

## Commentary on a Successful Spawning of American Shad in a Novel Recirculating Aquaculture System

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**Abstract:**

American shad is one of the most vulnerable and sensitive fish species to disturbance. Any handling may cause serious lesion or death, and suspend gonad maturation and ovulation, eventually leading to difficulties in its culture and reproduction. How to avoid disturbance and reduce stress would be very important measures to be successful in inducing spawning for this species. Recently, we reported a successful integration of maturation and natural reproduction of American shad for the first time in a novel Recirculating Aquaculture System (RAS) without any handling for hormone administration.

**Keywords:** American Shad; Spawning; Brookstock

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## Introduction

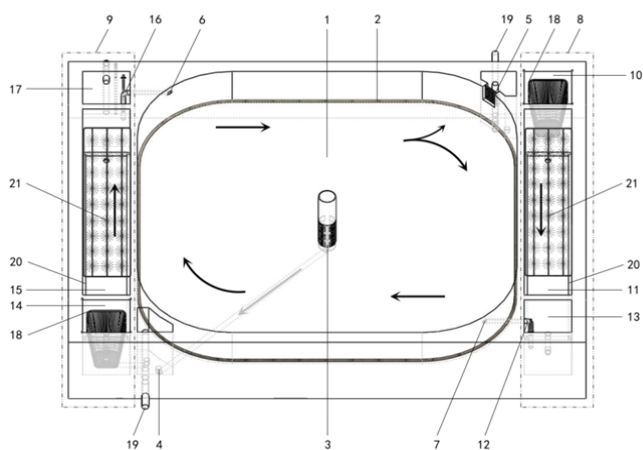
The RAS in this study was a dual-drain recirculating aquaculture system, which consisted of one spawning tank (100 m<sup>2</sup>, 1.2 m depth) in the center and two water treatment sections (10 m<sup>2</sup>, 1.2 m deep) on both sides of the fish tank (Figure 1). Each water treatment section had one filtration compartment and one biofiltration compartment to treat the effluent of two layers from the fish tank respectively, and two low-head pumps opposite to each other in a diagonal arrangement of the fish tank were connected with two water treatment sections to keep continuous water recirculation in the system. The upper layer water passed through the opening window of the wall to the upper water treatment section. The bottom layer water flowed into the central drainage, and then went through the bottom outlet to the nylon cage in the filtration compartment, which was designed to collect particles from bottom water or collect eggs during the spawning period.

One-year-old shad were selected as brookstock with a sex ratio of 1:1 in September, 2018 and raised in the dual-drain RAS under seasonal temperature manipulations. The gonadosomatic indices increased significantly in two months before the start of spawning when the water temperature reached 19.3°C in March, 2019. The fish spawned every day for two months and the most intensive spawning was observed from 19:30 to 21:00. On average, females successively produced 65,900 eggs per kg body

weight during the 2-month spawning period, resulting in 77.5% fertilization rate and 41.0% hatching rate. The results indicated that the broodstock of two years old showed good growth performance and reproductivity in this system, and their relative fecundity was more than the one of wild shad of five years old.

The success of the integration of maturation and natural reproduction of American shad is contributed to the special designs of the RAS to overcome the difficulties to culture shad, and to fit the unique features for the growth, maturation and natural spawning of American shad. First, a large fish tank with round corners is required for shad swimming. The shad are constant school swimmers with a high speed and vigilant to the environmental disturbance all the time. However, when frightened, they swim madly at a high speed. Large square tanks with round corners create a spacious runway for their escaping without deadly colliding with each other or with the tank wall. Second, two low-head pumps in a diagonal position provide a constant water flow, which is not only important to gonad development, favorable to the nature of constant swimming of shad against water current in a tank, but also significantly facilitates the absorption of oxygen for shad. Third, shad are very sensitive to water quality, especially susceptible to dissolved oxygen, ammonia and nitrite. The dual-drain RAS is equipped with two independent sections of water treatments to efficiently treat the upper clear water and the bottom dirty water separately. The system provides suitable and controllable culture environments with good quality water and the convenience for seasonal temperature manipulation, which is important to meet the special environmental requirements for gonad maturation and spawning for American shad.

We demonstrated that the integration of grown-out and natural reproduction for the broodstocks of American shad in the dual-drain RAS is an efficient reproduction system, and it may have a potential to be applied to the culture and reproduction for vulnerable species, especially for other anadromous clupeid fish, such as Hilsa shad, an important commercial fish of the Indo-Pacific region.



**Figure 1:** Diagram of the dual-drain recirculating aquaculture system for growth and natural spawning of American shad. 1: fish tank; 2: aerotube™ aeration; 3: central drainage outlet; 4: bottom water outlet; 5: opening window for upper water outlet; 6: inlet pipe from bottom water treatment section; 7: inlet pipe from upper water treatment section; 8: upper water treatment section; 9: bottom water treatment section; 10: filtration compartment for upper water treatment; 11: biofiltration compartment for upper water; 12: low-head pump for upper water treatment; 13: pump compartment for upper water treatment; 14: filtration compartment for bottom water; 15: biofiltration compartment for bottom water; 16: low-head pump for bottom water treatment; 17: pump compartment for bottom water treatment; 18: nylon cage; 19: drainage outlet; 20: biofiltration aeration; 21: biofiltration.