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A Contribution to the Aquatic Insect Fauna of Lake Winnipeg.

By
Ferris Neave, University of Manitoba.

(With three text-figures.)

The following notes are based mainly on collections and observations made over a period of some six years (1927—1932). During this period the writer visited most parts of Lake Winnipeg and some of its tributaries in company with his friend and colleague Dr. A. D. Bajkov, to whom he is indebted for considerable material and much assistance in various ways. In the course of a general biological survey of the lake some attention was given to insects of many different orders but the present paper only attempts to deal with three of these, namely, the Plecoptera, Ephemeroptera and Trichoptera, the others being consigned to a problematical future.

General Considerations.

Lake Winnipeg is the largest lake in the Hudson Bay drainage system, having an area of about 24,200 km². The level of the water has varied somewhat in recent years but at the present time the maximum depth hardly exceeds 18 metres. A considerable area in the northern part of the lake, however, is close to this depth.

Owing to its size and shallowness a thermocline is only present for a brief period in the spring, and in summer the water at the bottom of the lake is often only 2° or 3° colder than near the surface. The complete circulation of water which thus takes place also brings about a relatively even vertical distribution of oxygen, which is a factor of importance in considering the bottom fauna. A set of readings made near George island in June, when the variation between surface and bottom temperatures is somewhat greater than later in the season, was as follows:

	Surface	Bottom at 17 metres
Temperature	13.8°	8.6°
Oxygen (parts per 1,000,000)	11.0°	10.83°

In winter the lake is frozen over from December until May but the dissolved oxygen content remains high.

A noticeable feature of the lake is the turbidity of the water („Winnipeg" is an Indian term meaning „muddy water".) This is mostly due to sediment brought in by rivers from the south and west, notably the Red river and the Saskatchewan. Secchi's disc readings in the lake vary from 1 metre to 1.75 metre. In this connection it may be noted that Lake Winnipeg covers the boundary between the limestones, etc. of the prairies and the Archaean rocks of the „Pre-Cambrian Shield" and thus shows striking differences between the character of its eastern and western shores.

Related to these geological facts are the pH values. The lake itself and its southern and western tributaries are alkaline (7.6 to 8.4). The lowest readings are from points near the east shore. Some of the tributaries from this side are actually on the acid side of neutral (e. g. Black river 6.8) while others are from 7.2 to 7.5.

The net result of the various physical and chemical conditions appears to be very favourable for a large development of phytoplancton. Bajkov (1930) estimates that the total amount of plancton (excluding nannoplancton) varies from 2cc. to 20cc. per 1,000 litres of water. In summer particularly, a large proportion of this consists of algae and diatoms.

This phytoplancton, either living or dead, provides one of the main direct sources of food for the insectan and other elements of the bottom fauna. The present writer has shown (1932) how the growth rate of the mayfly *Hexagenia limbata occulta* follows closely the seasonal variation in the amount of phytoplancton in the lake. Incidentally of course the richness of the bottom fauna (speaking from a quantitative point of view) can support a large quantity of nekton. It may be mentioned in this connection that Lake Winnipeg is the main source of production of one of the largest inland fisheries industries in the world.

In considering the entomological resources of the area, the following types of waters can be noted briefly:

1. Tributaries (and outlet).
2. Lagoons.

3. Open shores.
4. Offshore waters.

1. Tributaries.

Only those portions lying near, or fairly near, to the lake (see remarks before list of species) are included in the records given in the present paper, as it is impossible at the present time to give even the barest details of the aquatic insects throughout the length of the many watercourses that comprise the Lake Winnipeg system. Two types of running waters can be recognized from an ecological standpoint.

(a) Permanent. In so far as these have been investigated they have a generally slow or moderate current, but in many cases there are rapids or waterfalls at intervals. The eastern tributaries in particular descend to the lake by a series of „steps" of this kind, with intervening stretches of placid water. The considerable differences in chemical and geological nature between the eastern and western tributaries appear to have less influence than one might suppose on the insect fauna, which is perhaps more closely linked with speed of current, amount of oxygen, etc., at least within the limits of variation present in our area. In general, however, the rivers from the south and west, being somewhat slower and muddier, possess a less varied Plecopteran fauna and a greater diversity of certain Trichoptera such as Limnephilidae and Phryganeidae. Characteristic of both sides are the stoneflies *Pteronarcys dorsata* and *Isoperla bilineata*, the mayflies *Hexagenia*, *Ephemera simulans*, *Blasturus cupidus*, *Siphloplecton basalis*, *Baetisca bajkovi* and the caddisflies *Helicopsyche borealis* and *Molanna flavicornis*. More characteristic of the eastern rivers are such Plecoptera as *Perla media*, *Isoperla fumosa* and the Ephemerids *Ephemerella bicolor*, *Isonychia*, *Siphlonurus alternans*. *Chimarrha aterrima*, *Hydropsyche recurvata* and *Neureclipsis* are corresponding forms among the Trichoptera.

(b) Temporary. In spring the melting snows of the prairies produce a large amount of water in the form of temporary „sloughs" and ponds, which dry up as the summer advances. These often drain into the lake or its tributaries by small watercourses, either natural or in the form of artificial ditches. Owing to their temporary nature, these waters are not suitable for the prolonged requirements of most of the insects with which we are concerned. The writer knows of no

stonefly which utilizes these waters but a mayfly nymph, *Blasturus cupidus*, enters them in large numbers in the spring and sometimes migrates to distances of a mile from its winter quarters, transforming in its new habitat (Neave, 1930). Certain Limnephilid caddis larvae are also to be found in these temporary waters. Their life history is unknown to me but they appear to be the result of eggs laid on the spot and not to be migrants from permanent bodies of water.

A negative feature of the running waters of the Lake Winnipeg area is the great scarcity of small, rapid, permanent brooks and streams. This is sufficient to account for the comparatively poor stonefly fauna and also for the absence of many species belonging to the other two orders.

2. Lagoons, ponds, etc.

These are found lying behind low sandhills along various parts of the lake shore. They range in size from Gimli lagoon (about 8 km^2) down to the veriest puddles. They are mentioned here chiefly in order that the writer may emphasize his ignorance of their insect fauna. They are frequently weedy and are often rich in Limnephilidae, etc., but have been very little investigated. They possess, of course, a rich fauna of other insect forms, particularly Odonata, Hemiptera, Coleoptera and Diptera.

3. Open shores.

Most of the shore line of Lake Winnipeg and its islands is of the „exposed" kind, — stony or rocky, with stretches of sand in many places. The chief exponents of the latter habitat are *Ephemera simulans* and *Molanna flavicornis*, with *Ephoron album* in some places. *Ephemera* burrows in the bottom, while *Molanna* crawls with its wide flat case, which is composed of the same substance as the substratum. It occasionally reaches a concentration of 80 per sq. metre (Neave, 1933).

In a few places there are large bays well protected by sandspits, e. g. Limestone bay in the extreme north west and Gull bay. In these two cases the bottom consists of sand or sand and mud, with Potamogeton and other weeds in spots, and yields large numbers of *E. simulans*, *Hexagenia limbata occulta* and *rigida* and *Molanna flavicornis*.

The more extensive shore areas of stones or rocks are inhabited by a rather more diversified but still scanty and highly characteristic

insect fauna. In addition to the rigours of wave action and lack of vegetation to which an open shore fauna is naturally exposed, two further conditions are well developed in Lake Winnipeg. The first of these is the presence of ice from about November to May, reaching a depth of 1 m. to 1.5 m. in late winter. Secondly, the water level in the south part of the lake may fluctuate more than 1 metre in the course of two or three days. This is due to wind action. When the wind is from the north water is driven through the neck of the Narrows and accumulates in the south end. After a south wind the water recedes from this portion. These fluctuations are less marked in the great northern portion of the lake. They must have a considerable effect on the shore fauna.

Only one stonefly (*I. bilineata*) is of frequent occurrence along the shore of the lake. At the Narrows, however, there is a slight permanent deep current from south to north, in addition to the frequent occurrence of a special surface current in either direction as mentioned above, making this point ecologically a river. As a result, *Acroneuria perbranchiata*, usually a river form, is present here.

Other typical members of the ordinary exposed shore line are *Stenonema tripunctatum*, *S. interpunctatum*, *Heptagenia pulla*, *Hydropsyche recurvata*, *H.* sp.?, *Helicopsyche borealis* and, more locally, *Leptocerus ancylus*. The two last named larvae have characteristic coiled or curved cases, closely simulating snail shells.

4. Offshore waters.

The bottom of the lake, except near shore, consists mostly of fine mud. This area, of vast extent, is the most characteristic feature of Lake Winnipeg. Owing to the relatively even depth of the lake no great variation in conditions is found, except near river mouths. The abundant supply of phytoplancton falling on the bottom forms the direct or indirect basis for a dense population but the number of species in the bottom fauna is very small. *Leptocerus* invades this area to some extent and *Molanna flavicornis* is found where there is enough coarser material to build its case, but the only insects which are really characteristic are *Hexagenia limbata occulta*, *H. rigida*, *Phryganea cinerea* and certain Chironomidae. These are often present in enormous numbers. *Phryganea*, in some seasons at least, averages more than 4,000,000 per km^2 over the great north part of the lake. It is independent of depth or distance from land and can utilize materials

of great diversity for its case (Neave, 1933). *H. limbata occulta* is absent from the central part of the north portion but at a conservative estimate averages 60,000,000 per km^2 in the south part and reaches local concentrations of 750 per sq. metre. The ratio of *H. l. occulta* to *H. rigida* in 1929—1930 was about 7 : 1 over the whole lake (Neave, 1932). Both genera are eaten in great numbers by various species of fishes.

Geographical Distribution.

In view of its central position on the continent and its situation, in part at least, between the coniferous forests and the prairies, it might be supposed that Lake Winnipeg would show a combination of eastern and western elements in its fauna. Our present limited knowledge of these insects makes it risky to draw too many inferences regarding distribution. It may be noted, however, that there is no other barrier to distribution in the northern part of the continent comparable in importance with the Rocky Mountains. Throughout the whole of the territory lying east of this chain there is considerable similarity in the aquatic insect fauna. The presence or absence of species probably depends more on local conditions than on broad geographical considerations. As regards the groups in question Lake Winnipeg belongs, in a general sense, to the eastern fauna. The greater number of species recorded are known from localities further east or south east. Very few, if any, have their centres of distribution further west. A number of species have been described from the Lake Winnipeg region or adjacent areas and are as yet unknown elsewhere, but the limits of their distribution are in most cases quite uncertain. It may be necessary eventually to recognize a „central" group to accommodate some of these.

In making comparisons with other parts of the world many difficulties arise in synonymy and in the status accorded to generic and subgeneric groups in different countries. A few species of Ephemeroptera and Trichoptera are believed to be common to Europe and North America, though none of these appear in the present list. Several of the listed forms, however, are very close to European representatives, e. g. *Oecetis vicaria*. It is safe to say that 70% or 75% of the genera recorded from Lake Winnipeg occur in Europe, even if some of the names are not adopted there. In this connection it is interesting to note that the proportion of genera common to both regions is much greater in the Trichoptera, which of course is the

most highly developed of the three orders in structure and life history. The proportions are, roughly: Plecoptera 57%; Ephemeroptera 70%; Trichoptera 80%. Their weak powers of flight and intolerance of varied conditions probably account in some measure for the more localized distribution of the Plecoptera. The Pteronarcidae are notable absentees from the European fauna. Among the Ephemeroptera the important genus *Hexagenia* and the aberrant *Baetisca* are found throughout much of North America but are absent from Europe. In the Trichoptera the curious little *Helicopsyche* may be mentioned. Most of the other genera are holarctic or at least not strikingly different from European forms.

The following is a preliminary list of species from Lake Winnipeg and certain of its larger tributaries. I have included the various „Red River" records given by Hagen and Banks (mostly of specimens collected by Robert Kennicott some 70 years ago) although the exact localities are unknown. I therefore cannot logically exclude records from Winnipeg, which is on the Red river about 60 kilometres distant from Lake Winnipeg. Most of these latter specimens were collected by Mr. J. B. Wallis and presented by him to the University of Manitoba. With regard to the other rivers mentioned the records are all from points nearer than this to Lake Winnipeg and in many cases at or close to their mouths.

In the following list the absence of a name or a reference after a locality indicates that the specimens were collected by the present writer.

PLECOPTERA.

Of the twelve species known, three (*I. fumosa*, *A. perbranchiata* and *N. stigmata*) were described from this area and are as yet unrecorded from elsewhere.

Pteronarcidae.

Pteronarcys dorsata Say Winnipeg, common; Pigeon river, common.

P. californica Newport „Lake Winnipeg" Smith, 1917, p. 449. This is a long way from the other known localities and the record seems rather doubtful.

P. proteus Newman Red river (Kennicott) Hagen, 1861, p. 14.

Perlidae.

Perla media Wlk. Wanipigow river, 27. VI; Manigotagan river, 28. VI; Pigeon river 11 and 12. VI.

Chloroperla cydippe Newman Pigeon river June to August, abundant.
Clioperla sp. Pigeon river, 3. VI. female, also nymph skin.
Isoperla bilineata Say Common along much of the Lake Winnipeg shoreline from south to extreme north. Abundant along tributaries such as Red, Wanipigow and Pigeon rivers, May to August.

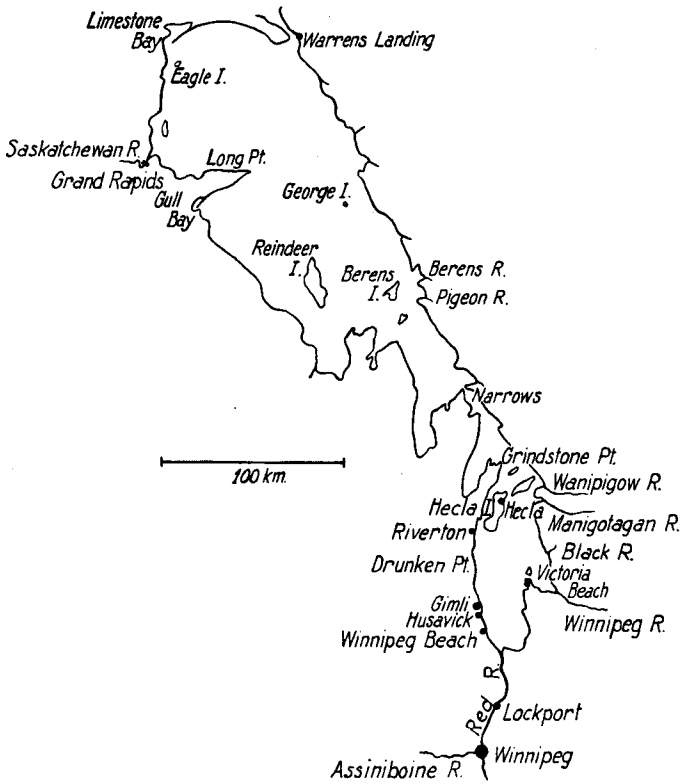

Fig. 1. Lake Winnipeg, showing localities referred to in the text.

I. fumosa Neave Pigeon river, May and June; Manigotagan river, 3. VI.; George Island, 27. VI. (Rabeneck); Warren's Landing, 1. VIII. (Bajkov). Occurs with *bilineata* but is less plentiful.
I. longiseta Bks. A few specimens from Winnipeg, taken in June, appear to be this species.
Acroneuria perbranchiata Neave Common along various eastern tributaries, e. g. Manigotagan, Wanipigow, Pigeon. Also Winnipeg (Wallis); George Island and the Narrows. June to August.

A. pennsylvanica Ramb. Pigeon river, 5—7. VIII., female. Also nymphal skins which may belong to this species.

Nemoura stigmata Bks. Winnipeg, 17. VI., holotype (per J. B. Smith). Banks, 1900, p. 244.

N. sp. Pigeon river, 6. VI., female.

EPHEMEROPTERA.

Ephemerinae.

Ephemera simulans Wlk. Common along the lake shore, particularly in sandy localities, from June to August, but not appearing in the vast numbers characteristic of *Hexagenia*. Also found at Winnipeg (Wallis). The nymphs live in sand and apparently do not descend more than a few metres deep.

Hexagenia limbata occulta Wlk. By far the most abundant Ephemerid in the lake. The adults reach their maximum abundance in the middle of July. The nymphs are found to a depth of 17 metres. Also found in many rivers, e. g. Red, Pigeon, Icelandic.

H. rigida McD. Also abundant, but less so than the preceding, except in the neighbourhood of the Narrows.

Ephoron album Say. Along the lake shore at Winnipeg Beach and Gimli. Also Red river, Winnipeg river (types) and Pigeon river. July to September.

Baetinae.

Blasturus cupidus Say. Red river (Winnipeg to mouth); Manigotagan river, common; lake shore near Winnipeg Beach. June.

B. nebulosus Wlk. Grindstone point, 14—15. VI.; George island, 16—17. VI.

Ephemerella bicolor Clem. Pigeon river, May and June, nymphs.

Caenis forcipata McD. Victoria Beach (Wallis); Gimli; Riverton; Gull Bay. June to August.

C. simulans McD. Mouth of Pigeon river. 17. VIII.

Baetis .Several species occur on the lake and its tributaries.

Centroptilum quaesitum McD. ? Gull Bay, 7. VII.; Warren's Landing, 11. VII.

C. infrequens McD. Winnipeg Beach, 10. VII., holotype (A. T. Hunter). McDunnough, 1924, p. 98.

Callibaetis ferrugineus Walsh. Red river (Eaton, p. 194); Riverton, 21. VI.; Pigeon river, 6—7. VIII.; Husavick, 1. VIII. (Wallis).

Baetisca bajkovi sp. nov.

Nymph. Brownish, with small dark spots, more numerous on dorsal side. Tarsi dark at tips. A pair of rather prominent dark spots on ventral side between first and second pairs of coxae and sometimes also between second and third. Frontal projections prominent. Genae produced into broad, rounded, shelf-like projections. Mesonotum with antero-lateral corners acute, projecting forward. Lateral spines large, dorsal spines absent. Length of largest specimen (excluding setae) 7.75 mm. (fig. 2).

Apparently related to *B. lacustris* McD., but distinguishable by the well-developed frontal tubercles and genal projections. The habitat also appears to be different, as the present species is known only from rivers.

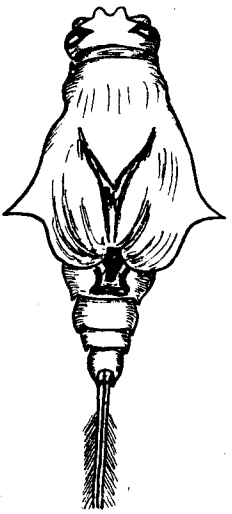

Fig. 2. Baetisca bajkovi, nymph.

Holotype (nymph): Sturgeon falls, Pigeon river, 12. VI. 32 (F. Neave).

Paratypes (nymphs): Headingley, Man. (Assiniboine river), 2. VI. 28 (F. Neave).

Heptageniinae.

Isonychia sp. Pigeon river (nymph skins).

Siphloplecton basalis Wlk. „Lake Winnipeg", type (Hagen, 1861, p. 50); Manigotagan river, 3. VI.; Red river at Lockport, 12. VI.; Pigeon river, 3. VI.

Siphlonurus alternatus Say. Pigeon river, 4. VIII., swarming in great numbers.

Heptagenia hebe McD. Husavick, 29. VII. (Wallis); Gimli, 23—24. VII.

H. pulla Clem. Common along exposed parts of the lake shore. Also Pigeon river. June to August.

Stenonema tripunctatum Bks. Common along stony shores of the lake. Also Red river at Lockport.

S. interpunctatum Walsh. A very common species along open shores. Also Pigeon river. June and July.

S. terminatum Walsh. Grindstone point, 30. VI.; Gimli, 23—25. VII.; George island, 9. VIII.

TRICHOPTERA.

The following list is doubtless quite incomplete, but may serve as a basis for future work. The large and important family of the Limnephilidae makes a poor showing. This is partly due to difficulties in identification but largely because most of my collections have been made in the main body of the lake and in the more rapid portions of tributary rivers, — habitats which are not extensively occupied by these forms. The Rhyacophilidae are unrepresented, but the absence of small, rapid streams is sufficient to account for their scarcity. On the other hand, the Leptoceridae, Hydropsychidae, etc., are well represented and are highly characteristic elements in the entomofauna of the localities studied.

Several of the species listed here are probably new, but with one exception I refrain from describing them at the present time.

Phryganeidae.

Phryganea cinerea Wlk. Lake Winnipeg, abundant.

Prophryganea straminea Hag. Limestone Bay, 13. VII.

P. bradorata Milne. Eagle island; Warrens Landing; Berens island. All in July.

P. colorata Hag. (?) Victoria Beach, 5. VII. (Bajkov).

Banksiola concatenata Wlk. Red river (Kennicott). Hagen, 1873, p. 385.

Ptilostomis ocellifera Wlk. Red river (Kennicott). Hagen, 1861, p. 252.

P. postica Wlk. Red river (Kennicott. Hagen 1861, p. 251); Riverton, 22. VI.

P. semifasciata Say. Gimli, 10. VII. (Bajkov).

Neuronia inornata Bks. Gimli, 16. VI.; Riverton, 18. VI.

Limnephilidae.

Limnephilus externus Hag. Red river (Kennicott). Hagen, 1861, p. 257.

L. hyalinus Hag. Red river (Kennicott). Hagen, 1861, p. 258.

L. ornatus Bks. Winnipeg, 19. VI. (Wallis).

L. roberti Bks. Lake Winnipeg (Kennicott), holotype. Banks, 1930, p. 227.

Anabolia bimaculata Wlk. Red river (Kennicott). As *A. sordida*, Hagen, 1861, p. 264.

Platycentropus maculipennis Kol. Red river (Kennicott). As *Hallesus hostis*, Hagen, 1861, p. 266.

Apolopsyche pallida Bks. Lake Winnipeg (Kennicott). holotype. Banks, 1924, p. 442.

Apatania canadensis Bks. Winnipeg, 1. IX. (Wallis), holotype. Banks, 1924, p. 442.

Philopotamidae.

Chimarrha aterrima Hag. Manigotagan river, June; Pigeon river, June and August.

Sericostomatidae.

Brachycentrus sp. Winnipeg, 31. V. (Wallis).

Helicopsyche borealis Hag. Husavick (Wallis); Gimli; Pigeon river; Winnipeg. June and July. The curious larvae are often common on stony or rocky, wave-washed shores.

Lepidostoma sp. Gimli, June and July.

Molannidae.

Molanna flavicornis Bks. Abundant in many places from north to south end of the lake in July and August. Also occurs in rivers. The types are from Husavick and Winnipeg (Wallis).

Leptoceridae.

Leptocerus resurgens Wlk. Husavick, June and Winnipeg, July, (Wallis); Gimli.

L. ancylus Vorhies. George island, 27. VII. (Bajkov); Drunken point; Narrows. More local than *Helicopsyche borealis* but the larvae live in similar (sometimes the same) habitats.

L. tarsi-punctatus Vorhies. Winnipeg, 29. VI. (Wallis); Gimli, 24. VII.

L. sp. A. Gimli, 24. VI.

L. sp. B. Gimli, June.

L. sp. C. Hecla island, 23. VI.

L. sp. D. Cox reef, 8. VIII.; Grindstone point, 30. VI.

L. sp. E. Winnipeg Beach, 16. VI.

Triaenodes sp. Gimli, 24. VII.; Limestone bay, 13. VII.

Leptocella albida Wlk. Winnipeg, 29. VI. (Wallis).

L. uwarowii Kol. Husavick, 23. VIII. (Wallis).

Oecetis (*Oecetina*) *incerta* Wlk. Husavick, 4. and 5. VII. (Wallis); Gimli, July and August; Grindstone point, 30. VI.

Oecetis vicaria sp. nov.[1])

Male. Head brown, clothed with yellow hair. Antennae yellow with narrow dark rings at the articulations. Palps and legs yellow. Thorax brown. Abdomen yellow with a more or less distinct longitudinla dorsal dark stripe. Wings hyaline, with yellow hair. Hind wings with pale golden posterior fringe. Veins mostly pale; venation as in *O. ochracea* Curt. Spurs 1,2,2. Genitalia as in fig. 3. Length of body 9 mm.; to tip of wings 15 mm.; Wing expanse 26 mm.

This is an *Oecetis* in the strict sense and differs from all the described American species (which are placed in the genus *Oecetina* by Banks) in the relatively short discal cell and in the first apical cell being pedicellate. In all respects it is very close to the European *ochracea*. The latter is recorded from North America (Georgia) by Hagen, but is not admitted by Banks in his catalogue. There are slight differences in the genitalia between the present species and *O. ochracea* as figured by Ulmer (1909).

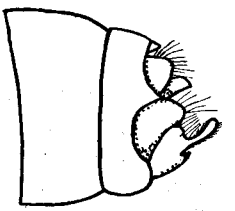

Fig. 3. Oecetis vicaria, male genitalia.

Holotype (male): Limestone bay, Lake Winnipeg, 13. VII. 30, F. Naeve.

Paratypes (males): Narrows, Lake Winnipeg, 28. VI. 32 (F. N.); Cox reef, Lake Winnipeg, 8. VIII. 28 (F. N.); Husavick, 2. VII. 10 (Wallis).

Mystacides sepulchralis Wlk. Warren's Landing and Eagle island, July.

M. sp. Limestone bay, 13. VII.

Hydropsychidae.

Hydropsyche alternans Wlk. Red river (Kennicott). As *H. morosa*, Hagen, 1861, p. 287.

H. chlorotica Hag. Red river (Kennicott). Hagen, 1861, p. 290.

H. recurvata Bks. The most abundant member of the family along exposed shores of the lake, throughout its length. Also Pigeon river. June to August.

H. scalaris Hag. Winnipeg, 9. VI. (Wallis); George island and Gimli, July. Red river (Kennicott) (?) Hagen, 1861, p. 287.

Hydropsychodes speciosa Bks. Grand Rapids, Saskatchewan river, 18. VIII. (Rabeneck).

[1]) As the final proofs of the present paper are being read, I have received a paper by L. J. Milne (Studies in North American Trichoptera I, printed privately, April 1934) in which this form is described as *O. ochracea* ssp. *carri* nov.

H. sp. Hecla island, 23. VI.; Pigeon river, 2. VI.

Polycentropidae.

Plectrocnemia canadensis Bks. (?) Riverton, 18. VI.; Gimli, 30.VI.
Holocentropus flavus Bks. Riverton. 21. VI.
H. sp. Riverton, 18. VI.
Phylocentropus maximus Vorhies. Mouth of Berens river, 28. VI.
P. placidus Bks. (?). Hecla, 31. VII.
Neureclipsis signata Bks. Frequent along the shore-line from Hecla to Warren's Landing and Limestone bay. The larvae of this or some other member of the genus is common in the rapids of Pigeon river.

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