1999

Consumption Rates of Summer Flounder Larvae on Rotifer and Brine Shrimp Prey During Larval Rearing

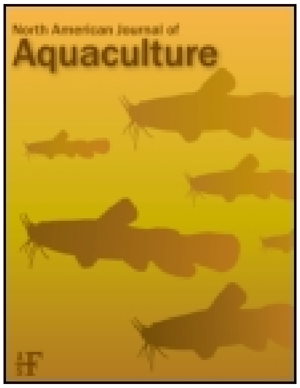
David A. Bengtson
University of Rhode Island, bengtson@uri.edu

Timothy R. Gleason
University of Rhode Island

Mohamad A. Hossain

Citation/Publisher Attribution

David A. Bengtson, Timothy R. Gleason and Mohamad A. Hossain. (1999): Consumption Rates of Summer Flounder Larvae on Rotifer and Brine Shrimp Prey During Larval Rearing. *North American Journal of Aquaculture.* 61(3):243-245.
Available at: http://dx.doi.org/10.1577/1548-8454(1999)061<0243:CROSFL>2.0.CO;2



North American Journal of Aquaculture
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/unaj20

Consumption Rates of Summer Flounder Larvae on Rotifer and Brine Shrimp Prey during Larval Rearing

David A. Bengtson [a], Timothy R. Gleason [a] & Mohamad A. Hossain [b]
[a] Department of Zoology, University of Rhode Island, Kingston, Rhode Island, 02881, USA
[b] Fisheries Research Institute, Marine Fisheries and Technology Station, Cox's Bazar, Bangladesh

Version of record first published: 09 Jan 2011.

To cite this article: David A. Bengtson , Timothy R. Gleason & Mohamad A. Hossain (1999): Consumption Rates of Summer Flounder Larvae on Rotifer and Brine Shrimp Prey during Larval Rearing, North American Journal of Aquaculture, 61:3, 243-245

To link to this article: http://dx.doi.org/10.1577/1548-8454(1999)061<0243:CROSFL>2.0.CO;2

North American Journal of Aquaculture 61:243–245, 1999

Consumption Rates of Summer Flounder Larvae on Rotifer and Brine Shrimp Prey during Larval Rearing

DAVID A. BENGTSON*[1] AND TIMOTHY R. GLEASON[2]

Department of Zoology, University of Rhode Island, Kingston, Rhode Island 02881, USA

MOHAMAD A. HOSSAIN

Fisheries Research Institute, Marine Fisheries and Technology Station, Cox's Bazar, Bangladesh

Abstract.—Larval summer flounder *Paralichthys dentatus* were hatched and reared through metamorphosis in the laboratory. At several points in the rearing cycle, larvae were removed from their rearing chambers and placed in small bowls, where they were fed known quantities of the rotifer *Brachionus plicatilis* (flounder larvae age 6, 10, or 13 d posthatch) or nauplii of brine shrimp *Artemia* sp. (flounder larvae age 23, 28, 34, or 47 d posthatch). Counts of prey organisms remaining in the bowls after 24 h allowed us to calculate numbers of prey consumed. Consumption rates increased from 62 rotifers/24 h (6-d larvae) to 301 rotifers/24 h (13-d larvae) and from 59 brine shrimp/24 h (23-d larvae) to 394 brine shrimp/24 h (47-d larvae). These rates can be used to calculate the approximate rotifer and brine shrimp production necessary for rearing summer flounder through metamorphosis in aquaculture hatcheries.

The aquaculture industry for summer flounder *Paralichthys dentatus* is currently going through its developmental stages on the Atlantic coast of North America. Both technical and economic aspects of production are being addressed during the process of research and development leading to commercialization (Bengtson 1999). Larval rearing through metamorphosis and weaning to a prepared diet are critical parts of the production process. In our research hatchery, operating at about 20°C, we typically raise summer flounder larvae by feeding them ad libitum on rotifers alone from age 3 d after hatch (DAH; when they initiate feeding) until 15 DAH; they are then fed a transition diet of both rotifers and nauplii of brine shrimp *Artemia* sp. from 16 to 22 DAH. Finally, they are fed a diet of brine shrimp alone from 23 DAH through metamorphosis (which normally occurs sometime from 35 to 65 DAH).

The commercial industry needs information on specific costs related to production. We therefore wanted to quantitatively estimate consumption rates of the larvae on each type of diet so that hatchery operators could calculate the costs of food production required to raise batches of larvae. We conducted a series of determinations of prey consumption rates by groups of larvae that had been removed from their rearing aquaria and placed in small bowls with known quantities of prey.

Methods

Eggs from captive broodstock summer flounder were hatched, and the larvae were reared by the methods described by Bisbal and Bengtson (1993). Larvae were removed from the rearing aquaria on the afternoon before each consumption rate determination and placed in four 190-mm crystallization bowls (number per bowl for each age tested is given in Table 1) containing filtered (10-μm), autoclaved seawater with a salinity of 30‰ (i.e., no food was available to them for 18 h before the experiment). Prey items (rotifers cultured with *Tetraselmis suecica* or newly hatched nauplii of Reference *Artemia* III nauplii [Collins et al. 1991]) were harvested from their culture vessels and diluted to a standard volume. From that volume, four 1-mL subsamples were taken to obtain estimates of number of prey per milliliter. Counting of 1-mL subsamples was accomplished with a Sedgwick–Rafter counting cell. An appropriate subvolume was then removed from the standard volume of prey and added to each crystallization bowl to provide the nominal initial number of prey per bowl. In addition, similar subvolumes were added to two control bowls (with no fish). Bowls contained 1 L of seawater for the rotifer experiments and 2 L of

* Corresponding author: bengtson@uriacc.uri.edu

[1] Present address: Department of Fisheries, Animal and Veterinary Science, University of Rhode Island, Kingston, Rhode Island 02881, USA.

[2] Present address: U.S. Environmental Protection Agency, 27 Tarzwell Drive, Narragansett, Rhode Island 02882, USA.

Received May 13, 1998; accepted February 12, 1999

TABLE 1.—Data on summer flounder larvae and prey used in the experiments on prey consumption rates, including ages of larvae used in days after hatch (DAH), number of larvae of each age placed in each replicate crystallization dish, and the initial nominal number of each prey type added to each crystallization dish for each age group. Calculated values are provided for milligrams dry weight of fish per liter for each crystallization dish. Actual number of prey per crystallization dish was determined as the number of prey remaining in two control crystallization dishes at the end of each experiment.

Age of larvae (DAH)	Number of larvae/ dish	Dry weight fish per volume (mg/L)	Nominal number prey/dish	Prey type	Actual number prey/dish
6	50	2.15	5,000	Rotifers	3,835 ± 191
10	50	4.10	8,000	Rotifers	11,200 ± 3,210
13	30	[a]	8,000	Rotifers	11,725 ± 2,510
23	10	1.42	1,000	Brine shrimp	1,050 ± 28
28	10	2.37	2,000	Brine shrimp	2,065 ± 49
34	10	5.00	2,000	Brine shrimp	2,070 ± 0
47	10	15.93	4,000	Brine shrimp	4,080 ± 71

[a] Dry weight data for fish on day 13 were not properly collected.

seawater for the brine shrimp experiments. Bowls were placed in a blackened chamber with a 12 h light : 12 h dark photoperiod, and the larvae were allowed to feed for 24 h, after which larvae were anesthetized with tricaine methanesulfonate and removed from the bowls. Water remaining in each bowl was filtered through a 75-μm-mesh screen to collect all uneaten prey items, which were again diluted to a standard volume, from which four 1-mL subsamples were again removed and the prey items counted. The same procedure was used to count prey remaining in the control bowls. Consumption was determined by subtracting average number of prey in bowls that contained fish from the average number of prey remaining in control bowls. Experiments were conducted at 19 ± 1°C. On each day of consumption rate determination, an additional subsample of five larvae was randomly removed from the rearing aquarium for determination of dry weight. Larvae were individually placed on tared aluminum weighing pans and dried at 60°C for 48 h, then weighed to the nearest microgram on an electronic microbalance.

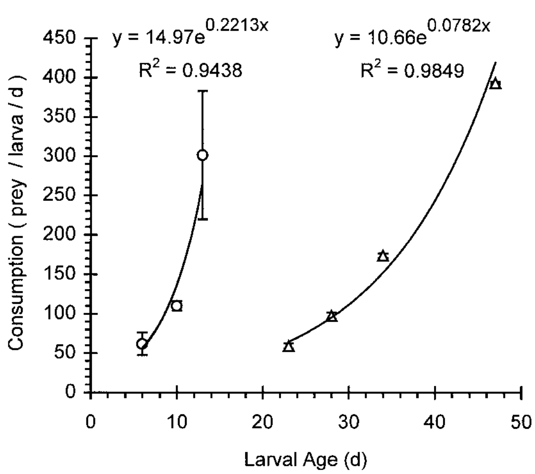


FIGURE 1.—Consumption of prey (mean ± SD) by summer flounder larvae from day 3–47 after hatching at 19°C in the laboratory. The data, curve, and equation on the left represent numbers of rotifers consumed per 24 h by larvae from day 6 to day 13 after hatching. The data, curve, and equation on the right represent numbers of brine shrimp nauplii consumed per 24 h by larvae from day 23 to day 47 after hatching. Numbers on the ordinate axis refer to either rotifers or brine shrimp, depending on the age of the fish (see Table 1).

Results and Discussion

Food consumption increased exponentially as the larvae grew through both their rotifer- and brine shrimp-feeding phases (Figure 1). Summer flounder begin feeding at 3 DAH (Bisbal and Bengtson 1995a). Their point-of-no-return is between 5 and 6 DAH at 21°C (Bisbal and Bengtson 1995b). Point-of-no-return is the time at which, if a larva has not yet fed, it is destined to die even if food is provided afterward. We therefore chose to begin consumption rate determinations with larvae of age 6 DAH. We did not attempt determinations between 14 and 23 DAH (i.e., during the feeding transition from rotifers to brine shrimp nauplii that occurs from 16 to 23 DAH) because of the added complexity of some larvae eating only rotifers, some eating only brine shrimp, and some eating both. Actual numbers of prey measured in the control bowls at the end of each experiment showed that numbers of rotifers were quite different from the expected (nominal) numbers, but

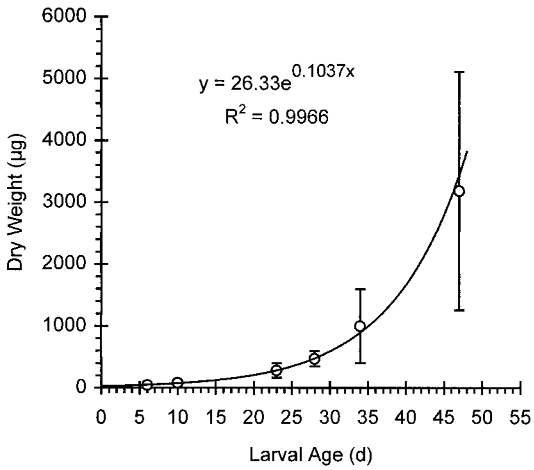


FIGURE 2.—Dry weights (mean ± SD) of representative subsamples of summer flounder larvae taken on the day of each determination of prey consumption rate, as a function of age in days, for larvae reared at 19°C in the laboratory.

that numbers of brine shrimp were very close to expected.

The increase in weight of flounder with age was well described by an exponential function (Figure 2). To our knowledge, this is the first report of laboratory growth data for summer flounder larvae. To calculate the total number of rotifers and total number of brine shrimp nauplii needed per larva to achieve metamorphosis, we integrated the areas under the curves in Figures 1a and 1b. We further assumed a linearly decreasing usage of rotifers from 16 to 22 DAH and a concomitant linearly increasing usage of brine shrimp nauplii in the same period. We then calculated that each larva requires about 3,500 rotifers and about 4,800 brine shrimp nauplii to reach metamorphosis. A hatchery operator can use these numbers to calculate the approximate food costs per metamorphosed larva, given the costs of acquiring or producing rotifers and brine shrimp nauplii. It must be pointed out, however, that metamorphosed, settled summer flounder still require brine shrimp nauplii for some period of time, and apparently the longer the better (Bengtson et al. 1999, this issue), until they can be weaned to a formulated diet. One other caveat is that these results were obtained using a 12 h light : 12 h dark photoperiod, and it is reasonable to assume that the larvae, which are probably visual feeders, fed only during the light phase. If a longer photophase is used, the larvae may have more time per day to consume prey. In a commercial hatchery that raises summer flounder larvae in constant light, the consumption rates are approximately twice those reported here (G. Nardi, GreatBay Aquafarms, personal communication)

Acknowledgments

This research was supported by the National Marine Fisheries Service, Saltonstall–Kennedy grant NA-90-AA-H-SK33. The visit of M A. Hossain to the United States was supported by the U.S. Agency for International Development. We thank the U.S. Environmental Protection Agency laboratory in Narragansett, Rhode Island, for providing some of the facilities for broodstock fish and larval rearing.

References

Bengtson, D. A. 1999. Aquaculture of summer flounder (*Paralichthys dentatus*): status of knowledge, current research, and future research priorities. Aquaculture 176:39–49.

Bengtson, D. A., L. Lydon, and J. D. Ainley. 1999. Green-water rearing and delayed weaning improve growth and survival of summer flounder. North American Journal of Aquaculture 61:239–242.

Bisbal, G. A., and D. A. Bengtson. 1993. Reversed asymmetry in laboratory-reared summer flounder, *Paralichthys dentatus.* Progressive Fish-Culturist 55:106–108.

Bisbal, G. A., and D. A. Bengtson. 1995a. Development of the digestive tract in larval summer flounder, *Paralichthys dentatus.* Journal of Fish Biology 47:277–291.

Bisbal, G. A., and D. A. Bengtson. 1995b. Effects of delayed feeding on survival and growth of summer flounder, *Paralichthys dentatus*, larvae. Marine Ecology Progress Series 121:301–306.

Collins, G. B., D. A. Bengtson, and J. C. Moore. 1991. Characterization of Reference *Artemia* III for marine toxicological studies. Pages 315–323 *in* M. A. Mayes and M. G. Barron, editors. Aquatic toxicology and risk assessment,14th volume. American Society for Testing and Materials, Philadelphia.