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Bulletin 68

ENTOMOLOGY 18

AQUATIC INSECTS IN NEW YORK STATE

A study conducted at the entomologic field station, Ithaca N. Y. under the direction of
EPHRAIM PORTER FELT D.Sc.

BY

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ment of Culicidae is a generic synopsis of the family—and much more; for he tabulates our known species of each genus, except Culex. His careful and complete treatment of the Corethriinae is specially gratifying because this subfamily has been neglected by other American students of Culicidae. In the Chironomidae, that Chironomus which is the chief article of diet for brook trout in Bone pond [*see* pt 2] is treated as completely as possible. Life histories are offered in two genera new to our fauna. This is but the beginning of Mr Johannsen's work on the Chironomidae.

Dr Davis's paper is a monograph of the Sialididae of America, and will be of great service to students of this neuropterous family, since it brings together descriptions of all known American species with an account of what is known of their life histories.

There remain, of station material still to be reported on, some Chironomidae and a large number of bred Perlidae and Ephemeridae.

Part 2

FOOD OF BROOK TROUT IN BONE POND

BY JAMES G. NEEDHAM

I have already given in New York State Museum bulletin 47, page 395-96, a brief statement of the conditions under which there were obtained from Bone pond during the summer of 1900 the stomach contents of 27 brook trout for study. These trout were all taken with hook and line. They were all adults and had selected their food in the natural way from what the pond offered.

The pond itself is a small natural body of water less than 300 meters in greatest diameter and nearly circular. It is without outlet and is surrounded by deep woods. I have given a brief sketch of its shore vegetation in bulletin 47 on page 389-90, with mention of the commoner animals collected there. It contains no fish but the brook trout. It was artificially stocked years ago, and has been repeatedly replanted with fry. Of the three propagating ponds controlled by the Adirondack Hatchery, it is by far the most successful in trout production. From the beginning the trout have been able to maintain themselves in large numbers. Most of the trout I saw taken from it in 1900 were rather lean, though otherwise in good and healthy condition, and suggested that possibly it was becoming overstocked.

Of the 27 stomachs obtained, one was empty, and the contents of another were lost through the breaking of a bottle, leaving 25 for study. I give below in tabular form a bare statement of what these 25 had eaten, and follow it with an account of what has been learned elsewhere of the biology of the insects constituting their food.

Table showing the stomach contents of 25 brook trout from Bone pond

Number	Date	Chironomus sp.? larva	Chironomus sp.? pupa	Corethra sp.? larva	Corethra sp.? pupa	Trichopter larva	Trichopter pupa	Trichopter cases	Aeschna constricta	Callibaetis sp.? nymph	Atax crassipes	Daphnidae	Miscellaneous
1	28 July	6	....	....	3	....	....	....	....	....	2	....	....
2	30 "	124	....	5	2	1	....	11	....	1	....	....	....
3	3 Aug.	14	2	....	....	2	....	44	....	....	....	....	....
4	3 "	7	....	....	....	....	....	....	....	....	....	....	....
5	3 "	235	....	42	....	....	....	....	....	....	....	fragments	....
6	3 "	313	1	....	20	1	....	1	....	....	....	....	....
7	3 "	15	340	....	....	2	....	5	....	....	....	....	*a*
8	3 "	77	2	5	....	....	....	....	....	1	....	....	....
9	3 "	7	....	1	12	1	....	5	....	....	....	....	*b*
10	3 "	114	....	1	3	....	....	....	1	....	....	....	....
11	3 "	36	32	3	2	....	...	....	....	....	....	....	*c*
12	3 "	9	1	1	....	....	....	....	....	....	....	....	....
13	3 "	2	....	1	4	....	....	....	....	1	....	....	....
14	3 "	5	58	....	....	....	3	....	....	....	1	....	*d*
15	3 "	351	....	....	4	....	1	....	....	....	....	....	....
16	3 "	......	....	....	....	1	....	....	....	2	....	....	....
17	3 "	12	....	....	27	2	....	10	....	....	4	250	*e*
18	3 "	30	8	3	9	....	....	....	....	....	....	....	*f*
19	3 "	......	....	....	1	....	....	....	....	1	....	....	....
20	8 "	......	....	....	....	....	....	....	....	1	....	....	....
21	8 "	174	....	1	....	....	....	....	1	....	....	....	....
22	15 "	245	....	....	4	....	....	....	....	....	....	....	*g*
23	15 "	310	....	1	1	....	....	....	....	....	....	....	....
24	18 "	132	....	....	....	....	....	....	....	....	....	....	....
25	18 "	244	....	....	....	....	....	1	....	....	1	....	....
	Total..	2 462	444	64	92	10	4	77	2	7	8	250	....

[a] A few brook trout scales.
[b] One little fresh-water mussel.
[c] Antenna of adult ♂ chironomid of small size.
[d] Carabid beetle claw.
[e] Scolytid beetle elytron and two little adult Chironomids.
[f] Achorutes sp.? (Order Thysanura).
[g] Three little adult Chironomids.

In this table the food species have been arranged in what seemed to be the order of their importance as constituents of the food of the trout at the time and place taken. The totals, counting larvae and pupae of a species together, are 2906 Chironomus, 156 Corethra, 14 trichopter larvae, 2 nymphs of Aeschna constricta, 7 nymphs of Callibaetis, 8 Atax crassipes, 250 (approximately) Daphnidae, and a few wholly unimportant things listed as miscellanies. The numerical ratio of these is 116.24 Chironomus, 6.24 Corethra, 10 Daphnidae, .56 trichopter larvae, .32 Atax, .28 Callibaetis, .08 Aeschna to each of the 25 trout. What may be the relative food value of these species is, of course, wholly undetermined. In arranging them in the foregoing table, I have taken into account only their relative size. I should be inclined to regard only the three first named in the table as of any considerable importance to the trout.

To my mind the chief value of this table is that it clearly indicates one species of economic importance to trout culture—the Chironomid of whose larvae and pupae an average of 116 specimens had been eaten by each trout. The largest number eaten by a single trout was 351, while three trout had eaten none at all. It is possibly significant, possibly only accidental, that the May fly nymphs were eaten chiefly by those trout that had found no Chironomids.

NOTES ON THE FOOD SPECIES OF THE TABLE

1 Chironomus sp.?

There can be no doubt that in Bone pond this is an exceedingly important species. Unfortunately, the day this fact became apparent, in the cursory examination of the food as taken from the stomachs, was the last day of study permitted us at the pond. What the species is, consequently remains unknown. Mr Johannsen has studied the larva and pupa systematically, and has treated them in part 3. His figures [pl. 49] should make the recognition of the species possible when other larvae shall have been obtained and bred.

Professor Forbes in his studies of Illinois fishes (the brook trout was not one of the fishes he studied), has clearly pointed out the importance of these small larvae as fish food: "Among aquatic insects, minute slender dipterous larvae, belonging mostly to Chironomus, Corethra and allied genera, are of remarkable importance, making, in fact, nearly one tenth of the food of all the fishes studied."[1] In his report[2] on the aquatic invertebrate fauna of the Yellowstone national park, almost every page testifies to the abundance, general distribution and ecological importance of Chironomus. On page 228 are given some observations indicating that it is of as great importance to young trout as to adults:

The pond was swarming with mountain trout (Salmo mykiss), a few of which I dissected for a determination of their food. One of these an inch and a half in length had eaten Chironomus larvae and imagos chiefly, the remainder of its latest meal consisting of other insect larvae, not in condition to identify, and the entomostrachan Polyphemus pediculus. A second, an inch and a quarter long, had also fed on Chironomus in its various stages of larva, pupa and imago, but had made about a third of its meal of Entomostracha. Another, still smaller (.92 of an inch long) taken from the open lake among the small weeds growing on a flat, muddy rock, had filled itself with Chironomus pupae only, as had still another of the same size. A third specimen from this situation had eaten more larvae of Simulium than of Chironomus, and a fourth had also eaten Simulium larva and another dipterous larva unknown to me. I may add here that other young trout, in a small swift rivulet near the Lake hotel, were feeding continuously, Aug. 9, on floating winged insects, mostly, if not all, Chironomus and smaller gnatlike forms.

With these certain indications of the economic importance of the genus at hand, it is indeed time we were able to recognize its species. Mr Johannsen's work in part 3 is a beginning in that direction. All the above mentioned references, as well as most others to immature stages wherever published, are to the genus only; and Chironomus is a great genus, and includes forms with considerable diversity of structure, habitat and

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[1] Ill. State Lab. Nat. Hist. Bul. 2, p.483.
[2] U. S. Fish Com. Bul. 11, p.207-56.

habits. It is quite probable that with pond culture, as with agriculture, when real progress begins it will be necessary to recognize not only species, but also varieties of the more important species.[1]

Notwithstanding the indefiniteness of our knowledge concerning Chironomus as a whole, it may be worth while to venture some general observations concerning the habits of the genus, since these will explain some peculiarities of the table. Among the larvae attributed to the genus there is considerable diversity of structure, and a very striking range of color. Color differences have led to the distinction "white larvae" and "red larvae" in such papers as the one above quoted. The distinction is arbitrary, however, and of very limited applicability. The range of color is continuous from bright crimson in some of the red larvae to translucent pale yellowish or greenish in the others. Moreover, all are "white larvae" when newly hatched; and the red color is correlated with a considerable increase in size without a corresponding development of the tracheal system in the body, and is due to the increase of hemoglobin in the blood plasma. In general, it may be said that the "red larvae" are larger, have a more extensive development of blood gills, and live in deeper or less well aerated water; the "white larvae," most of which are not Chironomus in the stricter sense, are as a rule smaller, have little development of blood gills or of hemoglobin in the blood plasma, and live in rapids, on shore vegetation in shallower, cleaner, better aerated water.

The Chironomus of the foregoing table is one of the larger species, with larvae of bright red color. Many of them were alive when taken from the trout stomachs, and wriggled about as actively as if just taken from the water. In shore collecting none were found, but a few of their loose, flocculent gelatinous cases were found at the farthest reach of a long handled net (depth 5-6 feet). The species is doubtless a denizen of the deeper water, which is the proper feeding ground of the trout. It lives

[1] Several British species are characterized in their immature stages, and a good general introduction to the study of the biology of the genus is now available in Miall & Hammond's *The Harlequin Fly*, Oxford 1900.

on the bottom in the midst of a very thin layer of silt and vegetable debris covering the white sand. Its loose gelatinous case is covered with adherent silt, and takes on the general, protective color of the bottom. As is well known, the larvae of the larger red species are among the most characteristic bottom forms in all our larger and deeper lakes, being usually associated with deep water mollusks (Pisidium) and caddis fly larvae. This distribution, the natural abundance of the larvae, and the constant succession of generations through the year, leaving no period of absence of the larvae from the water, constitute the claim of these larvae to economic importance.

The pupae at first are red, but that color is generally quickly obscured by the development of the pigment of the adult insect. Within a few days at most after the transformation from the larva, the pupa rises to the surface and floats there, descending when disturbed, but quickly rising again. Pupae are less uniformly distributed over the surface than are larvae over the bottom, for the wind may drive them together in great masses. Pupae are often taken in numbers in a surface net in towing; larvae are rarely taken so, and then only at night, and in shallow water, for the larvae often leave their retreats at night and go swimming considerable distances with figure-of-eight loopings of the body.

It will be seen in the table that, with the exception of trout 11, every trout that had eaten Chironomus at all had eaten either larvae or pupae largely in excess; a large number of one stage, few or none of the other. In the light of the differences in habits of larvae and pupae just stated, this should indicate that some of the fish had been feeding chiefly or wholly at the bottom, others at the surface of the pond. The larger number of larvae eaten may indicate either that larvae were more easily obtained, or that they were preferred, or that bottom feeding was preferred.

2 Corethra

This is another form that is common in our northern lakes generally. It was not studied at Bone pond, and was collected there only by the trout. Corethra plumicornis is common in a pond on the campus at Lake Forest, and there I have observed its habits for several years.

The larvae are free swimming and are found most abundantly beyond the line of the shore vegetation. They are entirely transparent, except for two pairs of air sacs and some pigment in the eyes, and, generally, food in the alimentary canal, appearing as a dark line through the middle of the body. Their transparency doubtless secures them some immunity from enemies. I have experimented with feeding them to a hungry nymph of a dragon fly Libellula pulchella. Placed in the nymph's mouth, they were eaten with avidity, but, placed thickly in the water with it and swimming around within easy reach, none were captured or even reached after by the nymph. It was probably unable to see them, for it quickly seized water boatmen (Corisa) when substituted for the Corethra larvae. I very much doubt whether the trout can see them. If they are as abundant in Bone pond as they often are in my campus pond, even the considerable number shown in the table, might, I think, have been taken in the straining of the water through the gill rakers, without selection of any individuals for capture.

The pupae of Corethra are at first likewise transparent and free swimming, but soon rise to the surface and float there, like Chironomus, and just before transformation, become darker colored. The imagos settle on low vegetation around the borders of the water, or rise, dancing in swarms in sheltered and sunny places. The females deposit the eggs on the surface of the water, laying them down flatwise, in a spiral held together by scanty gelatine.

Among insects these larvae are the most independent of the shore vegetation. They feed on free swimming unicellular plants and animals. In my campus pond during April and May (the months of my observation) they live chiefly on a species of Peridinium, with a sprinkling of other flagellate infusorians. Specimens taken freshly from the pond generally show a distinct brown streak through the middle of the body, due to the Peridinia eaten. They are not incapable of disposing of much larger prey, however. Very frequently in my aquariums, after the supply of other food has run out, I have found a larva, with another larva of its own species and nearly of its own size, two thirds swallowed and one third digested.

We have but few species of Corethra, and they are much alike, and should be readily recognized generically in larval and pupal stages by comparison with the figures given on plate 39.

3 Unknown trichopter larva from bottom of Bone pond

This is another species that lives outside the line of the shore vegetation. Just outside that line, on bottoms shallow enough to be reached with a long handled sieve net, Mr Betten found the cases of the species in great abundance, but they were all empty. He has described the case in bulletin 47, page 572, as no. 2.

Because all students of our lake bottoms have reported caddis fly larvae along with Chironomus larvae as a constant part of the fauna, I have thought it desirable to have the structural characters of this species illustrated as fully as possible in the hope of its recognition by comparison in the future. The only specimens seen were obtained from the trout stomachs, and were pretty well digested. Some of the cases were fairly well preserved, but the pupae were so badly disintegrated as to be hardly distinguishable as pupae; the parts of the larvae most strongly chitinized, and the parts most important for the distinguishing of the species were fairly well preserved, and have been used, together with a perfect case collected from the water and apparently belonging to the same species, as a basis for the figures presented on plate 6.

The trout swallow the animals case and all, doubtless being unable to get them apart. The case persists after the animal within has been disintegrated, but the sand grains gradually fall off, and the brown, lining tube of silk gradually breaks up into fragments. Most of the stomachs contained a little sand, doubtless derived from this source, and trout nos. 2, 3, 6, 7 and 17 contained large quantities loose, in addition to that still on the walls of the cases remaining.

4 Aeschna constricta

The nymphs of this dragon fly live in the midst of the shore vegetation in shallow water. The trout that eat them probably have to go beyond the confines of their usual feeding grounds to get them. The advanced stage of digestion in which the specimens were found seemed to indicate that the specimens had been taken during the preceding night. Aeschna nymphs attached to a hook were taken by the trout, but not more readily than minnows, small frogs or other bait.

These were the largest animals the trout had eaten. The volume of one of them would equal perhaps that of 15 to 20 Chironomous larvae, or 30 to 40 Corethra larvae, or 5 to 7 caddis fly larvae, or 4 to 5 Callibaetis nymphs. They are among the most powerful members of the aquatic insect community and clamber about frequently on exposed places on plant stems, where the trout, if at hand, might easily seize them.

In a small way the dragon fly nymphs are competitors of the trout for food. They eat small insects promiscuously, and doubtless many pupae of Chironomus and Corethra fall victims to them. They will eat young trout, also, as long as themselves. I demonstrated this at Saranac Inn by confining them together in a breeding cage. One little trout would be captured quickly, and then the others would be wary of the nymphs and keep away from them well, so that we would think they would evade a similar fate, but one by one they would disappear till all had been eaten. The Aeschna nymph approaches its prey with the slowness and poise and stealth of a cat till within striking distance. Plate 5, figure B, shows a nymph of this species poising for a stroke at a backswimmer (Notonecta).

The adult dragon fly is shown also on this plate. Transformation occurs in the latter part of June and in July. The female inserts her eggs by means of an ovipositor into the stems of plants just below the surface of the water. The eggs hatch in about three weeks, and the little nymphs at once take up their abode among the submerged plants and eat promiscuously any other animals they can overpower; they also eat one another.

I have not been able to determine as yet whether in relation to trout culture Aeschna is more disadvantageous than otherwise. It eats a few of the fry and it eats the food of the larger trout; but, on the other hand, it furnishes a moderate supply of food itself for the larger trout.

Out in the proper foraging ground of the trout, burrowing shallowly under the silt of the bottom of the pond, are other dragon fly nymphs of the genus Gomphus, which would seem to be wholly detrimental. They feed voraciously on other insects of the bottom fauna, and, doubtless, on Chironomus larvae, while by their burrowing habits they seem to escape the trout altogether.

5 **Callibaetis** sp.?

These nymphs, like the preceding, were found in an advanced stage of digestion. That they were Callibaetis, however, was determinable from the structure of the jaws, the top of the thorax and the bases of the setae, which were preserved. Since no adult May flies were collected at the pond and no nymphs bred, what the species is could not be established. Callibaetis ferrugina was taken at the hatchery, and the nymphs may very well have belonged to this species.[1]

This is a large genus, peculiar to the new world. A considerable number of species are already described, and doubtless many more will yet be discovered. I have found the nymphs exceedingly abundant in many small lakes and ponds. They are most abundant amid the shore vegetation, but wander out into deeper water, resting on the bottom, and darting rapidly from place to place. I think it likely that they will be found more important as the food of young fishes than of adults, because of their greater abundance in the shallower water.

It is due to the occurrence of a new species of Callibaetis in my campus pond at Lake Forest, where, with my students, I have watched it year by year, that I am able to give some facts respecting the genus, which have a bearing on its economic

[1] While this is going through the press there comes to my table a description of the nymph of this species with figures by Berry, in the *American Naturalist*. 1903. 37:29, 30.

status. The nymphs are associated with Corethra larvae, and, like them, are generally in excessive abundance at all seasons of the year. Unlike the better known May flies, this species has no single period of transformation; but imagos may be found beside the pond most of the time from April till September. There are, to be sure, as with Corethra, a larger number in evidence at the beginning of their season, about the middle of May, than at any time thereafter, but that, I think, is due to the cold weather retarding the process of transformation more than it retards growth. I have found the imagos quite abundant in September. This repetition and overlapping of generations makes for continuity of food supply in the water.

The nymphs at transformation climb up only to the surface on some support, and then leave their cast skins floating on the water. The subimago stage lasts about 24 hours and is spent, as is usual, inactively. The male imagos are much in evidence, flying in little flocks in sheltered places in the sunshine, weaving up and down in their peculiar, rapid, dancing flight, and scattering on the approach of a net and settling on the reeds so quickly and sitting so quietly that they usually entirely disappear from view. I have found it difficult to capture many specimens of this species, even when they are abundant. The females are very seclusive. I have rarely found one flying with the males, or been able to discover one resting on shore. They are frequently seen floating on the surface of the pond, resting on the water with wings outspread, in which manner, like many other species of May flies, they deposit their eggs.

I append a description of this species in both adult and nymphal stages. The accompanying figures will suffice for the recognition of the genus. The adults of the genus are recognizable by the costal band of brown on the wings, best marked in the female, and the generic characters of the nymphs are stated in the table for the genera of May fly nymphs given in bulletin 47 on page 419.

Callibaetis skokiana n. sp.

Plate 7

Imago. Length of body 9–10mm; expanse of wings 18–20mm; length of setae, male 20mm, female 16mm. Ground color pale flesh tint, tinged with yellow (more yellowish in the female) marked, mottled and dotted with brown; antennae, legs and setae white.

Head pale brownish, with whitish margins; in the male, occupied superiorly by the large turbinate superior portion of the compound eyes, which are pale egg-yellow on their superior, faceted surface, with paler margins, and which are as large as all the remainder of the head; in the female the top of the head is very flat, and is traversed by two longitudinal, irregular, pale brown bands, which are surrounded and separated by whitish.

Prothorax paler, thickly dotted with brownish color. Dorsum of the mesothorax with a pale, longitudinal median suture, each

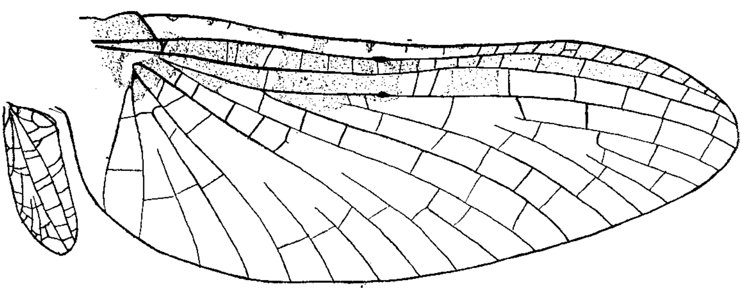


Fig. 1 Wings of Callibaetis skokiana, male

side of which is a band of brown rounded off posteriorly, and at the sides there are brown spots inferiorly. The median narrow pale line is continued posteriorly to the abdomen, and there are brown spots on the sides of the metanotum. Sides of thorax irregularly speckled with brown. Legs white with darker markings at the knees and at the ends of the tarsal segments, the last one of which is wholly washed with brown. Wings with the usual costal band, differing in the sexes, behind which they are hyaline. The band in the female is darker and better developed. It covers proximally the bases of all the veins and is regularly narrowed to the apex, ending just before the apex of the wing, not lobed posteriorly, fenestrate with hyaline on most of the cross veins except toward the base, and reduced to a yellowish wash in the stigmatic region and about the humeral cross vein. In the male the costal fascia is paler, and usually disappears just before the yellowish stigmatic space, which is sometimes filled with anastomosing cross veins. The venation of the male is shown in figure 1. There is much variability in the number of cross veins in any part, but in general they are more numerous in the female. Behind the costal brown band in the female there are about 70 cross veins, not in a single row, not in regular rows at all.

Abdomen pale yellowish or flesh tinted, thickly dotted and dashed with brown, tending to form a dark middorsal band, more or less completely divided on the base of each segment, a line of brown dashes each side just above the pale lateral margin on segments 1–9, with a more or less separate curved mark above the anterior end of each dash. At the sides the metathorax overlaps the first abdominal segment and almost reaches the base of segment 2. The ventral side of the abdomen is paler with more uniform dots and a pair of submedian brown ()– marks

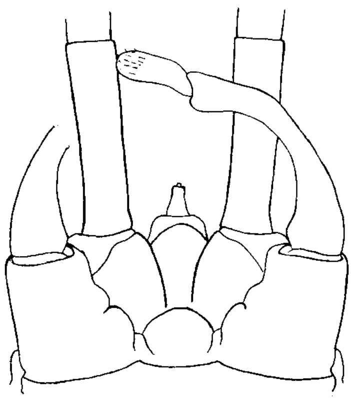


Fig. 2 End of abdomen of Callibaetis skokiana, male, ventral view, showing forceps, rudimentary median caudal filament and bases of lateral filaments

on segments 2–9, abbreviated on segment 9. Forceps of the male [figure 2] and setae of both sexes pure white.

Subimago. Differs in having the setae shorter (about 9mm long in both sexes), the wings faintly smoky brown, or slightly tinged with yellowish on the middle of what is to be the costal band, and the principal bands of brown on the body faintly indicated.

Nymph. Length of body 12–13mm, setae 6–7mm additional; width of head 1.2mm, of thorax 1.8mm. Color greenish, marked with pale fuscous.

Head pale, suffused with brownish around the eyes and across the ocelli in front, a longitudinal band bounding each eye internally, tinged with yellowish.

Prothorax pale marked with fuscous on the front margin and at the sides, with a pair of pale spots in irregularly contoured brown inclosures on the dorsum. Mesothorax and metathorax darker dorsally with pale markings at the front margin and at the rear between the wings; brown spots on the base and in the furrows of the wings. Legs pale, smooth, somewhat infuscated on the tarsi.

Abdomen with a median dorsal interrupted band of brown, preceded by an urceolate divided brown mark on the metathoracic dorsum, furcate anteriorly on segment 1 of abdomen, broadly overspreading segments 2 and 3 with additional brown spots at the sides and divided by paler apically; reduced to a slender T-mark on 4, the T-mark and lateral spots reappearing on 5, the T-mark joined to an apical transverse line on 6, and on 7, fused with the lateral spots, a median line with lateral ()-marks on 8 and 9, 10 with the line and the margins narrowly (the apical margin more broadly) fuscous.

Gills on segments 1–7, on 7 simple, and almost symmetric, a slightly indicated basal lobe on the posterior side, on 6, 5, 4 and 3 this basal lobe is successively more pronounced, becoming separated by a deep notch on 3; on 2 and 1 this lobe becomes a third as large as the body of the gill under which it is then folded, and a shallow incision appears on the anterior side of the body of the gill, nearer apex than base. All gills erect, with tracheae pinnately branched. The setae are pale with a wash of darker color near the tip.

Other items in the food

The eight water mites, A t a x c r a s s i p e s Müll., found in the food may well have been taken accidentally, as they are so small they could scarcely have been taken otherwise.

The large number of Daphnidae found in a single stomach is a peculiarity for which I have no explanation to suggest. They were in an advanced state of digestion, and the number given is only approximate. There were fragments of what I took to be Daphniae in the stomach of trout 5 also, but scarcely recognizable. The difficulty of recognizing and counting these was quite in contrast to the ease and certainty with which the same things were done for the other food constituents. The heads of Chironomus and Corethra were most distinctive, and were the parts longest resisting digestion, so that among a mass of fragments it was only necessary to count the heads.

The items listed as miscellanies were doubtless all accidental and unimportant. I think that the trout scales found did not indicate that any trout had been eaten, but only that they had been fighting, and this one had bitten another deeply enough to loosen a bit of its cuticle.

EXPLANATION OF PLATES

PLATE 1

Renwick lagoon at the head of Cayuga lake, Ithaca N. Y. Characteristic shore vegetation. Photo by J. H. Comstock

PLATE 2

Renwick lagoon, open water. Photo by J. H. Comstock

PLATE 3

Upper reaches of a bayou leading from Renwick lagoon across "the flats." Photo by J. H. Comstock

PLATE 4

Two views along Fall creek, near Ithaca N. Y. (1) Forest lake, looking toward the fall where the creek enters. (2) In the bottom of the gorge; one of the many small cascades; Simulium territory. Photos by H. N. Howland

PLATE 5

Aeschna constricta Say

1 Male imago. Photo from life by J. G. Needham

2 The nymph approaching a back swimmer. Drawing by Miss Anthony

PLATE 6

Unknown caddis fly larva, eaten by Bone pond brook trout

1 Head of larva. 2 End of abdomen. 3 Case. 4, 5 and 6 Legs of one side.

PLATE 7

Callibaetis skokiana Ndm.

1 Imago

2 Nymph

Photo from life by J. G. Needham, colored by Miss Anthony, after life

PLATE 8

Epiphragma fascipennis Loew. Drawing by Miss Anthony

PLATE 9

Epiphragma fascipennis, larva and pupa. Drawings by Miss Anthony

1 Larva, lateral view, anal gills almost withdrawn into the body

2 Respiratory disk on end of abdomen of larva

3 Pupa, ventral view

PLATE 10

Diptera

Immature stages

1 Larva of an unknown Leptid from rapids

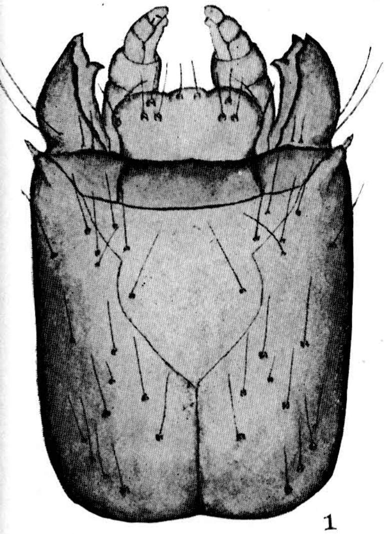
2 One of its paired bifurcated abdominal prolegs, showing grappling hooklets protruded

3 Pupa of Tipula flavicans Loew

4 Larva of an unknown Tipulid from springs

5 End of abdomen of same from above

Plate 6



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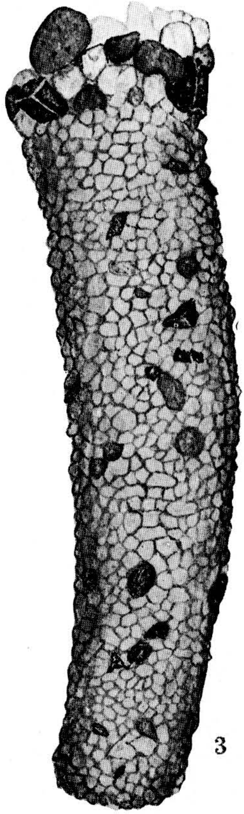

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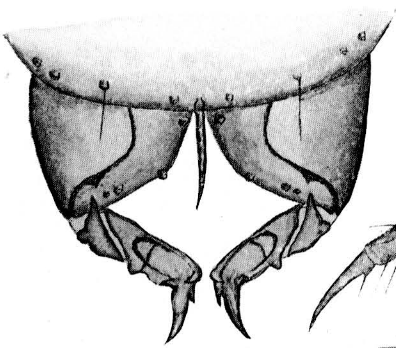

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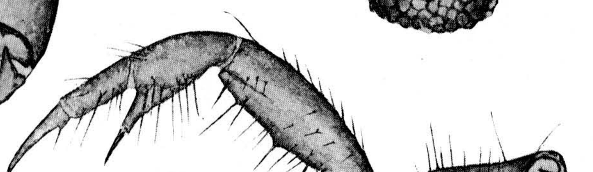

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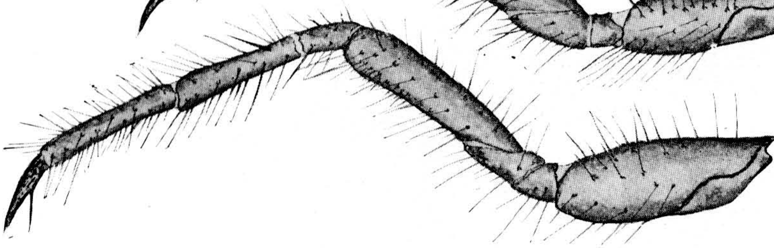
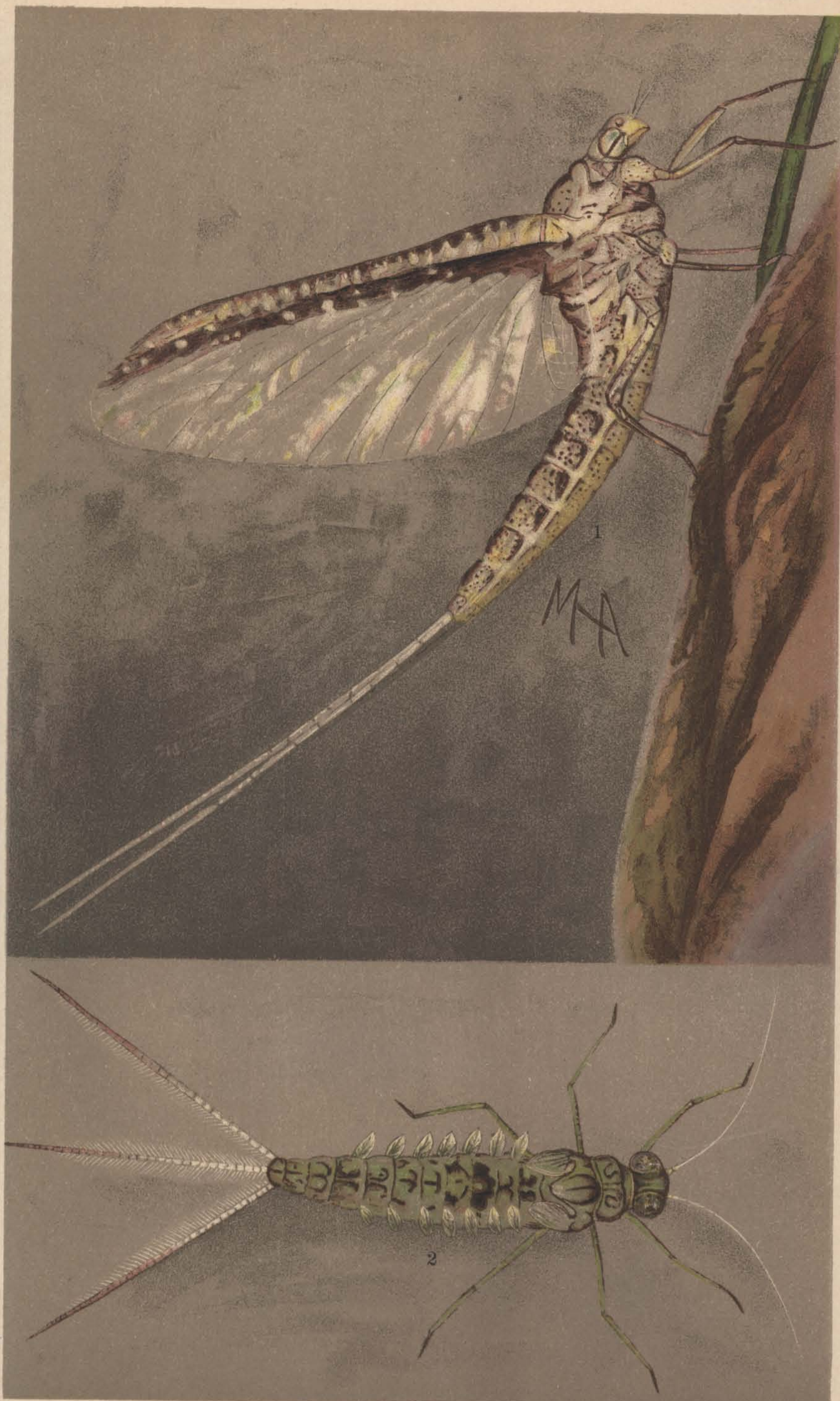


6

Caddis worm: brook trout food



Callibaetis skokiana