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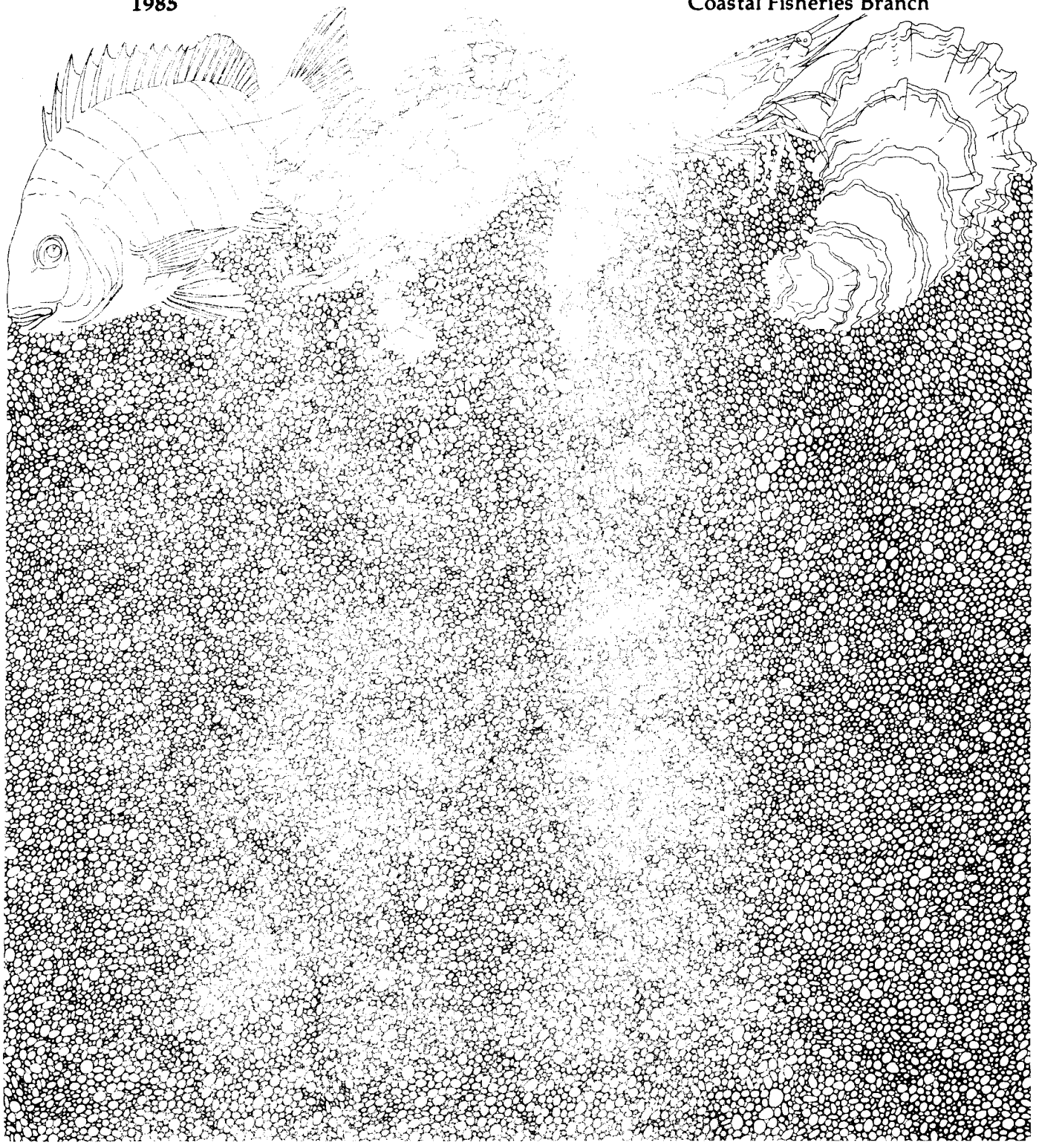

EFFECTS OF TWO FERTILIZERS ON RED DRUM SURVIVAL IN PONDS

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ABSTRACT

Comparison of zooplankton density and red drum (Sciaenops ocellatus) survival in two saltwater earthen ponds fertilized with cottonseed meal to two ponds fertilized with alfalfa meal was inconclusive. However, the mean densities of all zooplankton groups were significantly higher in cottonseed meal fertilized ponds than in alfalfa meal fertilized ponds. Low dissolved oxygen in cottonseed meal ponds at stocking may have caused complete fry mortality and no zooplankton cropping. Cottonseed meal ponds yielded no red drum. The two alfalfa meal ponds yielded 6.0 and 2.5% survival.

INTRODUCTION

Red drum (Sciaenops ocellatus) support an important fishery throughout the southeastern United States (Matlock 1980). The potential for red drum culture was recognized as early as 1962 (Bearden 1967), but extensive pond research awaited development of techniques for spawning captive fish (Arnold et al. 1977, Roberts et al. 1978). With large numbers of fry readily available, the Texas Parks and Wildlife Department (TPWD) initiated studies to develop techniques for rearing fish in earthen ponds. Initial procedures were essentially those used for rearing striped bass (Morone saxatilis) (Bonn et al. 1976). Hatcheries typically use cottonseed meal, alfalfa meal, alfalfa pellets or peanut hay as organic fertilizers to stimulate zooplankton forage. Initial red drum culture studies used cottonseed meal (Colura et al. 1976). The present study was conducted to determine if fertilizing with less expensive alfalfa meal would increase zooplankton forage and red drum survival in earthen ponds.

MATERIALS AND METHODS

The study was conducted 22 August to 24 September, 1980 in four 0.8-hectare earthen ponds at the TPWD Marine Fisheries Research Station, Palacios, Texas. Paired ponds were assigned either cottonseed meal (43% protein) or alfalfa meal (15% protein) test fertilizer. Test fertilizers were spread on dry pond bottoms at 568 kg/hectare. Matagorda Bay water, filtered through 0.5-mm saran, was used to fill the ponds using the puddle method (Bonn et al. 1976).

Fry were obtained from laboratory maintained adults induced to spawn by controlled cycling of photoperiod and temperature (Arnold et al. 1977, Roberts et al. 1978). Fertilized eggs were removed from the spawning tank and transferred 1850-ℓ cone bottom incubation tanks. Three-day old fry were stocked into ponds at 750,000/hectare 3 days after filling began.

Zooplankton were sampled by collecting 10-ℓ surface samples (Weber 1973) when fish were stocked and thereafter every Monday, Wednesday, and Friday until harvest. Samples were concentrated using a 10-μ plankton net and preserved in 5% buffered formalin solution until analysis. Samples were enumerated using methods of Gilmore et al. (1975). Population densities (number of organisms/liter) were determined for mixed rotifers, copepod nauplii, copepods, and polychaete larvae.

Water quality was examined daily at each pond drain box between 0700 and 0900 hours. Bottom dissolved oxygen, surface water temperature and salinity were determined by the membrane electrode method (Delta 1010, National Science Corporation Lindenhurst, N.Y.), a glass thermometer and refractometer, (American Optical Corporation), respectively.

A mixed model two-way analysis of variance (Sokal and Rohlf 1981) was used to compare the mean daily value of each water quality variable and each zooplankton group in cottonseed meal ponds to those in alfalfa meal ponds. Fertilizer represented the fixed effect, and day the random effect. Copepod and polychaete densities were transformed to common logarithm before analysis to reduce heteroscedasticity based upon results of the F-max test (Sokal and Rohlf 1981).

RESULTS

The effect of fertilizer type on red drum survival and zooplankton density was inconclusive. Cottonseed meal fertilized ponds yielded no red drum in this study (Table 1). Alfalfa meal fertilized ponds, however, yielded 6.0 and 2.5% survival. The temporal pattern in polychaete and rotifer densities were similar among ponds, but copepod and nauplii densities were not. An apparent bimodal density growth curve for copepods and a skewed growth pattern for nauplii occurred in cottonseed meal ponds but not alfalfa meal ponds (Fig. 2). However, the mean densities of all zooplankton groups (Table 1) were significantly higher in cottonseed meal ponds than in alfalfa ponds (Table 2).

August and September mean salinities averaged 29-30 o/oo and were generally stable in all four ponds. Mean surface water temperatures remained stable at 27 to 29 C and averaged 28 C. Dissolved oxygen concentrations varied significantly among ponds ($F = 2.97$; d.f. = 3, 72; $P < 0.05$) with means in alfalfa meal ponds about 1 ppm higher than in cottonseed meal ponds (Table 1). Dissolved oxygen in alfalfa meal ponds was generally stable and above 4 ppm throughout the study (Fig. 1). But, dissolved oxygen in cottonseed meal ponds was generally low (<3.5 ppm) early in the experiment and then increased.

DISCUSSION

Alfalfa meal may be a better fertilizer than cottonseed meal for rearing red drum in ponds at substantially less cost. During this study, alfalfa meal was about 50% cheaper, produced more red drum, and did not lower dissolved oxygen as much as cottonseed meal. However, failure to obtain any red drum from the cottonseed meal ponds interferes with attempts to compare survival. This result is inconsistent with previous studies in which cottonseed meal typically yielded 20% survival (Colura et al. 1976). Low dissolved oxygen (< 3.5 ppm) shortly after stocking may have affected survival in cottonseed meal ponds, but this is impossible to verify with current data. Dissolved oxygen did not reach these low levels in alfalfa ponds; yet survival was only 2.5-6.0%. Perhaps survival was also limited by the stocking sequence. Fry were stocked 3 days after

filling ponds, but densities of rotifers and copepod nauplii, important foods of larval fishes (Houde 1972), peaked about 11 to 14 days post stocking. Fry should be stocked when zooplankton of the appropriate size are undergoing peak reproduction to maximize available food. Lack of cropping because of mass fry mortality in cottonseed meal fertilized ponds may have contributed to the production of greater zooplankton population densities. Furthermore, zooplankton population densities in alfalfa meal fertilized ponds generally exceeded those reported by Colura et al. (1976) for cottonseed meal fertilized red drum culture ponds. If alfalfa meal is indeed a better fertilizer than cottonseed meal, then a survival greater than 20% obtained by Colura et al. (1976) could be expected. Additional fertilizer comparisons are needed before concluding that alfalfa meal will consistently increase red drum survival. Later stocking during these peak densities would have increased the fishes opportunity to initiate feeding.

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Table 1. Summary of red drum survival, water quality, and zooplankton density (No./liter) in 0.8-hectare ponds (numbers 18-21) fertilized with alfalfa or cottonseed meal in August-September 1980.

Item	Alfalfa		Cottonseed	
	18	21	19	20
Survival (o/o)	6.0	2.5	0	0
Mean surface salinity (o/oo) ± 1 SE	29 ± 0.3	30 ± 0.2	29 ± 0.3	30 ± 0.2
Mean bottom dissolved oxygen (ppm) ± 1 SE	4.7 ± 0.2	5.0 ± 0.2	4.0 ± 0.3	4.2 ± 0.3
Mean surface temperature (c) ± 1 SE	28 ± 0.2	28 ± 0.2	28 ± 0.2	28 ± 0.2
Rotifers ($\times 10^3$)	6022 ± 2927	3047 ± 1332	7938 ± 2980	9240 ± 4539
Polychaetes ($\times 10^3$)	465 ± 220	727 ± 330	1236 ± 476	2098 ± 1139
Copepod nauplii ($\times 10^3$)	1095 ± 647	938 ± 369	1975 ± 751	1847 ± 754
Copepods ($\times 10^3$)	189 ± 74	524 ± 234	564 ± 232	360 ± 103

Table 2. Results of two-way analysis of variance of zooplankton densities in ponds treated with two fertilizers and stocked with red drum fry. Copepod and polychaete densities transformed to common logarithms before analysis.

Zooplankton group	Source of variation	Degrees of freedom	Sums of squares	Mean square	F
Copepods	Total	43	39.3479		
	Fertilizer	1	0.2729	0.2729	0.30 NS
	Day	10	25.2857	2.5286	11.91 **
	Fertilizer x Day	10	9.1187	0.9119	4.30 **
	Error	22	4.6706	0.2123	
Nauplii	Total	43	194759102		
	Fertilizer	1	9034070	9034070	5.39 *
	Day	10	157274255	15727426	29.58 **
	Fertilizer x Day	10	16753146	1675315	3.15 *
	Error	22	11697631	531711	
Rotifers	Total	43	4619619055		
	Fertilizer	1	238817310	238817310	5.68 *
	Day	10	3318059055	331805906	11.37 **
	Fertilizer x Day	10	420672290	42067229	1.44 NS
	Error	22	642070400	29185018	
Polychaetes	Total	43	101.8285		
	Fertilizer	1	2.7041	2.7041	
	Day	10	85.9560	8.5956	34.10 **
	Fertilizer x Day	10	0.7932	0.0793	15.28 **
	Error	22	12.3752	0.5625	0.14 NS

*P < 0.05
**P < 0.01

Figure 1. Dissolved oxygen values measured in each pond (ponds 18 and 19 are closed circles, ponds 20 and 21 are open circles) during July-September 1980.

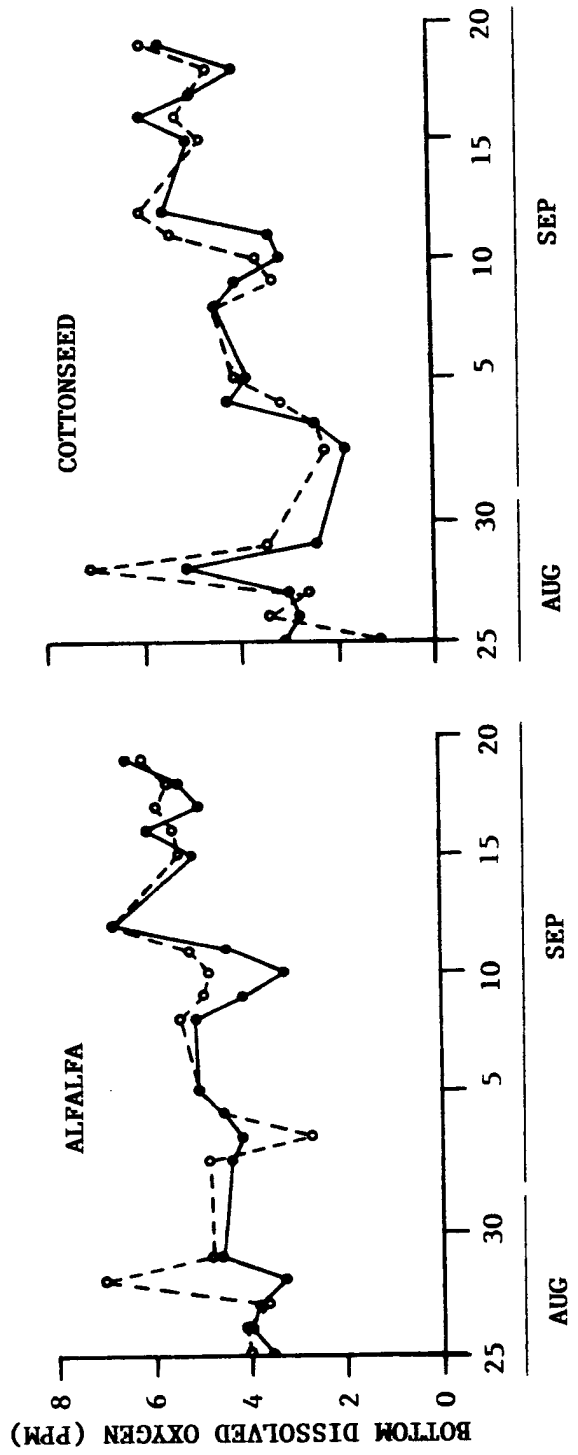
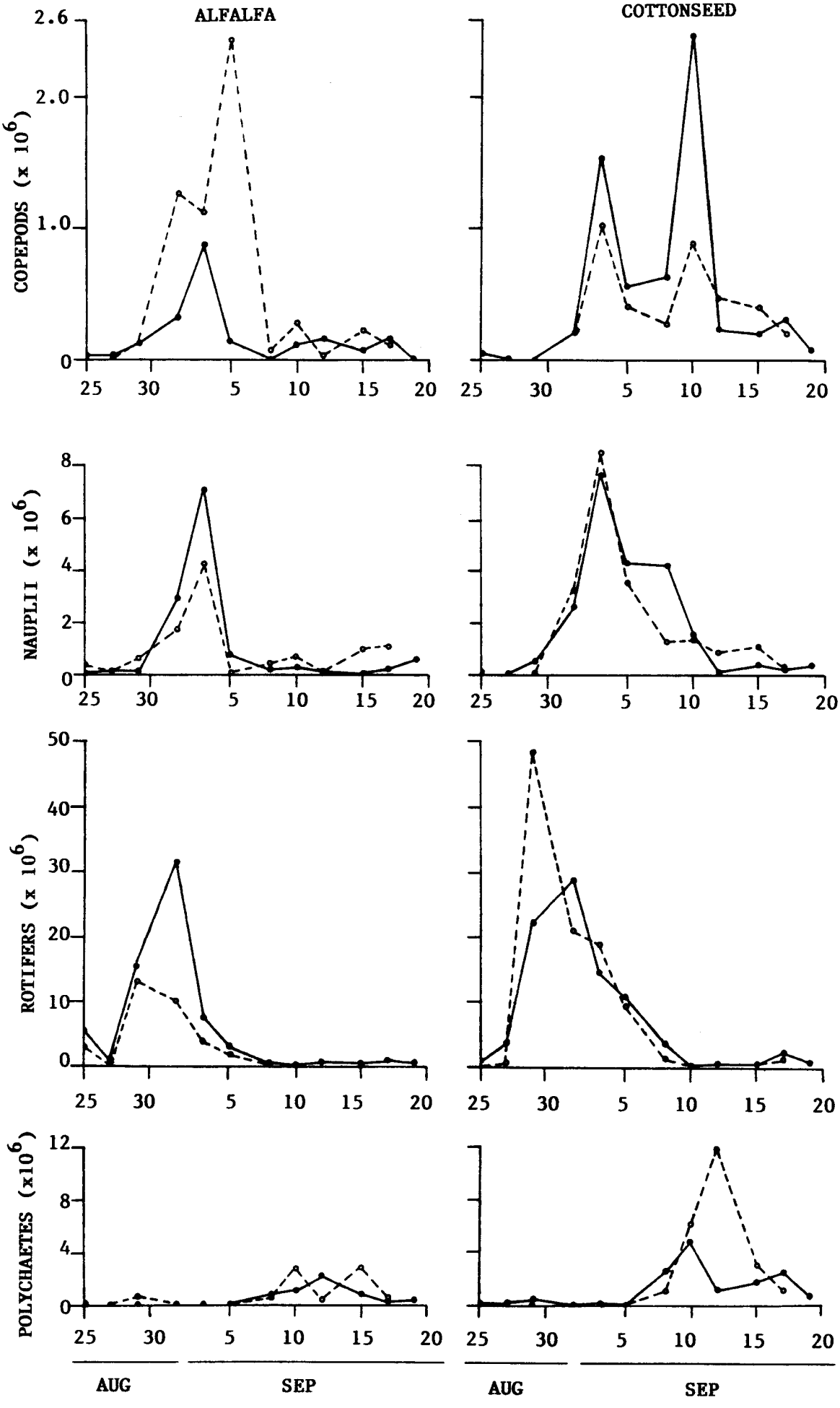

BOTTOM DISSOLVED OXYGEN (PPM)
8
6
4
2
0
ALFALFA
COTTONSEED
25
30
AUG
5
10
15
20
SEP

Figure 2. Zooplankton densities in each of four ponds, two fertilized with alfalfa meal and two with cottonseed meal. Closed circles represent ponds 18 and 19; open circles are ponds 20 and 21.


ALFALFA
COTTONSEED
COPEPODS (x 10^6)
NAUPLII (x 10^6)
ROTIFERS (x 10^6)
POLYCHAETES (x10^6)
2.6
2.0
1.0
0
8
6
4
2
50
40
30
20
10
12
25
30
5
10
15
20
AUG
SEP

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