rest were collected using onion-bag collectors. Hatchery and wild spat were deployed separately. Water parameters were measured monthly in each zone: temperature, salinity, dissolved oxygen and total suspended solids. There were better water conditions towards the mouth of the channel. The scallops were harvested from 27 July to 18 August 1995: a total of 2.87 million scallops from the original 4.48 million. Their mean shell height was 56.2 mm and the mean weight of their adductor muscles was 6.8 g. The production was 19.3 t of adductor muscles. Statistically significant differences in mean shell height and mean adductor weight were found between scallops grown in different zones, but no statistically significant differences were found comparing yields from hatchery vs. wild scallops. To find the best culture conditions, a scallop relative value (SRV) was calculated by multiplying survival by adductor muscle weight and relative market price, and dividing by the growout duration. There were higher SRVs for scallops cultured in zones closer to the channel mouth. The highest SRV was found in a group from this zone, with 86% survival, 6.25 g mean adductor weight, and a growout duration of only 3.6 months. A new successful method for growing scallops in shallow areas is, thus presented here. It gave better results than suspension methods tested in the same area.
DESCRIPTORS: Mollusc culture, evaluation, polyethylene, netting, stocking density, water quality, water temperature, salinity, dissolved oxygen, turbidity, height, benthos, weight, Mexico.

Mortensen, S.; T. Van der Meeren; A. Fosshagen; I. Hernar; L. Harkestad; L. Torkildsen; O. Bergh. **Mortality of scallop spat in cultivation, infested with tube dwelling bristle worms, Polydora sp.** *Aquac Int.* Dordrecht, The Netherlands : Kluwer Academic Publishers. 2000. v. 8 (2/3) p. 267-271. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: Pecten maximus, Polychaeta, infestation, mortality, Mollusc culture, outbreaks, seasonal variation, fouling, sediment, sexual reproduction, feeds, economic analysis, Norway.

O' Sullivan, G.; Mulcahy, M.F. (2000) **Reproductive biology of pacific oysters: Some enigmas.** *Journal of Shellfish Research* 19 (1): 640, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: aquaculture, pollution assessment control and management, toxicology, Pelecypoda, Crassostrea gigas, pacific oyster, aquaculture species, female, hermaphrodite, male, spat, shell, integumentary system, tributyltin, pollutant, toxin, chlorophyll A, Dungarvan Bay (Ireland, Europe, Palearctic region).

Pfeiffer, T. J.; K. A. Rusch. **An integrated system for microalgal and nursery seed clam culture.** *Aquac Eng.* Amsterdam, The Netherlands : Elsevier Science. Dec 2000. v. 24 (1) p. 15-31. ISSN: 0144-8609.
NAL CALL NUMBER: SH1.A66
DESCRIPTORS: Mollusc culture, clams, phytoplankton, algae culture, Bacillariophyta, foods, volume, water reuse, water flow, velocity, design, wastes, evaluation, stocking density.

Riquelme, C.; R. Araya; R. Escribano. **Selective incorporation of bacteria by Argopecten purpuratus larvae: implications for the use of probiotics in culturing systems of the Chilean scallop.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. Jan 1, 2000. v. 181 (1/2) p. 25-36. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
ABSTRACT: Experiments on ingestion rates, colonization and impact of inhibitory producer substances bacteria (IPB) on larvae of Argopecten purpuratus, were carried out to evaluate potential use of bacteria as probiotics in cultures of this Chilean scallop. Three selected strains, named as 11, C33 and 77, obtained from larval cultures of A. purpuratus were tested at different concentrations and incubation times. After 6 h of incubation at a concentration of 10(6) cells ml-1, A. purpuratus larvae ingested cells of strains 11 and 77, but not those of C33. When comparing bacterial incorporation among these strains, the 77 became the dominant bacteria of the larval microflora, causing no differences in larval survival at different bacterial concentrations. Our results suggest that strain 77 appears as a potential probiotic for scallop larvae and hence, as a promising method to control and prevent infections in hatcheries systems.
DESCRIPTORS: Argopecten, larvae, probiotics, bacteria, Mollusc culture, ingestion, colonization, inhibition, strains, strain differences, inoculation, microbial flora, survival, disease control.

Robledo, J. A. F.; C. A. Coss; G. R. Vasta. **Characterization of the ribosomal rna locus of Perkinsus atlanticus and development of a polymerase chain reaction-based diagnostic assay.** *J Parasitol.* Lawrence, Kan. : American Society of Parasitologists, 1914. Oct 2000. v. 86 (5) p. 972-978. ISSN: 0022-3395
NAL CALL NUMBER: 448.8 J824
DESCRIPTORS: Bivalvia, Venerupis, Perkinsus, protozoal infections, ribosomal RNA, cloning, nucleotide sequences, polymerase chain reaction, assays, diagnostic techniques, Mollusc culture, Spain, Atlantic ocean.

Sakurai, I.; M. Seto. **Movement and orientation of the Japanese scallop Patinopecten yessoensis (Jay) in response to water flow.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. Jan 15, 2000. v. 181 (3/4) p. 269-279. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
DESCRIPTORS: Bivalvia, water flow, orientation, movement, animal behavior, Mollusc culture.

Stotz, W. **When aquaculture restores and replaces an overfished stock: is the conservation of the Species assured? The case of the scallop Argopecten purpuratus in Northern Chile.** *Aquac Int.* Dordrecht, The Netherlands : Kluwer Academic Publishers. 2000. v. 8 (2/3) p. 237-247. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: Argopecten, endangered species, nature conservation, Mollusc culture, wild animals,
domestication, biodiversity, genetic diversity, artificial selection, Chile.

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Barbeau, M. A.; H. Caswell. **A matrix model for short-term dynamics of seeded populations of sea scallops.** *Ecol Appl.* Washington, D.C. : Ecological Society of America. Feb 1999. v. 9 (1) p. 266-287. ISSN: 1051-0761.

NAL CALL NUMBER: QH540.E23
DESCRIPTORS: Pectinidae, Mollusc culture, population dynamics, mathematical models.

Ford, S.; Powell, E.; Klinck, J.; Hofmann, E. (1999) **Modeling the MSX parasite in eastern oyster (Crassostrea virginica) populations. I. Model development, implementation, and verification.** *Journal of Shellfish Research* 18 (2): 475-500, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: models and simulations, computational biology, parasitology, Pelecypoda, Sporozoa, Protozoa, Crassostrea virginica, eastern oyster, fisheries species, parasite host, Haplosporidium nelsoni, Sporozoa, parasite, pathogen, microorganisms, Protozoans, hemocyte, blood and lymphatics, immune system, MSX disease, parasitic disease, host parasite environment interactions, mathematical model, proliferation, salinity, survival, temperature, transmission rate.

Gonzalez, M. L.; D. A. Lopez; M. C. Perez; V. A. Riquelme; J. M. Uribe; M. Le Pennec. **Growth and the scallop, Argopecten purpuratus (Lamarck, 1819), in southern Chile.** *Aquaculture.* Amsterdam, Elsevier. May 15, 1999. v. 175 (3/4) p. 307-316. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: The northern scallop, Argopecten purpuratus, has a high economic value. Its natural geographical distribution occurs only in the north of Chile. However, this species has been introduced to the south of Chile for mass culture. This area has advantages for suspended cultures, such as the existence of many sheltered, wave-protected bays and lower levels of fouling and boring species. Low temperatures in this area, however, may hinder growth rates. The growth of A. purpuratus was studied in cultures carried out in southern Chile. The cultures were undertaken in two locations: Metri Bay (41 degrees 36'S, 72 degrees 43'W) and Quihua Channel (41 degrees 50'S, 73 degrees 05'W). Seasonal variations, density effects and culture location were evaluated. In addition, in Chidhuapi Channel (41 degrees 48'S, 73 degrees 7'W), growth was evaluated in two different culture systems: lantern nets and pockets. Growth varied according to area, season and culture system. The growth was higher and density-dependent in Metri Bay and lower and density-independent in Quihua Channel. The growth rate was higher in spring than in winter in both areas. Individual growth in the pocket system was higher than that of the lantern system at densities of 25 individuals/tray. Results show that the northern scallop introduced to the south of Chile, reaches a commercial size in slightly longer periods than those in natural distribution areas. However, the successful culture in the south of Chile depends on the season, culture area and the culture system. Factors such as temperature, water flow and maximum food levels may also influence cultures. The existence of sheltered bays protected from waves low levels of fouling and boring species and suitable growth levels indicate that the introduction of scallops to the south of Chile, make mass culture of this species feasible.
DESCRIPTORS: Argopecten, growth, Mollusc culture, geographical distribution, water temperature, seasonal variation, geographical variation, stocking density, nets, water flow, feeds, growth rate, Chile.

Grice, A. M.; J. D. Bell. **Application of ammonium to enhance the growth of giant clams (Tridacna maxima) in the land-based nursery: effects of size class, stocking density and nutrient concentration.** *Aquaculture.* Amsterdam, Elsevier. Jan 1, 1999. v. 170 (1) p. 17-28. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: This study investigated the effects of ammonium (NH_4^+) enrichment and stocking density on the growth of juvenile Tridacna maxima throughout the land-based nursery stage. In four sequential experiments, clams of 5, 11, 16 and 18 mm shell length (SL) were maintained at

low and high stocking densities in 60-1 tanks with unfiltered seawater (8 l h-1) for 25 days. Throughout this period, clams received daily spikes of dissolved ammonium sulfate at concentrations of < 1 (control), 20, 35 and 50 micromolar NH4+ for the three smallest size classes of clams, and < 1, 35, 50 and 80 micromolar NH4+ for the largest size class. Our experiments simulated the conditions used to mass-produce clams of this species during the nursery phase. All individuals used in the four experiments were from the same cohort. The growth responses of T. maxima to ammonium enrichment were dependent on the size of the clams. For clams of 5 mm SL, both increase in mean wet weight and SL were significantly lower at 35 and 50 micromolar NH4+ competed to control and 20 micromolar NH4+ spikes. In contrast, increases in mean wet weight and SL of giant clams of 11, 16 and 18 mm SL were all significantly greater when ammonium was added, with the greatest increases in mean weight and SL occurring at the highest ammonium levels for the two largest size classes. The abundance of zooxanthellae per clam increased in response to addition of ammonium for clams of 11, 16 and 18 mm SL, but not for individuals of 5 mm SL. Stocking density had a variable effect on changes in mean weight, shell length and abundance of zoaxanthellae. Values of all variables were significantly greater at low stocking densities for clams of 11 mm SL, but only marginally significant for most variables for clams of 16 and 18 mm SL. This study shows that addition of ammonium does not enhance growth of T. maxima during the early stages of rearing clams in the land-based nursery, but that relatively high levels of ammonium should be applied in the latter part of the nursery phase. This highlights the importance of identifying changes in nutrient requirements as juvenile giant clams grow.
DESCRIPTORS: clams, Bivalvia, ammonium sulfate, growth, size, stocking density, nutrient availability, concentration, enrichment, length, application rates, liveweight, Mollusc culture.

Hart, A. M.; J. D. Bell; T. P. Foyle. **Improving culture techniques for village-based farming of giant clams (Tridacnidae).** *Aquac Res.* Oxford : Blackwell Science, c1995. Mar 1999. v. 30 (3) p. 175-190. ISSN: 1355-557X.
NAL CALL NUMBER: SH1.F8
ABSTRACT: Eight experiments aimed at improving methods for the village-based farming of giant clams were conducted in the Solomon Islands. The experiments focused on either improving the fitness of seed clams delivered to village farmers, assessing whether differential growth rates of seed clams in nursery tanks persisted during grow-out at farms, or testing the effects of alterations to the design of grow-out cages on the growth and survival of clams. We found that Tridacna squamosa (Lamarck) 'seed' transferred from land-based nursery tanks to a floating ocean nursery (FON) for approximately equal to 3 months at the end of the nursery phase were significantly larger than seed reared only in land-based nursery tanks. Similarly, T. maxima (Roding) placed in a FON for 2 to 5 months generally grew at a significantly greater rate than tank-reared 'seed'. However, the use of FONs did not improve survival. There were no consistent differences in the growth and survival of fast- and slow-growing seed of T. derasa (Roding) at village sites when slow-growing seed were retained in the nursery until reaching a larger size. The survival of T. maxima was enhanced significantly by placing an insert of smaller mesh (a 'settlement ring') in grow-out cages for the first 2 months after delivery of seed to farmers. The settlement ring retained clams in cages until they found a suitable place to attach their byssal threads. Attempts to remove the sediment which impedes the attachment of T. maxima to the base of grow-out cages by perforating the substrate did not improve survival: the perforated substrate resulted in poor attachment of clams and harbored predators (Cymatium spp.). The survival of T. crocea (Lamarck) was not improved by 'softening' the concrete base of grow-out cages to simulate dead coral rock and to encourage the clams to burrow in the substrate. The survival of T. crocea in grow-out cages was enhanced significantly by enclosing the cages in fine mesh after the delivery of the seed clams to prevent predation and disturbance

by juvenile wrasse, Thalassoma spp. The experiments indicate that the critical stage for village farming of giant clams is during the initial weeks following distribution of seed. Further research is needed to improve the survival of T. crocea and T. maxima during this phase.
DESCRIPTORS: clams, Mollusc culture, techniques, growth rate, growth, survival, equipment, sea water, tanks, marine areas, sediment, substrates, predation, Cardiidae, Solomon Islands.

Karaan, A.S.M. (1999) **Bridging the small-big divide: A transaction cost approach to enterprise modelling for mussel mariculture in Saldanha Bay [South Africa].** *Agrekon* 38(4) p. 680-692, ISSN: 0303-1853.
NAL CALL NUMBER: 281.8 AG835
DESCRIPTORS: South Africa, small farms, commercial farming, mussels, aquaculture, costs, marketing, models, Africa, southern Sahara, enterprises, farming systems, farms, shellfish.

Mazzola, A.; E. Favaloro; G. Sara. **Experiences of integrated mariculture in a southern Tyrrhenian area (Mediterranean Sea).** *Aquac Res.* Oxford : Blackwell Science, c1995. Oct 1999. v. 30 (10) p. 773-780. ISSN: 1355-557X.
NAL CALL NUMBER: SH1.F8
ABSTRACT: To ascertain the potential for exploiting marine areas for mariculture, data on the cultivation of molluscs and fish in the open sea of the southern Tyrrhenian were collected from May 1994 to June 1995. The aims of this integrated study were to test simple breeding methods for molluscs and fish, to apply these to the practices employed by local fishermen and to experiment with the use of a cage system requiring a low level of investment. Crassostrea gigas (Thunberg) and Mytilus gallo-provincialis (Lamarck) were cultivated on submerged long lines around cages used for cultivating Seriola dumerili (Risso) and Diplodus puntazzo (Cetti). S. dumerili specimens were placed in two cages and fed with either fish scraps or pellets, while in a third cage, D. puntazzo were fed with pellets only. After a period of 12 months, the following results were obtained: the oysters measured 47.50 +/- 12.30 mm and weighed 0.13 +/- 0.09 g; the mussels placed in culture as juveniles reached a length of approximately equal to 40 mm, while the mussels placed in culture as subadults reached the commercial size of about 60 mm. The mean length and weight measurements of the two fish species were as follows: Diplodus 228 +/- 14.4 mm and 228 +/- 40.48 g; Seriola (lot A) 438.1 +/- 25.28 mm and 1149 +/- 172.2 g; Seriola (lot B) 347 +/- 25.6 mm and 576 +/- 139 g.
DESCRIPTORS: fish culture, Mollusc culture, breeding methods, sexual reproduction, cages, fish feeding, pelleted feeds, liveweight, length, integrated systems, sicily, Mediterranean Sea.

Muroga, K.; Inui, Y.; Matsusato, T. (1999) **Workshop "Emerging diseases of cultured marine molluscs in Japan".** *Gyobyo-Kenkyu-=-Fish-Pathology* 34: 4, 219-231; 6 ref., ISSN: 0388-788X. Note: In Japanese.
NAL CALL NUMBER: SH171.G86
DESCRIPTORS: mortality, diagnosis, risk factors, environmental temperature, aetiology, pathology, oysters, Japan, amyotrophia, Bivalvia, aquatic animals, aquatic organisms, East Asia, Asia, developed countries, OECD countries, prion viral bacterial and fungal pathogens of animals, diagnosis of animal diseases, aquaculture animals.

O'Connor, S. J.; M. P. Heasman; W. A. O'Connor. **Evaluation of alternative suspended culture methods for the commercial scallop, Pecten fumatus Reeve.** *Aquaculture.* Amsterdam, Elsevier. Feb 15, 1999. v. 171 (3/4) p. 237-250. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: Commercial scallops, Pecten fumatus, glued to plastic mesh disks showed growth and survival equal to or greater than similar sized scallops in conventional earhung and cage

culture. In two experiments of 13 and 25 weeks duration, some aspects of disk culture, such as spacing between disks, scallop orientation and the choice of valve by which the scallops were glued, were examined to determine their effects on shell growth, somatic tissue weight increase, predation and survival. As disk spacing was increased through 40, 60, 80 to 100 mm, predation increased at disk spacing greater than 60 mm and total soft tissue mass peaked at 60 mm and above. There were no significant differences in soft body weight or shell height between scallops glued by either valve in either normal (flat left valve uppermost) or inverted (cupped right valve uppermost) orientation. However, scallops glued by the left valve had higher percentage survival and larger muscle weights regardless of orientation. By contrast, those glued by the right valve had heavier gonads. Orientation and the scallop culture technique employed significantly affected spionid polychaete infestation of the shell. Scallops glued by the left valve, with left or right valve uppermost, and glued by the right valve with this valve uppermost had significantly lower polychaete prevalence than scallops contained in cages, earhung or glued by the right valve with left valve uppermost.
DESCRIPTORS: Pecten, Mollusc culture, evaluation, techniques, growth, survival, orientation, stocking density, liveweight gain, predation, adhesion, infestation, height, gonads.

Pfeiffer, T. J.; T. B. Lawson; K. A. Rusch. **Northern quahog, Mercenaria mercenaria, seed clam waste characterization study: precursor to a recirculating culture system design.** *Aquac Eng.* Amsterdam, The Netherlands : Elsevier Science. Aug 1999. v. 20 (3) p. 149-161. ISSN: 0144-8609.
NAL CALL NUMBER: SH1.A66
ABSTRACT: The high demand and price of the northern quahog, Mercenaria mercenaria, enable this species to be an excellent commercial aquaculture candidate for coastal Georgia. The most economical method to grow clams is in the natural environment at controlled densities. Commercial nurseries grow small seed from the hatchery (1-2 mm) to a size suitable for planting in the field (8-10 mm). The pivotal role of the nursery phase to the success of bivalve mariculture has prompted research into improving nursery culture systems. Utilizing recirculation technology can contribute to the development and success of land-based nursery systems that offer higher survival and faster growth than field-based systems. This paper presents baseline excretion data that can be useful in the design of a recirculating system for culturing bivalve Mercenaria seed clams in a land-based system. The total ammonia nitrogen excretion rate based on a 24-h isolation period ranged from 20.0 to 89.4 microgram NH(4)-N g clam(-1) day(-1) for Mercenaria seed clams with a shell length ranging from 3.0 to 12.6 mm. The low ammonia production rate combined with the high ammonia tolerance limits of bivalves minimizes the need for a biofilter unit. The BOD(5) loading rate was highly variable and ranged from 0.05 to 0.32 mg l(-1)-O(2) g clam(-1) day(-1). For the seed clams that were less than 8 mm in shell length, the effluent total suspended solids concentration was three times greater than the larger size clams (10-12 mm shell length). Results indicated the importance of a solids removal mechanism to decrease the BOD(5) loading rate and reduce potential psuedofaeces production.
DESCRIPTORS: Mercenaria mercenaria, Mollusc culture, water reuse, animal wastes, population density, rearing techniques, survival, growth, excretion, ammonium nitrogen, ammonia, biological filtration, biochemical oxygen demand, turbidity, size, filtration, water purification, Georgia.

Racuyal, J.T.; Albina, M.B.; Masbad, M.; Severo, R.T.; Mabonga, D.A.; Doncillo, L.D.; Delima, E.A.; Maiso, B.P. (1999) *Establishment of red tide monitoring center in Region 8 [Eastern Visayas, Philippines].* Philipine Council for Aquatic and Marine Research and Development - Department of Science and Technology, Los Banos, Laguna (Philippines). Research and development highlights of the NARRDS (National Aquatic Resources Research and

Development System) 1993-1997. Los Banos, Laguna (Philippines). 1999. 416 p. Received Feb 2000, ISBN 971-8624-33-3.
ABSTRACT: The recurrence of red tide and paralytic shellfish poisoning (PSP) is a major concern among the government institutions in the country. Inrecent years, however, Maqueda Bay and Villareal Bay face the problem of the periodic occurrence of the harmful algal bloom where the mariculture of green mussels (Perna viridis) are located. Cognizant of the need of information by the government to draw-up contingencies and minimize the effects of the harmful algal bloom on fisheries and public health, a red tide monitoring center was established in Region 8. The red tide monitoring center has mainly focused its activities on upgrading of existing laboratory facilities, environmental monitoring of hydrographic parameters and cell density of Pyrodinium bahamense var. compressum and other marine microalgae. The results of the monitoring cruises indicated that there was an isolated presence of toxic dinoflagellates in April (5,000 cells/l) and Nov (24 cells/l). The presence of the species was considered insignificant. Among the dinoflagellates identified, it was observed that Noctiluca sp. was the most abundant. However, 32 diatom species were also identified and comprised 85 percent, the largest concentrations of the total plankton samples. It was observed that Thalassiosira sp. (2,032,400 cells.l) was the most dominant. Rhizosolenia sp. (1,792,000 cells/l) was recorded next in rank, followed by Thalassionema sp. and Chaeloceros sp. with a total concentration of 633,634 cells/l. The distribution and abundance of diatoms showed that the Thalassiosira sp. was found abundant in station 1 in Nov. The Rhizosolenia sp. dominated the samples in station 2 in Dec while the Chaetoceros sp. was found abundant in April. Hydrographic parameters were also monitored and results (temperature: 26.6 deg C - 31.5 deg C and salinity: 24.5-34 ppt) showed within the ranged of the observed values for Pyrodicium bloom, (i.e. 24.4-31.9 deg C and 24.7-36.8 ppt) in Papua New Guinea.
DESCRIPTORS: Perna, plankton blooms, geographical distribution, foodborne diseases, shellfish, Philippines, Papua New Guinea, Asia, biogeography, Bivalvia, Oceania, Southeast Asia, aquatic ecology.

Ramirez, J. L.; S. Avila; A. M. Ibarra. **Optimization of forage in two food-filtering organisms with the use of a continuous, low-food concentration, agricultural drip system.** *Aquac Eng.* Amsterdam, The Netherlands : Elsevier Science. Aug 1999. v. 20 (3) p. 175-189. ISSN: 0144-8609.
NAL CALL NUMBER: SH1.A66
ABSTRACT: An alternative feeding system for food-filtering organisms in hatcheries is presented. The system consists of a modified agricultural irrigation drip system. The use of this system allows for a continuous water flow and a permanent supply of food in multiple rearing tanks. The system was evaluated using two experimental subjects; white shrimp larvae (Penaeus vannamei) and catarina scallop (Argopecten ventricosus) broodstock. Shrimp larvae under this system grew larger and had a higher survival than those grown under a no-flow, batch-feeding system. Also, this rearing system resulted in a reduction of differences between shrimp larvae derived from spawns of different quality, evidenced by a reduction in the between-family variance component when using it versus a batch, no-flow system. For scallop broodstock, the use of this system optimized forage, inasmuch as it provided a constant supply of food that resulted in a steady removal rate of microalgae by the scallops. That result contrasted with the batch, no-flow system for conditioning scallop broodstock, for which the large amounts of food required during maturation conditioning, added in intervals, resulted in pseudofeces produced and in a large variation in food
availability and therefore also of the microalgae removal rate.

DESCRIPTORS: Argopecten, Penaeus vannamei, forage, feeding, trickle irrigation, equipment, water flow, rearing techniques, tanks, larvae, developmental stages, survival, growth, feces, nutrient availability, phytoplankton, feeds, shrimp culture, Mollusc culture.

Roman, G.; M. J. Campos; C. P. Acosta; J. Cano. **Growth of the queen scallop (Aequipecten opercularis) in suspended culture: influence of density and depth.** *Aquaculture.* Amsterdam, Elsevier. July 15, 1999. v. 178 (1/2) p. 43-62. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: The effects of density and depth on the growth of juveniles of Aequipecten opercularis held in suspended culture for 11 months in the Ria de Arosa (Galicia, NW Spain) were studied. The densities were 25, 50 and 100 spat per tray (200 to 800 spat m(-2)), and depths were 2, 7 and 12 m. Density and depth were found to affect growth. Although maximum growth occurred at 25 scallops tray(-1), the growth recorded at densities of 50 and 100 scallops tray(-1) was only slightly lower. Therefore, on a commercial scale, culture using the higher densities is recommended. There was less growth at 2 m than at 7 and 12 m, due to the surface layers having lower salinities during winter, higher temperatures during summer and lower concentrations of chlorophyll a throughout most of the year. Most growth took place between late autumn and early winter. After 11 months of culture, scallops of initial size 22 mm (shell height) and mean weight of 1.14 g reached a mean size of approximately equal to 58 mm and a mean weight of approximately equal to 26 g with mortality of less than 5%. The performance of A. opercularis in suspended culture makes it possible to consider this species as a good candidate for aquaculture in the Galician rias, NW Spain.
DESCRIPTORS: scallops, growth, Mollusc culture, stocking density, depth, developmental stages, salinity, water temperature, chlorophyll, nutrient availability, algae, seasonal variation, liveweight, size, mortality, biological competition, Pectinidae, Spain.

Zhu, S. M.; B. Saucier; J. Durfey; S. L. Chen; B. Dewey. **Waste excretion characteristics of Manila clams (Tapes philippinarum) under different temperature conditions.** *Aquac Eng.* Amsterdam, The Netherlands : Elsevier Science. Sept 1999. v. 20 (4) p. 231-244. ISSN: 0144-8609.
NAL CALL NUMBER: SH1.A66
DESCRIPTORS: tapes, animal wastes, excretion, water temperature, water reuse, ammonium nitrogen, nitrogen, biochemical oxygen demand, Mollusc culture, water quality, feces.

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Adams, C. M.; P. J. Van Blokland. **Economic and financial considerations regarding the small-scale commercial culture of hard clams in Florida.** *J Appl Aquac.* Binghamton, NY : Food Products Press, 1991. 1998. v. 8 (1) p. 19-37. ISSN: 1045-4438.
NAL CALL NUMBER: SH135.J69
DESCRIPTORS: Mercenaria mercenaria, Mollusc culture, economic analysis, income, stocking density, prices, survival, Florida.

Buchal, M. A.; C. J. Langdon. **Evaluation of lipid spray beads for the delivery of water-soluble materials to a marine suspension-feeder, the Manila clam Tapes philippinarum (Deshaes 1853).** *Aquac Nutr.* Oxford, [England] : Blackwell Science, 1995. Dec 1998. v. 4 (4) p. 263-274. ISSN: 1353-5773.
NAL CALL NUMBER: SH156.A658

ABSTRACT: We describe the development and evaluation of a new microparticle for delivering low-molecular weight, water-soluble materials to suspension feeders. Spray beads successfully incorporated materials dissolved in an aqueous phase or as dry particulate, within a triacylglyceride bead composed of tripalmitin, 600 mg g-1 tripalmitin/400 mg g-1 triolein, or 600 mg g-1 tripalmitin/400 mg g-1 fish oil. Riboflavin was successfully incorporated (up to 44 mg g-1 lipid) and retained (up to 98% over 24 h in seawater) as dry particles in all three mixtures of lipid. Aqueous oxytetracycline hydrochloride or polymeric dye were incorporated (45.6 mg g-1 lipid and 18.1 mg g-1 lipid, respectively) and retained best (99% and 94%, respectively) in spray beads composed of tripalmitin. The addition of triolein or fish oil to the lipid bead reduced incorporation and retention efficiencies for aqueous core materials by up to 75%. Manila clam seed readily ingested and digested lipid micro-particles, spray beads and lipid-walled microcapsules. Microparticies composed of tripalmitin were excreted with their payloads intact. Intact microparticles composed of 600 mg g-1 tripalmitin/400 mg g-1 fish oil were largely absent in faecal strands suggesting successful release and delivery of microparticle contents to clams. Spray beads composed of tripalmitin softened with 400 mg g-1 fish oil represent an effective microparticle type for delivering low-molecular weight, water-soluble materials to aquatic suspension feeders.
DESCRIPTORS: tapes, Mollusc culture, feeding, feeds, lipids, evaluation, molecular weight, solubility, fish oils, riboflavin, dyes, feed intake, digestion, feces, encapsulation.

Child, A.R.; Laing, I. (1998) **Comparative low temperature tolerance of small juvenile European, Ostrea edulis L., and Pacific oysters, Crassostrea gigas Thunberg.** *Aquaculture Research* v. 29(2) p. 103-113.
NAL CALL NUMBER: SH1.F8
DESCRIPTORS: feed intake, aquaculture, oysters, Ostrea edulis, Ostrea, Crassostrea gigas, water temperature, temperature, body weight, winter, survival, mortality, behaviour, Bivalvia, feeding habits, seasons, shellfish, temperature.

Dore, W.J.; Henshilwood, K.; Lees, D.N. (1998) **The development of management strategies for control of virological quality in oysters.** *Water Science and Technology* v. 38(12) p. 29-35.
NAL CALL NUMBER: TD420.A1P7
DESCRIPTORS: oysters, Bivalvia, viruses, food hygiene, shellfish, hygiene, infectious diseases, shellfish.

Green, J.; Henshilwood, K.; Gallimore, C.I.; Brown, D.W.G.; Lees, D.N. (1998) **A nested reverse transcriptase PCR assay for detection of small round-structured viruses in environmentally contaminated molluscan shellfish.** *Applied and environmental microbiology* v. 64(3) p. 858-863, ISSN: 0099-2240.
NAL CALL NUMBER: 448.3 AP5
ABSTRACT: We describe the evaluation of a nested reverse transcriptase PCR (RT-PCR) procedure for the detection of small round-structured viruses (SRSVs) in molluscan shellfish and the application of this assay for the detection of SRSVs in commercially produced shellfish and in shellfish implicated in outbreaks of gastroenteritis. The range of virus strains detected and the sensitivity of detection were evaluated by using a representative panel of 21 well-characterized SRSV strains. The nested RT-PCR detected 15 or 21 SRSVs, demonstrating that the assay detects a broad range of SRSVs including strains from both genogroup I and genogroup II. Seeding experiments showed the nested RT-PCR assay to be 10 to 1,000 times more sensitive than the single-round RT-PCR assay for the detection of SRSV in shellfish. SRSV-contaminated samples were identified by nested RT-PCR for shellfish grown in polluted harvesting areas and for shellfish associated with outbreaks of gastroenteritis which were negative by a previously

described single-round RT-PCR. The assay was shown to be effective for investigation of virus elimination during commercial shellfish processing procedures such as depuration and relaying and has potential applications for monitoring at-risk shellfish harvesting areas, for investigation of SRSV contamination in shellfish from producers linked to gastroenteritis outbreaks, and for the direct detection of virus in shellfish implicated in outbreaks.
DESCRIPTORS: Crassostrea gigas, oysters, biological contamination, polymerase chain reaction, microbial contamination.

Hart, A. M.; J. D. Bell; T. P. Foyle. **Growth and survival of the giant clams, Tridacna derasa, T. maxima and T. crocea, at village farms in the Solomon Islands.** *Aquaculture.* Amsterdam, Elsevier. June 15, 1998. v. 165 (3/4) p. 203-220. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: A series of large-scale grow-out trials for giant clams (Tridacna derasa, T. maxima, T. crocea) were undertaken at 11 village farms in Solomon Islands. Eight hundred juveniles of each species, measuring 20-30 mm shell length (SL), were distributed equally between four replicate cages at each site. Growth and survival of the clams were then monitored for up to 24 months. Environmental and husbandry variables were measured throughout these experiments. T. derasa had the best growth and survival, attaining a mean SL of 150 mm +/- 19.8 s.d., and mean weight of 710 g +/- 26 s.d., after 24 months grow-out. Mean survival of T. maxima was 38.9% +/- 16.6 s.d., and survival of T. crocea after 17 months was 39% +/- 22.6 s.d. Factors influencing growth of all species included water temperature, exposure to wave action, water clarity and water flow. Together, these factors explained between 66% and 79% of variation in growth, depending on the species. Regressions of environmental factors against survival were a poorer fit, they explained 15% (T. derasa), 53% (T. maxima), and 52% (T. crocea) of variability among sites. Estimated net revenue for village farmers growing giant clams for the aquarium market was greatest for T. derasa, due to high survival. Although T. crocea is in great demand by the aquarium trade, it was the least suitable species for village farming because it has slow growth and low survival. Unless survival rates at village farms can be enhanced considerably, T. crocea can probably be reared more successfully in a land-based system.
DESCRIPTORS: clams, growth, survival, Mollusc culture, length, animal husbandry, water flow, species, water quality, species differences, economic analysis, income, growth rate, Solomon Islands.

Laing, I.; Earl, N.H. (1998) **The lipid content, spatfall and subsequent growth of early and late settling hatchery-reared Pacific oyster, Crassostrea gigas Thunberg, larvae.** *Aquaculture Research* v. 29(1) p. 19-25.
NAL CALL NUMBER: SH1.F8
DESCRIPTORS: aquaculture, shellfish, Crassostrea gigas, lipids, growth, larvae, animal developmental stages, biological development, Bivalvia.

Laing, I.; A. Psimopoulous. **Hatchery cultivation of king scallop (Pecten maximus) spat with cultured and bloomed algal diets.** *Aquaculture.* Amsterdam, Elsevier. Nov 1, 1998. v. 169 (1/2) p. 55-68. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: Growth rates of small (2-15 mm shell length) hatchery-reared king scallop (Pecten maximus L.) spat were estimated by computer analysis of video images taken of the scallops held in petri dishes containing seawater. This technique reduced the amount of handling and minimised any effect stress due to handling might have had on growth. Experimental diets consisting of algae from both intensive hatchery cultures and from outdoor bloom tanks were fed to the scallop spat. For all diets, growth rate (as increase in shell length) increased linearly with a

logarithmic increase in initial shell length. Scallops thus characteristically showed a growth pattern whereby dry weight-specific growth rate increased rapidly with increasing shell size to a maximum at 4-5 mm shell length (2.6-5.0 mg dry weight). This weight-specific growth rate then showed a gradual decrease with a further increase in shell size. For the algal diets consisting of single species that had been cultured intensively, nutritional value was in the order Pavlova lutheri (Droop) Green > Chaetoceros calcitrans (Paulsen) Takano > Rhinomonas reticulata var. reticulata Novarino > T-ISO (Isochrysis sp.) > Tetraselmis suecica (Kylin) Butcher. A mixture of the first two of these species gave significantly faster growth rates than any other combination of species tested. Growth rates of scallop spat fed bloomed seawater at rations of 0.33-1.0 g (organic weight of algae) g-1 (live weight of spat) week-1 were similar to those fed an intensively cultured algal diet of high nutritional value. There was some evidence that the spat were less efficient at filtering smaller (2-5 micrometers) algae cells.
DESCRIPTORS: Pecten maximus, Mollusc culture, feeds, growth rate, size, image processing, sea water, stress, algae, dry matter, nutritive value, mixtures, filtration.

Lodeiros, C. J.; J. J. Rengel; L. Freites; F. Morales; J. H. Himmelman. **Growth and survival of the tropical scallop Lyropecten (Nodipecten) nodosus maintained in suspended culture at three depths.** *Aquaculture.* Amsterdam, Elsevier. June 1, 1998. v. 165 (1/2) p. 41-50. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: We examined growth and survival of juvenile Lyropecten (Nodipecten) nodosus, measuring 9.4 mm in shell height, which were placed in mid-December 1993 in pearl nets at 8, 21 and 34 m in depth at Turpialito in the Golfo de Cariaco, Venezuela. The mean growth rate in shell height during the first 5 months varied inversely with depth (10.0, 8.5 and 5.0 mm mon-1 at 8, 21 and 34 m in depth, respectively). Somatic tissues also showed a progressively slower growth rate with increasing depth. The decreased growth rate with depth was not associated with the mass of total seston or its organic content but were proportional to the decrease in phytoplankton biomass with depth (chlorophyll a decreased from 4.8 to 0.7 micrograms l-1 between 8 and 34 m). Temperature also decreased with depth but the differences were likely too slight to account for differences in growth. Mortality varied markedly with depth. There was a sharp increase in mortality in July at 34 m and a total mortality in August at 8 m. In contrast, at 21 m survival was high throughout the study. After 5 months (in May), wet muscle mass of the scallops at 8 m attained the commercial size (5-6 g). A possible culture strategy for L. nodosus is to initially grow the scallops at 8 m in depth, where growth is greatest, and then transfer them to 21 m, where survival is greatest and where growth will continue at a moderate rate to a larger size.
DESCRIPTORS: scallops, growth, survival, mortality, Mollusc culture, shells, depth, growth rate, mass, phytoplankton, biomass, chlorophyll, water temperature, seasonal variation, Pectinidae, Venezuela, Caribbean Sea.

Marques, H. L. de A.; R. T. L. Pereira; B. C. Correa. **Seasonal variation in growth and yield of the brown mussel Perna perna (L.) cultured in Ubatuba, Brazil.** *Aquaculture.* Amsterdam, Elsevier. Dec 1, 1998. v. 169 (3/4) p. 263-273. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: Seasonal variation in growth and yield of cultured brown mussels Perna perna was studied in Ubatuba, south-east Brazilian coastline. Young mussels were transplanted (seeded) into four groups of 16 polyethylene net tubes 2 m long, suspended from a wooden raft (18 m2). The first group was set out in April (autumn), the next in July (winter), the next in October (spring) 1984 and the final group in January (summer) 1985. One net tube of each group was sampled monthly and biometric data were collected. Growth was initially faster for the spring

group, but at the end of the culture period length and weight were not statistically different between groups. L(oo) and W(oo) were 73.9. 71.3, 72.7 and 73.8 mm and 26.3, 23.9, 25.7 and 25.7 g for the autumn, winter, spring and summer groups, respectively. Maximum yield was attained 9 months after seeding for groups of autumn, winter and spring (7.2, 5.2 and 6.3 kg X m-1, respectively) and after 10 months for the summer group (6.9 kg X m-1). The conclusion of this study is that, growth and yield were unaffected by the season of seeding at the study site and that it is not commercially worthwhile to farm mussels more than 9 months, due to yield decrease.
DESCRIPTORS: mussels, Mytilidae, seasonal variation, growth, yields, Mollusc culture, growth rate, length, weight, Sao Paulo.

Mitchelmore, C.L.; Chipman, J.K. (1998) **DNA strand breakage in aquatic organisms and the potential value of the comet assay in environmental monitoring.** *Mutat Res* 399(2): 135-47, ISSN: 0027-5107.
NAL CALL NUMBER: QH431.M8
ABSTRACT: This review considers the potential for DNA strand breaks, particularly as measured by the comet assay, to act as a biomarker of genetic toxicity in fish and other aquatic species. The background need for such biomarkers is introduced in relation to carcinogenicity, reproductive effects and other adverse effects of pollution. Sensitive measurements of DNA strand breakage can be achieved, e.g., by alkaline elution, alkaline unwinding or by single cell gel electrophoresis (comet) techniques. The DNA damage can be a reflection, not only of direct strand breakage, but also of alkali-labile sites and of repair enzyme-mediated breakage (i.e., is non-specific). A range of genotoxic chemicals (both with and without the requirement for metabolic activation) give positive effects in various cell types of vertebrate and invertebrate aquatic species, following in vitro and in vivo exposures under laboratory conditions. A limited number of analyses of organisms exposed to polluted waters or sediments in the field have implicated DNA strand breakage as a relatively sensitive, rapid and broad specificity indicator of genotoxic pollutant exposure. The comet assay deserves further exploitation to assess inter-individual and inter-cell variability in response to pollutants and naturally occurring genotoxic stimuli, and to assess the persistence of these effects.
DESCRIPTORS: DNA damage, fishes genetics, cells cultured, chromosome breakage, environmental exposure, liver ultrastructure, mussels genetics, mutagens toxicity, water pollution.

Navarro, J. M.; C. M. Gonzalez. **Physiological responses of the Chilean scallop Argopecten purpuratus to decreasing salinities.** *Aquaculture.* Amsterdam, Elsevier. Sept 1, 1998. v. 167 (3/4) p. 315-327. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: Argopecten purpuratus (Chilean scallop) is a filter-feeding bivalve which inhabits sheltered areas of the north and central Chile. Considering that culture of this species has started in the south of Chile, it is of great interest to know the tolerance of this bivalve to conditions of decreasing salinity, which can occur in these locations. For this purpose, different physiological processes related to the acquisition and utilisation of energy (clearance rate, absorption, oxygen uptake and excretion) were measured at different salinities (30, 27, 24, 21 and 18 per thousand) on a wide range of body size after the scallops had been acclimatised to the experimental salinities for a week at 12 degree C. Clearance rate showed higher and similar values at 30 and 27 per thousand, decreasing significantly at the lower salinities. Oxygen uptake increased with decreasing salinity from 30 to 24 per thousand, showing the lowest value at the extreme condition of 18 per thousand. A similar pattern was presented by the excretion rate, which also increased within the range 30-24 per thousand, to show a reduction with decreasing salinities.

The O/N ratio also decreased with reduction in salinity in the 5 and 10 g size classes. A negative relationship was observed between the size of A. purpuratus and the O/N ratio. Scope for growth was highly affected by low salinities, with positive values only between 27 and 30 per thousand. Negative scope for growth was observed at all the other experimental salinities. The data obtained suggest that the selection of sites to cultivate this species must take into consideration the tolerance of this species to the salinity, and positive growth rates can be expected at salinities over 27 per thousand.
DESCRIPTORS: Pectinidae, salinity, saline water, physiology, Mollusc culture, energy intake, oxygen, uptake, excretion, acclimatization, nitrogen, ratios, nitrogen content, growth rate, site factors.

Rajagopal, S.; V. P. Venugopalan; K. V. K. Nair; G. van der Velde; H. A. Jenner; C. den Hartog. **Reproduction, growth rate and culture potential of the green mussel, Perna viridis (L.) in Edaiyur backwaters, east coast of India.** *Aquaculture.* Amsterdam, Elsevier. Mar 15, 1998. v. 162 (3/4) p. 187-202. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: The green mussel Perna viridis is an edible mollusc with enormous culture potential. This paper presents data on the reproduction, spat settlement and growth rate of P. viridis in Edaiyur backwaters on the east coast of India. The mussels exhibit two spawning periods and temperature appears to regulate the onset of reproductive events. Spat settlement densities are greater in the adjacent coastal waters as compared to the backwaters. Growth rate data show that the mussels reach an average shell length of 83 mm in 1 year. The results also show that shell and meat weight exhibit different seasonal patterns of growth in Edaiyur backwaters. In rope culture, marketable size (50-60 mm shell length) was achieved in about 6 months with an annual production of 47 kg m(-1) and biomass (wet meat weight) of 22 kg m(-1). The annual production values in Edaiyur backwaters are relatively higher than those reported from other parts of India. The present study suggests that Edaiyur backwaters represent a potential site for successful cultivation of P. viridis considering the availability of sustainable wild stocks of P. viridis and abundance of seed along with favourable environmental conditions.
DESCRIPTORS: mussels, sexual reproduction, growth rate, spawning, water temperature, population density, length, seasonal variation, biomass, economic analysis, Mytilidae, mussel culture, India, Indian Ocean.

Sabaliunas, D.; Lazutka, J.; Sabaliuniene, I.; Sodergren, A. (1998) **Use of semipermeable membrane devices for studying effects of organic pollutants: comparison of pesticide uptake by semipermeable membrane devices and mussels.** *Environmental toxicology and chemistry* 17(9): 1815-1824, ISSN: 0730-7268.
NAL CALL NUMBER: QH545 A1E58
ABSTRACT: Uptake of four pesticides-the organochlorines chlordane and endosulfan and the synthetic pyrethroids fenvalerate and allethrin-by triolein-containing semipermeable membrane devices (SPMDs) and by the lake mussel Anodonta piscinalis was studied in a laboratory continuous-flow system. Uptake of the analytes by the SPMDs and mussels was linear during the exposure period of 20 d. These kinetic data were used to calculate the first-order uptake rate constants. On a SPMD-whole body basis, the uptake rates were 3.5 to 5.5 times higher in the membrane devices than in the organisms. The synthetic pyrethroids were sampled at lower rates than the organochlorines, and this difference may be attributed to the larger molecular dimensions of the pyrethroids rather than analyte molecular weight and lipophilicity, which were similar for all test compounds. Because of the disparate sampling rates, concentration factors of analytes differed between SPMDs and mussels. However, the percent composition (ratios) of analytes in SPMDs and in mussels was similar, which indicates that SPMDs may serve as good

surrogates for aquatic organisms with respect to the discriminatory uptake of hydrophobic chemicals. Semipermeable membrane device dialysate, mussel extract, as well as two artificial mixtures of the four pesticides were tested with standard toxicity and genotoxicity tests, including Microtox (inhibition of bacterial luminescence), Daphtoxkit, and Rotoxkit (toxicity tests with freshwater invertebrates Daphnia pulex and Brachionus calyciflorus, respectively), and sister chromatid exchange in human lymphocytes in in vitro assay. Results of these tests suggest that integration of the SPMD technique and bioassays may be a valuable approach for the assessment of levels and effects of bioavailable hydrophobic pollutants.
DESCRIPTORS: sampling, chlordane, endosulfan, fenvalerate, allethrin, aquatic animals, bioassays, agricultural chemicals, aquatic organisms, biological analysis, methods, synthetic pyrethrins, pollution, fisheries and aquaculture general aspects.

Shafee, M. S.; A. Berraho; M. Rafik. **Culture of carpet-shell clam, Ruditapes decussatus (L.) on the Atlantic coast of Morocco.** *J Aquac Trop.* Calcutta : Oxford IBH, 1986. Feb 1998. v. 13 (1) p. 17-36. ISSN: 0970-0846.
NAL CALL NUMBER: SH135.J68
DESCRIPTORS: clams, Mollusc culture, growth, survival, growth rate, seasonal variation, body condition, mortality, geographical variation, veneridae, morocco, eastern central Atlantic.

Smith, B. C.; G. H. Wikfors. **An automated rearing chamber system for studies of shellfish feeding.** *Aquac Eng.* Amsterdam, The Netherlands : Elsevier Science. Feb 1998. v. 17 (1) p. 69-77. ISSN: 0144-8609.
NAL CALL NUMBER: SH1.A66
ABSTRACT: Producing large volumes of high quality microalgae to feed shellfish and other organisms is a limiting factor in the development of the aquaculture industry. Feeding regimes yielding the highest conversion efficiencies of algal feed to molluscan growth are required to maximize the return on algal-culture investments. In the past we have used 12 specialized, manually-controlled molluscan rearing chambers to study nutritional requirements and growth of oysters, clams, and scallops. A computer-controlled, solenoid-valve system was added to automate seawater flow, volume of microalgal food delivered, and feeding duration independently for each chamber. Labor was reduced from 7 h per week to 3 h, while adding flexibility. Each chamber represents a model for a programmed nursery system. Evidence that superior growth of bivalves can be achieved by feeding regimes made possible by this apparatus are provided by an experiment with juvenile bay scallops (Argopecten irradians).
DESCRIPTORS: clams, scallops, oysters, feeding, phytoplankton, Mollusc culture, algae culture, feed conversion, feed conversion efficiency, nutrient requirements, growth, duration, volume, sea water, labor, feed dispensers, automation.

Soudant, P.; J. R. Le Coz; Y. Marty; J. Moal; R. Robert; J. F. Samain. **Incorporation of microalgae sterols by scallop Pecten maximus (l.) larvae.** *Comp Biochem Physiol*, Part A Mol integr physiol. New York : Elsevier Science, c1998. Feb 1998. v. 119A (2) p. 451-457. ISSN: 1095-6433.
NAL CALL NUMBER: QP1.C6
ABSTRACT: Changes in sterol composition of Pecten maximus larvae during the larval development stage with standard algal mixtures and unialgal diets were analysed. The sterol composition of four microalgae currently used in mollusc hatchery were also examined. Under standard algal conditions, the larvae quickly use the steryl ester from larvae reserves during the endotrophic and the mixotrophe phases. The preferential incorporation of Pavlova lutheri and T-Isochrysis sterols, rather than Skeletonema costatum sterols, during the larval development stage would indicate that S. costatum cells were poorly ingested and digested by larvae. Among

the ingested sterols, cholesterol and stigmasterol were preferentially incorporated by the larvae. Conversely, the larvae appeared able to limit the incorporation of methylpavlovol, ethylpavlovol, and 4 alpha-methylporiferasterol. In the unialgal experiment, the best growths were obtained with the diet richest in cholesterol (Chaetoceros calcitrans) and the best compromise of good growth and settlement rate was observed with the diet richest in C24 ethyl sterol. The selective incorporation of the cholesterol was confirmed by the larval rearing with C. calcitrans. The strong sterol dietary imprint in larvae corroborated the absence of an important capacity in P. maximus larvae to convert or biosynthesise sterol.
DESCRIPTORS: Pecten maximus, scallop, microalgae sterols, algal mixtures, unialgal diets, larval rearing/ development, Chaetoceros calcitrans, sterol biosynthesis/ uptake/ conversion, nutrition, lipids, incorporation, metabolism.

Southgate, P. C.; P. S. Lee. **Hatchery rearing of the tropical blacklip oyster Saccostrea echinata (Quoy and Gaimard).** *Aquaculture.* Amsterdam, Elsevier. Dec 1, 1998. v. 169 (3/4) p. 275-281. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: This paper reports on two growth trials in which larvae of the tropical black-lip oyster, Saccostrea echinata (Quoy and Gaimard), were reared to settlement, and on early spat growth to 2 weeks post-settlement. Broodstock oysters were induced to spawn by increasing water temperature to 33 degrees C followed by rapid reduction in salinity and water temperature. Female oysters spawned a mean of 8.0 X 10(6) and 9.4 X 10(6) eggs in the first and second spawning, respectively. The maximum number of eggs spawned per individual was 18 X 10(6). Mean egg diameter was 52.9 +/- 3.2 micrometer (+/- s.d. n = 30) and 55.2 +/- 2.8 micrometer (n = 50) in the first and second spawning, respectively. Larvae reared at 28-31.2 degrees C and fed an algal diet consisting of Isochrysis sp. (clone T-ISO), Paulova salina and Chaetoceros muelleri reached settlement 20 days after-fertilisation. However, larvae reared at 27-30 degrees C and fed only T-ISO and P. salina developed more slowly and did not reach settlement until 25 days after fertilisation. Survival from D-stage to competent pediveliger stage was low and ranged from 4.2-5.2%. At 2 weeks post-settlement, spat had a mean shell length of 2.3 +/- 0.4 mm and a mean dry weight of 1.7 +/- 0.2 mg. Although S. echinata seed can successfully be reared in the hatchery, poor larval survival may limit the potential of this species to support a hatchery-based aquaculture industry.
DESCRIPTORS: oysters, Ostreidae, larvae, growth rate, developmental stages, spawning, water temperature, salinity, ova, diameter, fecundity, Mollusc culture, algae, length, dry matter, survival.

Spencer, B. E.; M. J. Kaiser; D. B. Edwards. **Intertidal clam harvesting: benthic community change and recovery.** *Aquac Res.* Oxford : Blackwell Science, c1995. June 1998. v. 29 (6) p. 429-437. ISSN: 1355-557X.
NAL CALL NUMBER: SH1.F8
ABSTRACT: Mechanical harvesting of intertidal bivalve molluscs inevitably leads to the physical disturbance of the substratum and its associated fauna. Hence, it is necessary to consider the consequences of such activities for the requirements of other species (e.g. fish and birds) which utilize these areas. The present study reports a long-term experiment that studied the effects of Manila clam, Tapes philippinarum Adams and Reeve, cultivation on an estuarine benthic habitat and its fauna. The study began with the initial seeding of the clams, and continued through ongrowing, and finally, harvesting 30 months later. Earlier observations revealed that plots covered with netting elevated sedimentation rate, and hence, encouraged the proliferation of certain deposit-feeding worm species which persisted throughout the cultivation cycle until harvesting took place. The immediate effects of harvesting by suction dredging caused a

reduction of infaunal species and their abundance by approximately 80%. Recovery of the sediment structure and the invertebrate infaunal communities, judged by similarity to the control plots on both the harvested and unharvested but originally netted plots, had occurred 12 months after harvesting. Comparisons with other similar studies demonstrate that, in general, suction harvesting causes large short-term changes to the intertidal habitat. The rate at which recolonization occurs and sediment structure is restored varies according to local hydrography, exposure to natural physical disturbance and sediment stability. The management of clam farming procedures and other forms of mechanical harvesting should incorporate a consideration of site selection rotational seeding, cultivation and harvesting to create fallow areas, and seasonal harvesting to ameliorate the recovery of sites.
DESCRIPTORS: tapes, coastal areas, collection, communities, ecosystems, long term experiments, estuaries, Mollusc culture, benthos, habitats, species diversity, colonization, community ecology, sediment.

Utting, S. D.; P. F. Millican. **The role of diet in hatchery conditioning of Pecten maximus L.: a review.** *Aquaculture.* Amsterdam, Elsevier. June 15, 1998. v. 165 (3/4) p. 167-178. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: Techniques to bring adult scallops Pecten maximus L. into spawning condition in a hatchery environment, known as broodstock conditioning, are reviewed. Previously unpublished data from experiments carried out at the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) Conwy Laboratory on food quantity and quality are also included. Factors shown to be important for the production and viability of scallop eggs and embryos (in terms of numbers developing into D-larvae) are identified. In particular, eicosapentaenoic acid (20:5n-3), docosahexaenoic acid (22:6n-3) and arachadonic acid (20:4n-6) are named as essential fatty acids that must be supplied in microalgae diets during broodstock conditioning. Other factors that are considered include the uptake and assimilation of microalgae species as well as the optimisation of seawater temperature and photoperiod. Techniques for the hatchery conditioning of P. maximus are discussed in relation to those for other pectinid species.
DESCRIPTORS: eicosapentaenoic acid, Pecten maximus, Mollusc culture, feeding, feeds, spawning, feed rations, quality, ova, embryos, larvae, biological development, docosahexaenoic acid, algae, water temperature, photoperiod, literature reviews.

Walker, R. L. **Comparative gametogenesis of Spisula solidissima solidissima and Spisula solidissima similis cultured in coastal Georgia.** *J World Aquac Soc.* Baton Rouge, La. : World Aquaculture Society, c1987. 1998. v. 29 (3) p. 304-312. ISSN: 0893-8849.
NAL CALL NUMBER: SH138.W62
DESCRIPTORS: Spisula solidissima, genetic variation, gametogenesis, reproductive physiology, seasonal variation, Mollusc culture, gonads, spawning, sex ratio, developmental stages, Georgia.

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Barber, B. J.; C. V. Davis. **Growth and mortality of cultured bay scallops in the Damariscotta River, Maine (USA).** *Aquac Int.* London : Chapman & Hall, 1993. Sept 1997. v. 5 (5) p. 451-460. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627

DESCRIPTORS: Argopecten irradians, Mollusc culture, growth, seasonal variation, water temperature, shells, height, nets, survival, mortality, evaluation, life cycle, growth rate, rivers, Maine.

Cliche, G.; S. Vigneau; M. Giguere. **Status of a commercial sea scallop enhancement project in Iles-de-la-Madeleine (Quebec, Canada).** *Aquac Int.* London : Chapman & Hall, 1993. May 1997. v. 5 (3) p. 259-266. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: research, Pectinidae, population density, Mollusc culture, fisheries, animal breeding, nets, growth, height, growth rate, Quebec.

Felix Pico, E. F.; A. Tripp Quezada; J. L. Castro Ortiz; G. Serrano Casillas; P. G. Gonzalez Ramirez; M. Villalejo Fuerte; R. Palomares Garcia; F. A. Garcia Dominguez; M. Mazon Suastegui; G. Bojorquez Verastica. **Repopulation and culture of the Pacific Calico scallops in Bahia Concepcion, Baja California Sur, Mexico.** *Aquac Int.* London : Chapman & Hall, 1993. Nov 1997. v. 5 (6) p. 551-563. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: Argopecten, Mollusc culture, biomass production, growth, mortality, water temperature, sexual reproduction, collection, weight, seasonal variation, geographical variation, population density, survival, Mexico.

Harvey, J.S.; Lyons, B.P.; Waldock, M.; Parry, J.M. (1997) **The application of the 32P-postlabelling assay to aquatic biomonitoring.** *Mutat Res* 378(1-2): 77-88, ISSN: 0027-5107.
NAL CALL NUMBER: QH431.M8
ABSTRACT: The aquatic environment is known to contain a variety of natural and anthropogenic compounds that are capable of interacting with the genetic material of aquatic organisms. The increases in the levels of these anthropogenic contaminants, associated with widespread industrialisation, has led to the requirement for reliable methodologies to monitor their potential impact upon exposed aquatic organisms. Of the molecular techniques currently available, the 32P-postlabelling assay for the detection of DNA adducts offers considerable potential for the qualitative and quantitative assessment of genotoxin exposure. Here we describe several studies in which the technique was adapted for evaluation in two marine bioindicator species the common mussel Mytilus edulis and the flatfish Limanda limanda. Laboratory studies in which M. edulis specimens were exposed to 2-aminofluorene and 4-nitroquinoline 1-oxide confirmed the species' capacity to form genotoxin-related adducts. However, in further studies, no exposure-related adducts could be detected in M. edulis specimens placed in mesocosms containing environmentally realistic levels of anthropogenic contaminants. Biologically significant levels of adducts were detected in L. limanda specimens exposed to sediment bound contaminants under controlled conditions, although the levels did not appear to be statistically significant. An in situ study in which adduct levels were determined in L. limanda specimens from two sites of contrasting contamination levels proved to be more conclusive. The results were both biologically and statistically significant, suggesting that adduct levels could well be related to the levels of sediment-bound contaminants. Together the studies confirmed that the determination of the levels of DNA adducts could be used as indicators of the exposure of aquatic organisms to environmental genotoxins.
DESCRIPTORS: DNA adducts analysis, environmental monitoring, flatfishes metabolism, mussels chemistry, mutagens analysis, water pollutants, chemical analysis, Aspergillus nuclease S1 metabolism, autoradiography, chromatography thin layer, DNA metabolism, DNA adducts metabolism, England, gills chemistry, liver chemistry, marine biology, mutagens metabolism,

mutagens toxicity, pancreas chemistry, phosphorus radioisotopes metabolism, polychlorinated biphenyls analysis, polychlorinated biphenyls metabolism, polychlorinated biphenyls toxicity, polycyclic hydrocarbons, aromatic analysis, polycyclic hydrocarbons, aromatic metabolism, polycyclic hydrocarbons, aromatic toxicity, seawater, water pollutants, chemical metabolism, water pollutants, chemical toxicity.

Hawkins, A.J.S.; Smith, R.F.M.; Bougrier, S.; Bayne, B.L.; Heral, M. (1997) **Manipulation of dietary conditions for maximal growth in mussels, Mytilus edulis, from the Marennes-Oleron Bay, France [maximum growth rate].** *Aquatic Living Resources* v. 10(1) p. 13-22, ISSN 0990-7440.
NAL CALL NUMBER: SH1.A8
DESCRIPTORS: mussels, Mytilus edulis, feeding habits, growth, fish feeding, diet, rations, experimentation, France, animal feeding, aquaculture, behaviour, biological development, Bivalvia, Europe, fish culture, Mediterranean countries, Mytilus, shellfish, Western Europe.

Lu, Y.; N. J. Blake. **The culture of the southern bay scallop in Tampa Bay, an urban Florida estuary.** *Aquac Int.* London : Chapman & Hall, 1993. Sept 1997. v. 5 (5) p. 439-450. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: Argopecten irradians, Mollusc culture, sea water, feeding, feeds, algae, spawning, ova, fecundity, larvae, metamorphosis, shells, height, nets, survival, mortality, evaluation, growth, life cycle, estuaries, Florida.

Pozdnyakova, L. A.; A. V. Silina; G. A. Evseev. **Age, size distribution and growth of native and cultured Japanese scallops in Possjet Bay, Sea of Japan, Russia.** *Aquac Int.* London : Chapman & Hall, 1993. Jan 1997. v. 5 (1) p. 79-88. ISSN: 0967-6120.
NAL CALL NUMBER: SH1.A627
DESCRIPTORS: Bivalvia, age differences, size, growth, Mollusc culture, population dynamics, geographical distribution, height, geographical variation, shells, liveweight, Pectinidae, Russia, Sea of Japan.

1996

Atmar, R.L.; Neill, F.H.; Woodley, C.M.; Manger, R.; Fout, G.S.; Burkhardt, W.; Leja, L.; McGovern, E.R.; Le-Guyader, F.; Metcalf, T.G.; Estes, M.K. (1996) **Collaborative evaluation of a method for the detection of Norwalk virus in shellfish tissues by PCR.** *Appl Environ Microbiol* 62(1): 254-8, ISSN: 0099-2240.
NAL CALL NUMBER: 448.3 AP5
ABSTRACT: A multicenter, collaborative trial was performed to evaluate the reliability and reproducibility of a previously described method for the detection of Norwalk virus in shellfish tissues with the PCR (R.L. Atmar, F. H. Neill, J. L. Romalde, F. Le Guyader, C. M. Woodley, T. G. Metcalf, and M. K. Estes, Appl. Environ. Microbiol. 61:3014-3018, 1995). Virus was added to the stomachs and hepatopancreatic tissues of oysters or hard-shell clams in the control laboratory, the samples were shipped to the participating laboratories, and viral nucleic acids were extracted and then detected by reverse transcription-PCR. The sensitivity and specificity of the assay were 85 and 91%, respectively, when results were determined by visual inspection of ethidium bromide-stained agarose gels; the test sensitivity and specificity improved to 87 and 100%, respectively, after confirmation by hybridization with a digoxigenin-labeled,

virus-specific probe. We have demonstrated that this method can be implemented successfully by several laboratories to detect Norwalk virus in shellfish tissues.
DESCRIPTORS: Norwalk virus isolation and purification, polymerase chain reaction methods, shellfish virology, base sequence, clams virology, evaluation studies, molecular sequence data, oysters virology, RNA, viral analysis, reproducibility of results, sensitivity and specificity.

Brooke, S.; Mann, R. (1996) **Use of mesocosms for 'in situ' culture of marine invertebrate larvae.** *Journal of Shellfish Research* 15 (2) 491-492, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: development, ecology, environmental sciences, general life studies, physiology, wildlife management, conservation, Pelecypoda, Crassostrea virginica.

Gatenby, C.M.; Neves, R.J.; Parker, B.C. (1996) **Influence of sediment and algal food on cultured juvenile freshwater mussels.** *Journal of the North American Benthological Society* 15 (4) 597-609, ISSN: 0887-3593.
NAL CALL NUMBER: QL141.F7
DESCRIPTORS: freshwater ecology, environmental sciences, nutrition, physiology, soil science, wildlife management, conservation, Chlorophyta, Algae, Plantae, Flagellata, Protozoa, Lepidoptera, Insecta, Arthropoda, Pelecypoda.

1995

Araya, N.O.; Ganning, B.; Bucke, R.F. (1995) **Embryonic development, larval culture, and settling of American pearl-oyster (Pteria sterna, Gould) spat.** *California Fish and Game* 81 (1) 10-21, ISSN: 0008-1078.
NAL CALL NUMBER: 410 C12
DESCRIPTORS: development, estuarine ecology, environmental sciences, physiology, wildlife management, conservation, Pelecypoda, Pteria sterna.

Belda, C.A.; Yellowlees, D. (1995) **Phosphate acquisition in the giant clam-zooxanthellae symbiosis.** *Marine Biology Berlin* 124 (2) 261-266, ISSN: 0025-3162.
NAL CALL NUMBER: QH91.A1M35
DESCRIPTORS: biochemistry and molecular biophysics, cell biology, ecology, environmental sciences, marine ecology, nutrition, physiology, Flagellata, Protozoa, Pelecypoda, Pyrrophyta, Algae, Plantae, Flagellata, Symbiodinium sp., Tridacna gigas, algae, microorganisms, nonvascular plants, protozoans.

Dore, W. J.; D. N. Lees. **Behavior of Escherichia coli and male-specific bacteriophage in environmentally contaminated bivalve molluscs before and after depuration.** *Appl Environ Microbiol.* Washington : American Society for Microbiology. Aug 1995. v. 61 (8) p. 2830-2834. ISSN: 0099-2240.
NAL CALL NUMBER: 448.3 Ap5
ABSTRACT: We monitored the differential reduction rates and elimination patterns of Escherichia coli and male-specific (F+) bacteriophage during UV depuration for 48 h in oysters (Crassostrea gigas) and mussels (Mytilus edulis) contaminated by short-term (1 to 3 weeks) and long-term (more than 6 months) exposure to sewage in the marine environment. The time taken to reduce levels of E. coli by 90% was 6.5 h or less in all cases. In contrast, the amounts of time needed to reduce levels of F+ bacteriophage by 90% were considerably longer: 47.3 and 41.3 h (after short- and long-term exposures, respectively) in mussels and 54.6 and 60.8 h (after short-

and long-term exposures, respectively) in oysters. No differences in the rates of reduction of indicators of viral pollution following exposure of the shellfish to either short- or long-term sewage contamination were observed. Further experiments were conducted with mussels to determine the relative distributions of E. coli and F+ bacteriophage in tissue before and during depuration. Prior to depuration the majority of E. coli organisms (90.1%) and F+ bacteriophage (87.3%) were detected in the digestive tract (i.e., the digestive gland and intestine). E. coli and F+ bacteriophage were reduced in all tissues except the digestive gland to undetectable levels following depuration for 48 h. Within the digestive gland, levels of F+ bacteriophage were reduced to 30% of initial levels, whereas E. coli was reduced to undetectable levels. These results confirm previous laboratory studies showing the differential reductions of levels of E. coli and F+ bacteriophage during depuration. They also demonstrate that these differential elimination patterns are not affected by the duration of sewage contamination and that F+ bacteriophage are retained only in the digestive gland and are not sequestered into other internal tissues.
DESCRIPTORS: Escherichia coli, bacteriophages, microbial contamination, Crassostrea gigas, Mytilus edulis, sewage, decontamination, ultraviolet radiation, indicator species, digestive tract, intestines.

Le Bris, H.; Pouliquen, H.; Debernardi, J.M.; Buchet, V.; Pinault, L. (1995) **Preliminary study on the kinetics of oxytetracycline in shellfish exposed to an effluent of a land-based fish farm: Experimental approach.** *Marine Environmental Research* 40 (2) 171-180, ISSN: 0141-1136.
DESCRIPTORS: biochemistry and molecular biophysics, marine ecology, environmental sciences, physiology, pollution assessment control and management, toxicology, wildlife management, conservation, Pelecypoda.

Numaguchi, K. (1995) **Effects of water temperature on catabolic losses of meat and condition index of unfed pearl oyster Pinctada fucata martensii.** *Fisheries Science* v. 61(5) p. 735-738, ISSN 0919-9268.
NAL CALL NUMBER: SH1.F8195
DESCRIPTORS: Pinctada fucata, starvation, environmental temperature, body condition, evaluation, catabolism, meat, dry matter content, weight losses, laboratory experimentation, animal products, Bivalvia, environmental factors, experimentation, feeding, losses, metabolism, Pinctada, proximate composition, temperature.

Pipe, R.K.; Coles, J.A. (1995) **Environmental contaminants influencing immune function in marine bivalve molluscs.** *Fish and Shellfish Immunology* v. 5(8) p. 581-595.
NAL CALL NUMBER: QL638.97 F55
DESCRIPTORS: pollutants, water pollution, contamination, immunity, phagocytes, immune response, heavy metals, blood, pollution, Bivalvia, cadmium, copper, phenolic compounds, aromatic compounds, cells, elements, heavy metals, immunity, metallic elements, pollution, transition elements.

Ruiz, A.P.; Rodriguez, S.R.; Martin, J.B. (1995) **Culture of coquina clam, Donax trunculus, larvae.** *Aquaculture* 139: 1-2, 151-155; 13 ref., ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
DESCRIPTORS: aquaculture, larvae, culture, chloramphenicol, growth, survival, sources, environmental temperature, antibiotics, Donax, algae, clams, Isochrysis, Chaetoceros, Tetraselmis, Rhodomonas, Donacidae, Bivalvia, plants, aquaculture animals, microbiology of

feed processing, feed additives, animal nutrition production responses, animal toxicology, poisoning and pharmacology.

Shi, A.J.; Chen, S.N. (1995) **Polarization microscopic observation on the secretion of the in vitro cultured mantle of Critaria plicata.** *Acta Zoologica Sinica* 41 (1) 35-40, ISSN: 0001-7302. Note: In Chinese.
NAL CALL NUMBER: 410 AC87
DESCRIPTORS: freshwater ecology, environmental sciences, methods and techniques, morphology, physiology, Pelecypoda, Critaria plicata.

Ver, L.M.; Wang, J.K. (1995) **Design criteria of a fluidized bed oyster nursery.** *Aquacultural Engineering* 14 (3) 229-249, ISSN: 0144-8609.
NAL CALL NUMBER: SH1.A66
DESCRIPTORS: development, digestive system, ingestion and assimilation, marine ecology, environmental sciences, nutrition, physiology, wildlife management, conservation, Pelecypoda.

Zaroogian, G.; Anderson, S. (1995) **Comparison of cadmium, nickel and benzo(alpha)pyrene uptake into cultured brown cells of the hard shell clam, Mercenaria mercenaria.** *Comparative Biochemistry and Physiology C Pharmacology Toxicology and Endocrinology* 111(1): 109-116.
NAL CALL NUMBER: QP901.C6
DESCRIPTORS: Bivalvia, cell culture, Mercenaria, cadmium, nickel, benzopyrene, hydrocarbons, pollutants, heavy metals, clams, aromatic compounds, aromatic hydrocarbons, culture techniques, elements, heavy metals, hydrocarbons, in vitro culture, metallic elements, shellfish, transition elements, miscellaneous animal disorders, aquaculture production, animal physiology nutrition.

1994

Dimock, R.V. Jr.; Wright, A.H. (1994) **Sensitivity of juvenile freshwater mussels to hypoxic, thermal and acid stress.** *Journal of the Elisha Mitchell Scientific Society* 109 (4) 183-192, ISSN: 0013-6220.
NAL CALL NUMBER: 500 EL4
DESCRIPTORS: biochemistry and molecular biophysics, development, freshwater ecology, environmental sciences, pathology, physiology, wildlife management, conservation, Pelecypoda.

Harewood, P.; Rippey, S.; Montesalvo, M. (1994) **Effect of gamma irradiation on shelf life and bacterial and viral loads in hard-shelled clams (Mercenaria mercenaria).** *Appl Environ Microbiol* 60(7): 2666-70, ISSN: 0099-2240.
NAL CALL NUMBER: 448.3 AP5
ABSTRACT: The feasibility of using 60Co gamma irradiation to inactivate total coliforms, fecal coliforms, Escherichia coli, Clostridium perfringens, and F-coliphage in hard-shelled clams, Mercenaria mercenaria, was investigated. The results of three trials indicated average D10 values of 1.32 kGy for total coliforms, 1.39 kGy for fecal coliforms, 1.54 kGy for E. coli, 2.71 kGy for C. perfringens, and 13.50 kGy for F-coliphage. Irradiation doses of > 0.5 kGy were significantly lethal to the shellfish.
DESCRIPTORS: bacteria isolation and purification, bacteria radiation effects, clams microbiology, clams radiation effects, coliphages isolation and purification, coliphages radiation effects, food irradiation, Clostridium perfringens isolation and purification, Clostridium

perfringens radiation effects, dose response relationship radiation, Enterobacteriaceae isolation and purification, Enterobacteriaceae radiation effects, Escherichia coli isolation and purification, Escherichia coli radiation effects, feces microbiology, food microbiology, gamma rays.

Lees, D.N.; Henshilwood, K.; Dore, W.J. (1994) **Development of a method for detection of enteroviruses in shellfish by PCR with poliovirus as a model.** *Appl Environ Microbiol* 60(8): 2999-3005, ISSN: 0099-2240.
NAL CALL NUMBER: 448.3 AP5
ABSTRACT: The application of the PCR to complex samples is hindered by amplification inhibitors. We describe a reverse transcription-PCR-based method capable of inhibitor removal for the detection of enteroviruses in shellfish. Initial virus extraction stages based on a modified polyethylene glycol precipitation technique (G.D. Lewis and T.G. Metcalf, Appl. Environ. Microbiol. 54:1983-1988, 1988) were followed by virus purification with 1,1,2-trichloro,2,2,1-trifluoroethane and concentration by ultrafiltration. A guanidine isothiocyanate-glass powder extraction system was utilized for sample lysis, RNase protection, and nucleic acid purification. Removal of PCR inhibitors and method sensitivity were quantified in shellfish (oysters and mussels) seeded with poliovirus. PCR sample tolerance exceeded 4 g for depurated shellfish; however, polluted field samples were more inhibitory. Virus recoveries of 31% for oyster extracts and 17% for mussel extracts and nucleic acid extraction reverse transcription-PCR detection limits down to 1 PFU yielded an overall sensitivity limit of < 10 PFU of poliovirus in up to 5 g of shellfish. PCR-positive results were obtained from a variety of polluted field samples naturally contaminated with human enteroviruses. The methods developed for virus recovery and PCR inhibitor removal should be equally applicable to detection of other RNA viruses such as hepatitis A virus, Norwalk virus, and other small round-structured viruses in shellfish.
DESCRIPTORS: Enterovirus isolation and purification, Polioviruses isolation and purification, polymerase chain reaction methods, shellfish microbiology, base sequence, Enterovirus genetics, food microbiology, molecular sequence data, Polioviruses genetics, RNA, viral isolation and purification, RNA directed DNA polymerase, sensitivity and specificity, sewage.

Norton, J. H.; A. D. Thomas; J. R. Barker. **Fungal infection in the cultured juvenile boring clam Tridacna crocea.** *J Invertebr Pathol.* Orlando, Fla. : Academic Press. Nov 1994. v. 64 (3) p. 273-275. ISSN: 0022-2011.
NAL CALL NUMBER: 421-J826
DESCRIPTORS: Bivalvia, mycoses, body parts, histopathology, Mollusc culture.

Peterson, C.H.; Skilleter, G.A. (1994) **Control of foraging behavior of individuals within an ecosystem context: the clam Macoma balthica, flow environment, and siphon-cropping fishes.** *Oecologia* 100(3): 256-267, ISSN: 0029-8549.
NAL CALL NUMBER: QL750 O3
ABSTRACT: Macoma balthica (L.), an abundant clam, ubiquitous in temperate estuaries across the North Atlantic, is known to practice both alternative basic modes of feeding available to seafloor invertebrates. It either holds its feeding organ, the siphon, at a fixed position just above the sediment surface to filter out food particles suspended in the overlying water or else extends and moves its siphon around to vacuum up deposited food particles on the sediment surface. Previous laboratory experiments have established an understanding of the role of current flow in dictating the choice of whether suspension or deposit feeding will be used by marine invertebrates with the facultative flexibility to choose. Faster flows imply greater fluxes of suspended particles so that the energetic rewards of suspension feeding are enhanced. Slower flows imply reduced renewal rates of suspended foods in the bottom boundary layers and

enhanced deposition of food particles on the seafloor so that a switch to deposit feeding is favored. Like early optimal foraging theory, this understanding is based on energetic considerations alone without incorporation of broader implications of how population interactions such as predation and competition influence individual foraging behavior. Feeding behavior of Macoma balthica is influenced in the Neuse River estuary by both hydrodynamics and siphon-cropping by juvenile demersal fishes. Under conditions of identical concentrations of suspended particulates in the water column and organic contents of surface sediments, Macoma exhibited much higher levels of deposit feeding where currents were slower.
DESCRIPTORS: clams, foraging, hydrodynamics, behaviour, saltwater fishes, fishes, physics, shellfish, aquatic ecology.

Van Beneden, R.J. (1994) **Molecular analysis of bivalve tumors: models for environmental/genetic interactions.** *Environ Health Perspect* 102 Suppl 12: 81-3, ISSN: 0091-6765.
NAL CALL NUMBER: RA565.A1E54
ABSTRACT: An increase in both the numbers and types of tumors found in finfish and shellfish has been noted in the past several decades. In many cases, while the increase in tumor incidence can be correlated with increases in aquatic toxicant levels, causality cannot be definitively proven. One recent epidemiologic investigation identified the prevalence of gonadal cancers as high as 40% in softshell clams (Mya arenaria) in Maine and 60% in hardshell clams (Mercenaria spp.) from Florida. A second study of these same geographic areas identified human mortality rates due to ovarian cancer as significantly greater than the national average. The rise in mortality rates in humans correlated with the increased use of herbicides in these areas as well as with the appearance of significant numbers of gonadal tumors in the clams. Studies were initiated in our laboratory to examine the molecular basis of these neoplasms in bivalves. NIH3T3 transfection assays were used to examine DNA isolated from these molluscan tumors for the presence of activated oncogenes. DNAs isolated from advanced tumors in both species were able to transform NIH3T3 cells and induce tumors in athymic mice. Studies are now underway to identify the gene(s) detected by these assays and also to examine the molecular mechanisms of toxic response of herbicide-exposed clams.
DESCRIPTORS: cell transformation, neoplastic genetics, clams genetics, cell transformation, neoplastic drug effects, DNA neoplasm, DNA viral, gonads pathology, gonads virology, herbicides adverse effects, mice, mice mude, neoplasms, experimental pathology, neoplasms experimental virology, receptors aryl hydrocarbon drug effects, water pollutants, chemical adverse effects.

Victor, A.C.C.; Chellam, A.; Dharmaraj, S.; Velayudhan, T.S. (1994) **Recent developments in pearl oyster research in India.** *Journal of Shellfish Research* 13 (1) 353, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: climatology, environmental sciences, development, nutrition, physiology, reproductive system, wildlife management, conservation, Pelecypoda, gonadal development, juvenile, larva, oyster breeding, pearl seeding, rearing, seasonality, spat setting.

1993

Denton, G.R.W.; Heitz, L.F. (1993) *Heavy metal uptake and loss in the burrowing clam, Tridacna crocea: implications from a public health and mariculture viewpoint.* [Conference paper]. Fitt,-W.K. (Georgia Univ., Athens (USA)) (ed.). Biology and mariculture of giant clams.

Canberra, A.C.T. (Australia). Australian Centre for International Agricultural Research. p. 119-132, ISBN 1-86320-095-9.
NAL CALL NUMBER: S542.A8M34 no. 47
ABSTRACT: Field transplant and laboratory exposure studies demonstrate that Tridacna crocea clams possess a marked capacity to confine zinc, copper and lead levels to a remarkably narrow range that is unlikely to exceed health standards even in substantially enriched waters. Prolonged exposure to cadmium, however, may require clams to be purged in clean water before marketing. In contrast, the clam has a high affinity for mercury, and even relatively short and minor episodes of Hg enrichment could have commercially disastrous effects.
DESCRIPTORS: clams, heavy metals, pollutants, water pollution, contamination, foods, elements, metallic elements, pollution, shellfish.

Douillet, P.; Langdon, C.J. (1993) **Effects of marine bacteria on the culture of axenic oyster Crassostrea gigas (Thunberg) larvae.** *Biological Bulletin Woods Hole* 184 (1) 36-51, ISSN: 0006-3185.
NAL CALL NUMBER: 442.8 B52
DESCRIPTORS: development, marine ecology, environmental sciences, morphology, nutrition, physiology, systematics and taxonomy, wildlife management, conservation, bacteria general unspecified, Eubacteria, bacteria, Chrysophyta, algae, Plantae, Flagellata, Protozoa, Pelecypoda.

Kraak, M.H.; Schoon, H.; Peeters, W.H.; Van Straalen, N.M. (1993) **Chronic ecotoxicity of mixtures of Cu, Zn, and Cd to the zebra mussel Dreissena polymorpha.** *Ecotoxicol Environ Saf* 25(3): 315-27, ISSN: 0147-6513.
NAL CALL NUMBER: QH545.A1E29
ABSTRACT: Organisms in contaminated freshwater ecosystems are often exposed to a variety of toxicants for their entire lifetime. To evaluate the ecological consequences of these long-term contaminations, the effects of mixtures of heavy metals on the filtration rate and survival of the freshwater mussel Dreissena polymorpha were studied during chronic exposure. In laboratory experiments, mussels were exposed to equitoxic mixtures of Cu + Zn, Cu + Cd, Zn + Cd, and Cu + Zn + Cd in concentrations causing a 50% decrease in filtration rate in short-term (48 hr) experiments. The filtration rate was measured once a week, during a 9- to 10-week exposure period. For all metal combinations effects on mortality increased when exposure time was prolonged from 48 hr to 9-10 weeks. In contrast, the effects on filtration rate did not increase, indicating that the filtration rate was related to the metal mixture concentration in the water, but not related to the metal concentrations in the mussels. Consequently, the effects on mortality and filtration rate were not related. In short-term experiments Cu + Cd were more than concentrations additive, whereas in chronic experiments Cu + Cd were strongly less than additive, indicating a loss of potential for additivity during prolonged exposure. In general, Cu, Zn, and Cd did not affect each others uptake. It was concluded that the chronic effects of mixtures could not be predicted from their short-term effects nor from the chronic effects of the metals tested individually.
DESCRIPTORS: cadmium toxicity, copper toxicity, mussels drug effects, water pollutants, chemical toxicity, zinc toxicity, cadmium analysis, copper analysis, zinc analysis.

1992

Wildish, D.J.; Kristmanson, D.D.; Saulnier, A.M. (1992) **Interactive Effect of Velocity And Seston Concentration On Giant Scallop Feeding Inhibition.** *Journal of Experimental Marine Biology and Ecology*, V 155, N2, P. 161-168.

NAL CALL NUMBER: QH91.A1J6
DESCRIPTORS: bivalve Mollusk, filtration feeding, velocity seston, filtration rate, growth, flow, fluxes, flow velocity; marine bivalve, particle capture, mussel pump, ciliated larvae, microbial filter feeding.

1991

Martinez Manzanares, E.; F. Egea; D. Castro; M. A. Morinigo; P. Romero; J. J. Borrego. **Accumulation and depuration of pathogenic and indicator microorganisms by the bivalve mollusc, Chamelea gallina L, under laboratory conditions.** *J Food Prot.* Ames, Iowa : International Association of Milk, Food, and Environmental Sanitarians. Aug 1991. v. 54 (8) p. 612-618. ISSN: 0362-028X.
NAL CALL NUMBER: 44.8-J824
ABSTRACT: The comparative accumulation and depuration processes for several microorganisms (Escherichia coli, Salmonella typhimurium, Vibrio parahaemolyticus, Aeromonas hydrophila, Streptococcus faecalis, Staphylococcus aureus, and MS-2 coliphage) by the striped venus, Chamelea gallina, under controlled laboratory conditions were studied. Microorganisms accumulated rapidly in bivalves during the first 6 h, with accumulation rates between 3.2 to 360.5 organisms/h depending on the type of microorganism. The relative patterns and rates of elimination of the microorganisms suggest that they are eliminated from shellfish in two different ways. One is of a mechanical nature that results in microbial elimination during the first 12 h. The other elimination mechanism depends upon the microbial species and their accumulated number. All microorganisms tested were eliminated completely by the molluscs after 3 d of depuration, except MS-2 bacteriophages. Results indicate that MS-2 coliphages may be a more reliable indicator of the microbial depuration efficiency by the shellfish under laboratory conditions than E. coli.
DESCRIPTORS: Bivalvia, microbial flora, purification, growth, bacteriophages, bacterial count, indicators.

1990

Adams C.; B. Pomeroy. **Preliminary financial feasibility analysis for hard clam mariculture systems.** *Staff Pap Univ Fla Food Resour Econ Dep Inst Food Agric Sci.* Gainesville, Fla. : The Department. Feb 1990. (381) 69 p. ISSN: 0886-7615
NAL CALL NUMBER: HD1751.A1S73
DESCRIPTORS: Mercenaria, Mollusc culture, marine fisheries, financial planning, feasibility studies, south eastern states of USA.

1989

Della-Seta, G. (1989) *Aspects of the Italian production of aquaculture and of problems related with trout and mussel culture.* Organisation de Cooperation et de Developpement Economique, Paris (France). Aquaculture. A review of recent experience. Aquaculture. Examen des donnees d' experiences recentes. Paris (France). OCDE. p. 279-290. ISBN 92-64-23218-4. Note: In French.
NAL CALL NUMBER: SH135.A49
DESCRIPTORS: Italy, aquaculture, trout, mussels, production data, fish ponds, brackishwater environment, production location, aquatic environment, diadromous fishes, environments,

Europe, fishes, freshwater fishes, Mediterranean countries, shellfish, western Europe, production economics, aquaculture production.

Fabregas, J.; Otero, A.; Romaris, M.; Cancelo, M.; Munoz, A. (1989) **Computer prediction of the evolution of mollusc cultures: application to Ostrea edulis culture.** *Aquacultural Engineering* 8: 3, 165-176; 7 ref., ISSN: 0144-8609.
NAL CALL NUMBER: SH1.A66
DESCRIPTORS: environmental factors, aquaculture, prediction, automatic control, temperature, oxygen, salinity, pH, Mollusc culture, control, algae, Ostrea edulis.

1988

Fisher, W. S. *Disease processes in marine bivalve molluscs.* Special publication (American Fisheries Society) ; 18. Bethesda, Md. : 1988. viii, 315 p. : ill., maps. ISBN: 0913235520.
NAL CALL NUMBER: QL430.6.D48
DESCRIPTORS: Bivalvia Diseases, Bivalvia Parasites.

McCoy, E. W.; T. Chongpeepien. *Bivalve mollusc culture research in Thailand.* ICLARM technical reports, 0115-5547 ; 19. ICLARM contribution ; no. 455. Bangkok, Thailand : Dept. of Fisheries ; Manila, Philippines : International Center for Living Aquatic Resources Management ; Eschborn, Federal Republic of Germany : Deutsche Gesellschaft fur Technische Ausammenarbeit (GTZ), 1988. xiii, 170 p. : ill., maps. ISBN: 9711022435.
NAL CALL NUMBER: SH367.T5B58
DESCRIPTORS: Shellfish fisheries Research Thailand, Shellfish culture Thailand.

1986

Siri Tookwinas (1986) *Coastal aquaculture ground survey method and survey report at Ban Tanyong Pao, Pattani province [Thailand].* Kasetsart Univ. Kamphaengsaen Campus, Nakhon Pathom (Thailand). Kasetsart Univ. Research and Development Inst. Central Laboratory and Greenhouse Complex Center. Fourth annual conference on methodological techniques in biological sciences. Kan prachum thang wichakan khrang thi 4 technique khong withikan thang witthayasat chiwaphap. Nakhon Pathom (Thailand). 1986. 78 p. p. 33-34.
ABSTRACT: Thailand has a total coast line, both on the Gulf of Thailand and Andaman sea, of approximately 2,600 kms. The mangrove area has been estimated to be 1,099,150 rai and the mud flats to be over one million rai. From the report in 1982, the coastal aquaculture has expanded up to 208,245 rai and production of 89,906 tons/yr. The types of culture are shrimp farm, cage culture of fish, shellfish culture, eg. blood cockle, green mussel and oyster. Coastal ecosystem, or estuarine ecosystem, represents a meeting place between freshwater, as run-off from the land, and sea water. Consequently, the estuarine environment is more extreme, and undergoes more violent fluctuations than the open sea or freshwater habitats. Therefore, coastal aquatic organisms have to tolerate variations in the physico-chemical properties of the habitat. The main purpose of this report is to state some ecological aspects of coastal aquatic organisms which have been cultured in Thailand. Certain bio-physicochemical parameters of the estuarine ecosystem which have influence on cultured species are summarized. Suitable habitats are shown. The coastal aquaculture ground survey method at Ban Tanyong Pao, Pattani province, are also reported in detail.
DESCRIPTORS: aquaculture, coastal fisheries, surveying, yields, water quality, environment, Thailand, Asia, fisheries, quality, Southeast Asia.

1985

Broom, M. J. *The biology and culture of marine bivalve molluscs of the genus Anadara.* International Center for Living Aquatic Resources Management. ICLARM studies and reviews ; 12. Manila, Philippines : ICLARM, 1985. vi, 37 p. : ill. ISBN: 9711022214.
NAL CALL NUMBER: QL408.B7
DESCRIPTORS: Bivalvia, Marine fauna, Aquaculture.

1984

Buroker, N. E. **Gene flow in mainland and insular populations of Crassotrea (mollusca).** *Biol Bull.* Woods Hole, Mass. : Marine Biological Laboratory. June 1984. v. 166 (3) p. 550-557. ill. ISSN: 0006-3185.
NAL CALL NUMBER: 442.8 B52

Fitt, W. K.; C. R. Fisher; R. K. Trench. **Larval biology of tridacnid clams.** *Aquaculture.* Amsterdam : Elsevier Scientific Publishing. June 15, 1984. v. 39 (1/4) p. 181-195. ill. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
DESCRIPTORS: Tridacna gigas, Hippopus hippous.

Hershberger, W. K.; J. A. Perdue; J. H. Beattie. **Genetic selection and systematic breeding in Pacific oyster culture.** *Aquaculture.* Amsterdam : Elsevier Scientific Publishing. June 15, 1984. v. 39 (1/4) p. 237-245. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
DESCRIPTORS: USA, Crassostrea gigas.

Heslinga, G. A.; F. E. Perron; O. Orak. **Mass culture of giant clams (F. Tridacnidae) in Palau.** *Aquaculture.* Amsterdam : Elsevier Scientific Publishing. June 15, 1984. v. 39 (1/4) p. 197-215. ill. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
DESCRIPTORS: Caroline Islands.

Umezawa, S.; Nogami, K.; Fukuhara, O. (1984) **Relation between high mortality and some environmental conditions for ark shell, Scapharca broughtonii (Schrenck) in cage culture.** *Bulletin of the Nansei Regional Fisheries Research Laboratory* (no.16) p. 231-244. Note: In Japanese.
NAL CALL NUMBER: SH19.N35
DESCRIPTORS: bivalves, arkshells, Mollusc culture, mortality, environmental conditions, cages, animal housing, aquaculture, aquatic animals, aquatic organisms, buildings, environment, foods, health, housing, isscaap group b 56, isscaap groups of species, seafoods, shellfish, shellfish culture, vital statistics, zootechny.

Zhang, F. **Mussel culture in China.** *Aquaculture.* Amsterdam : Elsevier Scientific Publishing. June 15, 1984. v. 39 (1/4) p. 1-10. ill., maps. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
DESCRIPTORS: China, Mytilus edulis.

1983

Claus, C.; H. Maeckelberghe; N. de Pauw. **Onshore nursery rearing of bivalve molluscs in Belgium Ostrea edulis, Crassostrea gigas and Venerupis semidecussata.** *Aquacultural Eng.* London : Applied Science Publishers. Mar 1983. v. 2 (1) p 13-26. ill. ISSN: 0144-8609.
NAL CALL NUMBER: SH1.A66
DESCRIPTORS: Belgium.

Shaw, W. N. **The culture of molluscs in Japan. 4. Pearl culture in Japan Pinctada.** *Aquaculture Mag.* Little Rock : Briggs Associates, Inc. Mar/Apr 1983. v. 9 (3) p. 41-42. ill. ISSN: 0199-1388.
NAL CALL NUMBER: SH1.C65
DESCRIPTORS: Japan.

Watling, H. R.; R. J. Watling. **Sandy beach molluscs as possible bioindicators of metal pollution. 2. Laboratory studies Donax serra, Bullia rhodostoma.** *Bull Environ Contam Toxicol.* New York : Springer-Verlag. Sept 1983. v. 31 (3) p. 339-343. ISSN: 0007-4861.
NAL CALL NUMBER: RA1270.P35A1
DESCRIPTORS: metals metabolism, Mollusca metabolism, water pollutants metabolism, water pollutants, chemical metabolism, cadmium metabolism, copper metabolism, zinc metabolism.

1982

Engel, D.W.; Brouwer, M. (1982) **Detoxification of accumulated trace metals by the American oyster, Crassostrea virginica: laboratory vs. environment [Pollutants].** *Physiological mechanisms of marine pollutant toxicity.* New York, Academic Press. p. 89-107.
DESCRIPTORS: pollution, animal physiology and biochemistry, oysters.
NAL CALL NUMBER: QL121 S9 1981

Garland, C.D.; Nash, G.V.; McMeekin, T.A. (1982) **Absence of surface-associated microorganisms in adult oysters (Crassostrea gigas).** *Appl Environ Microbiol.* 44(5): 1205-11, ISSN: 0099-2240.
NAL CALL NUMBER: 448.3 AP5
ABSTRACT: Healthy, actively feeding intertidal oysters were removed from an estuarine environment (Pipeclay Lagoon, Tasmania). The epithelial surfaces of various organs of the mantle cavity and alimentary tract were explored by scanning and transmission electron microscopy. All epithelial tissues examined were ciliated, and nearly all were partly covered with secreted mucus. However, microorganisms were seen rarely in the adhesive mucus and never attached to the epithelium. Electron microscopy also failed to demonstrate a surface microflora in emersed oysters which had been incubated at 5 to 25 degrees C for 6 or 24 h. The absence of an internal surface microflora did not vary on a seasonal basis. In laboratory experiments, oysters were allowed to filter feed from seawater containing diverse types of marine bacteria at concentrations of 10(3) to 10(7)/mL. However, no surface microflora could be found within actively feeding oysters or in emersed animals incubated at 20 degrees C for 6 or 24 h. In contrast, surface-associated microorganisms were detected readily by scanning electron microscopy on the external shell of healthy oysters and on various internal tissues in spoiled oysters. It is suggested that the major mechanisms restricting microbial growth within oysters are ciliary movement and mucus secretion.

DESCRIPTORS: bacteria isolation and purification, oysters microbiology, epithelium microbiology, microscopy, electron, mucus microbiology.

Kikuchi, S.; Fujii, T.; Watanabe, S.; Kikuchi, Y. (1982) **Evaluation of environmental conditions for the surf-clam by the growth of mark-recaptured individuals.** *Bulletin of Tohoku Regional Fisheries Research Laboratory* (no.44) p. 79-82. Note: In Japanese.
NAL CALL NUMBER: SH301.S852
DESCRIPTORS: surf clams, spisula growth, fishing grounds, benthic environment, evaluation, coasts, animals, aquatic animals, aquatic environment, aquatic organisms, biological development, bivalves, clams, environment, fishing areas, foods, isscaap group b 56, isscaap groups of species, methods, physiographic features, physiological functions, physiology, seafoods, shellfish.

1981

Claus, C.; N. De Pauw; E. Jaspers. *Nursery culturing of bivalve molluscs : proceedings of the International Workshop on Culturing of Bivalve Molluscs, Ghent, Belgium, 24-26 February, 1981.* Special publication / European Mariculture Society ; no. 7, 1981. Bredene, Belgium : 1981. xiii, 394 p. : ill.
NAL CALL NUMBER: SH138.S64 no.7 1981
DESCRIPTORS: Shellfish culture Congresses, Oyster culture Congresses, Mollusks Congresses.

MacKenzie, C.L. (1981) **Biotic potential and environmental resistance in the American oyster (Crassostrea virginica) in Long Island Sound.** *Aquaculture* v. 22(3) p. 229-268.
NAL CALL NUMBER: SH1.A6
ABSTRACT: The American oyster (Crassostrea virginica) in Long Island Sound was studied throughout its life span on commercial beds by conducting SCUBA surveys and supporting laboratory tests from 1966-1972. The oyster had a biotic potential of a magnitude large enough to cover the entire bottom of the Sound within a few years, given optimum environmental conditions. The limiting factors were mainly: low temperatures, a lack of clean shell substratum on which oyster larvae could set, and about 20 causes of mortality in sedentary oysters, the most substantial of which were: (1) predation by starfish (Asterias forbesi), oyster drills (Eupleura caudata and Urosalpinx cinerea) and crabs (Cancer irroratus and Neopanope sayi); (2) competition by slipper-shells (Crepidula fornicata and Crepidula plana) and other animals on shells; (3) suffocation by silt and (4) shell fracture during transplating by oyster growers. Oyster mortalities occurred mostly from spring to fall and were negligible during winter. The mortalities were area-specific within beds, bed-Specific and much higher in spat than in 1, 2 and 3-year-old oysters. The survival of oysters from setting of spat throughout their life span on cultured beds was estimated to be 2-5%. Few oysters could survive in the Sound without bed culture. During 1966 and continuing afterwards, the growers applied improved cultural methods and new technologies to remove a number of limiting factors from the beds and this resulted in an oyster "abundance and production takeoff".
DESCRIPTORS: aquatic ecology, oysters, USA.

Mowdy, D.E. (1981) **Elimination of laboratory-acquired cadmium by the oyster Crassostrea virginica in the natural environment.** *Bulletin of Environmental Contamination and Toxicology* v. 26(3) p. 345-351. ISSN: 0007-4861.
NAL CALL NUMBER: RA1270.P35A1
DESCRIPTORS: Pollution; Oysters.

Shaw, W. N. **Nursery culture of bivalve molluscs.** *Aquaculture Mag.* Little Rock, Ark., Briggs Associates, Inc. Nov/Dec 1981. v. 8 (1) p. 36-37. ill. ISSN: 0199-1388.
NAL CALL NUMBER: SH1.C65
DESCRIPTORS: Bivalves, culture, workshop preceedings/ conclusions, housing, grow-out systems, nursery phase/ stage, growth, land-based and natural facilities.

1979

Bayne, B.L.; Moore, M.N.; Widdows, J.; Livingstone, D.R.; Salkeld, P. (1979) **Measurement of the responses of individuals to environmental stress and pollution: studies with bivalve molluscs.** *Philos Trans R Soc Lond B Biol Sci* 286(1015): 563-81, ISSN: 0962-8436.
NAL CALL NUMBER: 501 L84Pb
ABSTRACT: Certain physiological differences between individuals in different populations of the mussel, Mytilus edulis, are described. In particular, the scope for growth differs in space and time and may be used to assess the animals' physiological condition. When the required measurements are made in the field, the rates of growth predicted from the physiological data agree well with observed rates of growth. An alternative approach utilizes mussels transplanted to various waters, with indices of condition then measured in then measured in the laboratory under standard conditions; an example of this approach is illustrated. Laboratory experiments are used to equate various levels of physiological condition with fecundity, in an attempt to equate physiological effects on the individual with likely population damage. A cytochemical index of stress is described, based on the latency of lysosomal enzymes; spatial variability in this index, and its relation with the scope for growth, are discussed. Finally, the results of some experiments on the effects of petroleum hydrocarbons on mussels are described and the presence of inducible activity of NADPH-dependent tetrazolium reductase in the blood cells is demonstrated. Certain considerations that apply in adopting similar measurements of biological effects of pollution in environmental monitoring programmes are discussed.
DESCRIPTORS: hydrocarbons adverse effects, mussels growth and development, seawater, water pollution, England, hemocytes enzymology, hydrolases metabolism, mussels enzymology, NADH-NADPH oxidoreductases metabolism, Rhode Island, Wales.

Frazier, J.M. (1979) **Bioaccumulation of cadmium in marine organisms.** *Environ Health Perspect* 28: 75-9, ISSN: 0091-6765.
NAL CALL NUMBER: RA565.A1E54
ABSTRACT: A general review of cadmium concentrations in marine organisms and studies of cadmium bioaccumulation is presented. Factors which influence cadmium concentrations, such as regional differences, seasonal fluctuations and salinity, are discussed and species which are likely to accumulate cadmium identified. Experimental studies designed to investigate the influence of some of these factors on cadmium bioaccumulation in a filter feeding bivalve mollusk, the American oyster (Crassostrea virginica), are presented. Field studies of seasonal dynamics of cadmium in oysters indicate patterns which may be correlated with seasonal physiological activity. The bioaccumulation of cadmium following input to estuarine systems by natural phenomena is observed. Cadmium concentrations in oysters collected from regions of different salinity suggest an inverse relationship between cadmium concentration and salinity. Laboratory experiments designed to investigate mechanisms of cadmium accumulation demonstrate that an inducible cadmium binding protein, similar to metallothiomein, is present in the American oyster.
DESCRIPTORS: cadmium metabolism, Mollusca metabolism, cadmium analysis, calcium analysis, environmental exposure, magnesium analysis, metalloproteins biosynthesis, oysters

analysis, oysters metabolism, seasons, seawater, sodium chloride, temperature, zinc analysis, animal, comparative study.

Fujii, T. (1979). **The study for periodic behaviour of bivalves, 1: Periodicity observed in short-necked clam Tapes japonica Deshyes put in natural environment.** *Bulletin of Tohoku Regional Fisheries Research Laboratory* (Japan). (Jan 1979). (no.40) p. 37-46, ISSN 0049-402X. Note: In Japanese.
NAL CALL NUMBER: SH301.S852
DESCRIPTORS: aquatic ecology, clam.

Walne, P. R. *Culture of bivalve molluscs : 50 years' experience at Conwy. 2d ed.* Farnham : Fishing News for the Buckland Foundation, 1979. 189 p. : ill. ISBN: 0852380631.
NAL CALL NUMBER: SH367.W3W3 1979
DESCRIPTORS: Oyster culture Wales, Fisheries Wales.

1978

Ito, K. (1978) **Nutritional environment for pearl oyster Pinctada fucata (Gould) in pearl cultured ground, Ago Bay [Japan].** *Bulletin of the National Pearl Research Laboratory* (no.22) p. 2363-2381, Note: In Japanese.
DESCRIPTORS: fisheries production, aquatic ecology, oysters, Japan, littoral zone.

Sobsey, M.D.; Carrick, R.J.; Jensen, H.R. (1978) **Improved methods for detecting enteric viruses in oysters.** *Appl Environ Microbiol* 36(1): 121-8, ISSN: 0099-2240.
NAL CALL NUMBER: 448.3 AP5
ABSTRACT: New and improved methods for concentrating enteroviruses, reoviruses, and adenoviruses from oysters have been developed and evaluated. Viruses are efficiently adsorbed to homogenized oyster meat by adjusting the homogenate to pH 5.0 and a conductivity of less than or equal to 2,000 mg of NaCl per liter. After low-speed centrifugation, the virus-free supernatant is discarded and the viruses are eluted from the sedimented oyster solids with pH 7.5 glycine-NaCl having a conductivity of 8,000 mg of NaCl per liter. The oyster solids are removed by low-speed centrifugation and filtration, and the viruses in the filtered supernatant are concentrated to a small volume by either ultrafiltration or acid precipitation at pH 4.5. The concentrate is treated with antibiotics and inoculated into cell cultures for virus isolation and quantitation. When these methods were tested with oysters experimentally contaminated with polioviruses, reoviruses, and adenoviruses, recovery efficiencies averaged about 46%. With the exception of virus assay and quantitation, these methods are simple and inexpensive enough to be done in typical shellfish microbiology laboratories.
DESCRIPTORS: Adenoviridae isolation and purification, Adenoviruses Simian isolation and purification, food microbiology, microbiological techniques, oysters, Polioviruses isolation and purification, Reoviridae isolation and purification, Reovirus 3 isolation and purification, hydrogen ion concentration, micropore filters, precipitation.

1977

Yamaguchi, K.; Hasuo, M. (1977) **Relation between activity of pearl oyster and seasonal changes of environmental factors in culture ground.** *Bulletin of the National Pearl Research Laboratory* (no.21) p. 2315-2324. Note: In Japanese.
DESCRIPTORS: aquatic ecology, oysters.

1974

Walne, P. R. *Culture of bivalve molluscs : 50 years experience at Conwy / P. r. walne.* Buckland Foundation book. Surrey, Eng. : Fishing News (Books), 1974. 173 p. : ill.
NAL CALL NUMBER: SH367.W3W3
DESCRIPTORS: Bivalves, oyster structure/ physiology/ reproduction, Ostrea edulis, larval observations, oyster larvae hatchery rearing techniques, oyster spats, Tal-y-foel oysterage.

Cephalopods

2000

Claes, M.F.; Dunlap, P.V. (2000) **Aposymbiotic culture of the sepiolid squid Euprymna scolopes: Role of the symbiotic bacterium Vibrio fischeri in host animal growth, development, and light organ morphogenesis.** *Journal of Experimental Zoology* 286 (3): 280-296, ISSN: 0022-104X.
NAL CALL NUMBER: 410 J825
DESCRIPTORS: development, ecology, environmental sciences, Cephalopoda, Vibrionaceae, facultatively anaerobic gram negative rods, Eubacteria, bacteria, microorganisms, Euprymna scolopes, symbiotic host, Vibrio fischeri, symbiotic bacterium, bacteria, Eubacteria, microorganisms, light organ, morphogenesis, light organ accessory tissues, mariculture system, bioluminescent mutualism, predator avoidance.

1997

Lee, J. Y.; J. B. Eun; S. H. Choi. **Improving detection of Vibrio vulnificus in Octopus variabilis by PCR.** *J Food Sci.* Chicago, Ill. : Institute of Food Technologists. Jan/Feb 1997. v. 62 (1) p. 179-182. ISSN: 0022-1147.
NAL CALL NUMBER: 389.8 F7322
ABSTRACT: PCR methods can detect foodborne pathogenic bacteria with simplicity, specificity and speed. In order to improve sensitivity and speed of PCR methods for detection of Vibrio vulnificus in small octopus homogenate, several media and culture conditions were compared. Modified brain heart infusion media containing 2% NaCl and adjusted to pH 8.0 and 30degrees C was most effective for enrichment of the bacteria. Procedures affecting the efficiency of template DNA extraction and target DNA amplification were also optimized. By these combined efforts, a PCR procedure capable of detecting V. vulnificus as low as 10 cells/mL within 10h was developed.
DESCRIPTORS: octopus, pathogens, foodborne diseases, Vibrio vulnificus, detection.

1995

Cortez, T.; Castro, B.G.; Guerra, A. (1995) **Reproduction and condition of female Octopus mimus (Mollusca: Cephalopoda).** *Marine Biology Berlin* 123 (3) 505-510, ISSN: 0025-3162.
NAL CALL NUMBER: QH91.A1M35
DESCRIPTORS: behavior, development, environmental sciences, marine ecology, physiology, reproductive system, Cephalopoda, Octopus mimus, animals, maturation, parental care, spawning.

Sakurai, Y.; Young, R.E.; Hirota, J.; Mangold, K.; Vecchione, M.; Clarke, M.R.; Bower, J. (1995) **Artificial fertilization and development through hatching in the oceanic squids Ommastrephes bartramii and Sthenoteuthis oualaniensis (Cephalopoda: Ommastrephidae).** *Veliger* 38 (3) 185-191, ISSN: 0042-3211.
DESCRIPTORS: biochemistry and molecular biophysics, conservation, development, marine ecology, environmental sciences, morphology, physiology, reproductive system, wildlife management, conservation, Cephalopoda, Ommastrephes bartramii, Sthenoteuthis oualaniensis.

Sanchez, P. (1995) **Age and growth of Illex coindetii.** *ICES Marine Science Symposia* 199 (0) 441-444, ISSN: 0906-060X.
DESCRIPTORS: biosynchronization, climatology, environmental sciences, development, ecology, morphology, physiology, sense organs, sensory reception, Cephalopoda, Illex coindetii, Spain, Europe, Palearctic region.

1989

Sugiyama, M. *Utilization of squid.* Rotterdam : A.A. Balkema, 1989. xv, 251 p., [4] p. of plates : ill. (some col.) ISBN: 9061914795.
NAL CALL NUMBER: SH335.I3313 1989
DESCRIPTORS: Fishery processing, Squids, Squids Composition, Squids Preservation.

1984

Hartwick, E. B.; R. F. Ambrose; S. M. C. Robinson. **Dynamics of shallow-water populations of Octopus dofleini.** *Mar Biol.* Berlin, W. Ger. : Springer International. 1984. v. 82 (1) p. 65-72. maps. ISSN: 0025-3162.
NAL CALL NUMBER: QH91.A1M35
DESCRIPTORS: octopus, marine ecology, fishery resources.

1983

Cook, D. **Squid Marketable item by commercial fishermen in the United States, culture.** *Mar Resour Bull Va Inst Mar Sci.* Glouster Point : The Institute. Winter 1983. v. 15 (1) p. 2-6, 10. ill.
NAL CALL NUMBER: GC1000.M352
DESCRIPTORS: USA.

Dewees, C. M.; R. J. Price. **The California squid fishery Biology, history, processing, marketing.** *Leafl Univ Calif Coop Ext Serv.* Berkeley : The Service. Apr 1983. (21330) 14 p. ill.
NAL CALL NUMBER: S544.3.C2C3
DESCRIPTORS: California.

Ehrhardt, N. M.; P. S. Jacquemin; B. F. Garcia; D. G. Gonzalez; J. M. Lopez. **On the fishery and biology of the giant squid Dosidicus gigas in the Gulf of California, Mexico.** *J Kans Entomol Soc.* Lawrence, Kan. : The Society. 1983. (231) p. 306-340. ill., maps. ISSN: 0022-8567.
NAL CALL NUMBER: 420 K13
DESCRIPTORS: Mexico.

Rayudu, G. V.; P. Chandra Mohan. **Cephalopod fishery and its marketing in India.** *Seafood Export J.* Cochin, India : Seafood Exporters Association of India. July 1983. v. 15 (7) p. 21-22. ISSN: 0037-010X.
NAL CALL NUMBER: SH299.S4
DESCRIPTORS: India.

1982

Macy III., W. K. **Feeding patterns of the long-finned squid, Loligo pealei, in New England waters.** *Biol Bull.* Woods Hole, Mass., Marine Biological Laboratory. Feb 1982. v. 162 (1) p. 28-38. ISSN: 0006-3185.
NAL CALL NUMBER: 442.8 B52
DESCRIPTORS: Loligo pealei, long-finned squid, prey-type selection, feeding strategy, predation, diet, spatial and temporal variations.

Rayudu, G. V.; P. Chandra Mohan. **A note on the fishery of squid and cuttlefish of Visakhapatnam.** *Seafood Export J.* Cochin, India : Seafood Exporters Association of India. Apr 1982. v. 14 (4) p. 23, 25-27. ISSN: 0037-010X.
NAL CALL NUMBER: SH299.S4
DESCRIPTORS: India.

1981

Amaratunga, T. **The short-finned squid (Illex illecebrosus) fishery in eastern Canada Management of the resource.** *J Shellfish Res.* Duxbury, Mass., Battelle. Dec 1981. v. 1 (2) p. 143-152. ill., map.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: Canada.

Dawe, E. G. **Development of the Newfoundland squid (Illex illecebrosus) fishery and management of the resource.** *J Shellfish Res.* Duxbury, Mass., Battelle. Dec 1981. v. 1 (2) p. 137-142. ill.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: Canada.

Grant, W. E.; W. L. Griffin; J. P. Warren. **A management model of the northwest African cephalopod fishery.** *Marine Fish Rev.* Seattle, Wash., Scientific Publications Office, National Marine Fisheries Service, NOAA. Nov 1981. v. 43 (11) p. 1-10. ISSN: 0090-1830.
NAL CALL NUMBER: 157.5 F532
ABSTRACT: Extract: Two versions of a bioeconomic model of the northwest African cephalopod fishery, one assuming an instantaneous natural mortality rate of M = 1.25 on an annual basis and the other a rate of M = 2.0, predict the harvest of octopus, Octopus vulgaris; cuttlefish, Sepia spp.; and squid, Loligo spp. These predictions are compared with actual harvest data, the sensitivity of model behavior to change in important biological parameters is examined, and two management schemes for the fishery are evaluated.
DESCRIPTORS: Africa.

Hirtle, R. W. M.; M. E. DeMont; R. K. O'Dor. **Feeding, growth, and metabolic rates in captive short-finned squid, Illex illecebrosus, in relation to the natural population.** *J Shellfish Res.* Duxbury, Mass., Battelle. Dec 1981. v. 1 (2) p. 187-192. ill.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: Illex illecebrosus, short-finned squid, feeding, growth, metabolic rates, correlations, maintenance, behavioral interactions, respirometry, statistical evaluation, physiology, cannibalism.

1975

Mottet, M. G. *The fishery biology of Octopus dofleini (Wulker) / Madelon Green Mottet.* [Olympia] Management and Research Div., Washington Dept. of Fisheries, /, 1975. iii, 39 p. : ill., map. technical report; no. 16.
NAL CALL NUMBER: SH222.A1W2 No.16
DESCRIPTORS: Octopus dofleini (Wulker), resource management, biology, larval stage, immaturity, maturity, catch methods, traps, drifting lines.

1973

Voss, G. L. **Cephalopod resources of the world.** *Food and Agriculture Organization of the United Nations. Fishery Resources Division. FAO fisheries circular; no. 149.* Rome : Food and Agriculture Organization of the United Nations, 1973. iv, 75 p. : ill., maps.
NAL CALL NUMBER: SH1.F59 No.149
DESCRIPTORS: Cephalopoda.

Gastropods

2001

Gallardo, C. S.; K. A. Sanchez. **Induction of metamorphosis and its effect on the growth and survival of postmetamorphic juveniles of Chorus giganteus (Gastropoda: Muricidae).** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. Oct 1, 2001. v. 201 (3/4) p. 241-250. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
ABSTRACT: One of the most critical steps in the life cycle of a mollusc is marked by its abandonment of planktonic life and passage through metamorphosis to assume a benthonic existence. The present study evaluated the usefulness of potassium ion (as KCl) to determine competence for settlement and effectiveness in induction of metamorphosis in free-swimming larvae of the commercially valuable snail Chorus giganteus. Two groups of larvae were compared, the first of natural origin, and the second from egg
capsules produced under culture conditions. In both cases, concentrations of 20 and 30 mM K(+) ion effectively induced metamorphosis of recently hatched larvae of this species, indicating that they were competent at the moment of release from their egg capsules. Concentrations of 40 and 50 mM of this ion proved toxic to the larvae. Observations were made on the relative effects of artificial induction of metamorphosis on survival and growth in both groups of juvenile snails during their first 5 months in out-culture. The results showed comparatively higher survival of individuals from egg capsules produced in

the culture system. Among the artificially induced subgroups of juvenile snails, those obtained from culture and induced with 30 mM KCl had the highest growth rate. Among the non-induced subgroups, juveniles from culture had higher growth rates than those from the field. The results suggested differences between cohorts of this species with respect to the origin of the egg capsules, which are interacting with the response of the juveniles to the different treatments, a factor of some significance to future research and development of this culture.
DESCRIPTORS: Gastropoda, metamorphosis, developmental stages, biological development, growth, survival, life cycle, potassium, cations, larvae, ova, rearing techniques, toxicity, growth rate.

2000

Evans, F.; C. J. Langdon. **Co-culture of dulse Palmaria mollis and red abalone Haliotis rufescens under limited flow conditions.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. May 2, 2000. v. 185 (1/2) p. 137-158. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
DESCRIPTORS: Haliotis rufescens. Rhodophyta, seaweeds, algae culture, Mollusc culture, mixtures, stocking density, growth rate, photoperiod, illumination, light intensity, water quality, ammonia, uptake, excretion, feed intake, liveweight.

Green, B. J.; W. Y. Li; J. R. Manhart; T. C. Fox; E. J. Summer; R. A. Kennedy; S. K. Pierce; M. E. Rumpho. **Mollusc-algal chloroplast endosymbiosis. Photosynthesis, thylakoid protein maintenance, and chloroplast gene expression continue for may months in the absence of the algal nucleus.** *Plant Physiol.* Rockville, MD : American Society of Plant Physiologists, 1926. Sept 2000. v. 124 (1) p. 331-342. 1ISSN: 0032-0889.
NAL CALL NUMBER: 450 P692
ABSTRACT: Early in its life cycle, the marine mollusc Elysia chlorotica Gould forms an intracellular endosymbiotic association with chloroplasts of the chromophytic alga Vaucheria litorea C. Agardh. As a result, the dark green sea slug can be sustained in culture solely by photoautotrophic CO2 fixation for at least 9 months if provided with only light and a source of CO2. Here we demonstrate that the sea slug symbiont chloroplasts maintain photosynthetic oxygen evolution and electron transport activity
through photosystems I and II for several months in the absence of any external algal food supply. This activity is correlated to the maintenance of functional levels of chloroplast-encoded photosystem proteins, due in part at least to de novo protein synthesis of chloroplast proteins in the sea slug. Levels of at least one putative algal nuclear encoded protein, a light-harvesting complex protein homolog, were also maintained throughout the 9-month culture period. The chloroplast genome of V. litorea was found to be 119.1 kb, similar to that of other chromophytic algae. Southern analysis and polymerase chain reaction did not detect an algal nuclear genome in the slug, in agreement with earlier microscopic observations. Therefore, the maintenance of photosynthetic activity in the captured chloroplasts is regulated solely by the algal chloroplast and animal nuclear genomes.
DESCRIPTORS: Vaucheria, chloroplasts, symbiosis, photosynthesis, thylakoids, protein metabolism, chloroplast DNA, gene expression, nuclei, life cycle, carbon dioxide, light, duration, oxygen, gas production, electron transfer, photosystem i, photosystem ii, light harvesting complexes, Gastropoda.

Neori, A.; M. Shpigel; D. Ben Ezra. **A sustainable integrated system for culture of fish, seaweed and abalone.** *Aquaculture.* Amsterdam : Elsevier Pub. Co., c1972. June 15, 2000. v. 186 (3/4) p. 279-291. ISSN: 0044-8486.
NAL CALL NUMBER: SH1 .A6
ABSTRACT: A 3.3 m(2) experimental system for the intensive land-based culture of abalone, seaweed and fish was established using an integrated design. The goals were to achieve nutrient recycling, reduced water use, reduced nutrient discharge and high yields. Effluents from Japanese abalone (Haliotis discus hannai) culture tanks trained into a pellet-fed fish (Sparus aurata) culture tank. The fish effluent drained into macroalgal (Ulva lactuca or Gracilaria conferta) culture, and biofilter tanks. Algal production fed the abalone. The system was monitored to assess productivity and nitrogen partitioning over a year. The fish grew at 0.67% day(-1), yielding 28-kg m(-2) year(-1).The nutrients excreted by the fish supported high yields of U. lactuca (78-kg m(-2) year(-1)) and efficient (80%) ammonia filtration. Gracilaria functioned poorly. Ulva supported an abalone growth rate of 0.9% day(-1) and a length increase of 40-66 micrometers day(-1) in juveniles, and 0.34% day(-1) and 59 micrometers day(-1) in young adults. Total abalone yield was 9.4 kg year(-1). A surplus of seaweed was created in the system. Ammonia-N, as a fraction of total feed-N was reduced from 45% in the fish effluents to 10% in the post-seaweed discharge. Based on the results, a doubling of the abalone: fish yield ratio from 0.3 to 0.6 is feasible.
DESCRIPTORS: Haliotis discus, Pagrus aurata, algae, algae culture, effluents, waste treatment, water reuse, sustainability, integrated systems, Mollusc culture, fish culture, intensive production, nutrient balance, biological filtration, biomass production, growth rate, excretion, ammonia, yields.

Sales, J.; P. J. Britz. **South African abalone culture succeeds through collaboration.** *World Aquac.* Baton Rouge, La. : World Aquaculture Society,. Sept 2000. v. 31 (3) p. 44-45, 49-50, 61. ISSN: 1041-5602. NAL CALL NUMBER: SH1.W62
DESCRIPTORS: Abalones, Mollusc culture, economic development, feeds, history, technology transfer, research institutes, cages, water temperature, feeding, larvae, transport of animals, handling, developmental stages, health, seafoods, food processing, Haliotis, South Africa.

Siqueiros Beltrones, D. A.; D. Voltolina. **Grazing selectivity of red abalone Haliotis rufescens postlarvae on benthic diatom films under culture conditions.** *J World Aquac Soc.* Baton Rouge, La. : World Aquaculture Society, c1987. June 2000. v. 31 (2) p. 239-246. ISSN: 0893-8849.
NAL CALL NUMBER: SH138.W62
DESCRIPTORS: Haliotis rufescens, feeding preferences, benthos, Bacillariophyta, developmental stages, Mollusc culture, digesta, species diversity, frequency, microbial flora.

Viana, M. T.; P. Jarayabhand; P. Menasveta. **Evaluation of an artificial diet for use in the culture of the tropical abalone Haliotis ovina.** *J Aquac Trop.* Calcutta : Oxford IBH, 1986. Feb 2000. v. 15 (1) p. 71-79. ISSN: 0970-0846.
NAL CALL NUMBER: SH135.J68
DESCRIPTORS: Haliotis, feeds, Mollusc culture, evaluation, agar, rearing techniques, feed intake, food restriction, growth rate, analysis of variance, length, growth.

1999

Capinpin, E.C. Jr.; J. D. Toledo; V. C. Encena II.; M. Doi. **Density dependent growth of the tropical abalone Haliotis asinina in cage culture.** *Aquaculture.* Amsterdam, Elsevier. Feb 15, 1999. v. 171 (3/4) p. 227-235. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: The effects of different stocking densities on the growth, feed conversion ratio and survival of two size groups of the tropical abalone Haliotis asinina were determined. Three culture trials were conducted in net cages installed in a sheltered cove, Guimaras Province, Philippines. Trials 1 and 2 were conducted using 15-20 mm abalone juveniles for 150 days, while trial 3 was conducted using 35-40 mm abalone for 180 days. The animals were fed sufficient amounts of the red alga, Gracilariopsis bailinae (= G. heteroclada), throughout the experiment. There was an inverse relationship between growth (length and weight) and stocking density. Feed conversion ratio was not influenced by density, but was observed to be higher for larger animals. Survival was not significantly affected by density. Net cages are appropriate for culture of H. asinina. This study showed that H. asinina can reach commercial size of about 60 mm in one year. It also showed that growth of H. asinina can be sustained on a single-species diet. An economic analysis will be important in choosing the best stocking density for commercial production.
DESCRIPTORS: Haliotis, growth, population density, Mollusc culture, stocking density, feed conversion, feed conversion efficiency, survival, size, length, weight, Rhodophyta, feeding, Philippines.

Chaitanawisuti, N.; A. Kritsanapuntu. **Effects of different feeding regimes on growth, survival and feed conversion of hatchery-reared juveniles of the gastropod mollusc spotted babylon Babylonia areolata (Link 1807) in flowthrough culture systems.** Aquac-res. Oxford : Blackwell Science, c1995. Aug 1999. v. 30 (8) p. 589-593. ISSN: 1355-557X.
NAL CALL NUMBER: SH1.F8
ABSTRACT: The effects of feeding regimes on the growth, survival and feed conversion of hatchery-reared juvenile spotted babylon Babylonia areolata (Link) were assessed. Six continuous and discontinuous feeding regimes were fed at satiation to triplicate groups of snails in 200-L flowthrough (3.0 L h(-1)) indoor rectangular tanks for 180 days. Shell length growth rates of juvenile B. areolata did not differ significantly ($P > 0.05$) between the various feeding treatments. Body weight gain and feed conversion of snails were not significantly different between various feeding treatments, nor were there significant differences in mean survival between any of the feeding treatments.
DESCRIPTORS: Gastropoda, marine animals, feeding, growth, rearing techniques, survival, feed conversion efficiency, Mollusc culture, growth rate, shells, length, feed rations, feed intake, frequency.

Preece, M. A.; P. V. Mladenov. **Growth and mortality of the New Zealand abalone Haliotis iris Martyn 1784 cultured in offshore structures and fed artificial diets.** *Aquac Res.* Oxford : Blackwell Science, c1995. Nov/Dec 1999. v. 30 (11/12) p. 865-877. ISSN: 1355-557X.
NAL CALL NUMBER: SH1.F8
DESCRIPTORS: Haliotis, growth, mortality, Mollusc culture, feeds, feeding, equipment, growth rate, feed intake, infestation, water quality, silt, feed conversion efficiency.

Viana, M. T.; J. M. Guzman; R. Escobar. **Effect of heated and unheated fish silage as a protein source in diets for abalone Haliotis fulgens.** *J World Aquac Soc.* Baton Rouge, La. : World Aquaculture Society, c1987. Dec 1999. v.30 (4) p. 481-489. ISSN: 0893-8849.
NAL CALL NUMBER: SH138.W62

DESCRIPTORS: Haliotis, fish silage, heat treatment, protein sources, feeds, evaluation, Mollusc culture, nutrient availability, growth rate, leaching, fish meal, stability, dry matter.

1998

Aldana Aranda, D.; V. Patino Suarez. **Overview of diets used in larviculture of three Caribbean conchs: Queen conch Strombus gigas, Milk conch Strombus costatus and Fighting conch Strombus pugilis.** *Aquaculture.* Amsterdam, Elsevier. Sept 1, 1998. v. 167 (3/4) p. 163-178. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: The genus Strombus is widely distributed in the Caribbean. Six species are of commercial importance: S. gigas, S. raninus, S. costatus, S. alatus, S. gallus and S. pugilis. Economically, the Queen conch, S. gigas is the most important and consequently the most widely studied. However, since 1970 a decline of S. gigas populations due to over-fishing has been observed. Many authors have studied S. gigas hatchery rearing techniques in order to address this problem; however, for these hatchery techniques to be successful, an adequate diet must be provided for the larvae. Some information of the nutritional requirements of S. gigas larvae have been reported since nutritionally complete diet is still not available. In this work we summarize the different algae have been used for S. gigas, S. costatus and S. pugilis larvae rearing. Twenty one different algae species have been used: Amphidinium carteri, Chaetoceros gracilis, Dunaliella tertiolecta, Emillania huxleyi, Heterocapsa pygmacea, Isochrysis (Caicos), Isochrysis (Tahiti), Isochryus sp., Monochrysis sp., Nannochloris, Nitzchia, Platymonas sp., P. tetraselmis, Prorocentrum minimun, Rhodomonas sp., Skeletonema costatus, Tetraselmis chuii, Tetraselmis sp., T. suecica, Thalassiosira fluviatilis and T. weissflogii. There are other diets that have seldom been studied with Strombus veliger larvae, that could be a potential food source for these gastropods. The type concentration of algae, larval rearing conditions are summarized along with the results attained in larval growth, metamorphosis, survival, ingestion and digestion rates.
DESCRIPTORS: Gastropoda, Mollusc culture, feeds, larvae, species differences, feeding, nutrient requirements, algae, feed rations, digestion, survival, feed intake, literature reviews.

Encena II, V.C.; E. C. Capinpin Jr.; N. C. Bayona. **Optimal sperm concentration and time for fertilization of the tropical abalone, Haliotis asinina Linne 1758.** *Aquaculture.* Amsterdam, Elsevier. June 15, 1998. v. 165 (3/4) p. 347-352. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
ABSTRACT: Current interest in the tropical abalone Haliotis asinina has generated research into seed production and culture techniques. However, there has been no report regarding the optimal sperm concentration for fertilization and development and gamete viability for this species. Spawned eggs of H. asinina were artificially fertilized using eleven final sperm concentrations ranging from 1 X 10(2) to 1 X 10(7) sperm ml-1. In another experiment eggs were fertilized using sperm spawned at the same time at a final sperm concentration of 1 X 10(5) sperm ml-1 at 1, 2, 3, 4, and 5 h after spawning. Sperm concentrations of 5 X 10(3) to 1 X 10(5) sperm ml-1 gave both maximal fertilization rate and normal trochophore development. The sperm to oocyte ratio of this range is 1 x 10(3) to 2 x 10(4). Gametes were still viable 2 h after spawning; both fertilization and normal development rates decreased when fertilized later. It is recommended to use 1 X 10(5) sperm ml-1 for artificial fertilization of H. asinina eggs within 2 h after spawning.
DESCRIPTORS: Haliotis, spermatozoa, fertilization, viability, Mollusc culture, oocytes, spawning, concentration, biological development, time.

Fukami, K.; Kawai, A.; Asada, M.; Okabe, M.; Hotta, T.; Moriyama, T.; Doi, S.; Nishijima, T. Yamaguchi, M.; Taniguchi, M. (1998) **Continuous and simultaneous cultivation of benthic food diatom Nitzschia sp. and abalone Haliotis sieboldii by using deep seawater.** *Journal of Marine Biotechnology* 6 (4) 237-240, ISSN: 0941-2905.
NAL CALL NUMBER: TP248.27 M37J68
DESCRIPTORS: cell biology, marine ecology, ecology, environmental sciences, methods and techniques, Chrysophyta, Algae, Plantae, Gastropoda, Haliotis sieboldii, abalone, Nitzschia, benthic food diatom, Microorganisms, Nonvascular Plants, benthic food diatom cultivation, cell culture method, deep seawater.

Jess, S.; R. J. Marks. **Effect of temperature and photoperiod on growth and reproduction of Helix aspersa var. maxima.** *J Agric Sci.* Cambridge : Cambridge University Press. May 1998. v. 130 (pt.3) p. 367-372. ISSN: 0021-8596.
NAL CALL NUMBER: 10 J822
DESCRIPTORS: Helix aspersa, snail, growth, sexual reproduction, regulation, temperature, photoperiod, light intensity, dark, Mollusc culture, methodology, Gastropoda.

Matthiessen, P.; P. E. Gibbs. **Critical appraisal of the evidence for tributyltin-mediated endocrine disruption in mollusks.** *Environ Toxicol Chem.* Pensacola, Fla. : SETAC Press. Jan 1998. v. 17 (1) p. 37-43. ISSN: 0730-7268.
NAL CALL NUMBER: QH545.A1E58
ABSTRACT: This article reviews the field and laboratory evidence for endocrine disruption in gastropod mollusks caused by tributyltin (TBT). Abundant and undisputed field data link TBT with an irreversible sexual abnormality of female neogastropod snails known as "imposex." This phenomenon is a masculinization process involving the development of male sex organs, notably a penis and a vas deferens; in certain species the imposition of a vas deferens disrupts oviducal structure and function, preventing normal breeding activity and causing population disappearance. In some species, oogenesis is supplanted by spermatogenesis. A related condition referred to as "intersex" has been reported in littorinid mesogastropods, and these too become unable to lay eggs. Field evidence clearly associates these syndromes with the use of TBT as an antifoulant, chiefly on boat hulls, and dose-related effects can be replicated in laboratory exposures to environmentally relevant concentrations of TBT compounds. It has now been established that imposex and intersex are forms of endocrine disruption caused by elevated testosterone titers that masculinize TBT-exposed females. The precise mechanism by which increased levels of testosterone are produced has not been fully described, but the weight of evidence suggests that TBT acts as a competitive inhibitor of cytochrome P450-mediated aromatase. Some recent data suggest that TBT may also inhibit the formation of sulfur conjugates of testosterone and its active metabolites, thus interfering with its excretion. In summary, TBT-induced masculinization in gastropods, imposex and intersex, is the clearest example of endocrine disruption described in invertebrates to date that is unequivocally linked to a specific environmental pollutant.
DESCRIPTORS: organotin compounds, pollutants, toxicity, adverse effects, nontarget organisms.

Searcy Bernal, R.; C. Anguiano Beltran. **Optimizing the concentration of gamma-aminobutyric acid (GABA) for inducing larval metamorphosis in the red abalone Haliotis rufescens (Mollusca: Gastropoda).** *J World Aquac Soc.* Baton Rouge, La. : World Aquaculture Society, c1987. 1998. v. 29 (4) p. 463-470. ISSN: 0893-8849.
NAL CALL NUMBER: SH138.W62

DESCRIPTORS: Haliotis rufescens, gamma aminobutyric acid, larvae, metamorphosis, application rates, Mollusc culture, efficiency, bacteria, degradation, toxicity, evaluation, survival, growth.

Shields, J.D.; Buchal, M.A.; Friedman, C.S. (1998) **Microencapsulation as a potential control technique against sabellid worms in abalone culture.** *Journal of Shellfish Research* V. 17, N1 (JUN), P. 79-83, ISSN: 0730-8000.
NAL CALL NUMBER: SH365.A1J6
DESCRIPTORS: microcapsules, Abalone, parasite, pest, Sabellid, liposomes, microcapsules, Polychaete, diets, delivery, protein, larvae, growth.

Wiedemeyer, W. L. **Contributions to the larval biology of the red-lipped conch, Strombus luhuanus L. 1758, with respect to seed production for mariculture.** *Aquac Res.* Oxford : Blackwell Science, c1995. Jan 1998. v. 29 (1) p. 1-7. ISSN: 1355-557X.
NAL CALL NUMBER: SH1.F8
ABSTRACT: Spawning behavior and embryology of the red-lipped conch, Strombus luhuanus L. 1758 (Strombidae, Gastropoda), was investigated from 4 April to 19 May 1991, at Okinawa, southern Japan. At the laboratory and at a water temperature of 22.5-23.5 degree C, veliger larvae developed 92 h after spawning. In all, 2140 larvae were examined for morphometric data. Growth and development was monitored at different water temperatures (23, 28 and 33 degree C), in natural sea water filtered through 150-micrometer, 60-micrometer and 1-micrometer screens and when fed various combinations of food organisms, namely Chaetoceros sp., Dunaliella sp. and Pavlova sp. The minimum duration of the pelagic period of the larvae was 14.5 days. Infestation by parasites was the main cause of high larval mortality before the age of 10-12 days if the water was not filtered at a minimum of 60 micrometer. Inappropriate food diversity was the most significant source of mortality beyond this age. The maximum age reached during all rearing experiments was 16 days. Under optimized feeding conditions and in natural sea water filtered at 1-60 micrometer, the pelagic period of S. luhuanus larvae lasted 16.5 to 17.4 days (95% confidence limits). Optimum water temperature was 23-28 degree C. A stepwise increment of filter sizes and a contemporary provision of a combination of specific supplementary food organisms is advised through grow-out of the larvae.
DESCRIPTORS: morphology, Gastropoda, larvae, Mollusc culture, sexual reproduction, spawning, embryonic development, growth, water temperature, filtration, feeding, foods, algae, mortality, infestation, nutrient requirements, feed supplements, ova, Ryukyu Archipelago.

1997

Gimin, R.; C. L. Lee. **Effects of different substrata on the growth rate of early juvenile Trochus niloticus (Mollusca: Gastropoda).** *ACIAR Proceedings ; No. 79.* Trochus status, hatchery practice and nutrition proceedings of a workshop held at Northern Territory University, 6-7 June 1996. Canberra : Australian Centre for International Agricultural Research, 1997. p. 76-80. ISBN: 186320203X.
NAL CALL NUMBER: S542.A8A34-no.79
DESCRIPTORS: shellfish culture, substrates, nitzschia, food, unrestricted feeding, survival, growth rate.

Gomot, A.; Pihan, F. (1997) **Comparison of the bioaccumulation capacities of copper and zinc in two snail subspecies (Helix).** *Ecotoxicol Environ Saf* 38(2): 85-94, ISSN: 0147-6513.
NAL CALL NUMBER: QH545.A1E29

ABSTRACT: Bioaccumulation analyses of copper and zinc were carried out in two snail subspecies (Helix aspersa aspersa and Helix aspersa maxima) after 3 months of controlled farming (out of ground) with foods of different formulations. The results reveal some clear interspecific differences in affinity toward copper and zinc. For the two metals considered, H. aspersa aspersa has a bioaccumulation capacity much greater than that of H. aspersa maxima, mainly in the foot for copper and in the viscera for zinc. After 3 months, the concentrations of copper in feet and viscera are much higher than those presented in the literature on field animals. The farming and the analysis methodologies permitted obtaining snails under standard condition and open the way to the development of rational protocols for ecotoxicological studies in a laboratory as well as in the field.
DESCRIPTORS: copper pharmacokinetics, helix snails chemistry, zinc pharmacokinetics, copper metabolism, helix snails drug effects, tissue distribution, toxicity tests, zinc metabolism.

Rebhung, F.; S. M. Renaud; D. L. Parry; C. L. Lee. **Fatty acid composition characteristic of Trochus niloticus (Mollusca: Gastropoda) fed on naturally growing microalgae in an aquaculture system.** *ACIAR Proceedings ; No. 79.* Trochus status, hatchery practice and nutrition proceedings of a workshop held at Northern Territory University, 6-7 June 1996. Canberra : Australian Centre for International Agricultural Research, 1997. p. 114-117. ISBN: 186320203X.
NAL CALL NUMBER: S542.A8A34-no.79
DESCRIPTORS: shellfish culture, diet, shellfish, chemical composition, fatty acids, age, size, Gastropoda.

Renaud, S. M.; M. Djafar; D. L. Parry. **Preliminary investigation of an artificial diet for the marine topshell, Trochus niloticus (Mollusca: Gastropoda).** *ACIAR Proceedings ; No. 79.* Trochus status, hatchery practice and nutrition proceedings of a workshop held at Northern Territory University, 6-7 June 1996. Canberra : Australian Centre for International Agricultural Research, 1997. p. 109-113. ISBN: 186320203X.
NAL CALL NUMBER: S542.A8A34-no.79
DESCRIPTORS: feeding preferences, feeds, attractants, formulations, water, stability, shellfish culture, Gastropoda.

1996

Baturo, W.; L. Lagadic. **Benzo[a]pyrene hydroxylase and glutathione S-transferase activities as biomarkers in Lymnaea palustris (Mollusca, Gastropoda) exposed to atrazine and hexachlorobenzene in freshwater mesocosms.** *Environ Toxicol Chem.* Pensacola, Fla. : SETAC Press. May 1996. v. 15 (5) p. 771-781. ISSN: 0730-7268.
NAL CALL NUMBER: QH545.A1E58
ABSTRACT: Freshwater pond mesocosms were used to validate xenobiotic-metabolizing enzymes as biomarkers of contamination by atrazine and hexachlorobenzene (HCB) in a basommatophoran gastropod, Lymnaea palustris (Muller). Over long-term (21-d) exposure to 5, 25, and 125 microgram/L atrazine and to 0.5, 1.25, and 5 microgram/L HCB, the uptake and internal concentration of both pesticides were followed, and the activities of benzo[a]pyrene hydroxylase (BaPH) and glutathione S-transferases (GSTs) of pesticide-exposed snails were compared with those of control animals maintained in untreated mesocosms. Internally recovered HCB concentrations were much higher than internal atrazine concentrations, but the uptake of atrazine was faster than that of HCB. Although it affected the integrity of microsomal membranes, HCB had no relevant effects on BaPH and GST activities at concentrations which

affected growth and fecundity, thus confirming the low inducibility of mollusc xenobiotic-metabolizing enzymes by chlorinated compounds. In contrast, atrazine markedly inhibited BaPH and both postmitochondrial and cytosolic GSTs at the same concentrations, which had no effects on growth or reproduction. Enzyme inhibition was negatively correlated with the maximal internal amount of atrazine and positively correlated with the bioconcentration factor, suggesting that effects on xenobiotic-metabolizing enzymes may affect pharmacokinetics of atrazine within the snail body. Correlation between the bioconcentration factor and enzyme inhibition may serve as a descriptor of the physiological status of animals and can also be used to indirectly estimate the pesticide concentration in the environment. Laboratory data were considered for the interpretation of results obtained in the mesocosms. In the biomarker context, BaPH and GST activities are proposed, along with other biochemical markers already identified in atrazine- and HCB-exposed L.
palustris, as elements of a multiparametric approach of the ecotoxicological effects of pesticides on freshwater ecosystems.
DESCRIPTORS: atrazine, hexachlorobenzene, concentration, exposure, uptake, lymnaea, oxygenases, glutathione transferase, enzyme activity, inhibition, biological indicators, water pollution.

1993

McQuaid, C.D.; Froneman, P.W. (1993) **Mutualism between the territorial intertidal limpet Patella longicosta and the crustose alga Ralfsia verrucosa.** *Oecologia* v. 96(1) p. 128-133, ISSN 0029-8549.
NAL CALL NUMBER: QL750.O3
ABSTRACT: Mutualistic relations between plants and animals are well documented on land but have received less attention in marine systems. This study examined the relationship between the territorial intertidal limpet Patella longicosta and the crustose brown alga Ralfsia verrucosa. Adult Patella are found exclusively in association with Ralfsia, on which they feed, while Ralfsia occurs primarily, but not exclusively, in Patella territories. Ralfsia benefits directly from both the presence and the territorial behaviour of Patella. Algal productivity was assessed by measuring oxygen evolution and utilization in situ and deriving photosynthesis/irradiance curves. Productivity was increased by about 30% by the presence of Patella in both summer (P(max) of grazed algae 0.0098; ungrazed algae 0.0063 mg C pro square cm pro h) and winter (P(max) grazed algae 0.0081; ungrazed algae 0.0053 mg**-2 pro C pro h). Algal growth rates were not significantly increased by the application of limpet mucus in the laboratory. Nutrient regeneration by the limpet was not examined, but the increase in photosynthetic rate may depend on the limpet's grazing pattern which creates secondary sites for growth. Ralfsia also benefited from the territorial behaviour of Patella. The effects of different grazing regimes were investigated in different seasons by removing territorial limpets and either excluding all limpets using copper-based antifouling paint, or allowing access to non-territorial limpets (mostly P. oculus) using partial paint barriers.
DESCRIPTORS: snails, algae, symbiosis, plant animal relations, biomass, intertidal environment, aquatic environment, environments, marine environment.

Okino, T.; Hatsushika, R. (1993) **An experimental study of the embryonation and hatching of Parafossarulus manchouricus eggs: Influence of chlorinity on the culture solution.** *Japanese Journal of Parasitology* 42 (1) 18-23, ISSN: 0021-5171. Note: In Japanese.
NAL CALL NUMBER: 436.8 J27

DESCRIPTORS: development, ecology, environmental sciences, physiology, Gastropoda, Biomphalaria glabrata.

Viana, M.T.; Lopez, L.M.; Salas, A. (1993) **Diet Development for Juvenile Abalone Haliotis fulgens Evaluation of 2 Artificial Diets and Macroalgae.** *Aquaculture* V 117, N1-2 (NOV 1), P. 149-156, ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
DESCRIPTORS: agriculture, biology & environmental sciences, fisheries, marine & freshwater biology.

1991

Castellanos, Z. J. A. de. *Gastropoda mollusks.* Fundacion para la Educacion, la Ciencia y la Cultura. Buenos Aires : FECIC, 1991, v. : ill. Fauna de agua dulce de la Republica Argentina; v. 15, no. 1, etc. Note: In Spanish.
NAL CALL NUMBER: QL141.F3 v.15, NO.1,ETC
DESCRIPTORS: Argentina, pulmonates, freshwater snails, native animals, biology, ecology, distribution, morphology, Biomphalaria species, Schistosoma mansoni.

1984

Winger, P.V.; Imlay, M.J.; McMillan, W.E.; Martin, T.W.; Takekawa, J.; Johnson, W.W. (1984) **Field and laboratory evaluation of the influence of copper-diquat on apple snails in southern Florida.** *Environmental toxicology and chemistry (USA)* 3(3) p. 409-424, ISSN: 0730-7268.
NAL CALL NUMBER: QH545.A1E58
DESCRIPTORS: Florida, herbicides, toxicity, aquatic organisms, Helobiae, America, Monocotyledons, North America, pesticides, south eastern states USA.

1983

Charrier, M.; Daguzan, J. (1983) *Study of food consumption and production of the edible brown snail.* The snail and heliciculture. Paris (France). Ministere de l' Agriculture. Informations Techniques des Services Veterinaires, p. 37-51.
NAL CALL NUMBER: 41.9 F843I
DESCRIPTORS: snails, feed consumption, food preferences, kales, compound feeds, laboratory experiments, snail culture, environmental conditions, growth period, agriculture, animal production, animals, aquatic animals, aquatic organisms, behaviour, consumption, crops, developmental stages, economic plants, environment, experiments, feed crops, feed crucifers, feeding habits, feeds, green vegetables, plants, production, research, vegetable crops.

1982

Burch, J. B. *Freshwater snails (Mollusca: Gastropoda) of North America.* Environmental Monitoring and Support Laboratory, Cincinnati, Ohio: Office of Research and Development, U.S. Environmental Protection Agency, 1982. vi., 294 p. : ill. EPA 600/3-82-026.
NAL CALL NUMBER: QL430.4.B8

DESCRIPTORS: Gastropoda North America Identification, Mollusks North America Identification.

1976

Nagai, T.; Suda, A. (1976) **Gastropodous and bivalvate (Mollusca) faunas in the trawl fishing ground of the eastern Bering Sea in summer with reference to their environment.** *Bulletin Far Seas Fisheries Research Laboratory* (no.14) p. 163-179. Note: In Japanese.
DESCRIPTORS: aquatic ecology, Bering Sea.

Miscellaneous

2001

Lutz, C .G. **Comparing apples to apples: genotype environment interactions.** *Aquac Mag.* [Little Rock, Ark., Briggs Associates, inc.]. Sept/Oct 2001. v. 27 (5) p. 67-70. ISSN: 0199-1388.
NAL CALL NUMBER: SH1.C65
DESCRIPTORS: freshwater fishes, shellfish, shellfish culture, Mollusc culture, genotype environment interaction, fish culture, shrimp culture, ponds, cages, fish ponds.

Nickum, M. J. **A summary of aquaculture in Canada: Atlantic and Pacific regions.** *Aquac Mag.* [Little Rock, Ark., Briggs Associates, inc.]. Sept/Oct 2001. v. 27 (5) p. 42-50. ISSN: 0199-1388.
NAL CALL NUMBER: SH1.C65
DESCRIPTORS: fish culture, salmon culture, shellfish culture, Mollusc culture, water pollution, environmental impact, Canada, northwest atlantic, northeast pacific.

2000

Castell, J. **Farming the waters: bringing aquatic plant and animal species to agriculture.** *Can J Anim Sci.* Ottawa : Agricultural Institute of Canada, 1957. June 2000. v. 80 (2) p. 235-243. ISSN: 0008-3984.
NAL CALL NUMBER: 41.8 C163
ABSTRACT: Aquaculture has a long history, with carp culture in Asia starting before 2000 BC and oyster culture in the Roman Empire before the time of Julius Caesar. However, it is clearly the past 40 yr that have seen the most dramatic expansion of aquaculture. The world's population now exceeds 6 billion people and is still growing at an alarming rate. The world's wild fish harvest has clearly peaked at or above the maximum sustainable yield of about 90 million t. Many fish stocks are suffering from over-fishing and there is little hope of any increase in the capture fisheries production. Though modern agricultural practices have been very efficient at increasing the per acre yields, the world is experiencing an alarmingly steady decrease in the amount of agricultural land devoted to food production. In the past 20-30 yr production of fish, molluscs, crustaceans and aquatic plants (aquaculture) has become an increasingly important means of producing food, and in some countries aquaculture production accounts for more than half of the total fishery harvest and is even as high as 90% in a few countries. I have reviewed the historical growth of aquaculture, compared the product value in various countries and reviewed aquaculture practices for a number of plant, molluscan, crustacean and fish species around the world. These culture technologies were compared and contrasted with agricultural

practices. Finally, some predictions for the future of aquaculture development in Canada and the world have been made.
DESCRIPTORS: aquaculture, aquatic plants, aquatic animals, fish farming, history, food production, fish diseases, world, prediction, Canada.

Nash, C. E.; A. Nagasawa. **Sumiyoshi fishermen remember their angel.** *World Aquac.* [Baton Rouge, La.: World Aquaculture Society,. June 2000. v. 31 (2) p. 39, 41-42. ISSN: 1041-5602.
NAL CALL NUMBER: SH1.W62
DESCRIPTORS: seaweeds, fishermen, history, life cycle, algae culture, spores, seasonal variation, dormancy, reproduction, Mollusca, shells.

Saito, H.; Imabayashi, H.; Kawai, K. (2000) **Interaction between handling cost and growth of the bivalve-feeder Halla okudai under rearing conditions, in relation to prey species.** *Fisheries Science Tokyo* 66 (5): 863-870, ISSN: 0919-9268.
DESCRIPTORS: development, ecology, environmental sciences, Pelecypoda, Polychaeta, Annelida, Crassostrea gigas, Pacific oyster, Halla okudai, Mytilus galloprovincialis, blue mussel, Ruditapes philippinarum, short neck clam, Annelids, energy budget, foraging behavior, growth increment, intertidal communities, oxygen consumption, prey conditions, prey handling cost, rearing conditions, respiration rate.

Saito, H.; Imabayashi, H.; Kawai, K. (2000) **Interaction between searching cost and growth of the bivalve-feeder Halla okudai under rearing conditions, in relation to prey size.** *Fisheries Science Tokyo* 66 (5): 908-914, ISSN: 0919-9268.
DESCRIPTORS: behavior, ecology, environmental sciences, Pelecypoda, Polychaeta, Annelida, Halla okudai, predator, Ruditapes philippinarum, prey, Annelids, feces, digestive system, energy budget, feeding experiment, foraging behavior, growth rate, predator prey interactions, prey searching cost, prey size, rearing conditions, respiration rate.

Verschuere, L.; Rombaut, G.; Sorgeloos, P.; Verstraete, W. (2000) **Probiotic bacteria as biological control agents in aquaculture.** *Microbiol Mol Biol Rev* 64(4): 655-71, ISSN: 1092-2172.
NAL CALL NUMBER: QR1.B25
ABSTRACT: There is an urgent need in aquaculture to develop microbial control strategies, since disease outbreaks are recognized as important constraints to aquaculture production and trade and since the development of antibiotic resistance has become a matter of growing concern. One of the alternatives to antimicrobials in disease control could be the use of probiotic bacteria as microbial control agents. This review describes the state of the art of probiotic research in the culture of fish, crustaceans, mollusks, and live food, with an evaluation of the results obtained so far. A new definition of probiotics, also applicable to aquatic environments, is proposed, and a detailed description is given of their possible modes of action, i.e., production of compounds that are inhibitory toward pathogens, competition with harmful microorganisms for nutrients and energy, competition with deleterious species for adhesion sites, enhancement of the immune response of the animal, improvement of water quality, and interaction with phytoplankton. A rationale is proposed for the multistep and multidisciplinary process required for the development of effective and safe probiotics for commercial application in aquaculture. Finally, directions for further research are discussed.
DESCRIPTORS: aquaculture methods, bacteria, pest control biological methods, probiotics, Crustacea, fishes.

1997

Skakelja, N. (1997) **An overview of genetic research in the Laboratory of Aquaculture at the Institute of Oceanography and Fisheries, Split, Croatia.** Bartley, D.M. (FAO, Rome (Italy). Fisheries Resources and Environment Division); Basurco, B. Centre International de Hautes Etudes Agronomiques Mediterraneennes, Zaragoza (Spain). Institut Agronomique Mediterraneen de Zaragoza; FAO, Rome (Italy). Genetics and breeding of Mediterranean aquaculture species. Zaragoza (Spain). *CIHEAM-IAMZ* 1998, ISSN 1022-1379.
ABSTRACT: This paper is an overview of marine aquaculture in Croatia and an in-depth coverage of works and achievements of scientists in the Laboratory of Marine Aquaculture. At the end of the 80's the first steps into the field of fish genetics were made by working on hybrids of Sparus aurata x Diplodus puntazzo, Sparus aurata x Diplodus vulgaris and finally Dentex dentex x Diplodus sargus; the last cross was found to be potentially interesting for marine aquaculture. Further research on chromosome manipulation was conducted to induce triploidy of Sparus aurata by temperature shocking freshly fertilized eggs. At the beginning of the 90's research on population genetics of mussel (Mytilus galloprovincialis) was conducted in the Laboratory in co-operation with French colleagues from IFREMER. The present work includes research on chromosome structure of Sparid species from the Eastern Adriatic as well as population genetics. In the future, will be implemented a database on Adriatic fish, mainly with the goal to support a program of protection of wild populations of finfish.
DESCRIPTORS: Sparus, Diplodus, Mytilus, Croatia, aquaculture, karyotypes, population genetics, Balkans, Bivalvia, bony fishes, cell structure, Europe, fishes, genetics, Mollusca, Percoidei.

1996

Jalabert, B.; Michel, A. (1996) **Which researches and which developments for aquaculture?** *Comptes Rendus de l'Academie d'Agriculture de France* 82 (9) 171-182, ISSN: 0989-6988.
Note: In French.
NAL CALL NUMBER: S5 C65
DESCRIPTORS: conservation, physiology, systematics and taxonomy, wildlife management, conservation, Europe, Palearctic region, France, aquaculture, aquatic environment, development policies, outlets stability, rearing systems, research, resource management, socioeconomic context.

1995

Lees, D.N.; Henshilwood, K.; Green, J.; Gallimore, C.I.; Brown, D.W. (1995) **Detection of small round structured viruses in shellfish by reverse transcription-PCR.** *Appl Environ Microbiol* 61(12): 4418-24, ISSN: 0099-2240.
NAL CALL NUMBER: 448.3 AP5
ABSTRACT: We describe the application of a previously developed sample extraction procedure to the detection of small round structured viruses (SRSVs) in shellfish. Initial seeding experiments showed that PCR inhibitor removal and virus recoveries were comparable to those in previous studies with poliovirus. Shellfish from a range of sewage-contaminated sites were then tested for the presence of SRSVs by using broadly reactive PCR primers followed by Southern blotting with internal probe sites. Positive results were obtained from 5 of 31 field samples tested. Four of these positive samples were from highly polluted sites. PCR product

sequence analysis confirmed their identity as SRSV and showed sequence diversity compared with virus controls, suggesting that the results were not a consequence of PCR cross-contamination. Finally, shellfish associated with four separate outbreaks of viral gastroenteritis were tested by PCR and Southern blot for the presence of SRSVs. All outbreak samples tested gave positive results. As far as we are aware, this is the first demonstration of the detection in environmentally contaminated shellfish of the SRSVs responsible for human gastroenteritis. This development may help contribute to the further development of public health controls for molluscan shellfish.
DESCRIPTORS: food microbiology, Norwalk virus isolation and purification, shellfish virology, amino acid sequence, base sequence, molecular sequence data, polymerase chain reaction methods, sequence alignment.

1993

McVey, E. M. **Mollusc culture: January 1989 - February 1993.** *Quick Bibliogr Ser U S Dep Agric Natl Agric Libr U S.* Beltsville, Md. : The Library. Mar 1993. (93-19) 27 p. ISSN: 1052-5378.
NAL CALL NUMBER: aZ5071.N3
DESCRIPTORS: Mollusc culture, shellfish, bibliographies.

1991

Day, J. D.; A. P. Edwards; G. A. Rodgers. **Development of an industrial-scale process for the heterotrophic production of a micro-algal mollusc feed.** *Bioresource Technol. Essex* : Elsevier Applied Science Publishers. 1991. v. 38 (2/3) p. 245-249. ISSN: 0960-8524.
NAL CALL NUMBER: TD930.A32
DESCRIPTORS: algae culture, industrial methods, dry feeds, powders, feeding, trials, UK.

Nash, C. E. *Production of aquatic animals : crustaceans, molluscs, amphibians, and reptiles.* Amsterdam ; New York : Elsevier Science, 1991. xii, 244 p. : ill. World animal science. C, Production-system approach ; 4. ISBN: 0444883126.
NAL CALL NUMBER: SH370.P76 1990
DESCRIPTORS: Shellfish culture, Amphibian culture, Reptile culture, Aquaculture.

1989

Kautsky, N.; Folke, C. (1989) **A sustainable development of aquaculture.** *Food Laboratory News* (no. 18) p. 43-48, ISSN: 1100-3227.
NAL CALL NUMBER: TX541.F663
DESCRIPTORS: Mollusc culture, fish culture, aquatic communities, environmental effects, aquaculture, biocoenosis, injurious factors, shellfish culture.

Quayle, D. B.; G. F. Newkirk. *Farming bivalve molluscs : methods for study and development.* Advances in world aquaculture ; v. 1. Baton Rouge, LA : World Aquaculture Society in association with the International Development Research Centre, c1989. ix, 294 p. : ill. ISBN: 0962452904.
NAL CALL NUMBER: SH370.Q82
DESCRIPTORS: Shellfish culture, Bivalvia.

1988

Amidei, R. E. *West Coast mollusc culture : a present and future perspective : proceedings of a California Sea Grant Workshop, in cooperation with the Pacific Sea Grant College Program, July 9-10, 1987, University of California, Berkeley.* Sea grant report; no. T-CSGCP-017. California Sea Grant Workshop (1987 : University of California, Berkeley). University of California (System). Sea Grant College Program. Pacific Sea Grant College Program. La Jolla : Institute of Marine Resources, 1988. 87 p. : ill.
NAL CALL NUMBER: SH365.A18C3 1987
DESCRIPTORS: Mollusks Pacific Coast U.S. Congresses, Shellfish culture Pacific Coast U.S. Congresses.

1984

Glude, J. B. **The applicability of recent innovations to mollusc culture in the western Pacific Islands.** *Aquaculture.* Amsterdam : Elsevier Scientific Publishing. June 15, 1984. v. 39 (1/4) p. 29-43. ill., maps. ISSN: 0044-8486.
NAL CALL NUMBER: SH1.A6
DESCRIPTORS: Pacific Islands.

Morse, D. E.; K. K. Chew; R. R. Mann. *Recent innovations in cultivation of Pacific molluscs : proceedings of an international symposium sponsored by the California Sea Grant College Program and the Pacific Sea Grant College Programs in Alaska, Hawaii, Oregon, and Washington : held at La Jolla, California, U.S.A., 1 December to 3 December 1982.* University of California (System). Sea Grant College Program. International Symposium on Recent Innovations in the Cultivation of Pacific Molluscs (1982 : La Jolla, Calif.). Developments in aquaculture and fisheries science ; 14. Amsterdam ; New York : Elsevier : Distributors for the United States and Canada, Elsevier Science Pub. Co., 1984. xi, 404 p. : ill., maps. ISBN: 0444423508.
NAL CALL NUMBER: SH1.D43 v.14
DESCRIPTORS: Shellfish culture Pacific area Technological innovations Congresses, Shellfish culture Technological innovations Congresses.

1982

Lynch, T. **Award-winning research team continues advances in mollusc culture techniques.** *Aquaculture Mag.* Little Rock : Briggs Associates, Inc. Sept/Oct 1982. v. 8 (6) p. 14-17. ill. ISSN: 0199-1388.
NAL CALL NUMBER: SH1.C65
DESCRIPTORS: Abalone culture, rearing techniques, reproduction, larval development, metamorphosis, growth, molecular mechanisms, biological/ cellular/ physiological processes.

1981

Boyle, P. R. *Molluscs and man.* The Institute of Biology's studies in biology, 0537-9024 ; no. 134. London : Edward Arnold, c1981. 59 p. : ill. ISBN: 0713128240 (pbk.).
NAL CALL NUMBER: QH301.I52 no.134
DESCRIPTORS: Shellfish culture.

Colt, J. E.; D. A. Armstrong. **Nitrogen toxicity to crustaceans, fish, and molluscs.** *Proceedings of the Bio-Engineering Symposium for Fish Culture* / edited by Lochie Jo Allen and Edward C. Kinney. Bethesda, Md. : Fish Culture Section of the American Fisheries Society, c1981. p. 34-46.
NAL CALL NUMBER: SH151.B54 1979
DESCRIPTORS: nitrogen toxicity, bioengineering, mechanisms, toxic effects, culture growth, maintenance, aeration, culture system hyraulics, animal welfare.

Tagatz, M.E.; Ivey, J.M.; Gregory, N.R.; Oglesby, J.L. (1981) **Effects of pentachlorophenol on field- and laboratory-developed estuarine benthic communities.** *Bull Environ Contam Toxicol* 26(1): 137-43, ISSN: 0007-4861.
NAL CALL NUMBER: RA1270.P35A1
DESCRIPTORS: chlorophenols toxicity, pentachlorophenol toxicity, water pollutants toxicity, water pollutants chemical toxicity, Annelida drug effects, Arthropods drug effects, Florida, Mollusca drug effects, pentachlorophenol analysis, seawater analysis.

1980

Gottardi, G. **"Active" water in fish culture Sanitation, contamination of water, molluscs. Acque "attive" in piscicoltura.** *Inf Zootec.* Bologna, Edagricole. Jan 31, 1980. v. 27 (2) p. 40-41. ill. ISSN: 0020-0778. Note: In Italian.
NAL CALL NUMBER: 49 IN3
DESCRIPTORS: contaminant sources, culture, aquaculture, water contamination, chemical pollutants, micro-organisms, potential pathogens, active water.

Persoone, G.; C. Claus. **Mass culture of algae: a bottleneck in the nursery culturing of molluscs.** *Algae biomass : production and use* / sponsored by the National Council for Research and Development, Israel and the Gesellschaft fur Strahlen- und Umweltforschung (GSF), Munich, Germany; editors, Gedaliah Shelef, Carl J. Soeder. Amsterdam, Elsevier/North-Holland Biomedical Press, 1980. p. 265-285. ill.
NAL CALL NUMBER: SH389.A44
DESCRIPTORS: mass algae culture, nursery culturing, production/ use of algae biomasses, nutrition, feeding, housing, water sources, environment, ecology, continuous culture, induced blooming, marine algae, postlarval bivalves.

World Wide Web Resources

Bivalves

Bivalves- Research, Training, Electronic Dissemination of Data
http://peet.fmnh.org/default.html
•From the site, "A joint program based at the Field Museum of Natural History and the American Museum of Natural History. Drs. Rüdiger Bieler (FMNH) and Paula M. Mikkelsen (AMNH), principal investigators". Included in this site are resources, research, and also databases.

Bivalvia
http://paleo.cortland.edu/tutorial/Bivalves/bivalvia.htm
•A bivalve topical research information section from the State University of New York College at Cortland. As listed on the index page at: http://paleo.cortland.edu/tutorial/index.html#phylumlist "This web site was created to be a companion to the laboratory for GLY 363 - Invertebrate Paleontology. It is designed to provide the student enrolled in GLY 363 with an additional resource for reviewing laboratory materials. It is set up in a format which parallels the laboratory handouts. Most of the images contained within the web site are taken directly from specimens that are found on display for study in the paleontology laboratory". Other sections are listed as well including a comprehensive section on Cephalopoda, Gastropoda, and other Molluscs.

The Centro de Estudios de Almejas Muertas (C.E.A.M.)

http://www.geo.arizona.edu/ceam/index.html
•As listed on this web site, "English translation: Center for the Study of Dead Clams] is an informal organization dedicated to the study of taphonomy. Taphonomy is the study of dead things and how they get incorporated into the fossil record".

Another page on this site at: http://www.geo.arizona.edu/ceam/tapho.htm
has some good links under **Mollusk Links** at: http://www.geo.arizona.edu/ceam/tapho.htm#link5

The parent home page is from the University of AZ, Dept. of Geosciences at:
http://www.geo.arizona.edu/
More also available at:
http://www.geo.arizona.edu/geo3xx/308/mollusc.html#biva

Intergalactic Marigenetics Center
http://www-bml.ucdavis.edu/imc/Oyster.html
•As listed on the home page, "Target species is the Pacific oyster, *Crassostrea gigas*. Some project topics include broodstock development using classical genetic techniques, and mapping of QTL's associated with heterosis". An interesting, informative web site including protocols, software, pictures, and more- definitely a site to check out.

Junglewalk.com
http://www.junglewalk.com/frames.asp
•As listed on the about us page, "Our large compilation of video and audio clips, which is currently the primary focus of this site, should complement other available animal directories in the web. We have avoided using precise scientific classification and references to academic work to keep this site accessible to the younger crowd. However, we hope the site will still be useful to educators, parents, and anyone interested in animals". There is a section focused on clams and Bivalves. Also included are sections on Cephalopods and Gastropods.

Living Reef Images
http://www.livingreefimages.com/index.htm
•A special section with photographs available at:
http://www.livingreefimages.com/Page66.html
As stated on the home page, "A library of aquarium and natural reef photographs available to publishers world wide". Also contains some additional pages on Gastropods and Cephalopods at:

http://www.livingreefimages.com/Page65.html

http://www.livingreefimages.com/Page67.html

The Living World of Molluscs
http://members.lycos.co.uk/Mollusks/
•By Robert Nordsieck- general and comparative information on the phyllum of molluscs.
Here's the Bivalve section:
http://members.lycos.co.uk/Mollusks/muscheln.html

National Shellfisheries Association
http://www.shellfish.org/
•From the homepage, "Founded in 1908, The National Shellfisheries Association is an international organization of scientists, management officials and members of industry, all deeply concerned with the biology, ecology, production, economics and management of shellfish resources - clams, oysters, mussels, scallops, snails, shrimp, lobsters, crabs, among many other species of commercial importance". A good site to visit to explore the positive influence of aquaculture on research with respect to other readily available web resources as listed.

The Neogene Marine Biota of Tropical America (NMITA)
http://porites.geology.uiowa.edu/index.htm
Bivalve page:
http://porites.geology.uiowa.edu/database/bivalves/bivalmnu.htm
Also has a bibliography available at:
http://nmita.geology.uiowa.edu/database/mollusc/bivlifebib.htm
•As listed on the About Us page, "The Neogene Marine Biota of Tropical America (NMITA) WWW Site contains images and information on taxa collected as part of two large multi-taxa fossil sampling programs: (1) the Panama Paleontology Project coordinated by the Smithsonian Tropical Research Institute in Panama; (2) the Neogene Paleontology of the northern Dominican Republic (DR) project coordinated by the Natural History Museum in Basel, Switzerland. NMITA is designed for use in research and education in systematics and evolutionary paleontology. Partial information is currently available for bryozoans, corals (zooxanthellate and azooxanthellate), molluscs (gastropods and bivalves), ostracodes, and fish".

Russian Academy of Sciences, Far East Branch

http://www.fegi.ru/prim/index.htm

•This page has some specific information on Bivalves (complete with descriptions and images):

http://www.fegi.ru/prim/sea/mol_dvu.htm

Cephalopods

Cephalopoda, Gastropoda, and other Molluscs
http://paleo.cortland.edu/tutorial/Ceph%26Gast/ceph%26gast.htm
•As listed above, this web site is made available from the State University of New York College at Cortland. Classifications and geologic ranges are included as well.Also see above for additional information.

Cephalopod International Advisory Council
Addresses of current officers are posted on the website.
http://www.nbs.ac.uk/public/mlsd/ciac/index.html
Email: P.rodhouse@bas.ac.uk
•Founded in 1983, the aims of CIAC are to stimulate, accelerate and influence the direction of cephalopod research, to provide help and advice on aspects of cephalopod biology, including those relevant to the management of the increasingly important cephalopod fisheries, and to spread information on past and current research.
•CIAC holds workshops and symposia, endorses meetings organized by cephalopod workers, and produces workshop proceedings and a newsletter. Publications produced by CIAC include: *List of Cephalopod Workers of the World* (http://www.cephbase.dal.ca/cephdir.cfm), a *Computerised Bibliography of Cephalopod Research*, *Keys for the Identification of Cephalopods*, and *State of the Art* papers in selected areas of research.

The Cephalopod Page
http://is.dal.ca/~ceph/TCP/
Email: ceph@is.dal.ca
•This site is maintained by graduate student James B. Wood, a graduate student at Dalhousie University. The comprehensive site contains in-house articles ranging from procurement, housing, and breeding cephalopods to cephalopods in cinema. There are species factsheets with photos, a list of suppliers by species with links to the supplier's sites, conference information, news, and links to related sites including CephBase. In addition to the information, your mouse will turn into a squid and squirt black ink all over the screen in its trail.

The Cephalopod Page Listserver
•The Cephalopod Page listserver is devoted to promoting discussion of cephalopod biology, husbandry, and behavior. This list is moderated and open to everyone. The site is maintained by James B. Wood, a graduate student at Dalhousie University. To post a message to everyone on the ceph-list, mail it to: ceph-list@ac.dal.ca
To subscribe to ceph-list, send mail to: mailserv@ac.dal.ca with the single line message: subscribe ceph-list
To remove yourself from ceph-list, send mail to: mailserv@ac.dal.ca with the single line message: unsubscribe ceph-list
To retrieve a file from the list archive, send mail to: mailserv@ac.dal.ca with the single line message: send ceph-list.yyyymm where "yyyymm" is the year and month (e.g., 199410) for which you would like the archived messages. The Cephalopod Page FAQ at http://www.cephbase.utmb.edu/TCP/faq/tcpfaq.cfm and for information about keeping octopuses in aquaria, see http://www.dal.ca/~ceph/TCP/octokeep.html

CephBase
http://www.cephbase.dal.ca/
Email: ceph@ia.dal.ca
•CephBase is a dynamic html relational database-driven interactive web page. The purpose of CephBase is to provide life history, distribution, catch and taxonomic data on all living species of cephalopods (octopus, squid, cuttlefish and nautilus). It also provides predator-prey information. A search engine allows searching records by species. CephBase is created and maintained by James B. Wood and Catriona L. Day under the supervision of Dr. Ron K. O'Dor, Dalhousie University, Halifax, Nova Scotia, Canada.

Directory of Cephalopod Workers
http://www.cephbase.dal.ca/cephdir.cfm
•A list of researchers working with cephalopods. Includes contact information, projects, and links to related reports and publications. The database is searchable and allows users to enter or delete their own information.

The EuroSquid World Wide Web Page
http://www.abdn.ac.uk/eurosquid/
Email: g.j.pierce@abdn.ac.uk
•This site contains information about research on cephalopods at the Department of Zoology, University of Aberdeen and collaborating institutions, along with some general information about cephalopods and people working on them. There are also links to the "marine mammal" and "fisheries" pages and more general pages about Marine and Fisheries Science at the University of Aberdeen. "Eurosquid" was the nickname given to the EC-funded project on "Fishery Potential of North East Atlantic Squid Stocks" (1990-92).
•The website contains bibliographic citations, abstracts, and posters from researchers in the program; abstracts from ICES (International Council for the Exploration of the Sea) annual meetings; job information; squid-related links; news items; and a page hosting the ICES Working Group on Cephalopod Fisheries and Life History.

The Living World of Molluscs
http://members.lycos.co.uk/Mollusks/
•By Robert Nordsieck- general and comparative information on the phyllum of Molluscs.
Here's the Cephalopod section:
http://members.lycos.co.uk/Mollusks/kopffuesser.html

Mote Marine Laboratory Octopus Pages
Email: debi@marinelab.sarasota.fl.us
•Here's where you'll find the cover image of this publication and more:
http://www.marinelab.sarasota.fl.us/OCTOPI.HTM
Describes the natural history of the octopus and includes a short reference list.
http://www.mote.org/~lauren/motenews/winter96/octopus.phtml
Describes the octopus circulatory system.

National Resource Center for Cephalopods
http://www.nrcc.utmb.edu
Marine Biomedical Institute
The University of Texas Medical Branch
301 University, Ewing Hall-ground floor
Galveston, TX 77555-1163

Tel: (409) 747-0768, Fax: (409) 772-1822, Email: lswalsh@utmb.edu
•The National Resource Center for Cephalopods (NRCC) offers cephalopods, including squid and nautalus for use in education and research projects. The website includes the species available, prices per animal, transport costs, and fees to use NRCC facilities. The site also includes a recommended reading list and a searchable citation database. Current research emphasizes sub-cellular ion channel formation and function, equilibrium receptor function and pharmacology, skin pigment synthesis, aspects of aging, cataract formation, regulation of reproduction and development, respiratory and cardiac physiology, and biochemistry of gene repair, and behavior.

The Ocean Lab Giant Squid Page
http://www.oceanlab.abdn.ac.uk/archi/
•The Aberdeen University Ocean Research Laboratory is based in the Zoology Department. The research group includes biologists and engineers investigating the ecology and behavior of marine animals. This site contains information and photos of the giant squid (*Architeuthis sp.*). Topics include strandings, factsheets, and links.

Smithsonian Institution Cephalopod Bibliography
http://www.siris.si.edu/
Cephalopod Bibliography
Department of Invertebrate Zoology-Mollusks
NMNH MRC-118
Smithsonian Institution
Washington, DC 20560 USA
Fax: (202) 357-2343, Email:CEPHBOX@SIVM.SI.EDU

•The *Cephalopod Bibliography* describes publications (books, journal articles, etc.) about recent cephalopods and cephalopod related subjects (predators, prey, etc.). It is searchable by keyword, title, author, and subject. This bibliography comprises publications located at the Division of Mollusks, NMNH. At present, the entries concentrate primarily on works in English or those with an English summary. Future additions to this catalog will include foreign language publications. No attempt has been made for comprehensive coverage of cephalopod publications on fossils or neurophysiology.

Tree of Life - Cephalopoda
http://tolweb.org/tree?group=Cephalopoda&contgroup=Mollusca
Dept of Oceanography
University of Hawaii
Honolulu, Hawaii, USA 96822
Email: ryoung@hawaii.edu
•An international site containing general characteristics, a reference list, and related links. Also includes a classification table which contains detailed information on every order, family, genus, and species.

Zoological Record Internet Resource Guide for Zoology: Cephalopoda
http://www.york.biosis.org/zrdocs/zoolinfo/moll_cep.htm
•List of web sites relating to cephalopods.

Gastropods

Aplysia Hometank
http://ganglion.med.cornell.edu/Aplysia/Hometank.html
•Information resource for the molluscan neuroscience community produced at Cornell University Medical College. Includes the searchable Aplysia Database.

Australian Museum Online
http://www.amonline.net.au/
•See this page:
http://www.amonline.net.au/invertebrates/mal/ponder_microsnails.htm
for information on research, projects, collections, and more from as listed, "The Australian Museum has an international reputation in the fields of natural history and indigenous studies research, community programs and exhibitions. The Museum was established in 1827 and is Australia's first museum, with unique and extensive collections of natural science and cultural artefacts". Lots of additional information is included as well.

Bibliographia Nudibranchia
http://scilib.ucsd.edu/sio/indexes/mcdonald.html
•Gary McDonald's bibliography of the nudibranch literature. This bibliography attempts to list all publications which mention nudibranchs, with the exception of textbooks and field guides to local marine animals. Citations were compiled from Biological Abstracts, its RRM counterpart and antecedent, BIOSIS, Current Contents, Zoological Record, Russells's Index Nudibranchia and supplement, and *Opisthobranch Newsletter*. Additional citations were gleaned from the "references cited" sections of numerous major nudibranch articles. A search engine allows keyword and Boollean literature searches.

The Living World of Molluscs
http://members.lycos.co.uk/Mollusks/
•By Robert Nordsieck- general and comparative information on the phyllum of molluscs. Here's the Gastropod section:
http://members.lycos.co.uk/Mollusks/schnecken.html

NIH/University of Miami National Resource for *Aplysia*
http://www.rsmas.miami.edu/groups/sea-hares/
RSMAS - University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149
Tel: (305) 361-4946, Fax: (305) 361-4934, Email: tcapo@rsmas.miami.edu
•Provides laboratory cultured *Aplysia*. The site contains the newsletter *Slime Lines*, the NIH qualification form, a 3-D tour of the laboratory, and information about rearing and ordering *Aplysia* and red seaweed *Gracilaria* needed to feed them.

The Neogene Marine Biota of Tropical America (NMITA)
http://porites.geology.uiowa.edu/index.htm
•See as listed above under Bivalves. Here's the Gastropods page:
http://porites.geology.uiowa.edu/database/mollusc/mollsmnu.htm

The Neogene Marine Biota of Tropical America (NMITA)
http://porites.geology.uiowa.edu/index.htm
•See description above under Bivalves. Also as stated above, contains information on Gastropods

at:
http://porites.geology.uiowa.edu/database/mollusc/mollsmnu.htm
and
http://nmita.geology.uiowa.edu/database/mollusc/gastdietbib.htm

Sea Slug Forum
http://www.seaslugforum.net/welcome.htm
•An Australian Museum website that allows you to ask questions and post information on nudibranchs and related sea slugs such as bubble-shells, sea hares and side-gilled slugs. Past questions are categorized for easy searching. Topics range from medical use to captive care. A species list, book reviews, participant list, and links are also provided.

Miscellaneous

Junglewalk.com
http://www.junglewalk.com/frames.asp
•See above as listed under Bivalves.

Living Reef Images
http://www.livingreefimages.com/index.htm
•See above under Bivalves for a description.

Marine World
http://www.mcsuk.org/index.htm
•Has some interesting information on Molluscs and other species as well. Made available by the Marine Conservation Society. You will have to navigate through the index to get to the Molluscs page.

Molluscan Pictures. Com
http://www.molluscan.com/shellimages/
•An image collection of molluscs found mainly in Singapore and Malaysia. A large set of images and classification listings to match. As listed on this web site, "Molluscan Pictures or Molluscan.com is about Singapore or Southeast Asian seashells, snails or molluscs and general nature, maintain by CHAN Sow-Yan since late 1996".

Nature Portfolio Image Library
http://www.natureportfolio.com/index.htm
•Large collection of natural history photographs with a special section on Molluscs at:
http://www.natureportfolio.com/inverts/molluscs.php A fee-based system; however, classifications/listings of common bivalves, cephalopods, and gastropods are made available free.

www.aquaculture.ie
http://www.aquaculture.ie/index.html
•As stated on their about us page, "www. aquaculture. ie arose from a need to have a comprehensive list of links and resources covering all aspects of aquaculture in Ireland in one place. No frills and snazzy graphics, just informative, comprehensive, and useful. From this basic premise, the idea grew into the concept of The Gateway to Aquaculture in Ireland a web-based resource aimed at both the Irish and International community.
Being based at the Aquaculture Development Centre, University College Cork, Ireland, with over

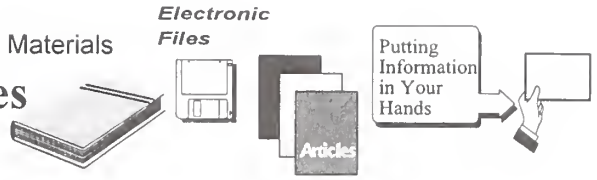
14 years participation in Irish aquaculture R&D, we are well-placed to carry out this task. As we are part of an academic institution, all services and resources are completely free and open to everyone". Have an interesting poster section with varying Mollusc research at:
http://www.ucc.ie/ucc/research/adc/docs/pubs.html#posters
Additional contact info:

Gerry Mouzakitis, PhD
Aquaculture Development Centre
University College Cork
Lee Maltings, Prospect Row,
Cork, Ireland.

University of AZ, Dept. of Geosciences- also see above under Bivalves

Mollusc information at:
http://www.geo.arizona.edu/geo3xx/308/mollusc.html
The parent home page is from the University of AZ, Dept. of Geosciences at:
http://www.geo.arizona.edu/
Additional information on Gastropods and Cephalopods at:
http://www.geo.arizona.edu/geo3xx/308/mollusc.html#gast
and
http://www.geo.arizona.edu/geo3xx/308/mollusc.html#ceph

NAL Document Delivery Services



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- Date after which item is no longer needed.
- Copyright Compliance
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Richard Smith
ARS, USDA
Research Station
Heartland, IA 56789

Canadian Journal of Soil Science 1988 v 68(1): 17-27
De Jong, R. Comparison of two soil-water models under semi-arid growing conditions.

NAL Call Number: 56.8 C162 **Ver:** AGRICOLA

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Richard Smith 7/25/00 Phone# (301)555-1234
(your) Fax#: (301)555-5678 (your) ARIEL IP Address: 111.222.333.444.555

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