Hammer

COMMERCIAL FISHERIES RESEARCH AND DEVELOPMENT ACT
PROGRESS REPORT

CONTROLLED REARING OF DUNGENESS CRAB LARVAE AND THE INFLUENCE OF ENVIRONMENTAL CONDITIONS ON THEIR SURVIVAL

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INTRODUCTION

Construction of a larval rearing system and development of rearing techniques for Dungeness crab larvae were the objectives of the first year's program. Preliminary work involved a literature search, consultation with biologists involved with molluscan and crustacean larval culture, and the design of a rearing system based on the success of contemporary workers.

MATERIALS AND METHODS

A semi-closed rearing system was required and constructed (Figures 1 and 2). Sea water from Yaquina Bay, Oregon, enters the system through a pre-system filter, passes through a head tank, a second filter, an ultra-violet unit, and enters ten incubators through needle valves. Used sea water drops into a sump and is either recirculated or discarded.

The pre-system filter removes macroscopic matter from the sea water precluding obstruction of the second filter (Figure 3). Sea water falls into the head tank through three filter stages containing coarse gravel, fine gravel and glass wool, respectively. Each stage is removable for rapid cleaning. The filter capacity is ten gallons per minute.

A 750-gallon head tank assures sea-water quality during periods of adverse sea-water conditions and maintains head for gravity flow to other system components. The tank is lined with a polyethylene sheet.

Most microscopic matter is removed by a Filterite L 20 U filter equipped with 5 or 15 micron orlon elements.

A Steritronic SWL-10 ultra-violet unit is employed to reduce bacteria levels by 99%. Protozoans and unicellular algae are immobilized by the ultra-violet light.

Five-liter polyethylene incubators placed in a temperature bath contain suspended rearing trays and receive a continuous supply of treated sea water

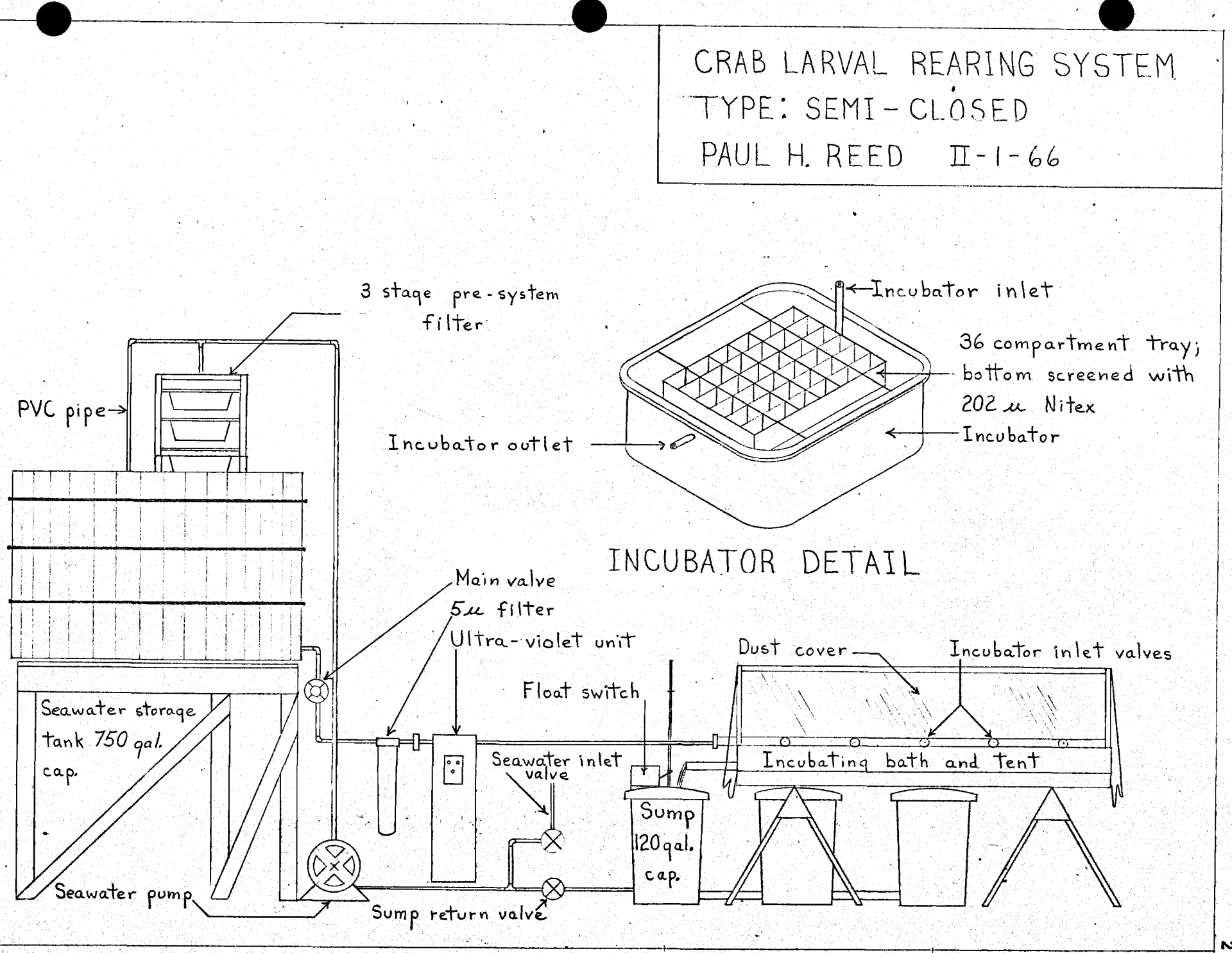

Figure 1. Arrangement and Design of the Larval Rearing System.

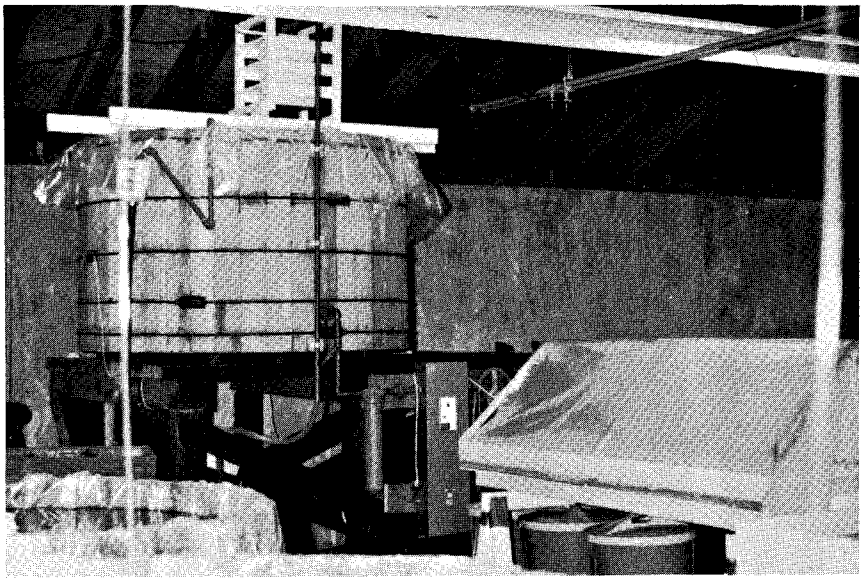

Figure 2. The Larval Rearing System Showing the Pre-system Filter, Head Tank, 5 Micron Filter, Ultra-violet Unit, Incubating Enclosure and Sump.

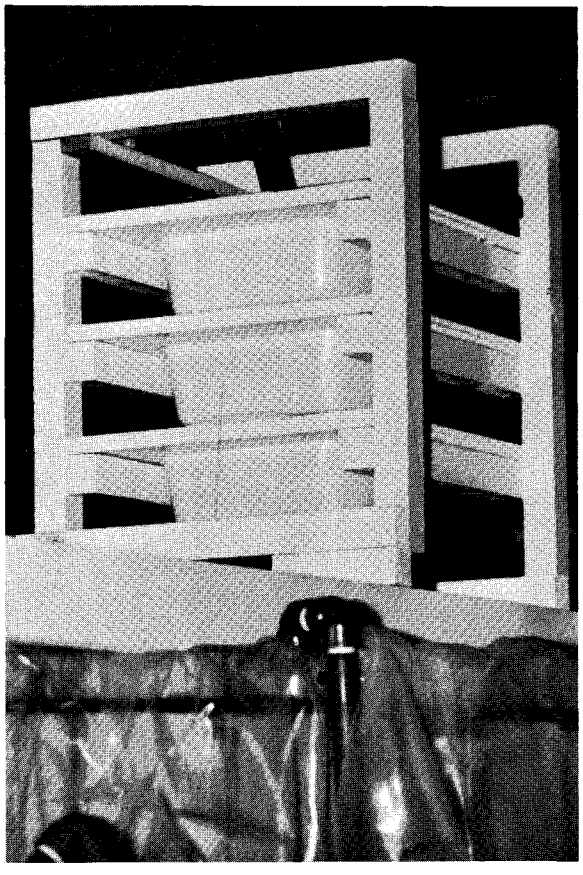

Figure 3. The Pre-system Filter Showing the Three Removable Stages.

(Figure 4). The rearing trays, with 36 compartments of 25 ml capacity each, are covered on the bottom with 202 micron Nitex screen (Figure 5). There are ten incubators and 360 individual compartments in the system. Sea-water exchange in the incubators is regulated by needle valves and circulates from the bottom end of one incubator to the opposite top end.

Sea water from the incubator flows into a common manifold and falls into a 120-gallon sump. During periods of recirculation, a float switch is activated and governs pump operation for returning sea water to the head tank bypassing the pre-system filter. During sea-water replacement the float switch is deactivated and sump water spills out of the system through an overflow pipe. The pump is a Vanton CC-T60A ten-gallon-per-minute unit with hypalon and polyethylene sea-water components. All pipe and valves are made of polyvinyl chloride (PVC).

Samples of all materials used in system construction were bioassayed with mussel larvae to eliminate possible sources of toxicity.

During operation, one larva was held in each rearing tray compartment. Cleaning and feeding was conducted every Monday, Wednesday, and Friday. A calibrated automatic pipette was used to dispense food assuring a uniform amount to each larval container. A temperature control was not used, but temperatures and salinities were held within reasonable limits by monitoring the laboratory sea-water supply and replenishing the system when sea-water quality was acceptable. The system filters were cleaned as required; after 750 gallons passed through the pre-system filter and twice a week for the Filterite filter.

A few larvae were held in a temperature control room in 250 ml Erlenmeyer flasks (five per flask) containing 175 ml of sea water. Cleaning of flasks and feeding larvae followed the rearing system schedule.

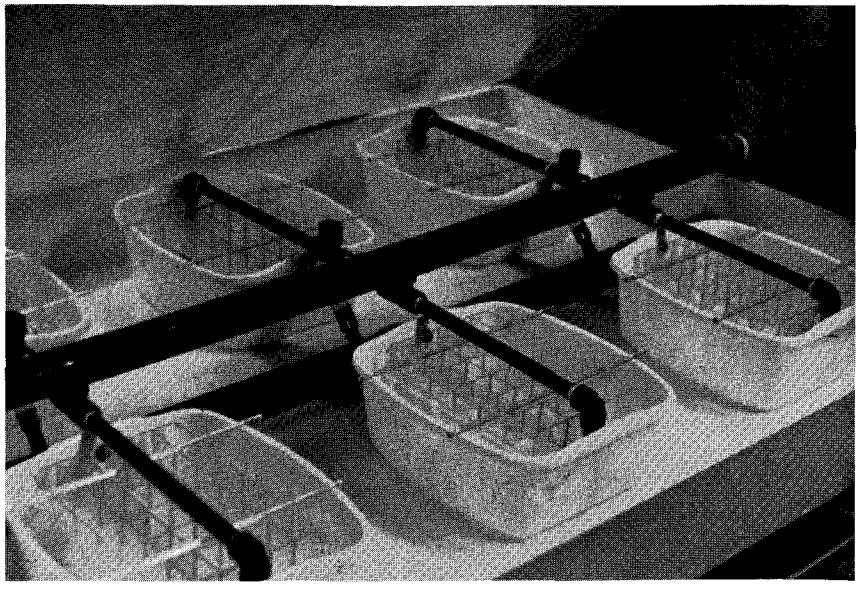

Figure 4. Arrangement of the Incubating System Inside the Covered Waterbath.

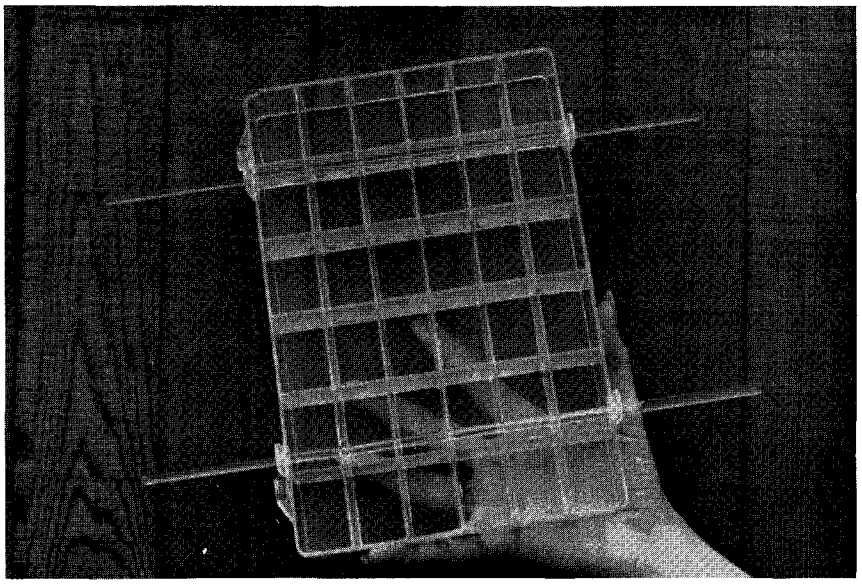

Figure 5. Detail of an Incubating Tray.

RESULTS

Because of delayed filling of the principal investigator position and time required to design and construct the system, few gravid Dungeness crabs were available for experimentation after March 1, 1966. Three separate hatches provided first zoea crab larvae for initial rearing attempts. From the first hatch on March 9, 1966, 288 zoea were placed in the rearing system, but a very high hatching mortality was evident before the zoea were collected. Zoea were held at salinities ranging from 29 to 33 ppt; temperature was not controlled and ranged from 46 F to 58 F, although fluctuations below 50 F and above 56 F were rare. Brine shrimp were used for food. Survival dropped alarmingly and after ten days less than 10% were alive (Figure 6-A). A later experiment indicated that good survival was possible without feeding during the first week of incubation. Therefore, poor viability of larvae was suspected as the decimating factor. At 65 days all the larvae had died and only few attained the fourth zoeal stage.

A second hatch occurred on April 9, 1966 and was used for a short-term study of food suitability. The zoea were incubated in 200 ml glass jars in a makeshift temperature bath, but overflow of an adjacent water tank terminated the experiment prematurely. Results suggest Dungeness crab zoea can survive seven days without food and that barnacle nauplii offer substantial promise as food for early zoeal stages.

The final gravid female produced zoea on April 20, 1966; 144 of these were incubated in the rearing system and 30 were set in Erlenmeyer flasks in the temperature control room. All zoea were fed barnacle nauplii. Temperature and salinity ranges for the rearing system were 50 to 58 F and 32 to 33 ppt, respectively. The respective information for larvae incubated in the controlled temperature room was 60 to 64 F and 31 to 34 ppt. Survival of the zoea incubated in the rearing system was slightly better than the first attempt, but

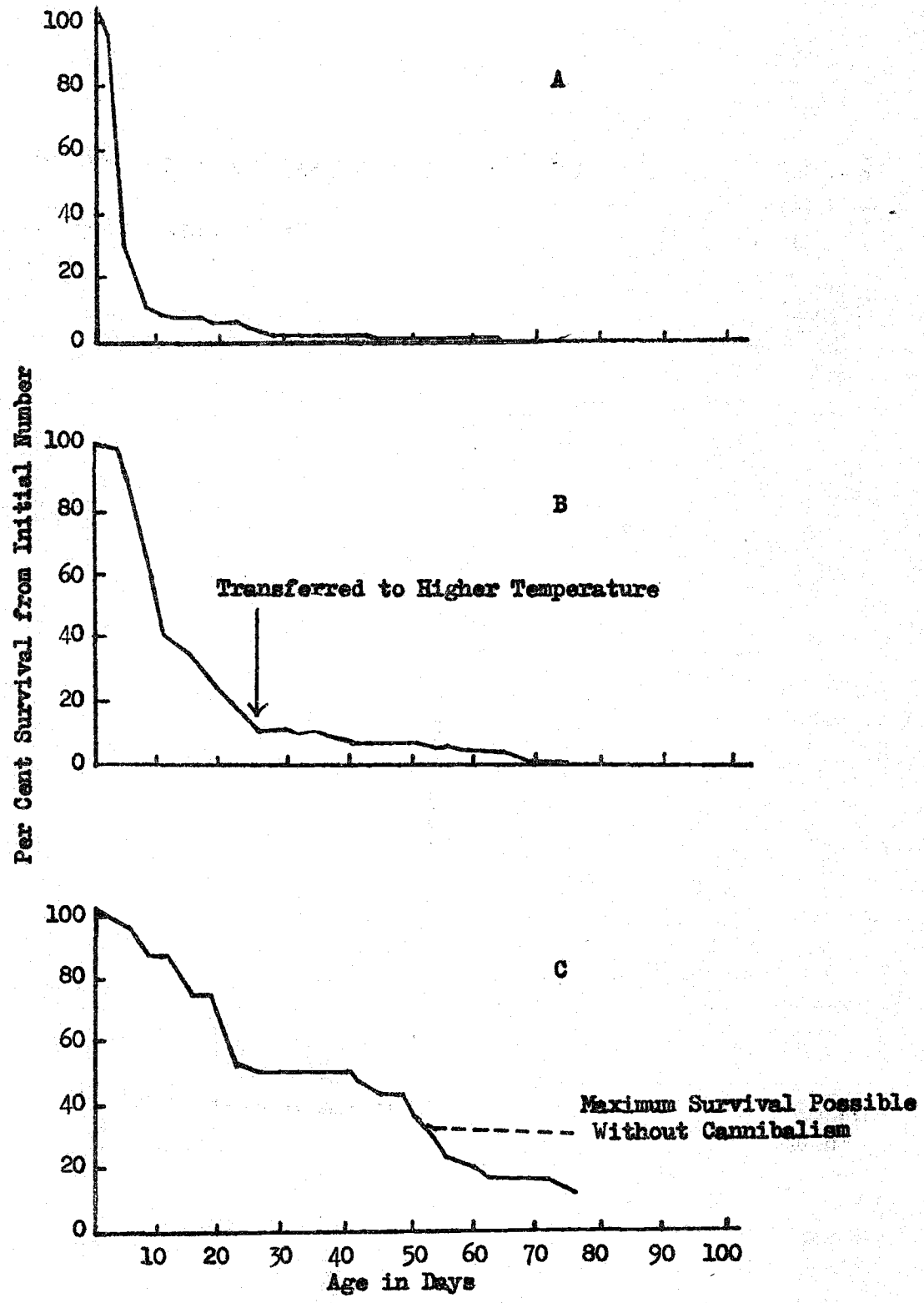

Figure 6. Survival of Various Lots of Dungeness Crab Larvae:

A. 288 Zoea Hatched March 9, 1966 and Reared Without Temperature Control;
B. 144 Zoea Hatched April 20, 1966 and Reared Without Temperature Control for the First 25 Days;
C. 30 Zoea Hatched April 20, 1966 and Reared at Controlled Temperature.

was still disappointing (Figure 6-B). About 40% survived the first ten days but by 25 days only 10% remained. The zoea incubated at higher temperatures were highly successful--after a month of rearing 50% were alive and healthly (Figure 6-C). An initial slump in survival was expected due to exposure to a new environment. The slight drop in survival between 40 and 50 days may have been due to metamorphosis from the fifth zoea to the megalops. After 50 days virtually all mortality was due to cannibalism on non-tran formed zoea by megalops. Had this factor been eliminated by isolation, survival levels may have exceeded 25% through the megalops stage (Figure 6-C, dotted line). Based on the above success, zoea from the rearing system were transferred to higher temperatures on the 25th day and mortality was immediately reduced (Figure 6-B). Larval Dungeness crab have been successfully cultured from the egg (Figure 7) through five zoeal stages (Figure 8), the megalops stage (Figure 9), and into the seventh instar or sedentary juvenile crab (Figure 10).

Although early rearing attempts were marked by limited success, recent ventures have resulted in good survival through all larval stages. Results are encouraging and sustain aspirations for tests of environmental effects on larval growth and survival attendant with permissible mortality rates. Plans are being formulated for next season's crab hatch (October-March). Although refinement of rearing techniques will be the foremost consideration, experiments involving the combined effects of temperature and salinity are being designed to estimate tolerance limits for these factors during each larval stage.

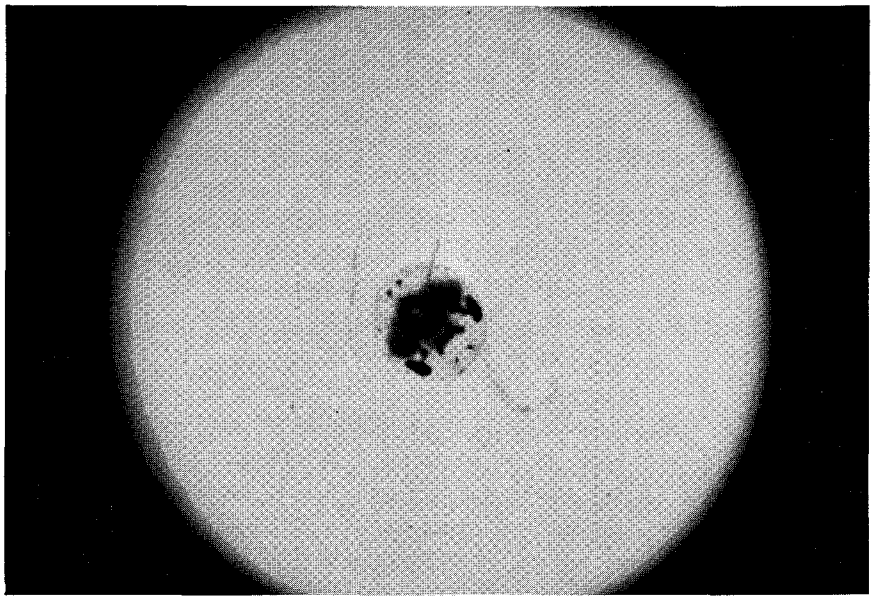

Figure 7. Eyed Egg of Cancer magister with Attachment Stalk, Two Weeks Before Hatching.

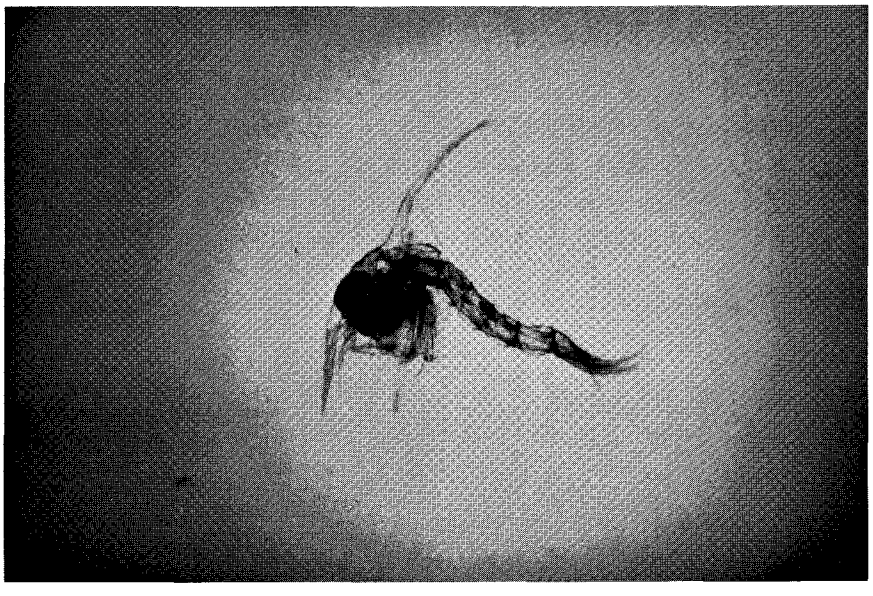

Figure 8. First Zoea of Cancer magister.

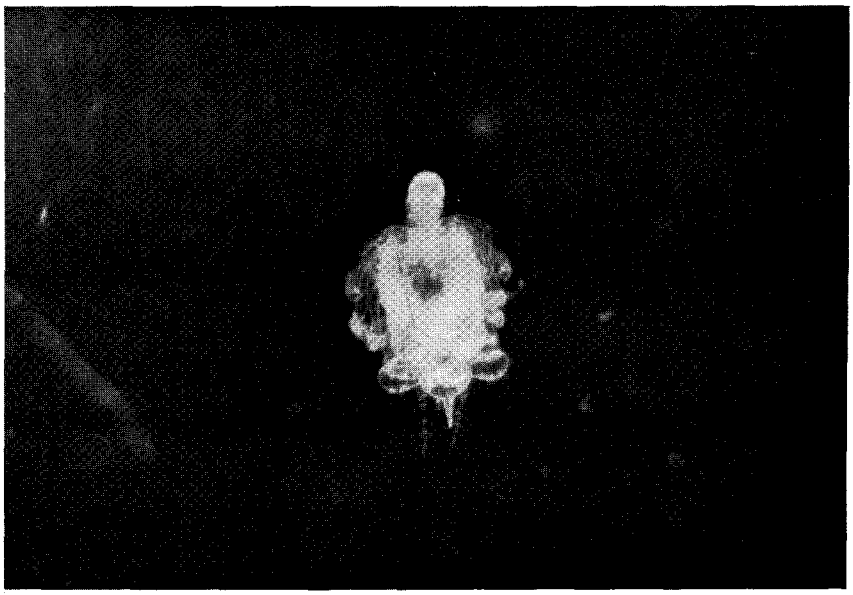

Figure 9. Megalops of Cancer magister.

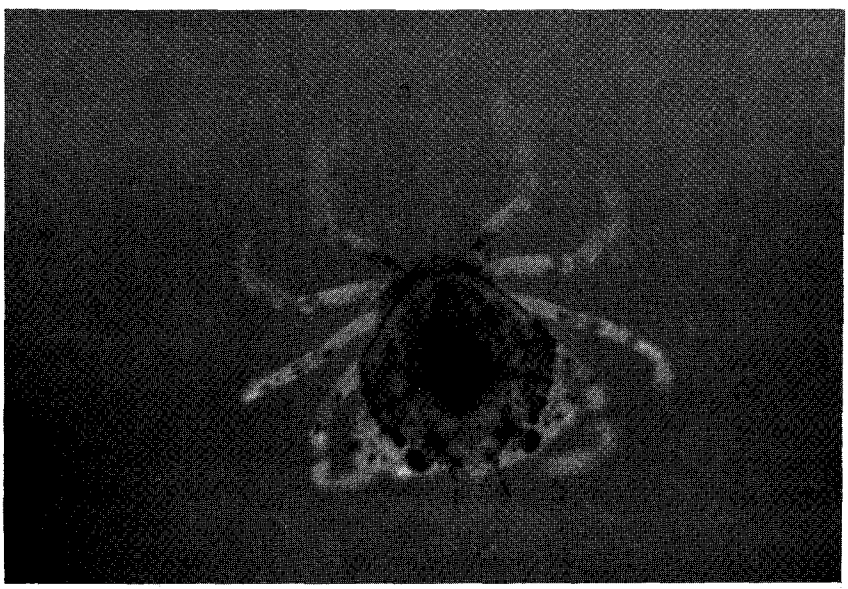

Figure 10. Seventh Instar of Cancer magister (first sedentary stage).