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STEPHEN A. FORBES, *Chief*

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An Entomological Survey of the Salt Fork of the Vermilion River in 1921, with a Bibliography of Aquatic Insects

BY

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ERRATA

Page 57, statistical headings: for *Year 1920* read *Year 1910;* for *Year 1909* read *Year 1920*; in the ratio heading, for *1909* read *1920*, and for *1920* read *1910*. The entries in the Year columns should change places.

Page 85, line 13 from bottom, for *87* read *86*.

Page 88, line 20, delete *red*.

Page 115, line 6, over the column of figures read *Acres*.

Page 136, line 5, for *135* read *131*.

Page 145, *First table*, 4th column, for *35.97* read *33.40;* last column, for .052 read .0418.

Second table, second column, for .2158 read .2004; 5th column, for .1131 read .0977; last column, for .0926 read .0772.

Last table, second column, for .714 read .663 and for total read $4.710; 5th column, for .374 read .323 and for total read $2.201; the last column, for .307 read .256 and for total read $1.700.

Page 146: *First table*, second column, for 8.02 read 7.45 and for total read 52.92; third column, for 3.45 read 2.88 and for total read 19.10; 4th column for 19.28 read 17.90 and for total read 127.18; last column, for 8.29 read 6.92 and for total read 46.35.

Second table, for 43.02 read 38.66.

Last table, for 8.0 read 6.7.

Page 382, line 10 from bottom, for *Platythemis* read *Plathemis*.

Page 385, in list, the specific names of No.'s 33, 35, and 40 should end in *us* instead of *a*.

Pages 445 (line 4), 448 (line 4), 449 (line 23), 454 (line 8 from bottom), read *Belostomidae* for *Belostomatidae*.

Page 457, line 21, for *cornutus* read *cornuta*.

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INTRODUCTION

Publication of the following paper, prepared in 1921, setting forth the effects on aquatic insects of the heavy pollution of a small stream by sewage from the twin towns of Champaign and Urbana, has been delayed by deficiency of funds for the printing of articles in the Bulletin of the State Natural History Survey, preference having been given there to papers of a more immediate importance.

The recent installation of an adequate plant for the purification of the sewage of these towns before it enters the stream has removed, it is hoped forever, the pollutional conditions here described, and the biological effects of this renovation can presently be made manifest by a comparison of the restored insect life of the stream with that here discussed. As an indispensable and irreplaceable basis for such a comparison this paper has acquired a very special value, and fortunately its publication need be no longer delayed.

A wide-spread campaign, vigorously promoted by the Izaak Walton League, for the suppression of stream pollution is stimulating a study of the subject throughout the country, and a carefully prepared bibliography appended to this report will doubtless be found useful as a guide to published information, widely scattered as this is in very many journals, American and European.

STEPHEN A. FORBES.

ARTICLE VIII.—*An Entomological Survey of the Salt Fork of the Vermilion River in 1921, with a Bibliography of Aquatic Insects.* By CHARLES P. ALEXANDER.

The Salt Fork is the most westerly of the three Illinois branches of the Vermilion River, and one of the chief affluents of the Wabash from the west. It takes rise in a group of small streams in the west-central part of Champaign county, Illinois, flowing south to Urbana, thence east to near St. Joseph. Near this village the stream takes a large bend and flows southward to near the village of Sidney, after which it flows in a general easterly direction, uniting with the Vermilion River just west of Danville. The Middle Fork unites with the Salt Fork between the villages of Oakwood and Hillery.

Originally a clean-water, permanent stream, the Salt Fork was later utilized to receive the sewage and manufacturing wastes of the cities of Urbana and Champaign, with the inevitable consequence that for several miles beyond the Twin Cities the stream became badly polluted and contaminated to the elimination of a great majority of the less tolerant members of the original fauna and flora. Thus we have on a small scale almost a duplication of the conditions obtaining in the upper reaches of the Illinois River which receives the sewage of Chicago and cities along its banks. The biological changes that have taken place in the Illinois River as a result of the diversion of the Chicago sewage to this stream twenty-five years ago, have been critically studied and recorded in a series of papers by Forbes and Richardson cited in the general bibliography in the second part of this paper. The Salt Fork stream, flowing close to the University of Illinois, has more recently attracted the attention of local naturalists, and one paper has already been published which is concerned with the effects of pollution on its fauna. This paper by Baker (1922) on the molluscan fauna of the Vermilion River and the Salt Fork is of especial value in its particular field in this connection. At the suggestion of Dr. Stephen A. Forbes, Chief of the State Natural History Survey, the writer in 1921 attempted to supplement Mr. Baker's studies from a purely entomological view-point. The stream was examined at short intervals, from above the source of pollution near Crystal Lake, Urbana, to just beyond the union of the Salt and Middle forks near Hillery in Vermilion county, Illinois. A total of thirty-three stations were established, corresponding rather closely with the collecting points chosen by Mr. Baker and with the bacteriological stations of the Illinois Water Survey. The collections of insects taken at the various stations are recorded later in this paper. An effort has been made to decide which of the species may be taken as indicators of the various degrees of

pollution commonly recognized, but the results have scarcely justified any sharp lines of subdivision except that between foul-water and clean-water species. The rather numerous tolerant species that can dwell in a varying degree of contamination occupy an intermediate classification that is discussed in some detail in its proper place.

When a stream becomes polluted by sewage or chemicals, the most sensitive and least tolerant species of plants and animals are soon eliminated, being gradually replaced by more tolerant forms as the amount and degree of pollution increases. The destruction of the clean-water insect fauna is often compensated for by a marked increase in the number of species and individuals of certain unusually tolerant or foul-water forms, notably species of small annelid worms (Tubificidae) and larvae of midges (Chironomidae) which, in places, form an important source of food for the few species of tolerant fish that exist in such waters. Thus in certain areas of both the Illinois River and the Salt Fork, almost the only water-breathing insect life consists of larvae of a few species of various genera of midges which are often extremely abundant.

Sewage Entomology

Considerable literature has been written upon the fauna and flora of polluted water-courses and sewage-disposal plants. The entomology of polluted streams exhibits certain general features which may be briefly outlined as follows.

The septic or grossly polluted portions of a stream are those in which the decomposition of organic matters is progressing actively, producing an abundance of carbon dioxide and the earlier and more complex nitrogenous decomposition products to the more or less complete exclusion of dissolved oxygen. The organisms of this zone are those which have been termed by Kolkwitz and Marsson (1909) polysaprobic and by Forbes and Richardson (1913) *septic* or *saprobic*. The lower forms of plant life, especially Schizomycetes, are abundant. Insects are very rare and include no water-breathing forms. The most conspicuous insects of this zone, both in America and Europe, are the so-called "rat-tailed maggots"—larvae of certain syrphid flies (*Eristalis* and *Helophilus*). *Eristalis tenax* (Linn.) was the only insect recorded by Kolkwitz and Marsson (1909), Johnson (1914), and Suter and Moore (1922) from this zone. It should be understood that this larva is air-breathing, obtaining its oxygen supply through the spiracles at the tip of a long, extensile breathing tube, the spiracular disk being held at the surface while the animal feeds at will beneath. The range of oxygen content usually selected by this species of *Eristalis* is stated by Suter and Moore (1922) to be from 0 to 40 per cent saturation. Other characteristic organisms of this region are the sludge-worms belonging to the family Tubificidae. The mud bottoms of the saprobic zone invariably have an offensive odor and are blackened by deposits of iron sulphide which churn up in dark clouds when the bottom is disturbed.

The polluted or mesosaprobic zone represents the next step toward purification of the waters. A variety of higher water-plants may exist in this zone and there may be considerable amounts of dissolved oxygen present. The natural physical re-aeration of the water and the oxygen given off by the higher plants or the more tolerant phytoplanktonts permit the existence of a much larger and more diversified fauna than was found in the saprobic zone. To this zone Kolkwitz and Marsson gave the name *mesosaprobic*, and further divided it into the sub-zones alpha, more strongly polluted, and beta, less strongly polluted. The two subdivisions of this region correspond in a general way to the *pollutional* and *contaminate* zones of Forbes and Richardson (1913). The fermentations that consume oxygen have become less here and the decomposition of the nitrogenous products has progressed to the stage where free amomnia usually predominates, though amounts of both ammonia nitrogen and dissolved oxygen are subject to change in a wide range. Kolkwitz and Marsson (1909) record eight insects from their alpha zone, and nine from their beta zone. Of the alpha forms, all but three are air-breathers, these being *Stratiomyia chamaeleon* L., *Psychoda phalaenaides* L., *P. sexpunctata* Curt. (=*alternata* Say), *Ptychoptera contaminata* L., and *Velia currens* Fabr. An orl-fly, *Sialis lutaria* L., and the two midges *Chironomus plumosus* L. and *Tanypus monilis* L. are water-breathers. From the beta sub-zone all but one of the species are water-breathers. The air-breathing species is *Culex annulata* F.; the water-breathing forms are caddis-worms (Trichoptera, 4) and Diptera (4). From this same zone Johnson (1914) records three species of Diptera only, these being *Chironomus plumosus* L., *Psychoda phalaenoides* L., and *P. sexpunctata* Curt. (=*alternata* Say), all air-breathing species. Suter and Moore describe the sewage-fly (*Psychoda alternata* Say) and the sewage crane-fly (*Eioptera* sp.) from conditions which belong to this zone. The large, brick-red larvae of the phantom crane-fly, *Bittacomorpha clavipes* (Fabr.), were found by Weston and Turner (1917) to be important factors in the reduction of sewage in the Coweeset stream near Brockton, Massachusetts, and to belong to the mesosaprobic zone. In the Salt Fork, the writer found a considerable number of insects which would seem to find their place chiefly in the beta mesosaprobic or weakly pollutional zone. This list includes a variety of water-scavenger beetles (Hydrophilidae), belonging to the genera *Tropisternus* (2), *Helophorus* (1), *Enochrus* (1), *Paracymus* (1), *Berosus* (2), almost all adult air-breathing beetles but including also many larvae. The occurrence of the immature stages of these beetles and others listed in the first section of this paper, together with water-breathing nymphs of a May-fly, *Callibaetis* sp., in company with large numbers of sludge-worms (Tubificidae), suggests that the insects are more than ordinarily tolerant of pollution.

The part of a stream lying between the mesosaprobic lower limit and that of the cleanest zone normal to rivers has been called by Kolkwitz and Marsson *oligosaprobic*, and by Forbes and Richardson the zone of clean water. The water here is regularly of the normal purity characteristic of

streams unpolluted by man, and the waste organic nitrogen has been more or less completely mineralized. The rate of consumption of dissolved oxygen is slow, and is often more than balanced by mechanical and biological re-aeration. The water has a slightly alkaline reaction and is at low stages highly transparent, unless colored by algae. A great variety of both plant and animal life occurs, but characteristic saprobic forms are, at least in large numbers, lacking. Members of the Characeae, very sensitive to pollutional conditions, begin to reappear where physical conditions are suitable and in their proper geographical range. The gradual increase in the amount and variety of light green algal forms, replacing the blue-greens, further indicates a clearing up of the water. From this region Kolkwitz and Marsson record a rather extended list of insects belonging to the following groups: Plecoptera (4), Ephemerida (6), Anistoptera (2), Zygoptera (2), Trichoptera (?), Hemiptera (8), Diptera (*Sayomyia* (1), Coleoptera (6), Dytiscidae (4), Gyrinidae (1), Hydrophilidae (1). The Plecoptera and Ephemerida have in the past experience of the writer and of other American authors been usually associated with the best aerated and most nearly pure water in this zone. There is often some invasion of the freer-ranging cleaner water species into the mososaprobic, beta, or contaminate zone, especially after heavy rains, these species often including higher forms of aquatic life, such as fish.

The above remarks apply chiefly to sewage in streams. A rather similar condition obtains in the disposal of organic matter in sewage-disposal plants. Here the principal insect involved is the sewage-fly, *Psychoda alternata* Say, which sometimes occurs in vast numbers. The gelatinous or amorphous film (milk of aluminum) which is used in the filters supports a myriad of lower organisms and it is upon these forms that the sewage-fly lives. It apparently does no harm in the filter-plant, but when it becomes numerous, as happens in some of the larger eastern cities, as Baltimore, the adult flies become a serious nuisance to housewives in the vicinity. This subject has been discussed in detail by Headlee and Beckwith (1918) and Headlee (1919).—see p. 460.

Description of the Stations made in the 1921 Survey of the Salt Fork of the Vermilion River

As mentioned above, a total of thirty-three stations were established during the progress of the survey. The location of these stations, with lists of the insects occurring at each, is given below.

The Salt Fork above the entrance of the Urbana and Champaign sewers is a small, clean-water stream. Beyond the mouths of these sewers for a distance of several miles, the stream has been artificially straightened and deepened into what is termed the Drainage Ditch, a distanec of approximately thirteen miles. This ditch continues to just west of the village of St. Joseph. The condition of the water in the drainage ditch is very bad, with no water-breathing insects present. About a mile west of St. Joseph, or a short distance above (west of) the

entrance of Spoon River, the conditions are considerably ameliorated and numerous tolerant insects and other forms of life are found. This pollutional or upper mesosaprobic condition obtains to near mid-distance between St. Joseph and Sidney where the water becomes still cleaner, and may be considered mesosaprobic, beta, or contaminate, in the classifications already cited. At or near the village of Sidney, the exact place varying with the season and amount of rains, the condition of the stream has become such that it supports a fauna that may be considered as oligosaprobic, or that normal to clean water, and this continues to the union of the stream with the Vermilion River.

The conditions by stations may be briefly summarized as follows:

Station 1.—Salt Fork stream above the sewer outlets; clean-water or oligosaprobic fauna. (Check Station)
Stations 2, 3.—Pollutional or mesosaprobic, alpha.
Stations 4-9, 31.—Septic or polysaprobic.
Stations 10, 12, 13, 29, 30.—Pollutional or mesosaprobic, alpha.
Station 11.—Spoon River; clean-water fauna or oligosaprobic. (Check Station.)
Stations 14, 15, 26-28, 32.—Contaminate or mesosoprobic, beta.
Stations 16-25, 33.—Clean-water, or oligosaprobic.

Station 1.—Taken on the Salt Fork at the bridge over Market Street, Urbana, in Crystal Lake Park, July 20. Water clear, the fauna strictly a clean-water one.

Ephemerida.	Ephemeridae: *Heptagenia* sp.; naiades.
	Caenis sp., possibly *diminuta* Walk.
Hemiptera.	Veliidae: *Rhagovelia obesa* Uhl.
	Gerridae: *Trepobates pictus* (H. S.)
Trichoptera.	Hydropsychidae: *Hydropsyche* sp.
Decapoda.	*Cambarus* sp., abundant.

Station 2.—The Boneyard stream, near the Big Four Shops, Urbana, immediately before it unites with the Salt Fork, July 20 The stream here is about eight feet wide, heavily polluted on the south side, the north three feet much clearer. Depth approximately one foot. Bottom gravel, without much sludge.

Hemiptera.	Corixidae.
Coleoptera.	Dytiscidae: *Laccophilus proximus* Say, adults.
Diptera.	Chironomidae: *Tanypus* sp., two larvae.

Sludge-worms, Tubificidae, abundant.

Station 3.—Salt Fork, 100 feet below the entrance of the Boneyard stream, July 20. Collections made in the riffles where the water was fairly well aërated in spite of the pollution.

Coleoptera.	Haliplidae: *Peltodytes 12-punctatus* (Say), adults.
	Dytiscidae: *Laccophilus proximus* Say, adults.
	L. maculosus (Germ.), adults.

Diptera. Chironomidae: *Chironomus* sp., larvae.
Sludge-worms, *Tubificidae,* very abundant.
Adults of the damsel-fly, *Hetaerina americana* (Fabr.) were very abundant along the stream but no naiades could be found.

Station 4.—Salt Fork, one-fourth mile below the outlet of the Champaign sewer, July 20. Stream wide and fast-flowing, but the bottom black and with a foul odor.

Hemiptera. Gerridae: *Gerris marginatus* Say, one adult.
Beneath the surface, the only life found was a sparse number of sludge-worms. The damsel-fly *Ischnura verticalis* (Say) was common but no naiades were to be found.

Station 5.—Salt Fork at the first iron bridge (between the Champaign sewer outlet and the Augurville bridge), July 20. The water runs rapidly and the upper surfaces of the rocks appear rather clean, though blackened. On lifting the rubble, however, a mass of inky black sludge is loosened that would preclude any except the most septic organisms. No insects occurred and no other life except a few specimens of sludge-worms.

Station 6.—The Augurville or Brownfield Bridge, July 20. The stream here is broken into riffles but this does not suffice to support a fauna any more varied than at the last station. No insects occur and only a few sludge-worms. Adults of the following Odonata were noted: *Plathemis lydia* (Dru.) and *Argia violacea* (Hagen). These presumably come from ponds or backwaters with clean water, as no naiades were taken at this station.

Station 7.—Third bridge over the Salt Fork, July 20. Conditions quite as at Station 6. No insects were to be found and only a few sludge-worms.

Station 8.—Cottonwood Bridge, July 20. The stream here was very low (July 20) and extremely black and polluted. Odor bad. No life of any sort

Station 9,—Mayview Bridge, July 20. Conditions here about as at Station 8. The only insects in the water were large swarms of whirligig beetles, *Dineutes americanus* Say. A careful search was made for their larvae but these do not occur and the swarms must migrate from purer water. Adults of Odonata, *Plathemis lydia* (Dru.) and *Ischnura verticalis* (Say) were noted, but not ovipositing.

Station 10.—The Salt Fork, 100 yards above (west of) the mouth of Spoon River, near St. Joseph, July 23. Water low (6 to 9 inches) but the sandy bottom very clear, not polluted heavily as in Stations up to nine. There is no apparent bad odor, but the people living here state that later in the season at times the odor is very bad. Frogs and turtles

live in this water but no fish were found, although they probably come in from Spoon River at high water. Insect life was surprisingly abundant and included many water-breathing species.

Hemiptera.	Belostomatidae: *Belostoma flumineum* Say, nymphs of all sizes, adults.
	Gerridae: *Gerris marginatus* Say, adults.
	Mesoveliidae: *Mesovelia mulsanti* White, adults common, some winged.
Coleoptera.	Dytiscidae: *Laccophilus maculosus* (Germ.), adults and larvae.
	Bidessus lacustris (Say), adults.
	Gyrinidae: *Dineutes americanus* Say, adults.
	Hydrophilidae: *Tropisternus glaber* (Hbst.), adults and larvae.
	T. lateralis (Fabr.), adults.
	Helophorus lineatus Say, adults.
	Berosus peregrinus (Hbst.), adults.
	Enochrus ochraceus (Melsh.), adults.
	Paracymus subcupreus (Say), adults.
	Helmidae: *Stenelmis* sp., one adult.
Diptera.	Chironomidae: *Chironomus viridicollis* v. d. W., extremely abundant, larvae.
	Tabanidae: *Tabanus* sp., one larva.

The great abundance of water scavenger-beetles, Hydrophilidae, and *Chironomus viridicollis* indicate a polluted but scarcely septic condition of the water.

Station 11.—Spoon River, 100 yards above the union with Salt Fork, July 23. Studied as a check on the main stream. The stream here is very muddy but the bottom is hard, composed of gravel, small crushed stones, and broken shells. The stream is almost choked with great beds of water-willow, *Dianthera americana*.

Ephemerida.	Ephemeridae: *Hexagenia bilineata* Say, large naiades.
Odonata.	Aeschnidae: *Anax junius* (Dru.), young naiades.
	Libellulidae: *Plathemis lydia* (Dru.), adults.
	Coenagrionidae: *Ischnura verticalis* (Say), adults.
	Enallagma exsulans (Hag.), adults and naiades abundant.
	E. antennatum (Say), naiades.
Hemiptera.	Corixidae: unidentified.
	Gerridae: *Trepobates pictus* (H. S.), adults and nymphs.
Neuroptera.	Sialidae: *Sialis infumata* Newm., larvae of various sizes.
Coleoptera.	Dytiscidae: *Laccophilus maculosus* (Germ.), adults.

	Haliplidae: *Peltodytes 12-punctatus* (Say), adults.
	P. edentulus (Lec.), adults rare.
	Hydrophiliade: *Berosus striatus* (Say), adults.
Diptera.	Chironomidae: *Procladius* sp., larvae.
	Chironomus sp., larvae, few.

The occurrence of *Hexagenia* and *Sialis* usually indicates a clean-water fauna, though *Sialis infumata* has been found to prefer trashy and sometimes slightly foul places.

Station 12.—Station made in the Salt Fork, one mile west of the junction with Spoon River, July 23. The Fork here is deep but foul-smelling. Masses of sludge lie about the bottom, giving it a mottled appearance.

Odonata.	Libellulidae: *Libellula pulchella* Dru. and *Plathemis lydia* (Dru.). Adult females were observed ovipositing in the stream but no naiades were found.
Hemiptera.	Corixidae: common, all adults.
	Gerridae: *Gerris marginatus* Say, adults.
Coleoptera.	Dytiscidae: *Laccophilus proximus* Say, adults.
	Haliplidae: *Peltodytes 12-punctatus* (Say), adults.
	Hydrophilidae: *Berosus striatus* Say, adults.
Diptera.	Chironomidae: *Chironomus* sp., larvae abundant.
	Palpomyia sp., larvae common.
Sludge-worms.	A very large species of *Tubifex* occurs.

Station 13.—Railroad Bridge west of St. Joseph, July 23. The river here is of bad odor and the bottom blotched with small masses of sludge. Small patches of duckweed (*Lemna*) float on the stream-surface.

Ephemerida.	Ephemeridae: *Callibaetis* sp., possibly *ferruginea* Walk., a few naiades. This is the most tolerant May-fly known to the writer.
Odonata.	Aeschnidae: *Anax junius* (Dru.), naiades.
	Libellulidae: *Libellula pulchella* Dru., naiades.
Hemiptera.	Mesoveliidae: *Mesovelia mulsanti* White, adults.
Coleoptera.	Dytiscidae: *Laccophilus proximus* Say, adults.
	Haliplidae: *Peltodytes 12-punctatus* (Say), adults.
	P. edentulus (Lec.), adults, few.
	Hydrophilidae: *Tropisternus* sp., large larvae.
	Enochrus ochraceus (Melsh.), adults.
	Berosus striatus (Say), adults.
Diptera.	Chironomidae: *Palpomyia* sp., larvae common.
	Procladius sp., larvae, few.
	Chironomus sp., larvae, abundant.

Sludge-worms, *Tubifex* sp., and blood-worms, *Chironomus* sp., are abundant in the shallow waters.

Station 14.—Benchmark 666, south of St. Joseph, August 9. The stream here is comparatively clear. There are some small masses of sludge but the whole stream is virtually choked with great masses of the water-net, *Hydrodictyon.* In the water, small areas of *Sagittaria* are growing, indicating a clearing up of polluted conditions.

Hemiptera.	Corixidae: extremely abundant, mostly adults but including many large nymphs.
Diptera.	Chironomidae: *Procladius* sp., larvae.
	Chironomus sp., larvae, a few only.

No Ephemeridae, Odonata, or Coleoptera were taken here on this date (compare with Station 28 later). A few sludge-worms were found.

Station 15.—The Shakerack Bridge, one and one-half miles west of Tipton, August 9. The bridge is at the west end of a small woodland. The stream here is comparatively deep but dirty. No algal or other plant life occurs.

Ephemerida.	Ephemeridae: *Callibaetis* sp., possibly *ferruginea* Walk., fully grown naiades.
Odonata.	Aeschnidae: *Gomphus* sp., small naiades of a burrowing species.
Hemiptera.	Corixidae: common, mostly young nymphs, although a few adults were found.
Diptera.	Chironomidae: *Chironomus* sp., few larvae.

Sludge-worms still common.

Station 16.—The Stone bridge, one-half mile east of Sidney, August 9. The stream here appears practically normal. Great beds of water-willow, *Dianthera,* almost choke the stream. A large and varied aquatic insect fauna occurs here, including abundant Odonata and ephemerid naiades.

Ephemerida.	Ephemeridae: *Hexagenia bilineata* Say, naiades.
	Heptagenia sp., fully grown naiades.
	Caenis sp., possibly *diminuta* Wk., naiades.
	Callibaetis sp., naiades.
Odonata.	Libellulidae: *Libellula pulchella* Dru., naiades.
	Coenagrionidae: *Ischnura verticalis* (Say), naiades.
	Enallagma sp., naiades.
Hemiptera.	Corixidae: common.
	Notonectidae: *Notonecta variabilis* Fieb., several, adults and nymphs.
	Buenoa platycnemis Fieb., adults and nymphs.
	B. margaritacea Bueno, adults.
	Gerridae: *Metrobates hesperius* Uhl., adults and nymphs.

	Mesoveliidae: *Mesovelia mulsanti* White, adults and nymphs.
	Hydrometridae: *Hydrometra martini* Kirk, adults.
	Belostomatidae: *Belostoma fluminеum* Say, common, the males with egg-masses.
Neuroptera.	Sialidae: *Sialis infumata* Newm., larvae.
Coleoptera.	Haliplidae: *Peltodytes 12-punctatus* (Say), adults.
	Hydrophilidae: *Tropisternus glaber* (Hbst.), larvae and adults.
	Berosus striatus (Say), larvae and adults.
Diptera.	Chironomidae: *Chironomus* sp., a few larvae.

No sludge-worms are present. *Cambarus* sp. and *Hyalella knickerbockeri* are common. The occurrence especially of *Hexagenia* and *Sialis* point to clean-water conditions. These genera were last taken at Station 11, the Spoon River. Tadpoles, and young catfish and sunfish are common.

Station 17.—Five miles east of Sidney, about three miles west of Homer Park, August 17. At the place where collections were made the stream has a bottom that is almost pure clay. Small fish of fingerling length are abundant and many set-lines of the natives indicate good fishing. Insect life in this clay bottom is not large or varied.

Odonata.	Aeschnidae: *Gomphus* sp., a few naiades.
Hemiptera.	Corixidae: common.
	Gerridae: *Metrobates hesperius* Uhl., nymphs of the second and third instars common.
Neuroptera.	Sialidae: *Sialis infumata* Newm., larva.
Coleoptera.	Gyrinidae: *Dineutes americanus* Say, adults.

Station 18.—Below the dam at Homer Park, August 17. Riffles over the broken stone and small pebbles. An entirely clean-water fauna present.

Plecoptera.	Perlidae: *Perla* sp., naiades.
Ephemerida.	Ephemeridae: *Polymitarcys albus* (Say), naiades.
	Ephemerella sp.
	Caenis sp., possibly *diminuta* Wk.
	Heptagenia sp.
	Baetis sp.
	Chirotenetes albomanicatus Ndm.
Odonata.	Aeschnidae: *Ophiogomphus* sp., naiades.
	Agrionidae: *Hetaerina americana* (Fabr.), adults were common, ovipositing in the clean water.
	Coenagrionidae: *Argia moesta putrida* Hag., adults were common, ovipositing in the clean water.
Hemiptera.	Corixidae: common.
	Hydrometridae: *Hydrometra martini* Kirk., few adults.

Gerridae: *Metrobates hesperius* Uhl., adults and nymphs abundant.
Veliidae: *Rhagovelia obesa Uhl.*, adults and nymphs abundant.
Neuroptera. Sialidae: *Corydalis cornuta* (Linn.), small larvae common.
Sialis infumata Newm., larvae.
Trichoptera. Hydropsychidae: *Hydropsyche* sp., extremely common with their nets.
Coleoptera. Hydrophilidae: *Tropisternus glaber* (Hbst.), adults.
Berosus striatus (Say), adults.
Enochrus ochraceus (Melsh.), adults.
Helmidae: *Stenelmis* sp., adults and larvae common.
Diptera. Chironomidae: *Chironomus* sp., small larvae.

Station 19.—One and one-half miles east of Homer Park, August 22. Great beds of water-willow, *Dianthera*, in the stream. Collections were made principally in these dense beds.

Ephemerida. Ephemeridae: *Hexagenia bilineata* Say, naiades.
Odonata. Aeschnidae: *Gomphus* sp., naiades.
Coenagrionidae: *Enallagma* sp., naiades.
Hemiptera. Belostomatidae: *Belostoma flumineum* Say, adults and nymphs.
Gerridae: *Gerris marginatus* Say, adults.
Trepobates pictus (H. S.), adults and nymphs.
Mesoveliidae: *Mesovelia mulsanti* White, adults and nymphs.
Hydrometridae: *Hydrometra martini* Kirk., adults and nymphs.
Coleoptera. Helmidae: *Helmis vittata* Melsh., adults.
Stenelmis sp., adults and larvae abundant.
Dascyllidae: *Cyphon* sp., or *Scirtes* sp., larvae very common.
Diptera. Chironomidae: *Chironomus* sp., larvae.
Cambarus sp., very abundant. Small catfish and sunfish are very numerous.

Station 20.—Two miles southwest of Fithian, August 22. Here the stream is nearly choked with water-willow, *Dianthera*, with some beds of *Elodea*.

Plecoptera. Perlidae: *Perla* sp., naiades.
Ephemerida. Ephemeridae: *Hexagenia bilineata* Say, naiades.
Polymitarcys albus (Say), naiades.
Caenis sp., possibly *diminuta* Wk., naiades.
Baetis sp., naiades.
Heptagenia sp., naiades.

Odonata.	Libellulidae: *Macromia* sp., possibly *illinoiensis* Walsh, numerous small naiades.
	Coenagrionidae: *Enallagma antennatum* (Say), small naiades.
	Enallagma sp., naiades abundant.
	Agrionidae: *Hetaerina americana* (Fabr.), adults common, ovipositing in the stream.
Hemiptera.	Nepidae: *Ranatra americana* (Mont.), adults.
	Hydrometridae: *Hydrometra martini* Kirk., adults abundant.
	Mesoveliidae: *Mesovelia mulsanti* White, adults abundant.
	Gerridae: *Trepobates pictus* (H. S.), few nymphs and adults.
Neuroptera.	Sialidae: *Sialis infumata* Newm., fully grown larvae.
Coleoptera.	Gyrinidae: *Gyrinus aeneolus* Lec., adults.
	Helmidae: *Helmis vittata* Melsh., adults.
	Stenelmis sp., adults and larvae.
Diptera.	Culicidae: *Anopheles punctipennis* Say, larvae.

Station 21.—Salt Fork, one-fourth mile below its union with Stony Creek, August 25. The bottom is covered with coarse rubble, forming riffles. The banks and margins of the stream are dense with *Dianthera* which in places quite chokes the stream.

Plecoptera.	Perlidae: *Perla* sp., naiades.
Ephemerida.	Ephemeridae: *Hexagenia bilineata* Say, naiades.
	Ephemera sp., naiades.
	Baetis sp., naiades abundant.
	Heptagenia sp., several species, naiades.
	Chirotenetes albomanicatus Ndm., naiades.
Odonata.	Agrionidae: *Hetaerina americana* (Fabr.), adults common, ovipositing in the stream.
	Coenagrionidae: *Argia moesta putrida* Hag. and *Ischnura verticalis* (Say), adults common, ovipositing in the stream.
Hemiptera.	Gerridae: *Metrobates hesperius* Uhl., adults abundant.
	Veliidae: *Rhagovelia obesa* Uhl., adults abundant.
	Mesoveliidae: *Mesovelia mulsanti* White, adults abundant.
Neuroptera.	Sialidae: *Corydalis cornuta* (Linn.) larvae very abundant, all sizes from newly emerged to almost fully grown.
Trichoptera.	Hydropsychidae: *Hydropsyche* sp., larvae and their nets.

Coleoptera.	Gyrinidae: *Dineutes americanus* Say, adults scarce.
	Helmidae: *Stenelmis* sp., larvae.
Diptera.	Chironomidae: *Tanytarsus* sp., larvae and cases.

Cambarus and species of darters were common in the stream.

Station 22.—Stony Creek, one-half mile above its union with the Salt Fork; a check station, August 25. The stream here is small but flowing in riffles. The fauna is strictly that of normally clean water, though slightly different from that of the adjoining parts of the Salt Fork.

Hemiptera.	Corixidae: unidentified.
	Gerridae, *Trepobates pictus* (H. S.), adults abundant.
	Hydrometridae: *Hydrometra martini* Kirk., adults.
Coleoptera.	Haliplidae: *Peltodytes 12-punctatus* (Say), adults.
	Dryopidae: *Helichus lithophilus* (Germ.), adults abundant.
	Helmidae: *Stenelmis* sp., adults abundant.
Diptera.	Tabanidae: *Chrysops* sp., larvae.

Station 23. Bridge south of Oakwood, Aug. 29. The collections made here show a large and varied fresh-water fauna.

Plecoptera.	Perlidae: *Perla* sp., half-grown naiades.
Ephemerida.	Ephemeridae: *Hexagenia bilineata* Say, naiades abundant.
	Polymitarcys albus (Say), naiades.
	Caenis sp., possibly *diminuta* Wk., naiades.
	Heptagenia sp., two species, naiades.
	Chirotenetes albomanicatus Ndm.
	Baetis sp., naiades.
Odonata.	Aeschnidae: *Epiaeschna heros* (Fabr.), naiades.
	Gomphus sp., burrowing species, naiades.
	Libellulidae: *Macromia* sp., possibly *illinoiensis* Walsh, naiades of various sizes.
	Agrionidae: *Hetaerina americana* (Fabr.), adults very abundant, ovipositing in water.
	Coenagrionidae: *Enallagma* sp., naiades common.
	E. exsulans Hag., adults common.
Hemiptera.	Nepidae: *Ranatra americana* (Mont.), adults.
	Gerridae: *Trepobates pictus* (H. S.), adults and nymphs.
	Metrobates hesperius Uhl., adults and nymphs.
	Veliidae: *Rhagovelia obesa* Uhl., adults and nymphs.
	Mesoveliidae: *Mesovelia mulsanti* White, adults and nymphs.

	Corixidae: adults.
	Gelastocoridae: *Gelastocoris oculatus* (Fabr.) adults and nymphs along wet margins of stream
Neuroptera.	Sialidae: *Sialis infumata* Newm., larvae.
	Corydalis cornuta (Linn.), larvae.
Trichoptera.	Hydropsychidae: *Hydropsyche* sp., larvae and nets.
Coleoptera.	Gyrinidae: *Dineutes americanus* Say, adults.
	Haliplidae: *Peltodytes 12-punctatus* (Say), adults.
	Hydrophilidae: *Tropisternus glaber* (Hbst.), adults.
	Dryopidae: *Helichus lithophilus* (Germ.), adults.
Diptera.	Tipulidae: *Eriocera* sp., possibly *gibbosa* Doane, larvae beneath stones in rapid water.
	Chironomidae: *Chironomus* sp., larvae abundant.
	Tabanidae: *Tabanus* sp., larva.

Station 24.—Collections made beyond the mouth of the Middle Fork, one and one-half miles south of Hillery. The conditions here were very much as in the Salt Fork farther west. Most collections were made in the rapids and among the roots of the *Dianthera* beds. The water at this date (August 31) was very low and had a strong odor like that of decaying fish.

Plecoptera.	Perlidae: *Pteronarcys dorsata* Say, naiades.
	Perla sp., naiades of various sizes.
Ephemerida.	Ephemeridae: *Caenis* sp., possibly *diminuta* Wk., naiades.
	Heptagenia sp., naiades.
	Chirotenetes albomanicatus Ndm., naiades.
	Callibaetis sp., possibly *ferruginea* Wk., naiades.
Odonata. .	Aeschnidae: *Gomphus* sp., naiades.
	Libellulidae: *Macromia* sp., possibly *illinoiensis* Walsh, naiades common.
	Agrionidae: *Hetaerina americana* (Fabr.), naiades abundant.
	Coenagrionidae: *Argia moesta putrida* Hag., naiades abundant.
Hemiptera.	Corixidae: adults and nymphs.
	Gerridae: *Metrobates hesperius* Uhl., adults.
	Mesoveliidae: *Mesovelia mulsanti* White, adults.
	Veliidae: *Rhagovelia obesa* Uhl., adults and nymphs abundant.
Neuroptera.	Sialidae: *Corydalis cornuta* (Linn.), larvae, all sizes, extremely abundant.
Trichoptera.	Hydropsychidae. *Hydropsyche* sp., larvae abundant.

Coleoptera.	Gyrinidae:	*Dineutes americanus* Say, adults.
	Dryopidae:	*Helichus lithophilus* (Germ.), adults.
	Helmidae:	*Stenelmis* sp., larvae and adults.
Diptera.	Tipulidae:	*Eriocera* sp., possibly *gibbosa* Doane, larva.

Station 25.—The bridge at Sidney, re-check on September 9 (equals Station 16). Conditions are about as on the previous examination (August 9) except that the water is higher due to heavy rains. A farmer states that until three years ago the stream was pure and supported many fish. The past two years, however, the stream became polluted, although the water looked clear, and all life died out. In 1921 the stream was muddy and vertebrate life re-appeared, this including certain fish, frogs, and turtles. It is of interest to note that the following summer (1922) the stream was again badly polluted and vertebrate life, including virtually all of the fish, was destroyed to a distance of two or three miles beyond Sidney. The exact nature of the pollution has not been ascertained, although it seems probable that it was a waste product of some one of the factories of Champaign and Urbana. Officers from the State Fish Commission who were sent to examine this condition in 1922 at the instance of the local Fish and Game Clubs, reported that it might be some years before the stream re-established its former condition.

Odonata.	Coenagrionidae:	*Enallagma* sp., naiades.
Hemiptera.	Corixidae:	adults and nymphs.
	Nepidae:	*Ranatra americana* (Mont.), adults.
	Hydrometridae:	*Hydrometra martini* Kirk., adults.
	Notonectidae:	*Buenoa platycnemis* Fieb., adults and nymphs.
Coleoptera.	Dytiscidae:	*Laccophilus proximus* Say, adults.
		L. maculosus (Germ.), adults.
		Hydroporus sp.

Station 26.—The Shakerack Bridge, re-check on September 9 (equals Station 15). The second collection revealed some species that were not noted on the former visit. Stream muddy, with no bottom vegetation.

Ephemerida.	Ephemeridae:	*Callibaetis* sp., possibly *ferruginea* Walk., naiades abundant.
Odonata.	Libellulidae:	*Sympetrum* sp., naiades.
Hemiptera.	Corixidae:	adults and nymphs abundant.
Coleoptera.	Dytsicidae:	*Laccophilus proximus* Say, adults and larvae abundant.
Diptera.	Chironomidae:	*Procladius* sp., larvae.
		Chironomus sp., larvae abundant.

Station 27.—Benchmark 66, re-check on September 9 (equals Station 14). A very abundant fauna at this time.

Ephemerida.	Ephemeridae:	*Callibaetis* sp., possibly *ferruginea* Walk., naiades.

Odonata.	Libellulidae: *Plathemis lydia* (Dru.), naiades.
Hemiptera.	Corixidae: adults and nymphs.
Coleoptera.	Dytiscidae: *Laccophilus maculosus* (Germ.), adults.
	Comptotomus interrogatus (Fabr.), adults.
	Dytiscid larvae abundant.
	Haliplidae: *Peltodytes 12-punctatus* (Say), adults.
	P. edentulus Lec., adults.
	Hydrophilidae: *Berosus* sp., larvae abundant.
Diptera.	Chironomidae: *Palpomyia* sp., larvae.
	Procladius sp., larvae.
	Chironomus sp., larvae abundant.

Sludge worms abundant.

Station 28.—Salt Fork, 100 yards south of the railroad bridge near St. Joseph, September 16 (nearly equals Station 13). The water is high and several land areas present on the first examination (July 23) are now submerged. The fauna here is almost identical with that of Station 27.

Ephemerida.	Ephemeridae: *Callibaetis* sp., possibly *ferruginea* Walk., naiades.
Hemiptera.	Corixidae: adults and nymphs abundant.
	Belostomatidae: *Belostoma flumineum* Say, adults and nymphs.
	Gerridae: *Gerris marginatus* Say, adults.
	Mesoveliidae: *Mesovelia mulsanti* White, nymphs.
Coleoptera.	Dytiscidae: *Laccophilus maculosus* (Germ.), adults.
	Haliplidae: *Peltodytes 12-punctatus* (Say), adults abundant.
	Hydrophilidae: *Tropisternus glaber* (Hbst.), adults.
	Berosus striatus Say, adults.
Diptera.	Chironomidae: *Procladius* sp., larvae and pupae.
	Chironomus sp., larvae abundant.

Station 29.—Salt Fork one mile west of the junction with Spoon River, re-check September 16 (equals Station 12). Water very high at this date.

Hemiptera.	Corixidae: adults.
	Belostomatidae: *Belostoma flumineum* Say, adults and nymphs of all sizes.
Coleoptera.	Haliplidae: *Peltodytes 12-punctatus* (Say), adults.
	Hydrophilidae: *Tropisternus glaber* (Hbst.), adults and larvae abundant.
Diptera.	Chironomidae: *Chironomus viridicollis* v. d. W., larvae very abundant.

No Odonata or Ephemerida found.

Station 30.—Salt Fork 100 feet below (east of) Spoon River, September 16. The water is high and very muddy but when the bottom is disturbed it churns up black. The pure water of Spoon River undoubtedly helps very considerably in purifying the waters of the Fork but these are still polluted, at least at this season.

Hemiptera.	Corixidae: adults and nymphs.
Coleoptera.	Dytiscidae: *Laccophilus proximus* Say, adults.
	L. maculosus (Germ.), adults.
	Hydrophilidae: *Tropisternus glaber* (Hbst.), adults.
	T. lateralis (Fabr.), adults.
	Enochrus ochraceus (Melsh.), adults.
Diptera.	Chironomidae: *Chironomus* sp., larvae abundant.

No sludge-worms were noted today.

Station 31.—Collections made in the Salt Fork 100 feet below (east of) the entrance of the Boneyard stream, September 23. Water very foul, all stones being draped with the foul-water fungus, *Sphaerotilus natans* Kützing.

Diptera.	Chironomidae: *Chironomus* sp., a few larvae.

No sludge-worms noted.

Station 32.—Collection made 100 feet above (west of) the Boneyard stream, September 23. The water looks clear but along the margins the net stirs up black clouds as in a polluted stream.

Odonata.	Coenagrionidae: *Ischnura verticalis* (Say), naiades.
Coleoptera.	Haliplidae: *Peltodytes 12-punctatus* (Say), adults.
	Hydrophilidae: *Tropisternus glaber* (Hbst.), adults.

Asellus is very common here.

Station 33.—Collection made in the Salt Fork 250 feet above (west of) the entrance to the Boneyard stream, September 23. The water here is comparatively pure, the stones being draped with green algae, with beds of *Elodea* growing along the margin.

Hemiptera.	Veliidae: *Rhagovelia obesa* Uhl., adults.
Trichoptera.	Hydropsychidae: *Hydropsyche* sp., larvae and nets.
Coleoptera.	Haliplidae: *Peltodytes 12-punctatus* (Say), adults.

Cambarus sp., young and adults, and *Asellus* are very common at this point.

Notes on the Species of Insects Collected

Plecoptera

As stated elsewhere in this paper, stone-fly naiades are notable inhabitants of rapids and well-aërated streams. In the present collection none were found except in clean water. The majority of specimens discovered in 1921 were species of the genus *Perla*. *Pteronarcys* was found only in the stream beyond the union of the Middle and Salt forks.

Ephemerida

Most species of May-flies are markedly intolerant of pollution. In the present survey, one species *(Callibaetis)* was constantly found in contaminated waters, or even, in one case, in waters that might be considered as polluted. All other members of the family Ephemeridae found, were distinctly clean-water species, these belonging to the genera *Hexagenia, Ephemera, Polymitarcys, Heptagenia, Baetis, Chirotenetes, Caenis, Callibaetis,* and *Ephemerella.*

Odonata

Naiades of *Anax junius* and *Libellula pulchella* were taken at Station 13 under conditions indicating pollution. The latter species has been taken in the Boneyard stream by students in the Department of Zoology at the University of Illinois and must be considered as being the most tolerant species encountered on this survey. Species of the genera *Gomphus* and *Sympetrum* were found in the stream at the Shakerack bridge (Stations 15 and 26) under conditions indicating contamination. All of the above are water-breathing forms. No naiades of the suborder Zygoptera were to be found in the stream except in clean water but there they occurred in great abundance. The Odonate fauna of the unpolluted portions of the Salt Fork belong to the genera *Gomphus, Ophiogomphus, Epiaeschna, Macromia, Hetaerina, Enallagma,* and *Ischnura.* In addition to these naiades, adult dragon-flies were observed ovipositing in the stream. These included *Libellula pulchella* and *Plathemis lydia* at Station 12, where the stream was strongly polluted, but it can not be stated that the naiades mature in polluted or septic streams. The fact that these insects oviposit in places where there is no chance of the continuance of the species is well known, as in temporary puddles over concrete pavement. In clean parts of the Salt Fork other adult dragon-flies seen ovipositing in the stream included such species as *Hetaerina americana, Argia mocsta putrida,* and *Ischnura verticalis.*

Hemiptera

A water-strider, *Gerris marginatus*, was observed at Station 4 where conditions were unquestionably septic. As the insect is an air-breather its occurrance here has no significance. At Station 10, where the water was considered to be polluted, the following groups of water-bugs were found: Corixidae, Belostomidae (*Belostoma flumineum*, including

nymphs of various sizes as well as adults), Gerridae (*Gerris marginatus* adults), and Mesoveliidae (*Mesovelia mulsanti*, adults; some of them winged—a rather rare occurrence in aquatic Heteroptera and one most frequently observed under conditions such as the present ones). The abundance of these insects under pollutional conditions is scarcely significant since they are all air-breathing forms that can come to the water-surface to obtain their supply of oxygen. The smaller water-striders (Gerridae, *Trepobates pictus* and *Metrobates hesperius;* Velilidae, *Rhagovelia obesa*); the back-swimmers (Notonectidae, *Notonecta variabilis, Buenoa platycnemis, B. margaritacea*); the Nepidae *(Ranatra americana),* and the Hydrometridae *(Hydrometra martini)* were all closely associated with clean water in the present survey. A number of genera and species of Corixidae were taken but the names are not vailable for consideration in this report.

Neuroptera

The larva of the orl-fly *Sialis infumata* is to be considered as an indicator of fairly clean water conditions, though it has been observed by Needham to prefer trashy places, and one of the European species, *S. lutaria,* was recorded by Kolkwitz and Marsson as living under strongly pollutional conditions. Similarly the larvae of the other Nearctic members of the family Sialidae, *Chauliodes* spp. and *Corydalis cornutus* L., are apparently confined to unpolluted waters. The larvae of the latter, the familiar Dobson or hellgrammite of bass fishermen, was very numerous in the lower portions of the Salt Fork and after the union with the Middle Fork.

Trichoptera

Species of the genus *Hydropsyche,* together with their nets and cases, were very common in the clean waters of the stream. None was observed anywhere in the stream under conditions that could be considered as being pollutional or even contaminate.

Coleoptera

At Station 8 in the most septic part of the Salt Fork, large swarms of whirligig beetles, *Dineutes americanus,* were noted. These, being air-breathers, are quite independent of the poisonous conditions beneath them and a careful search failed to reveal any sign of their larvae. There can be no doubt that they breed in clean waters and later move to the places where found. Whirligigs were common at intervals along the stream and in most instances proved to belong to this same species. Water scavenger-beetles (Hydrophilidae) were common at Stations 10, 13, 28, and 29, in polluted and contaminated portions of the stream. These included a rather considerable number of genera and species *(Tropisternus, Helophorus, Berosus, Enochrus,* and *Paracymus).* In clearer waters members of this family was less abundant. The polluted waters included not only the adult beetles but also a great abundance of larvae of the same.

Almost the same statements apply to the Haliplidae, two species of *Peltodytes* being very numerous in the stream between St. Joseph and Sidney under conditions that were strongly contaminate. Dytiscidae, the predaceous water-beetles, were about equally common in contaminated portions of the stream and at the critical station (25 and 16) near the bridge at Sidney where clean water conditions obtain for the first time. The Parnid beetles (Dryopoidea) included adults of a species of *Stenelmis* under pollutional conditions at Station 10. The majority of the members of this group appeared only in the cleaner water situations, however, as shown by the large numbers of specimens of *Helichus lithophilus*, *Helmis vittata*, and species of *Stenelmis* taken, the last-named being found both in the larval and adult stages. Although careful search was made for them, no specimens of the water-penny, *Psephenus herricki* (DeKay), were noted.* It may be that the range of the species is more northerly than the latitude of the Salt Fork. Members of the family Dascyllidae were noted commonly along the stream margins and among the beds of *Dianthera* in clean water conditions. The larval stage was the only one noted, and these may belong either to the genus *Cyphon* or to *Scirtes*.

* The writer can see no just reason for ignoring DeKay's name, *Fluvicola herricki*, applied to the larva of this species, under the misconception of its being an isopod crustacean, six years before the adult beetle was named *Psephenus lecontei* by Leconte. The generic name *Fluvicola* is preoccupied in Aves (Swainson 1827) and so can be dropped from consideration. However, there seems to be no reason for ignoring DeKay's specific name based on the immature stages. Similarly DeKay's *Fluvicola tuberculata* is very probably the larva of *Helichus lithophilus*. An entirely comparable case is found in the May-fly *Prosopistoma foliaceum* Fourc. in Europe, and in this instance the use of this name has never been questioned. The insect was described in 1764 by Geoffrey as a crustaceous form and re-named by Fourcroy in 1785 as a species of Crustacea. It was fully a century after its original discovery that the true relationship of this remarkable insect was made known.

Diptera

Together with the tubificid worms, members of the dipterous families Psychodidae, Chironomidae, and Syrphidae are considered as among the best indicators of septic or pollutional conditions. The larvae of the Psychodidae and Syrphidae are air-breathers, obtaining their supply of oxygen directly from the atmosphere through breathing-tubes, very short in the former case, extremely long and extensile in the case of the rat-tailed maggots (*Eristalis* and *Helophilus*). No members of these septic groups were encountered in the 1921 survey. The great family of midges, Chironomidae, includes a range of species from forms which can stand pollution (such as *Tanypus monilis*, L., *Chironomus plumosus* L., *C. maturus* Joh., and *C. frequens* Joh.); and less tolerant forms (such as *Chironomus crassicaudatus* Mall., *C. decorus* Joh., *C. globiferus* Say, *C. viridicollis* v. d. W., *Tanypus dyari* Coq.) to others which appear to be strictly clean-water species and unable at all to stand pollutional conditions (such as *Chironomus nigricans* Joh., *C. ferrugineovittatus* Zett., and *Procladius concinnus* Coq.). For a detailed consideration of these species the reader is referred to the paper by Richardson (1921a, page 72 and table).

In Europe, Rhode (1912) records *Chironomus interruptus* (Kieff.) and *C. rhyparobius* (Kieff.) as being polysaprobic: *Chironomus dichromocerus* (Kieff.), *Prodiamesa ichthyobrota* (Kieff.) and *Pelobia enhydra rhypophila* Kieff. as being between polysaprobic and alpha mesosaprobic. From the alpha mesosaprobic sub-zone he records *Chironomus pentatomus* (Kieff.), *C. thummi* (Kieff.), *Isocladius albipes* Kieff., *Cricotopus petiolatus* Kieff., *Psectrotanypus brevicalcar* Kieff., *Trichotanypus bifurcatus* Kieff., var., *Dactylocladius setosipennis* Kieff., and *D. hamifer* Kieff. From the beta mesosaprobic zone he records three species of *Chironomus*. The long, snake-like larvae of *Palpomyia* were common in polluted waters at Stations 12, 13, and 21.

The only Tipulidae noted on this survey were a few larvae of a carnivorous species (*Eriocera*) in strictly clean waters. The sewage crane-fly (*Erioptera* sp., possibly *vespertina* O. S., discussed by Suter and Moore (1922), is a species that can stand rather unusual conditions of pollution for members of this genus. The two common genera of Ptychopteridae, *Bittacomorpha* and *Ptychoptera*, are well-known inhabitants of contaminated water situations in streams. In Europe, *Ptychoptera contaminata* lives in filthy waters and was found by Kolkwitz and Marsson in their mesosaprobic or polluted zone. Similarly *Bittacomorpha clavipes* was found by Weston and Turner (1917) in the polluted Coweeset stream in Massachusetts. The larvae of members of this family are generally similar to the rat-tailed maggots in form, having the spiracles situated at the ends of an enormously elongated and extensile breathing tube that is projected above the water-level while the larva feeds at will beneath the surface.

A Bibliography of Aquatic Insects

In the following pages is given a list of the papers relating to aquatic insects. An especial effort has been made to complete the bibliography for the past decade. No attempt has been made to include scattered references to distribution, anatomy, histology, and similar subjects, but it has been endeavored to make the bibliography as complete as possible for the immature stages, biology, ecology, and physiology. It should be noted that the references include only those to the stage found in the water—the naiades of Odonata, Plecoptera, and Ephemerida; the nymphs and adults of Hemiptera; the larvae and pupae of Neuroptera, Trichoptera, Lepidoptera, Diptera, and certain Coleoptera; and the larvae and adults of Coleoptera and Hymenoptera. The numerous references to the aerial stages of these insects are altogether omitted. It is the intended purpose of this bibliography to aid the students of hydrobiology and limnology to determine the forms of insect life that they find in the water, and the inclusion of other stages would serve no especial function.

The literature of aquatic insects is widely scattered and there are no exhaustive lists of references except in a few special groups. The

relevant articles in these groups are incorporated in the present paper, and those which are provided with a bibliography are indicated in the following list by an asterisk preceding the title.

Sewage Entomology

Headlee, Thomas J.

1919. Practical application of the methods recently discovered for the control of the sprinkling sewage filter fly (*Psychoda alternata*). Journ. Econ. Ent. 12: 35-41, 4 figs., 2 pls.

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