NBS INFORMATION BULLETIN

NATIONAL BIOLOGICAL SERVICE
U.S. DEPARTMENT OF THE INTERIOR

NO. 32 1995

FATTY ACIDS IN FATHEAD MINNOWS AND AQUATIC INVERTEBRATES

Bait fish such as fathead minnows (*Pimephales promelas*) are known to compete directly with waterfowl for invertebrate foods. Competition between fish and waterfowl is most likely in semipermanent wetlands, which are often excellent rearing ponds for bait fish and are likely to be used for feeding by breeding dabbling ducks and ducklings. At the high densities that can occur with introduced minnows, however, minnows may become a food resource themselves. Little information exists for assessing the occurrence and importance of minnows in the diets of dabbling ducks.

In a recent study of the interactions among bait fish, mallard (*Anas platyrhynchos*) ducklings, and the invertebrate community in experimental ponds, some ducklings were found to consume minnows. In one pond, ducklings were observed diving within 2 weeks of hatch; they sometimes captured minnows, which they swallowed at the surface. Others had minnows in their digestive tracts. Minnows have not been reported in diets of wild mallard ducklings. To what extent ducklings feed on minnows in the experimental ponds or in natural wetlands is difficult to measure. If ducklings can capture minnows, the high energy and nutritional content of the fish may partly compensate for the lowered availability of invertebrates. I sought to determine whether the fatty acid signature of fathead minnows differed from that of aquatic invertebrates, and so could potentially be used as a measure of minnow consumption by ducklings or by other wetland birds.

FATTY ACIDS AS A BIOCHEMICAL MARKER

Fatty acids, the basic building blocks of lipids, are absorbed from the diet and incorporated into tissue with little or no change in type. Thus composition of dietary fatty acids strongly influences tissue composition in most animal groups. Dietary influences should be especially strong in ducklings 5–14 days after hatch because of the high growth rate and foraging of ducklings and their reliance on diet rather than endogenous nutrition.

Short chain fatty acids (14–20 carbons) occur in most animal tissue and have been the usual target of studies of fatty acid composition of tissue in relation to diet. Long-chain fatty acids (>20 carbons) are absent or at extremely low levels in bird tissue, but several long-chain ω3 fatty acids are present in relatively high levels in some fish. If the amounts of these fatty acids were higher in minnows than in other foods of ducklings, they would provide a biochemical marker in duckling tissue indicating the consumption of minnows and possibly a measure of the relative amount of minnows consumed.

SAMPLES OF MINNOWS AND AQUATIC INVERTEBRATES FROM EXPERIMENTAL PONDS

Because data on the fatty acid composition of freshwater fish and invertebrates were sparse, I sampled fathead minnows and various aquatic invertebrates from experimental ponds at Northern Prairie Science Center. In preliminary chemical analyses of short-chain (<20 carbon) fatty acids in fathead minnows and nine common aquatic invertebrates sampled in July 1993, no clear pattern emerged. Thus I resampled in 1994 and expanded the analyses to include longer-chain fatty acids.

A random sample of fathead minnows was obtained from the experimental ponds in mid-July 1994, about 6 weeks after the ponds were stocked. Minnows were separated into three sizes and samples of 20–30 fish of each size class from each of 10 ponds were pooled into a composite sample, homogenized in a blender, and frozen for storage and shipping. At the same time, a sample of common aquatic invertebrates was obtained from the ponds with a sweep net.

Invertebrates sampled were Cladocera, mayfly naiads (Ephemeroptera), damselfly naiads (Zygoptera), midge larvae (Diptera: *Chironomus*), and several snails (Lemnea, Physidae, and Planorbidae). Invertebrates were sorted, and samples from all ponds were pooled by invertebrate type, homogenized, and frozen.

The fatty acid composition was analyzed by the Missouri Agriculture Experiment Station Chemical Laboratory (University of Missouri, Columbia) according to standard procedures. The samples included specific tests for the levels of long-chain fatty acids (>20 carbons) and the more common fatty acids.

Fathead Minnows Have No Strong Fatty Acid Signature

The fatty acid composition of fathead minnows did not differ greatly from that of aquatic invertebrates. Simple comparisons were confounded by variation among minnow size classes, probably reflecting differences in minnow diet by size. Fatty acids of 22 or more carbons, present in most minnow samples, were lacking in most invertebrates except in mayfly and damselfly naiads. Erucic acid was unique to minnows but occurred only at trace levels in larvae and juvenile minnows. If ducklings consumed primarily adult minnows rather than smaller sizes, this might be a useful marker.

Nutritional Values of Minnows and Various Invertebrates

Although a unique biochemical marker for minnows was not found here, the resulting data provide new information about the nutritional composition of fathead minnows in comparison to various invertebrates in prairie wetlands. Minnows provide relatively high levels of crude fat and essential fatty acids (linoleic, linolenic, and arachidonic) for birds and mammals and are therefore a high-quality food source. In contrast, snails contain low levels of fat and of most long-chain fatty acids but high levels of some short-chain fatty acids.

Lipid content and fatty acid composition of minnows and invertebrates probably vary with the growth and reproductive stages of the organism and thus the time of collection. Further investigations of the nutritional value of fish or invertebrates for their predators (e.g., other birds, piscivorous fish, or mammals) should be of the full range of growth and reproductive stages at which the organisms are consumed by their predators.

For further information contact

Jane E. Austin
Northern Prairie Science Center
8711 37th Street S.E.
Jamestown, North Dakota 58401
(701)252-5363

Table 1. Fatty acid composition and crude fat content of fathead minnows and various aquatic invertebrates, expressed as g/100 g of sample.

	Fathead minnows			Aquatic invertebrates						
[illegible]ty acid	Larvae	Juveniles	Adults	Cladocera	Ephemeroptera	Zygoptera	Chironomus	Planobidae	Physidae	Lymnea
Myristic (14:0)	2.98	6.32	2.89	1.85	4.22	1.56	3.21	8.81	14.13	7.64
Palmitic (16:0)	24.78	33.50	23.05	22.93	28.54	19.32	20.14	37.79	37.91	30.79
Palmitoleic (16:1)	17.34	12.14	19.49	17.36	21.78	10.57	28.44	8.88	9.38	9.63
Stearic (18:0)	9.00	14.93	6.85	6.17	8.40	8.73	10.11	21.01	17.84	16.84
Oleic (18:1)	23.09	21.58	25.86	29.02	28.27	26.54	21.32	9.58	9.02	19.12
Linoleic (18:2)	6.73	3.74	5.15	4.90	2.83	7.89	3.60	tr	1.02	3.26
Linolenic (18:3)	4.91	1.93	4.76	5.98	0.62	5.39	0.99	3.26	2.76	0.35
— (18:4)	0.68	0.11	0.74	1.04	0.24	0.75	0.09	nd	0.14	nd
Arachidic (20:0)	0.68	0.38	0.58	0.05	0.52	1.54	1.70	1.00	0.67	0.05
Arachidonic (20:4)	1.77	0.83	1.80	3.41	0.04	5.50	nd	tr	nd	tr
Eicosapentaenoic (20:5)	1.48	0.33	2.47	5.54	0.08	9.93	nd	nd	nd	nd
Behenic (22:0)	0.53	0.39	0.46	nd	0.34	0.67	0.48	nd	nd	nd
Erucic (22:1*cis*)	tr[a]	tr	0.41	nd	nd	nd	nd	nd	nd	nd
Hexaenoic ([illegible]2:6)	0.99	nd[b]	1.03	nd	0.79	0.79	nd	nd	nd	nd
[illegible]noceric ([illegible]4:0)	0.20	nd	tr	nd	0.40	0.40	nd	nd	nd	nd
Moisture (%)	68.0	87.5	77.6	94.2	95.6	83.1	83.1	49.3	61.2	75.2
Crude fat (% dry wt)	13.9	13.4	22.5	6.5	20.2	13.8	1.5	1.9	2.5	2.0

[a]tr = trace
[b]nd = not detected