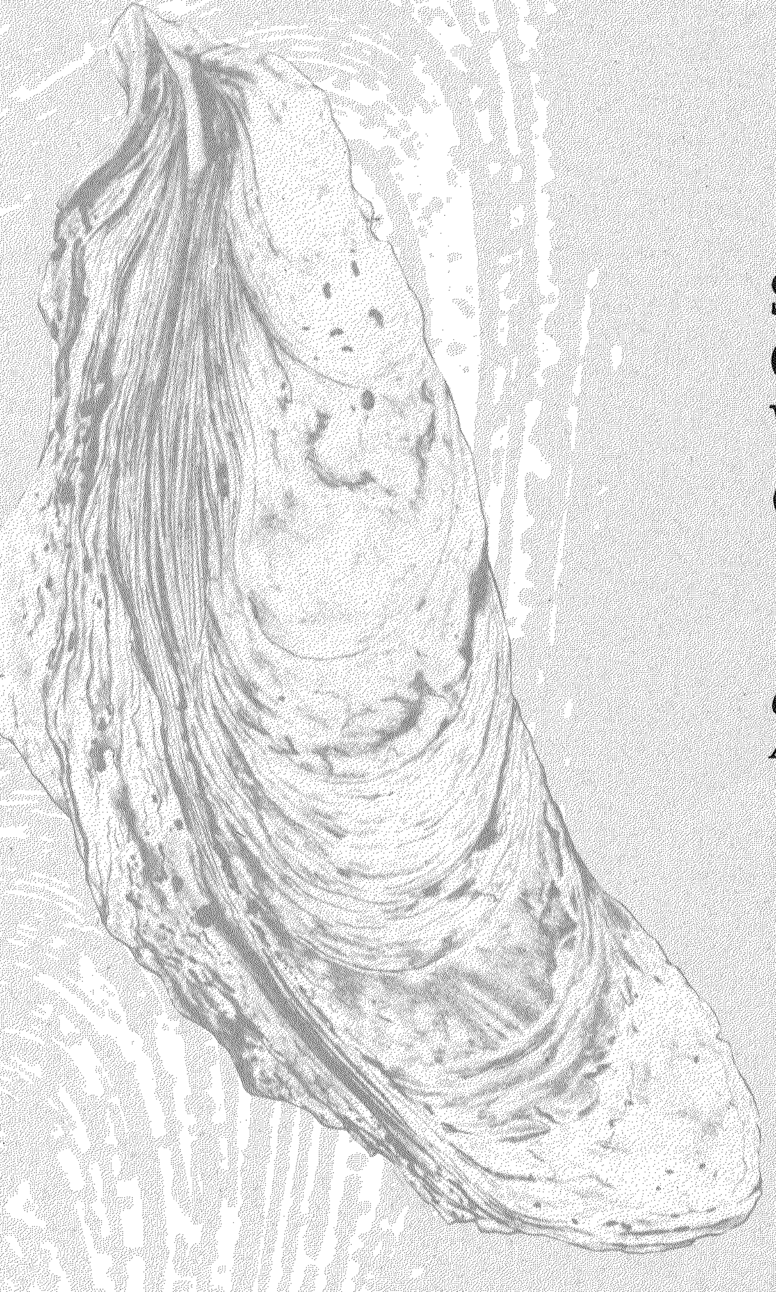

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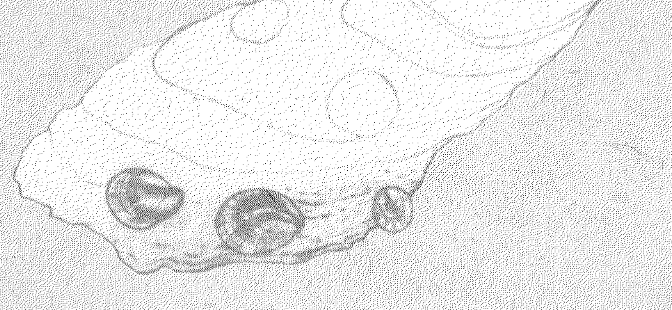
October 28-30, 1991
Annapolis, Maryland

The Oyster: Ecology and Management

Annapolis, Maryland, October 30-31, 1991



SYNOPSIS OF THE OYSTER ECOLOGY WORKSHOP ON *CRASSOSTREA GIGAS*

OCTOBER 28-30, 1991
ANNAPOLIS, MARYLAND

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INTRODUCTION

For more than a century, harvests of the Eastern oyster *Crassostrea virginica* in Chesapeake Bay and elsewhere have been declining as a result of overfishing, environmental degradation, habitat loss and, more recently, the inroads of two major disease organisms. Concerns over this decline have led to the convening of a number of workshops to assess the prospects for reversing the decline and rehabilitating the oyster resource and industry.

The first of these workshops, held at the Virginia Institute of Marine Science, largely focused on research needs for rehabilitating the *C. virginica* resource; the second, held in Annapolis, Maryland, focused on the socio-economic aspects of restoring the industry; the third at the Haskin Shellfish Research Laboratory evaluated the genetic impacts of introducing non-native oyster species in the mid-Atlantic.

One significant recommendation from the third workshop was to hold a final workshop on the ecology of *Crassostrea gigas*, a major candidate for introduction into the mid-Atlantic region. *C. gigas*, an oyster native to Japan, is a species that has been introduced into ecosystems throughout the world.

This final workshop was held on October 28-30, 1991, with the following objectives:

- To evaluate the ecological effects of *C. gigas* introductions around the world.
- To provide an overview of the ecological factors that affect *C. gigas*.
- To assess the ecological risks and benefits of introducing *C. gigas* in the mid-Atlantic region.

During the workshop, experts on oyster biology from four countries presented case histories on accidental and deliberate introductions of *C. gigas* into their ecosystems. Their presentations, *The Ecology of* Crassostrea gigas *in Australia, New Zealand, France and Washington State* are summarized and appended to this report.

In New Zealand, *C. gigas* was introduced accidentally and displaced a functioning and productive fishery, based on the native rock oyster. In Australia, *C. gigas* was introduced to the island of Tasmania, south of the mainland, to establish a new fishery; the species was then introduced, perhaps accidentally, perhaps deliberately, into New South Wales where it threatens the established rock oyster fishery in Port Stephens, a major oyster growing area. In Washington State, *C. gigas* was introduced deliberately in the early 20th century to replace a defunct fishery based upon the native Olympia oyster. In France, *C. gigas* was deliberately introduced to supplement the culture of the European flat oyster and replace the culture of the Portuguese oyster.

In the workshop, the experts from the four countries and invited participants (scientists and resource managers) discussed the ecological factors that affect the Pacific oyster and that might need to be considered if it were introduced into the mid-Atlantic region. The following topics were considered:

- Environmental requirements of C. *gigas* (will it survive and reproduce in U.S. mid-Atlantic estuaries?)
- Competition with C. *virginica* (if it sets, will it compete?)
- Disease/pathogens (what natural mortality will it face?)
- Predation (what natural mortality will it face?)
- Interbreeding with C. *virginica* (what potential exists?)
- Aquaculture (is C. *gigas* a potential candidate for aquaculture in mid-Atlantic estuaries?)

ECOLOGICAL FACTORS: AN OVERVIEW

Environmental Requirements of *C. gigas*

1. Present information suggests that C. *gigas will* persist (survive, grow, spawn, and set) in the mid-Atlantic region. Conditions of temperature, salinity, sediment loads and dissolved oxygen concentrations appear to be similar to those in regions inhabited by C. *gigas*. Although there is some suggestion that the optimum temperature is lower and the optimum salinity is higher for C. *gigas* than for C. *virginica*, the tolerances of the two species overlap broadly, there is little reason to suggest that they would be limited to different habitats (Table 1). No data were presented to compare the tolerances of the two species to other physical factors.

2. C. *virginica* may be more tolerant to intertidal exposure than C. *gigas*. C. *gigas* does not survive in the high intertidal zone in northern New Zealand (where temperatures are warm), or for long periods out of the water after harvest.

3. Both species appear to have similar substrate requirements.

4. C. *gigas is* more susceptible to TBT than C. *virginica* and the sensitivity may extend to other environmental contaminants.

Table 1. Temperature and salinity ranges for *C. virginica* and *C. gigas* (optima given in parentheses). Data from Mann, Burreson, and Baker, in press.

	C. virginica	*C. gigas*
TEMPERATURE (°C)		
Adult Growth	5-34 (28-32)	3-35 (11-34)
Adult Spawning	>15 (23)	16-30 (20-25)
Larval Survival	20-33	18-35 (30)
SALINITY (ppt)		
Adult Growth	>5 (12-27)	1-42 (35)
Adult Spawning		10-30 (20-30)
Larval Survival	8-39 (10-29)	19-35

Competition between *C. gigas* and *C. virginica*

1. There are no direct experiments on competition between the two species.

2. In New Zealand, *C. gigas* outcompeted the native rock oyster, *Saccostrea glomerata* by virtue of its faster growth, greater size, and regular and ample spatfalls.

3. Existing data suggest that *C. gigas* will spawn sooner, set more heavily, and grow faster to a larger size than *C. virginica*. The expectation is that *C. gigas* would outcompete *C. virginica* where the two species overlap. Given the highly heterogeneous environment and the potential for incomplete spatial overlap between the two species in mid-Atlantic estuaries, competitive elimination of *C. virginica is* not expected.

Disease/Pathogens

1. Current evidence indicates that *C. gigas is* less susceptible to *Perkinsus marinus* (Dermo) than *C. virginica*, but more information is needed about its susceptibility to *Haplosporidium nelsoni (MSX).*

2. A number of disease agents occur in *C. gigas*, some of which have caused mortalities, either in larval culture in hatcheries, or in growout areas. Certain of these organisms may be infective to other species.

Predators/Pests

1. No direct experiments have been conducted to examine the resistance of C. *gigas* to known oyster predators in the mid-Atlantic region. Likewise, no direct experiments exist that contrast the effect of any predator on the two species.

2. Spat of C. *gigas* have softer shells than C. *virginica* and may suffer higher mortality from crushing and drilling predators. Softer shells may also make C. *gigas* more susceptible to the boring polychaetes and sponges. However, C. *gigas* may reach a size refuge faster because of its higher growth rate. None of these possibilities has been examined critically.

Interbreeding with *C. virginica*

1. All attempts to produce hybrid adults of the two species have been unsuccessful.

2. The introduction of C. *gigas* to mid-Atlantic waters is not expected to have any direct genetic effects on native oyster populations. However, the gametes of the two species combine readily to produce nonviable progeny. Thus the introduction of C. *gigas* may reduce the reproductive potential of both species.

Aquaculture

1. Intertidal bottom and off-bottom culture of C. *gigas* seems feasible in the mid-Atlantic region. This species is farmed intensively in other parts of the world using these techniques.

2. There is no quantitative information available on unmanaged growth and reef formation of C. *gigas* on subtidal bottom. We can only speculate as to whether current fishing practices can be transferred to C. *gigas*.

ECOLOGICAL CONSEQUENCES

The following ecological consequences must be considered if a self-sustaining population of C. *gigas* were introduced in the mid-Atlantic region (under ICES guidelines).

1. The introduction will be irreversible.

2. The introduction may also introduce disease agents not present in mid-Atlantic waters.

3. *C. gigas* may be disease resistant and expand rapidly (because of its high fecundity) to produce large populations. Thus it:

   a. may replace or displace co-occurring or hard-bottom epibiota on primary substrate;

   b. may enhance co-occurring hard-bottom epibiota by providing secondary substrate;

   c. and may improve water quality (i.e., reduce the proportion of carbon cycled through microbial food webs and increase water clarity) by filtering the water column. This may enhance the growth of submerged aquatic vegetation that is currently light limited.

4. In areas where both species co-occur, the introduction may reduce the reproductive potential of both species through the production of nonviable hybrid offspring.

RESEARCH NEEDS

1. Physical tolerances of *C. gigas* and *C. virginica*

2. Disease
   Susceptibility of *C. gigas* to MSX
   Susceptibility of *C. virginica* to exotic pathogens

3. Resistance of *C. gigas* to endemic mid-Atlantic predators and pests (e.g. *Callinectes, Polydora, Cliona, Urosalpinx)*

4. Competition experiments with other hard-bottom epibiota on primary substrate (e.g. *C. virginica,* tunicata, bryozoa)

5. Gametic competition under laboratory conditions

Ultimately, carefully controlled field experiments will be necessary to answer a number of these research questions. However, we recognize the decision to conduct these field experiments is a management decision.

Oyster Ecology Workshop Participants

Invited Presenters
Peter Ayres, *Australia*
P. Dinamani, *New Zealand*
Ken Chew, *Washington State*
Phillipe Goulletquer, *France*

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