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Differences in the Occurrence of Nymphs of Two Species of Burrowing Mayflies in Fish Stomachs[1]

by

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In many of the lakes of southern Michigan two species of burrowing mayflies, Ephemera simulans (Say) and Hexagenia occulta (Walker)[2] are quite abundant. Bottom samples taken in these lakes by survey parties from the Michigan Institute for Fisheries Research have frequently revealed dense concentrations of nymphs and have shown that the two species often occur together, sometimes appearing in approximately equal numbers in a given Ekman or Peterson dredge haul.

The habits of nymphs of the two species have been little studied in nature. In particular, the depth to which they generally burrow, and the possibly different levels of the substrate which they may

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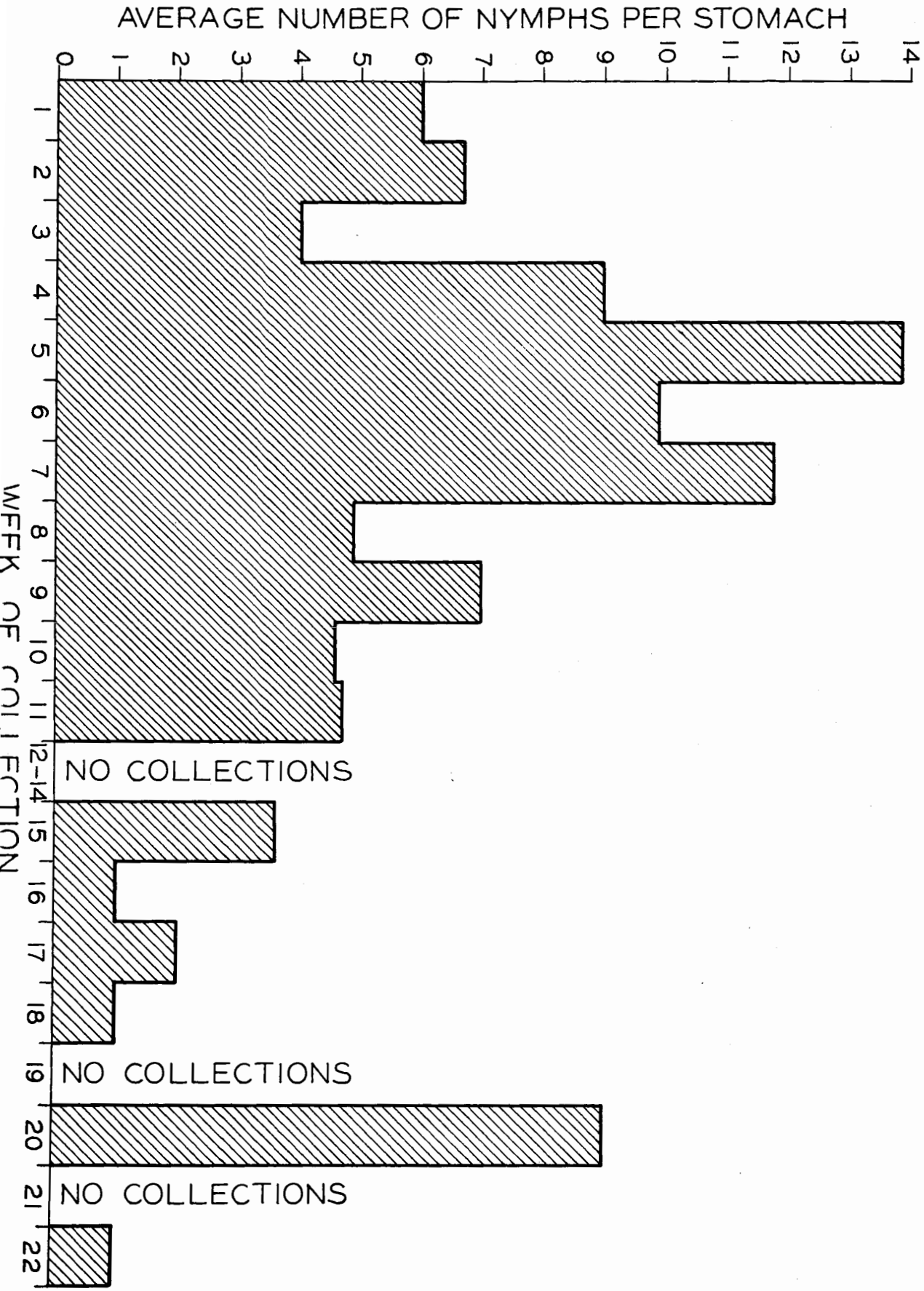
[1] Contributed from the Michigan Institute for Fisheries Research.

[2] The form listed by Spieth (1941) as Hexagenia limbata occulta (Walker); the name used here follows Needham, Traver and Hsu (1935).

occupy at different times of day and night, have not been established. Ide (1935) found that burrowing nymphs of Ephoron leukon inhabiting stony riffles of an Ontario stream had the habit of "--avoiding light during the day in the deeper part of the tube and coming up to the open end in the evening to feed." In a sand-bottom trout stream in Montmorency County, Michigan, where Hexagenia recurvata is abundant, the writer has seldom found the nymphs less than four inches below the surface of the stream bed.

The rate of occurrence of burrowing mayfly nymphs in fish stomachs may offer certain clues to their habits. It is commonly thought by fishery biologists that the diet of fishes in lakes and streams is determined largely by what potential food organisms are available to the fish. Forbes (1888) found that nymphs of Hexagenia (species undetermined) composed about one-tenth of the total food of many fishes from Illinois waters examined by him. Neither he nor various workers who have reported Hexagenia nymphs from fish stomachs in more recent years have supplied adequate information as to the season when their specimens were taken, although Neave (1932), after stating that nymphs of H. occulta were a very important food for sturgeon, whitefish, tullibee, goldeye and sauger in Lake Winnipeg, inferred that they were important the year around when he wrote "--owing to the limited season during which they (the winged phases) are available and because most of the marketable fish are bottom feeders, their direct importance as a food supply is negligible as compared with the nymphal stages." Little has been reported of the occurrence of Ephemera nymphs in fish stomachs although Ricker (1934) referring to a form listed by him as "Ephemera cf. simulans," stated that it was "found (in brook trout stomachs) throughout the year; excessively abundant at time of emergence."

In Birch Lake, an oligotrophic lake in southwestern Michigan, both E. simulans and H. occulta are plentiful. In connection with a fisheries management experiment, a series of 322 stomachs of rainbow trout (Salmo gairdnerii irideus Gibbons) 7-5/8 to 22-1/2 inches in length was collected from Birch Lake over a six-year period embracing a seasonal span of 31 weeks, from May 21 to December 19. Except for a few specimens taken in gill nets, all the fish were caught by anglers and the stomachs collected by a biologist acting as creel census clerk. Analysis of the contents of these stomachs revealed a striking disparity in the frequency of occurrence of the two species of ephemerines. Ephemera simulans appeared on only six dates: May 23, June 25 and 27, July 30, and August 2 and 3. Stomachs of trout taken on May 23, when a mass emergence of simulans took place, averaged 507 nymphs and 106 subimagoes per stomach, one 18-inch rainbow containing 789 nymphs and 232 subimagoes. In collections made on the other dates, simulans nymphs occurred in single stomachs at an average rate of three per stomach. By contrast, Hexagenia occulta nymphs were of steady occurrence in stomachs throughout the entire period covered by collections. They first appeared in trout caught on June 25; their occurrence during the ensuing 26-week span, summarized by weekly intervals, is shown in Figure 1. It will be seen that subimaginal and adult specimens were not eaten, although some of the nymphs taken in June appeared to be mature, the females with well developed eggs. Failure of the trout to feed on either of the winged stages is probably explained by the fact that in southern Michigan occulta seldom emerges before late June and early July, when the surface waters of the lake are generally so warm as to repel trout. It should be stated, in this connection, that terrestrial insects were of very rare occurrence in the stomachs except during October and early November.


AVERAGE NUMBER OF NYMPHS PER STOMACH
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
WEEK OF COLLECTION
1
2
3
4
5
6
7
8
9
10
11
12-14
NO COLLECTIONS
15
16
17
18
19
NO COLLECTIONS
20
21
NO COLLECTIONS
22

On a volumetric basis, the rainbow trout diet in Birch Lake was made up of the following major categories of food items: Fish, 43 percent; aquatic insects, 23 percent; vegetable matter, 6 percent; mollusks, decapod crustaceans and terrestrial insects (87 species of the last-named), 3 percent each. The remaining 19 percent was composed of unseparated organic debris and of negligible numbers of entomostracans, water mites and spiders. The aquatic insect portion of the stomach contents is detailed in Table 1. The catholicity of a diet so comprehensive as to embrace 170 species of invertebrates alone makes it appear likely that the rainbow trout is almost wholly opportunistic in its feeding. It seems obvious that throughout all seasons nymphs of H. occulta in Birch Lake were so readily available to the trout as to almost equal, in the diet, the volume of all other aquatic insects combined, whereas, with minor exceptions, nymphs of E. simulans became available only during the brief period of their migration to the lake's surface to transform. The fact that H. occulta appears to have a two-year life cycle and E. simulans an annual cycle in southern Michigan cannot explain the disparate occurrence of the two species, for stomach collections made over a period of six years and a seasonal span of seven months were examined. In the absence of recorded observations on the behavior of nymphs of the two species in their natural habitat it appears justifiable to conclude that E. simulans spends its nymphal life too deeply embedded in the substrate to be available to bottom-feeding rainbow trout and that H. occulta nymphs, on the other hand, either leave their burrows occasionally or at least come near enough to the surface of the lake bottom to fall a consistent prey.

Table I.--Aquatic insects appearing in the diet of rainbow trout collected from Birch Lake, Cass County, Michigan, over a 6-year period and a seasonal span of 31 weeks from May 21 to December 19. An asterisk (+) denotes values less than one-half of one percent.

Species[1]	Average number of organisms in stomachs containing them.	Percent of stomachs containing organism	Percent of total volume of aquatic insects.	Species	Average number of organisms in stomachs containing them.	Percent of stomachs containing organism	Percent of total volume of aquatic insects.
Ephemeroptera	...	66	77	Coleoptera (cont'd)	...	...	...
Ephemera simulans	274.0	3	(29)	Gyrinidae	1.0	1	...
Hexagenia occulta	7.0	64	(48)	Hydrophilidae	1.0	1	...
Ephemerella temporalis	4.7	1	...	Dryopidae	1.0	1	...
Baetinae	1.0	2	...	*Donacia* sp.	2.0	1	...
Callibaetis sp.	1.0	+	...	Trichoptera	...	23	14
Odonata	...	9	1	Hydroptilidae	1.9	5	...
Coenagrioninae	1.0	4	...	*Oxyethira* sp.	1.2	2	...
Enallagma sp.	1.7	3	...	*Banksiola selina*	21.0	1	...
Amphiagrion saucium	1.0	1	...	*Phryganea* cf. *cinerea*	11.2	6	...
Neogomphoides obscura	1.0	+	...	Limnephilidae	1.0	1	...
Stylurus sp.	2.0	+	...	*Leptocella exquisita*	1.5	1	...
Epicordulia princeps	1.0	+	...	*Leptocella albida*	4.0	6	...
Tetragoneuria simulans	1.0	1	...	*Oecetis* sp.	1.0	1	...
Libellula sp.	1.1	2	...	*Oecetis eddlestoni*	1.0	+	...
Plathemis lydia	1.0	+	...	*Triaenodes tarda*	1.0	+	...
Neuroptera	...	8	1	*Triaenodes injusta*	2.0	+	...
Sialis infumata	2.5	8	...	*Mystacides* sp.	2.0	1	...
Plecoptera	...	+	+	*Mystacides sepulchralis*	1.0	1	...
Isoperla sp.	1.0	+	...	*Brachycentrus* sp.	1.0	1	...
Hemiptera	...	2	+	Diptera	...	77	6
Arctocorisa sp.	1.5	2	...	*Tipula abdominalis*	1.0	1	...
Notonecta undulata	1.0	+	...	Chironomidae[2]	12.5	76	...
Belostoma flumineum	1.0	+	...	Ceratopogonidae	5.2	7	...
Coleoptera	...	6	1	*Culex* sp.	1.0	1	...
Haliplus sp.	1.0	+	...	*Chaoborus punctipennis*	1.0	+	...
Dytiscidae	1.0	1	...	*Simulium venustum*	1.0	+	...

[1] All species in immature stages except: *Ephemera simulans*, both nymphs and subimagoes; all Hemiptera, adult; *Haliplus* sp. and *Donacia* sp., adult; *Tipula abdominalis* and *Culex* sp., larvae and adults.

[2] Included *Polypedilum nubeculosum*, *Tanypus stellatus*, *Tanytarsus dimorphus*, *Chironomus plumosus*, *lobiferus* and *modestus*.

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