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[Communication]

Evaluation of Zooplankton in Hatchery Diets for Channel Catfish Fry

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Abstract.—The efficacy of zooplankton as a supplemental hatchery diet for fry of channel catfish *Ictalurus punctatus* was evaluated. When a commercial diet is used as a reference, fry fed exclusively on zooplankton—either live or dried—performed poorly in their growth rate. However, when live or dried zooplankton were fed to fry in conjunction with the commercial diet, fry weight increased 40–50% over the weight of fry fed the commercial diet alone in a 19-d feeding trial. Data from this study indicate that zooplankton may serve as a sustainable and reliable supplement during hatchery production. These data also reaffirm the importance of zooplankton as a feed source in the growth of channel catfish fry. Zooplankton are important in catfish fry culture, and when zooplankton are present with commercial diets, improved growth results. Based on results of this study, supplemental feeding of zooplankton to hatchery fry and managing fry ponds for increased zooplankton densities should increase fry growth during the nursery phase of culture.

After hatching, channel catfish *Ictalurus punctatus* fry are usually held in hatcheries from 7 to 14 d and fed prepared diets until stocked into nursery ponds in an effort to produce more vigorous fry that are better able to endure the transfer to nursery pond conditions (Tucker and Hargreaves 2004). During this holding phase, fry are fed high-quality, finely ground feeds containing 45–50% protein. Although these feeds are considered nutritionally complete for hatchery fish, diet supplementation has been shown to increase fry growth. Fry that were fed diets supplemented with decapsulated cysts of brine shrimp *Artemia* sp. were shown to increase their weight by 61–98% more than if they were only fed a catfish-starter diet (Weirich et al. 2000). Krill meal is also used as a dietary supplement in some hatcheries (Weirich et al. 2005). While artemia is commercially available, increased demand and variable yearly harvest due to changes in environmental conditions has dramatically increased the cost of artemia cysts. In addition, decapsulation or hatching of artemia cysts is complicated, and the quantities needed to supplement large-scale channel catfish hatcheries would be labor intensive and dramatically increase the cost of production.

Natural foods are not available in hatcheries, but, when given the opportunity, channel catfish fry will readily consume zooplankton and selectively forage on larger organisms such as copepods, cladocerans, and ostracods (Mischke et al. 2003a). Bonneau et al. (1972) reported that fry older than 2 weeks consume cladocerans and ostracods as well as chironomid larvae, and natural foods continue to be consumed by 5-week-old fry. In addition, the zooplankton selected by channel catfish fry meet or exceed all nutritional requirements of the fry, providing an excellent source of protein, fatty acids, and vitamins (Mischke et al. 2003b).

Because of previous improvements in fry growth through diet supplementation and the excellent nutritional value of zooplankton, it may be assumed that zooplankton would contribute to fry growth. However, positive impacts of including zooplankton in hatchery diets of channel catfish fry have not been demonstrated. The purpose of this study was to evaluate the effects of supplemental feeding with zooplankton on the growth of channel catfish fry.

Methods

Swim-up channel catfish fry that were just beginning exogenous feeding (4 to 5 d posthatch) were used in the studies. Fry were stocked at a rate of 9 fry/L into 114-L flow-through aquaria receiving well water at 1 L/min. Fry were offered the various feeds in excess to allow consumption to satiety.

In the first study, two aquaria were used for each feeding regimen of live zooplankton only, dried zooplankton only, commercial diet only (Finfish Starter; Ziegler Brothers, Gardners, Pennsylvania), or the commercial diet supplemented with either live or dried zooplankton. Zooplankton were harvested daily from production ponds with an electric pump and a canister filter with a 500-μm screen (Mischke and Wise 2008). Organisms captured in the filter were passed through a 1,000-μm sieve to remove large invertebrates. The treatments containing live zooplankton received additions of zooplankton four times daily at densities in excess of what was eaten by the fry.

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Periodic samples of 240 mL were collected from each aquaria and preserved in buffered formalin; then all zooplankton present in the samples were counted. Based on the samples, zooplankton densities remained above 100 organisms/L in the aquaria. Each day 25 g wet weight of captured zooplankton were held in the hatchery in aerated buckets and equally divided among the aquaria during the four daily feedings. For the dry zooplankton treatments, captured zooplankton were dried in a commercial food dehydrator and then fed directly to the fry or mixed with the commercial feed at a 1:1 ratio by volume. Dry diets were delivered to each aquaria by means of automated feeders (model AF6; Sweeney Enterprises, Boerne, Texas) at 1-h intervals for every 24 h. Feeding rates were adjusted to deliver excess feed on a daily basis.

In the first study, swim-up fry were fed for 6 d, at which time fry wet weight was determined. All fry were weighed together on a digital scale. Total weight was divided by the number of fry to determine individual weights.The same methods were used in the second study, except that only three treatment diets (commercial diet alone and two combinations of commercial diet and zooplankton—live or dry) were used, and swim-up fry were fed for 14 d. Seven days after initial feeding, a sample of approximately 100 fry were weighed on a digital balance, counted, and returned to the aquaria. Final wet weight was compared among treatments using one-way analysis of variance (ANOVA) and the least significant difference (LSD) test at $P < 0.05$.

Results and Discussion

Throughout both studies, feed was present on the bottom of each aquaria every morning, indicating that fish in all treatments were given equal opportunity to feed to satiation. Results from the first study showed that the combination of zooplankton (either live or dry) with the commercial diet resulted in larger fry than just commercial feed alone (Figure 1). However, fry that received only zooplankton weighed significantly less ($P < 0.05$) than fry fed other diet treatments. Because zooplankton alone did not produce desirable results, the zooplankton-only treatments were not used in the second study.

As in the first study, supplementing the diet with zooplankton increased fry growth during the second study (Figure 2). After 14 d of feeding, fry that had been fed dry zooplankton (292 mg) or live zooplankton (312 mg) with the commercial diet were significantly ($P < 0.05$) heavier and weighed 40% and 50% more, respectively, than fry fed the commercial diet alone (209 mg).

Zooplankton-only diets were clearly inadequate for channel catfish fry, resulting in a reduction in growth compared with all other diets. Zooplankton from channel catfish nursery ponds contain 65% crude protein and 9% fat on a dry matter basis (Mischke et al. 2003b). Swim-up channel catfish fry require 58% protein for maximum growth up to about 1 week of age (Winfree and Stickney 1984). The dietary energy–protein ratio of zooplankton may be too low for optimal growth of channel catfish fry when zooplankton are the only food source. Estimated digestible

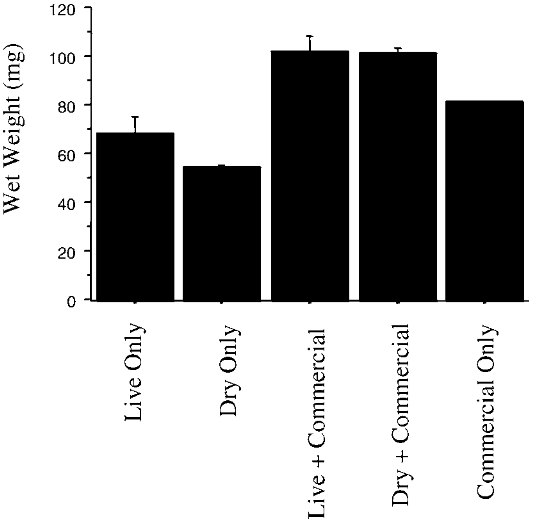

FIGURE 1.—Final mean weight (mg) of channel catfish fry fed live zooplankton only, dry zooplankton only, live plus commercial diet, dry plus commercial diet, and the commercial diet only for 6 d.

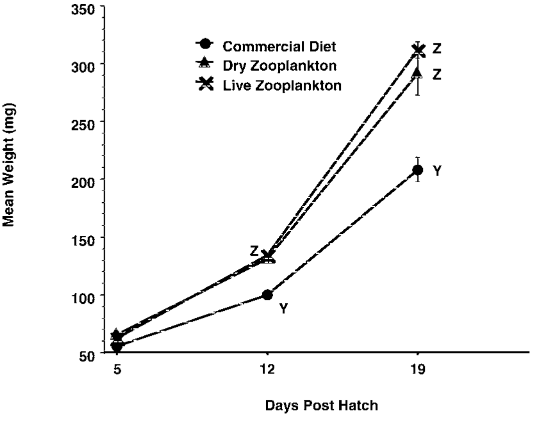

FIGURE 2.—Mean weight (mg) of channel catfish fry fed a commercial diet, the commercial diet supplemented with dried zooplankton, and the commercial diet supplemented with live zooplankton for 14 d. Means with different letters at a given sampling time are significantly different ($P < 0.05$)

energy (kcal/g = 4 × [protein + nonfiber CHO] + 9 × [fat]) to protein ratio of zooplankton is 5.14, compared with 6.89 for the commercial diet.

Another possible reason for reduced growth of fry fed on zooplankton-only diets is the difference in bulkiness between zooplankton and commercial feed. Zooplankton are about three times more bulky than the commercial diet (60.4 g/100 mL versus 18.2 g/100 mL, respectively).

It is not clear why supplementation of zooplankton led to increased growth of fry. Commercial diets are considered to be nutritionally complete, but it is common with members of many species for poor growth to occur when fed prepared diets during the early stages of fry development. Poor growth when fed commercial diets is thought to be because of lack of ingestion, digestion, or assimilation of these feeds (Holt 1993). Lack of growth in larvae of striped bass *Morone saxatilis* fed prepared diets was attributed to a deficiency of growth factors supplied in live foods (Baragi and Lovell 1986). Ingestion of prepared diets is not a problem with channel catfish fry, so zooplankton in the diet must in some way aid in digestion or assimilation of the feed.

Fry are typically held in the hatchery 7–14 d after hatching to increase their size and vigor before pond stocking (Tucker and Robinson 1990). Commercial hatchery diets are considered to be nutritionally complete and to promote optimal survival; however, they may not support optimal growth. Our data support other findings that show that supplementation of commercial diets with natural feeds can improve growth of channel catfish fry (Weirich et al. 2000). Also, Weirich et al. (2001) showed that fry tend to demonstrate increased growth when proper zooplankton are abundant in ponds. When stocked into small pools at 2 or 7 d after hatching, fry grew larger than when stocked at 14 d after hatching, with no differences in survival rate. This increase in growth was attributed to fry consuming zooplankton in the ponds.

Zooplankton may serve as a sustainable and reliable supplement during hatchery production. These data reaffirm the importance of zooplankton as a feed source in the growth of channel catfish fry. Historically, little attention has been placed on pond preparation in terms of selecting for optimal numbers and taxa of zooplankton. Based on results of this study, managing fry ponds for increased zooplankton densities (Mischke and Zimba 2004) may increase fry growth during the nursery phase of culture. Also, it may be beneficial to supplement commercial diets with zooplankton while fry are being held in the hatchery.

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