Above: California halibut larvae 12 days after hatching. Right: Halibut near the end of metamorphosis at 30 days posthatch (7.5 mm).

California halibut juvenile at 45 days posthatch (12.8 mm).

Summary:

Although aquaculture offers potential for the production of California halibut, several aspects of production have yet to be optimized. Research at the University of California in Davis, California, USA, found that the addition of live algae or algae paste to the culture water of halibut larvae improved growth and greatly increased survival.

Greenwater Culture Of California Halibut Larvae

Jean-Benoit Muguet
jamuguet@ucdavis.edu

Douglas E. Bush
Douglas E. Conklin, Ph.D.

Department of Animal Science
University of California
One Shields Avenue
Davis, California 95616 USA

German E. Merino
Raul H. Piedrahita, Ph.D.

Department of Biological and Agricultural Engineering
University of California
Davis, California, USA

The California halibut, *Paralichthys californicus*, an endemic species along the California coast of the United States, is an important sport fish with potential for culture in aquaculture systems.

Small-scale production of California halibut juveniles was originally realized in a clearwater flow-through system at the California Halibut Hatchery Program in Redondo Beach. The systems used conical-bottom tanks for the pelagic phase and shallow raceways for the benthic period thereafter.

A larger recirculation system was developed at the University of California in Davis, where larger numbers of juveniles have been produced. However, the larval growth and survival in both systems was too limited to be applied to large-scale production.

Microalgae Improves Performance

Numerous studies have shown that the addition of microalgae to tanks during early rearing can improve larval performance for a number of species. The authors recently investigated the potential benefits of greenwater larviculture for California halibut using both live algae and algae paste. The study was funded by the National Sea Grant College Program of the U.S. Department of Commerce National Oceanic and Atmospheric Administration and the California State Resource Agency.

California Study

A batch of California halibut eggs was collected at the California Halibut Hatchery Program facility. The newly hatched larvae were transported to the University of California in Davis and divided into three groups.

The first group was raised in clearwater in two 180-l cylindrical tanks of 0.8 m diameter and 1.1 m maximum depth with conical bottoms connected to a recirculation system. The second group was reared in two static 120-l cylindrical tanks of 0.5 m diameter and 0.6 m maximum depth. Additions of *Isochrysis* algae paste were made twice a day to maintain the algae concentration between 800,000 and 1 million cells/ml.

The third group was cultured in 100-l static raceways that measured 2.2 m long, 0.35 m wide, and 0.15 m deep. Live *Isochrysis* were used to maintain the greenwater environment.

For all groups, water quality parameters were kept as follows: temperature – 21.0 ± 0.5° C, dissolved oxygen – 7.7 ± 1.0 mg/l, salinity: 30.5 ± 1.0 g/l, and photoperiod – 16 hours light and eight hours dark. Starting at mouth opening three days posthatch, the larvae were given rotifers fed baker's yeast and enriched with a rotifer growout diet. During the 15-40 days after hatching, the fish were fed enriched *Artemia* nauplii and metanauplii.

Twenty larvae were sampled at regular intervals in each treatment for total length measurement. Survival was evaluated by counting at 28 and 38 days posthatch for the clear- and greenwater tanks, respectively.

Table 1. Larval halibut growth and survival.

	Live Algae	Algae Paste	Clearwater
Total length at 17 days posthatch (mm)	5.90	5.80	5.60
Total length at 35 days posthatch (mm)	8.20	7.90	6.80
Survival at 38 days posthatch (%)	54.55	52.65	7.70

Positive Results

Fish survival was significantly affected by the presence of the microalgae. Both treatments with microalgae had a better survival rate than the clearwater treatment (Table 1). Larvae growth was also positively affected by the algae.

The increase in size was similar for all treatments during the premetamorphic period. However, after 35 days posthatch, the larvae raised in greenwater were significantly larger. Growth was similar for fish raised with algae paste or live algae.

Other parameters were also influenced by the use of algae. The number of unpigmented juveniles was reduced dramatically, and subsequent weaning onto artificial diets was more successful in the greenwater fish, probably due to their larger size.

Algae Use Recommended

The beneficial effects of microalgae during larviculture have been reported for numerous fish. The fivefold increase in survival reported in this research, for example, was consistent with similar experiments carried out with different marine species. Multiple factors are thought to improve larval quality: better localization of the live prey, stabilization or improvement of the water quality, direct or indirect nutritional effects, and increased pancreatic and intestinal enzymatic production.

The use of dead but intact microalgae (?) did not affect the results, and no beneficial effects on water quality could be attributed to the greenwater performance in comparison to the clearwater method. Greenwater culture of California halibut larvae using live algae or algae paste is therefore strongly recommended.