ALLIANCE™
(https://debug.globalseafood.org)

Responsible Seafood ADVOCATE

Health & Welfare

Managing natural productivity in channel catfish nursery ponds

1 June 2006

By Charles C. Mischke, Ph.D.

Catfish fry stocking decision should be based on abundance of cladocerans, copepods

The application of fertilizers to channel catfish nursery ponds helps stimulate the ponds' natural productivity.

Although channel catfish culture is the largest aquaculture industry in the United States, little research has been conducted on improving the efficiency of the fry-to-fingerling stage of production. Survival of fry after stocking into nursery ponds is unpredictable and highly variable. More effective pond fertilization practices and zooplankton population monitoring may be ways to improve the efficiency of this stage of catfish production.

Zooplankton selection

Recent pond and laboratory experiments at the National Warmwater Aquaculture Center in Stoneville, Mississippi, USA, determined the zooplankton selectivity of channel catfish fry. Fry were stocked into experimental ponds and aquariums with differing zooplankton communities and allowed to forage for 24 hours before sampling. Stomach contents were removed from the sampled fry and examined microscopically. Zooplankton taxa and quantities consumed were compared with the overall taxa and numbers of zooplankton available in the water.

Although the taxonomic compositions of the zooplankton communities were different, fish in all trials showed the same zooplankton preferences (Table 1). Channel catfish fry preferred large cladocerans such as *Daphnia, Moina* and *Sida* to all other groups of zooplankton. Although the cladocerans were rare in the zooplankton samples taken, the fry actively sought them.

Mischke, Zooplankton preferences of swim-up channel catfish, Table 1

Zooplankton Group	Rank	Fry Behavior
Large cladocerans	1[a]	Preferred
Copepods	2[bc]	Neutral

Small cladocerans	3[c]	Avoided
Copepod nauplii	4[d]	Not consumed
Rotifers	4[d]	Not consumed

Table 1. Zooplankton preferences of swim-up channel catfish fry. Ranks containing the same letters are not significantly different.

The copepods *Diaptomus, Halicyclops* and *Cyclops* were generally consumed in the same proportions in which they occurred in the water. Small cladocerans, including *Bosmina, Alona* and *Chydorus,* were consumed by the fry, but avoided if larger prey were present. Rotifers and copepod nauplii, although abundant in all experiments, were never consumed by the fry.

Zooplankton nutritional value

Zooplankton are assumed to play a major role in catfish nutrition after fry are stocked into ponds, whereas uneaten prepared feeds serve as fertilizer for natural pond productivity. Although some studies have determined the nutritional value of specific zooplankton – typically cultured zooplankton – the authors wanted to determine the nutritional value of the wild zooplankton consumed by channel catfish fry and small fingerlings.

Eight ponds were fertilized for one month, and then large zooplankton (copepods, cladocerans, and ostracods) were collected from each pond. The zooplankton were identified and analyzed for chlorophyll and carotenoid pigment composition, crude protein and fat, amino acids, fatty acids, vitamins, and minerals.

Protein and fat

The zooplankton contained 65 percent crude protein on a dry matter basis, which exceeds the 58 percent protein requirement for channel catfish fry raised from swim-up to about 1 week of age. The minimum protein requirement appears to decline with fish growth and size to about 55 percent to 46 to 50 percent at 3 to 5 grams. The zooplankton under study contained about 9 percent fat, a level slightly lower than in typical catfish starter diets and higher than in typical fingerling feeds.

Minerals and vitamins

The results of mineral analyses from pond zooplankton samples are presented in Table 2. All analyzed minerals exceeded the requirements determined for catfish fingerlings. Analysis of composite vitamin samples (Table 2) showed the zooplankton were excellent sources of niacin and vitamin E, with concentrations several times higher than the requirements for fingerlings.

Mischeke, Dry-matter mineral and vitamin composition, Table 2

	Zooplankton Content	Requirement
Minerals		
Calcium (%)	3.30	None*
Phosphorus (%)	1.01	0.03-0.04

Copper (ppm)	42.40	4.80
Iron (ppm)	1,000.00	20.00
Manganese (ppm)	135.00	2.40
Selenium (ppm)	0.80	0.25
Zinc (ppm)	100.00	20.00
Vitamins (ppm)		
Folic acid	2.20	1.50
Niacin	107.50	7.40-14.00
Pantothenic acid	14.00	10.00-15.00
Vitamin B6	6.00	3.00
Ascorbic acid	18.00	11.00-60.00
Vitamin E	109.00	25.00-50.00
Thiamin	2.00	1.00
Riboflavin	17.00	6.00-9.00

Table 2. Dry-matter mineral and vitamin composition of sampled zooplankton and related catfish fry nutritional requirements.

Amino and fatty acids

All indispensable amino acids were in excess of the requirements for fingerling catfish. Assuming the digestibility of the zooplankton was 80 percent or greater, all amino acid requirements for the fingerlings were met.

The 16:0, 18:1, and 20:5 omega-3 were the dominant fatty acids. Channel catfish do not appear to be as sensitive to fatty acid deficiency as some other species, but require omega-3 highly unsaturated fatty acids (HUFAs) for optimum growth. It appears that 1-2 percent dietary linolenic acid (18:3 omega-3) or 0.75 percent omega-3 HUFAs will satisfy the omega-3 fatty acid requirement of fingerling catfish.

The omega-3 HUFAs from zooplankton in the study averaged 18 percent of total fat or 1.6 precent of dry matter, which exceeded the requirement. The large size fraction of the zooplankton compared favorably to other omega-3 HUFA sources.

Phytopigments

Phytopigments (chlorophylls and carotenoids) in the zooplankton were also analyzed. Carotenoids indicate the taxa of algae consumed by zooplankton, but may also be biologically important for fry. Carotenoids may influence fry survival and immunity, and have an antioxidant role.

Chlorophyll a was the most abundant chlorophyll detected. The carotenoids chinenone, canthaxanthin, and β-carotene were also abundant in the zooplankton. Echinenone and canthaxanthin indicated grazing on blue-green algae.

Pond fertilization research

Previous

Most fertilizers are used with a strong initial dose followed by several lesser applications.

recommendations for fertilization of channel catfish nursery ponds were the result of research done in Alabama during the 1930s and 1940s. A common recommendation is to fertilize with high-phosphorus inorganic fertilizer at 561 to 1,122 grams per hectare every two days until a bloom develops. Also, some sources recommend applications of organic fertilizer (rice bran, cottonseed meal, or alfalfa pellets) at up to 280 kilograms per hectare, followed by weekly applications at half the initial rate.

To determine if such recommended fertilization practices are appropriate for northern Mississippi, phytoplankton and zooplankton responses to both organic and inorganic fertilization in channel catfish nursery ponds before fish stocking were evaluated. The authors also evaluated the responses to fertilizers in newly constructed versus established catfish nursery ponds.

In 2001, three control ponds did not receive fertilizer. Three additional ponds received an initial application of 224 kilograms per hectare cottonseed meal, 56 kilograms per hectare calcium nitrate, and 5.6 l per hectare triple superphosphate. The fertilized ponds also received weekly applications of 28 kilograms per hectare cottonseed meal and twice-weekly applications of 28 kilograms per hectare calcium nitrate and 1.87 l per hectare triple superphosphate for four weeks.

Few differences were apparent between the fertilized and control ponds. Although phosphorus levels were higher in the fertilized ponds, algal populations were not different among all the ponds. Nitrogen levels were similar in all ponds, and the preferred zooplankton populations were unchanged by fertilization.

In 2002, 26 ponds were studied. Sixteen ponds were newly constructed and 10 were previously used for fish production for several years. Within each pond age group, treatments of no fertilizer additions, organic fertilizer only, inorganic fertilizer only, or a combination of organic and inorganic fertilizers were assigned.

The organically fertilized ponds received an initial application of 84 kilograms per hectare cottonseed meal followed three days later by 56 kilograms per hectare of the meal. Thereafter, 28 kilograms per hectare was added twice per week for three weeks. Inorganically fertilized ponds received an initial application of 44.8 kilograms per hectare urea and 5.6 l per hectare triple superphosphate, followed by twice-weekly applications of 22 kilograms per hectare urea and 2.8 l per hectare triple superphosphate for three weeks.

Compared to levels in the control ponds and organic-only treatments, nitrogen was higher in the older ponds and those that received inorganic fertilizer and the combined organic and inorganic fertilizer treatments. Phosphorus was higher in the old ponds and in all that received inorganic fertilizer.

Chlorophyll a, zooplankton

Chlorophyll a was higher in the inorganic and inorganic plus organic treatments compared to the controls and organic-only treatments. The control ponds and organically fertilized ponds – both old and new – were similar in chlorophyll a concentration and decreased over the study. Chlorophyll a in new ponds fertilized with inorganic or combination fertilizers was low and remained constant throughout the study. Old ponds fertilized with inorganic only or both inorganic and organic fertilizers increased initially in chlorophyll a, then decreased throughout the second half of the study.

The three groups of zooplankton important for channel catfish are copepods, cladocerans, and ostracods. Copepod numbers were higher in old ponds and those fertilized with both organic and inorganic fertilizer. In all fertilizer treatments, copepod numbers increased over the study, with peak numbers reached 14 to 24 days after filling.

Cladoceran numbers were not significantly different between old and new ponds, but were higher in ponds fertilized with inorganic fertilizer as compared to all other treatments. In inorganically fertilized ponds, cladocerans reached peak numbers 17 days after filling in both new and old ponds. Ostracods were more numerous in older ponds, but no differences occurred among fertilizer treatments.

Larger plankton, such as *Daphnia sp.*, Calanoid copepods, and *Bosmina sp.*, are the preferred food of growing catfish fry.

Recommendations

Although some species of fish fry initially consume small zooplankton, channel catfish fry were found to consume the largest zooplankton groups immediately at swim-up. The stocking decision on which pond in which to stock catfish fry should therefore be based on the abundance of large cladocerans and copepods present, rather than total zooplankton abundance.

North Mississippi nursery ponds are primarily nitrogen limited. This is in contrast to previous thought that phosphorus is the key ingredient in fertilizer. Although the 2002 protocol resulted in significant differences among treatments, even higher nitrogen applications may be beneficial, especially in new ponds. Organic fertilizers had little effect on primary productivity or zooplankton populations. Higher rates of organic fertilizer may eventually produce responses, but may also reduce water quality.

The authors suggest using only established ponds for fry culture, filling ponds one or two weeks before stocking, and applying inorganic fertilizer at an initial rate of about 20 kilograms per hectare nitrogen and 1.1 to 2.2 kilograms per hectare phosphorus, followed by subsequent applications of half the initial rate for three or four weeks. If newly constructed ponds are used, higher fertilizer rates are probably necessary to achieve the same response.

(Editor's Note: This article was originally published in the June 2006 print edition of the Global Aquaculture Advocate.*)*

Author

CHARLES C. MISCHKE, PH.D.

Mississippi State University
Thad Cochran National Warmwater Aquaculture Center
P.O. Box 197
Stoneville, Mississippi 38776 USA

cmischke@drec.msstate.edu (mailto:cmischke@drec.msstate.edu)