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SHORT COMMUNICATIONS

ADAPTATION OF A BROWN WATER CULTURE TECHNIQUE TO THE MASS CULTURE OF THE COPEPOD *ACARTIA TONSA*

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ABSTRACT The use of bay water, filtered to 5 microns, was found to be sufficiently nutritious to sustain an average of 232,000 adult *Acartia tonsa* per m^3. Copepods survived up to 24 days as adults and produced up to 75 nauplii per adult. Nauplii could be sieved to produce copepods of known age or known parentage. Survival of nauplii to adults ranged from 15 to 88%. Culture water varied from 6 to 28°C in temperature, and from 1 to 26 ppt in salinity.

INTRODUCTION

The usefulness of the copepod *Acartia tonsa* (Dana) as a source of larval fish food and for bioassays involving copepods of known age has generated considerable interest in their culture. Culture systems for copepods have traditionally required the feeding of cultured algae (Kinne 1977). The culture of algae is time intensive and expensive, making it economically impractical to produce the numbers of copepods necessary for larval food.

The use of bay water filtered through a 5-micron GAF filter bag has been found to be sufficiently nutritious to allow the rearing of moderate numbers of copepods at the Gulf Coast Research Laboratory oyster biology facility located at Point Cadet, Biloxi, Mississippi. Nitrate values of ambient water and the resulting phytoplankton, as indicated by chlorophyll-a determinations over several years, were found to be comparable to or exceed values for cultured-algae diets that were being fed to oyster larvae. This has led to the use of the "brown water" technique for the operation of an oyster hatchery (Ogle 1979). The contamination of oyster larval cultures in late summer and fall by *Acartia tonsa* led to the use of the identical techniques for culturing copepods in moderate numbers throughout the winter and spring months.

MATERIALS AND METHODS

The culturing facility consisted of a 3.9 x 13 m (12 x 40 ft) greenhouse constructed of a double wall of polyethylene (Monsanto 602) stretched over polypropylene pipes anchored to the ground. The copepods are reared in four fiberglass circular tanks of 1890-l (500-gal.) capacity. Bay water is pumped by a 1-hp pump from a pier extending 46 m (150 ft) into Mississippi Sound and passes through a 5-micron filter bag into the culture tanks. The water is not fertilized or aged. The tanks are stocked with approximately 1 million copepods and the water is completely changed three times weekly. The tanks are drained through 2.54-cm (1 in.) pipes into a sieve box which filters out the copepods before the water flows to a waste drain. Drains and air lines are changed with each water change. Tanks are hosed out, scrubbed and allowed to air dry between changes. Aeration is provided in each tank by a single stone from a vibrator pump.

The copepods used for stocking were recruited from the wild by holding tanks of unfiltered water for several days and then removing the stage animals desired. By culturing unstocked tanks containing bag-filtered water it was demonstrated that no recruitment occurred from using water passed through a 5-micron filter.

The various stages of copepods can be separated readily by utilizing sieves of various sizes. A 212-micron sieve will retain only the adults, allowing copepodites and nauplii to pass through. The copepodites will be retained by a 100-micron sieve and the nauplii by a 45-micron sieve. If copepods of known parentage are desired, one can sieve a mixed population, retain the adults, and in the following change retain the nauplii from those parents. If animals of known age are required, the tanks can be sieved daily, thereby concentrating all nauplii hatched within the preceding 24 hours. These nauplii are then reared to maturity in separate tanks. After three changes during a week's period, the nauplii will have grown to adults. On the fourth change (9 days), these copepods will themselves be producing nauplii.

Contrary to previous reports of sensitivity to handling (Gentile and Sosnowski 1968), these copepods were handled somewhat roughly as they were routinely sieved and concentrated into 10 l of water, stirred with a plunger plate, and a 1-ml sample withdrawn and enumerated to estimate the total number of animals.

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RESULTS

Copepods were reared from November 1978 until May 4, 1979. During November and December, five successive generations were reared. Naupliar production and survival were followed for one generation during the month of December, and production of an additional generation was followed during April (Table 1). Naupliar production ranged from 2.3 to 75 nauplii per adult for the month of December and ranged from 2.2 to 10 nauplii per adult for the April brood. The copepods survived as adults for about 20 days during December and 24 days during April. Survival of the nauplii varied from 17 to 69% during December and 15 to 88% during April. During these studies, a life cycle was completed in 9 to 12 days.

Temperature ranged from a low of 5.5°C to a high of 27.7°C averaging 20°C, while salinity ranged from a low of 1 ppt to a high of 26 ppt averaging 12 ppt over the culture period.

DISCUSSION

Copepods have been reared in fertilized ponds previously (Raymont and Miller 1962) with densities of 100 and 200 per liter of water. However, several species were mixed and no control was possible over the population. Bay water was used in 1-gallon jars by Heinle (1966) in his rearing experiments for producing small numbers of copepods. The production from the system used here averaged 232,000 adults per m^3 which is 580 times the maximum concentration of copepods found in adjacent waters (McIlwain 1968). This was accomplished simply by removing competitors and predators and without fertilization or supplemental feeding. Production from these tanks was excessive to the requirements of bioassay purposes and experimental larval fish-rearing, but cannot meet the needs for mass fish-rearing projects. The results are encouraging and it is possible that with supplemental feeding, better handling techniques and more constant culture conditions, even higher yields might be achieved.

TABLE 1.

Naupliar production and survival of *Acartia tonsa* during the months of December (1978) and April (1979).

Date	Brood	Parents	Numbers Produced			Nauplii per adult	Survival %
			Nauplii	Copepodites	Adults		
12/14	1	180,000	410,000	300,000	70,000	2.3	17
12/18	2	160,000	1,200,000	1,000,000	830,000	7.5	69
12/22	3	80,000	2,000,000	1,100,000	1,300,000	16.4	65
12/26	4	20,000	1,500,000	830,000	–	75.0	–
12/30	5	20,000	540,000	–	–	27.0	–
4/ 3	1	80,000	720,000	–	220,000	9.0	31
4/ 9	2	70,000	700,000	–	490,000	10.0	70
4/16	3	60,000	130,000	–	20,000	2.2	15
4/23	4	50,000	170,000	–	150,000	3.4	88

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