

Original: Fish Division  
cc: Education-Game  
J. W. Leonard  
J. T. Wilkinson

INSTITUTE FOR FISHERIES RESEARCH

DIVISION OF FISHERIES  
MICHIGAN DEPARTMENT OF CONSERVATION  
COOPERATING WITH THE  
UNIVERSITY OF MICHIGAN

ALBERT S. HAZZARD, PH.D.  
DIRECTOR

ADDRESS  
UNIVERSITY MUSEUMS ANNEX  
ANN ARBOR, MICHIGAN

Report No. 1165

March 9, 1948

THE SEASONAL OCCURRENCE OF MAYFLIES IN A  
MICHIGAN STREAM

Presented before a joint session of the Entomological and Ecological Societies of America at the annual meeting of the American Association for the Advancement of Science, Chicago, Illinois, December 30, 1947.

by

Justin W. Leonard

The mayflies (Ephemeroptera) have received comparatively little attention from American entomologists. Although members of the order are of economic importance as a major element in the diet of freshwater fishes, our knowledge of the taxonomy, biology and ecology of the group has continued to lag behind that of almost every other insect order. Although the publications of fishery workers teem with references to the occurrence of mayflies in fish stomachs and in lake and stream survey collections, only meagre entomological interest derives from such reports, in which determinations seldom have been carried beyond ordinal, or at most generic, levels.

RECEIVED  
MARCH 1948

FISH DIVISION

A notable contribution to our appreciation of the role of water temperatures as a factor determining the emergence periods of stream-inhabiting mayflies was made by Ide (1935). Information as to periods when transformation and mating flights of the various species may be expected is of interest to entomologists, fishery biologists, and anglers. The following observations are presented as an addition, however modest, to the small existing body of mayfly emergence data.

The collections upon which Ide (op. cit.) based his studies were taken ". . . at intervals of about two weeks during summer months, and at longer intervals in winter." The observations to follow were made on a daily basis over a four-month period extending from May 12 to September 11, 1947. During this period the writer operated a temporary laboratory established in a summer cottage on the banks of the Pere Marquette River in Lake County, Michigan, about three miles south of the village of Baldwin. It was possible to maintain intensive observations on a swift, gravel-bottom section of stream immediately in front of the laboratory, and it is the mayfly fauna of this restricted stream area which forms the basis of my report.

The stream section involved was approximately 50 yards in length. The average width was 50 feet, average depth 18 inches, maximum depth 37 inches, rate of flow 3 feet per second at the surface. The bottom material was gravel and rubble overlying stabilized sand. A few boulders 18 inches or more in diameter were partially imbedded in the substrate. The water was clear and distinctly hard; traces of marl deposition were evident on submerged stones. No rooted plants were apparent in early May, but a few species appeared soon thereafter, --Potamogeton filiformis

in the central portions of the stream, Elodea in beds near the edges, and cattails (Typha) here and there at the extreme edge. At either end of the section the water depth increased to an average of 30 inches, maximum 48 inches, and the surface current velocity dropped to 1.5-2.0 feet per second. On the south and southeast sides of the stream the bank rose sharply to a height of forty or fifty feet and bore an open stand of white pine and black oak. The combination of bank and trees provided shade for the section except for the period from approximately 10:00 a.m. to 5:00 p.m. Owing to frequent spring-water increments, stream temperatures did not follow closely the fluctuations in air temperatures. The highest water temperature recorded, following a 10-day period of air temperatures above 90° F., was 68° F.

Collections were made by each of four methods: (1) collection of nymphs (many of which were reared subsequently) by examination of submerged stones and other objects, by use of a wire-screen net (16-mesh), and with the Surber square-foot samples; (2) collection of subimaginal and adult material by standard air net, aided by artificial light when necessary and utilizing a nearby foot bridge which spanned the stream 20 feet above the surface to collect from high-flying swarms; (3) sweeping and hand-collecting of subimagoes and imagoes from streamside vegetation and other diurnal resting sites; and (4) collection of phototropic forms attracted to light supplied by a No. 2 photo flood bulb or 200-watt Mazda bulb in a portable reflector, directed toward the stream. With minor exceptions, collections and observations were made daily throughout the four-month period.

The study section yielded 38 species of mayflies representing 17 genera. Of this total 25 species were reared; of the 13 remaining,

8 were too rare to provide adequate material, and for 5 successful rearing techniques were not discovered.

A chart (Figure 1) has been prepared to show the time when 31 of these species first appeared on the wing, and the duration of the period throughout which flying stages could be found. Seven species<sup>2</sup> have been

---

<sup>2</sup> Rhithrogena, 2; Isonychia, 1; Ephemerella, 1; Baetis, 2; Pseudocloeon, 1.

---

emitted from the chart, each a form taken in numbers too few to permit satisfactory determinations to be made. In the table, each month has been divided into four approximately week-long periods. Space limitations render impractical any more exact method of diagraming these data; however, the method seems sufficiently accurate for depiction of a variable occurrence. The solid lines showing extent of occurrence of winged stages of each species are continuous if examples were obtained at intervals of at least three days; if a species was not taken during a period of four or more successive days a broken line has been drawn to call attention to such absence.

A majority of the species emerged from the stream as subimagos in late afternoon or evening, as might be expected. Transformation of the various Stenonema and Heptagenia occurred sporadically during all daylight hours and at various times during the night, without any mass emergences. Both species of caenines, Tricorythodes allectus and Brachycercus sp., transformed in the early morning hours, performed mating and egg-laying flights in huge swarms between approximately 7:00 a.m. and 11:00 a.m., and largely disappeared thereafter, each day. Of the 10 species of

## SEASONAL OCCURRENCE OF WINGED MAYFLIES

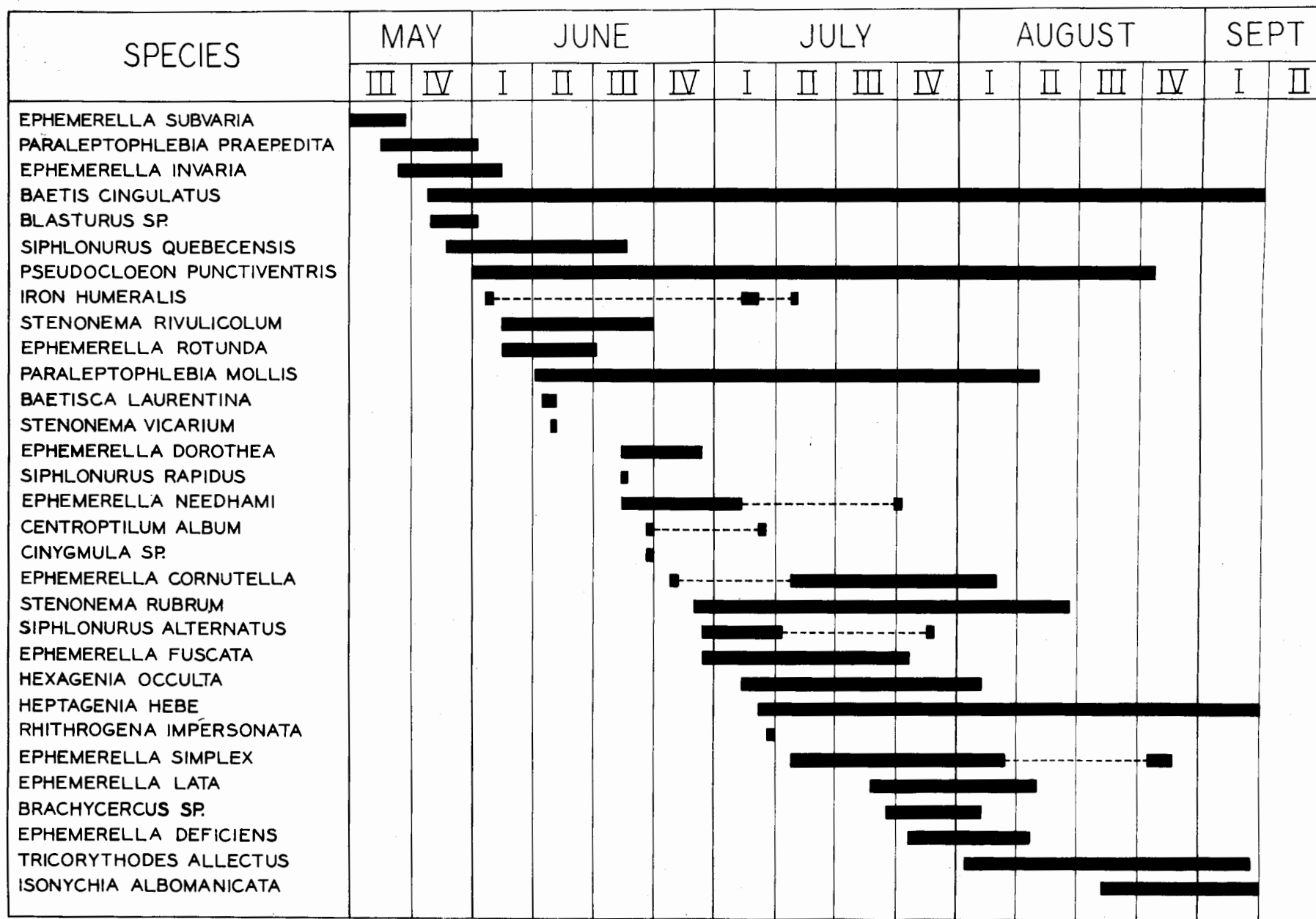


Figure 1.--Seasonal occurrence of winged mayflies in the Pere Marquette River near Baldwin.

Ephemerella, all but deficiens and simplex appeared in mass emergences at and shortly after dusk, and reappeared 24 to 48 hours later in very extensive mating and ovipositing flights, at about the same time of evening. Swarms of imaginal Siphonurus were also made up of very many individuals. The remaining species seldom appeared in large numbers at any given time, although the nymphs of many of them were abundant, and their total numbers of adults for the season large.

From a purely economic standpoint, mayflies hold greatest interest for fishery biologists and sports anglers, because these insects are, in general, a very significant item in the diet of fresh-water fishes, especially the trouts. Although published stomach analysis studies permit us to assume that nymphal Ephemeroptera constitute a much greater proportion of the total annual food intake of such fishes than do the winged stages (with certain exceptions, one of which has been noted elsewhere by the writer) (Leonard, 1947), the winged stages are of great importance in furthering the utilization of game fish supplies by anglers. Thus anglers casting for trout with artificial flies usually take more fish per unit of effort when, in their parlance, a "hatch" is on the water, and fish have been attracted to the surface by large numbers of "natural" insects. Many workers consider the trouts to be almost wholly opportunistic in their feeding. If this be true, the extent of availability to fish of various stream-inhabiting mayflies in both aquatic and winged stages might be greatly affected by even minor differences in habit and behavior which deserve greater attention by observers.

During the course of the season it was observed that brook, brown and rainbow trout rose to mayflies frequently and in large numbers only when stimulated by the occurrence of large-scale transformations. It was

further observed that many mayflies, even species swarming in large numbers, were available to trout only during the transformation of nymph to subimago, while others were available in quantity only during oviposition. Members of the invaria group of Ephemerella, which start to transform as soon as the nymph releases its hold on the stream bed and which are usually free of the nymphal exuviae while still some inches below the surface, drove the fish into a veritable frenzy of feeding activity. Since the females of this group generally drop their egg masses while still well above the surface, the adults are rarely available to fish again, except for those which may drop to the surface in a spent and dying condition. Nymphs of the species of Siphonurus found in the study area generally swam, rapidly as a minnow, to stream banks or protruding objects, and transformed after climbing out of the water. There was no indication that fish captured these nymphs in appreciable quantity. Siphonurus mating and egg-laying flights soared high above the stream, so that the only times when the insects were within reach of fish were when, for a period of a few seconds, females floated on the surface to release their eggs, and when individuals of both sexes were forced to the water's surface by accident or the weakness of imminent death. Subimagoes of both species of Paraleptophlebia were seen to float on the water for as long as twenty or thirty seconds before rising to fly toward shelter. On a few occasions, especially early in the season, they were on the water in numbers large enough to stimulate considerable trout feeding activity. Although the two caenines emerged late in the summer and during morning hours, time of season and of day considered unproductive by many trout fishermen, they were heavily preyed upon by surface-feeding trout.

One situation shown in Figure 1 which should perhaps be stressed is the occurrence of adult mayflies, in fair variety and number, through the midsummer months on into September. Reporting on studies of Ontario streams Ricker (1934) wrote: "Most of the mayflies \* \* \* emerge during May and June, and are hence absent from the stream in July." However, Ide (op. cit.), also concerned with Ontario streams, found several species, notably heptageniids, which occurred on the wing as late as September.

Experimental evidence is accumulating that the species composition of trout stream insect faunas can be altered significantly and predictably by the installation of various types of stream improvement or environmental control devices. There is reason to believe that as our knowledge of the ecology of stream insects, including mayflies, increases, we may be able to alter environments to favor the species which contribute most to the nutrition of fishes and to their utilization, and to discourage species which are scantily available to fish, or undesirable because of competitive food habits.

#### References

Ide, F. P.

1935. The effect of temperature on the distribution of the mayfly fauna of a stream. Publ. Ont. Fish. Res. Lab. 50: 1-76, 10 pls.

Leonard, Justin W.

1947. Differences in the occurrence of nymphs of two species of burrowing mayflies in fish stomachs. Ann. Ent. Soc. Amer. 40 (4) (In press)



Ricker, William E.

1934. An ecological classification of certain Ontario streams.

Publ. Ont. Fish. Res. Lab. 49: 1-114, 11 figs., 21 tables.

INSTITUTE FOR FISHERIES RESEARCH

Justin W. Leonard  
Associate Fisheries Biologist

Approved by: A. S. Hazzard

Typed by: S. E. Putman