ABSTRACTS

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(Abstracts arranged alphabetically by author.)

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GROWTH AND MORTALITY OF TRAY-HELD OYSTERS IN THE PATUXENT RIVER, MARYLAND

by

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Three size classes of oysters, C. virginica, were held in trays for 27 months on the Patuxent River to determine differences in growth and survival. For 24 months seed and market oysters showed similar growth, but after 27 months differences could be seen. Differences in growth of spat were apparent from the beginning. Meat condition was similar throughout the study.

Two-year mortality was within a normal range. Following tropical storm Agnes in June 1972, a 69% mortality occurred in the Patuxent River. It is believed that low salinity during high ambient temperatures was responsible for the heavy mortality. These data will be discussed in relation to changes in salinity of the Patuxent River noted since 1963.

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PHYSIOLOGICAL RESPONSES OF THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA GMELIN, TO SALINITY CHANGES.

by

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Measurements of osmotic and chloride ion concentration of the pericardial fluid from Crassostrea virginica Gmelin showed that the fluid conformed to the ambient medium throughout the non-lethal range of salinities studied. The pericardial fluid remained very slightly hyperosmotic to the environment over the salinity range. Oysters moved to salinities below 4 ppt died before reaching osmotic equilibrium. Those animals transferred to salinities between 4 and 8 ppt reached a new steady state of fluid concentration at a slower rate than those moved to higher salinities. Analyses of chloride ion concentrations after transfer demonstrated a similar pattern of delayed conformity, but the resulting concentrations were slightly lower than the media. Changes in percent body water and percent ash as a result of salinity alterations occurred at slower rates than those of the pericardial fluid, but final values were proportional to the extent of sea water dilution.

UPTAKE AND DEPURATION OF PETROLEUM HYDROCARBONS BY THE AMERICAN OYSTER, CRASSOSTREA VIRGINICA GMELIN

by

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American oysters, Crassostrea virginica Gmelin, were exposed to oil-water emulsions of selected crude oils and petroleum fractions. The rate of uptake and depuration of petroleum hydrocarbons was determined by gas chromatographic and ultraviolet spectrophotometric methods.

Oysters rapidly accumulated saturated and aromatic hydrocarbons from oil-water mixtures. Aromatic hydrocarbons were accumulated to a greater extent than n-paraffins relative to their respective concentrations in the exposure water. Saturated hydrocarbons were accumulated in higher amounts from crude versus petroleum fractions. Accumulation of oil-derived petroleum hydrocarbons was not consistent when uptake of oil by oysters was measured over a period of several days. Following return to oil-free seawater, oysters depurated the saturated chains and most aromatic fractions rapidly. Depuration was nearly completed within 21 days.

Groups of oysters were exposed to oil-water mixtures then returned to bay waters for shell growth studies. Daily average growth of experimental and control populations revealed nearly uniform results. Growth of oyster control groups averaged slightly below most of the experimentals except for a slight difference in one test group. (Supported by the American Petroleum Institute)

TRENDS IN PESTICIDE RESIDUES IN SHELLFISH

by

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The National Estuarine Monitoring Program, a cooperative effort of the States and the Federal Government, collected and analyzed shellfish samples at monthly intervals during the past 7 years in 15 coastal states for persistent synthetic pesticides.

The recently completed study of the 8000-plus samples demonstrates that the residues found, primarily DDT, were:

1. Universally too low to have human health significance,
2. Areas of high and low incidence were clearly defined geographically,
3. In some areas there has been a trend towards a wider distribution of residues but at lower levels, and
4. There has been a marked decline generally in DDT residues since 1968 when peak levels were detected.

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WASTE MANAGEMENT IN CLOSED-CYCLE MARICULTURE SYSTEMS THROUGH FOAM-SEPARATION AND CHLORINATION

by

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The paper proposes a scheme of non-bacterial waste treatment for recycling sea water in closed systems for aquaculture production.

Removal of organic matter from water is accomplished by foam-separation. Essentially the water is heavily aerated into foam. The foam, which concentrates organic matter, is removed from the system.

The foam-separation technique has been extensively evaluated in closed cycle oyster culture system, and has proven to be effective in maintaining low levels of organic matter in the system. However, an additional device is required to remove ammonia from the water. Break-point chlorination offers a promising method for this purpose. Chlorine oxidizes ammonia to form chloramines and finally nitrogen gas. Any possible harmful effects of chlorine and their remedies are also under investigation.

BASIC STUDIES OF OYSTER CULTURE. 1. HOW DO SINGLE OYSTERS LAND ON THE BOTTOM WHEN PLANTED?

by

Gordon Gunter and Katherine A. McGraw

Oysters were gathered from natural reefs in Mississippi off Pass Christian. They were culled into single market oysters. They were planted by shovel in a swimming pool eight feet deep in Ocean Springs. A thousand oysters or approximately two and one half barrels were used. Unexpectedly only 41% of the animals landed on the bottom on their left valves with the normal right side up, and 50% landed with the right or flat side down. According to fishermen, oysters landing on the bottom in this position will eventually die.

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FACTORS IN THE RECRUITMENT OF EUROPEAN OYSTERS IN MAINE

by

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and
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Ostrea edulis populations in Maine, introduced in the 1940's, today maintain marginal populations levels. However, hatchery reared progeny from these stocks may exhibit superior overwintering qualities when compared to California hatchery-reared stocks. Thus preservation of this Maine adapted gene pool is essential for use here in an intensive aquacultural development. A combined laboratory and field program is investigating factors important in recruitment.

In the laboratory the gregarious setting response is much in evidence. Larvae can be "triggered" to set by exposure to adult extrapallial fluid prior to exposure to cultch shells indicating action of a waterborne pheromone. This contradicts the British view of "surface chemistry" response of the setting larvae. Extrapallial fluid of the American oyster stimulates setting in European oysters indicating an interspecific response. Other laboratory studies are investigating the biochemical nature of the setting pheromone in addition to describing the role and ultrastructure of larval sense receptors, particularly the eyespot and apical sense organ. A Latin-square field plot has been initiated in Boothbay Harbor to determine the importance of gregarious setting in field populations of European oysters. The presence of adult oysters appears to increase setting on nearby cultch shells but results are inconclusive at this point.

EFFECT OF SALINITY ON MUCUS IN THE MANTLE OF THE QUAHOG, MERCENARIA MERCENARIA

by

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The purpose of the study was to determine whether salinity changes had any effect on mucus secretions in the quahog clam, Mercenaria mercenaria. The specific tissues studies were located in the mantle edge.

Six separate groups of clams were established. One group was held in seawater at 35 parts per thousand salinity, one at ambient salinity (approximately 30 ppt), one at 25 ppt, one at 20 ppt, one at 15 ppt and one at 10 ppt. After a week of exposure at the appropriate salinities, sections of the mantle edge were prepared for histochemical studies of the quality and quantity of mucus.

There appeared to be a relationship between salinity and mucus production in the quahog in that as salinity increased so did the amount of reactive acid mucopolysaccharide.

BIOLOGY OF THE CLAM RANGIA CUNEATA: WHAT WE NOW KNOW AND WHAT IT MEANS

by

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Our laboratory studies have shown that Rangia juveniles and adults can live indefinitely (months or years) in salinities from near 0 to at least 32 ppt; can regulate internal salinity (in water of salinity below 10 ppt); feed on algae and detritus particles, and absorb glucose from dilute solutions, at rates unaffected by salinity; can live 2 weeks (at 22°C) anaerobically by using their large supply of stored glycogen, and have other adaptations to extremely variable or otherwise adverse conditions. Nevertheless, they are ecologically almost entirely limited to the zone of 0.5 - 15 ppt salinity. The reason is their requirement for a change in salinity to stimulate spawning, and requirement of eggs and early larvae for salinity between 2 and 10 (possibly 15) in order to survive and develop. After reaching setting stage, 6 - 7 days after fertilization of eggs, the juveniles can live and grow in salinities from 2 to 30 ppt, and perhaps in lower and higher salinities that were not tested. Adults can live for 15 - 20 years in salinities too low, too high, or too stable for reproduction. In such waters the entire population may be of one or two year classes. Presence of several to many year classes means that the conditions favoring reproduction and recruitment occur every year, or most years. This makes Rangia cuneata useful as an indicator of salinity climate, in addition to its commercial value for shell and meat and its ecological value as food for fishes, crustaceans, birds and mammals.

A PRELIMINARY ASSESSMENT OF THE EFFECTS OF ALASKAN NORTH SLOPE CRUDE OIL ON DEVELOPING LARVAE OF THE PACIFIC OYSTER, CRASSOSTREA GIGAS

by

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The discovery of oil under Alaska's North Slope, and proposals to transport the oil to the Puget Sound area for processing have precipitated public concern for the durability of the local marine biota. To help assess the potential danger of accidental oil spills, the toxicity of Prudhoe Bay crude oil to larvae of the Pacific oyster (Crassostrea gigas) is under investigation. Osyter larvae were selected as the test organisms for this study because their use is rapidly becoming a standard for the evaluation of environmental degradation.

Fertilized oyster eggs were subjected to graded doses of whole crude oil and to doses of two different kinds of seawater extracts of the oil. The extracts are subsequently being analysed for their content of small hydrocarbon compounds consisting of fewer than nine carbon atoms. Differences in the larval developmental responses to the various toxicants are discussed, and some potential biological repercussions of oil importation into Pugent Sound are considered.

SUMMARY OF FLORIDA'S PENSACOLA AREA OYSTER CULTURE PROGRAM

by

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To offset effects of extensive September 1971 kills of Crassostrea virginica, the Florida Department of Natural Resources used a National Marine Fisheries Service grant to conduct public oyster culture programs in the Pensacola estuarine area.

Hydrographic and biological sampling during October 1971 through February 1972, led to selection of five oyster restoration sites in East and Escambia Bays. Beginning in April 1972, 50-100 yd^3 mounds of clam shells and oyster shells were planted on firm mud bottoms. In addition, approximately 5,725 bushels of live seed oysters were relocated to planting areas in Escambia Bay. At two areas spatfall on 100 cm^2 asbestos tiles was monitored and temperatures and salinities were recorded.

Spatfall on cultch plantings and on asbestos tiles was negligible except in September and October 1972. The effects of siltation, predators, and fouling organisms were generally slight. Spatfall was better on East Bay plantings than on those in Escambia Bay, and commercial harvesting during the 1973-1974 oyster season appears feasible.

ANNUAL PERIODICITY AND ITS RELATION TO THE INTERNAL SHELL MORPHOLOGY OF *MYTILUS EDULIS*

by

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Although daily or tidal periodicity structures are generally poorly preserved or lacing within the shell of the blue mussel, annual cycles are reflected in growth increment sequences in the innermost shell layer, facilitating age determination. Each valve of 24 specimens of *Mytilus*, all of known or assumed ages, was longitudinally sectioned along the antero-posterior axis. Individuals having survived one, three, and five winters show, respectively, one, three, and five dark bands in the nacreous layer of the shell. Spawning and disturbance lines, if present, are readily distinguished from annual bands and, therefore, present no problems similar to those encountered in classical age determination studies based upon surface shell morphology. Careful examination of growth patterns in the inner shell layer of other bivalves may facilitate age and growth rate determinations of many Recent and fossil mollusks.

SYSTEMS ENGINEERING OF OYSTER PRODUCTION

by

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The possibility of producing oysters in a closed environment, away from the hazards of nature, has been discussed among people working in mariculture for a number of years. However, oysters produced in their natural environment still cost less than those that might be produced in the currently envisioned closed systems. The purpose of this paper is to indicate the important cost factors in the closed system, show some of the important developments needed and, finally, indicate where research effort might be expended in making the closed system competitive. The base system analyzed is that proposed in a study performed by the American Cyanamid Company for the Connecticut Research Commission in 1968.

The dominant system cost results from the pumping and heating of the mixture of salt and fresh water being delivered to the oysters. A recycle system, with at least 85% recycle, is necessary to bring the costs within range of the naturally produced oysters.

Developments beyond that of the partially recycled water are required to make the system economically competitive. A sensitivity analysis shows areas where major gains might be realized. An analysis of research costs, probability of success and relationship to the cost-sensitive areas shows that effort is justified for research in the following areas, listed in order of decreasing importance: heat recovery, improved growth rates in the hatchery, growing algae and the oysters in the same tanks, cross-breeding for more rapid growth, developing less costly tank designs such as PVC-lined artificial ponds and better definition of water requirements for the growing oysters. With the expected degree of success in each research task, the cost of oysters produced in a closed environment would be less than that for naturally grown oysters.

STATUS AND POTENTIAL OF OYSTER CULTURE IN PUERTO RICO

by

S. G. Martin

Current production of the mangrove oyster, Crassostrea rhizophorae, in lagoons and small bays of Puerto Rico is limited. Historically, the greatest harvest area, Laguna Rincon, produced only 20,900 pounds of oyster, including shell, during 1972. Several factors are responsible for this condition, including primitive harvesting techniques, over-exploitation, predation, lack of appreciable setting areas, competition for space on mangrove aerial roots, and little knowledge of modern oyster growing techniques.

Approximately 776 acres are potentially available for raft and shoreline culture methods in four prime oyster-producing areas on the island, and if one or more mariculture methods prove feasible and these areas are extensively utilized for oyster culture, oyster farming in Puerto Rico can be greatly enhanced.

To study the possibilities of augmenting production, oyster mariculture experiments are in progress. First, growth, survival, seasonal sexual pattern, and histologic condition of mangrove oysters, transplanted from Laguna Rincon to several prime growing areas are being studied. Second, raft culture is being attempted in two suitable areas, involving experimentation with various cultch materials as rubber, asbestos and wood and varying the horizontal distances between strings in order to obtain optimum growth and maximum production. Growth in lagoons versus growth in open water areas are being compared. Third, disease-free seed of the Pacific oyster, C. gigas, and the eastern oyster, C. virginica, are being raised to planting size in a running seawater system and will be planted in key areas, protected from gastropod predation, and monitored closely for growth, survival, and presence or absence of disease organisms. Although all oyster importations into Puerto Rico have failed thus far, it is thought that by closely monitoring these factors mortalities can be controlled and the introduced species survive and eventually compete favorably with local species.

Preliminary observations based on examination of 490 specimens show oysters from two typical growing areas, Puerto Real and Laguna Rincon, with an average length of 30.7 mm and a maximum length of 75.0 mm. Also, histologic analyses have revealed evidence of protandry in oysters from both areas and the presence of a gregarine parasite, Nematopsis sp. in the connective tissue surrounding the digestive tubules, gut and mantle, and in the gill epithelium. Also a Labyrinthomyxa-like organism has been observed in the stomach, gut, and collecting duct epithelium, often accompanied by increased hemacytic diapedesis. These organisms do not appear to be harmful to the host.

AROCLOR® 1254, DDT AND DIELDRIN: ACCUMULATION AND LOSS BY AMERICAN OYSTERS (CRASSOSTREA VIRGINICA) EXPOSED CONTINUOUSLY FOR 56 WEEKS[1]

by

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Separate populations of oysters were exposed continuously for 56 weeks to 0.01 µg/ℓ of Aroclor® 1254, p,p'-DDT and its metabolites, or dieldrin and sampled at 8-week intervals for residues. Maximum concentrations based on body weight (µg/g) occurred after 8 week of exposure, but maximum concentrations based on absolute amount of toxicant accumulated (µg) occurred after 56 weeks of exposure. After 8 weeks,whole-body residues (wet-weight) were: Aroclor 1254, 1.65 µg/g, 4.0 µg; DDT and metabolites, 0.46 µg/g, 1.0 µg; and dieldrin, 0.08 µg/g, 0.2 µg. After 56 weeks, residues were: Aroclor 1254, 0.89 µg/g, 25.7 µg; DDT and metabolites, 0.37 µg/g, 7.0 µg; and dieldrin, 0.03 µg/g, 0.6 µg. Seasonal patterns of accumulation and loss of the three toxicants were similar. Residues based on body weight (µg/g) decreased 45% to 81% in early July and late October, apparently as the result of spawning, and increased following these periods. This shows that the life history of oysters must be considered when evaluating residue data from monitoring programs. Growth rate (height and in-water weight) of exposed oysters was not different from that of control oysters (Student's t-test; $\alpha = 0.01$). Mortality was not significant in any group.

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[1]Contribution No. 174, Gulf Breeze Environmental Research Laboratory.

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BIOLOGICAL MAGNIFICATION OF DIELDRIN IN A TWO PART FOOD CHAIN

by

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This study explored the possibility of biological magnification of the chlorinated hydrocarbon insecticide dieldrin in a two member food chain consisting of the bivalved mollusc Rangia cuneata and the decapod crustacean Callinectes sapidus.

Clams were exposed to dilute solutions of dieldrin in seawater for 36 hours. At the end of the exposure time sub-samples of clam tissues were analyzed for residues of dieldrin and remaining contaminated tissues fed to blue crabs in a specially designed feeding apparatus.

Results of analyses of tissues by gas-liquid chromatography indicate a magnification factor of 33-35 times ambient water concentration in clam tissues and 3.9 - 6.8 times clam tissue residue levels in crabs.

Thus it is shown that dieldrin can be accumulated from water by bivalves and concentrated in predator tissues as a result of feeding.

UPTAKE AND DEPURATION OF PETROLEUM HYDROCARBONS BY THE ESTUARINE CLAM RANGIA CUNEATA

by

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Clams, Rangia cuneata, were exposed to oil-in-water dispersions and water-soluble fractions of #2 fuel oil and South Louisiana crude oil or to sea water solutions of specific aromatic petroleum hydrocarbons. The rate of uptake of oil hydrocarbons by the tissues during exposure and rate of depuration when the clams were returned to oil-free sea water was determined by gas chromatographic and ultraviolet spectrophotometric methods.

Clams rapidly accumulate oil-derived n-paraffins and aromatic hydrocarbons from oil in water dispersions and solutions. Aromatic hydrocarbons are accumulated to a greater extent than n-paraffins relative to their respective concentrations in the exposure water. The alkylnaphthalenes, 2 methylnaphthalene and dimethylnaphthalenes were the oil-in-water dispersions. Following return of the clams to oil-free sea water depuration of all classes of oil hydrocarbons was very rapid, though depuration rate was dependent on the hydrocarbon type. N-paraffins were depurated most rapidly, followed by naphthalene and alkylnaphthalenes. Alkyl benzenes and polycyclic aromatics appear to be depurated most slowly. Depuration is essentially complete within 1-2 weeks after exposure to oil. (Supported by a contract from the American Petroleum Institute.)

THE PRESENT STATUS OF THE SOFT-SHELL CLAM IN MARYLAND

by

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The soft-shell clam, Mya arenaria, has been a major commercial fishery in Maryland since the development and use of the escalator dredge in the early 1950's. Between 1960-70, annual landings have fluctuated between 4-8 million pounds. These were valued at 1-3 million dollars. As a result of Hurricane Agnes in June 1972, high mortalities occurred among the Chesapeake Bay soft-shell clams and all commercial fishing in the Bay was stopped.

Of major importance was to determine the true extent of the mortalities in the Bay and to determine if those clams that survived the storm would spawn and establish new year classes. Several extensive surveys were conducted throughout Maryland following "Agnes." The results of these surveys indicated that in certain areas enough clams survived so that the fishery could be reopened on 1 June 1973. Unfortunately, the majority of clams in commercial numbers were located in one county, Talbot, and, unless careful surveillance is maintained, these clams could be overfished.

By histological examination, it was determined that the surviving clams had normal gonadal development and spawned around October of 1972. In addition, by monitoring the Bay with special spat collectors, soft-shell clam setting occurred in all major clam areas in Maryland. Similar monitoring is being done during the spring of 1973 to determine if setting will occur during this period.

At this time, it is too early to know if the soft-shell clam will fully recover from the effects of Hurricane Agnes. Findings to date have been encouraging.

SUBMERGED PLASTIC NET STRUCTURES FOR OYSTER PROPAGATION

by

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The work presented in this report is an experimental investigation of the performance of submerged plastic net structures (S.P.N.S.) for oysters. The experimental model is described. There are three variables involved in this study, net mesh size, population density and oyster initial length. Floatation was added to the structure so the unit floated off the bottom and below the surface to avoid both bottom predation and surface freezing. Data gathered from the experimental models were used to make cost/benefit comparisons.

Graphs are presented which show various relations between growth rate, mesh size, population density, initial size, final size and total growth. It is concluded that on the basis of observed performance and cost-benefit relations, the S.P.N.S. system appears to be an attractive possibility for a future low investment shellfish aquafarm. However, other biological aspects of the concept require investigation before the feasibility of this system is firmly established.

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A MODEL RELATING MOLLUSK FOOD UPTAKE, METABOLIC WASTES, AND WATER FLOW, AND AN APPARATUS TO TEST THE CONCEPT

by

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One major problem in the design of commercial shellfish raising systems is the lack of feeding information which is useful to the design engineer. In commercial systems economics dictate that some of the shellfish in the system will receive the water before others. The first individuals to receive the water will remove some of the food and add their own body wastes. Therefore, later individuals will receive water which has a lower food concentration and a higher waste concentration. These later animals will not grow as fast. Optimum utilization of the food supply can be enhanced by a knowledge of the effect of these feeding parameters.

Chemical kinetic techniques are used to determine the relationship of food and waste concentrations in the water, water flow rate, and various water distribution patterns to the rate of shellfish growth. Included are a theoretical analysis of these feeding parameters, and the design of an experimental apparatus to test the technique.