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LARVAL DEVELOPMENT OF THE GEODUCK CLAM *(PANOPE GENEROSA, GOULD)*[1]

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ABSTRACT

Geoduck clams (Panope generosa, *Gould) were conditioned at 9-10 C and spawned in the laboratory using thermal stimulation, sperm suspensions, and algae as spawning inducements. Fertilized eggs were reared to the post-larval stage in 14 C water. Larval development required 47 days, and at metamorphosis the larvae averaged 381 „m in shell length. Photomicrographs and shell measurements of the developing larval stages are included.*

INTRODUCTION

The geoduck (*Panope generosa*, Gould) is an important sport and commercial clam in Washington State. Landings from the Puget Sound, Washington commercial fishery in 1977 were 3.9-million kilograms (8.5-million lb). A commercial fishery has recently developed in British Columbia.

Geoducks can grow to an acceptable commercial size of 0.7 kilograms in about six years (Goodwin, 1976). Post-harvest surveys have shown that geoduck recruitment into commercially harvested beds occurs nearly every year, but at very low rates. The average number of geoducks, four years or younger, counted in 36 transects from three locations was 0.01/m² compared to an average of 0.9/m² of older clams.[2] With the low recruitment rate, it is desirable to reduce the time interval between successive harvests by planting harvested beds with cultured juvenile clams. Planting of intertidal public beaches for sport digging is also a possibility. Geoducks are large and have a high value which could off-set the high costs of the cultured seed.

During the past several years, geoducks have been spawned and their larvae reared through metamorphosis at the Point Whitney Laboratory. In this paper we describe the general conditioning, spawning, and culture techniques found to be most successful. Larval descriptions, photomicrographs, and measurements are included to aid in the identification of geoduck larval stages in plankton samples.

METHODS

General spawning and culture techniques used were developed by Loosanoff and Davis (1963). Photomicrographs and measurements were made following the procedures of Loosanoff et al. (1966).

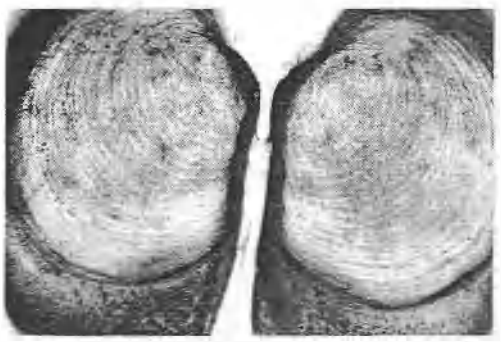
Spawning

In Puget Sound geoducks spawn in the spring (Goodwin, 1976; Andersen, 1971). Parent stocks

1 The work reported here was partially financed by the National Marine Fisheries Service, Fisheries Research and Development Act, PL 88-309.

2 Goodwin, Lynn. 1978. Project progress report 309. Hardshell clam and geoduck studies. Unpub. Manuscr. State of Wash. Dept. of Fish. Olympia, WA

Post larvae 800x650



Hinged valves from geoduck
Post-larvae showing line between
Prodissoconch II and dissoconch 500x425

Posterior end of dissoconch shell with spines
725x570

FIGURE 2. *Photomicrographs of geoduck post-larvae, length and width measurements are given in micrometers.*

250 larvae per liter. Tetracycline was not necessary and significantly slowed growth in the post-larvae.

Development of Larvae

Within 2 hours of fertilization the embryos begin to divide and by 48 hours are at the straight hinge stage (Goodwin, 1973). At this stage the prodissoconch 1 is 111 μm ± 5SD (n = 31) in length and 86 μm ± 5SD (n = 31) in width (Figures 1 and 3).[3] Umbones begin to appear at about 165 μm shell length and the larval foot becomes visible at about 300 μm. At 14 C the larvae grow to a length of 381 μm ± 19SD (n = 62), [the average maximum length of the prodissoconch 11 measured in post-larval clams (Figures 2 and 4),] in about 47 days. Larvae held at 17.6°C without tetracycline grew to a length of 377 μm ±46 SD (n = 14) in 30 days. In some cultures larvae lose

3 Length = maximum anterior-posterior dimension
Width = maximum dorsal-ventral dimension

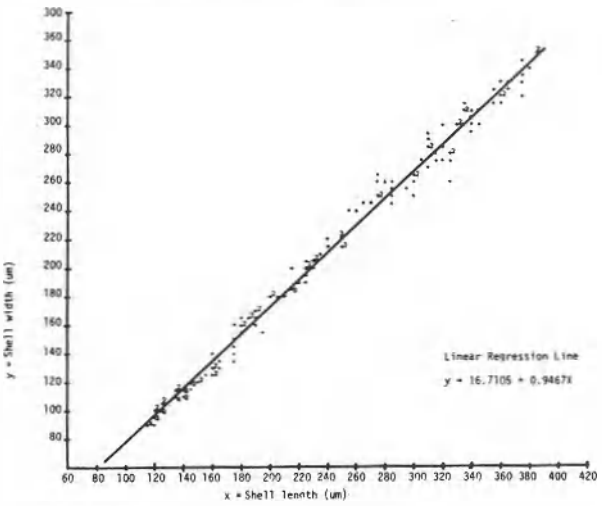


FIGURE 3. *Length - width relationship of geoduck larvae.*

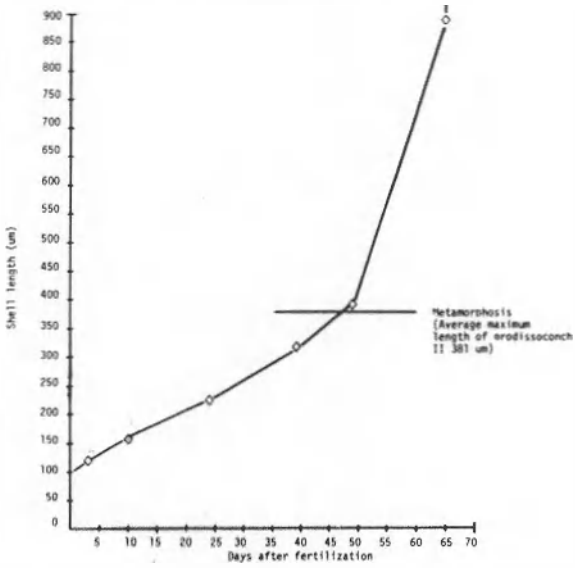


FIGURE 4. *Growth of geoduck larvae and post-larvae. Cultured at 14-15 C. Each dot represents the mean length of 20 larvae randomly chosen.*

for our studies were obtained with diver-operated water jets (standard commercial gear) from subtidal beds in southern Puget Sound during October-April when water temperatures are about 8-9 C. The clams were brought into the laboratory and placed in trays with flowing heated seawater from Dabob Bay (salinity 28.8 o/oo ± 0.8SD, n = 36). Water temperature in the trays was maintained at 9-10 C. Clams were held at this temperature for a minimum of two weeks before any attempt was made to induce spawning. During this period no food was added to the unfiltered bay water.

Spawning was induced by raising the temperature from 9-10 C to 14-15 C over a 3-4 hour period. The algae *Monochrysis lutheri* or sperm from a sacrificed male geoduck or both were added as spawning stimulants. Spawning normally began with release of sperm by one or two males from the 20-30 clams in each tray, followed by release of gametes by both sexes. Gametes are released continuously from the excurrent siphon for several minutes to over an hour with occasional violent contractions of the siphons which produce large quantities of sperm or eggs. Spawning females were transferred to small individual containers of unfiltered 14 C seawater to avoid contamination of the eggs and excessive concentration of sperm. Females can produce at least 15-20-million eggs during one spawning but normally less than half this amount are released. The clams can be returned to cooler water and induced to spawn again during the ensuing 1-2 months.

The fertilized eggs, 80 m m in diameter (Figure 1) were cleaned and placed in 650-liter rectangular tanks filled with filtered 14 C bay water at a density of 4,000-10,000 per liter.

Culture Maintenance

The tanks were cleaned and refilled with filtered 14 C seawater two or three times a week. The larvae were held on the appropriate size screens during cleaning. The larvae were then placed in the clean tanks and fed *Monochrysis lutheri, Isochrysis galbana, Pseudoisochrysis paradoxa,* and *Phaeodactylum tricornutum* either singly or mixed at a density of about 50,000 cells/ml.

Mortalities were extremely high (80%-100%) during the early larval stages in the first experiments. In later experiments this mortality has been reduced to 30%-50% with the use of tetracycline hydrochloride at 12 ppm. However, antibiotics did not control the high mortality during metamorphosis (50%--80%) or the constant mortality which occurred after metamorphosis during the first month of post-larval life.

During the spring of 1979, mortality in the early larval stages and during metamorphosis was reduced to less than 5% in cultures raised with and without tetracycline. The sharp decline in mortality from previous experiments is attributed to use of algae cultures which were nearly free of bacteria and to reduction in larval densities throughout the experiments. Straight hinged larvae were raised at a density of 3,000 larvae per liter compared to previous densities of 4,000-10,000 per liter. Density of larvae at the time of metamorphosis was reduced from 400-1,000 larvae per liter in past experiments to

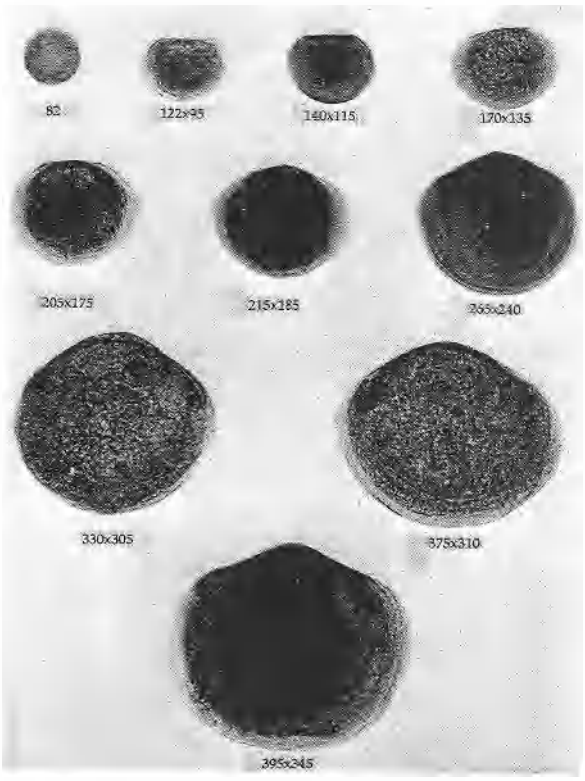


FIGURE 1. *Photomicrographs of a geoduck fertilized egg and larvae from early straight hinge to metamorphosis stage. Length and width measurements given in micrometers.*

their swimming ability at 350 μm and in other cultures larvae as rge as 400 μm, can still swim. Savage and Goldberg (1976) defined metamorphosis as the loss of the swimming functions of the velum. Prior to loss of the velum, the larvae may spend considerable time on or near the bottom of the containers even in apparently healthy unstressed cultures.

The post-larvae are very active crawlers and have a foot that can be extended more than the length of the shell. The dissoconch shell is covered by prominent spines which are common in other hiatelid clams (Savage and Goldberg, 1976). The spines begin along a distinct line in the shell between the prodissoconch 11 and the dissoconch and are easily distinguished in postlarval shells (Figure 2).

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