THE ADULT RHYACOPHILIDAE AND LIMNEPHILIDAE (TRICHOPTERA) OF ALBERTA AND EASTERN BRITISH COLUMBIA AND THEIR POST-GLACIAL ORIGIN

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Of the Rhyacophilidae 22 species and of the Limnephilidae 91 species are recorded here from the area, making a total of 113 species. Each species is described, and keys are provided for identification of adult specimens to species.

Seven species of Limnephilidae are described as new: Imania hector; Apatania alberta; Homophylax baldur; Oligophlebodes zelti; Limnephilus susana; Limnephilus valhalla; *and* Philocasca thor.

The post-glacial origin of this fauna is examined, taking into consideration the possible effects of past and present climatic patterns, extent of glacial ice masses and locations of possible refugia, and locations and drainage patterns of major glacial and post-glacial lakes. Also examined are the 12 range patterns exhibited by the species, and the distributions of each species relative to the other species in its genus or species group. The 12 range patterns form two main groups: one group of six is restricted wholly to the western Cordillera of North America; and the remaining six are more widely distributed, being largely trans-continental in extent. Altitudinal distributions are also briefly examined.

The conclusions reached are that only 5% of the present fauna is derived postglacially from the Beringian refugium, while 95% is derived from North America south of the southern limit of glacial ice. Dividing the 95% portion further, 61% is derived from the western Cordillera of the United States, 8% from eastern North America, 7% from the central Great Plains, 18% from all of North America south of the ice, i.e. from trans-continental species, and 1% is of uncertain derivation. (Traduction française à la page 234).

CONTENTS

Purpose of the study

The primary objective of this study is to determine the composition of the fauna of two families of Trichoptera, the Rhyacophilidae and Limnephilidae, in Alberta and eastern British Columbia. Secondly, by an examination of species distributions and relationships it is hoped to elucidate the post-glacial origins of the fauna.

While these are the major objectives of the study, there are some subsidiary benefits to be derived from the results. The first is the additional knowledge of North American Trichoptera which accrues, as to distributions, correlation of the sexes in species in which the female was previously unknown, and the discovery of new species. A second advantage of such a compilation as this, on a regional fauna, is the facilitation of ecological and other

studies of the adult Trichoptera of the area. Identifications should be possible without recourse to a scattered and difficult literature.

The third benefit is facilitation of studies of the immature stages of the species of the two families in the study area. The immature stages of most species are unknown at present, and it is hoped that the identification facilities supplied in this study will permit the immatures to be correctly correlated and identified. Once this is done ecological studies on the immature stages can be carried out.

The taxa studied

Originally I had hoped to examine all families of Trichoptera in the study area, but the large number of species, estimated at close to 200, and limitations of time precluded this. Consequently two families were decided upon: the Rhyacophilidae and Limnephilidae. A minimum of 113 species of these two families is recorded here from the study area.

Apart from my intrinsic interest, these two families were selected for the following reasons. The Rhyacophilidae are a distinctly mountain group of Trichoptera and should thus prove useful in tracing faunal changes in the study area. The Limnephilidae occur in both mountains and plains, with distinctive large faunas in each area, and should prove useful in elucidating faunal changes in both areas.

The Rhyacophilidae are represented in the study area by 22 species of one genus, *Rhyacophila*. These species represent 11 species groups which, in the text, are presented in the sequence of Ross (1956). The Limnephilidae are represented in the study area by 91 species. These variously represent a total of five subfamilies, four tribes, and 26 genera. In this study Schmid's (1955) order of presentation is used. Table 1 presents the names and organisation of the higher taxa of the Limnephilidae of the area.

The study area

Geographically the investigation embraces the Province of Alberta and the Rocky Mountains of eastern British Columbia. The western limits in British Columbia comprise the line from Kimberly to Golden, thence to Revelstoke, to Avola, and finally to the Mount Robson area. By these limits the northern portion of the Selkirk Mountains is also included.

Some information is also included which was derived from a collection from the Simpson Islands of Great Slave Lake, Northwest Territories. The lake is just over 50 miles north of the northern boundary of Alberta and the area was, until recently, difficult of access. It is felt that any faunal information on Trichoptera from the lake would be applicable to northern Alberta and I took the opportunity in 1964 of arranging with Mr. D. J. Larson, Lethbridge, Alberta, to collect adult Trichoptera for me while in the area.

Figure 1 illustrates the positions of the localities from which insects recorded here were taken. Figures 1a and 1b are enlargements of certain portions of Fig. 1 in which too many localities are recorded for inclusion in that figure. In Fig. 1, 1a, and 1b, many localities are listed as such-and-such a lake or river. This refers to the point at which the nearest road touches on, or crosses these bodies of water.

The study is limited to the area outlined above for two main reasons. It is a convenient delimited area located immediately across the mountain and plains routes between Alaska and the remainder of North America, and can be expected to yield evidence of faunal changes or dispersals due to glaciations or climatic changes. Also, embracing as it does both mountain and plains regions (Fig. 2), and ranging from boreal forest in the north, through aspen parkland, to near desert grassland in the south (Fig. 3), the area could be expected to yield a large and most interesting fauna of Trichoptera.

Table 1. The family Limnephilidae in Alberta and eastern British Columbia.

Subfamily	Tribe	Genus
Dicosmoecinae	–	*Dicosmoecus*
		Onocosmoecus
		Imania
		Amphicosmoecus
		Ecclisomyia
Apataniinae	Apataniini	*Apatania*
Neophylacinae	–	*Oligophlebodes*
		Neothremma
Pseudostenophylacinae	–	*Homophylax*
Limnephilinae	Limnephilini	*Limnephilus*
		Grammotaulius
		Nemotaulius
		Anabolia
		Asynarchus
		Clistoronia
		Philarctus
		Arctopora
		Lenarchus
		Hesperophylax
	Stenophylacini	*Chyranda*
		Pycnopsyche
		Philocasca
	Chilostigmini	*Glyphopsyche*
		Chilostigmodes
		Psychoglypha
		Phanocelia

MATERIALS

Total number of specimens

I examined 7,604 specimens of both sexes: 2,915 specimens of Rhyacophilidae; and 4,689 specimens of Limnephilidae. The total number of specimens of each species examined, by numbers per sex, is given at the end of its description in the text.

Sources of material

Most of the above material was collected by me during the summers of 1965, 1966,

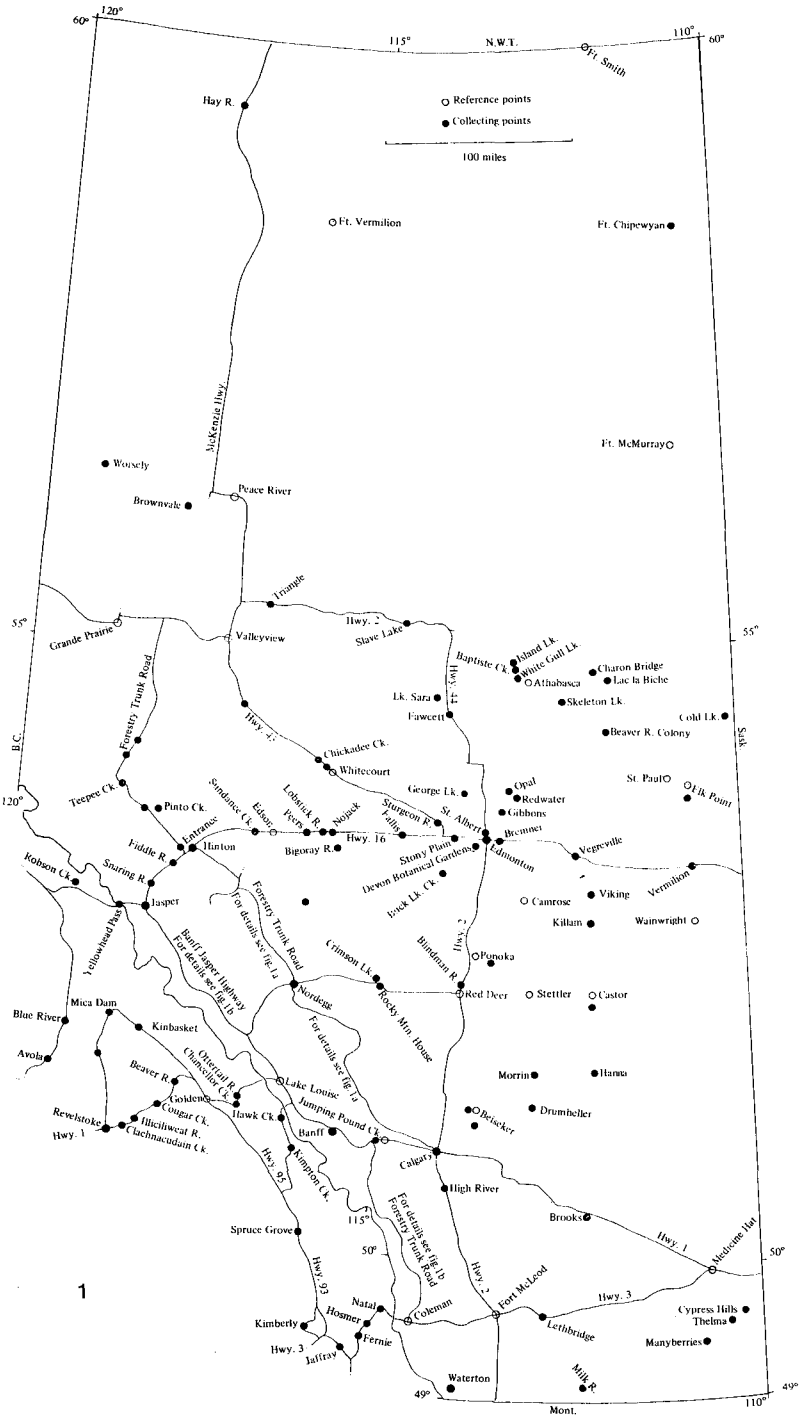


Fig. 1. Alberta showing major highways, secondary roads, and collecting points. See also Fig. 1a and 1b.

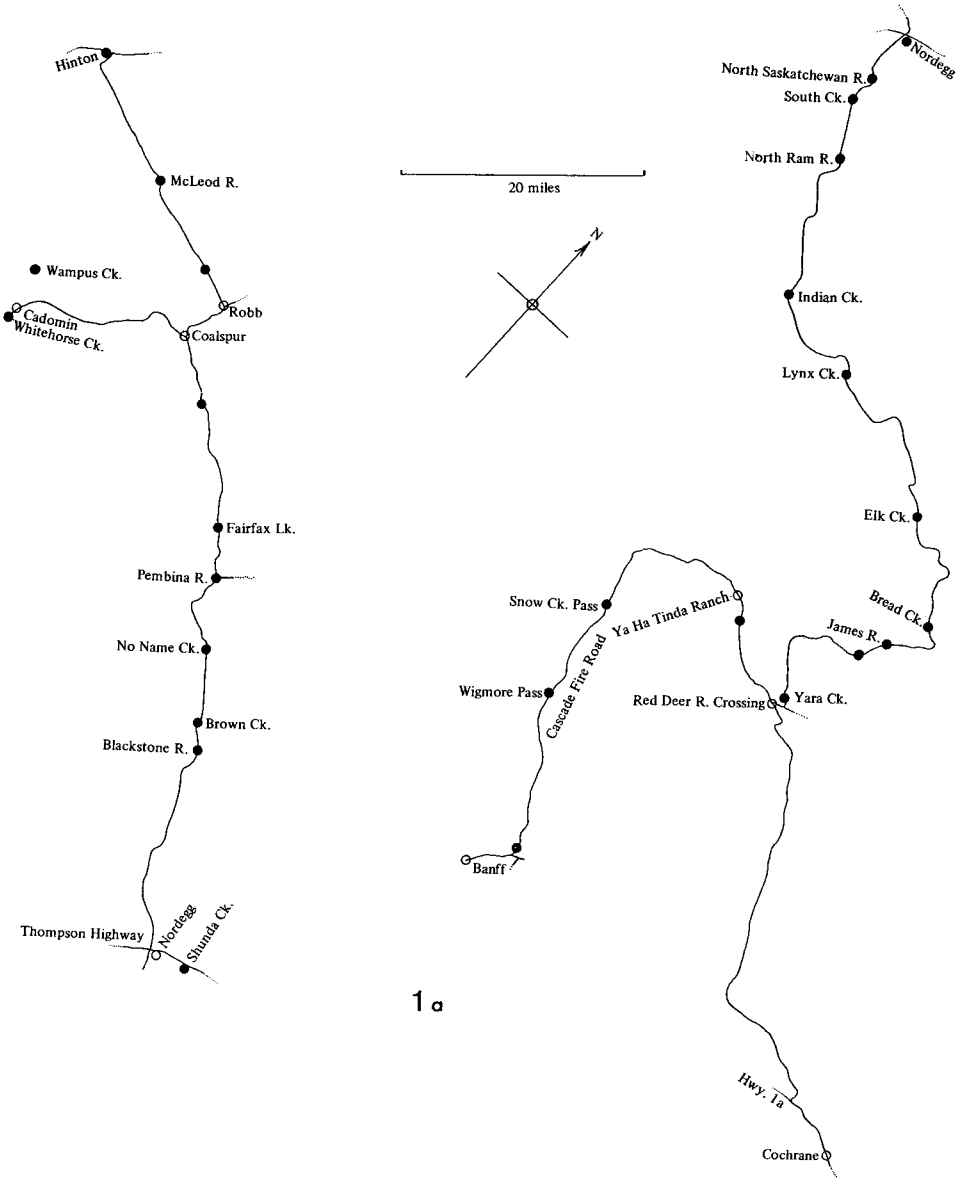
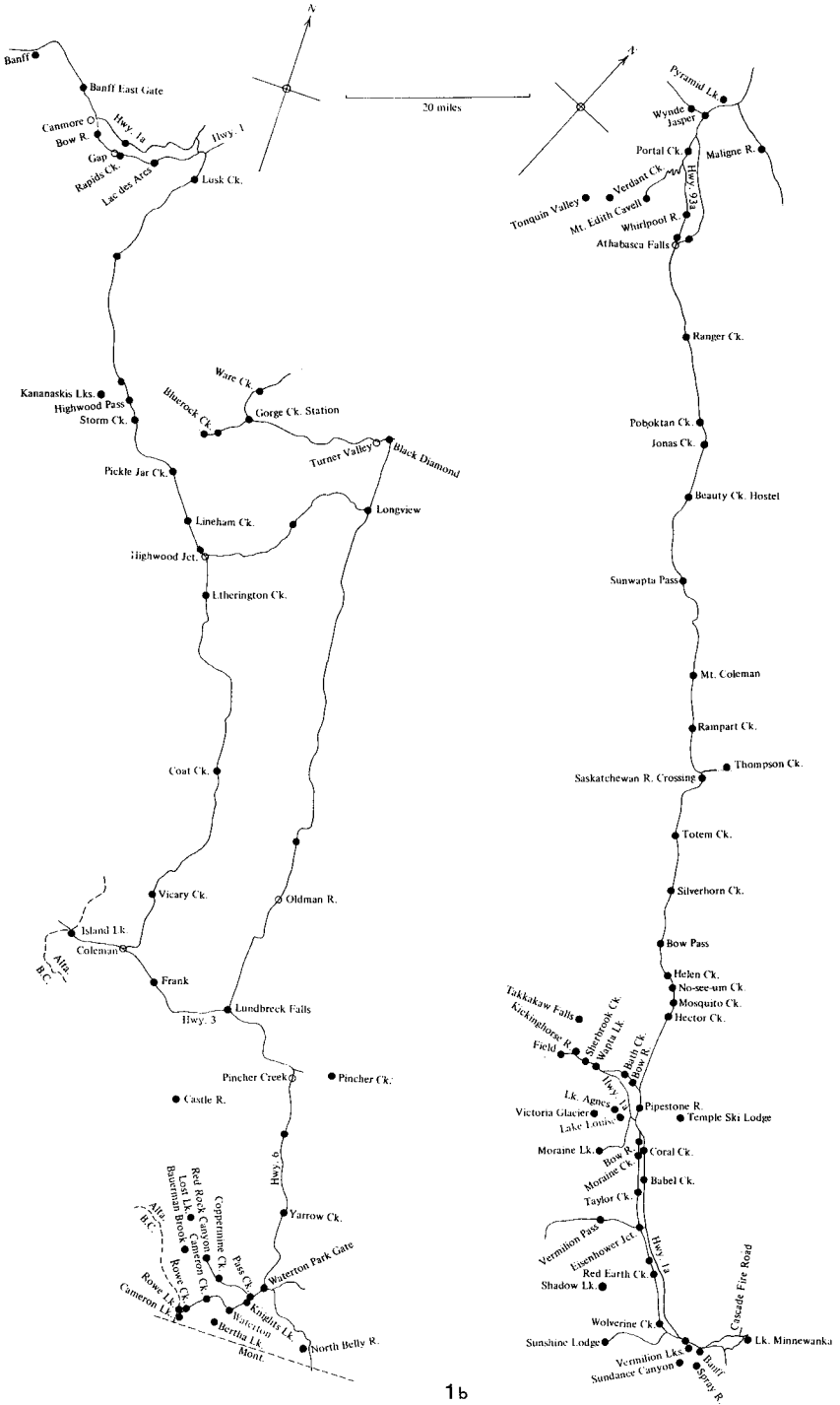


Fig. 1a. Outline map of the Forestry Trunk Road between Hinton and Nordegg (left), and Nordegg and Cochrane (right). ● – collecting points



1b

Fig. 1b. Forestry Trunk Road and connecting roads between Waterton and Banff (left); Banff-Jasper Highway between Banff and Jasper (right); ● – collecting points.

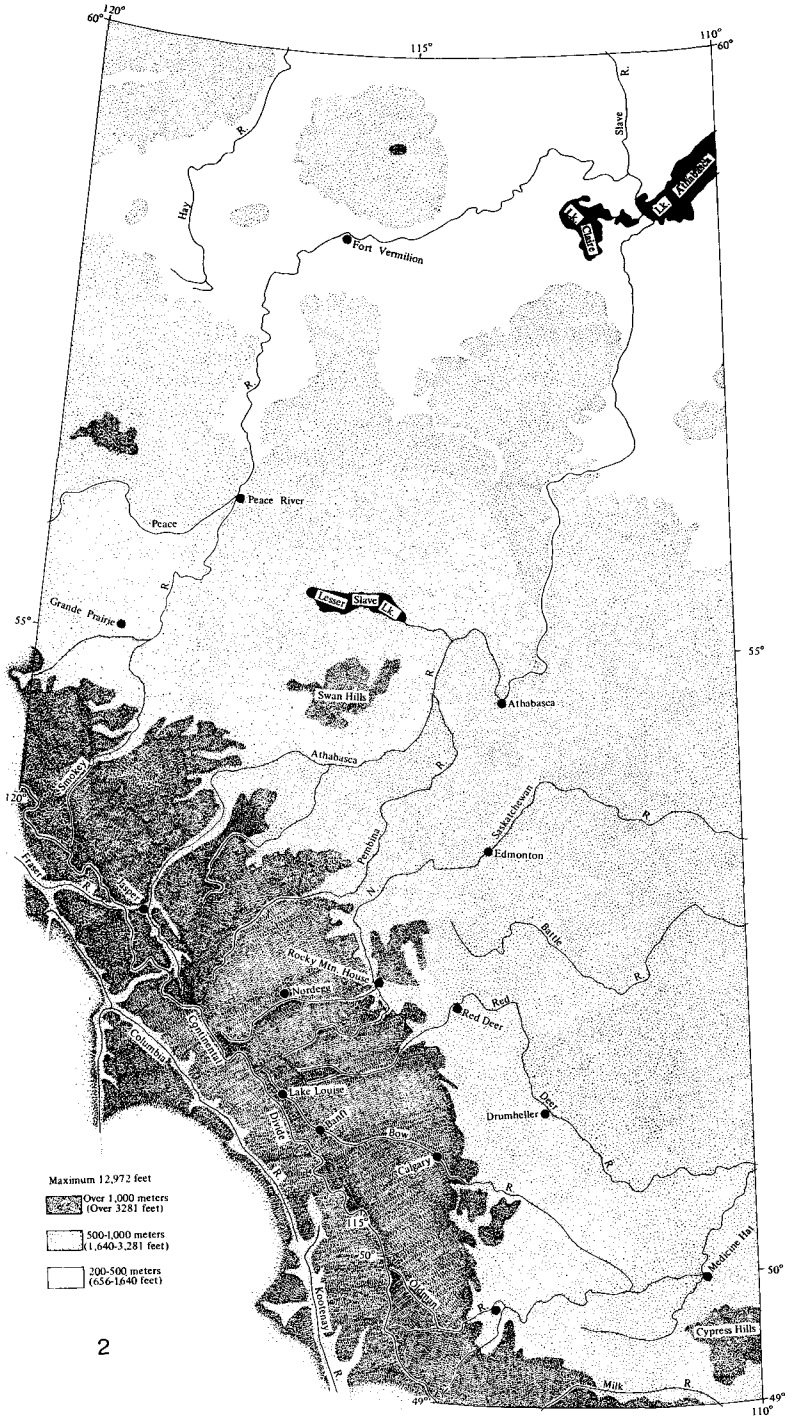


Fig. 2. Major physical features of Alberta and eastern British Columbia, showing rivers, lakes, and three levels of altitude.

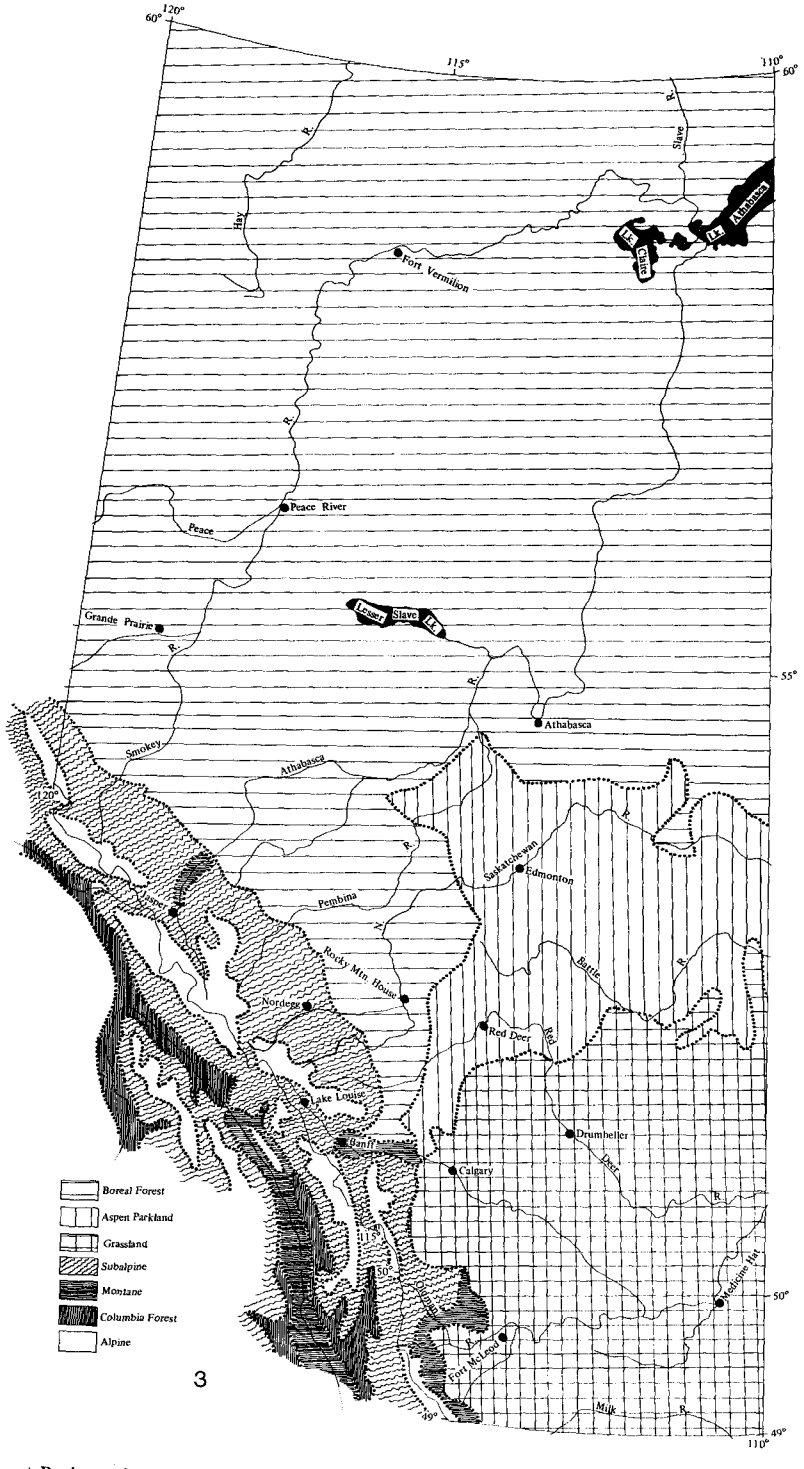


Fig. 3. Forest Regions of Alberta and eastern British Columbia (adapted from Rowe, 1959).

1967, and 1968. Some specimens were obtained from the collections of the Department of Entomology, University of Alberta. A very small proportion was obtained on loan from the following institutions: Canadian National Collection, Ottawa; Royal Ontario Museum, Toronto; Illinois Natural History Survey, Urbana, Illinois, United States; and the United States National Museum, Washington, D. C., United States. The source of the borrowed material is given with species descriptions wherever applicable. Some material was obtained from graduate students in the Department of Zoology, University of Alberta, who obtained it in the course of their own studies, and passed it on to me for identification. The material recorded from Great Slave Lake was the result of a collection made in the summer of 1964 by Mr. D. J. Larson, and passed on to me. A small collection was obtained on loan from the Banff National Park Museum, Banff, Alberta.

In the text, locality records have been condensed to map form. Lists of localities and dates are given for new species only. A complete list of all such data is deposited in the Department of Entomology, University of Alberta, Edmonton, and is available to interested workers.

Disposition of material

All borrowed material was returned to the lending institutions.

Type material. – All type material is deposited in the Canadian National Collection, Ottawa, unless stated otherwise in the descriptions of new species. Borrowed material here designated as type material was returned to the lending institution. Where sufficient paratype material exists in unborrowed material, at least one of each sex is deposited in the Strickland Museum, Department of Entomology, University of Alberta.

Other material. – Most of the remainder of the material, all of which was obtained in the field in the course of this study, is deposited in the Strickland Museum of the Department of Entomology, University of Alberta. All remaining material, with the agreement of the Department of Entomology, University of Alberta, forms part of my own reference collection, or was distributed to other institutions or workers who expressed an interest in obtaining such material.

Determination of species present in the study area

It was too much to hope that all species known from the study area would be represented in my field collections. Therefore recourse was had to the literature pertaining to North American Trichoptera, and to Fischer's 'Trichopterorum Catalogus' (1960, 1967, 1968) in a search for species recorded from Alberta, but not represented in my collections. The collections of the Canadian National Collection, Royal Ontario Museum, and the Illinois Natural History Survey were searched for specimens from the area, both to add to my records and to supplement the list of species. These methods proved most successful, and the names of several species were added to the list in consequence.

METHODS

Collecting methods

Several methods were employed in collecting the adult specimens used in this study. First was hand-netting, either of individuals in flight, or by sweeping vegetation adjacent to bodies of fresh water. Specimens were collected from a variety of vegetation, including trees overhanging the water, and sedges in the water. The next method involved searching the undersides of bridges, or the interior surfaces of culverts under roads. This method was very effective, but was of maximum use only after much practice.

The above methods were employed in daytime collecting. Collection of adult Trichoptera is also possible at nighttime, by the use of light sources of various types. As the insects generally land close to the light source, a white sheet is used below the light to render them more conspicuous and thus easier to pick up. The best times and conditions for light trapping are from twilight to about 1 or 1½ hours later, at air temperatures greater than 55 F, on cloudy evenings with no wind other than the most gentle air movements (see Nimmo, 1966b).

The first light source was a kerosene pressure lamp. This method is of use on warm, humid evenings only. Car headlights were also used. They were aimed toward the body of water from which the insects were expected to arrive in flight. An electric lamp rich in the ultra-violet wavelengths was especially productive, even on cooler evenings. It was most reliable when connected to a mains supply of current. This, however, was rarely possible and other sources were used, including a portable gasoline generator, and a portable 12-volt battery and DC-AC rectifier. The generator and battery sources, however, were unreliable.

Preservation of material

I collected all specimens directly into 80% ethanol, which both killed and preserved the specimens. While this preservative may fade some specimens it permitted me to manipulate whole specimens under the microscope. Storage is also facilitated. Dried, pinned specimens are difficult to handle, shrivel up on drying, and are much more liable to damage.

Sorting of collections

All material acquired at one time and locality was collected into a single vial and labelled with pertinent information. In the laboratory the contents of each vial were sorted to species and all specimens of each species, from each collecting episode, were placed collectively and permanently in a new vial of 80% ethanol and labelled. After this initial sorting the vials were sorted to groups, each of which contained specimens of one species.

Association of males and females. – On occasion it was difficult to correlate correctly the specimens of the two sexes of a species. On the initial sorting of field collections this was accomplished in one of three ways. Firstly, if both sexes were already described in the literatures no problem was encountered. Secondly, if pairs *in copula* were taken in the field, each pair was segregated immediately to a separate vial. Later examination in the laboratory provided the information required to correctly associate specimens of the two sexes of any one species in mixed field collections, and specimens of each sex collected individually and in separate vials. And finally, if the above two sources of information were not available, wing colour patterns, venation, and various other body characters were used for associative purposes. Frequently the general facies of the specimens was all that was required. Also, a knowledge of the general facies of the genera involved assisted in narrowing the field. Rarely were very closely related species taken together. This last method was, in retrospect, found to have worked remarkably well; improper associations were rare and were later corrected.

Identification of material. – In identifying the material collected, the available literature was consulted. The specimens of Rhyacophilidae were identifiable with the assistance of Ross' (1956) publication. For the Limnephilidae Schmid's (1955) publication was used to the generic level. Identification to species was then made with the aid of scattered minor literature referred to by Schmid for each species. In case of doubt, material was forwarded to F. Schmid, of the Entomology Research Institute, Ottawa, G. B. Wiggins, of the Royal Ontario Museum, Toronto, H. H. Ross, of the Illinois Natural History Survey, Urbana, Illinois, or to D. G. Denning, Moraga, California for identification. I also spent one week at the Illinois Natural History Survey examining the collections, both for records, and for purposes of identifying material.

Type material was not normally examined. Little such material was available at the institutions which I visited. Many of my identifications were made from specimens identified by workers who had previously had access to such type material. For a very few species type material was all that was available and this was either borrowed, or drawings made from the type were obtained on loan from the original authors.

Preparation of material. – To identify the Trichoptera recorded as occurring in the study area genitalic characters were used at the species level, and venational, genitalic, and other non-genitalic characters were used at the supraspecific level. Material for identification and drawing was prepared as set out below.

The wings. The wings of the right side of the thorax were illustrated. These were torn off cleanly at their bases with stiff, needle-pointed forceps. They were then passed through 95% ethanol for washing and stiffening, and spread on a clean glass slide. A second slide, with 2.0 mm wide strips of cellulose tape along each lower edge, was then placed on top of the first and the whole assemblage placed in a small hand-sized press. After clamping the slides into the press the long edges were united by an application of Lepage's white 'Bondfast' glue, which was found effective in binding the two slides together on drying. The cellulose tape prevented seepage of glue between the slides. The slides were then unclamped, labelled, and filed for future use. The wings were taken from the males, unless sexual dimorphism was evident on *in situ* examination, in which case the female wings were also treated as above, and illustrated. When only the female was known, the wings of this sex were illustrated.

The genitalia. The male and female genitalia were prepared for examination and illustration by removing the entire abdomen of a specimen and boiling it in a very strong solution of KOH, to dissolve the abdominal organs and tissues. The abdomen was then removed immediately to glacial acetic acid for clearing. After using this procedure for some time, I discovered that, while in the acid, a vigorous evolution of gas occurred within the abdominal contents; this gas was violently expelled on return to the boiling KOH, removing the abdominal contents in large part. Several such transfers between the two solutions resulted in swift removal of the abdominal contents. The genital capsule and abdomen together were then returned to the vial of 80% ethanol which contained the donor specimen.

Preparation of drawings

Wing drawings were made with a camera lucida mounted on a stereo binocular microscope. Slides were made of the wings of all species recorded here, but not all are illustrated as, in *Limnephilus* for example, the venation varied little between species.

Genitalic drawings were made using a square-grid eyepiece in a stereo binocular microscope. The image was imparted to a segment of bristol board lined in pencil with a similar squared grid. The size of the grid squares varied according to the size of the specimen, as it was desired to produce drawings of similar sizes for all species. The genital capsule being drawn was held steady, in a dish of 80% ethanol under the microscope, by a piece of wire of sufficient weight inserted anteriorly into the abdominal cavity.

In the drawings of the male the genital segments (IX and X) are frequently extracted from their normal position, retracted into segment VIII; this was done for greater clarity, but was not possible with the specimens of certain species. In the drawings of the male genital capsule of *Rhyacophila* spp. the lateral aspect shows the mesal face of the far (right hand) side clasper as this is the face which bears important characters.

Measurements and scales

Wing length is used to indicate relative sizes of species to each other. It is the distance,

in millimeters, from the fore wing tip to the base at the costal edge where the wing folds over at rest. Males were measured, unless only females were available. Scale bars are provided for the genitalic and wing drawings. The genitalic scale bars represent 0.5 mm or 0.25 mm, depending on the size of the specimen. The wing scale bars represent 4.0 mm. All measurements and scale bars were obtained by use of a micrometer eyepiece in a stereo binocular microscope. The scale bars for the genitalic drawings are immediately adjacent to the lateral aspect of the male genital capsule. All drawings, male and female, with the exception of wing drawings, which are located elsewhere, for any one species are to the same scale. When only the female is known no scale is given. Drawings derived from sources other than specimens available to me, have no scale, since the original sources had none.

Criteria employed

Inasmuch as this study is not a revision but a faunal survey, I restrict my remarks to taxa at the species level. For higher taxa I have adhered to the work of Ross (1956) and Schmid (1955). It is desirable to outline criteria at the species level as several new species are described.

Characters used in distinguishing species. – In the study of Trichoptera at the species level, with the exception of the species of a very few genera, the genitalic characters are of prime importance. Species are segregated and recognised on the basis of differences in genitalic characters. Other characters may be referred to in combination as distinguishing one species from another. Such are, the colour pattern of the fore wing, if sufficiently distinctive and constant, spur formula, coloration of the thorax, head or legs, and form and setation of designated areas or parts of the body. But the use of such characters individually is strictly subsidiary, as they are rarely sufficiently distinctive by themselves to provide a basis for erection of species. On the other hand, such characters may be utilised in the erection of higher taxa, when common to two or more species of still higher taxa. Wing pattern is, however, of paramount importance in distinguishing species of certain genera (e.g. *Leptocella*, of the Leptoceridae) where genitalic characters are highly variable and of dubious utility.

In the study of genitalic structures at the species level, form, structure, setation or spination are the important characters to be observed. Coloration, for example, is usually held to be of no importance, varying with age of the specimens. While it is accepted, indeed expected, that the characters in which interspecific differences may be detected vary intraspecifically, in most species recorded here this variation is limited and can, with practice, be recognised for what it is. In opposition to certain other groups of insects, Trichoptera species may be distinguished by critical examination of the general facies of the characters selected. No application of statistical techniques has yet been found necessary.

While supraspecific taxa are generally excluded from this discussion, it may be noted that, in initially segregating species of higher taxa to membership in these taxa, the characters employed are frequently venational, or are a variety of general body characters, and are frequently genitalic, involving considerations of characters less varied than at the specific level, and more revealing of the broader evolutionary history of the group.

Criteria at the species level. – Simpson (1961) defines the genetical species as follows: 'Species are groups of actually or potentially inter-breeding natural populations, which are reproductively isolated from other such groups'. This biological species definition is the ideal, which I accept, but it is normally impractical to use it as a working definition due to lack of information. Simpson discusses this at some length. He also states that, in practice, this definition employs morphological criteria, but without the adverse implications of the 'morphospecies'.

In dealing with Trichoptera species only morphological and distributional data are available at present, as outlined above. The data are, however, applied with the intentions of the above definition in mind; morphological differences are taken as evidence of reproductive isolation.

In this study I employ the following definition: A species is that group of individuals which is recognized as a unit by a multiplicity of characters, the nature of forms of which are peculiar to, and constant within, the available specimens, and which are distinguished from specimens of the presumed most closely related species by pronounced discontinuities in any or all of the characters. Interspecific variation, as mentioned above, is taken into account with regard to the constancy of characters within a species, and the discontinuities between species.

While, in most species of the Alberta Rhyacophilidae and Limnephilidae, the interspecific discontinuities are sufficiently evident as to require no comment, in some genera or species groups the recognised species are very similar. This may lead to some confusion in sorting if specimens of two similar species are collected simultaneously. With regard to such species, particularly if described as new, I reserved judgement as to their separate identity until I had sufficient information on which to base a decision. This information was acquired in the form of collecting data. Specimens of the species concerned had to be collected separately at different localities sufficiently often to instil confidence in regarding them as separate entities.

Miscellaneous notes

Notes on the descriptions. – General body descriptions are derived from the male. Sexual dimorphisms of the female are noted wherever applicable. Wing colours are of the male unless stated otherwise; the hind wings are hyaline in most species. The costal area referred to is that part of the wing between the costa and subcosta, extending from the humeral cross-vein to the point at which the costa and subcosta meet distally.

Notes on the text. – Most species recorded herein are strictly nearctic in distribution. The literature for each of these species is, to the best of my knowledge, complete to early 1970. However, for the holarctic species in the study area, only references to nearctic literature are recorded here, and the reader is referred in appropriate cases to Fischer's 'Trichopterorum Catalogus' (1967; 1968) for a complete listing of palaearctic literature. This system is adopted as the literature on these holarctic species is too extensive for complete inclusion here. Synonymies for each species are complete, however. Type localities are named for each specific epithet, and are given in the citation for each species.

The keys used here for supraspecific taxa are adapted in translation from Schmid (1955). They are adapted by restricting them to the taxa recorded from the study area. At the species level, keys have been constructed for the males, and females, of each genus, if known. The character synopses for the supraspecific taxa of the Limnephilidae are adapted in translation from Schmid (1955), and are greatly condensed.

Immediately following each species description is a short statement of the known, or suspected, habitats, and biology, including notes on emergence if available and flying season, of the species. This information was largely derived from personal notes.

Notes on distribution maps. – The range maps presented here give only an approximate outline of collecting localities in the study area due to limitations of scale (see above, p. 11, for information on exact listing of collecting localities for each species). The inset maps of North America give only the nearctic distributions of each species. In the cases of holarctic species the palaearctic ranges are described briefly in the text.

THE FAMILY RHYACOPHILIDAE STEPHENS

This family is represented in Alberta and eastern British Columbia by the genus *Rhyacophila* Pictet only, belonging to the subfamily Rhyacophilinae Ulmer. Immediately following are synopses of the familial characteristics of the Rhyacophilidae, as adapted from Mosely (1939) and Mosely and Kimmins (1953), excluding the Glossosomatidae, and the subfamilial characteristics of the Rhyacophilinae, as adapted from Mosely (1939) and Ross (1956). The synopsis of characteristics for the genus *Rhyacophila* is adapted from Mosely (1939) and Ross (1956). The grouping of species within the genus is adopted from Ross (1956).

Character synopsis of the Rhyacophilidae. – Ocelli three. Maxillary palpi each of five articles in both sexes; basal articles short, remainder long, cylindrical. Metascutellum with or without warts. In some genera the middle tibia is dilated considerably. Spurs 3, 4, 4 in both sexes. Wings elongate, roughly parabolic, obliquely truncated apically. Hind wings shorter, narrower than fore wings. Venation generally complete (Fig. 4). Fore wings with apical cells f1-f5 present. Hind wings with only f2 and f5 present in some genera. Discoidal cell open or closed on fore and hind wings, or lacking on hind wings. R1 of fore wings forked apically or not. Thyridial cell present, sub-radial present or absent.

Character synopsis of the Rhyacophilinae. – Middle tibia not dilated. Fore wings with apical cells f1-f5 present; hind wings with f1-f3, and f5, present. Discoidal cell of both fore and hind wings open. Male genitalia with anal sclerite generally present, rarely absent.

The genus *Rhyacophila* Pictet

Synopsis of characters. – Antennae slender, shorter than wings; pedicel very short. Second article of maxillary palpus short, globular. Tergum VIII of male rarely modified posterodorsally. Segment IX wide throughout, but varying in width. Claspers of two articles; of varied size; large, conspicuous. Segment X with anal sclerite in most species. Female genitalia long, tapered, slender, with pair of terminal cerci. Segments IX-XI membranous. Segment VIII with basal portion sclerotized, in some species complexly, with attendant lobes.

The genus Rhyacophila *in Alberta and eastern British Columbia.* – As presented in this study the genus is represented by 22 species, of which two are represented by unassociated females. The species are primarily confined to the mountain and foothill areas, but several range eastward to the plains, and two are transcontinental.

Following are separate keys to the males and females of the genus known to be present in the area.

Key to the Males of the Alberta and eastern British Columbia species of *Rhyacophila* Pictet

1a. Aedeagus simple, limnephiloid in general appearance, with paired lateral arms and simple median shaft (Fig. 25, 29, 33). Segment X rather like bird's head in lateral aspect; the crown with multiple rounded depressions (Fig. 24, 28, 32) 2

1b. Aedeagus not limnephiloid, ranging from very small and simple (Fig. 91) to large and complex, with as many as five lobes (Fig. 52) 4

2a.(1a) Distal article of clasper very deeply cleft, with ventral lobe lanceolate, dorsal lobe finger-like (Fig. 32). Lateral arms of aedeagus fringed distally with tuft of fine hairs (Fig. 33) . . . . . *R. glaciera* Denning, p. 21.

2b. Distal article of clasper not constructed 3

3a.(2b) Distal article of clasper with dorsal lobe directed strongly meso-anterad along mesal face of basal segment (Fig. 24). Anal sclerite flanked by simple, laterally

uncleft, ventral lobes of segment X ..... *R. alberta* Banks, p. 19.

3b. Distal article of clasper with dorsal edge thick, fleshy; horizontally almost cylindrical. Anal sclerite flanked by two lobes of segment X on each side (Fig. 28) ..... *R. tucula* Ross, p. 20.

4a.(1b) Postero-dorsal edge of tergum VIII with one or more lobes (Fig. 54, 86)..... 5

4b. Postero-dorsal edge of tergum VIII unmodified 6

5a.(4a) Tergum VIII with one small, rounded lobe (Fig. 54) .... *R. rickeri* Ross, p. 28.

5b. Tergum VIII with three distinct lobes; lateral lobes large, rounded distally and flanking curved, square tipped median lobe (Fig. 86, 87)..... *R. verrula* Milne, p. 34.

6a.(4b) Postero-dorsal edge of segment IX with distinct tuft of long, thick setae, directed posterad (Fig. 96)..... *R. vemna* Milne, p. 24.

6b. Postero-dorsal edge of segment IX quite clear of setae or hairs 7

7a.(6b) Postero-dorsal edge of segment IX developed posterad as distinct lobe projected well beyond segment (Fig. 39, 51, 89, 93)..... 8

7b. Postero-dorsal edge of segment IX not so developed 11

8a.(7a) Segment X with long, thin, curved and folded strap-like median lobe (Fig. 89, 93)..... 9

8b. Segment X without strap-like median lobe..... 10

9a.(8a) Lobe of segment IX bilobed distally, in dorsal aspect (Fig. 90) ..... *R. vagrita* Milne, p. 35.

9b. Lobe of segment IX trilobed distally, in dorsal aspect; lateral lobes shorter than median lobe (Fig. 94)..... *R. milnei* Ross, p. 36.

10a.(8b) Segment X without anal sclerite. Aedeagus small, with median shaft short and with two rounded lateral wings (Fig. 39); lateral arms ventral, membranous, terminated by brush of stout, dark spines (Fig. 40) ..... *R. acropedes* Banks, p. 23.

10b. Segment X with anal sclerite and large, dish-like tergal strap; segment X of two thin, vertical plates (Fig. 51). Aedeagus huge, with membranous base, long clavate lateral arms, hooded tip on median shaft and two lanceolate ventral lobes (Fig. 52) ..... *R. hyalinata* Banks, p. 27.

11a.(7b) Distal article of clasper bilobed (Fig. 35, 57, 65, 69, 75, 79) 12

11b. Distal article of clasper not bilobed 16

12a.(11a) Distal article of clasper cleft apically, appearing scissors-like (Fig. 69, 75)... 13

12b. Distal article of clasper not scissors-like 14

13a.(12a) Anal sclerite small, with two button-like disto-lateral lobes (Fig. 70) curved dorsad (Fig. 69)..... *R. vaccua* Milne, p. 31.

13b. Anal sclerite larger, with two simple, rectangular distal lobes (Fig. 76) directed ventrad from segment X (Fig. 75) ..... *R. chilsia* Denning, p. 32.

14a.(12b) Segment X massive, convoluted plate (Fig. 57, 58) longer than claspers. No evident anal sclerite ..... *R. vepulsa* Milne, p. 28.

14b. Segment X shorter than claspers. Anal sclerite evident..... 15

15a.(14b) Distal article of clasper with acuminate, triangular dorsal lobe (Fig. 35) ..... *R. vofixa* Milne, p. 22.

15b. Dorsal lobe of distal article minute, hooked ventrad (Fig. 65) ..... *R. pellisa* Ross, p. 30.

15c. Dorsal lobe of distal article large, rectangular (Fig. 79) ..... *R. vobara* Milne, p. 32.

16a.(11b) Segment X long, plate-like, cleft deeply, in dorsal aspect (Fig. 63, 83) 17

16b. Segment X short, of two lateral plates flanking anal sclerite (Fig. 42, 47) . . . 18

17a.(16a) Aedeagus large plate with lateral edges curled dorsad, ejaculatory duct prolonged by slender, tapered, dorsally curved median tube (Fig. 62). . . . . *R. belona* Ross, p. 29.

17b. Aedeagus complex, with two very long, membranous lateral arms terminated by spatulate, setose distal plate (Fig. 84) . . . . . *R. angelita* Banks, p. 33.

18a.(16b) Lateral plates of segment X simple (Fig. 42, 43) *R. bifila* Banks, p. 25.

18b. Lateral plates of segment X bilobed (Fig. 47, 48) . . . . . *R. coloradensis* Banks, p. 26.

Key to the Females of the Alberta and eastern British Columbia species of *Rhyacophila* Pictet

1a. Basal portion of segment VIII strongly sclerotized, clearly demarcated from membranous distal portion (Fig. 26) 2

1b. Basal portion of segment VIII weakly sclerotized, merged almost imperceptibly with distal membranous portion (Fig. 85) 15

2a.(1a) Sclerotized portion of segment VIII with distinct lobes or processes quite free from main body of segment, except at bases (Fig. 26, 38, 45, 53, 65, 73) 3

2b. Sclerotized portion of segment VIII without such processes (Fig. 30, 34, 41, 61, 68, 92, 100) 9

3a.(2a) Distal portion of segment VIII, and segments IX-XI shortened, partly retracted within sclerotized base of segment VIII (Fig. 45) 4

3b. Distal portion of segment VIII, and segments IX-XI long, tapered gradually distad 5

4a.(3a) Ventral lobes of segment VIII long, thin, arcuate, in ventral aspect (Fig. 46) . . . . . *R. bifila* Banks, p. 25.

4b. Ventral lobes of segment VIII short, rounded apically, on common pedicel (Fig. 50) *R. coloradensis* Banks, p. 26.

5a.(3b) Segment VIII with one medial ventral process, (Fig. 26, 27) 6

5b. Segment VIII with two ventro-lateral processes (Fig. 38, 53, 65) 7

6a.(5a) Ventral process acute-triangular, but with deep v-shaped distal cleft; process extended well posterad under membranous portion of segment (Fig. 73, 74) . . . . . *R. vaccua* Milne, p. 31.

6b. Ventral process short, triangular, with rounded apex (Fig. 27) . . . . . *R. alberta* Banks, p. 19.

7a.(5b) Membranous distal portion of segment VIII flanked on either side, just distad of sclerotized base by lightly sclerotized, oblong plate (Fig. 53) . . . . . *R. hyalinata* Banks, p. 27.

7b. Membranous distal portion of segment VIII without sclerotized plates 8

8a.(7b) Spermathecal sclerites long, slender, each with deep narrow hook at posterior end (Fig. 38) . . . . . *R. vofixa* Milne, p. 22.

8b. Spermathecal sclerite long, triangular in lateral aspect (Fig. 64) . . . . . *R. belona* Ross, p. 29.

9a.(2b) Posterior edge of sclerotized portion of segment VIII with dorsal portion offset anterad, with dorsal and ventral edges joined by long sloping edge (lateral aspect) (Fig. 61, 100) 10

9b. Posterior edge not offset as above 11

10a.(9a) Anterior sclerotized edge of segment VIII with retractor rod attached (Fig. 100) . . . . . *R.* species 1, p. 37.

10b. Anterior sclerotized edge of segment VIII without retractor rod attached (Fig. 61) ..... *R. vepulsa* Milne, p. 28.

11a.(9b) Membranous portion of segment VIII emergent from upper half of sclerotized portion; lower half pinched off in form of thin, plate-like keel posteriorly (Fig. 41) ..... *R. acropedes* Banks, p. 23.

11b. Membranous portion of segment VIII emergent from entire diameter of sclerotized portion 12

12a.(11b) Dorsal surface of segment VIII immediately distad of sclerotized portion, minutely spinate (Fig. 30) ..... *R. tucula* Ross, p. 20.

12b. Membranous portion of segment VIII not spinate 13

13a.(12b) Sclerotized portion of segment VIII with posterior edge indented ventrally, laterally, and dorsally, as two pairs of lateral extensions (Fig. 81) ..... *R. vobara* Milne, p. 32.

13b. Sclerotized portion of segment VIII with posterior edge circular, or only slightly sinuate 14

14a.(13b) No evident spermathecal sclerites (Fig. 34) ..... *R. glaciera* Denning, p. 21.

14b. Spermathecal sclerite long, narrow strap in ventral aspect, with slightly wider, darker, posterior end and distinctly widened, pierced, anterior end (Fig. 68) ..... *R. pellisa* Ross, p. 30.

14c. Spermathecal sclerite long, thin, irregular rod in lateral aspect; tip small, pick-like (Fig. 92) ..... *R. vagrita* Milne, p. 35.

15a.(1b) Abdomen in area of segments VIII-X with one or more distinct annular swellings (Fig. 88, 102) 16

15b. No such annular swellings present 17

16a.(15a) Tergum X clearly sclerotized ..... *R. verrula* Milne, p. 34.

16b. Tergum X not sclerotized. Spermathecal sclerite spindle shaped in lateral aspect, with anterior end attenuated (Fig. 102) ..... *R.* species 2, p. 37.

17a.(15b) Spermathecal sclerite spindle shaped in lateral aspect (Fig. 56, 85) 18

17b. Spermathecal sclerite relatively long, tapered posterad in ventral aspect; anterior end cleft, with distinct median fissure (Fig. 99) *R. vemna* Milne, p. 24.

18a.(17a) Spermathecal sclerite with both ends (in lateral aspect) attenuated (Fig. 85) ..... *R. angelita* Banks, p. 33.

18b. Spermathecal sclerite (in lateral aspect) sigmoid in outline (Fig. 56) ..... *R. rickeri* Ross, p. 28.

The *alberta* group

Males of this group are characterised by large anal sclerites, simple tenth terga and, especially, by simple, limnephiloid aedeagi, with simple lateral arms and median shaft. The group contains four species of which three are found in Alberta.

Rhyacophila alberta Banks, 1918
(Fig. 4a, 4b, 24-27, 104)

Rhyacophila alberta Banks, 1918:21. (Type locality: Banff, Alberta). Banks, 1918:3b. Dodds and Hisaw, 1925b:386. Ulmer, 1932:209. Betten, 1934:135. Milne, 1936:98, 106, 110. Ross, 1944:291. Ross, 1950a:261. Ross, 1956:76, 116. Schmid, 1958:13. Fischer, 1960:70. Ross, 1965:591. Schmid, 1970:55, 124.

Males of this species are distinguished from males of other species of the *alberta* group by

dorsal lobe of distal article of clasper directed meso-anterad (Fig. 24). The rounded triangular lobe on lower posterior edge of segment VIII is characteristic of females of this species (Fig. 27).

Description. – Antennae very pale yellow. Vertex of head mottled red-brown. Fore wing length of male 11 mm; pale yellowish brown, heavily irrorate, with dark areas concentrated on veins. Stigma pale, opaque. Venation of fore and hind wings as in Fig. 4a, 4b.

Male genitalia. (Specimen from Gap, near Exshaw, Alberta). Segment IX rectangular dorsally, tapered sharply antero-ventrad to lateral sutures then widened ventrally (Fig. 24). Claspers each with massive rectangular basal article concave mesally, especially at base. Distal article with long triangular ventral lobe, and dorsal lobe directed meso-anterad along mesal face of basal article. Segment X with dorsal portion rather like skull and beak of bird, with small rounded depressions at peak. Ventral part of segment cleft dorso-ventrally, flanking divided anal sclerite. Aedeagus with median shaft long, thin, bulbous at mid point (Fig. 25); lateral arms long, with large, rounded, ventral lobe distally with five long, curved spines.

Female genitalia. (Specimen from Gap, near Exshaw, Alberta). Basal quarter of segment VIII sclerotized, proximal edge slightly bulged and divided from distal area by thin annular line; distal edge produced ventrally as short, stout, triangular tooth (Fig. 26, 27). Cerci short, hyaline.

Notes on biology. – Adults of this species appears to emerge from streams ranging from small mountain brooks to large, turbulent mountain torrents. The flying season extends from August 12 to October 9.

Geographical distribution. – The known range of this species extends from Alaska to Colorado and Utah (Fig. 104) apparently being confined largely to the Rocky Mountain chain. In Alberta this species is found in the mountains and foothills at altitudes between 4,000' and 6,500'. Dodds and Hisaw (1925b) recorded it from Colorado, between 9,000' and 11,000'.

I have examined 174 specimens, 131 males and 43 females, from the study area.

Rhyacophila tucula Ross, 1950
(Fig. 5a, 5b, 28-31, 105)

Rhyacophila tucula Ross, 1950a:261. (Type locality: Gardner River, Yellowstone National Park, Wyoming). Ross, 1952:45. Ross, 1956:116. Ross, 1965:591. Anderson, 1967:508. Smith, 1968:658, 666-668, 673. Schmid, 1970:55, 124.

Males of this species are distinguished from males of other members of the *alberta* group by bifid lateral flaps of segment X enclosing anal sclerite, and by long, rectangular dorsal ridge or fold of distal article of clasper (Fig. 28). The spinate dorsal surface of membranous portion of segment VIII (Fig. 30) is distinctive of females.

Description. – Antennae pale yellow. Vertex of head red-brown, with distinct cruciform pattern posteriorly, formed from two intersecting sutures. Thorax straw yellow, to red-brown dorsally. Spurs dark brown. Fore wing length of male 9.5 mm; pale red-brown, irregularly irrorate with no distinct stigma. Venation of fore and hind wings as in Fig. 5a, 5b.

Male genitalia. (Specimen from Sundance Creek, west of Edson, Alberta). Segment IX laterally rectangular but with large triangular bight in lower half of posterior edge (Fig. 28). Claspers each with long, rectangular basal article channeled along entire length of mesal face. Segment X laterally similar to birds head, with two bifid ventral lobes flanking anal sclerite. Aedeagus with long, slender median shaft; distal portion of shaft very slender tube, basal portion long slender bulb; lateral arms long, slender, smoothly expanded distally, each with distal spine, and mesal edge with heavy, dark spines (Fig. 29).

Female genitalia. (Specimen from Alaska; in Illinois Natural History Survey). Segment VIII with basal half sclerotized, tapered (Fig. 30); proximal half of sclerotized portion light brown, remainder darker, clearly demarcated. Dorsal surface of membranous portion of segment VIII minutely spinate. Spermathecal sclerite long, almost hyaline (Fig. 31); distal end constricted as circular head (ventral aspect); lateral edges darker than remainder.

Notes on biology. – Smith (1968) records the larvae from ". . . small to medium streams with mixed rubble bottoms", in Idaho. My records indicate fairly fast, rock filled streams to be the habitat of larvae of this species. Smith also records the adult flying season as September-October. My records indicate a flying season of August 24 to October 12.

Geographical distribution. – The known range of this species extends from Alaska to Wyoming and Oregon (Fig. 105). It extends east to the Rockies but appears to be centered primarily in the Coast Ranges. In Alberta the species is known only from one locality in the low eastern foothills near Edson. The two localities shown in eastern British Columbia are also at low altitude (under 4,000').

I have examined six males from the area.

Rhyacophila glaciera Denning, 1965
(Fig. 6a, 6b, 32-34, 106)

Rhyacophila glaciera Denning, 1965a:263, 265. (Type locality: Glacier National Park, Montana). Schmid, 1970:55, 124.

Males of this species are distinguished from males of other species of the *alberta* group by long, deeply cleft distal article of clasper. Females are distinguished by relatively unmodified segment VIII: posterior rim of sclerotized portion only very shallowly indented laterally.

Description. – Antennae light yellowish brown. Vertex of head deep reddish brown, except warts paler. Thorax brownish yellow, to red-brown dorsally. Spurs brown. Male fore wing length 8.8 mm; clear mottled greyish brown; stigma evident but light. Venation of fore and hind wings as in Fig. 6a, 6b.

Male genitalia. (Specimen from Mt. Edith Cavell, Jasper, Alberta). Segment IX with or without small dorsal, hyaline fin (Fig. 32). Segment IX strongly pinched in at lateral sutures, as in *R. tucula*. Claspers each with short basal article channeled on mesal face; distal article large, with very deep u-shaped cleft dividing it to rounded, finger-like, dorsal lobe and knife-like ventral lobe. Segment X with dorsal body only sparsely indented, forming rough semicircle. Aedeagus (Fig. 33) with median shaft in two distinct parts; distal part long, very thin; proximal part much thicker, continued thus to base. Lateral arms clavate in dorsal aspect; terminated by thick brush of setae.

Female genitalia. (Specimen from Mt. Edith Cavell, Jasper, Alberta). Basal part of segment VIII sclerotized, truncated, cone with slightly sinuate postero-lateral edges (Fig. 34). No cerci evident.

A note on taxonomy. – In his original description Denning (1965a) states that this species is not related to any other species of the genus. This may appear to be so, but an examination of the male genitalia, and a close comparison with the genitalia of *R. alberta* and *tucula* places this species in the *alberta* group beyond doubt. The virtual identity of the aedeagi of specimens of these species is of special importance in this connection.

Notes on biology. – This species frequents mountain streams ranging from small, turbulent, rocky creeks, to very small alpine trickles. The adult flying season extends from August 19 to October 7. I have taken specimens of this species crawling about on one to two feet of snow in October at the Mt. Edith Cavell alpine meadows in Jasper National Park. The nearby stream was largely frozen, but with occasional open holes in the thin ice.

Geographical distribution. – The known range of this species is very small. The species was only recently described from Montana. It is known only from the Rocky Mountains and Alberta. Altitude range is from 5,000' to 7,000'.

Eight specimens, six males and two females, were examined from the study area.

The *vofixa* group

This group, represented here by only one species, is characterised by simple male genitalia in which the anal sclerite is divided into two large, ovate, lateral lobes. Aedeagus with large, finger-like, dorsal process; median shaft flanked by two finely divided lateral lobes like sheaves of spines. There are only two known species in this group, of which one occurs in Alberta.

Rhyacophila vofixa Milne, 1936
(Fig. 7a, 7b, 35-38, 107)

Rhyacophila vofixa Milne, 1936:95, 102, 111. (Type locality: Edmonton, Alberta). Ross, 1944:291. Ross, 1956:80, 101, 116. Schmid, 1958:17. Fischer, 1960:152. Smith, 1968: 672-673. Schmid, 1970:67, 126.

Males of this species are recognized by form of distal article of clasper, with acuminate triangular dorsal lobe and thick, fleshy, triangular ventral lobe (Fig. 35). Females are recognized by hooked spermathecal sclerites (Fig. 38).

Description. – Antennae yellow-brown. Vertex of head red-brown. Thorax light red-brown, slightly darker dorsally. Spurs brown. Fore wing length of male 11.1 mm, deep chocolate-brown with reddish tinge; scattered hyaline irrorations. Stigma dark, opaque, clothed with fine mat of hairs.

Male genitalia. (Specimen from Rapids Creek, Gap, Alberta). Segment IX wide dorsally, narrower in ventral third of total height. Extreme ventral area segregated by dark suture lines (Fig. 35). Claspers each with large, trapezoidal, mesally concave, basal article. Distal article bilobed; dorsal lobe acuminate triangular; ventral lobe triangular, larger than dorsal, rounded distally, heavy. Segment X with concave dorsal plate; lateral walls sharp edged. Anal sclerite of two rounded, mesally concave, lateral flaps located ventrad of distal tip of segment X (Fig. 36). Aedeagus relatively small, with ejaculatory duct terminated on peculiar pick-like, hyaline, median shaft; median shaft flanked basally by membranous lobes tipped by numerous long, thin spines. Base of aedeagus surmounted by large, fleshy, dorsal lobe terminated by dark, folded, sclerotized pocket (Fig. 37).

Female genitalia. (Specimen from Rapids Creek, Gap, Alberta). Basal portion of segment VIII sclerotized in form of truncated cone terminated in two pairs of lateral lobes (Fig. 38). Segment XI with pair of small, hyaline cerci. Spermathecal sclerites two, parallel to each other, lightly sclerotized, tapered finely anterad, with heavier, deeply hooked posterior ends.

Notes on biology. – Adults emerge from non-turbulent, smoothly flowing, but swift, mountain brooks, to smaller, but very turbulent mountain torrents. The flight season extends from July 15 to August 31.

Geographical distribution. – The known range of this species extends from Alaska to Idaho and Washington (Fig. 107), apparently ranging throughout the northern Cordillera. My collecting in Alberta indicates that the species is confined to the mountain and foothill areas, between 3,000' and 6,500'. The type locality is given as Edmonton by Milne (1936) which is at 2,000'.

I have examined 255 specimens, 184 males and 71 females, from the study area.

The *acropedes* group

Males of this group, represented here by two species, are characterised by simple aedeagus (Fig. 40) with lateral arms in form of membranous, extensible lobes with multi-spinate tips. One branch of this group has segment X with anteriorly directed basal processes (Fig. 96). In the second branch segment X is cleft dorsally down the middle. There are eight known species in this group, of which one is known from Alberta.

Rhyacophila acropedes Banks, 1914
(Fig. 8a, 8b, 39-41, 108)

Rhyacophila acropedes Banks, 1914:201. (Type locality: Deer Creek, Provo Canyon, Utah). Dodds and Hisaw, 1925b:386. Essig, 1926:176. Betten, 1934:135. Milne, 1936:93, 102, 110. Ross, 1938b:4. Ross, 1941a:36. Ross, 1944:291. Denning, 1948a:87. Leonard and Leonard, 1949b:3. Morse and Blickle, 1953:69. Ross, 1956:75, 83, 84, 117. Fischer, 1960:69. Flint, 1962:479-480. Denning, 1963:244. Ross, 1965:591. Anderson, 1967: 508, 517. Smith, 1968:658, 660, 667. Schmid, 1970:87, 131.

Males of this species are distinguished from males of other species of the *acropedes* group by lateral 'wings' on median shaft of aedeagus, and by acuminate lobe dorsad of segment X, attached to segment IX. Females are distinguished by postero-ventral keel of segment VIII.

Description. – Antennae yellow-brown. Vertex of head uniformly deep red-brown. Thorax deep yellow-brown, to deep red-brown dorsally. Spurs brown. Fore wing length of male 10.8 mm; colour grey-brown; costal area hyaline, stigma weak, indistinctly irrorate. Venation of fore and hind wings as in Fig. 8a, 8b.

Male genitalia. (Specimen from Cold Creek, Nojack, Alberta). Segment IX essentially rectangular, with irregular posterior edge (Fig. 39); postero-dorsal edge produced posterad as broad, triangular plate dorsad of segment X. Claspers each with basal article arcuate; basal area laterally flattened, distally tubular. Heavy distal article bilobed, with small pyramidal dorsal lobe, and massive ventral lobe roughly triangular in cross section. Segment X of two approximately rectangular, vertical plates side by side; base of each plate with broad lateral flange. Median shaft of aedeagus simple tapered tube (Fig. 40), flanked just distad of base by two rounded lateral 'wings'. Lateral arms large, membranous, tubes each terminated by sheaves of long, dark spines.

Female genitalia. (Specimen from Cold Creek, Nojack, Alberta). Basal portion of segment VIII heavily sclerotized; antero-lateral edges slightly depressed; ventro-posterior surface keeled, tapered gradually to sharp posterior edge; membranous remainder of segment emergent only above keel (Fig. 41). Spermathecal sclerites two, indistinct, simple. tapered.

Notes on biology. – This species emerges from a variety of stream types ranging from torrential, rocky, mountain streams, to swift, smoothly flowing, shallow streams on pebble beds, to very quiet, sluggish streams on earthen beds. Smith (1968) gives the adult flight period in Idaho as late July to early August; peak emergence is in late July. My records give the flight period in Alberta as July 1 to August 22. I have a record from Jaffray, in south eastern British Columbia, dated May 10; seven of each sex were taken. Smith states that the species overwinters in Idaho as third or fourth instar larvae; pupation occurs in late May and June. He also adds that the adults are active in the afternoon, ceasing flight at dusk, and do not come to light. My own observations confirm this, specimens usually being taken under bridges or culverts. Both Smith (1968) and Denning (1948a) report that both sexes emit an unpleasant odour when handled. I have not noticed this phenomenon.

Geographical distribution. – The known range of this species extends from British Colum-

bia in the west to Labrador in the east, and south as far as Colorado (Fig. 108). This is one of the two transcontinental species of *Rhyacophila* known to occur in the study area. From the map there is seen to be a gap in mid-continent; this may be genuine or an artifact of collecting. In Alberta the species seems to be largely confined to the mountain and foothill regions. However, two localities well away from the main Cordillera are recorded. One, near Whitecourt (Chickadee Creek), is on the south west edge of the Swan Hills, an isolated rise of land; the other is at Cold Creek, Nojack, which is quite outside any unusual elevation of land, and about 50 miles from the eastern extremity of the foothills. This stream is peculiar in affording a rather large selection of otherwise mountain caddis-flies while, at the same time, affording a selection of plains species. This species ranges between 2,500' and 7,000' altitude.

I have examined 698 specimens, 449 males and 249 females, from the study area.

Rhyacophila vemna Milne, 1936
(Fig. 21a, 21b, 96-99, 120)

Rhyacophila vemna Milne, 1936:92, 102, 111. (Type locality: White River, Mt. Rainier, Washington). Ross, 1944:291. Denning, 1948a:105-106. Ross, 1956:84. Smith, 1965: 243. Schmid, 1970:86, 131.

Males of this species are distinguished from males of other species in the *acropedes* group by long tuft of setae on posterior edge of tergum IX (Fig. 96), and by long, twisted, distal article of clasper. Females are distinguished by open-ended, mesally fissured spermathecal sclerite (Fig. 99).

Description. – Antennae red-brown. Vertex of head red-brown. Thorax light red to yellow-brown, darker dorsally. Spurs brown. Fore wing length of male 18.1 mm; chocolate-brown to reddish brown, heavily irrorate, with thick stigma. Hind wings with distal half stained clear brown. Venation of fore and hind wings as in Fig. 21a, 21b.

Male genitalia. (Specimen from Gap, near Exshaw, Alberta). Segment IX with anterior edges essentially straight, vertical; posterior edges with large, smooth, ventral indentation; dorsal portion curved antero-dorsad to narrow dorsal ridge (Fig. 96). Clasper with distinct mesal ledge basally on basal article; distal article twisted as if part of coil, with thick, rounded, distal lip. Dorsal part of segment X of two thin, short, vertical plates; distally with darkened, folded, deeply incised plate, denticulate on dorsal surface (Fig. 97). Median shaft of aedeagus slender, tapered; lateral arms membranous, very thick, terminated by heavy brushes of long, amber setae; these lobes surmount median shaft (Fig. 98).

Female genitalia. (Specimen from Gap, near Exshaw, Alberta). Basal half of segment VIII simple, tapered, lightly sclerotized tube. Spermathecal sclerite in ventral aspect (Fig. 99) spanner-like in appearance, with anterior end open; spindle shaped fissure located mesally. Cerci minute.

Notes on biology. – This species inhabits small, swift, gravel bedded, mountain streams. The flight period of the adults in Alberta extends from May 17 to July 7.

Geographical distribution. – The known range of this species extends from the Cascade Mountains of Washington to the Rockies of Alberta.

I have examined 21 specimens, 12 males and nine females, from the study area.

The *invaria* group

Members of this group are characterised by essentially simple male genitalia. Anal sclerite large, with deep root. Aedeagus with two lateral arms, complex median shaft, and specialised ventral lobes. Tergal strap attached to aedeagal base; expanded into sclerotized apical band.

There are two main branches of this group (Ross, 1956): one is located in eastern North America, the other in western North America. The western branch includes five species, of which two are dealt with here.

Rhyacophila bifila Banks, 1914
(Fig. 9a, 9b, 42-46, 109)

Rhyacophila bifila Banks, 1914:201. (Type locality: Vernon, British Columbia). Essig, 1926:176. Betten, 1934:135. Milne, 1936:91, 110. Ross, 1944:291. Ross, 1947:127. Denning, 1948a:98. Ross, 1952:43. Ross, 1956:88, 118. Fischer, 1960:76. Denning, 1963:244. Smith, 1965:242-243. Denning, 1965b:694. Smith, 1969:658, 660-661, 673. Schmid, 1970:60, 125.

Males of this species are distinguished from males of other species in the *invaria* group by long, thin, conical, very dark lateral arms of aedeagus; by heavy, blade-like ventral lobes. Segment X is divided to two simple, lateral, tergal flaps (Fig. 42, 43). Females are distinguished by ventral lobes of segment VIII long, thin, arcuate, in ventral aspect (Fig. 46) arising from separate bases.

Description. – Antennae brown; each article annulated dark brown distally. Vertex of head very dark chocolate-brown. Thorax brown, to dark chocolate-brown dorsally. Legs yellow, distal ends of articles dark brown. Spurs brown. Fore wing length of males 10 mm; dark chocolate-brown, irrorate; stigmatic area almost black. Venation of fore and hind wings as in Fig. 9a, 9b.

Male genitalia. (Specimen from Canmore, Alberta). Tergum IX projected well posterad; remainder of segment IX narrow, tapered slightly ventrad (Fig. 42). Clasper short, massive; basal article roughly trapezoidal, mesal face occupied by two, almost contiguous, short ridges. Distal article of clasper polygonal, distal edge slightly concave; mesal face ridged, partly with fine setae. Segment X divided, as pair of flared, dorso-lateral plates; ventro-laterad of each plate is single, large, rounded lobe which appears as dorsal extension of tergal strap. Anal sclerite divided mesally (Fig. 43), arched dorsad. Median shaft of aedeagus thick, with rounded dorsal lobe overhanging tip (Fig. 44); attached ventrad of median shaft are two massive, folded, sclerotized lobes terminated by short, stout, acuminate plates with tips directed dorsad. Lateral arms of aedeagus long, conical, attached at aedeagal base, with distal quarter very finely attenuated as a hair.

Female genitalia. (Specimen from Canmore, Alberta). Segment VIII short, sclerotized, with short, membranous distal portion enclosed by short, widely separated, blunt, dorsal lobes, and blunt, vertically thin, ventral lobes attached to polygonal sternum (Fig. 45, 46). Dorsal and ventral lobes connected by thin lateral band anterad of which segment VIII is weakly sclerotized. Segments IX-XI short, stout. Cerci represented by two minute papillae. Spermathecal sclerites absent.

Notes on biology. – This species emerges from a great variety of streams and rivers, ranging from fast and turbulent to slow, from boulder strewn to pebble bottomed. Denning (1965) records it from clear, cold mountain streams. Smith (1968) records the Idaho flight period of the adults as late June to early September, peaking in late June. My records give the Alberta flight period as May 22 to August 23. Smith (1968) states that the species is crepuscular and its members are attracted to light.

Geographical distribution. – The known range of this species extends from British Columbia and Alberta to California and Wyoming (Fig. 109). In Alberta this species is found in the lower river courses, between 3,000' and 5,000', of the mountains and foothills.

I have examined 161 specimens, of which 102 were males, and 59 females.

Rhyacophila coloradensis Banks, 1904
(Fig. 10a, 10b, 47-50, 110)

Rhyacophila coloradensis Banks, 1904a: Plate 1, Fig. 7. (Type locality: Las Vegas, New Mexico). Banks, 1905:10. Banks, 1907a:41. Ulmer, 1907a:210. Banks, 1911:354. Dodds and Hisaw, 1925b:386. Essig, 1926:176. Muttkowski, 1929:192. Betten, 1934:135. Milne, 1936:91, 111. Ross, 1938b:5. Ross, 1944:291. Denning, 1948a:101. Ross, 1952: 43. Ross, 1956:88, 118. Schmid, 1958:12. Fischer, 1960:78. Denning, 1965b:691. Smith, 1968:658, 661, 663, 673. Unzicker, 1868:4, 18, 44. Schmid, 1970:60, 125.

Rhyacophila stigmatica Banks, 1904a:108. (Type locality: Las Vegas, New Mexico). Ulmer, 1905a:72. Banks, 1905:10. Fischer, 1960:78.

Rhyacophila anomala Banks, 1924:444. (Type locality: Tolland, Colorado). Dodds and Hisaw, 1925b:386. Betten, 1934:135. Milne, 1936:111. Fischer, 1960:78.

Males of this species are distinguished from males of *R. bifila* Banks by bilobed, dorso-lateral sclerites of segment X (Fig. 47, 48). Females are distinguished by paired ventral lobes of segment VIII attached to common pedicel (Fig. 50) in *R. coloradensis.*

Description. – Antennae brown. Vertex of head virtually black. Thorax deep chocolate-brown, to virtually black dorsally. Spurs dark brown. Fore wing length of male 10 mm; dark chocolate-brown, irrorate, stigmatic area solid brown. Hind wings clear, dark brown distally, stigma slightly darker. Venation of fore and hind wings as in Fig. 10a, 10b.

Male genitalia. (Specimen from Chancellor Peak, Yoho, British Columbia). Segment IX virtually rectangular laterally, slightly wider dorsally than ventrally (Fig. 47), traversed by lateral sutures. Basal article of clasper short, stout, almost square; mesal face with short ventral ridge. Distal article of clasper massive, polygonal, with slightly concave mesal face with distal half with short setae. Dorso-lateral sclerites of segment X mesally concave, with dorsal hooks (Fig. 47, 48). Anal sclerite cleft mesally, arched dorsad, paralleling sclerites of segment X. Tergal strap terminated as two small lobes laterad of anal sclerite. Median shaft of aedeagus very similar to that of *R. bifila* Banks (Fig. 44, 49), but ventral lobes massive, rounded, folded, sclerotized, not acuminate distally; lateral arms rod-like, tipped with minute spines (Fig. 49).

Female genitalia. (Specimen from Chancellor Peak, Yoho, British Columbia). Sclerotized basal portion of segment VIII similar to that of *R. bifila* Banks laterally, except ventral lobes horizontal, not vertical; in ventral aspect both lobes arise from common pedicel (Fig. 50).

Notes on biology. – This species frequents both the fast, turbulent mountain creeks with boulder beds, and the slower, smoother flowing, pebble-bottomed creeks. Smith (1969) gives the Idaho flight period as March, April, May, and September, indicating two peaks of emergence, one in Spring, the other in Fall. My records indicate only one period of emergence in Alberta, albeit rather an extended one, from May to August, peaking in May (May 7 to August 30). I have one record, from Banff, Alberta, on April 17, 1915, by N. B. Sanson. Smith (1968) indicates that the adults are most active at dusk in Idaho, but start flying in the afternoon.

Geographical distribution. – The known range of this species extends from Alberta and British Columbia to California, New Mexico, and all intervening states except Nevada (Fig. 110). It appears to be truly widespread throughout the Cordillera. In Alberta the species is found in the foothills, but primarily in the mountains. In altitude it ranges from at least 3,000' to about 6,000'. Dodds and Hisaw (1925b) recorded it from Colorado at between 6,000' and 11,000'.

I have examined 268 specimens, 127 males and 141 females, from the study area.

The *hyalinata* group

Males of species in this group are characterised by wide apical band of tergal strap projecting beyond ventral corner of tergum X (Fig. 51); by truncate anal sclerite with definite root, and by simple tergum X (Ross, 1956). There are four species in this group of which one is known to occur in Alberta.

Rhyacophila hyalinata Banks, 1905
(Fig. 11a, 11b, 51-53, 111)

Rhyacophila hyalinata Banks, 1905:10. (Type locality: southwestern Colorado). Banks, 1907a:41. Ulmer, 1907a:201. Banks, 1911:354. Dodds and Hisaw, 1925b:386. Essig, 1926:177. Betten, 1934:135. Milne, 1936:96, 104, 111. Ross, 1938b:6. Ross, 1944:291. Denning, 1948a:101. Ross, 1956:88, 92, 118. Schmid, 1958:17. Fischer, 1960:96. Smith, 1968:658, 663-664, 673. Schmid, 1970:59, 124.

Males of this species are distinguished from those of other species by dorsally arched postero-dorsal extension of segment IX; by shape of distal article of claspers, which are parallel sided but bowed ventrad (Fig. 51), and by complex aedeagus (Fig. 52).

Description. – Antennae red-brown. Vertex of head deep chocolate. Thorax chocolate-brown, to darker chocolate dorsally. Spurs brown. Fore wing length of male 13.7 mm; dark purplish-brown, especially on veins; cells lighter, irrorate; stigma very thick. Venation of fore and hind wings as in Fig. 11a, 11b.

Male genitalia. (Specimen from Vicary Creek, north of Coleman, Alberta). Segment IX wide; anterior edges bowed anterad, posterior edges angular. Postero-dorsal edge developed as triangular, cup-like process overtopping segment X (Fig. 51). Basal article of clasper short, rectangular. Distal article bowed ventrad; swollen tip with fine hairs. Segment X of two large, warped, dorsal plates fused diagonally along mesal faces. Anal sclerite long, thin, angular laterally, apical band of tergal strap engaged distally. Tergal strap horizontal, lateral edges curled dorsad, apical band in form of recurved distal horn. Median shaft of aedeagus heavily sclerotized (Fig. 52) with distal tip overhung by dorsally concave lobe; acute triangular plate flanked basally by two lateral pads ventrad to ejaculatory duct. Lateral arms attached to membranous bases; each clavate, long, terminated by small, acuminate spine. Median shaft and lateral arms of aedeagus distad of massive membranous base overhung basally by acuminate, ventrally concave plate.

Female genitalia. (Specimen from Vicary Creek, north of Coleman). Basal portions of segment VIII sclerotized, flanked laterally by pair of lateral flaps, two acute triangular lobes ventrad (Fig. 53). Two lightly sclerotized, dorso-lateral plates posterad. No evident spermathecal sclerites, or cerci.

Notes on biology. – This species frequents the faster, more turbulent types of mountain stream with rocky beds; it is also, however, found in the faster, smoother flowing, pebble-bottomed streams. Smith (1968) records the adult flying season as late June to early August in Idaho. My records give a total span from July 5 to September 12 in Alberta, with the peak in later July.

Geographical distribution. – The known range of this species extends from Alberta and British Columbia to California and Colorado. The species is widespread in the Cordillera (Fig. 111). In Alberta it appears to be confined to the mountain areas. In altitude it ranges between 3,500' and 6,000'. Dodds and Hisaw (1925b) record it from Colorado at 9,000' to 11,000'.

I have examined 428 specimens, 270 males and 158 females, from the study area.

The *sibirica* group

Males of this group are characterised by ventral fusion of lateral arms, forming ventral membranous base terminated by ovate or elongate scoop with dorsal brush of hair (Fig. 54, 60) (Ross, 1956). Some species have lost this structure (Fig. 62). There are 26 species in this group, of which four are known to occur in Alberta.

Rhyacophila rickeri Ross, 1956
(Fig. 12a, 12b, 54-56, 112)

Rhyacophila rickeri Ross, 1956:95, 98, 120. (Type locality: Babine River, 50 miles north of Hazelton, British Columbia). Schmid, 1970:63, 126.

Males of this species are distinguished from males of other species of the *sibirica* group by postero-dorsal lobe of tergum VIII, and similar lobe of tergum IX (Fig. 54). Tergal strap wide, telescoped, with ventral aperture for aedeagus distinctive.

Description. – Antennae brown. Vertex of head dark brown anteriorly, lighter posteriorly. Thorax dark yellow-brown laterally, speckled dark brown on lighter ground. Spurs yellow-brown. Fore wing length of male 11.2 mm; light greyish brown, transparent. Venation of fore and hind wings as in Fig. 12a, 12b.

Male genitalia. (Specimen from Mt. Edith Cavell, Jasper, Alberta). Tergum IX with bulbous postero-dorsal process dorsad of segment X (Fig. 54). Segment IX rectangular laterally, with sinuate posterior edge. Basal article of clasper large, thick, directed postero-dorsad; distal article long, tapered, setose. Segment X with two distinct cerci whose bases pass mesad to two mesal protrusions (Fig. 55); thin flaps flank three-arched anal sclerite ventrolaterad of cerci. Tergal strap prominent, dark, sinuate, with ventral aperture for passage of aedeagus. Median shaft of aedeagus long, thin, with distinct basal piece (Fig. 54); attached to large flared base, which flanks it; ventral process membranous, highly extensible, with dorsally concave tip spinate internally.

Female genitalia. (Specimen from Mt. Edith Cavell, Jasper, Alberta). Proximal third of segment VIII sclerotized; wide, shallow, longitudinal groove dorsally. Spermathecal sclerite warped, dorsal surface concave, ventral convex, at posterior end, reversed at anterior end. Laterally sclerite sigmoid in appearance (Fig. 56).

Notes on biology. – This species inhabits small, very shallow, cold alpine streams, in high moraine country. These streams are little more than trickles but persist throughout the year. I have taken specimens at Mt. Edith Cavell, on 1 to 2 feet of fresh snow in early October.

Geographical distribution. – The known range of this species extends from Alaska to Alberta and British Columbia (Fig. 112). I have taken specimens at only two localities, both at about 7,000' altitude.

I have examined 23 specimens, 20 males and three females, from the study area.

Rhyacophila vepulsa Milne, 1936
(Fig. 14a, 14b, 57-61, 113)

Rhyacophila vepulsa Milne, 1936:96, 102, 111. (Type locality: Salmon River, Lincoln County, Oregon). Ross, 1944:291. Denning, 1948a:106. Ross, 1952:45. Ross, 1956:97, 98, 120. Fischer, 1960:151. Denning, 1963:245. Anderson, 1967:508, 517, 518. Smith, 1968:658, 670, 673. Thut, 1969:895, 896, 897, 898. Schmid, 1970:125.

Males of this species are distinguished from males of other species of the *sibirica* group by

massive segment X (Fig. 57, 58) and by asymmetrical distal cup of ventral process of aedeagus (Fig. 60). Females are distinguished by angularly offset dorsal and ventral surfaces of segment VIII (Fig. 61).

Description. – Antennae uniform chocolate-brown. Vertex of head dark chocolate. Thorax dark reddish-brown dorsally, grey-brown laterally. Spurs dark brown. Fore wing length of male 8.5 mm; uniform dull grey-brown; stigmatic area faint. Venation of fore and hind wings as in Fig. 14a, 14b.

Male genitalia. (Specimen from Rowe Creek, Waterton National Park, Alberta). Segment IX slightly narrower ventrally than dorsally (Fig. 57). Basal article of clasper with straight dorsal edge, sinuate ventral edge. Distal article polygonal, slightly indented distally, ventral lobe swollen. Segment X massive plaque (Fig. 57, 58) weakly bilobed distally; dorsal surface irregular in lateral aspect, with distinct anterior hump; ventral surface concave anteriorly and posteriorly, convex between. Median lobe of aedeagus long, thin, with thinner distal quarter directed postero-dorsad (Fig. 59); attached ventrad of dorsally arched basal plate with disto-ventral surface produced as dorsally directed, slender, rounded, distally spinate, process. Proximad of basal complex of aedeagus is short, rounded, minutely spinate process directed anterad above aedeagal base. Ventral process of aedeagus attached to membranous base on slender pedicel; massive, ladle-like, setose around lateral walls; lateral walls asymmetrical (Fig. 59, 60).

Female genitalia. (Specimen from Rowe Creek, Waterton National Park, Alberta). Basal half of segment VIII simple, sclerotized, tapered cone; distal edge angular laterally (Fig. 61).

Notes on biology. – I have records of adults of this species taken in the vicinity of large, turbulent rivers, and from small, pebbly slow streams. Smith (1968) records the larvae from ". . . riffles of headwaters streams with compact, pebbly bottoms", in Idaho. He also gives the Idaho adult flight season as late July. My records for the study area are few, but they indicate a flight season in early August (August 1-5). This is not a common species.

Geographical distribution. – The known range of this species extends from Alaska to California and Montana (Fig. 113). In Alberta my records are too few to state with certainty the range of the species, but it appears to be confined to the mountains. Altitudinally it occurs from 4,000' to 6,000'.

I have examined eight specimens, five males and three females, from three localities in the study area.

Rhyacophila belona Ross, 1948
(Fig. 15a, 15b, 62-64, 112)

Rhyacophila belona Ross, 1948:19-20. (Type locality: East of Logan Pass, Glacier National Park, Montana). Ross, 1956:97, 120. Schmid, 1970:65, 125.

Males of this species are distinguished from males of other species of the *sibirica* group by long, thin, dorsally curved median shaft of aedeagus, with basal two-thirds flanked laterally by thin up-curved wings (Fig. 62). Females are distinguished by lateral aspect of spermathecal sclerite, which is triangular (Fig. 64).

Description. – Antennae almost black. Vertex of head black. Thorax black-brown, to black dorsally. Spurs dark brown. Fore wing length of male 8.4 mm; very deep purplish brown, with patches of slightly lighter purple-brown. Hind wings transparent chocolate-brown. Venation of fore and hind wings as in Fig. 15a, 15b.

Male genitalia. (Specimen from Mt. Edith Cavell, Jasper, Alberta). Segment IX wide dorsally, sharply narrowed ventrad (Fig. 62). Basal article of clasper straight, tapered distad; distal article acute-triangular except for basal constriction, ventral edge thickened. Segment

X large, complexly folded, distally bilobed process (Fig. 62, 63) with roots well inside segment IX. Ventrad of base of segment X is rugose, domed plate. Aedeagus simple, slender, smoothly up-curved, tapered tube flanked along basal two-thirds by thin, dorsally curved, lateral wings (Fig. 62).

Female genitalia. (Specimen from Mt. Edith Cavell, Jasper, Alberta). Basal portion of segment VIII sclerotized, truncated-conical tube (Fig. 64); ventro-posterior edge with two small processes; dorsad of these are two larger, triangular flaps. Cerci simple, papillate.

Notes on biology. – This species inhabits high alpine brooks in moraine topography. The flight season of the adults extends from June 1 to July 21.

Geographical distribution. – This species is known only from Alberta and Montana (Fig. 112). It ranges from 6,000' to 7,000'.

I have examined 14 specimens, 10 males and four females, from the study area.

Rhyacophila pellisa Ross, 1938a
(Fig. 16a, 16b, 65-68, 114)

Rhyacophila pellisa Ross, 1938a:118. (Type locality: Cascade Lodge, Rocky Mountain National Park, Colorado). Ross, 1944:291. Denning, 1948a:102. Ross, 1956:95, 97, 120. Fischer, 1960:121. Denning, 1963:244. Anderson, 1967:508. Smith, 1968:666, 673. Schmid, 1970:64, 125.

Rhyacophila doddsi Ling, 1938:61. (Type locality: Yellowstone Park, Wyoming). Ross, 1944:291.

Males of this species are distinguished from males of other species of the *sibirica* group by very long claspers, very short segment X and simple aedeagus with long, thin, tapered median shaft and simple, setose ventral process (Fig. 66). In dorsal aspect segment X is simple, rounded, bilobed and deeply cleft (Fig. 64); another similar species which may eventually be found in Alberta has similar segment X but with only very shallow cleft. Females are distinguished by long, proximally pierced spermathecal sclerite (Fig. 68).

Description. – Antennae dark brown. Vertex of head almost black. Thorax dark chocolate-brown, to almost black dorsally. Spurs dark brown. Fore wing length of male 8.4 mm; uniform deep reddish brown; cells translucent, stigma prominent.

Male genitalia. (Specimen from Gap, near Exshaw, Alberta). Segment IX with robust, rectangular dorsal area separated from partially keeled, narrower ventral area by fine suture (Fig. 66). Basal article of clasper massive, tapered distad, variably channeled on mesal face; distal article somewhat trapezoidal, with thick ventral lobe, minute ventrally hooked, dorsal lobe. Segment X small, set dorsally on segment IX, deeply cleft mesally, with short, rounded lobes (Fig. 64); merged ventrally with flat, square-cut plate dorsad of anus. Tergal strap and apical band as smoothly curved distal hook. Median shaft of aedeagus long, thin, tapered, recurved tube (Fig. 67); ventral process long, with membranous base, short sclerotized pedicel, and slightly wider, setose, distal body.

Female genitalia. (Specimen from Gap, near Exshaw, Alberta). Basal half of segment VIII strongly sclerotized (Fig. 68), dorsal surface slightly shorter than ventral. Spermathecal sclerite in ventral aspect long, thin, clavate anteriorly; anterior end pierced; posterior end slightly expanded, darker, with two-arched hyaline line near tip.

Notes on biology. – This species frequents streams ranging from small, pebble-bottomed brooks, to larger, fast, rocky rivers. The Idaho flight season is given by Smith (1968) as late July to early August. The Alberta flight season is from July 19 to August 31. Smith states that daily flight is confined to late morning.

Geographical distribution. – The known range of this species extends from Alberta to

California and Colorado (Fig. 114). In Alberta it is largely confined to the mountain areas, but appears to extend eastward in the foothills. Its altitudinal range is 3,500' to 6,000'.

I have examined 142 specimens, 98 males and 44 females, from the study area.

The *betteni* group

This group is characterised, in males, by unusually long lateral arms of aedeagus; these are ventral in position, and fused in some species. Of the eight known species of this group, two are known to occur in the study area.

Rhyacophila vaccua Milne, 1936
(Fig. 13a, 13b, 69-74, 116)

Rhyacophila vaccua Milne, 1936:94-95, 102, 111. (Type locality: Cultus Lake, British Columbia). Ross, 1944:291. Denning, 1948a:102. Ross, 1952:45. Schmid and Guppy, 1952:41. Ross, 1956:99, 100, 121. Fischer, 1960:150. Denning, 1963:245. Smith, 1968 658, 668, 673. Thut, 1969:895, 896, 897, 898. Schmid, 1970:68, 126.

Rhyacophila complicata Ling, 1938:60. Ross, 1944:291.

Rhyacophila bruesi Milne and Milne, 1940:153-156. Ross, 1944:291.

Males of this species are distinguished from males of other species of the *betteni* group by abrupt ventral narrowing of segment IX (Fig. 69), by dorsally curved process of anal sclerite, and by narrow tenth segment (Fig. 70). As the female of *R. chilsia* Denning is unknown I cannot give comparative details within the group. However, females of this species are distinguished from all others by distinctive sternum of segment VIII (Fig. 73, 74), and by complex spermathecal sclerites (Fig. 73).

Description. – Antennae dark brown. Vertex of head uniformly very dark brown. Thorax dark grey-brown, mottled by almost white areas. Spurs dark brown. Fore wing length of male 10.4 mm; dark grey-brown interspersed with hyaline areas. Venation of fore and hind wings as in Fig. 13a, 13b.

Male genitalia. (Specimen from Red Earth Creek, Banff National Park, Alberta). Segment IX with distinct, narrow, sternum (Fig. 69); tergum large, widened dorsally, dorsal surface sloped antero-ventrad. Basal article of clasper rectangular laterally, with mesal shelf at base joined medially with identical member of opposing clasper. Distal article bifid; dorsal lobe acuminate, with basal median flange overlapped with basal lateral flange of thumb-like ventral lobe. Segment X small, recessed dorsally into segment IX, channeled longitudinally along dorsal surface (Fig. 70). Anal sclerite small, bilobed distally, curved dorsad. Tergal strap large, curved, with apical band horizontal, attached to segment X disto-ventrally. Median shaft of aedeagus long, thick, distal end cleft horizontally, with rounded dorsal lobe overhanging ejaculatory duct (Fig. 71); median shaft completely shielded dorsally by thin, arched, distally acuminate plate (Fig. 71, 72); lateral arms fused except for heavily spinate distal lobes.

Female genitalia. (Specimen from Gap, near Exshaw, Alberta). Basal portion of segment VIII heavily sclerotized, partly free distally from membranous portion, very deeply cleft dorsally and ventro-laterally (Fig. 73, 74); sternum distinct from tergum, posterior edge produced posterad as acuminate-triangular lobe, with v-cleft distally. Spermathecal sclerites two long, slender, ventral rods, slightly bulbous posteriorly, set close together; dorsad of these rods is located a large, dorsally arched structure tapered anterad; single unit with light and dark areas as in Fig. 73.

Notes on biology. – This appears to be rather a ubiquitous species, being taken in the vicinity of a great variety of streams. I have collected specimens in the vicinity of large and

small, fast and slow, rocky and pebbly streams. Smith (1968) records the larva from small to medium, clear streams with mixed rubble bottoms, in Idaho. He also gives the adult flight season in Idaho as September and October. The Alberta flight season is August 19 to October 4.

Geographical distribution. – The known range of this species extends from Alberta and British Columbia to California and Wyoming (Fig. 116). In Alberta it is confined largely to the mountains, with a few records from the foothills. Most records are from south of Banff. In altitude it ranges between at least 3,500' and 6,000'.

I have examined 72 specimens, 47 males and 25 females, from the study area.

Rhyacophila chilsia Denning, 1950
(Fig. 75-78, 115)

Rhyacophila chilsia Denning, 1950:115-116. (Type locality: Maligne Canyon, Jasper, Alberta). Ross, 1956:100, 121. Schmid, 1970:68, 126.

Males of this species are distinguished from those of *R. vaccua* Milne by minute dorsal lobe of distal article claspers, by segment X well separated dorsally from segment IX, and by ventrally directed, angular, anal sclerite (Fig. 75).

The only known specimen of this species is a male, from Maligne Canyon, Jasper, Alberta. Being thus unable to prepare my own drawings, Dr. D. G. Denning very kindly lent me his original drawings of the species, which I have partly redrawn and present here (Fig. 75-78). I also present Denning's original description of the male, altering only his figure numbers to mine.

Description. – 'Length [?] 9.5 mm. Fore and hindwing fuscous, veins and pterostigma somewhat darker. Body, head, palpi and antennae yellowish; legs and spurs luteous. Sixth and seventh abdominal sternites with a short acute mesal spine.

Genitalia as in Fig. 75-78. Ninth segment gradually widened dorsally, meso-apical margin of tergum in the form of a sub-acute projection. Tenth tergum narrow plate-like structure; meso-dorsal margin projected caudad as acute process, pair of small acute mesal projections close to ventral margin and best discernible from dorso-caudal aspect; mesal surface of tergum concave; ventral process cleft nearly entire length (Fig. 75), and capable of only slight dorso-ventral movement; dorsal aspect of tergum as in Fig. 77. Apical segment of clasper gradually narrowed distally, distal margin cleft to form acuminate digitate process, setation sparse. Structures in association with aedeagus as in Fig. 78; apex of lateral arms somewhat asymmetrical, but each divided into four acute projections' (Denning, 1950).

Notes on biology. – I do not know which part of Maligne Canyon is meant, but the Maligne River in the area is fast, fairly smooth water on rocky, but not boulder, bottom; in the canyon itself the river is considerably narrowed, deeper, with frequent pools and cascades. Date of capture of the male was July 23.

Geographical distribution. – The position of the one known locality is indicated in Fig. 115. It is at an altitude of 3,800'.

The *vobara* group

Males of this group are distinguished by apical band of the tergal strap attached directly to inner ends of anal sclerite (Fig. 79). One of the two known species occurs in Alberta.

Rhyacophila vobara Milne, 1936
(Fig. 17a, 17b, 79-81, 115)

Rhyacophila vobara Milne, 1936:94, 102, 111. (Type locality: Cultus Lake, British Columbia). Ross, 1944:291. Denning, 1948a:106. Ross, 1952:45. Ross, 1956:102, 116, 121. Schmid, 1958:17. Fischer, 1960:152. Smith, 1968:672, 673. Schmid, 1970:67, 126.

Males of this species are distinguished by thin, high segment IX with sinuate edges (Fig. 79), by massive proximo-mesal swelling of basal article of claspers, and by dorsal toothed plate at aedeagal base (Fig. 80).

Description. – Antennae dark brown. Vertex of head deep chocolate-brown, warts almost white. Thorax dark brown. Spurs brown. Fore wing length of male 8.5 mm; pale to dark chocolate-brown, with large irrorations, primarily at distal ends of peripheral cells. Stigma weak. Venation of fore and hind wings as in Fig. 17a, 17b.

Male genitalia. (Specimen from Ranger Creek, Jasper Park, Alberta). Segment IX high, narrow, pinched ventrad of mid-line (Fig. 79). Basal article of clasper sinuate, with massive bulge on mesal face. Distal article almost square; distal edge irregular, with thick ventral lobe. Segment X irregular longitudinally folded sclerite. Anal sclerite large, tapered basad, with dark distal edge; articulated with ventral corner of segment X, which flanks it laterally. Apical band of tergal strap curved, attached to segment X at ventral edge. Median shaft of aedeagus short, thin, between two sclerotized, acuminate lateral arms; longer, thin, tubular process dorsad of shaft (Fig. 80). Aedeagal base roofed over by heavy, dark, flat, plate with large dorsal thorn; base ventrad of this plate enclosed in lightly sclerotized tube.

Female genitalia. (Specimen from Ranger Creek, Jasper Park, Alberta). Basal portion of segment VIII sclerotized (Fig. 81) with two pairs of disto-lateral lobes; dorsal lobes rounded, ventral lobes somewhat triangular.

Notes on biology. – Specimens of this species have been taken in the vicinity of small, fast, turbulent mountain creeks, small, gravelly alpine trickles, and slow, deep streams emerging from alpine peat bogs. The flight period of Alberta adults is from July 3 to September 10.

Geographical distribution. – The known range of this species extends from the Yukon Territory to Idaho. In Alberta my records are all from the mountains, except for one locality in the northern foothills. In altitude this species ranges from at least 3,500' to over 6,000'.

I have examined 36 specimens, 20 males and 16 females, from the study area.

The *angelita* group

Males of this group are characterised by large dorsal lobe of segment X (Fig. 82), by deep root of anal sclerite, and by an extra pair of lateral lobes on aedeagus (Fig. 84). One of the three known species in this group occurs in Alberta.

Rhyacophila angelita Banks, 1911
(Fig. 18a, 18b, 82-85, 117)

Rhyacophila angelita Banks, 1911:352, 355. (Type locality: Pasadena, California). Essig, 1926:176. Betten, 1934:135. Milne, 1936:92, 103, 110. Ross, 1944:291. Denning, 1948a:97. Ross, 1952:43. Schmid and Guppy, 1952:41. Ross, 1956:102, 121. Schmid, 1958:12. Fischer, 1960:71. Denning, 1963:244. Smith, 1968:658, 660, 673. Schmid, 1970:62, 125.

Rhyacophila bipartita Banks, 1914:201-202. (Type locality: Banff, Alberta). Betten, 1934: 135. Milne, 1936:110. Fischer, 1960:71.

Rhyacophila species 1, Flint, 1962:478.

Males of this species are distinguished by large, elliptical bilobed dorsal lobe of segment X (Fig. 83), and by structure of aedeagus (Fig. 84).

Description. – Antennae yellow. Vertex of head brownish yellow. Thorax brownish yellow to straw. Spurs yellow-brown. Fore wing length of male 10.1 mm; hyaline, with very faint yellow-brown pattern; veins dark red-brown. Stigma weak. Venation of fore and hind wings as in Fig. 18a, 18b.

Male genitalia. (Specimen from Gap, near Exshaw, Alberta). Segment IX very wide dorsally; bowed, saddle-like; segment narrowed gradually ventrad; sternum curved anterad at lateral sutures (Fig. 82). Basal article of clasper long, parallel-sided, sinuate. Distal article mesally concave, with wide ventro-mesal ledge. Segment X small, enclosed plate, produced postero-dorsad as massive dorsal plate cleft deeply mesally (Fig. 83). Anal sclerite large, with deep root, flanking base of segment X. Tergal strap heavy, with laterally triangular apical band. Median shaft of aedeagus small, tapered, thin (Fig. 84); flanked laterally by pair of wide, dorsally hooked lobes. Two short, rectangular plates ventrad of median shaft. Lateral arms long, with membranous, extensible bases and spatulate tips with mesal concavities setose. Vertically bilobed prominence directed posterad on dorsum of aedeagal base.

Female genitalia. (Specimen from Gap, near Exshaw, Alberta). Basal portion of segment VIII tapered, sclerotized, truncated cone merged distally with membranous portion (Fig. 85). Dorsal surface of segment VIII base with deep channel; distally extended into dorsal swelling. Spermathecal sclerite simple, folded longitudinally, attenuated at each end.

Notes on biology. – This species appears to be cosmopolitan in its choice of habitat, specimens being taken near almost every type of water course available in the mountain area. The adult flight season extends in Alberta from July 7 to October 18. I have records for May 23 and June 20 also, but most of my records are within the range stated above.

Geographical distribution. – The known range of this species extends from the Yukon Territory to California and Colorado (Fig. 117). The species has also been recorded from the northern Appalachians of New Hampshire (Smith, 1968) which, in the present state of knowledge of this species, is a very isolated record probably representing a post-glacial remnant of a previously truly transcontinental species.

I have examined 530 specimens, 324 males and 206 females, from the study area.

The *verrula* group

This group contains only one known species of singular peculiarity. The detailed description following will serve to characterise the group.

Rhyacophila verrula Milne, 1936
(Fig. 19a, 19b, 86-88, 118)

Rhyacophila verrula Milne, 1936:90, 111. (Type locality: Cultus Lake, British Columbia). Knowlton and Harmston, 1938:286. Ross, 1944:291. Denning, 1948a:102. Denning, 1948b:22. Ross, 1952:45. Schmid and Guppy, 1952:41. Ross, 1956:108, 122. Schmid, 1958:12. Fischer, 1960:151. Denning, 1963:245. Smith, 1968:658, 671-672, 673. Thut, 1969:894, 895, 896, 897. Schmid, 1970:65, 126.

Rhyacophila oregonensis Ling, 1938:62. (Type locality: Corvallis, Oregon). Ross, 1944:291.

Males of this species are distinguished by trilobed postero-dorsal edge of tergum VIII (Fig. 86), by fused postero-dorsal lobes of segment IX, hooked ventrad (Fig. 86, 87), and by curious dorsal process of aedeagal base. Females are distinguished by sclerotized tergum X

and by two annular swellings of segment IX (Fig. 88).

Description. – Antennae dark brown, scapes yellow. Vertex of head dark brown antero-mesally; remainder, and warts, yellow. Thorax mottled yellow and dark brown. Spur formula of males 2, 4, 5; pro-thoracic spurs short, meso-apical spur of hind legs stout, long, distally bifid, in form of pincers; remainder normal. Spur formula of females 3, 4, 4; fore leg spurs short, remainder normal. Fore wing length of male 12 mm; light yellow-brown; pattern somewhat banded, colour alternated with hyaline areas; stigma opaque white. Venation of fore and hind wings as in Fig. 19a, 19b.

Male genitalia. (Specimen from Gap, near Exshaw, Alberta). Postero-dorsal edge of tergum VIII with projected median lobe dorsad of dorsal strap (Fig. 86, 87); flanked by two flap-like lateral lobes. Segment IX with narrow, short, dorsal strap ventrad of which postero-dorsal edges produced as two large, arched lobes fused distally but parted just at tips; each lobe with blunt, ventral, process basally fused to equivalent member opposite. Postero-lateral edges of segment IX rolled meso-anterad (Fig. 87). Basal article of clasper massive, rectangular; distal article small, rounded, concave on mesal face. Segment X small, arched, dorsal roof with two small distal lobes attached distally to ventral processes of lobes of segment IX. Anal sclerite as second, internal arch. Median shaft of aedeagus bulbous basally, thin, tapered distally, in deep, thin walled, sclerotized trough (Fig. 86), connected with stout, membranous, base; dorsal surface of base with long, slender, finger-like dorsal process, sinuate, fitted distally with anal sclerite.

Female genitalia. (Specimen from Gap, near Exshaw, Alberta). Segment VIII long, tapered, dilated annularly at distal extremity, lightly sclerotized for most of length (Fig. 88). Segments IX and X with annular swelling at point of junction. Segment X with posterior two-thirds of tergum sclerotized. Cerci small, membranous. No evident spermathecal sclerite.

Notes on biology. – Smith (1968) reports that the larvae of this species are totally phytophagous, which sets the species apart from other species of the genus. He reports larvae from small, cold, pebbled riffles of clear streams. I have usually taken specimens near larger, swift, deep, boulder strewn mountain creeks, and occasionally from smaller, shallower, pebbly creeks. Smith (1968) reports the Idaho adult flight period to be September to October, peaking in September. My records indicate the Alberta flight season to range from August 20 to October 12.

Geographical distribution. – The known range of this species extends from Alaska to California and Colorado (Fig. 118). In Alberta the species is found in the mountains and high foothills, between 3,500' and 4,000'.

I have examined 64 specimens, 47 males and 17 females, from the study area.

The *vagrita* group

Males of this group are characterised by prominent postero-dorsal, strap-like, lobes of both segments IX and X (Fig. 89, 93), by small, very simple aedeagi (Fig. 91), and by interlocking of segment X, anal sclerite, and apical band of tergal strap; anal sclerite encloses small, spherical, tip of segment X, and is itself flanked laterally by apical band (Fig. 86, 93). Both species of this group are known from Alberta.

Rhyacophila vagrita Milne, 1936
(Fig. 20a, 20b, 89-92, 119)

Rhyacophila vagrita Milne, 1936:91-92, 105, 111. (Type locality: Cultus Lake, British Columbia). Ross, 1944:291. Denning, 1948a:105. Ross, 1950a:264. Ross, 1952:45. Ross,

1956:108, 122. Schmid, 1958:12. Fischer, 1960:150. Smith, 1968:658, 668, 670, 673. Thut, 1969:895, 896, 897, 898. Schmid, 1970:45, 122.

Males of this species are distinguished from males of other species of the *vagrita* group by distal article of claspers with acuminate dorsal lobe and thick, rounded, fleshy ventral lobe, and by bilobed postero-dorsal process of segment IX (Fig. 89, 90). Only the female of this species is known so no comparison can be made.

Description. – Antennae dark brown. Vertex of head dark brown anteriorly, laterally; postero-mesally light. Thorax dark grey-brown, to richer reddish brown dorsally. Fore wing length of male 9 mm; light grey-brown with scattered, rectangular, hyaline windows; stigma distinct, brown. Venation of fore and hind wings as in Fig. 20a, 20b.

Male genitalia. (Specimen from Snaring River, Jasper National Park, Alberta). Segment IX wide, with narrower dorsal strap peaked along anterior edge (Fig. 89); posterior edge of dorsal strap developed as long, sinuate, distally bilobed, thin, strap-like process (Fig. 89, 90). Basal article of clasper with very narrow base, approximately triangular, with mesal ledge basally. Distal article of clasper lanceolate, curved, acuminate dorsally, rounded and fleshy ventrally. Segment X with long, sinuate, dark brown dorsal process immediately ventrad of similar process of segment IX (Fig. 89, 90); ventrad of base of lobe are two small, peg-like cerci between which is located sclerotized, strap-like body of segment X, terminated between lateral horns of anal sclerite. Tergal strap sinuate, with apical band terminated at antero-ventral corner of anal sclerite. Aedeagus minute; ejaculatory duct directed dorsad from dorsal plate; dorsal process short, pick-like laterally; joined to sclerotized base (Fig. 91).

Female genitalia. (Specimen from Snaring River, Jasper National Park, Alberta). Segment VIII with short sclerotized tube at base (Fig. 92), with sigmoid posterior edges. Spermathecal sclerite long, thin, irregular, with minute, pick-like posterior tip; located centrally in membranous internal tube. No evident cerci.

Notes on biology. – Little is known of this species. The one locality at which I have taken it was adjacent to a wide, swift, smooth-flowing river with pebble and small boulder bottom.

Geographical distribution. – The known range of this species extends from Alberta and British Columbia to Utah (Fig. 119). In Alberta the two known localities are at the bottoms of major valleys at about 3,500'.

I have examined one specimen of each sex from the study area.

Rhyacophila milnei Ross, 1950
(Fig. 93-95, 119)

Rhyacophila milnei Ross, 1950a:264. (Type locality: Banff, Alberta). Ross, 1956:108, 122. Schmid, 1970:45, 122.

Males of this species are distinguished from those of *R. vagrita* Milne by trilobed postero-dorsal process of segment IX (Fig. 93, 94), by saddled dorsal area of segment IX, and by parallelogram shaped distal articles of claspers.

Description. – Antennae brown. Vertex of head very deep brown, almost black. Thorax deep reddish brown, to very dark brown dorsally. Spurs yellow-brown; spurs of middle and hind legs long and heavy. Fore wing length of male 8 mm; translucent red-brown. Venation of fore and hind wings identical to that of *R. vagrita* Milne.

Male genitalia. (Specimen from Banff, Alberta; paratype, in Illinois Natural History Survey). Segment roughly rectangular laterally (Fig. 93); dorsal surface longitudinally channeled, with posterior edge of two lateral arches over minute, stubby, cerci; postero-dorsal edge produced posterad as long, curved, trilobed strap; lateral lobes shorter than medial. Basal article of clasper slightly narrowed basad, with thick, rounded dorsal edge, and thin,

ledged, ventro-mesal edge. Distal article of clasper fused to basal article; parallelogram-like, with distinct acuminate dorsal lobe, and thick, rounded ventral lobe. Segment X with long, thin, sinuate, dorsal process immediately ventrad of that of segment IX (Fig. 93, 94); ventral surface concave. Ventral body of segment rounded, tubular, semi-circular laterally. Anal sclerite large, enclosing tip of segment X, open dorsally. Aedeagus minute; ejaculatory duct minute, directed postero-dorsad from membranous base below evenly rounded dorsal process; dorsal groove extended from base of aedeagus to top of dorsal process (Fig. 95).

Female unknown.

Geographical distribution. – The known range of this species is presently restricted to the type locality, which is simply 'Banff, Alberta' (Fig. 119).

Only one male of this species, a paratype, has been examined. The date of capture was September 5.

Unassociated females

Rhyacophila species 1
(Fig. 23a, 23b, 100-101, 121)

Description. – Antennae dark brown. Vertex of head deep reddish brown. Thorax light red-brown, to dark chocolate dorsally. Spurs brown. Fore wing length of female 8.0 mm; pale, clear brown, veins dark, stigma brown; hind wings much the same colour as fore, except anal area hyaline. Venation of fore and hind wings as in Fig. 23a, 23b.

Female genitalia. (Specimen from Lusk Creek, Kananaskis, Alberta). Basal half of segment VIII sclerotized; posterior edges angular, dorsal edge offset anterad (Fig. 100). Spermathecal sclerite laterally spindle-like with long membranous sack attached anteriorly; distal end and adjacent edges dark; ventrally tip square-cut; double hook pattern just anterad of tip of dark coloration (Fig. 101), with shaft of hood faded anterad.

Notes on biology. – The two creeks from which I have taken specimens of this species are shallow, slow riffled streams on small pebble beds. The dates of capture were May 18 in southeastern British Columbia, and July 15 at Lusk Creek, in the Kananaskis valley of Alberta.

Geographical distribution. – Only two records are available for this species at present (Fig. 121). Both are from low altitudes, about 3,000'

Rhyacophila species 2
(Fig. 22a, 22b, 102-103, 121)

Description. – Antennae pale straw, scapes slightly darker. Vertex of head yellow, to pale red-brown between ocelli. Thorax reddish straw, to pale red-brown dorsally. Spurs brown. Fore wing length of female 10.4 mm; pale straw-yellow, no discernible pattern except for opaque stigmatic area. Venation of fore and hind wings as in Fig. 22a, 22b.

Female genitalia. (Specimen from Gap, near Exshaw, Alberta). Basal two thirds of segment VIII very weakly sclerotized; segment long, tapered, terminated by annular swelling (Fig. 102). Spermathecal sclerite laterally spindle shaped, with anterior end attenuated (Fig. 102, 103); main body folded dorsad with thick lateral edges faded anterad.

Notes on biology. – The one known locality for this species is a fast, smooth mountain creek on a medium sized boulder bed. Date of capture is September 25.

Geographical distribution. – The one locality is Rapids Creek, at the Trans-Canada Highway, Gap, near Exshaw, Alberta (Fig. 121).

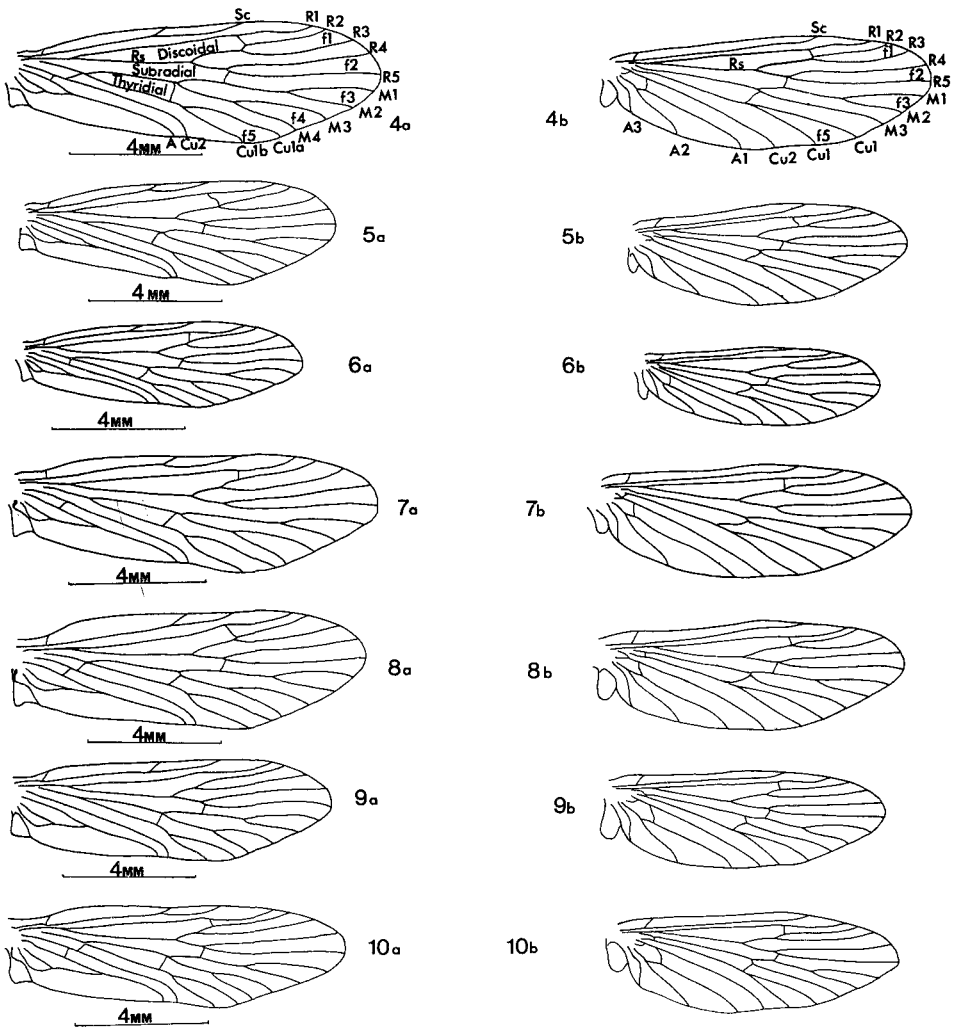


Fig. 4-10. Fore (a) and hind (b) wings of males of *Rhyacophila*. 4. *R. alberta* Banks. 5. *R. tucula* Ross. 6. *R. glaciera* Denning. 7. *R. vofixa* Milne. 8. *R. acropedes* Banks. 9. *R. bifila* Banks, 10. *R. coloradensis* Banks.

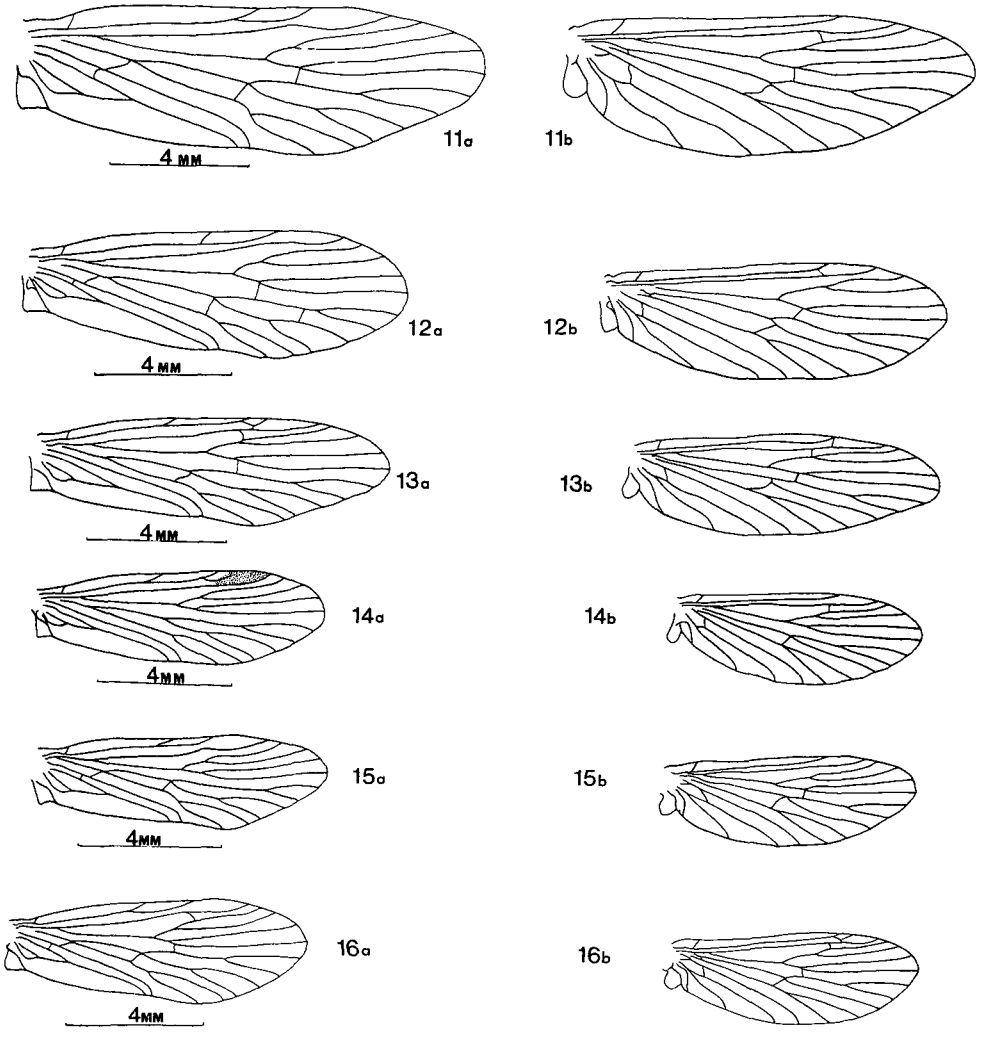


Fig. 11-16. Fore (a) and hind (b) wings of males of *Rhyacophila*. 11. *R. hyalinata* Banks. 12. *R. rickeri* Ross. 13. *R. vaccua* Milne. 14. *R. vepulsa* Milne. 15. *R. belona* Ross. 16. *R. pellisa* Ross.

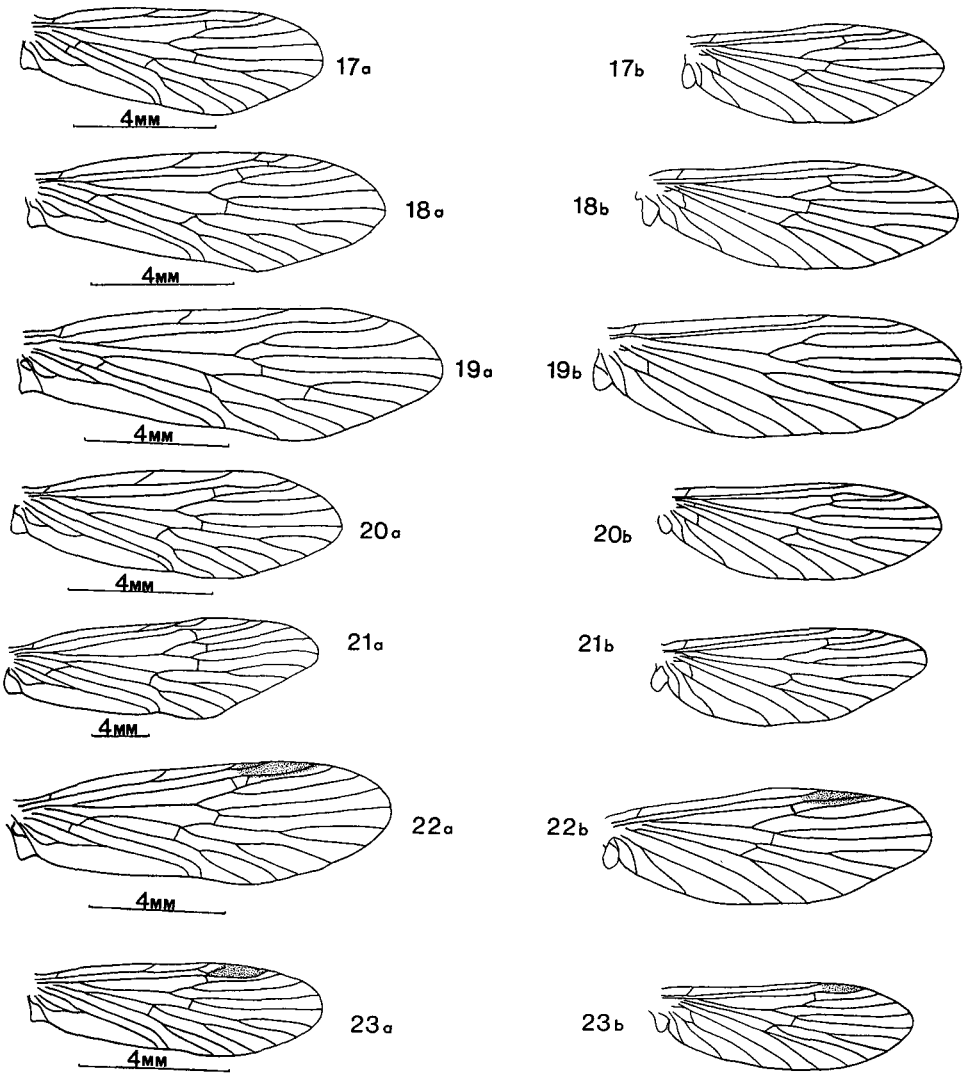


Fig. 17-23. Fore (a) and hind (b) wings of males, except where otherwise stated, of *Rhyacophila*. 17. *R. vobara* Milne. 18. *R. angelita* Banks. 19. *R. verrula* Milne. 20. *R. vagrita* Milne. 21. *R. vemna* Milne. 22. *R.* species 2, female. 23. *R.* species 1, female.

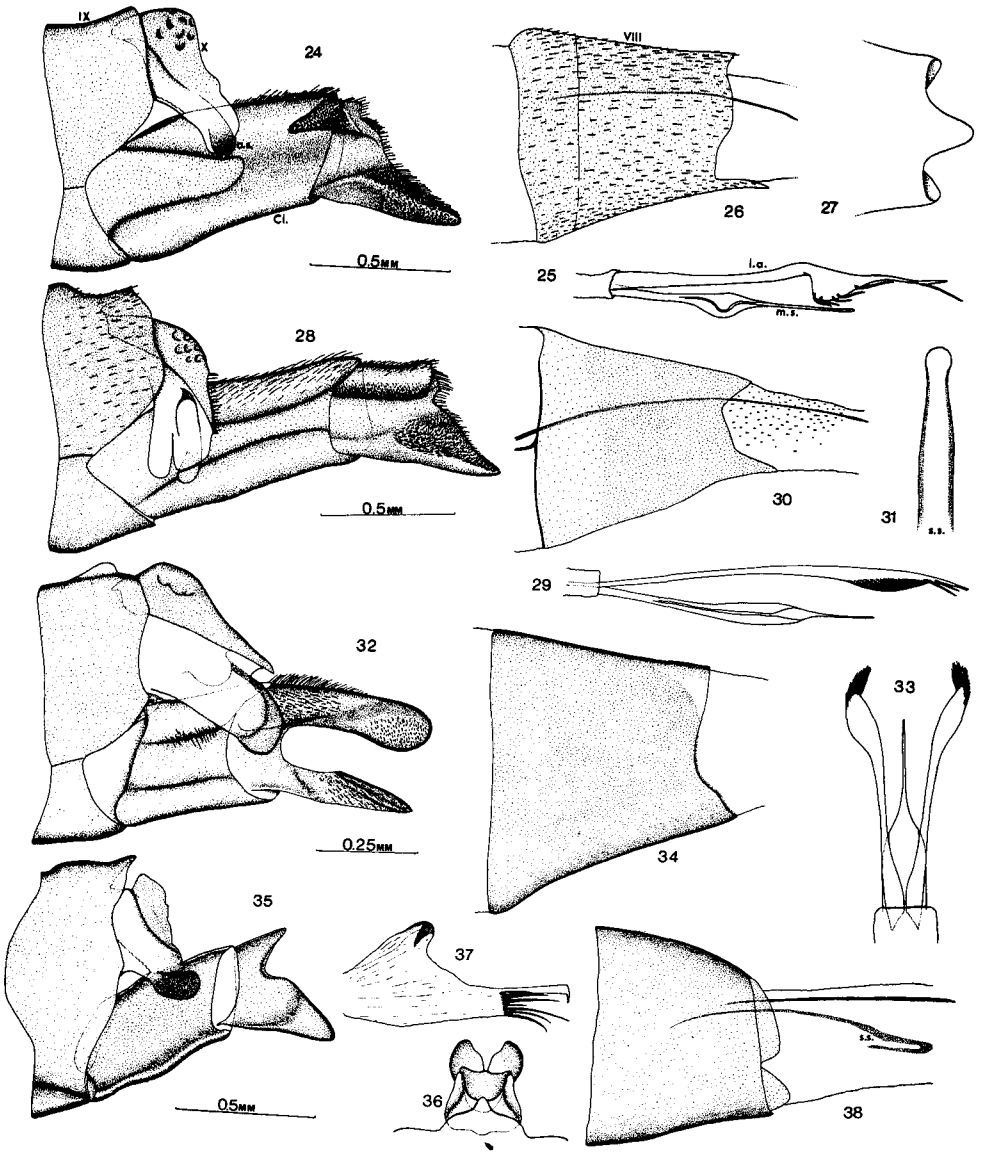


Fig. 24-38. Genitalia of *Rhyacophila* species. *R. alberta* Banks, 24. Male, lateral aspect. 25. Aedeagus, lateral aspect. 26. Female, sclerotized base of segment VIII, lateral aspect. 27. Female, sclerotized base of segment VIII, posterior edge, ventral aspect. *R. tucula* Ross, 28. Male, lateral aspect. 29. Aedeagus, lateral aspect. 30. Female, sclerotized base of segment VIII, lateral aspect. 31. Spermathecal sclerite, ventral aspect. *R. glaciera* Denning, 32. Male, lateral aspect. 33. Aedeagus, dorsal aspect. 34. Female, sclerotized base of segment VIII, lateral aspect. *R. vofixa* Milne, 35. Male, lateral aspect. 36. Segment X, dorsal aspect. 37. Aedeagus, lateral aspect. 38. Female, segment VIII, lateral aspect. A. S. – anal sclerite. Cl. – Clasper. L. A. – lateral arm of Aedeagus. M. S. – median shaft of aedeagus. S. S. – spermathecal sclerite. Scale bar for each species adjacent to lateral aspect of male genitalia; scale uniform for all drawings of a species. No scale given when only female known.

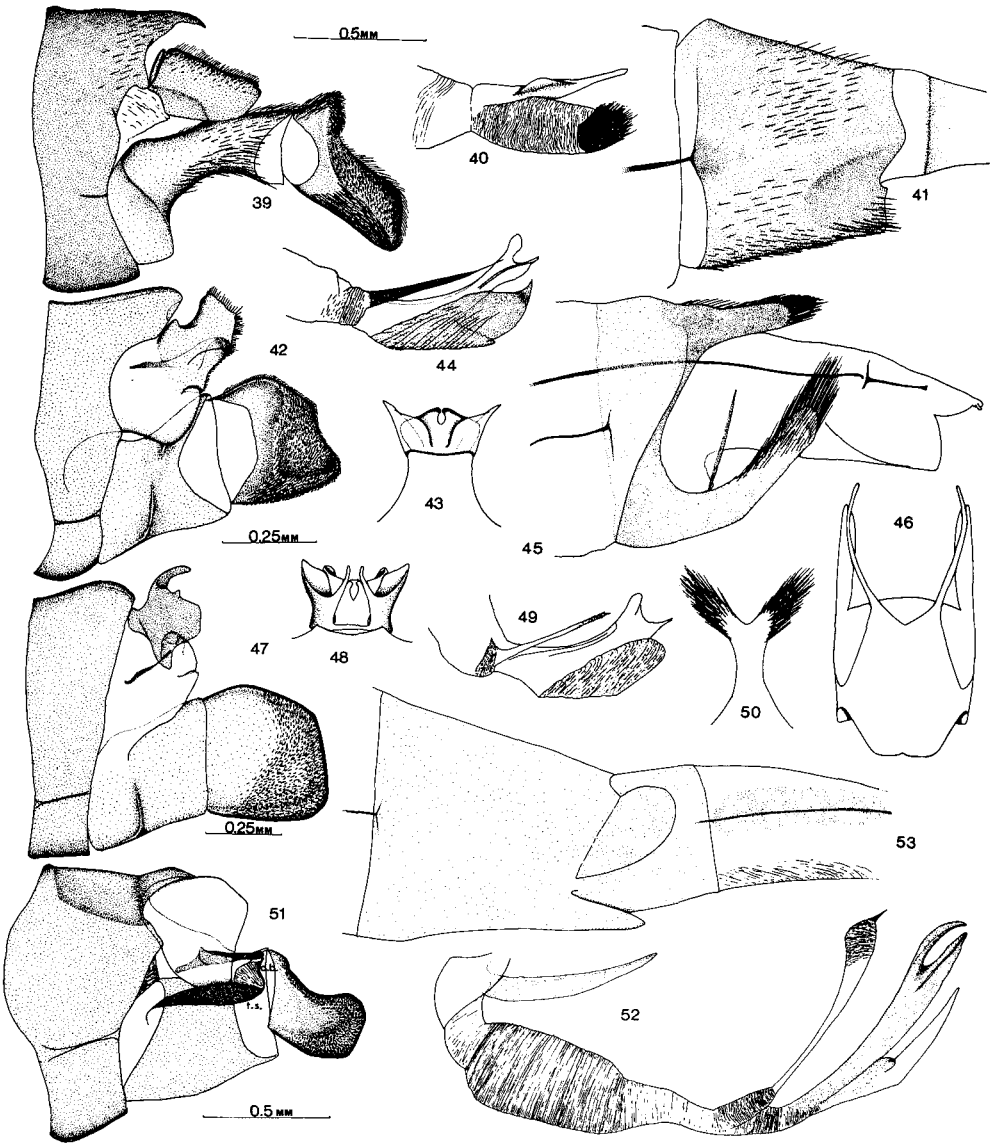


Fig. 39-53. Genitalia of *Rhyacophila* species. *R. acropedes* Banks, 39. Male, lateral aspect. 40. Aedeagus, lateral aspect. 41. Female, base of segment VIII, lateral aspect. *R. bifila* Banks, 42. Male, lateral aspect. 43. Segment X, dorsal aspect. 44. Aedeagus, lateral aspect. 45. Female, segments VIII-IX, lateral aspect. 46. Sclerotized base of segment VIII, ventral aspect. *R. coloradensis* Banks, 47. Male, lateral aspect. 48. Segment X, dorsal aspect. 49. Aedeagus, lateral aspect. 50. Female, ventral lobes of segment VIII, ventral aspect. *R. hyalinata* Banks, 51. Male, lateral aspect. 52. Aedeagus, lateral aspect. 53. Female, segment VIII, lateral aspect. A. B. – apical band of tergal strap. T. S. – tergal strap.

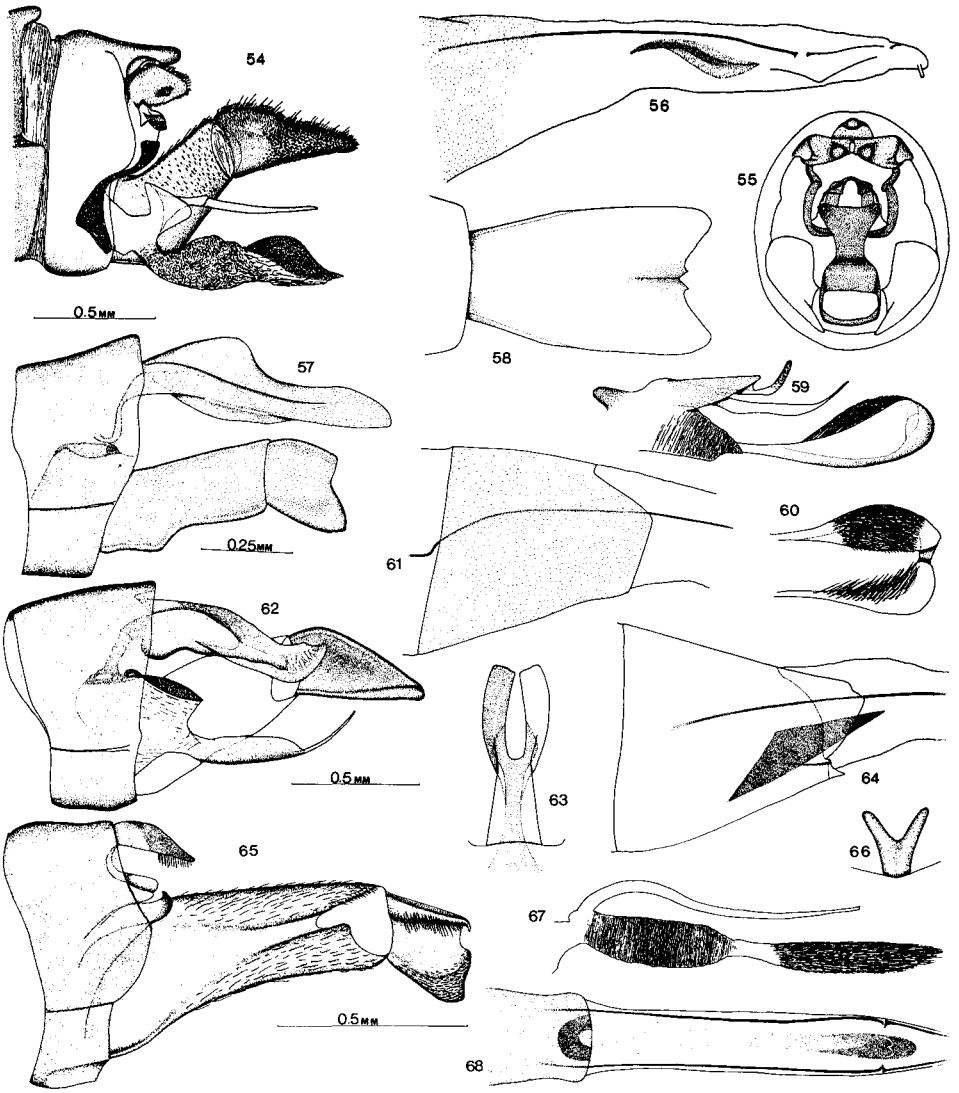


Fig. 54-68. Genitalia of *Rhyacophila* species. *R. rickeri* Ross, 54. Male, lateral aspect, including aedeagus. 55. Male, posterior aspect. 56. Female, segments VIII-IX, lateral aspect. *R. vepulsa* Milne, 57. Male, lateral aspect. 58. Segment X, dorsal aspect. 59. Aedeagus, lateral aspect. 60. Aedeagus, ventral process tip, dorsal aspect. 61. Female, segment VIII, base, lateral aspect. *R. belona* Ross, 62. Male, including aedeagus, lateral aspect. 63. Segment X, dorsal aspect. 64. Female, segment VIII, base, lateral aspect. *R. pellisa* Ross, 65. Male, lateral aspect. 66. Segment X, dorsal aspect. 67. Aedeagus, lateral aspect. 68. Female, segment VIII, ventral aspect.

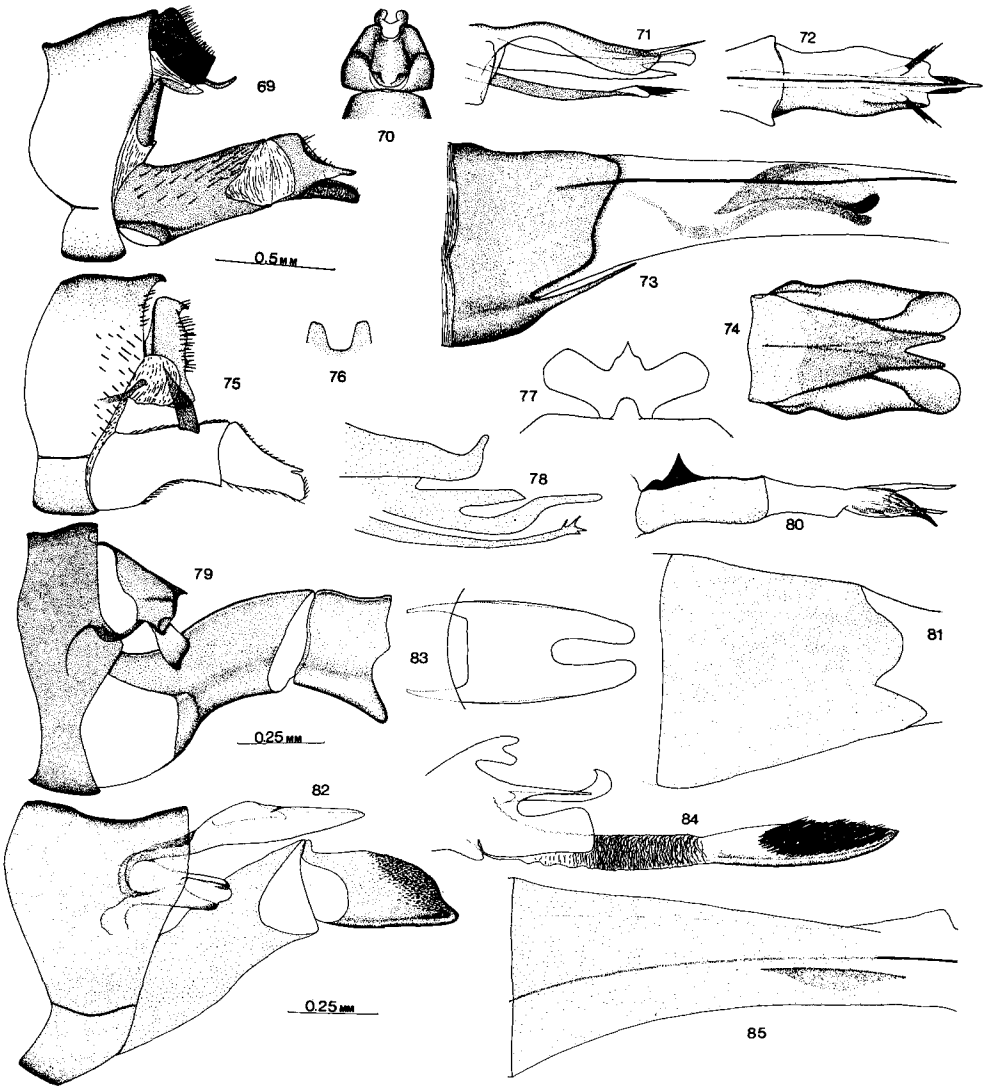


Fig. 69-85. Genitalia of *Rhyacophila* species. *R. vaccua* Milne, 69. Male, lateral aspect. 70. Segment X, dorsal aspect. 71. Aedeagus, lateral aspect. 72. Aedeagus, dorsal aspect. 73. Female, segment VIII, lateral aspect. 74. Sclerotized base of segment VIII, ventral aspect. *R. chilsia* Denning, 75. Male, lateral aspect (redrawn from Denning). 76. Anal sclerite, distal edge, dorsal aspect (after Denning). 77. Segment X, dorsal aspect (after Denning). 78. Aedeagus, lateral aspect (after Denning). No scale given. *R. vobara* Milne, 79. Male, lateral aspect. 80. Aedeagus, lateral aspect. 81. Female, segment VIII, base, lateral aspect. *R. angelita* Banks, 82. Male, lateral aspect. 83. Segment X, dorsal aspect. 84. Aedeagus, lateral aspect. 85. Female, segment VIII, base, lateral aspect.

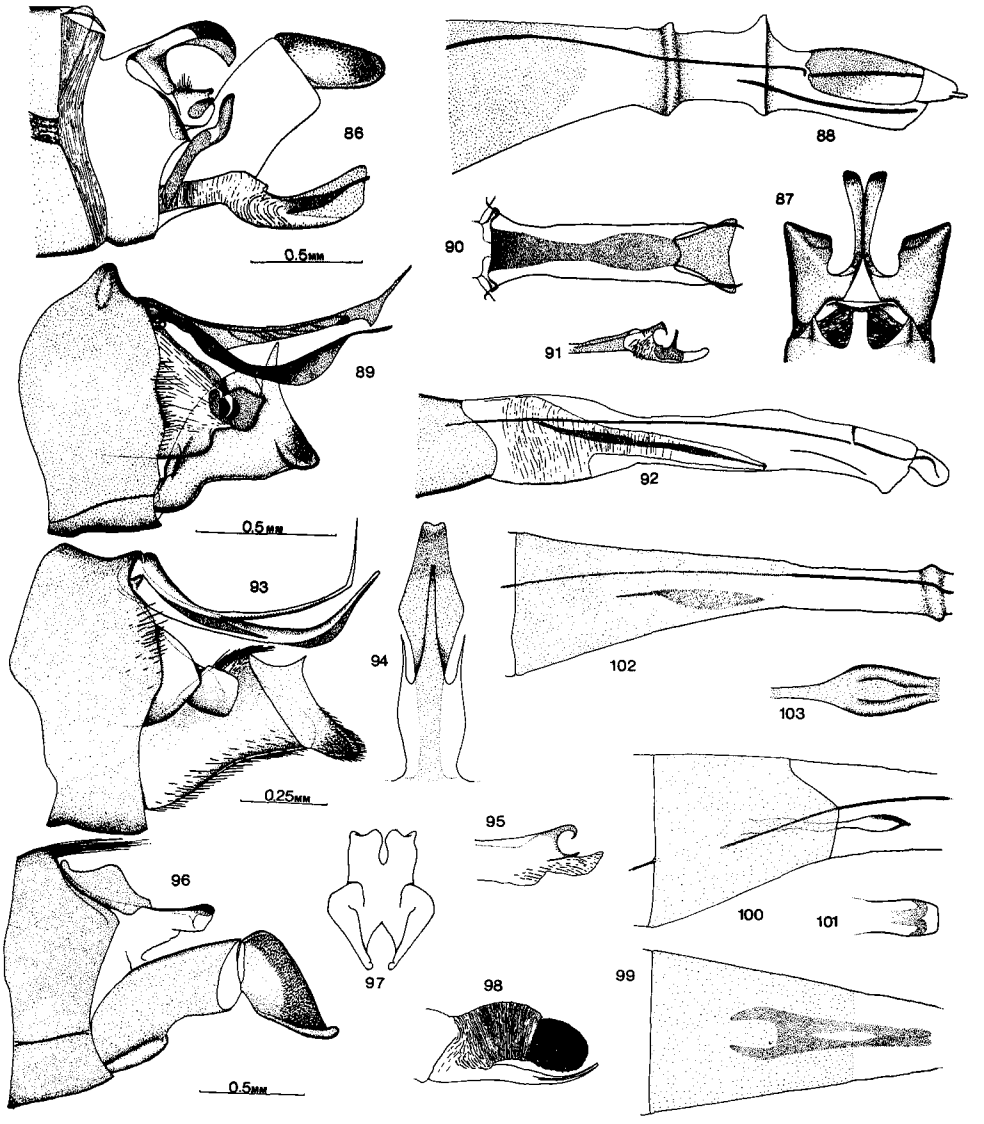


Fig. 86-103. Genitalia of *Rhyacophila* species. *R. verrula* Milne, 86. Male, lateral aspect. 87. Segments VIII, and IX, dorsal aspect. 88. Female, segments VIII-XI, lateral aspect. *R. vagrita* Milne, 89. Male, lateral aspect. 90. Posterior lobes, segments IX and X, dorsal aspect. 91. Aedeagus, lateral aspect. 92. Female, segment VIII, lateral aspect. *R. milnei* Ross, 93. Male, lateral aspect. 94. Posterior lobes, segments IX and X, dorsal aspect. 95. Aedeagus, lateral aspect. *R. vemna* Milne, 96. Male, lateral aspect. 97. Segment X, dorsal aspect. 98. Aedeagus, lateral aspect. 99. Female, segment VIII, ventral aspect. *R.* species 1, 100. Female, segment VIII, base, lateral aspect. 101. Posterior end of spermathecal sclerite, ventral aspect. *R.* species 2, 102. Female, segment VIII, lateral aspect. 103. Spermathecal sclerite, ventral aspect. No scale given when only female known.

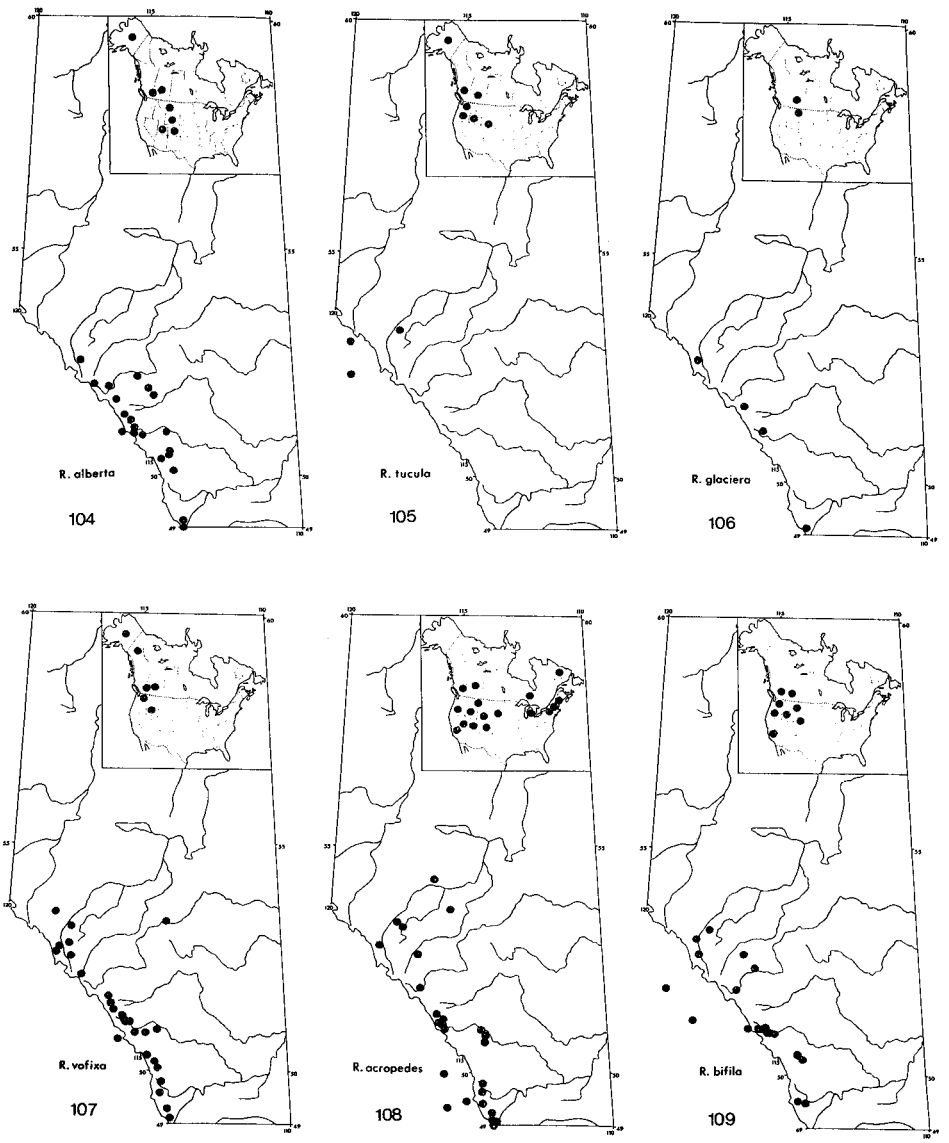


Fig. 104-109. Maps of geographical distribution of *Rhyacophila* species in Alberta, and North America.

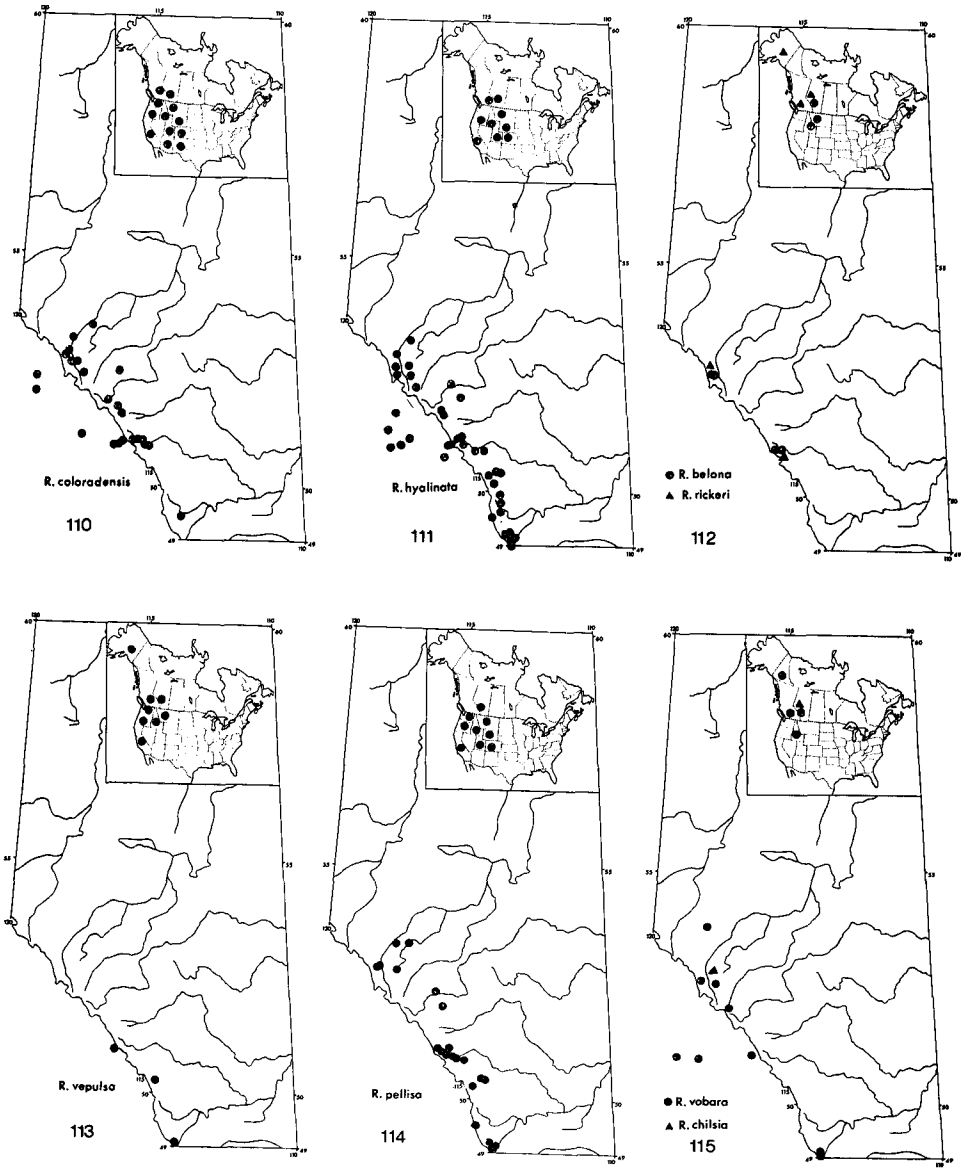


Fig. 110-115. Maps of geographical distribution of *Rhyacophila* species in Alberta, and North America.

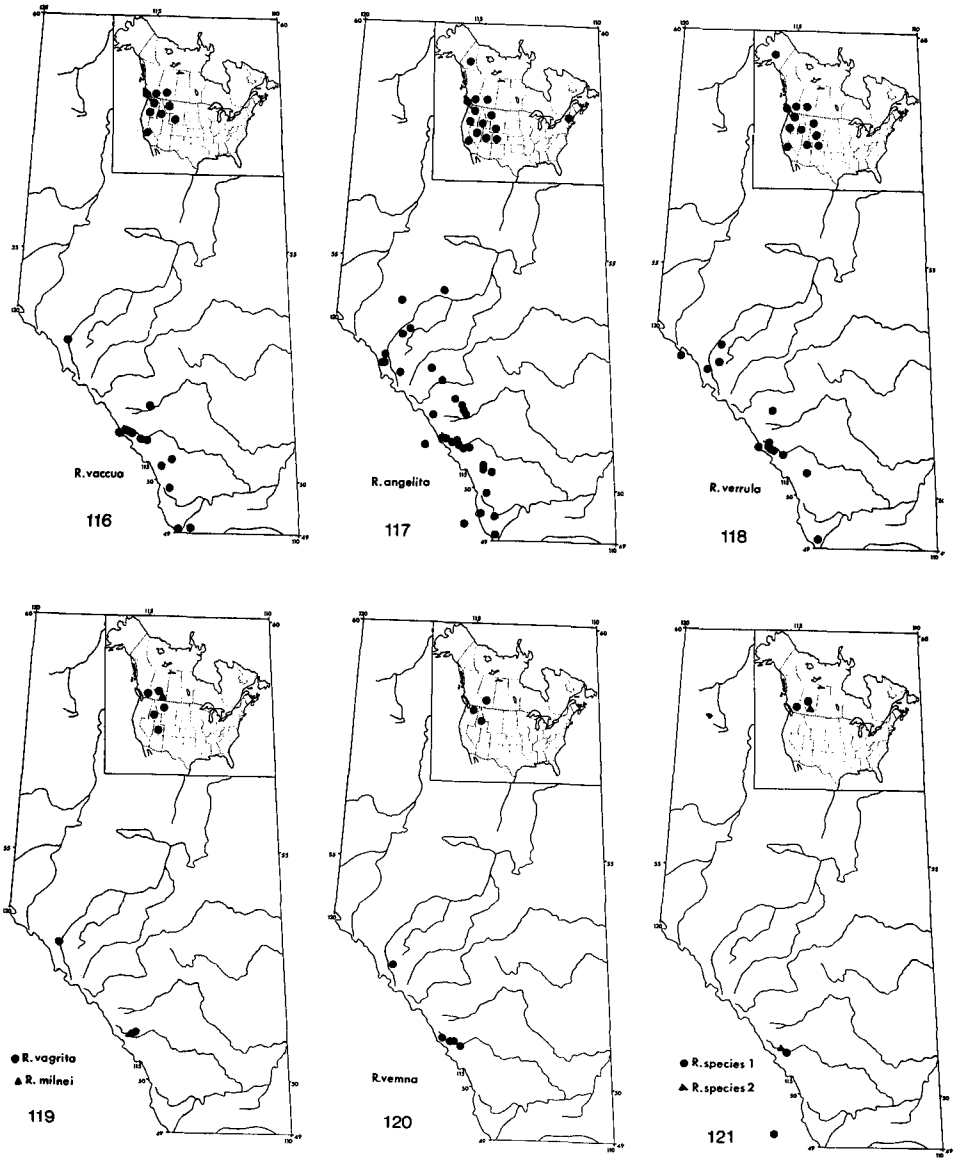


Fig. 116-121. Maps of geographical distribution of *Rhyacophila* species in Alberta, and North America.

THE FAMILY LIMNEPHILIDAE KOLENATI

This family is represented in Alberta and eastern British Columbia by 91 species belonging to 26 genera. The names of the genera are presented in Table 1 according to the scheme used by Schmid (1955).

The species in the study area are discussed individually in the text. Within genera, divisions to subgenera, or groups, follow Schmid (1955). Immediately following is a synopsis of familial characteristics translated and greatly condensed from Schmid (1955). The synopses of the subfamilial groups, including genera, are also derived and condensed from Schmid (1955), as are the keys to all taxa to the generic level. Schmid (1955) should be consulted for a complete exposition of the family and its constituent taxa. The keys include only those groups found in the study area. Keys are provided to the males of the species of each genus and are original unless stated otherwise. In the family as a whole the keys are applicable primarily to the males, as male genitalic characters are used sufficiently often to exclude the females. This situation is due to an insufficient knowledge of the females of the various taxa within the family, only the males being known for many species. The situation is aggravated by the relatively great homogeneity of body characters within the family, other than in the genitalia. Keys are provided to the females of some genera, but at present the best way to identify females is by association with males.

Some species are holarctic in distribution, ranging as far west as Europe. For such species there is a very large European literature. In this work only the literature pertaining to such species in North America is given in detail; the reader is referred, at the end of the literature and synonymy list for each species, to the appropriate volume of Fischer's 'Trichopterorum Catalogus' for a complete listing.

Character synopsis of the Limnephilidae. – Ocelli three. Antennae as long as, or little shorter than fore wings; thickened, not fine; scapes generally as long as head, cylindrical, thickened. Maxillary palpi of straight, sub-cylindrical articles; with three articles in males, five in females. Pronotum short. Dorsal line (i.e. pale coloured median stripe from interocellar space of head to metanotum) present or absent. Legs commonly long, heavy, not hairy or silky but spinate; spines most abundant on the tibiae and tarsi, generally black. Spurs yellowish, modified or not. Spur formula 1,3,4 to 1,1,1, variable intergenerically and interspecifically. Femora and tarsi of fore legs of males of certain genera provided with opposing brushes of short, stout, black spines. Fore wings of some genera basally narrow, distally expanded at stigma, with widely rounded apex; hind wings much larger, with well developed anal area (some dicosmoecine genera and all Limnephilinae). In all other genera the hind wing is reduced to varying degrees of similarity to the fore wing by reduction of anal area. Venation generally as in Fig. 122. Cross-vein R1-R2 of fore wing absent; f4 absent, median cell open. R1 of fore wing with distal kink of varied intensity, followed by smooth curve to encompass stigma, if present. Radial sector four branched, to encompass cells f1 and f2; discoidal cell longer than wide. Median and cubital veins each three branched to delimit f3 and f5 respectively. Thyridial cell between M and Cu1. All veins except Sc and R1 connected by cross-veins to form irregular, dispersed line known as anastomosis or chord. Venation of hind wing almost identical to that of fore wing, except chord more dispersed. Anal veins five in number. R1 without distal kink and bow, generally parallel to Sc.

Tergum VIII of male unmodified of variously developed and clothed with spines or hairs. Segment IX single, rigid, heavily sclerotized tube of fairly uniform width all round, or of varied widths; ventral area produced posterad to form shelf below aedeagus, or not produced; dorsal area reduced to strap of varied widths, or obsolete. Postero-ventral edges recessed, or not. In posterior aspect segment IX divided to dorsal and ventral cavities by

mesally directed extensions of lateral walls, or not divided. Claspers movable or fused to segment IX; composed of one or two articles, horizontal; if of two articles then curved, pincer-like; if of one article then short, plaque-like. Segment X small or large, with or without many lobes or branches.

Female genitalia less varied than those of males. Segment VIII unmodified or, in some genera, with slight concavity in sternum. Segment IX short, cylindrical, cleft ventrally, or lateral walls shortened to isolate ventral angles. In most genera segment IX of distinct terga and sterna. Segment X more or less incised, sclerotized tube distinct from segment IX, or fused to it. Supra-genital plate present except in a few genera, dorsad of genital cavity. Vaginal aperture on sternum IX or between sterna VIII and IX. Vulval scale ventrad of vaginal aperture, either as simple chitinous pad or strongly sclerotized, trilobed structure.

Key to the Subfamilies and certain Genera of Limnephilidae in Alberta and eastern British Columbia

1a.	Discoidal cell of hind wing open distally, or R1 of fore wing united to Sc by crossvein terminated at wing edge (Fig. 129a) ..... Apataniinae, p. 64.
1b.	Discoidal cell of hind wing open basally; i.e. RS divided from wing base; or F3 of hind wing absent, or both (Fig. 130, 131) ..... Neophylacinae, p. 71.
1c.	Discoidal cell of hind wing closed; f3 present 2
2a.(1c)	Chord of fore wing a single, irregular line (Fig. 133-135) ..... *Homophylax* (Pseudostenophylacinae), p. 78.
2b.	Chord of fore wing in two distinct lines (Fig. 138) 3
3a.(2b)	Fore wing reddish, narrow. Male maxillary palpus very large ..... *Chyranda* (Limnephilinae), p. 143.
3b.	Fore wing not narrowed. Maxillary palpus of normal size 4
4a.(3b)	Fore wing reddish, large, rounded; f1 with long common boundary with discoidal cell (Fig. 128). Mesal face of male clasper with one or more sclerotized spines (Fig. 195) ..... *Ecclisomyia* (Dicosmoecinae), p. 61.
4b.	Characters otherwise 5
5a.(4b)	Clasper of male two-articled and movable. Vaginal aperture of female on segment IX ..... Dicosmoecinae, p. 50.
5b.	Clasper of male of one article only, and fused to segment IX. Vaginal aperture of female between segments VIII and IX ..... Limnephilinae, p. 81.

The Subfamily Dicosmoecinae Schmid

Synopsis of characters. – Head very large; eyes large. Pronotum short; macrochaetae well developed. Spur formula 1,3,3; 1,2,2; or 1,3,4. Fore wings medium to large, parabolic. Hind wings much larger than fore wings or only slightly larger; anal edge smoothly convex. Venation of species in study area as in Fig. 122-128, basically simple and unmodified.

Male genitalia complex, varied. There is feeble specialization of appendages, or strong reduction in their numbers in some genera. Segment IX recessed into segment VIII in very few genera; of fairly uniform width except for dorsal lobes in certain genera, such as *Dicosmoecus*. Segment X not projected in most genera; large, roof-like over the aedeagal recess. There are four pairs of appendages which are reduced or absent in some genera. Claspers very large, pincer-like, two-articled, as in *Dicosmoecus* (Fig. 146), or smaller, with articles tending to fuse, as in *Amphicosmoecus* (Fig. 164). In certain genera (e.g. *Imania*) the claspers are complex, with distal article missing; not fused to segment IX. Aedeagus

highly varied in form and size; long and slender in some genera.

Segment IX of female genitalia of one piece, or of two distinct parts. Dorsal part well developed, but reduced in certain genera; in form of long tube; appendages absent. Segment X well developed, in form of simple cone (e.g. *Onocosmoecus* Fig. 162), bilobed dorsally with ventral plate. Supra-genital plate present. Vaginal orifice on segment IX. Vulval scale similar to that of other subfamilies but formed from posterior edge of segment IX, not VIII; trilobed.

Key to the Genera of Dicosmoecinae in Alberta and eastern British Columbia

1a. Fore wing reddish, large, rounded; f1 with long common border with discoidal cell (Fig. 128a) ..... *Ecclisomyia*, p. 61.

1b. Fore wing with f1 short, common border with discoidal cell (Fig. 122-127) 2

2a.(1b) Small insects, fore wing length less than 12 mm; fore wing very dark, brownish black ..... *Imania*, p. 56.

2b. Much larger insects, fore wing length over 17 mm; fore wing reddish brown or grey to grey-black 3

3a.(2b) Clasper of male with both articles fused, not articulated. Lateral lobes of female vulval scale stout, fleshy, with distal ends concave. Supra-genital plate arched dorsad, projected prominently posterad, free of remainder of genitalia (Fig. 164, 168, 169) ..... *Amphicosmoecus*, p. 55.

3b. Clasper of male with both articles articulated (Fig. 146). Median lobe of female vulval scale projected free, between thin, placoid lateral lobes. Supra-genital plate not as above; not projected freely and prominently (Fig. 151, 152, 156, 162, 163) 4

4a.(3b) Thorax abundantly clothed with silky hairs; large, black insects .... *Dicosmoecus*, p. 51.

4b. Thorax without many silky hairs; smaller, red-brown insects .... *Onocosmoecus*, p. 53.

The Genus *Dicosmoecus* McLachlan

This genus is represented in the study area by two species.

Synopsis of characters. – Head very large; ocelli large, close-set. Spur formula 1,3,4. Pleural sclerites, metanotum, and wing bases clothed with long, fine, silky hairs.

Male genitalia with segment IX narrow throughout, except for meso-ventral tongue which encloses the clasper bases. Claspers very long, two-articled, in form of semi-circular pincer; bases of claspers produced mesad as wide ledges divided by vertical ridge (Fig. 147); distal article tapered sharply. Aedeagus long, thin; lateral arms slender, finely spinate; variably fused to ensheath median shaft (Fig. 149).

Female genitalia with segment IX of two almost separate parts; tubular piece narrow, projected. Segment X flared, narrowed basally. Supra-genital plate large, short, thick. Vulval scale simple, pad-like, trapezoidal and convex (Fig. 151, 152).

Key to the Males of species of *Dicosmoecus* found in Alberta and eastern British Columbia

1a. Mesal ridge of clasper bases in posterior aspect vertical, roughly rectangular in outline, with smaller rectangular lateral lobe (Fig. 147) ..... *D. jucundus* Banks, p. 52.

1b. Mesal ridge of clasper bases in posterior aspect not vertical, only outer edge visible; long axis oriented obliquely dorso-ventrad; lateral lobe small, acuminate (Fig. 154) ..... *D. atripes* (Hagen), p. 53.

Key to the Females of species of *Dicosmoecus* found in Alberta and eastern British Columbia

1a. Median lobe of vulval scale sub-equal in length to lateral lobes. Segment X projected posterad, deeply cleft, the two halves thin, plate-like (Fig. 151) ..... *D. jucundus* Banks, p. 52.

1b. Median lobe of vulval scale only half as long as lateral lobes. Segment X short, cleft to two short, rounded, fleshy lobes (Fig. 156) ..... *D. atripes* (Hagen), p. 53.

Dicosmoecus jucundus Banks, 1943
(Fig. 122a, 122b, 146-152, 593)

Dicosmoecus jucundus Banks, 1943:358-359. (Type locality: Modoc County, California). Ross, 1944:297. Schmid, 1955:36. Flint, 1966:376. Fischer, 1967:66.

Males of this species (which Flint, 1966, considers to be a synonym of *D. atripes*) are most easily distinguished from males of *D. atripes* by posterior aspect of basal ridge of clasper (Fig. 147, 153), as defined in preceding key. Females are distinguished by length of median lobe of vulval scale relative to lateral lobes (Fig. 151, 156).

Description. – Antennae dark brown; antero-mesal faces of scapes with longitudinal glabrous, yellowish stripe. Vertex of head dark brown; warts yellowish. Thorax yellowish laterally, yellow to red-brown dorsally in form of cruciform pattern on nota, with base of cross directed posterad. Femora yellow, tibiae and tarsi chocolate-brown. Fore wing length of male 25 mm; dark brownish grey, with prominent, almost black veins; costal area almost hyaline and a clear area located at divergence of veins M1+2 and M3. Venation of fore and hind wings as in Fig. 122a, 122b.

Male genitalia. (Specimen taken 2 miles west of Hinton, Alberta). Segment IX high, very narrow, of irregular width (Fig. 146). Sternum produced posterad as broad shelf ventrad of clasper bases. Clasper massive, two-articled; distal article bowed slightly ventrad, with distal tooth directed postero-ventrad. Basal article with meso-ventral edge developed mesad as broad shelf (Fig. 147); shelf with two lobed vertical ridge extended meso-laterad; each lobe rectangular in posterior aspect, lateral lobe smaller, almost at right-angles to mesal lobe (Fig. 148). Median lobes of segment X short, rounded, spinate and semi-membranous. Intermediate lobes of segment X long, finger-like, each flanked laterally by thin ridge (Fig. 146); lobes connected by high, thin-ledged bridge with flat, plate-like crown (Fig. 147). Cercus long, rounded-rectangular, setose distally. Aedeagus long, slender, head little wider than stem. Lateral arms short, with thick basal half, needle-like distal half; four heavy, dark spines near middle and tip with two or three spines in tight cluster (Fig. 149, 150). Mesal faces of clasper bases and base of aedeagus joined by continuous, thin, sclerotized strap, looped around aedeagal base (Fig. 147).

Female genitalia. (Specimen from 2 miles west of Hinton, Alberta). Posterior edge of sternum VII with long, narrow fringe of short, hyaline hairs. Segment VIII with sternum markedly narrowed by antero-mesal constriction (Fig. 151). Vulval scale massive; lateral lobes around vaginal aperture; median lobe tapered slightly distad, tip rectangular, attached completely distad by membrane. Segment IX small, notum massive, connected to vulval scale by lateral lobes with broad ventral extremities (Fig. 152); lateral lobes darker than notal area. Supra-genital plate small, membranous, located between vulval scale and segment IX, in membranous sheet. Segment X of two large, convoluted lobes joined smoothly to segment IX.

Notes on biology. – Specimens of this species appear to emerge from small to large, smoothly flowing, pebbled streams and rivers. I have records of captures made along lake

edges, but it is possible that these are instances of individuals flying in from nearby streams. Adults are found from the last week in July to the last week in August.

Geographical distribution. – The known range of this species extends from Alberta and British Columbia to California (Fig. 593). In Alberta the species is confined to the low mountain valleys and foothills at altitudes between 3,400' and 5,450'.

I have examined 27 specimens, 20 males and seven females, from the study area.

Dicosmoecus atripes (Hagen), 1873
(Fig. 153-156, 592)

Platyphylax atripes Hagen, 1873b:600-601, 605, 606. (Type locality: Colorado Mountains, Colorado). Putnam, 1876:113. Banks, 1892:364. Ulmer, 1905a:21.

Dicosmoecus atripes; McLachlan, 1875:113. Banks, 1904a:107. Ulmer, 1905b:63-64. Ulmer, 1907a:60. Banks, 1907a:38. Martynov, 1914:243. Essig, 1926:176. Betten, 1934: 318. Milne, 1935:36, 50. Goodrich, 1935:57-64. Goodrich, 1937:243-248. Ross, 1938b: 30. Knowlton and Harmston, 1939:285. Goodrich, 1941:134-143. Ross, 1941a:103. Banks, 1943:358. Ross, 1944:297. Ross and Spencer, 1952:47. Schmid, 1955:36. Flint, 1960:4. Denning, 1963:259. Flint, 1966:376. Anderson, 1967:508. Fischer, 1967:64-65.

Specimens of this species are essentially identical to those of *D. jucundus* in the majority of characters, but differ as outlined below.

Description. – Meso-basal ledge of male clasper with ridge; in posterior aspect (Fig. 154) this ridge viewed along its crest; bi-partite, with larger lobe set at angle of about 40° along its long axis; smaller lobe tooth-like, with distinct acuminate tip, located latero-anterad of larger lobe. Distal article of clasper with distal tooth directed posterad from unbowed finger-like extension of article (Fig. 153). Lateral arms of aedeagus each tipped by dense cluster of spines; mid-point with four close-spaced lateral spines; basad with short single spine (Fig. 155).

Female genitalia essentially similar to that of *D. jucundus* in lateral aspect, but differing markedly in ventral aspect (Fig. 156). Vulval scale massive, with short, tapered median lobe square tipped; lateral lobes huge, bulbous, with distinct antero-lateral concavities. Supra-genital plate minute, triangular, located in sheet of membrane. Vaginal aperture roofed over by large sclerotized, straight-edged plate. Lateral lobes of segment X thick, fleshy, rounded, completely separated ventrally.

Geographical distribution. – The known range of this species extends from Alberta (Beaver Creek (Banks, 1943)) and British Columbia to California and New Mexico (Fig. 592). I have no records from Alberta in my own collections. The drawings were taken from Utah specimens in Illinois Natural History Survey.

The Genus *Onocosmoecus* Banks

This genus is represented by one species in the study area.

Synopsis of characters. – Spur formula 1,3,4. Pleural sclerites without silky hairs; macrochaetae less developed than in *Dicosmoecus*. Fore wings large, bluntly parabolic apically; hind wings larger than fore wings, with posterior edge regularly convex. Chord of fore wing markedly broken; posterior part slightly oblique to body axis. Chord of hind wing only slightly disrupted; posterior part oblique to body axis.

Male genitalia much as in *Dicosmoecus*. Aedeagus relatively shorter; median shaft expanded apically; lateral arms quite large, partly free, armed with few heavy spines (Fig. 159).

Female genitalia differing appreciably from *Dicosmoecus*. Segment IX massive, very strong, of one piece; ventrally vulval scale flanked by two large lobes (Fig. 162, 163). Segment X conical. Supra-genital plate small. Vulval scale thick, trilobed; lateral lobes semiglobose apically; small, tongue-like median lobe enclosed by lateral lobes (Fig. 163).

Onocosmoecus unicolor (Banks), 1897
(Fig. 157-163, 594)

Anabolia unicolor Banks, 1897:27-28. (Type locality: Skokomish River, Washington). Ulmer, 1905a:20.

Dicosmoecus unicolor; Banks, 1907a:38. Ulmer, 1907a:60. Essig, 1926:176. Betten, 1934: 318. Milne, 1935:36, 50. Ross, 1938b:30. Knowlton and Harmston, 1939:285. Ross, 1941a:103. Ross, 1944:297.

Dicosmoecus (Onocosmoecus) unicolor; Banks, 1943:361-362. Fischer, 1967:68.

Onocosmoecus unicolor; Schmid, 1955:39. Lindroth and Ball, 1969:138.

Specimens of this species are distinguished from other limnephilids in the study area by large size of body and wings, and by smoothly rounded parabolic form of wing tips. Specimens of this species may be confused with the still larger specimens of *Dicosmoecus* in the study area, and may be separated from them by general body coloration, which is red-brown rather than grey to black as in *Dicosmoecus*.

Description. – Antennae straw-yellow; antero-mesal face of scapes setaless; each article with distal half and anterior face depressed. Vertex of head dark straw-yellow. Thorax generally yellow, to brownish dorsally except for yellowish warts. Spurs dark yellow. Fore wing length of male 18.4 mm; warm orange-brown except for grey-brown areas at proximal ends of the four distal radial cells, and at first bifurcation of M. Anal area slightly darker brown. Venation of fore and hind wings identical to that of *Dicosmoecus* (Fig. 122a, 122b).

Male genitalia. (Specimen from Gorge Creek, 20 miles west of Turner Valley, Alberta). Segment IX high, narrow, sinuate (Fig. 157); with sparse fringe of setae round clasper base, and denser patch ventrad of base. Clasper large, two-articled, with rather spindly distal article black tipped. Basal article with ventro-lateral band of setae set in lighter coloured area. Meso-basal ledge of clasper with transverse, rounded, ridge at postero-mesal corner (Fig. 158). Median lobes of segment X long, narrow, partially fused; separated from ventral portion of segment by wide membranous area. Ventral portion of segment X truncate-triangular in dorsal aspect, with high sclerotized ridge on each side. Cercus large, blunt, lanceolate in lateral aspect, with concave mesal face. Aedeagus large, simple, sinuate (Fig. 159); lateral arms heavy, short, armed with three to five straight, black spines of varied lengths, with one dominantly large spine basally. Two large, black spines arise from dorsal membranous area between median shaft and lateral arms of aedeagus (Fig. 160). Aedeagal base flanked by two twisted, strap-like sclerites attached to antero-mesal edge of claspers (Fig. 161).

Female genitalia. (Specimen from Gorge Creek, 20 miles west of Turner Valley, Alberta). Posterior edge of sternum VII with wide fringe of fine, hyaline hairs, Vulval scale relatively small, complex. Median lobe squat, triangular, rounded (Fig. 163); lateral lobes rounded, spatulate on mesal faces, tending to enclose median lobe. Lateral lobes laterally enveloped by two folds of membrane. Segment XI massive, tapered ventrad, with large lateral bulges (Fig. 162, 163). No apparent supra-genital plate. Segment X large, tubular, merged imperceptibly with segment IX; with large, projected, roof-like dorsal area, and shorter, hemicylindrical ventral area with dentate posterior edge.

Notes on biology. – Larvae of this species apparently inhabit streams ranging from very small to rivers, with no apparent preference as to nature of the bottom. There is some indication that larvae might also inhabit lakes. The adult flight season extends from early May to late September, peaking in August.

Geographical distribution. – The known range of this species extends from Alaska to the New England states and New Mexico (Fig. 594). In Alberta the species is commonest in the low mountain valleys, but has been recorded well out in the plains, and is known from Saskatchewan. In Alberta the known altitudinal range is from around 2,000' to 5,450'.

I have examined 225 specimens, 154 males and 71 females, from the study area.

The Genus *Amphicosmoecus* Schmid

The single species of this genus is found in Alberta and eastern British Columbia.

Synopsis of characters. – Spur formula 1,2,4. Wings very large; fore wings bluntly rounded apically; hind wings with large anal area and M2 present (Fig. 123b).

Male genitalia with narrow dorsal strap on segment IX; remainder of segment greatly expanded ventrally (Fig. 164). Median lobes of segment X long, dorsally arched blades. Clasper large, long, blunt, pincer-like (Fig. 165); two-articled, both articles fused. Aedeagus small, housed in membranous pocket; lateral arms spiniform, armed with short, fine spines (Fig. 166).

Female with segment VIII unmodified. Vulval scale huge, massive; median lobe small, located in deep cleft between lateral lobes which are fleshy, and enclose vaginal aperture laterally (Fig. 168, 169). Segment IX large, of one piece, with no central lobes. Supra-genital plate large, projected well posterad, sclerotized (Fig. 169). Segment X small, recessed into segment IX; fused to segment IX; with long, thin median lobes.

Amphicosmoecus canax (Ross), 1947
(Fig. 123a, 123b, 164-169, 595)

Dicosmoecus canax Ross, 1947:149-150. (Type locality: Logan Canyon, Utah). Fischer, 1967:65.

Amphicosmoecus canax; Schmid, 1955:50. Nimmo, 1965:787. Smith, 1965:243, 244.

Males of this species are distinguished from all others by large, sickle-shaped, median lobes of segment X, and by claspers with fused articles. Females are distinguished by massive vulval scale, with small, minutely trilobed median lobe, and by long, slender median lobes of segment X.

Description. – Antennae orange-brown; scapes dark brown, with yellow, glabrous antero-mesal faces. Vertex of head dark straw-yellow with light brown areas. Thorax yellow to light brown especially laterad of terga. Spurs straw-yellow. Fore wing length of male 17.8 mm; pale greyish brown except for hyaline areas at extremity of Cu2, and initial bifurcation of M. Anal area posterad of Cu2 darker, slightly irrorate. Venation of fore and hind wings as in Fig. 123a, 123b.

Male genitalia. (Specimen from 2 miles east of Nordegg, Alberta). Segment IX with large ventral body; dorsal strap narrow, heavy, bilobed (Fig. 165); slight concavities occur at ventro-lateral faces of segment. Clasper large, two-articled, with articles fused; sharp, narrow, ledge along ventro-mesal face, and distinct groove on dorso-lateral face of basal portion thumb-like (Fig. 164, 165). Median lobes of segment X long, dorsally arched, thin blades; sickle-like, with acuminate tips. Cercus spatulate, setose, attached to large, bowl-shaped, lateral plates of segment. Aedeagus very simple (Fig. 166); tip slightly dilated, base slightly

wrinkled dorsally. Lateral arms very simple, plain rods with five to six simple, long spines distally. Aedeagus connected basally to clasper bases by lateral straps bent at angle of about 60° at point of departure from aedeagal base; terminated by large, hollow, spherical structures (Fig. 167).

Female genitalia. (Specimen from 2 miles east of Nordegg, Alberta). Posterior edge of tergum VII with short, narrow brush of short, yellow hairs. Vulval scale huge, with massive, fleshy lateral lobes, and small, trilobed median lobe (Fig. 169). Segment IX composed of single, trapezoidal tergum (Fig. 168). Supra-genital plate large, convoluted, with lateral edges turned dorsad. Segment X small, complex, with two short, stout, lateral lobes and two long, thin, hyaline, mesal lobes; bases of lobes produced ventrad as two broad, triangular flaps fitted loosely into two dorsal channels of supra-genital plate. Segment X recessed into segment IX.

Notes on biology. – Larvae of this species inhabit a wide variety of streams, from small, quiet brooks, to large rivers and turbulent mountain streams. The adult flying season extends from mid-September to late October.

Geographical distribution. – The known range of this species extends from Alberta and eastern British Columbia to Utah and California. Records are very scattered however (Fig. 595). In Alberta the species occurs mainly in the mountain and foothill areas. There is one record from Cold Creek, Nojack, however, which is well outside of this area. My records indicate an altitude range from at least 2,500' to 4,200'.

I have examined 67 specimens, 51 males and 16 females, from the study area.

The Genus *Imania* Martynov

This genus is represented in the study area by four species, one of which is here described as new. Ross (1950) divided the genus into four species groups, of which the *tripunctata* and *bifosa* groups are known to occur in the area.

Synopsis of characters. – Form of head varied. Spur formula 1,3,4. Macrochaetae poorly developed. Wings of different lengths; fore wings apically parabolic; hind wings slightly larger than fore wings, hardly indented posterad of apex (Fig. 124-127). Venation complete; fore wings unmodified, venation of hind wing slightly reduced. R1 of fore wing arched or not at stigma, or joined to Sc by cross-vein. Chord of fore wing strongly disrupted, concave to body. Hind wing with chord only slightly disrupted, posterior part oblique to body; Cu1a absent. Frenulum of seven or eight strong, curved spines at costa base.

Male genitalia with segment IX narrow laterally, with wide dorsal process (Fig. 170). Segment X elongate, slender; of two long, sclerotized, free or fused, portions (Fig. 171). Clasper large, two-articled; not pincer-like, complex, directed dorso-posterad; basal article long, subcylindrical, not baso-mesally enlarged, with baso-mesal area in some species developed as one or more sclerotized spines; distal article short, bilobed, with dorsal lobe with heavy, short, black teeth. Aedeagus small; lateral arms slender, spiniform, free or basally fused as sheath to median shaft (Fig. 175).

Female genitalia with segment IX of two parts not entirely separated; dorsal part simple, narrow, quite long, Segment X of two very large dorsal plates, strongly sclerotized. Vaginal aperture flanked by ventral lobes of segment X. Supra-genital plate large, not prominent. Vulval scale reduced to one lobe, membranous, wrinkled (Fig. 176, 177).

Key to the Males of species of *Imania* found in Alberta and eastern British Columbia

1a. Basal article of clasper with long, slender, acuminate spine attached to baso-mesal face (Fig. 171, 174, 184) ..... (*tripunctata* group) 2a

1b. Basal article of clasper without such spine (Fig. 179) ..... *I. bifosa* Ross, p. 60.
2a.(1a) Aedeagus with lateral arm bases fused to form sheath around aedeagal base (Fig. 175) ..... *I. cascadis* Ross, p. 58.
2b. Aedeagus without basal sheath (Fig. 171, 185) 3a
3a.(2b) Median shaft of aedeagus tapered to tip (Fig. 172); segment X deeply cleft, of two heavy, black, large spiniform lobes (Fig. 171) *I. tripunctata* (Banks), p. 57.
3b. Median shaft of aedeagus not tapered distally (Fig. 185); segment X not deeply cleft, with two short, acuminate distal lobes (Fig. 184) ..... *I. hector* Nimmo n. sp., p. 59.

Key to the Females of three species of *Imania* found in Alberta and eastern British Columbia

1a. Single, median, lobe of vulval scale massive, rectangular, dorsally directed flap (Fig. 176, 177) ..... *I. cascadis* Ross, p. 58.
1b. Median lobe of vulval scale small, dorsally directed (Fig. 181, 186)..... 2a
2a.(1b) Ventral aspect of lateral lobes of segment X triangular; short, wide, rounded in lateral aspect (Fig. 187)..... *I. hector* Nimmo n. sp., p. 59.
2b. Ventral aspect of lateral lobes of segment X trapezoidal (Fig. 181); in lateral aspect long, ventrally curved, slender (Fig. 182) ..... *I. bifosa* Ross, p. 60.

The *tripunctata* group

There are three species of this group known from the study area, one of which is new.

Males of species in this group are characterised by long, sinuate, blade-like spines developed from baso-mesal face of clasper (Fig. 174). Females are recognizable by roughly triangular ventral aspect of lobes of segment X (Fig. 176, 187).

Imania tripunctata (Banks), 1900
(Fig. 126a, 126b, 170-172, 596)

Apatania tripunctata Banks, 1900b:472. (Type locality: Yakutat, Alaska). Ulmer, 1905a: 23. Banks, 1907a:41. Martynov, 1914:20. Essig, 1926:176.
Hypnotranus ? tripunctatus; Ulmer, 1907a:72.
Allomyia tripunctata; Banks, 1916:120. Dodds and Hisaw, 1925a:386. Ulmer, 1932:216, 217. Betten, 1934:52, 380. Milne, 1935:49. Ross, 1944:297. Denning, 1948c:120. Fischer, 1967:71-72.
Imania tripunctata; Ross, 1950b:411, 412, 413. Ross and Spencer, 1952:47. Schmid, 1955: 43. Ross, 1965:590. Schmid, 1968:681.
Allomyia stylata Denning, 1948c:119-120. (Type locality: Snowy Range Mountains, Albany County, Wyoming). Ross, 1950b:412. Fischer, 1967:71-72.

Males of this species are distinguished from males of other species of the *tripunctata* group by massive, spiniform, heavily sclerotized distal lobes of segment X in ventral aspect (Fig. 171), and by smoothly tapered median shaft of aedeagus (Fig. 172).

Description. – Antennae chocolate-brown. Vertex of head dark chocolate with reddish tinges laterally. Thorax deep, warm red-brown laterally, darker dorsally. Spurs brown. Fore wing length of male 11.4 mm; dull red-brown, with hyaline areas along veins. Venation of fore and hind wings as in Fig. 126a, 126b.

Male genitalia. (Specimen from Cascade River, Banff National Park, Alberta). Posterior edge of sternum VIII with long, single parallel row of heavy, hyaline setae (Fig. 170). Segment IX with very narrow ventral and lateral walls, broadened dorsad of clasper bases.

Clasper massive, with high base, narrowed distad to uniform width along distal half of basal article. Baso-mesal face of clasper with long, thin, sinuate black spine. Distally basal article with flared fringe of long, stout setae. Distal article of clasper bilobed, claw-like, with dorsal lobe flat ventrally, armed with many stout, short, black pegs. Ventral lobe rounded, short, with some black spines distally. Segment X with median lobes overhung by large, rounded, dorsal bulge. Median lobes long, thin, acuminate structures curved dorso-laterad distally. Cercus long, almost rectangular plate (in Fig. 170 they are seen end-on, however, as they project laterad). Lateral arms of aedeagus sclerotized, finely tapered, with curved base (Fig. 172). Median shaft tapered, with attenuated tip; ejaculatory duct opens on dorsal surface of tip, between two lateral flanges.

Female genitalia. Unknown.

Geographical distribution. – The known range of this species extends from Alaska to Washington and Colorado (Fig. 596). I have only one record of the species in Alberta, from an altitude of 6,500', several miles northeast of Banff, on the Cascade Fire Road.

I have examined a single male of this species, on loan from Illinois Natural History Survey. The date of collection is May 30.

Imania cascadis Ross, 1950
(Fig. 124a, 124b, 173-177, 597)

Imania cascadis Ross, 1950b:411, 412, 415. (Type locality: Steven's Pass, nr. Berne, Washington). Schmid, 1955:43. Schmid, 1968:681.

Allomyia cascadis; Fischer, 1967:70.

Males of this species are distinguished from males of other species of *Imania* by basal aedeagal sheath of lateral arm bases (Fig. 175); by foreshortened basal article of clasper (Fig. 174); and by almost uncleft segment X, each half of which is more or less square cut distally in ventral aspect. Females are distinguished by very wide, long median lobe of vulval scale (Fig. 176).

Description. – Antennae reddish chocolate-brown; scapes with antero-mesal faces dark brown, remainder pale yellow. Vertex of head deep chocolate-brown; warts pale. Thorax deep red-brown laterally, almost black dorsally; warts pale. Fore wing length of male 10.4 mm; pale red-brown, lightly irrorate. Venation of fore and hind wings as in Fig. 124a, 124b.

Male genitalia. (Specimen from Spray River, at Banff, Alberta). Tergum VIII with single row of long, thick setae parallel to posterior edge. Segment IX high, uniformly narrow, bowed anterad (Fig. 173). Basal article of clasper with massive base and clearly delineated distal clumps of setae originated from pale surficial areas. Baso-mesal face of clasper with long, thin, sinuate black spine. Distal article of two short, stout lobes with teeth or pegs only at distal edges. Segment X of two parallel, concave plates with distal edges thin, sharp, directed dorsad (Fig. 173, 174). Cercus short, rounded lobe. Lateral arms of aedeagus arched high over distal portion; attached to massive, plate-like bases (Fig. 175). Ejaculatory duct of median shaft opening dorsally, well basad of cleft tip.

Female genitalia. (Specimen from Spray River, at Banff, Alberta). Tergum VIII with straight, single row of long, stout setae parallel to posterior edge. Sternum VIII unpigmented medially. Vulval scale of single, wide, dorsally curved median lobe (Fig. 176). Segments IX and X imperceptibly fused (Fig. 177) as massive, sigmoid structure in lateral aspect, cleft medially as two lateral plates abutted dorsally, each at angle of about 45°. Supra-genital plate semi-circular, hyaline.

Geographical distribution. – The known range of this species extends from Washington to

Alberta (Fig. 597). In Alberta it is known only from the Spray River, Banff, at an altitude of about 5,500'.

I have examined two specimens from the study area, one of each sex, in Illinois Natural History Survey. The date given is May 30.

Imania hector Nimmo n. sp.
(Fig. 127a, 127b, 183-187, 597)

Males of this species are distinguished from males of other species of *Imania* by form of segment X in ventral aspect (Fig. 184); segment cleft distally, two halves spread wide apart, blade-like and acuminate. Median shaft of aedeagus short, blunt, with distinct distal head (Fig. 185). Females are distinguishable by triangular form of lateral lobes of segment X in ventral aspect (Fig. 186), and by long, narrow, dorsally directed median lobe of vulval scale.

Description. – Antennae dark brown. Vertex of head dark brown to black. Thorax dark red-brown. Femora of legs dark brown, remainder lighter brown. Fore wing length of male 7.6 mm; uniform dark brown except for slight irrorations along R1, and three hyaline areas at bases of F2 and F3, at bifurcation of M1+2 and M3, and at end of Cu2. Venation of fore and hind wings as in Fig. 127a, 127b.

Male genitalia. (Specimen from Sunshine Lodge, Banff National Park, Alberta). Tergum VIII with single row of long setae parallel to posterior edge. Segment IX high, narrow, essentially parallel sided (Fig. 183). Basal article of clasper massive, cylindrical throughout, armed with long, light brown, sinuate spine on baso-mesal face (Fig. 183, 184). Distal article bilobed; dorsal lobe parallel sided, moderately toothed ventrally. Segment X fused to segment IX dorsally. Median lobes fused at bases; distally separate, triangular, spinate. Main body of segment X folded roof-like over anal aperture. Cercus long, narrow, in dorso-lateral depression of segment X. Aedeagus with two pairs of lateral arms; dorsal pair short, heavy, scythe-like; ventral pair long, straight, spatulate, in form of cylindrical sheath to membranous median shaft (Fig. 185). Ejaculatory duct open dorsally between distal flanges.

Female genitalia. (Specimen from Sunshine Lodge, Banff National Park, Alberta). Posterior edge of tergum VIII with single line of widely spaced hyaline hairs parallel to edge. Vulval scale single, long, rectangular median lobe; distal half wrinkled, curved dorsad (Fig. 186, 187). Vulval scale and vaginal aperture flanked by two large, sclerotized bodies. Segments IX and X fused; comprising two large, rounded lobes with flat mesal faces sloped meso-dorsad in form of roof-like structure; each lobe in ventral aspect triangular.

Notes on biology. – Individuals of this species appear to emerge from fast, turbulent mountain creeks with boulder beds. The flight season extends from June 1 to July 9.

Geographical distribution. – The known range of this species includes three localities close to the continental divide in Banff National Park, Alberta (Fig. 597). The altitudinal range extends from around 6,000' to 7,000'.

I have examined 13 specimens, nine males and four females, from the study area.

Holotype. – Male. Sunshine Lodge, Banff National Park, Alberta; July 9, 1962; W. R. M. Mason.

Allotype. – Female. Same data as holotype.

Paratypes. – Same data as holotype; four males, one female. Sunshine Lodge, Banff National Park, Alberta; July 9, 1962; K. C. Herrmann; four males. Hector Creek, at Banff-Jasper Hwy. north of Lake Louise, Banff National Park, Alberta; June 15, 1967; A. Nimmo; one female. Moraine Creek at Moraine Lake, Banff National Park, Alberta; June 1, 1958; W. E. Ricker; one female.

All type material is in the Canadian National Collection, Ottawa (type number 10,583) with the exception of the female from Hector Creek, which is in the Strickland Museum, Dept. of Entomology, University of Alberta, Edmonton.

This species is not named for Hector Creek but for the character of the same name in ancient Greek literature.

The *bifosa* group

One species of this group is known from the study area.

Males of the group are distinguished by absence of long, blade-like spine at baso-mesal face of basal article of clasper (Fig. 179); by presence of a short, acuminate extension of basal article of clasper, at meso-distal edge; and by presence of two pairs of long, curved, blade-like lateral arms on aedeagus (Fig. 180). Females are distinguished by lack of medial cleavage of segment X (Fig. 181); by trapezoidal outline in ventral aspect, of lateral bulges of segment X; and by long, narrow, dorsally curved median lobe of vulval scale.

Imania bifosa Ross, 1950
(Fig. 125a, 125b, 178-182, 597)

Imania bifosa Ross, 1950b:412, 415-417. (Type locality: Banff, Alberta). Ross and Spencer, 1952:47. Schmid, 1955:43. Schmid, 1968:681-682.

Allomyia bifosa; Fischer, 1967:70.

Males of this species are distinguished from males of other species of the genus by absence of baso-mesal spine on clasper base. Females are distinguished by trapezoidal lateral bulges of segment X.

Description. – Antennae dark brown to black. Vertex of head black. Thorax black to very dark brown. Fore wing length of male 8.5 mm; uniform dark chocolate-brown, appearing black in living insects. Venation of fore and hind wings as in Fig. 125a, 125b.

Male genitalia. (Specimen from Mt. Edith Cavell, Jasper National Park, Alberta). Tergum VIII with single line of long setae parallel to posterior edge. Segment IX very narrow, bowed anterad in lateral aspect. Clasper large, with massive basal article of uniform width (Fig. 178). Basal article with meso-distal edge produced posterad as short, acuminate spine (Fig. 179). Distal article bilobed; ventral lobe thin, parallel sided in lateral aspect; dorsal article irregular, arched dorsad, with heavily toothed ventral surface. Segment X with short, bulbous cercus; median lobes triangular in lateral aspect, curved postero-laterad; intermediate lobes small, located on ventral edges of median lobes. Segment X roof-like, with carinate dorsal ridge. Aedeagus with median shaft curved ventrad; ejaculatory duct terminated in dorsal groove. Two pairs of lateral arms; basal pair long, slender, arched dorsad; distal pair similar but shorter and wider (Fig. 180).

Female genitalia. (Specimen from Mt. Edith Cavell, Jasper National Park, Alberta). Posterior edge of tergum VIII with single line of well spaced setae. Vulval scale with single, median lobe originated from fold of membrane, curved dorsad. Segment IX with semicylindrical dorsum almost completely dissociated from two ventro-lateral lobes around genital cavity (Fig. 182). No evident supra-genital plate. Segment X fused completely with segment IX and cleft mesally very shallowly (Fig. 181).

Notes on biology. – Individuals of this species emerge from cold, alpine streams which originate primarily as glacial melt-water and flow over moraine debris. The adult flight season extends from June 29 to July 22.

Geographical distribution. – The known range of this species is restricted to southern

Alberta and British Columbia (Fig. 597). In Alberta the species is known only from high mountain regions close to the continental divide, at altitudes between 6,000' and 7,500'.

I have examined 116 specimens, 71 males and 45 females, from the study area.

The Genus *Ecclisomyia* Banks

Three species of this genus are known from the study area. Of these one is unidentified as only a single female is known.

Synopsis of characters. – Spur formula 1,3,4. Wings of normal size, elongate; fore wing rather narrowly parabolic; hind wing little larger. Venation complete, almost unmodified. Fore wing with long, narrow, discoidal cell; chord strongly disrupted, posterior part oblique to body. Hind wing with very long discoidal cell, chord not so disrupted, and posteriorly oblique to body (Fig. 128a, 128b).

Male genitalia with lateral walls of segment IX very wide; segment greatly narrowed dorsally and ventrally (Fig. 188, 194). Cercus very large, long, mesally concave. Median lobes of segment X fused in form of long process, concave basally, flattened distally. Clasper small, not recessed into segment IX, of one article, conical, with one or more stout, or long and thin, spines on baso-mesal face (Fig. 189, 195).

Female genitalia with segment IX very large, massive, of one piece. Segment X conical. Supra-genital plate short. Vaginal aperture along entire length of segment IX, partially obstructed by single, median, membranous vulval scale (Fig. 192, 193).

Key to the Males of two species of *Ecclisomyia* found in Alberta and eastern British Columbia

1a. Colour pale yellow-red. Clasper of genitalia with two pairs of long, fine, baso-mesal spines (Fig. 188, 189). Size smaller ..... *E. maculosa* Banks, p. 61.

1b. Colour dark purple-brown. Clasper of genitalia with single, massive, black, heavily sclerotized baso-mesal spine (Fig. 195). Size larger ... *E. conspersa* Banks, p. 62.

Key to the Females of species of *Ecclisomyia* found in Alberta and eastern British Columbia

1a. Colour pale yellow-red. Single median lobe of vulval scale massive, with distinct v-notch on distal edge (Fig. 192); supra-genital plate very large, very deeply cleft mesally. Size smaller ..... *E. maculosa* Banks, p. 61.

1b. Colour dark red-, or purple-brown. Vulval scale and supra-genital plate not as above. Size larger 2a

2a.(1b) Vulval scale very wide, long, rectangular, point of origin in membrane between segments VIII and IX (Fig. 200) ..... *E.* sp. 1, p. 63.

2b. Vulval scale with rectangular tip, membranous, originated imperceptibly from membrane between segments VIII and X (Fig. 199) .. *E. conspersa* Banks, p. 62.

Ecclisomyia maculosa Banks, 1907
(Fig. 128a, 128b, 188-193, 598)

Ecclisomyia maculosa Banks, 1907a:123-124. (Type locality: Boulder, Colorado). Banks, 1907b:40. Dodds and Hisaw, 1925b:386. Essig, 1926:176. Betten, 1934:356. Milne, 1935:37, 50. Ross, 1938b:31. Ross, 1944:300. Denning, 1948b:18. Ross, 1950b:423-425. Denning, 1951:161. Ross and Spencer, 1952:50. Schmid, 1955:59. Anderson, 1967: 508. Fischer, 1967:77-78.

Males of this species are distinguished from males of other species of *Ecclisomyia* by two

pairs of long, fine spines on each clasper (Fig. 188, 189). Females are distinguished by large, distally notched, median lobe of vulval scale. Specimens may be distinguished with the naked eye simply by their small size, and pale yellowish red coloration with scattered irrorations.

Description. – Antennae light yellow-brown; antero-mesal face of scapes paler, glabrous. Vertex of head with antero-mesal area brown bounded by yellow. Thorax pale reddish or yellowish brown. Lateral faces of maxillary palpi black or otherwise; mesal faces light brown to yellow. Lateral faces of front and middle tibiae black. Fore wing length of male 7.9 mm; very light reddish or yellowish brown, uniformly irrorate, except for hyaline costal area. Venation of fore and hind wings as in Fig. 128a, 128b.

Male genitalia. (Specimen from Lake Agnes, Lake Louise, Alberta). Segment IX with wide lateral walls, and narrower but strong dorsal strap (Fig. 188, 189). Clasper of one article, large, longer than thick, with two pairs of long, dark spines on baso-mesal face; basal pair about three times longer than distal pair (Fig. 188). Median lobe of segment X skittle-like in dorsal aspect (Fig. 189), with small dilated tip; laterally fringed with sparse, short, sharp setae. Intermediate lobes short, blunt. Cercus long, rounded, mesally concave. Aedeagus very simple, with dorsally directed, scoop-like tip extended over ejaculatory duct as hood; ejaculatory duct opening in padding of hyaline membrane on ventral surface of dorsal hood (Fig. 190, 191). Distal edge of hood dark brown, with u-shaped mesal notch.

Female genitalia. (Specimen from Lake Agnes, Lake Louise, Alberta). Vulval scale large, with median ridge between two rounded, ventral concavities; sides roughly parallel, posterior edge with shallow, wide v-notch (Fig. 192). Segment IX high, narrow, of one piece (Fig. 193). Tufts of long, yellow setae laterally, about mid-point. Supra-genital plate large, long, rectangular, divided in two rounded, rectangular lobes by very deep v-cleft. Segment X of two rounded, conical lobes joined dorsally toward base; each lobe with mesally directed flanges on basal half of ventral edges (Fig. 192).

Notes on biology. – Individuals of this species emerge from small, riffled mountain creeks, running gently over fine gravel bottoms. The adult flying season extends, in the study area, from July 14 to August 14.

Geographical distribution. – The known range of this species extends from Alberta and British Columbia to Oregon and Colorado (Fig. 598). In Alberta it is confined to the mountains and foothills, ranging in altitude from 4,500' to 7,000'.

I have examined 59 specimens, 54 males and five females, from the study area.

Ecclisomyia conspersa Banks, 1907
(Fig. 194-199, 599)

Ecclisomyia conspersa Banks, 1907b:123. (Type locality: Olympia, Washington). Banks, 1907a:40. Essig, 1926:176. Neave, 1929:189. Betten, 1934:356. Milne, 1935:37, 50. Ross, 1941a:114. Ross, 1944:300. Ross, 1950b:423, 425. Denning, 1951:162. Schmid and Guppy, 1952:42. Ross and Spencer, 1952:50. Schmid, 1955:59. Flint, 1960:24. Denning, 1963:263. Fischer, 1967:76. Lindroth and Ball, 1969:138.

Males of this species are distinguished by massive, black, heavily sclerotized spine on baso-mesal face of clasper (Fig. 195). Females are distinguished by membranous, tapered, rectangular tipped median lobe of vulval scale (Fig. 199).

Description. – Antennae brown; scapes dark brown, antero-mesal faces white in female, pale brown in male. Vertex of head dark brown, posterior edge and angles paler. Thorax light to dark chocolate-brown; warts of terga yellowish. Spurs dark brown. Fore wing length of male 13.8 mm; dark reddish brown, uniformly coloured costal area. Venation as in *E.*

maculosa.

Male genitalia. (Specimen from Kicking Horse Campground, Yoho National Park, British Columbia). Segment IX almost equilateral-triangular in lateral aspect (Fig. 194). Dorsal strap wide, short. Basal half of anterior edges banded with light and dark brown; remainder pale to hyaline. Clasper large, stubby; two articles fused but traces of suture evident. Setae on ventral, disto-ventral, and distal surfaces. Baso-mesal face occupied by massive, black, strongly sclerotized spine (Fig. 195), hooked laterad at tip; base of spine hemispherical. Median lobe of segment X acute-triangular in ventral aspect (Fig. 195), with disto-ventral hook. Intermediate lobes small, setose, placoid. Cercus large, rectangular, distally rounded, slightly concave on mesal face. Aedeagus large, with ejaculatory orifice on large, fleshy lobe between two stout, dark brown, distal spines (Fig. 196). Duct ventral on aedeagus, flanked by two lateral folds. Aedeagal strap roughly triangular (Fig. 197) at attachment point, with two thin straps connected to clasper bases.

Female genitalia. (Specimen from Kicking Horse Campground, Yoho National Park, British Columbia). Sternum VIII divided mesally by band of membrane of two lateral sternites (Fig. 199). Vulval scale rectangular distally, with rippled surface; attached to tapered fleshy extension of sternum VIII. Segment IX massive, trapezoidal in lateral aspect, fused almost imperceptibly to segment X, except ventrally (Fig. 198). Supra-genital plate cleft distally in form of two lobes; plate arched laterally, flanged to form partly enclosed passage to vagina. Segment X large, triangular in lateral aspect, with small notch distally. Ventral edges arched over and beyond anal aperture.

Notes on biology. – Individuals of this species emerge from small to large mountain creeks flowing turbulently over small stone or boulder bottoms. I have observed pupae of this species emerge from Whitehorse Creek, Cadomin, Alberta, at an altitude of about 6,500', on May 21. The pupae crawled out of the water onto streamside boulders or ice indiscriminately, remained still for about 10 minutes, then started to emerge as adults from the pupal skin, which required about 5 minutes. Upon completion of emergence the adults were active, but did not attempt to fly for about another 10-15 minutes. A total of 33 males and 17 females were collected on this occasion. The adult flight season extends from May 17 to September 12 in the study area.

Geographical distribution. – The known range of this species extends from Alaska to California and New Mexico (Fig. 599). In the study area the species is confined to the mountain and foothill areas, ranging in altitude from 2,600' to 7,300'.

I have examined 180 specimens, 131 males and 49 females, from the study area.

Ecclisomyia species 1
(Fig. 200-201, 600)

Only a single female is known to me, which is distinguished from the females of the other species of *Ecclisomyia* treated here by very large, rectangular, median lobe of vulval scale. This lobe has definite point of origin from membrane between segments VIII and IX, and is concave dorsally, convex ventrally (Fig. 200, 201).

Description. – Antennae yellow-brown; scapes darker, with antero-mesal faces almost white, glabrous. Vertex of head dark brown centrally, lighter round edges. Thorax deep yellow-brown laterally, to dark brown dorsally. Spurs brown. Fore wing length of female 15.8 mm; red-brown, heavily irrorate, except for clear costal area. Venation identical to that of *E. maculosa*.

Female genitalia. Vulval scale single, large, rectangular, median lobe (Fig. 200), concave dorsally, convex ventrally, i.e. spatulate. Segment IX massive, trapezoidal in lateral aspect

(Fig. 201). Supra-genital plate short, wide, bilobed. Segment X relatively large, closed dorsally, deeply cleft ventrally; very slightly bilobed distally, with lateral walls constricted antero-ventrad.

Geographical distribution. – The single known female specimen was taken under a road bridge over the Miette River, about 1 mile south of Jasper, Alberta, on highway 93a (Fig. 600), on July 6. It was already dead and trapped in cobwebs.

The Subfamily Apataniinae Ulmer

Head rather long, both sides convex; eyes, ocelli and cephalic warts small. Pronotum short; macrochaetal development slight. Spur formula varied, identical in both sexes of the same species. Wings constant, identical in both sexes; fore wing elongate, obliquely parabolic; hind wing hardly larger than fore, with convex trailing edge; clearly indented at termination of Cu2. Frenulum of three strong spines at base of costa of hind wing; spines curved basally, sharp, flattened distally. Venation complete, somewhat modified. R1 of fore wing of most species arched distally, united to Sc by cross-vein. Chord single line, irregularly disposed. Hind wing with distally open discoidal cell, very short f1 and four anal veins. See Fig. 129a, 129b.

Male genitalia with segment IX lengthened longitudinally slightly; clasper bases enclosed or not. Dorsally segment IX only weakly narrowed, with or without two basal lobes. These lobes various in size, separate or fused together, or fused to median lobes of segment X. Segment X sclerotized, annular, around anus; slightly developed and inconspicuous; with or without three pairs of appendages. Clasper always large, two-articled, movable, pincer-like in certain groups. Distal article various, little reduced. Aedeagus with median shaft and two lateral arms, freely movable.

Female genitalia with segment IX of one piece; wide dorsally, latero-ventrally attenuated with large, conical, ventral lobes. Segment X slender, poorly sclerotized; in some taxa long, tubular, with lateral concavities. Supra-genital plate present in most taxa; membranous or concave, rigid. Vulval scale membranous lobe of sternum VIII or with small lateral lobes. Vaginal aperture along length of sternum IX.

In the study area the subfamily Apataniinae is represented by one genus, *Apatania* Kolenati, of the tribe Apataniini (Martynov). In consequence, no outline of characters of the subfamily or genus is given. The species of *Apatania* are distinguished by the key to subfamilies on page 50. Schmid (1953, 1954a, 1955) presents a detailed account of the subfamily and its constituent taxa.

The Genus *Apatania* Kolenati

This genus is represented in the study area by five species belonging to four groups. One of these species is new.

Key to the Males of species of *Apatania* found in Alberta and eastern British Columbia

1a. Intermediate lobes of segment X with tips hooked antero-laterad, darker than remainder of genitalia (Fig. 206, 207) 2a

1b. Intermediate lobes of segment X not so hooked, not necessarily darker than remainder of genitalia (Fig. 202, 221) 4a

2a.(1a) Lateral arms of aedeagus attached to fleshy dorsal lobes at base; long, laminate blades (Fig. 208, 213) 3a

2b. Attachment of lateral arms not as above; median shaft of aedeagus thick, short,

with bulbous tip (Fig. 218) ..... *A. crymophila* McLachlan, p. 69.

3a.(2a) Median shaft of aedeagus strongly curved ventrad to form half circle (Fig. 208) ..... *A. shoshone* Banks, p. 68.

3b. Median shaft slightly curved ventrad, of irregular outline (Fig. 213) ..... *A. stigmatella* (Zetterstedt), p. 67.

4a.(1b) Clasper very long, slender (Fig. 221) ..... *A. alberta* Nimmo n. sp., p. 70.

4b. Clasper very short; distal article bilobed (Fig. 202) ..... *A. zonella* (Zetterstedt), p. 65.

Key to the Females of species of *Apatania* found in Alberta and eastern British Columbia

1a. Segment X separate and distinct from segment IX (Fig. 219, 224) 2a

1b. Segments X and IX fused solidly together (Fig. 204, 210, 214) 3a

2a.(1a) Median lobe of vulval scale abruptly widened distally to rectangular tip (Fig. 225) ..... *A. alberta* Nimmo n. sp., p. 70.

2b. Median lobe short, simple (Fig. 220) ..... *A. crymophila* McLachlan, p. 69.

3a.(1b) Segment X large, visible, fused solidly to segment IX; with acuminate distal lobes (Fig. 204, 214) 4a

3b. Segment X minute, concealed by posterior lobes of segment IX; segment IX massive, formless, rounded ..... *A. shoshone* Banks, p. 68.

4a.(3a) Segments IX and X fused (Fig. 214) ..... *A. stigmatella* (Zetterstedt), p. 67.

4b. Ventro-lateral lobes of segment IX present, distinct, separated by broad band of membrane (Fig. 204) ..... *A. zonella* (Zetterstedt), p. 65.

The *fimbriata* group

One species of this group is presently known from the study area.

Synopsis of characters. – Fore wing sexual dimorphism strong in certain species; male fore wing stigma well marked or not; C thickened. R1 of hind wing arched at stigma or not, in contact with Sc.

Male genitalia with cerci and median lobes only of segment X present, free (except in *A. kyotensis*), large in most species. Cerci long, simple, like slender pegs in most species. Claspers medium sized; distal article distinct; small, bilobed in certain species. Aedeagus spinate; lateral arms laminate blades.

Female genitalia with dorsum of segment IX not prominent; simple and convex; shortened in some species. Supra-genital plate sclerotized, fused solidly to segment X. Segment X short, small, as large as segment IX.

Apatania zonella (Zetterstedt), 1840
(Fig. 129a, 129b, 202-205, 600)

Phryganea stigmatella var. *zonella* Zetterstedt, 1840:1066. (Type locality; Lapland).
Apatelia zonella; (Literature Palaearctic; see Fischer, 1967:125-126).
Apatidea zonella; (Literature Palaearctic; see Fischer, 1967:126).
Apatania zonella; Schmid, 1953: Fig. 1. Schmid, 1954a:30-34. Schmid, 1955:82. Flint, 1960:26. Corbet, 1966:981. (For Palaearctic literature see Fischer, 1967:126).
Goniotaulius arctica Boheman, 1865. (Literature Palaearctic; see Fischer, 1967:127-129).
Goniotaulius arcticus; (Literature Palaearctic; see Fischer, 1967:127).
Apatelia arctica; (Literature Palaearctic; see Fischer, 1967:127-128).
Apatidea arctica; (Literature Palaearctic; see Fischer, 1967:129).

Radema arctica; Ross, 1944:297.
Apatidea auricula not Forsslund; (Literature Palaearctic; see Fischer, 1967:129).
Apatania groenlandica Kolbe, 1912. See Fischer, 1967:129.
Apatelia groenlandica; See Fischer, 1967:129.
Radema groenlandica; Ross, 1944:297.
Apatania inornata Wallengren, 1886. See Fischer, 1967:129.
Apatelia inornata; See Fischer, 1967:129.
Apatania palmeni Sahlberg, 1894. See Fischer, 1967:129-130.
Apatidea palmeni; See Fischer, 1967:130.
Apatelia palmeni; See Fischer, 1967:130.
Apatania stigmatella not Zetterstedt; See Fischer, 1967:130.
Apatania zonella (Zetterstedt) var. *dalecarlica* Forsslund; See Fischer, 1967:130.

Males of this species are distinguishable from males of other species of *Apatania* by very short claspers, with bilobed distal article (Fig. 202). Females are distinguishable by acuminate postero-ventral lobes of segment X and presence of ventro-lateral lobes of segment IX (Fig. 204).

Description. – Antennae dark brown; scapes with antero-mesal faces glabrous. Vertex of head black. Thorax very dark brown. Femora of legs irregularly patterned with dark and lighter brown. Spurs yellow-brown. Fore wing length of male 8.5 mm; translucent dark brown, with thick, irregular stigma. Venation of fore and hind wings as in Fig. 129a, 129b. Stigma of female fore wing weaker than male.

Male genitalia. (Specimen from Lake Hazen, Ellesmere Island, Northwest Territories). Tergum VIII with irregular single row of long setae parallel to posterior edge. Segment IX with narrow dorsal strap pinched in at each side as distinct crown; segment gradually expanded ventrad (Fig. 202). Clasper stout, short, with basal article laterally flattened, narrowed basally, disto-ventrally with long setae. Distal article bilobed; ventral lobe flattened dorso-ventrally, directed mesad. Segment X with irregularly dentate, pedicilate cerci. Median lobes large, hooked ventrad distally, with smooth dorsal edges and irregularly dentate ventral edges. Intermediate lobes fused in form of small, ventrally hooked lobe ventrad of median lobes. Aedeagus simple, with large, warped, sword-like lateral arms attached to membranous base dorsad of median shaft (Fig. 203). Median shaft arched dorsad, distally acuminate, bilobed, with cluster of basally directed spines disto-ventrally.

Female genitalia. (Specimen from Vermilion Lakes, Banff, Alberta). Posterior edge of sternum VII with narrow band of short, hyaline hairs. Vulval scale with single, median lobe (Fig. 205), slightly rugose distally. Segment IX small, parallel-sided in lateral aspect (Fig. 204); with large, irregular latero-ventral lobes separated by band of membrane. Supra-genital plate not evident. Segment X larger than IX with wide, smooth, warped ventral surface. Dorsal surface concave laterally, with median ridge.

Notes on biology. – This species is known to me in the study area from only two localities of the most opposite characteristics. The first is Lake Agnes, at Lake Louise, in Banff National Park, Alberta, at an altitude of 6,885', in the alpine meadows. The second is Vermilion Lakes just west of Banff, Alberta, at an altitude of 4,538'. This locality is a dense, valley bottom swamp in the Bow River valley. The collecting dates were July 21, and July 5 respectively.

Geographical distribution. – The known range of this species is Holarctic, extending in North America, from northernmost Canada (Ellesmere Island) to British Columbia, Montana, and Minnesota (Fig. 600).

I have examined three females of this species from the study area, and one male and seven females from Lake Hazen, Ellesmere Island, Northwest Territories.

The *stigmatella* group

Two species belonging to this group are known from the study area.

Synopsis of characters. – Cerci and intermediate lobes of male segment X large, massive, concave mesally. Median lobes of segment X on mesal faces of intermediate lobes (Fig. 207); very short and slender. Female genitalia with segment IX very long, without latero-ventral lobes (Fig. 210). Supra-genital plate poorly developed. Segment X very small.

Apatania stigmatella (Zetterstedt), 1840
(Fig. 211-215, 602)

Phryganea stigmatella Zetterstedt, 1840:1066. (Type locality: Lapland).
Limnephilus stigmatellus; Walker, 1852:50.
Apatania stigmatella; Ulmer, 1907a:76. Banks, 1907a:41. Banks, 1908b:61, 64. Dodds and Hisaw, 1925b:386. Ulmer, 1932:215. Betten, 1934:379-380. Schmid, 1953: Fig. 4m. Schmid, 1954a:13-14. Schmid, 1955:82. Flint, 1960:28. Fischer, 1967:118-121. Smith, 1969:48.
Parapatania stigmatella; See Fischer, 1967:119.
Apatelia stigmatella; Milne, 1935:25, 49. Ross, 1938b:29.
Radema stigmatella; Ross, 1944:297. Kimmins and Denning, 1951:121-122. Unzicker, 1968:4, 20, 54.
Apatania pallida Hagen, 1861:270. Hagen, 1864:805. Banks, 1892:364. Ulmer, 1905a:23. Ulmer, 1907a:76. Banks, 1907a:41. Thienemann, 1926:274. Betten, 1934:379. Milne, 1935:49. Ross, 1938b:29.
Apatania frigida McLachlan, 1867:57-58. Brauer, 1876:287. Milne, 1935:49. Kimmins and Denning, 1951:121-122.

Males of this species are distinguished by irregularly sinuate median shaft of aedeagus (Fig. 213), and by distal tooth set dorsally on intermediate lobes of segment X (Fig. 211). Females are distinguished by absence of latero-ventral lobes of segment IX, by segment X visible in lateral aspect (Fig. 214), and by simple, narrow, median lobe of vulval scale (Fig. 215).

Description. – Antennae brown; scapes white, with antero-mesal faces brown, glabrous. Vertex of head black, warts white. Thorax dark brown to almost black dorsally. Femora blotchy brown, light brown, hyaline. Spurs brown. Fore wing length of male 9.6 mm; light, clear yellow-brown, no pattern. Venation identical with that of *A. zonella.*

Male genitalia. (Specimen from Simpson Islands, Great Slave Lake, Northwest Territories). Tergum VIII with single row of long, well spaced setae parallel to posterior edge. Segment IX roughly rectangular, wider laterally (Fig. 211); dorsal strap segregated by two lateral grooves, bulged slightly dorsad. Clasper massive, with cylindrical, fluted basal article; distal article semi-circular, claw-like, fringed internally with long setae (Fig. 211, 212). Segment X with large, flared, triangular cerci. Median lobes long, thin, merged basally with cerci. Intermediate lobes complex, dark, with dorsal processes closely associated with cerci and laterad of them; with distal lateral and dorsal teeth. Aedeagus with median shaft irregularly sinuate (Fig. 213); aperture of ejaculatory duct disto-dorsad, between lateral flaps; lateral arms mounted dorsad of median shaft, long, slender, laminate blades.

Female genitalia. (Specimen from Simpson Islands, Great Slave Lake, Northwest Territories). Posterior edge of sternum VII with wide band of short, hyaline hairs. Vulval scale single, strongly dorsally curved median lobe (Fig. 214, 215). Segment IX large, irregular, with large postero-ventral cavity. Segment X small, with anterior edges slanted from vertical

(Fig. 214); anal cavity distinct.

Geographical distribution. – The known range of this species is Holarctic; in North America it extends from Alaska to Colorado, in the south, and Newfoundland, in the east (Fig. 602). The Colorado record is curious and, I suspect, open to some doubt. The species has not yet been recorded from Alberta but is included here as there is a high probability of it occurring in the far north of the province, which is similar to the area surrounding Great Slave Lake, and less than 100 miles distant.

I have examined a single specimen of each sex, from Great Slave Lake. These were taken on August 29.

Apatania shoshone Banks, 1924
(Fig. 206-210, 601)

Apatania shoshone Banks, 1924:442. (Type locality: Yellowstone National Park, Wyoming).
Schmid, 1954a:15-16. Schmid, 1955:82. Fischer, 1967:117. Smith, 1969:48.
Apatania shoshone; Betten, 1934:380.
Apatelia shoshone; Milne, 1935:25, 49. Ross, 1938b:29.
Radema shoshone; Ross, 1944:297.

Males of this species are distinguished by long, slender distal hooks of intermediate lobes of segment X (Fig. 206), and by strongly ventrally curved median shaft of aedeagus (Fig. 208). Females are distinguished by massive, formless segment IX, and minute segment X (Fig. 209, 210).

Description. – Antennae dark brown; antero-mesal face of scapes yellow, glabrous. Vertex of head very dark brown. Thorax dark brown, with interspersed lighter areas. Spurs yellow. Fore wing length of male 8.3 mm; pale, clear brown. Cross-vein Cu-R1 white line across stigma. Venation identical to that of *A. zonella*.

Male genitalia. (Specimen from Waterton National Park gate, Hwy. 5, Alberta). Tergum with single line of long, well spaced setae parallel to posterior edge. Segment IX of roughly uniform width throughout, sinuate (Fig. 206). Clasper massive, with cylindrical basal article, and smaller distal article strongly hooked mesad, with ventral tooth (Fig. 206, 207). Segment X with short, cylindrical median lobes, projecting, triangular cerci, and large, dark, trifid intermediate lobes hooked antero-laterad distally (Fig. 206, 207). Median shaft of aedeagus stout, curved strongly ventrad; ejaculatory pore in membranous area between distal flaps (Fig. 208). Lateral arms long, each laminate blade on single membranous dorsal process of aedeagal base.

Female genitalia. (Specimen from Cameron Lake, Waterton National Park, Alberta). Vulval scale of single median lobe; rectangular except for slightly expanded tip; distal end of lobe rugose ventrally (Fig. 209). Segment IX massive, of indefinite shape (Fig. 210); open ventrally and posteriorly with two short lateral lobes laterad of segment X and posterior opening. Supra-genital plate small, membranous, ventrad of postero-dorsal opening of segment IX. Segment X minute, bilobed, between lateral lobes of segment IX.

Notes on biology. – I am uncertain as to the possible emergence sites of this species. The single female from the Waterton Park gates may have emerged from the adjacent Waterton River, or flown in from the nearby Maskinonge Lake. The remainder of my records are from locations adjacent to large lakes. The adult flight season extends from July 23 to August 19.

Geographical distribution. – The known range of this species extends from Alberta to Colorado (Fig. 601). In Alberta I have records from the extreme south west corner of the province, at altitudes between 4,189' and 5,445'.

I have examined 19 specimens, 14 males and five females, from the study area.

The *wallengreni* group

One species belonging to this group is known to occur in the study area.

Synopsis of characters. – Fore wing stigma usually weak; costal vein not thickened. Sc and R1 of hind wing parallel throughout.

Male genitalia with segment IX narrow. Cerci setose, slightly concave mesally; triangular and projected well posterad (Fig. 216). Median lobes of segment X very slender; separate, or fused. Claspers unmodified, elongated, not thick, with basal article cylindrical; distal article as long as basal or shorter, sickle shaped in most species.

Female genitalia with dorsal part of segment IX characteristic, with pits and ridges, large; ventral lobes prominent (Fig. 219). Segment X long, slender; 1/3-1/4 times diameter of segment IX; quite divided to dorsal and ventral parts in certain species. Supra-genital plate triangular, shorter than segment X, weakly sclerotized.

Apatania crymophila McLachlan, 1880
(Fig. 216-220, 601)

Apatania crymophila McLachlan, 1880:44. (Type locality: Northwest Siberia). Ulmer, 1905a:23. Ulmer, 1907a:76. Schmid, 1954a:5-6. Schmid, 1955:81. Fischer, 1967:102-103. (For references to Palaearctic literature see Fischer, 1967).

Apatelia aenicta Ross, 1938c:162-163. (Type locality: Churchill, Manitoba). Schmid, 1954a: 5.

Radema aenicta; Ross, 1944:297.

Males of this species are distinguished from males of other species of *Apatania* by dilated, heavily setose, distal article of clasper (Fig. 216), and by short, crooked, distally bulbous, median shaft of aedeagus (Fig. 218). Females are distinguished by simple median lobe of vulval scale (Fig. 220), and segment X distinctly separated from segment IX (Fig. 219).

Description. – Antennae dark brown to almost black. Vertex of head black. Thorax black. Legs black to deep brown. Spurs red-brown. Fore wing length of male 9.8 mm; uniform greyish brown, with large, opaque, stigmatic area. Venation identical to that of *A. zonella*.

Male genitalia. (Specimen from Simpson Islands, Great Slave Lake, Northwest Territories). Postero-dorsal edge with single line of long setae. Segment IX high, narrow (Fig. 216); with row of about six short, heavy setae near clasper base. Clasper massive, with laterally compressed distal article heavily setose. Median lobes of segment X sinuate, bilobed; cerci attached laterad of median lobes, distally splayed. Intermediate lobes massive, hooked plates (Fig. 216, 217). Median shaft and lateral arms of aedeagus attached to common base (Fig. 218); lateral arms dorsad of median shaft. Median shaft distally bulbous, tip directed ventrad. Lateral arms as long as median shaft, thin, recurved.

Female genitalia. (Specimen from Simpson Islands, Great Slave Lake, Northwest Territories). Sternum VII with posterior edge clothed by broad band of scattered, fine, hyaline hairs. Vulval scale small, short, rectangular, disto-ventrally rugose, median lobe (Fig. 220). Segment IX high, narrow, parallel-sided, with broad, short, lateral lobes laterad of segment X (Fig. 219). No apparent supra-genital plate. Segment X with bilobed portion, and fused, plate-like, median lobes with common central spur (Fig. 219).

Geographical distribution. – The known range of this species is Holarctic; in North America it extends from Alaska to Manitoba (Fig. 601). It is not yet recorded from Alberta, but occurs in Great Slave Lake, Northwest Territories, which is so close to the northern boundary of Alberta that it is reasonable to expect that it occurs in the Province.

I have examined 71 specimens, 43 males and 28 females, from Simpson Islands, Great Slave Lake.

The *complexa* group

One species belonging to this group is known from the study area, and is here described as new.

Synopsis of characters. – Male genitalia slightly enlarged. Segment IX with very long, slender, paried, dorsal lobes (Fig. 221); fused with marked median channel or not. Cerci small, oval. Intermediate lobes of segment X very long, slender. Median lobes varied in size, small in some species, slender; interlocked with lobes of segment IX, shorter. Claspers varied. Basal article long, cylindrical. Distal article much shorter, spinate; in some species long, spiniform. Aedeagus short, stout.

Female genitalia with segment IX long throughout (Fig. 224). Segment X long, divided to dorsal and ventral parts. Supra-genital plate very short, thick, unsclerotized, fused to segment IX.

Apatania alberta Nimmo n. sp.
(Fig. 221-225, 602)

Males of this species are distinguished from males of other species of *Apatania* by aedeagus (Fig. 221) with lanceolate lateral arms attached laterad of aedeagal base at point where aedeagus bends sharply ventrad. Females are distinguished by single, median lobe of vulval scale abruptly broadened distally into rectangular head (Fig. 225).

Description. – Antennae very dark brown to black. Vertex of head black, setae hyaline. Thorax quite black. Spur formula 1,2,4; brown. Fore wing length of male 8.5 mm; uniform black. Cross-vein C-R1 white. Venation identical to that of *A. zonella*.

Male genitalia. (Specimen from Rapids Creek, Gap, Alberta). Tergum VIII with distinct postero-distal ridge with single row of long setae. Segment IX with high-peaked dorsal strap (Fig. 221); gradually widened ventrad, with small postero-ventral process. Clasper long, slender, with tip of distal article with short, stout setae. Base of proximal article with slight lateral depression; distal portion of article with long, slender setae. Segment IX with paired postero-dorsal processes, long, tapered, acuminate blades, fused basally. Median lobes of segment X directed postero-laterad, bilobed, with ventral lobe smaller; dark brown. Intermediate lobes ventrad of median lobes, with bifid base recessed into segment IX, and long, rounded, distally slightly dilated process in lateral aspect (Fig. 221). Intermediate lobes acute triangular plates in dorsal aspect (Fig. 223); abruptly pinched off at tip. Cercus small, dark, triangular, dorso-laterad of median lobe bases. Aedeagus with semi-cylindrical median shaft; open on dorsal surface (Fig. 221, 222). Lateral arms angular, directed dorso-laterad, attached laterad of aedeagal base.

Female genitalia. (Specimen from Rapids Creek, Gap, Alberta). Sternum VII with posterior edge clothed with short, hyaline hairs. Vulval scale with single, massive, median lobe (Fig. 224, 225); distal portion abruptly expanded laterally, rectangular, ventrally rugose. Segment IX large, semi-rectangular in lateral aspect (Fig. 224), with slightly expanded ventral portion. No evident latero-ventral lobes, or supra-genital plate. Segment X distinct from segment IX, rounded rectangular in lateral aspect, with disto-lateral clefts; with membranous ventral lobe dorsad of vaginal orifice; segment X completely open ventrally.

Notes on biology. – Adults of this species are usually associated with small, turbulent creeks, but, on occasion, some are near large, smooth-flowing rivers. A flight season from

May 5 to June 22 is indicated.

Geographical distribution. – To date this species is known only from the Banff area of Alberta (Fig. 602). All records are from areas at about 4,250' to 4,550' altitude.

I have examined 17 specimens, four males and 13 females, from the study area.

Holotype. – Male. Rapids Creek, Gap, Alberta; June 15, 1967; A. Nimmo.

Allotype. – Female. Same data as holotype.

Paratypes. – Same data as holotype; four females. Forty Mile Creek at Trans-Canada Hwy., Banff National Park, Alberta; June 15, 1967; A. Nimmo; five females. Bow River at Trans-Canada Hwy., Canmore, Alberta; A. Nimmo; one male, three females. As previous record; May 23, 1967; A. Nimmo; one male. Road to Sundance Canyon, Banff, Alberta; June 22, 1962; G. B. Wiggins; one male.

The type series has been assigned the type number 10,584 in the Canadian National Collection, Ottawa.

The holotype, allotype, and seven female paratypes are in the Canadian National Collection. One male and two female paratypes are in the Royal Ontario Museum, Toronto, Ontario. One male and two female paratypes are in the United States National Museum, Washington. The remaining male and female paratypes are in the collection of the Strickland Museum, Dept. of Entomology, University of Alberta, Edmonton, Alberta.

This species is named for the Province of Alberta.

The Subfamily Neophylacinae Schmid

Head short, large, eyes prominent. Ocelli small, placed well anterad. Pronotum short, chaetose. Spur formula 1,2,2; 1,2,3; 1,2,4; 1,3,3; or 1,3,4. Meso-apical spur of male hind leg modified in certain taxa. Wings rather variable, not reduced. Fore wings narrow, but greatly widened at chord in some taxa. Hind wings shorter than fore. Fore wings irrorate in certain taxa, hind wings darkened. Frenulum large; subcosta of hind wing with three to four very long, basal spines. Fore wing venation complete; hind wings rather incomplete, with strong sexual dimorphism. Fore wing R1 strongly arched at stigma, in some taxa united to Sc by cross-vein. Discoidal cell long, narrow; chord strongly disrupted. Hind wings of *Oligophlebodes* and *Neothremma* with much reduced but constant venation coupled with sexual dimorphism.

Male genitalia of short pieces in form of peculiar massive ensemble. Segment VIII setiferous. Segment IX very large, enclosing remainder of genitalia, especially claspers; strongly convex ventrally in form of plate fused to claspers; segment with pronounced lateral relief (*Oligophlebodes*) or large appendage (*Neothremma*); dorsally very narrow, indistinguishable from segment X. Dorsal lobes absent. Segment X visible only by three pairs of appendages. Claspers small, not prominent, well recessed into segment IX; two articled, with basal article reduced. Aedeagus, except in *Neothremma*, emergent from centre, or higher, of segment IX; slender, barely movable; lateral arms present or absent.

Female genitalia with segments IX and X very small, closely fused. Segment IX of two distinct parts; dorsal part short, or vestigial. Segment X fairly large, prominent, of two large, lateral, quite distinct pieces; narrowly cleft dorsally, quite open ventrally. Vaginal aperture wide and open on segment IX. Vulval scale simple or bilobed, attached to segment IX. Ventral lobes of segment IX more or less fused to vulval scale.

Key to the Genera of Neophylacinae in Alberta and eastern British Columbia

1a. Segment X of male two blunt lobes and two protuberant appendages (Fig. 226). Clasper small, recessed into segment IX. Ventral lobes of female segment IX large,

fused anterad of vulval scale (Fig. 230) ..... *Oligophlebodes*, p. 72.

1b. Segment X of male two very long blades strongly hooked ventrad (Fig. 244). Mesal face of segment IX with long, bilobed spine. Claspers almost entirely fused. Ventral lobes of female segment IX quite free (Fig. 248) ..... *Neothremma*, p. 75.

The Genus *Oligophlebodes* Ulmer

This genus is represented in the study by three species, one of which is described as new.

Synopsis of characters. – Spur formula 1,3,3. Apico-mesal spur of hind tibia thickened basally, bristled on mesal face. Fore wing obliquely parabolic apically; hind wing slightly larger, notched apically (Fig. 131). Venation constant, sexually dimorphic on hind wings. R1 of fore wing joined to Sc by short cross-vein; chord disrupted little; posteriorly oblique to body. R5 absent in male hind wing; only f2 present. Female hind wing with f1, f2, and f5 present.

Male genitalia with segment IX strongly developed, with pronounced lateral process attached to median lobes of segment X. Median lobes of segment X rounded, concave, separated by wide space. Aedeagus very small, embedded in membranous mass, very high in segment IX. Claspers small, recessed in fissure of segment IX.

Female genitalia with ventral lobes of segment IX transverse plates, massive, not prominent, weakly sclerotized, fused to ventral surfaces of vulval scale; also fused to sternum VIII.

Key to the Males of species of *Oligophlebodes* found in Alberta and eastern British Columbia

1a. Distal spine of clasper, short, curved dorsad (Fig. 238) ..... *O. zelti* Nimmo n. sp., p. 74.

1b. Distal spine of clasper straight (Fig. 226), or with disto-ventral tooth (Fig. 232) 2a

2a.(1b) Distal spine of clasper long, slender, straight (Fig. 226) .... *O. ruthae* Ross, p. 72.

2b. Distal spine of clasper short, stout, with disto-ventral tooth (Fig. 232) ..... *O. sierra* Ross, p. 73.

Key to the Females of species of *Oligophlebodes* found in Alberta and eastern British Columbia

1a. Segment X in ventral aspect deeply cleft, lateral lobes roughly triangular (Fig. 231) ..... *O. ruthae* Ross, p. 72.

1b. Segment X in ventral aspect not deeply cleft, or, if so, not widely separated or triangular (Fig. 237, 243) 2a

2a.(1b) Lateral lobes of segment X closely appressed, vulval scale latero-ventrally excavated (Fig. 237) ..... *O. sierra* Ross, p. 73.

2b. Lateral lobes of segment X in ventral aspect bilobed (Fig. 243), with semi-circular dorsal lobes ..... *O. zelti* Nimmo n. sp., p. 74.

Oligophlebodes ruthae Ross, 1944
(Fig. 130a, 130b, 131a, 131b, 226-231, 603)

Oligophlebodes ruthae Ross, 1944:283, 285, 300. (Type locality: Roe's Creek, Glacier National Park, Montana). Ross, 1949b:127-128. Ross and Spencer, 1952:50. Schmid, 1955:99. Fischer, 1967:155. Schmid, 1968:687.

Males of this species are distinguished from males of other species of *Oligophlebodes* by long, straight distal spine of clasper (Fig. 226). Females are distinguished by deeply divided, well separated, triangular lateral lobes of segment X in ventral aspect (Fig. 231).

Description. – Antennae dark brown; scapes somewhat darker. Vertex of head uniformly dark brown. Thorax more or less uniform dark brown. Spur formula 1,2,2, in both sexes in specimens examined here. Male only with mesal spur of hind leg swollen basally; curved, with short, thin process on inner face of curve. Fore wing length of male 7.4 mm; uniform light yellow to yellow-brown. Venation of male and female wings as in Fig. 130-131.

Male genitalia. (Specimen from Cameron Creek, Waterton National Park, Alberta). Tergum and sternum VIII each with single, distinct row of long setae parallel to posterior edge. Segment IX with high, thin dorsal strap and small, thin, irregular ventral body (Fig. 226). Ventral area produced posterad as long, narrow, triangular plate, ventrad of claspers (Fig. 227). Clasper fused to segment IX, large, complex, partly recessed into segment IX; with distinct, basally directed, long, dark, distal tooth; in ventral aspect tooth hooked mesad (Fig. 226, 227). Segment X with cerci trapezoidal, small. Median lobes well separated, with setose posterior edges. Lateral arms of aedeagus close to base of ejaculatory duct projected below them (Fig. 228, 229); distal end of lateral arms curved mesad.

Female genitalia. (Specimen from Cameron Lake, Waterton National Park, Alberta). Posterior edge of sternum VII with narrow fringe of short, fine setae. Vulval scale small, semi-circular, dark, median lobe partly enclosed ventrally by ventro-lateral lobes of segment IX (Fig. 231). Segment IX rectangular in ventral aspect, internally hollow, with ventral cleft; in effect large hood. Supra-genital plate not evident. Segment VIII with simple invagination on postero-lateral edge. Segment X bilobed (Fig. 231); lobes connected only basally; fused almost imperceptibly to segment IX (Fig. 230).

Notes on biology. – The adult flight season extends from July 3 to August 29. The adults appear to emerge from the mountain creek type of stream, ranging from relatively slow, gentle, gravel-bottomed foothills creeks to the more torrential, boulder strewn creeks.

Geographical distribution. – The known range of this species extends from Alberta and British Columbia to Oregon and Utah (Fig. 603). In Alberta it is found only in the mountain and foothill areas, ranging in altitude from about 5,000' to 6,000'.

I have examined 52 specimens, 35 males and 17 females, from the study area.

Oligophlebodes sierra Ross, 1944
(Fig. 232-237, 604)

Oligophlebodes sierra Ross, 1944:283, 284-285, 300. (Type locality: Dana Fork, Tolumne River, Yosemite National Park, California). Ross, 1949b:127. Ross and Spencer, 1952:50. Schmid, 1955:99. Flint, 1960:32. Denning, 1963:261-262. Smith, 1965:244. Fischer, 1967:144. Schmid, 1968:685, 687.

Males of this species are distinguished from males of other species of *Oligophlebodes* by short, stout distal spine of claspers, with disto-ventral tooth (Fig. 232). Females are distinguished by closely appressed lateral lobes of segment X, and by ventro-lateral concavities of vulval scale.

Description. – Antennae light brown. Vertex of head uniform reddish brown. Thorax uniformly yellow or pale purplish brown. Spur formula 1,3,3; meso-apical spur of male hind tibia swollen basally, with short, thin process on inner edge of curve. Fore wing length of male 7.6 mm; uniform pale brown, almost hyaline; no pattern except for pale grey stigma. Venation identical to that of *O. ruthae*.

Male genitalia. (Specimen from Athabasca River, Entrance, Alberta). Tergum and sternum of segment VIII with single rows each of setae parallel to posterior edges. Segment IX with small ventral body; high, very thin dorsal strap (Fig. 232). Clasper relatively large, fused to segment IX, distally black, with small disto-ventral tooth; with distinct, mesally directed, horizontal hooks (Fig. 233). Segment X with median lobes well separated, with irregularly dentate edges, and with distinct medially directed process (Fig. 233). Cercus large, rounded triangular, attached to horizontal dorsal edge of segment IX. Aedeagus minute; ejaculatory duct syringe-like, with bulbous inner end at attachment of membranous sperm duct (Fig. 234, 235); otherwise straight tube. Lateral arms dorsad and posterad of duct, overhung by large fold of hyaline membrane.

Female genitalia. (Specimen from Idaho; in Illinois National History Survey). Tergum VIII very large, separated from small, ventral sternum by wide band of folded membrane (Fig. 236); with row of strong setae parallel to posterior edge. Vulval scale single, median, dark, ventro-laterally concave lobe (Fig. 237). Segment IX fused almost indistinguishably to segment X; antero-laterally invaginated anterad into segment VIII. Segment X of two closely appressed lateral lobes.

Notes on biology. – My only record of this species in the study area is a single male taken at black-light about 100' above the Athabasca River, at the point where the Forestry Trunk Road crosses, at Entrance, Alberta. At that point the river is quite turbulent, with an obviously rocky bed. The date was July 25.

Geographical distribution. – The known range of this species extends from Alberta and British Columbia to California and Colorado (Fig. 604). The only Alberta record as given above was at an altitude of about 3,270'.

Oligophlebodes zelti Nimmo n. sp.
(Fig. 238-243, 604)

Males of this species are distinguished from males of other species of *Oligophlebodes* by short, black, dorsally curved distal lobes of claspers (Fig. 238), which are more widely separated than in the similar *O. sigma* (Fig. 239). Also ventral plate of segment IX prominent, horizontal and projected further posterad than in *O. sigma*. Females are distinguished by bilobed lateral lobes of segment X in ventral aspect (Fig. 243).

Description. – Antennae light to dark brown. Vertex of head dark brown. Thorax uniform dark reddish brown. Spur formula 1,2,2; meso-apical spurs of male hind legs basally enlarged, claw-like, with small spine basally, on inside of claw. Fore wing length of male 8.4 mm; pale yellowish brown, no pattern. Venation identical to that of *O. ruthae*.

Male genitalia. (Specimen from South Creek, Forestry Trunk Road, 20 miles south of Nordegg, Alberta). Segment VIII with single band of long, fine setae each side of tergum, parallel to posterior edge. Segment IX with high, narrow dorsal strap, with large, rounded triangular ventral body, and with short, dark, triangular plate projected posterad, ventrad of claspers (Fig. 238, 239). Clasper distally black, with distal process curved dorsad; in ventral aspect tip hooked mesad, otherwise squat triangular. Segment X with membranous median lobe and large, rectangular, setose, lateral lobes. Cercus small, dark, trapezoidal. Aedeagus with short, stout ejaculatory tube surmounted by two dark, bowed, lateral arms slightly bulbous distally (Fig. 240, 241). Median shaft of aedeagus surmounted by rectangular, membranous mass lightly spinate dorsally. Sperm duct passed anterad by way of large, oval aperture situated ventrally on membranous aedeagal sheath.

Female genitalia. (Specimen from South Creek, at Forestry Trunk Road, 20 miles south of Nordegg, Alberta). Posterior edge of sternum VII with narrow band of short, fine well

spaced setae. Vulval scale dark, table-like on median stalk (Fig. 243). Segment IX trapezoidal, with antero-lateral invaginations hooked ventrad (Fig. 242). Ventro-lateral lobes of segment IX square in lateral aspect, triangular in ventral aspect. Segment X fused smoothly to segment IX, except dorsally, where slight demarcation is noticeable; roughly triangular in lateral aspect; cleft dorsally. Segments IX and X together form large, cavernous hood, entirely open ventrally.

Notes on biology. – Individuals of this species emerge from small, turbulent, boulder or coarse gravel mountain streams. The adult flying season extends from July 14 to August 19.

Geographical distribution. – This species is presently known only from the mountains and foothills of Alberta (Fig. 604) between 4,700' and 5,500' in altitude.

I have examined 55 specimens, 16 males and 39 females, from the study area.

Holotype. – Male. South Creek, Forestry Trunk Road, 20 miles south of Nordegg, Alberta; August 8, 1965; A. Nimmo.

Allotype. – Female. Same data as for holotype.

Paratypes. – Same data as for holotype; 36 females. Same data as for holotype, except July 14, 1967; one male. Red Earth Creek, Trans-Canada Highway, Banff National Park, Alberta; July 30, 1967; A. Nimmo; one male. Helen Creek, Banff-Jasper Hwy., north of Lake Louise, Alberta; August 10, 1967; A. Nimmo; one female. Rowe Brook, Waterton National Park, Alberta; August 19, 1965; A. Nimmo; one male. Lynx Creek, Forestry Trunk Road, north of Clearwater River, Alberta; July 14, 1967; A. Nimmo; five males, one female. South Creek, Forestry Trunk Road, 20 miles south of Nordegg, Alberta; August 12, 1968; A. Nimmo; five males, one female. Wampus Creek, Cadomin, Alberta; August 18, 1967; K. Zelt; one male.

The type series has been assigned the type number 10,589 in the Canadian National Collection.

The holotype, allotype, and three male and 36 paratypes are in the Canadian National Collection. The Lynx Creek paratypes are in the Strickland Museum, Dept. of Entomology, University of Alberta, Edmonton, Alberta. One male and one female paratype are in the United States National Museum.

This species is named for Ken Zelt, a graduate student in the Dept. of Zoology, University of Alberta, who collected a single male near Cadomin.

The Genus *Neothremma* Banks

Two species of this genus are known from the study area.

Synopsis of characters. – Lateral ocelli almost immediately posterad of exceptionally large anterior cephalic warts. Spur formula 1,3,4. Maxillary palpus of male with long brush of distally hooked setae (Fig. 249). Fore wing venation unmodified; hind wing venation much reduced, with some sexual dimorphism. Fore wing f3 tapered proximally to point; chord strongly irregular (Fig. 132a). Hind wing with minute discal cell, f1 with long proximal stem; male M1+2, M3+4, Cu1, Cu2 all separate; with three anal veins. In the female hind wing M similar but Cu of three veins.

Male genitalia with segment IX well developed, not enclosing any appendages; laterally with very long, bifid, sclerotized lobe directed postero-mesad. Segment X much smaller than IX, well separated; median lobes long, simple, postero-ventrally arched blades, well separated basally by membrane of anus (Fig. 244). Clasper along ventral edges of segment IX; two-articled, with basal article of each clasper fused mesally as ventral plate; distal article baso-dorsad on basal article; large, fused to segment IX, covered with distinct tubercles.

Female genitalia with segment IX of two pieces (Fig. 247). Segment X of two large dorsal pieces, and ventral scale. Vulval scale large, bifid (Fig. 248). Ventral lobes of segment IX large, slightly concave mesally, laterad of vulval scale.

Key to the Males of species of *Neothremma* found in Alberta and eastern British Columbia

1a. Distal tooth of second article of clasper dorso-anterad of distal extremity (Fig. 244); intermediate lobes of segment X roughly rectangular in lateral aspect ..... *N. alicia* Banks, p. 76.

1b. Distal tooth of second article of clasper a postero-dorsal continuation of article (Fig. 591a); intermediate lobes of segment X trifid in lateral aspect ..... *N. laloukesi* Schmid, p. 77.

Neothremma alicia Banks, 1930
(Fig. 132a, 132b, 244-249, 605)

Neothremma alicia Banks, 1930a:229-230. (Type locality: Tolland, Colorado). Dodds and Hisaw, 1925a:127-129. Dodds and Hisaw, 1925b:386. Neave and Bajkov, 1929:202. Betten, 1934:413. Milne, 1936:116, 123. Balduf, 1939:122. Ross, 1944:300. Ross, 1949a:92. Schmid, 1955:101. Flint, 1960:5, 31. Denning, 1966:233. Fischer, 1967:145. Unzicker, 1968:4, 20, 52.

Neothremma alicea; Ross, 1938b:45.

Males of this species are distinguishable by high-arched, blade-like median lobes of segment X; by lateral processes of posterior edges of segment IX; and by fused basal articles of claspers. Females are recognizable by massiveness of genitalia (Fig. 247), with huge, rounded, latero-ventral lobes of segment IX.

Description. – Antennae dark brown, scapes paler, six times longer than pedicel, with long bunch of hyaline hairs on mesal faces. Vertex of head red-brown. Frons with scattered, spatulate-tipped hairs. Maxillary palpus of male with article III cylindrical, fringed on posterior face with distinct, even brush of long, black, distally hooked hairs (Fig. 249). Thorax light yellow to red-brown. Spurs yellow-brown. Fore wing length of male 7.7 mm; light red-brown; no pattern. Venation as in Fig. 132a, 132b.

Male genitalia. (Specimen from Banff, Alberta). Tergum VIII with single line of long, slender setae parallel to posterior edge. Segment IX with narrow, distinct, dorsal strap; wide ventrally, with small, rounded, ventro-posterad process (Fig. 244, 245). Clasper massive, articulated to segment IX, with disto-dorsal teeth; two-articled, with distal article dorsad of basal article, rounded, setose. Claspers fused ventrally together at basal articles. Segment IX with long, distally bifid latero-posterad processes. Median lobes of segment X long, dorsally arched, acuminate blades. Intermediate lobes roughly rectangular, flared ventro-laterad. Aedeagus with massive membranous base (Fig. 246) connected to base of proximal clasper articles; each clasper base with short, stout, black spine at point of fusion. Median shaft of aedeagus tapered, sclerotized, scoop-shaped structure with ejaculatory duct projected dorsad as thin, isolated tube.

Female genitalia. (Specimen from Bow River, at Trans-Canada Hwy., west of Lake Louise, Alberta). Tergum VIII with single, dorsal line of long setae. Vulval scale with squat, tapered, distally bifid median lobe (Fig. 248). Segment IX small, rectangular, with massive, rounded latero-ventral lobes (Fig. 247). Segment X with large, triangular lateral lobes laterad of mesal structure like inverted bowl. Vaginal orifice flanked by two lateral plates of segment X.

Notes on biology. – Specimens of this species emerge from small to large mountain streams, usually of the less turbulent variety. Adult flight season extends from June 22 to

August 13.

Geographical distribution. – The known range of this species extends from Alberta and British Columbia to Oregon, Utah and Colorado (Fig. 605). In Alberta it is restricted to the mountain areas close to the continental divide, ranging in altitude from 4,500' to 7,000'.

I have examined six specimens, two males and four females, from the study area.

Neothremma laloukesi Schmid, 1968
(Fig. 591a, 591b, 605)

Neothremma laloukesi Schmid, 1968:692-693. (Type locality: Lake Louise, Alberta).

Males of this species are distinguished from males of *N. alicia* by the characters presented in the key to males of *Neothremma* known from the study area.

The only known specimen of this species is a male, from Lake Louise, Alberta. Being thus unable to prepare my own drawings, Dr. F. Schmid very kindly lent me his original drawings of the species, which are presented here (Fig. 591a, 591b). I also present Schmid's original description of the male, in translation from the French, altering only his figure numbers to mine.

Description. – 'Fore wings uniformly golden brown. Head abundantly clothed by very long, golden hairs which are slightly denser between the scapes of the antennae. Male maxillary palpi short, thick, with dense clusters of black hairs on mesal faces, as in *N. alicia* Banks. Venation similar to *alicia*. Wing expanse of male 13 mm.

Male genitalia. Very similar to *alicia*, but basal article of clasper distinctly longer and narrower (Fig. 591a). Distal article of clasper also longer in lateral aspect, with clear outline gradually tapered from base to apex; distally curved dorsad at obtuse angle; regularly trapezoidal in ventral aspect (Fig. 591b), tapered distad.'

Female genitalia. Unknown.

Notes on biology. – Date of capture of the single known male was June 7.

Geographical distribution. – The single locality is indicated in Fig. 605.

The Subfamily Pseudostenophylacinae Schmid

Head short, very large; eyes large. Ocelli large, protuberant. Thoracic macrochaetae long, dense. Spur formula 1,2,2; 1,3,3; or 1,3,4. Wings large; fore wing of varied sizes, apically elliptical. Hind wing not larger than fore wing except when anal area well developed; anal edge convex or not; anal area sexually dimorphic in some taxa. Certain taxa with fore wings strongly granular, densely clothed with fine, bristly hairs; hind wings similar. Fore wings brown, irrorate. Venation complete. R1 of fore wing not arched at stigma; discoidal cell very long; chord irregularly disrupted, markedly curved in most taxa; f5 and thyridial cell sessile. Hind wing chord similar, but more oblique to body.

Male genitalia segment VIII with strongly marked, spinate zone, or not. Segment IX very short in lateral aspect, or longer. Cerci small, lateral, fused to intermediate lobe bases; intermediate lobes large, massive, generally paired, or as single horizontal plate, or paired plates elongated meso-dorsad. Claspers one-articled, reduced in certain taxa to simple buttons along edge of segment IX. Aedeagus very large in certain taxa; voluminous but short; membranous or sclerotized. Lateral arms enormous in most taxa, varied, membranous.

Female genitalia well sclerotized, loosely connected. Segment IX of two separate parts; dorsal part simple, without appendages. Segment X not prominent, of two lateral lobes. Ventro-lateral lobes of segment IX small, well sclerotized, well separated; meso-ventral part small, membranous, attached to lateral lobes. No supra-genital plate. Vaginal aperture be-

tween segments VIII and IX. Vulval scale small, strongly sclerotized; lobes lightly connected, movable; median lobe very small, narrow, very thick in some taxa; lateral lobes strongly sclerotized, voluminous, very thick.

This subfamily is represented in the study area by one genus, *Homophylax*.

The Genus *Homophylax* Banks

This genus is represented in the study area by three species, of which one is described as new. Females of only two species are known.

Synopsis of characters. – Spur formula 1,3,4. Wings large; fore wing markedly widened at chord, bluntly parabolic apically; hind wing blunted apically, scarcely larger than fore wing. Venation complete, modified, with strong sexual dimorphism in hind wings. Fore wing chord single line, slightly oblique to body anteriorly, not disrupted. Male hind wing with small, narrow discoidal cell; R and M crowded toward C; f1 petiolate, f2 tapered proximad to point, f3 with long petiole. Hind wing of female with very large, triangular, discoidal cell.

Male genitalia with sclerotized, smooth, posterior bulge to tergum VIII. Segment IX very wide laterally, ventrally. Median lobes of segment X in form of two symmetrical, sclerotized cavities dependent from very thin dorsal strap; fused mesally as strongly sclerotized mesal ridges with dark, dorsal and ventral paired lobes. Intermediate lobes stout, twisted, lobed plates fused to segment IX; interlocked with meso-dorsal blades of claspers. Claspers with small, ventral plates; antero-mesal angles produced postero-dorsally as long, thin, acuminate, strongly sclerotized, dark blades. Cerci large, somewhat oval lobes in lateral aspect (Fig. 250); fused at bases with sclerotized cavities of intermediate lobes. Aedeagus very small, stout.

Female genitalia with dorsum of segment IX small. Segment X rather narrow, long tube (Fig. 253). Ventral lobes of segment IX large, prominent, vertical, separate plates. Vulval scale blunt, recurved; two or three lobed. Supra-genital plate very small.

Key to the Males of species of *Homophylax* found in Alberta and eastern British Columbia

1a. Meso-dorsal lobes of clasper long, narrow (Fig. 250); median processes of segment X with flat-topped dorsal spines with lateral teeth distally (Fig. 251) ..... *H. crotchi* Banks, p. 78.

1b. Meso-dorsal lobes of clasper short, wide, heavy (Fig. 225, 261). Dorsal spines of median lobe of segment X without disto-lateral tooth 2a

2a.(1b) Median lobe dorsal spines fused basally, parallel sided (Fig. 256), with ventrally directed distal hook (Fig. 255) ..... *H. acutus* Denning, p. 79.

2b. Median lobe dorsal spines well separated basally, tapered, directed postero-laterad (Fig. 262) ..... *H. baldur* Nimmo n. sp., p. 80.

Key to the Females of two species of *Homophylax* found in Alberta and eastern British Columbia

1a. Segment X in ventral aspect (Fig. 254) narrow, with deep ventral cleft, shallow dorsal cleft ..... *H. crotchi* Banks, p. 78.

1b. Segment X in ventral aspect (Fig. 258) wide, with dorsal cleft at least as deep as ventral *H. acutus* Denning, p. 79.

Homophylax crotchi Banks, 1920
(Fig. 133a, 133b, 250-254, 606)

Homophylax crotchi Banks, 1920:345-346. (Type locality: Victoria, British Columbia). Betten, 1934:364. Milne, 1935:23, 51. Ross, 1938b:33. Ross, 1944:300. Ross and Spencer, 1952:50. Schmid, 1955:114. Denning, 1964:253, 254. Fischer, 1967:156.

Males of this species are distinguished from males of other species of *Homophylax* by small, laterally toothed dorsal spine of median lobes (Fig. 251), and by long, thin mesodorsal lobe of clasper. Females are distinguished by narrow segment X in ventral aspect (Fig. 254), with unequal dorsal and ventral clefts.

Description. – Antennae light red-brown. Vertex of head red-brown. Thorax warm light red-brown. Spurs brown. Fore wing length of male 16.4 mm; light brownish yellow, interspersed with slightly darker, irregular areas. Venation as in Fig. 133a, 133b. Without basal fore wing pouch and longitudinal hind wing fold between Rs and M (see Fig. 134, 135).

Male genitalia. (Specimen from Washington State, United States; in United States National Museum, Washington, D. C.). Tergum VIII with postero-dorsal area with distinct tooth close to posterior edge; with distinct lateral concavities (Fig. 250). Segment IX with dorsal strap narrowed laterally to junction with main body, expanded evenly ventrad. Claspers with ventral lobes slightly separated (Fig. 251), short, rounded; lateral lobes fingerlike, thick, fleshy; median lobes long, narrow blades with slightly thickened black tips. Median lobes or plates of segment X large, cupped laterad, with small, spiniform, recurved ventral lobes, larger, flat-topped, dorsal lobes each with distinct disto-lateral tooth. Intermediate lobes extended laterad from anal membrane, curved posterad above base of claspers. Cercus large, arched slightly dorsad; short, rounded distally. Aedeagus with large, membranous, dorsal lobe dorsad of median shaft (Fig. 252); like inverted trough, with concave ventral surface.

Female genitalia. (Specimen from Banff, Alberta). Sterna IV, V, and VI each traversed by thin dark line parallel to posterior edge interrupted mesally by roughly triangular tooth. Vulval scale with median lobe of two inconspicuous, small protuberances of posterior edge (Fig. 254). Lateral lobes curved dorsad to enclose two sclerites projected from vagina. Segment IX with laterally triangular, shell-like lateral lobes suspended from short, narrow dorsum. No supra-genital plate evident. Segment X long, tubular, of two lateral lobes distally projected well posterad of all other structures (Fig. 253).

Geographical distribution. – The known range of this species extends from Vancouver Island and Washington State to Alberta. In Alberta I have only two records of the species: Banff, at about 5,000' on Sulphur Mountain; and Lost Lake, Waterton National Park, at 5,500'.

Dates of capture were September 10 and August 17 respectively. I have not taken any specimens of this species myself.

I have examined one male and two females of this species; only the females are from the study area, however.

Homophylax acutus Denning, 1964
(Fig. 134a, 134b, 255-259, 606)

Homophylax acutus Denning, 1964:254, 256-258. (Type locality: Wallace, Idaho). Nimmo, 1965:787.

Males of this species are distinguished from males of other species of *Homophylax* by short, wide, heavy mesal lobes of claspers, and by large, basally fused, ventrally hooked dorsal spines of median lobe of segment X (Fig. 255). Females are distinguished by large, short segment X, with equal dorsal and ventral clefts (Fig. 258).

Description. – Antennae brownish yellow. Vertex of head pale yellow. Fore wing length of male 16.4 mm; dull brownish yellow, with darker areas especially in posterior parts of wing. Venation as in Fig. 134a, 134b. Hind wing with large, longitudinal fold posterad of Rs; fold with numerous scales, especially basally. Male fore wing with soft, membranous fold basally; female without fold.

Male genitalia. (Specimen from Mt. Edith Cavell, Jasper National Park, Alberta). Segment IX with thread-like dorsal strap; main body of segment wide ventrally, tapered abruptly dorsad, with slight concavities ventrad of peak (Fig. 255). Clasper with mesal lobe short, wide, bowed mesad in dorsal aspect (Fig. 256); lateral lobe bifid distally, separated by deep mesal cleft. Segment X with median processes of two toothed plates flared laterad in form of deep, sclerotized concavities; dorsal hooks only slightly parted, square tipped; ventral hooks directed dorsad, recurved. Intermediate lobes triangular, acuminate in lateral aspect. Cercus with straight ventral edge, dorsal edge curved gradually ventrad. Aedeagus with smooth, sclerotized, basal sheath followed by high, peaked dorsal lobe; median lobe sclerotized distally.

Female genitalia. (Specimen from Moraine Lake, Banff National Park, Alberta; in Canadian National Collection). Similar to *H. crotchi*, but lateral lobes of vulval scale larger; median lobe more pronounced (Fig. 259); vaginal sclerites more globose, with concave mesal faces. Ventro-lateral lobes of segment IX triangular but more rounded than in *H. crotchi*. Segment X heavier, larger, shorter; dorsal cleft deeper than ventral (Fig. 258).

Notes on biology. – This species is recorded from only two localities in Alberta to date. One locality is a deep, morainic mountain lake; the second is located in high, alpine meadows, with shallow pools and small water trickles. Altitudes are 6,200' and 7,000' respectively. Dates of capture were August 6 and 22.

Geographical distribution. – The known range of this species extends from Idaho to Alberta (Fig. 606). In Alberta it appears to be confined to high altitude creeks or pools.

I have examined two males and one female from the study area.

Homophylax baldur Nimmo n. sp.
(Fig. 135a, 135b, 260-263, 607)

Males of this species are distinguished by spiniform, widely separated dorsal processes of median lobes of segment X (Fig. 262) and by small membranous dorsal lobe of aedeagus (Fig. 263).

Description. – Antennae light yellow-brown; scapes with antero-mesal faces devoid of long setae. Vertex of head yellowish to reddish brown, with red-brown band between lateral ocelli. Thorax uniformly reddish yellow. Spurs red-brown. Fore wing length of male 17.3 mm; light yellowish brown, with slightly darker bands mesally and posteriorly. Anal flap of fore wings with white scales. Venation as in Fig. 135a, 135b. Fore wing with basal flap or pouch (Fig. 135a, 260). Hind wing with pronounced fold anterad of Cu1a; fold internally with hyaline scales; scales commonest in basal area of wing.

Male genitalia. (Specimen from Cameron Lake, Waterton National Park, Alberta). Postero-dorsal edge of tergum VIII triangular, raised plaque; in lateral aspect an overhanging tooth (Fig. 261). Segment IX with anterior edges produced anterad; posterior edge continuous to peak of dorsal strap. Dorsal strap virtually non-existent. Clasper with heavy, black, meso-dorsal process directed postero-dorsad; with straight dorsal edges, sinuate ventral edges; base warped at 90° to meet lateral lobe of clasper (Fig. 262). Median lobe of clasper fused ventrally, weakly divided. Segment X with two vertical median plates; plates toothed dorsally and ventrally; produced laterad as sclerotized concavities; dorsal teeth separated, acuminate;

ventral teeth small, button-like. Cercus almost triangular, with rounded tips. Aedeagus with small, membranous, dorsal process originated from membranous middle portion; bilobed in dorsal aspect.

Female genitalia. Not known.

Notes on biology. – The one Alberta record of this species is a high (5,445'), large mountain lake. The Utah record listed below is situated at 9,700'. Dates of capture were August 19, and September 17 respectively.

Geographical distribution. – The known range of this species is restricted to two localities (Fig. 607): one in extreme south west Alberta, the other in Utah.

I have examined 23 specimens from the study area, all males, and one other male, from Utah.

Holotype. – Male. Cameron Lake, Waterton National Park, Alberta; August 19, 1965; A. Nimmo.

Paratypes. – Same data as for holotype; 22 males. La Baron Lake, Circleville Mountain, 15.9 miles west Junction, Pinto County, Utah, United States; September 17, 1967; G. E. Ball; one male.

The type series has been assigned the type number 10,585 in the Canadian National Collection, Ottawa. The holotype and 19 paratypes are in the Canadian National Collection; the Utah specimen is in the Strickland Museum, Dept. of Entomology, University of Alberta, Edmonton, Alberta; and one paratype each are in the Royal Ontario Museum, Toronto and the United States National Museum, Washington.

This species is named for Baldur, a character of Norse mythology encountered in my reading.

The Subfamily Limnephilinae Ulmer

Synopsis of characters. – Spur formula 1,3,4, but the following combinations are also found: 1,1,1; 0,2,2; 1,2,2; 2,2,2; 0,3,3; or 1,3,3. Wings very varied in size, from very large to little more than scales, dicosmoecine in shape in certain genera; hind wings with well developed anal area; fore wing colour highly varied; hind wings hyaline in most genera. Frenulum barely evident, of some long setae at extreme base of subcosta. Venation complete, only feebly varied except in *Enoicyla* and *Phanocelia*; identical in both sexes. Fore wing discoidal cell one to three times longer than its own stem; thyridial cell pedicillate in very few taxa. Hind wing chord more or less broken, generally very oblique posterad; with five anal veins.

Male genitalia simple, with three pairs of appendages. Tergum VIII with spinate or setose postero-dorsal process or not. Segment IX constant; more or less elongate laterally, somewhat shortened ventrally; in most genera very reduced dorsally. Segment as whole deeply recessed into segment VIII. Cerci rounded lobes; concave mesally, unarmed or not, with or without teeth, ridges, or crenulations; small to very large, strongly sclerotized. Intermediate lobes of segment X sclerotized, not very varied in form but varied in size; between cerci, not fused. Lateral angles of segment IX tapered or not, curved mesad to effect a certain amount of separation between anal and aedeagal cavities. Clasper one-articled, fused to segment IX; generally comparable in form to very oblique cone, with apex directed dorso-posterad. Aedeagus highly variable in form and size, long or not, slender, with distal spines; membranous basally or distally; lateral arms generally large, with all degrees of reduction among taxa.

Female genitalia with segment IX of two parts. Dorsal part large or not, conical, tapered to segment X. Segment X variable; tubular, cylindrical or conical; cleft dorsally, ventrally, or even laterally, various parts reduced to independent scales in certain genera. Ventral parts

of segment IX of two lobes and median part. Supra-genital plate present or absent. Vaginal aperture between segments VIII and IX. Vulval scale trilobed or not; thickened, fleshy; three lobes fused basally or not, but in the Limnephilini lateral lobes not entirely fused to median; relative proportions of lobes highly variable among taxa.

Following is a key to tribes of Limnephilinae, using males only. The females proved intractable in the attempt to discover cohesive key characters and are best identified in association with the male, or by comparison with drawings. This key is good only for the study area.

Key to the Males of the Tribes of Limnephilinae found in Alberta and eastern British Columbia

1a. Lateral arms of aedeagus simple, spiniform, or apparently so (Fig. 542), with no accessory spines or lobes; originated dorsad or ventrad of aedeagal base (Fig. 531, 547, 568, 580), not laterad 2a

1b. Lateral arms clavate, multi-lobate, multi-spinate, parti-membranous, or combination of these (Fig. 473, 486, 527); or if spiniform (Fig. 367), attached laterad of aedeagal base ..... Limnephilini, p. 82.

2a.(1a) Ejaculatory duct terminated at extreme tip of median shaft of aedeagus, including lateral lobes or processes, excepting lateral arms (Fig. 531, 536, 547) ..... Stenophylacini, p. 142.

2b. Ejaculatory duct terminated basad of extreme tip of median shaft, on dorsal surface of shaft (Fig. 550, 553), or between longer distal lobes (Fig. 565) ..... Chilostigmini, p. 148.

The Tribe Limnephilini Schmid

Character synopsis of the Limnephilini. – Pronotum more developed than in other tribes of subfamily. Base of pro-femur and apex of opposing tibia with or without black brushes. Spur formula varied. Wings medium or small, not reduced, similar in both sexes. Fore wing evenly strap-like, little wider at stigma, with oblique, truncated apex. Hind wings much larger than fore. Fore wing coloration strongly contrasted; with large clear streak in mid-wing, second at proximal end of apical cells, third at distal end of M4+5, and fourth in thyridial cell. Chord of fore wing very oblique to body, narrowly broken. Hind wing chord parallel to body, zigzagged regularly, strongly accentuated.

Male genitalia with posterior edge of tergum VIII finely, not densely, spinate. Segment IX with postero-lateral edges convex or not, as supported to cerci. Cerci very varied in size and form. Intermediate lobes of segment X varied, pincer-like in opposition to neighbouring cerci or not; with lateral teeth or not. Claspers varied, base button-like, to almost vestigial; free part slender, directed almost horizontally. Aedeagus strong, large; median shaft very simple, unarmed, folded and extensible at base or not. Lateral arms with slender base and expanded, spinate tip.

Female genitalia with segment IX of two parts in most taxa, well developed, close set. Dorsal part prominent or not, without prominent lobes. Appendages present or not; large, free; fused solidly, either to segment IX, or segment X. Segment X much smaller than segment IX; cylindrical, slender, deeply cleft or not. Segment X large, with thick, fleshy walls, hardly cleft at all; extended as one piece, not separate scales as in Stenophylacini. Ventral lobes of segment IX large, convex, in contact ventrally. Supra-genital plate large, free, prominent, ogival. Vulval scale trilobed, incompletely fused to sternum VIII, intervening sutures clearly visible.

Key to Genera and Subgenera of Limnephilini found in Alberta and eastern British Columbia

1a. Apex of fore wing notched (Fig. 141a) ... *Nemotaulius (Macrotaulius)*, p. 123.
1b. Apex of fore wing smooth, without indentations 2a
2a.(1b) Apical spur of fore tibia large, triangular ..... *Philarctus*, p. 132.
2b. Spurs normal 3a
3a.(2b) Fore wing with one or more longitudinal, median, silver lines bordered with black ..... *Hesperophylax*, p. 139.
3b. Fore wings without such lines 4a
4a.(3b) R4+5 of hind wings strongly tinted brown ..... *Grammotaulius*, p. 122.
4b. R4+5 of hind wing not so coloured. Spur formula 1,3,4; 1,2,3; or 1,2,2 .... 5a
5a.(4b) Dorsal strap of segment IX well developed 6a
5b. Dorsal strap of segment IX very narrow, recessed into segment VIII 8a
6a.(5a) Wing span less than 20 mm; fore wing weakly irrorate ..... *Arctopora*, p. 133.
6b. Wing span greater than 25 mm; fore wing strongly irrorate 7a
7a.(6b) Dorsal strap of segment IX of male large plate overhanging remainder of genitalia (Fig. 495) ..... *Lenarchus (Lenarchus)*, p. 135.
7b. Dorsal strap of segment IX of male quite short, but prolonged by large plate formed by fused cerci (Fig. 501) ..... *Lenarchus (Paralenarchus)*, p. 136.
8a.(5b) Cercus of male strongly toothed, segment IX narrow throughout (Fig. 440) ..... *Clistoronia (Clistoroniella)*, p. 120.
8b. Characters otherwise 9a
9a.(8b) Sc. of hind wing turned sharply anterad distally (Fig. 138b) ..... *Limnephilus*, p. 83.
9b. Sc. of hind wing only slightly turned anterad (Fig. 142b) 10a
10a.(9b) Intermediate lobes of male segment X much smaller than cerci, button-like ..... *Asynarchus*, p. 128.
10b. Intermediate lobes of male segment X plate-like, spiniform, or reduced ... 11a
11a.(10b) Fore wing reddish, uniformly irrorate, or with regularly spaced minute patches of brown ..... *Anabolia*, p. 124.
11b. Fore wings otherwise colored; patterned with bars or large patches of colour, ranging from black to almost hyaline ..... *Limnephilus*, p. 83.

The Genus *Limnephilus* Leach

This genus is represented in the study area by 33 species, of which two are new, and one is known only from the female. In 1955 Schmid arranged the species of the genus in species groups. Sixteen groups are known from the study area. Besides these are three species which he did not classify, even though he placed other single species in groups of their own. In this study these three single species are placed in monotypic groups. According to Schmid (1955) the characters of this genus are the same as for the tribe.

Key to the Males of species of *Limnephilus* from Alberta and eastern British Columbia

1a. Postero-dorsal edge of tergum VIII spinate or setose (Fig. 370, 402) 2a
1b. Postero-dorsal edge of tergum VIII not spinate or setose (Fig. 309) 23a
2a.(1a) Spinate area of tergum VIII produced posterad, or ventrad, to varying degrees (Fig. 326, 342, 385, 427) 3a
2b. Spinate area of tergum VIII not produced (Fig. 273, 370, 421) 21a
3a.(2a) Spinate area of tergum VIII light or heavy bulbous lobe projected well posterad of membranous connection to segment IX (Fig. 291, 390, 402, 408) 4a

3b. Spinate area of tergum VIII not projected well posterad of membranous connection to segment IX; not bulbous or spinate 18a

4a.(3a) Mesal face of cercus with one or more black, strongly sclerotized teeth (Fig. 270b, 292, 321) 5a

4b. Mesal face of cercus without such teeth 13a

5a.(4a) Teeth basad of distal edge of cercus in single, dorso-ventral row (Fig. 265, 278, 301, 320) 6a

5b. Teeth of cercus not arranged thus 11a

6a.(5a) Lateral arms of aedeagus distally as acuminate, meso-dorsal, sclerotized teeth flanked by at least partly membranous, extensible ventro-lateral lobe (Fig. 266, 280, 293) 7a

6b. Lateral arms of aedeagus, if distally divided, with ventro-lateral lobes sclerotized, rigid, not membranous or extensible (Fig. 299, 322) 10a

7a.(6a) Median lobes of segment X long, laminate, narrow, dorsally curved blades (Fig. 264, 291) 8a

7b. Median lobes of segment X not as above; short, wide basally, tapered distally (Fig. 270b, 278) 9a

8a.(7a) Median lobes of segment X parallel almost to tips (Fig. 264); spinate dorsal process of tergum VIII large, globose ..... *L. sublunatus* Provancher, p. 89.

8b. Median lobes of segment X tapered evenly and gradually distad (Fig. 291); spinate postero-dorsal process of tergum VIII long, tapered, directed ventrad ..... *L. susana* Nimmo n. sp., p. 93.

9a.(7b) Distal process of clasper long, thin, tapered (Fig. 270a); spinate process of tergum VIII large, globose ..... *L. sansoni* Banks, p. 90.

9b. Distal process of clasper short, stout, blunt (Fig. 278); spinate process of tergum VIII small, thumb-like ..... *L. hageni* Banks, p. 91.

10a.(6b) Tip of clasper black, strongly sclerotized, with dorsally directed tooth (Fig. 320); median lobes of segment X hooked postero-ventrad ..... *L. externus* Hagen, p. 99.

10b. Tip of clasper not so armed, blunt (Fig. 298); median lobes of segment X tapered, directed directly postero-dorsad, with no hook ..... *L. indivisus* Walker, p. 95.

11a.(5b) Median lobes of segment X directed directly postero-dorsad (Fig. 326); spinate lobe of tergum VIII directed ventrad, located between cerci ..... *L. sericeus* (Say), p. 100.

11b. Median lobes of segment X wide basally, tapered abruptly to thin tooth curved dorso-anterad (Fig. 385, 402); spinate process of tergum VIII directed backwards over genitalia 12a

12a.(11b) Clasper with wide base, tapered gradually postero-dorsad (Fig. 385) ..... *L. perpusillus* Walker, p. 112.

12b. Clasper originated abruptly from base, almost rectangular in lateral aspect, divided shallowly distally (Fig. 402) ..... *L. labus* Ross, p. 115.

13a.(4b) Median lobes of segment X with distal portion curved dorsad (Fig. 305, 365, 408) 14a

13b. Median lobes of segment X otherwise 17a

14a.(13a) Median lobes of segment X long, narrow, evenly tapered throughout length (Fig. 304, 390) 15a

14b. Median lobes of segment X otherwise 16a

15a.(14a) Clasper with wide base, abruptly narrowed to finger-like distal portion (Fig.

304) ..... *L. infernalis* (Banks), p. 96.

15b. Clasper short, blunt, with short base (Fig. 390) ....*L. argenteus* Banks, p. 113.

16a.(14b) Clasper base very short; cercus narrow, long, dark, strongly sclerotized on distal edge (Fig. 408, 409) ..... *L. minusculus* (Banks), p. 116.

16b. Clasper with long base; cercus with wide base, short, rounded (Fig. 365) .... *L. spinatus* Banks, p. 108.

17a.(13b) Both cerci and median lobes of segment X short, strongly sclerotized, massive (Fig. 433, 434) ..... *L. canadensis* Banks, p. 120.

17b. Both cerci and median lobes of segment X long, slender, tapered, strongly sclerotized (Fig. 332, 333) ..... *L. femoralis* (Kirby), p. 102.

18a.(3b) Lateral arms of aedeagus distally bilobed (Fig. 286, 429); cercus relatively short, broad 19a

18b. Lateral arms of aedeagus simple (Fig. 344, 350); cercus very long, slender 20a

19a.(18a) Cercus long, parallel-sided; clasper short (Fig. 427) ..*L. rhombicus* (L.), p. 118.

19b. Cercus short, triangular; clasper with long, narrow distal process (Fig. 284).... ..... *L. partitus* Walker, p. 92.

20a.(18b) Postero-dorsal edges of segment IX distinctly concave; clasper long, acuminate (Fig. 350) ..... *L. valhalla* Nimmo n. sp., p. 106.

20b. Postero-dorsal edges of segment IX not concave; clasper short, blunt (Fig. 342) ..... *L. moestus* Banks, p. 104.

21a.(2b) Clasper massive, with distinct dorsal tooth (Fig. 421) .... *L. nigriceps* (Zetterstedt), p. 117.

21b. Clasper otherwise (Fig. 370) 22a

22a.(21b) Median lobes of segment X long, with irregular edges; disto-lateral tooth present (Fig. 273, 274); no teeth on mesal face of cercus... *L. extractus* Walker, p. 91.

22b. Median lobes of segment X short, with smooth edges; directed postero-mesad to teeth of mesal faces of cerci (Fig. 370, 371) .... *L. hyalinus* Hagen, p. 109.

23a.(1b) Clasper with long, narrow base (Fig. 375, 414) 24a

23b. Clasper with short base (Fig. 337, 355, 360) 27a

24a.(23a) Lateral arm of aedeagus expanded distally; blade-like, fringed peripherally with spines or setae (Fig. 311, 317) 25a

24b. Lateral arm not expanded distally (Fig. 377, 416) 26a

25a.(24a) Cercus deeply cleft distally, with distal ends of each lobe black, strongly sclerotized (Fig. 309, 310) ..... *L. ornatus* Banks, p. 97.

25b. Cercus not cleft, trapezoidal in lateral aspect (Fig. 315); meso-distal edge with distinct, regular, black tooth or spine (Fig. 316) .... *L. picturatus* McLachlan, p. 98.

26a.(24b) Lateral arm of aedeagus reduced; simple, distally spinate, membranous lobe (Fig. 377); cercus triangular, vertically high (Fig. 375) ....*L. secludens* Banks, p. 110.

26b. Lateral arm of aedeagus long, thin, with three or four distal spines across median shaft (Fig. 416, 417); clasper large, thin plate directed mesad, with black, dentate, dorsal edge (Fig. 414, 418) ..... *L. kennicotti* Banks, p. 116.

27a.(23b) Tips of median lobes of segment X directed dorso-laterad (Fig. 355, 380).. 28a

27b. Tips of median lobes of segment X not directed dorso laterad (Fig. 337, 347. 360, 395) 29a

28a.(27a) Clasper with disto-lateral tooth (Fig. 380) ..... *L. janus* Ross, p. 111.

28b. Clasper without such tooth; much smaller than median lobes of segment X

. . . . . *L. lopho* Ross, p. 107.

29a.(27b) Lateral arm of aedeagus curved sharply dorsad; not bilobed (Fig. 347, 398) 30a

29b. Lateral arm of aedeagus straight or, if turned dorsad, not sharply; not bilobed distally (Fig. 339, 362) 31a

30a.(29a) Cercus short, wide, thick (Fig. 395, 396) . . . . . *L. alberta* Denning, p. 114.

30b. Cercus long, narrow, thin, with concave mesal face (Fig. 347, 349) . . . . . *L. cockerelli* Banks, p. 105.

31a.(29b) Cercus long, narrow, tapered, with meso-distal tooth; median lobes of segment X set higher than cerci, arched, lyre-shaped in dorsal aspect (Fig. 337, 338) . . . . . *L. nogus* Ross, p. 103.

31b. Cercus short, squat, distally rounded, with concave mesal face; median lobes of segment X set low, between cercus, lamellar, parallel (Fig. 360, 361) . . . . . *L. parvulus* (Banks), p. 107.

Key to the Females of species of *Limnephilus* from Alberta and eastern British Columbia

1a. Segment X distinct from segment IX, either by distinct suture line or abrupt decrease in size, or both. Segment X partly recessed into segment IX or not (Fig. 268, 295, 331, 406, 431) 2a

1b. Segment X fused to segment IX; no suture lines or abrupt decrease in size; demarcated by slight declivity or not (Fig. 296, 318, 359, 363, 400, 419, 426) 17a

2a.(1a) Segment IX with ventro-lateral lobes separate, distinct; demarcated by sutures (Fig. 271, 290, 324, 431, 438) 13a

2b. Segment IX with ventro-lateral lobes, or not; if present, an integral part of segment, not separated by sutures (Fig. 268, 331, 340, 369, 388, 406) 3a

3a.(2b) Segment IX with distinct dorsal and ventral portions joined by laterally constricted strap; segment X flanked dorsally and ventrally, not laterally (Fig. 268, 295, 388) 11a

3b. Segment IX not constricted laterally, or segment X not flanked dorsally, or ventrally (Fig. 336, 369, 406, 412) 4a

4a.(3b) Segment X with dorso-lateral lobes (Fig. 313, 331, 336, 383, 406, 412) 5a

4b. Segment X without dorso-lateral lobes (Fig. 340, 369) 10a

5a.(4a) Opposing edges of median and lateral lobes of vulval scale very close, at least at base; if close only at base, in form of v-pattern (Fig. 330, 384, 407, 413) . . . 6a

5b. Opposing edges of vulval scale lobes markedly separated (Fig. 314, 336) 9a

6a.(5a) Dorso-lateral lobes of segment X tapered in lateral aspect (Fig. 383, 412) . . . 7a

6b. Dorso-lateral lobes of segment X not tapered; blunt or rounded distally (Fig. 331, 406) 8a

7a.(6a) Lateral lobes of vulval scale with concave ventral faces in lateral aspect (Fig. 383) . . . . . *L. janus* Ross, p. 111.

7b. Lateral lobes of vulval scale in lateral aspect with ventral faces not concave, median lobe markedly longer than lateral lobes (Fig. 412) . . . . . *L. minusculus* (Banks), p. 116.

8a.(6b) Meso-dorsal lobes of segment X, immediately dorsad of anus, black, long, very thin, acuminate in lateral aspect (Fig. 331) . . . . . *L. sericeus* (Say), p. 100.

8b. Meso-dorsal lobes of segment X immediately dorsad of anus short, triangular, blunt in lateral aspect (Fig. 406) . . . . . *L. labus* Ross, p. 115.

9a.(5b) Dorso-lateral lobes of segment X long, thin, finger-like (Fig. 313) . . . . . .

. . . . . *L. ornatus* Banks, p. 97.

9b. Dorso-lateral lobes of segment X short, squat, triangular (Fig. 335, 336). . . . . *L. femoralis* (Kirby), p. 102.

10a.(4b) Segment IX with distinct, trapezoidal, lateral lobes projected postero-laterad of segment X (Fig. 340) . . . . . *L. nogus* Ross, p. 103.

10b. Segment X without such lobes, with minute dorsal portion (Fig. 369) . . . . . *L. spinatus* Banks, p. 108.

11a.(3a) Cercus short, squat, rounded, appressed to top surface of segment X (Fig. 295, 388) 12a

11b. Cercus long, lamellar, attached to segment IX basally, otherwise free (Fig. 268) . . . . . *L. sublunatus* Provancher, p. 89.

12a.(11a) Median lobe of vulval scale approximately equal to lateral lobes (Fig. 389); segment X oriented vertically in lateral aspect (Fig. 388). . . . . *L. perpusillus* Walker, p. 112.

12b. Median lobe of vulval scale projected well beyond lateral lobes, up to twice their length (Fig. 294); segment X oriented antero-posterad (Fig. 295) . . . . . *L. susana* Nimmo n. sp., p. 93.

13a.(2a) Genitalia with cercus or cercus-like lobes dorsad of segment X (Fig. 271, 290, 324, 431) 14a

13b. Genitalia without cerci; segment X conical in ventral aspect (Fig. 437) . . . . . *L. canadensis* Banks, p. 120.

14a.(13a) Vulval scale small, shallowly recessed into sternum VIII (Fig. 290, 325); cercus in lateral aspect not divergent from segment X (Fig. 290, 325) 15a

14b. Vulval scale large, deeply recessed into sternum VIII (Fig. 272, 432); cercus in lateral aspect divergent widely from segment X (Fig. 271, 431). 16a

15a.(14a) Ventro-lateral lobe of segment IX divided as two sclerites (Fig. 290). . . . . *L. partitus* Walker, p. 92.

15b. Ventro-lateral lobe of segment IX undivided, of one piece (Fig. 324) . . . . . *L. externus* Hagen, p. 99.

16a.(14b) Base of cercus dorsad of segment X (Fig. 271), squarely cleft disto-laterally . . . . . *L. sansoni* Banks, p. 90.

16b. Base of cercus antero-dorsad of segment X (Fig. 431); segment X not disto-laterally cleft *L. rhombicus* (L.), p. 118.

17a.(1b) Ventro-lateral lobe of segment IX separate and distinct from dorsal part of segment by suture or membrane (Fig. 307, 318, 363, 419) 18a

17b. Ventro-lateral lobe of segment IX not distinguished from dorsal part of segment by suture (Fig. 282, 346, 378, 400) 25a

18a.(17a) Segment X with pair of dorso-lateral lobes or cerci (Fig. 302, 307, 318, 374) 19a

18b. Segment X without dorso-lateral lobes (Fig. 363, 394, 419, 426) 22a

19a.(18a) Distal end of segment X pair of meso-dorsal lobes or scales and single ventral lobe (Fig. 308, 319) 20a

19b. Distal end of segment X without such lobes (Fig. 303, 373) 21a

20a.(19a) Ventro-lateral lobes of segment IX roughly rectangular in lateral aspect, oriented vertically (Fig. 318), the two lobes meeting but not fused ventrally (Fig. 319) . . . . . *L. picturatus* McLachlan, p. 98.

20b. Ventro-lateral lobes of segment IX triangular in lateral aspect (Fig. 307); not meeting ventrally (Fig. 308). . . . . *L. infernalis* (Banks), p. 96.

21a.(19b) Dorso-lateral lobes of segment X flanked laterally by rectangular walls (Fig.

373, 374) ..... *L. hyalinus* Hagen, p. 109.

21b. Dorso-lateral lobes of segment X free, not flanked laterally (Fig. 302) ..... *L. indivisus* Walker, p. 95.

22a.(18b) Segment X composed of massive, mesally completely cleft, postero-dorsal plate (Fig. 419, 420) ..... *L. kennicotti* Banks, p. 116.

22b. Segment X otherwise 23a

23a.(22b) Segment X indistinguishable from segment IX; massive, blunt, with small, simple anal aperture at extreme posterior end (Fig. 425, 426) ..... *L. nigriceps* (Zetterstedt), p. 117.

23b. Segment X not massive; deeply cleft mesally, tapered posterad in lateral aspect (Fig. 364, 394) 24a

24a.(23b) Ventro-lateral lobes of segment IX high, narrow, oriented vertically (Fig. 394) ..... *L. argenteus* Banks, p. 113.

24b. Ventro-lateral lobes of segment IX almost as high as wide, with no special orientation (Fig. 363) ..... *L. parvulus* (Banks), p. 107.

25a.(17b) Ventro-lateral part of segment IX produced posterad as narrow, tapered lobe (Fig. 282, 296, 346, 353) 26a

25b. Ventro-lateral part of segment IX produced posterad at most as very broad-based, abruptly tapered lobe (Fig. 276, 359, 378, 400) 29a

26a.(25a) Dorso-lateral lobes, or cerci, of segment X long, thin, well separated from remainder of vulval scale much longer than lateral lobes 27a

26b. Dorso-lateral lobes, or cerci, of segment X short, rounded distally, lamellar (Fig. 346, 354); median lobe of vulval scale no longer than lateral lobes 28a

27a.(26a) Segment X cleft laterally (Fig. 296) ..... *L.* species 1, p. 94.

27b. Segment X not cleft laterally (Fig. 282) ..... *L. hageni* Banks, p. 91.

28a.(26b) Segment X with dorsal lobes located laterally (Fig. 354) ..... *L. valhalla* Nimmo n. sp., p. 106.

28b. Segment X with dorsal lobes more mesally located (Fig. 345) ..... *L. moestus* Banks, p. 104.

29a.(25b) Segment X cleft laterally (Fig. 276, 378) 30a

29b. Segment X not cleft laterally (Fig. 359, 400) 31a

30a.(29a) Dorso-lateral lobes, or cerci, of segment X small, short, reaching no more than halfway to extremities of segment (Fig. 378) ... *L. secludens* (Banks), p. 110.

30b. Dorso-lateral lobes, or cerci, of segment X large, triangular, equally as long as segment (Fig. 276) ..... *L. extractus* Walker, p. 91.

31a.(29b) Segment X deeply cleft dorsally (Fig. 401) ..... *L. alberta* Denning, p. 114.

31b. Segment X not deeply cleft dorsally (Fig. 358) ..... *L. lopho* Ross, p. 107.

The *subcentralis* group

Members of this group are recognizable in the field by wing pattern. This consists of a series of dark brown bars on lighter background; initially with median longitudinal band in vicinity of subradial cell, terminated at chord; distad of chord are two shorter bands, one between f1 and f2, the other on f4; remainder of wing irrorate to very irregularly patterned. Males are distinguished by thin, slightly concave mesal cerci, usually with short or long row of black teeth basad of distal ends; and by lamellate, tapered, median lobes of segment X (Fig. 273, 278, 291). Females are distinguished by presence of cerci or cercus-like postero-dorsal lobes of segment X, and by segment X being separated from remainder of genitalia by suture line (Fig. 268, 271, 290).

Limnephilus sublunatus Provancher, 1877
(Fig. 138a, 138b, 264-269, 607)

Limnophilus sublunatus Provancher, 1877:243. (Type locality: Quebec). Provancher, 1878a: 146. Provancher, 1878b:131-132. Schmid, 1955:135.

Limnephilus sublunatus; Banks, 1907a:37. Betten, 1926:529. Betten, 1934:333-334. Milne, 1935:44, 52. Milne, 1936:59. Ross, 1938b:34. Betten and Mosely, 1940:129. Banks, 1943:341-342. Ross, 1944:298. Ross and Merkley, 1952:448. Robert, 1960:59. Wiggins, 1961:700-701. Fischer, 1968:331-332.

Limnophilus americanus Banks, 1900a:253. (Type locality: Idaho). Ulmer, 1905a:19. Ulmer, 1907a:43. Essig, 1926:175. Fischer, 1968:331.

Limnephilus americanus Banks, 1907a:36. Betten, 1934:320. Milne, 1935:52. Ross, 1938b: 34. Fischer, 1968:331.

Limnephilus macgillivrayi Banks, 1908a:263. (Type locality: Axton, New York). Banks, 1930a:226. Milne, 1935:44, 51. Milne, 1936:59. Fischer, 1968:331-332.

Males of this species are distinguished from males of other species of the group by long, smoothly curved, lamellate cerci (Fig. 264), and by similar median lobes of segment X which are curved dorsad and rather blunt distally. Females are distinguished by thin, delicate cerci of segment X, which are apparently attached to segment IX; segment X recessed into segment IX, long, tapered, thin walled, in lateral aspect (Fig. 268).

Description. – Antennae pale yellow. Vertex of head brown-yellow, except for paler warts. Thorax pale yellow, with light brown patches on dorsal areas of pleura. Brush of anterior femur of male half length of femur; sparse, with short, black spines. Fore wing length of male 13.9 mm; orange-brown, clear areas hyaline; costal margin clear for two-thirds of length. Stigma light brown. Venation as in Fig. 138a, 138b.

Male genitalia. (Specimen from Canmore, Alberta). Postero-dorsal edge of tergum VIII produced posterad as large spinate bulb; spines black, sparse. Dorsal strap of segment IX of uniform width, overhanging main body of segment at angle of about 45° (Fig. 264). Main body of segment IX almost square; posterior edge directed mesad under postero-dorsal corner, which has finger-like aspect laterally. Clasper long, with wide base tapered quickly to finger-like dorsal portion. Segment X with median lobes long, thin, lamellate; distal third of dorsal edges black; lobes slightly up-turned in lateral aspect, warped in dorsal aspect (Fig. 265). Cercus long, narrow, of uniform width, with distal end black-toothed; with slightly darker dentate ridge two-thirds of distance from base (Fig. 265). Lateral arms of aedeagus bipartite distally; dorsal lobe sclerotized, dorsally directed spine (Fig. 266); ventral lobe membranous except for clear, sclerotized tip with fringe of brown setae.

Female genitalia. (Specimen from Canmore, Alberta). Vulval scale with slight concavities at posterior edges of lateral lobes; median lobe distally blunt, longer than lateral lobes (Fig. 269). Segment IX with lateral faces deeply depressed, recessed anterad as flanges. Ventral area directed posterad under segment X as acuminate plates (Fig. 268). Supra-genital plate large, semicircular, with hyaline basal area; with rectangular, membranous, basal area. Segment X very deeply cleft mesally (Fig. 269), with acuminate distal tips to lateral lobes; in lateral aspect segment tapered gradually posterad to tips. Cercus long, narrow, distal half clothed with short, fine, hyaline setae; cercus slightly longer than segment X, apparently attached to segment IX.

Notes on biology. – Specimens of this species appear to emerge from pools, sloughs or lakes fringed with horse-tails, or sedges. The flight period extends from July 1 to October 3. My records are insufficient to define a peak.

Geographical distribution. – The known range of this species extends from British Co-

lumbia, Idaho and Colorado to New Hampshire and Quebec (Fig. 607), with a large, mid-continental blank. In Alberta it is confined to the passes, and low valleys, of the mountains and foothills. In altitude it ranges from about 4,100' to 6,878'. I have taken specimens at the upper limit, but on the whole it is usually taken at the lower altitudes.

I have examined 45 specimens, 17 males and 28 females, from the study area.

Limnephilus sansoni Banks, 1918
(Fig. 270a-272, 608)

Limnephilus sansoni Banks, 1918:19. (Type locality: Banff, Alberta). Dodds and Hisaw, 1925b:386. Betten, 1934:337. Milne, 1935:44, 51. Ross, 1938b:39. Ross, 1944:298. Ross and Merkley, 1952:448. Fischer, 1968:295.

Limnophilus sansoni; Schmid, 1955:135.

Males of this species are distinguished from males of other species in the group by long, thin, tapered, dorsal process of clasper; by laterally toothed tip of median lobes of segment X; and by row of heavy, black teeth on mesal face of cercus (Fig. 270b). Females are distinguished by large, isolated cerci of segment X, and by segment X cleft squarely on latero-mesal faces (Fig. 271). Venation identical to that of *L. sublunatus*.

Description. – Antennae dark brown; scapes darker, with antero-mesal faces pale, glabrous. Vertex of head almost black in ocellar triangle; remainder brown, with warts yellow. Thorax generally dark brown. Body of female generally rich red-brown, with dark brown only dorso-laterally. Brushes of male anterior femora of strong, black spines on basal half only. Spurs yellow. Fore wing length of male 14.0 mm; light brown; costal area clear to distal end of sub-costa. Stigma present. Clear areas other than costal margin slightly cloudy brown to clear yellow.

Male genitalia. (Specimen from Totem Creek area, Banff-Jasper Hwy., north of Lake Louise, Alberta). Postero-dorsal edge of tergum VIII prolonged posterad as large, black, spinate bulb. Segment IX with very narrow dorsal strap directed postero-dorsad at about 45°. Main body of segment square; posterior edge indented at clasper bases as wide, thumb-like process dorsally (Fig. 270a). Clasper with long, narrow base and long, thin, finger-like dorsal process. Median lobes of segment X with small disto-lateral tooth; dorso-lateral edges black, denticulate; attached to mesal edges of small, basal plates. Cercus triangular, with posterior edges black, dentate; with strongly sclerotized, dorso-ventral, black, dentate ridge (Fig. 270b). Aedeagus essentially identical to that of *L. sublunatus*, except for slightly broader dorsal lobe.

Female genitalia. (Specimen from Totem Creek area, on Banff-Jasper Hwy., north of Lake Louise, Alberta). Vulval scale median lobe blunt, little tapered, longer than lateral lobes (Fig. 272). Ventro-lateral lobes of segment IX square, with acuminate, concave process directed posterad (Fig. 271). Supra-genital plate attached ventrad of segment IX, wide, with slightly flanged lateral edges, flanges folded mesad. Segment X rectangular in lateral aspect, with square lateral clefts; in ventral aspect wide, triangular basally; cleft ventrally only slightly; dorsal cleft complete to cercal bases. Cercus located on posterior half of segment X, projected posterad beyond segment for half its length.

Notes on biology. – Adults of this species are collected almost exclusively in the vicinity of sedge ponds or sloughs. The adult flight season extends from July 25 to October 3 with an apparent peak of emergence from mid-August to mid-September.

Geographical distribution. – The known range of this species extends from Alaska to Colorado, though records are few (Fig. 608). In Alberta it is confined to the mountain and foothill areas, ranging in altitude from 3,700' to 5,350'.

I have examined 276 specimens, 103 males and 173 females, from the study area.

Limnephilus extractus Walker, 1852
(Fig. 273-277, 609)

Limnephilus extractus Walker, 1852:34. (Type locality: St. Martin's Falls, Albany River, Hudson's Bay). McLachlan, 1863:157, 161. Hagen, 1864:835. Banks, 1892:363. Banks, 1907a:36. Banks, 1908a: plate 18, Fig. 6-7. Betten, 1934:324. Milne, 1935:44, 51. Milne (D. J.), 1943:192. Ross, 1944:298. Ross and Merkley, 1952:449. Morse and Blickle, 1953:98. Fischer, 1968:101-102.

Goniotaulius extractus; Hagen, 1864:815.

Limnophilus (Goniotaulius) extractus; Hagen, 1861:260.

Limnophilus extractus; McLachlan, 1876b:7. Ulmer, 1905a:19. Ulmer, 1907a:44. Betten and Mosely, 1940:135-136. Schmid, 1955:135.

Males of this species are distinguished from males of other species of the group by long, slender, black, median lobes of segment X; by inconspicuous posterior lobe of tergum VIII; and by short, trapezoidal claspers (Fig. 273). Females are distinguished by almost completely cleft segment X (Fig. 277); by lack of separate and distinct ventro-lateral lobe of segment IX (Fig. 276); and by laterally cleft segment X.

Description. – Antennae yellow to pale brown. Vertex of head yellow, to very pale brown in patches. Thorax pale yellow with slight local darkenings to pale brown. Male with brush of fore leg spinate, black, occupying only basal half of mesal face, in narrow band. Spurs yellow. Fore wing length of male 12.4 mm; pale brown to yellow; costal margin clear to wing tip and beyond. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Cold Lake, Alberta). Postero-dorsal margin of tergum VIII lightly setose; bounded laterally by depressions; setae pale. Segment IX with short dorsal strap; strap with mesal process directed ventrad (Fig. 273). Main body of segment abruptly expanded ventrad of dorsal strap, rectangular and featureless. Clasper small, blunt, attached to lower half of posterior edge of segment IX; trapezoidal in lateral aspect. Median lobes of segment X finger-like in lateral aspect; projected well posterad of cerci, black, each with small, distinct disto-lateral tooth (Fig. 274). Cercus triangular, concave on mesal face, not projected posterad of segment IX. Aedeagus simple; lateral arms originated dorsad of median shaft (Fig. 275); tips fringed with heavy setae along dorsal edges only; setae increase in length distally. Median shaft attached to distinct basal, sclerotized collar.

Female genitalia. (Specimen from Flatbush, Alberta). Vulval scale large, lobes well spaced; median lobe longer than lateral lobes, square-tipped, slightly tapered from base (Fig. 277); lateral lobes curved mesad distally. Segment IX large, higher than wide (Fig. 276); with slight latero-posterior lobes. Supra-genital plate semi-circular. Segment X fused to segment IX; of two pairs of lobes; cerci broad, triangular in lateral aspect; main body of segment cleft completely in vertical plane (Fig. 277); cleft slightly in horizontal plane.

Notes on biology. – This is a lake species. Adults are collected near sedge and other water weed-choked ponds and lakes. The adult flight period extends from May 22 to July 11.

Geographical distribution. – The known range of this species is primarily boreal, extending from Great Slave Lake and central Alberta to the northern New England States (Fig. 609). In Alberta it is confined to the central and northeast lowlands.

I have examined 27 specimens, 25 males and two females, from the study area.

Limnephilus hageni Banks, 1930
(Fig. 278-283, 610)

Limnephilus hageni Banks, 1930a:226. (Type locality: Fort Resolution, Great Slave Lake). Betten, 1934:336. Milne, 1935:44, 51. Ross, 1938b:36. Ross, 1944:298. Ross and Merkley, 1952:448. Fischer, 1968:173.
Limnophilus hageni; Schmid, 1955:135.

Males of this species are distinguished from males of other species in the group by high, narrow clasper bases, with thick, blunt dorsal process (Fig. 278); by row of black teeth extended only half way across cerci; and by dorso-laterally directed tips of median lobes of segment X. Females are distinguished by long, thin, cerci extended more than half their length beyond segment X; by absence of discrete ventro-lateral lobes of segment IX; and by very long median lobe of vulval scale (Fig. 282, 283).

Description. – Antennae light yellowish brown. Vertex of head with diamond-shaped black area with two corners occupied by lateral ocelli. Thorax light yellowish brown, with darker areas on thorax. Brush of male fore leg of single row of black spines extended along basal half of femur. Spurs yellow-brown. Fore wing length of male 11.8 mm; light brown, clear areas hyaline. Costal area quite clear; stigma slight. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Forestry Trunk Road in area of Kananaskis Lakes, Alberta). Postero-dorsal edge of tergum VIII produced as short, black-spinate bulb. Segment IX with long, tapered dorsal strap; main body of segment stout, rectangular, with postero-dorsal angle directed mesad, furrowed (Fig. 278). Clasper short, blunt distally; base high, narrow. Median lobes of segment X short, stout in lateral aspect, black distally, with tips curved dorso-laterad (Fig. 278, 279). Cercus large, with dorsal edge curved gently distad; posterior edge black, irregularly dentate; mesal face with short, curved dentate line from dorsal edge. Median shaft of aedeagus with distinct distal head; opening of ejaculatory duct at extreme tip. Lateral arms large, each bifid, ventral lobe membranous, extensible, distally fringed with long setae; dorsal lobe sclerotized, toothed distally, with tooth directed dorso-mesad (Fig. 281).

Female genitalia. (Specimen from Forestry Trunk Road in area of Kananaskis Lakes, Alberta). Vulval scale with long, narrow, median lobe (Fig. 283); lateral lobes small, widely spaced, lateral edges slightly flanged. Segment IX large, rectangular, with small ventro-lateral lobes (Fig. 282). Supra-genital plate large, semi-circular. Segment X indistinct from segment IX; deeply cleft dorsally. Cerci long, thin, well separated from segment X.

Notes on biology. – Adults of this species are found in smaller ponds or sloughs with dense sedge and horse-tails present. The adult flight period extends from July 15 to September 22; my records are insufficient to indicate a peak period.

Geographical distribution. – The known range of this species extends from British Columbia to Ontario and Great Slave Lake (Fig. 610). In Alberta it is confined to the mountains and foothills, ranging in altitude from 4,600' to 5,350'.

I have examined 26 specimens, 16 males and 10 females, from the study area, and one (male) from Great Slave Lake.

Limnephilus partitus Walker, 1852
(Fig. 139a, 139b, 284-290, 611)

Limnephilus partitus Walker, 1852:32. (Type locality: St. Martin's Falls, Albany River, Hudson's Bay). McLachlan, 1863:157, 161. Banks, 1907a:37. Betten, 1934:330. Milne, 1935:20, 47. Milne, 1936:60. Ross, 1944:298. Ross and Merkley, 1952:448. Etnier, 1965:149. Fischer, 1968:252-253.
Limnophilus partitus; Betten and Mosely, 1940:127-129.

Males of this species are distinguishable by irregular posterior edges of segment IX (Fig. 284); by high, narrow-based claspers, with dorsal process long, thin, directed dorso-posterad; by very wide dorso-posterior process of tergum VIII (Fig. 285); and by small, sclerotized ventral lobe of lateral arm (Fig. 286). Females are distinguished by divided ventro-lateral lobes of segment IX (Fig. 290).

Description. – Antennae black. Vertex of head black, warts dark brown. Thorax black in male, brown in female. Spurs light brown. Fore wing length of male 12.3 mm; brown, with large clear areas. Costal margin clear for about four-fifths of length. Stigma present, with distinct, white area immediately basad. Venation as in Fig. 139a, 139b; both fore and hind wings with cell between f2 and f3 pedicellate.

Male genitalia. (Specimen from pond 2 miles east of Nordegg, Alberta). Tergum VIII black with pale ventro-lateral edges; postero-dorsal edge produced posterad as black-spinate bulge dorsad of genitalia. Dorsal strap of segment IX hyaline, discrete from remainder of segment (Fig. 284); narrow in posterior aspect (Fig. 285). Main body of segment squat, with distinct bulge on dorsal edge. Clasper with base coincident with entire posterior edge of segment IX; dorsal process finger-like. Median lobes of segment X attached to mesal edges of lateral, concave lobes; massive, directed dorso-posterad; quite black. Cercus with distal edge black, dentate; with thin, weak line of teeth on mesal face. Lateral arms of aedeagus bilobed (Fig. 286); dorsal lobe heavily sclerotized, distally spiniform, directed dorsally; ventral lobe hyaline, spatulate, fringed distally with setae.

Female genitalia. (Specimen from pond 2 miles east of Nordegg, Alberta). Vulval scale wide (Fig. 289); lateral arms with concave distal faces; median lobe wide basally, gradually tapered distad, rounded. Segment IX with small dorsal body, divided to ventro-lateral lobes (Fig. 290). Supra-genital plate large, projected well posterad of vulval scale. Segment X completely cleft dorsally; anal opening wide, flared. Cerci short, acute-triangular in ventral aspect, held close to segment X.

Notes on biology. – Adults of this species are collected near ponds or sloughs thickly vegetated with sedges, or sedges and horse-tails. The adult flight period extends from August 7 to October 3. Peak emergence appears to be from mid-August to mid-September.

Geographical distribution. – The known range of this species extends from British Columbia and Great Slave Lake, to Newfoundland (Fig. 611). In Alberta it is confined to the mountains and foothills, ranging in altitude from 3,800' to 5,200'.

I have examined 77 specimens, 49 males and 28 females, from the study area and Great Slave Lake.

Limnephilus susana Nimmo, n. sp.
(Fig. 291-295, 612)

Males of this species are distinguished from males of other species in the group by evenly tapered, dorsally directed median lobes of segment X (Fig. 291); and by tapered, ventrally curved lobe of tergum VIII. Females are distinguished by short, stout cerci closely appressed to segment X and of equal length (Fig. 295); and by vulval scale median lobe twice as long as lateral lobes (Fig. 294).

Description. – Antennae red-brown. Vertex of head reddish to yellowish brown except for dark, chocolate-brown between ocelli, in cruciform pattern in male. Thorax very dark brown laterally and dorsally. Brush of male fore leg of scattered short, black spines on basal half of femur. Spurs light red-brown. Fore wing length of male 14.6 mm; chocolate-brown, with lighter, reddish brown, areas. Costal area almost hyaline. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Forestry Trunk Road, at Pembina River, Alberta). Postero-dorsal lobe of tergum VIII broad, somewhat flattened, tapered, curved ventrad. Segment IX high, narrow, with main body nearly rectangular in lateral aspect (Fig. 291); with deep furrow at postero-dorsal angle. Dorsal strap deep, vertical band. Clasper large, with long, sinuate base; dorsal process of uneven width, directed dorsad distally, twisted slightly to form ridge at right angles to body axes. Median lobes of segment X long, narrow, evenly tapered, dorsally upturned blades; with disto-lateral tooth (Fig. 292) and large concave plates basally. Cercus massive, curved, of approximately uniform width; distally with row of dark teeth; second series of three to four dark teeth two-thirds of distance from base (Fig. 292). Median shaft of aedeagus stout, dorsally curved; lateral arms massive, bilobed (Fig. 293). Dorsal lobe heavy, distally toothed, sclerotized; ventral lobe membranous but with lightly sclerotized distal edges with long, stout setae dorsally.

Female genitalia. (Specimen from Forestry Trunk Road, at Pembina River, Alberta). Vulval scale large, with long, rectangular, median lobe, rectangular, almost square, lateral lobes (Fig. 294); all lobes well separated; median lobe twice as long as lateral lobes. Supra-genital plate large, pentagonal in ventral aspect. Segment IX with two thin, ventral lobes, and triangular dorsal portion, all connected by narrow lateral straps (Fig. 295). Segment X robust, terminated distally by two pairs of lobes; dorsal lobes thin, triangular; ventral lobes vertically thin, wide in lateral aspect. Cerci short, closely attached to dorsal surface of segment X; rounded, spindle-shaped.

Notes on biology. – Known only from a single slough with thick growth of horse-tails and a fine-bladed sedge; water shallow. Date of capture was September 22.

Holotype. – Male. Forestry Trunk Road about 1 mile north of crossing of Pembina River, Alberta (Fig. 612); September 22, 1968. A. Nimmo.

Allotype. – Female. Same data as holotype.

Paratypes. – Same data as for holotype; one male, two females.

The holotype, allotype, and one female paratype are in the Canadian National Collection, Ottawa, where they have been assigned the type series number 10,586. The remaining male and female paratypes are in the Strickland Museum. Dept. of Entomology, University of Alberta, Edmonton, Alberta.

This new species is named for my wife, Susan.

Limnephilus species 1
(Fig. 296-297, 612)

Females of this species are distinguished from females of other species in the group by large dorsal body to segment IX, by long, distally up-turned segment X, and by long, slender, tapered cerci not appressed dorsally to segment X (Fig. 296).

Description. – Antennae yellow-brown. Vertex of head deep red-brown. Thorax yellow-brown. Spurs dark brown; formula 1,3,3. Fore wing length of female 11.8 mm; red-brown, with hyaline areas typical of the pattern for the *subcentralis* group, except no evident longitudinal bars at wing tip. Venation identical to that of *L. sublunatus*.

Male genitalia. Unknown.

Female genitalia. (Specimen from 2 miles north of Athabasca Falls, on Hwy. 93a, Jasper National Park, Alberta). Median lobe of vulval scale much longer than lateral lobes, with square tip, gradually tapered. Lateral lobes sub-triangular (Fig. 297). Segment IX large, with two ventro-lateral, rounded, not separate, lobes (Fig. 296). Dorsal portion convex, bounded by lateral declivities which result in concave sides of segment. Segments IX and X partly separated by faint suture. Supra-genital plate relatively small, convex ventrally; polygonal in

ventral aspect. Segment X cylindrical, deeply cleft mesally; not so deeply cleft laterally; dorsal lobes thus formed small, triangular in lateral aspect; ventral lobes larger, wider. Cerci long, tapered, thin, free from dorsal surface of segment X.

The single specimen of this species known to me was taken from a small muskeg lake 2 miles north of Athabasca Falls, on Hwy. 93a, Jasper National Park, Alberta, September 10, 1966 (Fig. 612).

The *stigma* group

Males of this group are characterised by relatively small claspers, with high, ventrally tapered bases, and short, blunt dorsal processes; by small postero-dorsal lobes of tergum VIII projected well posterad from membranous connection to segment IX (Fig. 304). Females are characterised by presence of separate and discrete ventro-lateral lobes of segment IX (Fig. 302).

Limnephilus indivisus Walker, 1852
(Fig. 298-303, 614)

Limnephilus indivisus Walker, 1852:34. (Type locality: Nova Scotia). McLachlan, 1863: 157, 161. Hagen, 1864:836. Banks, 1892:363. Banks, 1899:208. Simpson, 1903:98-100. Banks, 1907a:36. Lloyd, 1915:205-208. Krafka, 1923: plate 9, Fig. 58. Betten, 1926: 529. Ricker, 1932:132. Ricker, 1934:54. Betten, 1934:325-326. Milne, 1935:46, 51. Mickel and Milliron, 1939:575-579. Ross, 1941:109. Ross, 1944:5, 185, 186, 189, 191, 298. Proctor, 1946:211. Leonard and Leonard, 1949a:18. Schmid and Guppy, 1952:42. Ross and Spencer, 1952:48. Ross and Merkley, 1952:448. Morse and Blickle, 1953:98. Flint, 1960:5, 47-49, 51, 53, 57. Robert, 1960:59. Etnier, 1965:149. Fischer, 1968: 196-198. McConnochie and Likens, 1969:150.

Limnophilus indivisus; Hagen, 1861:260-261. Ulmer, 1905a:19. Ulmer, 1907a:44. Siltala, 1907a:17. Siltala, 1907b:329, 486. Lloyd, 1921:41, 47-51. Branch, 1922:256, 257, 258, 259, 263, 265, 266, 267, 270. Sibley, 1926:107, 191, 193, 194. Muttkowski and Smith, 1929:259. Handlirsch, 1936: Fig. 1601, 1608. Needham and Lloyd, 1937:345. Balduf, 1939:144, 151, 161, 179. Betten and Mosely, 1940:129-132. Schmid, 1955:136.

Limnephilus subguttatus Walker, 1852:34-35. Ross, 1944:191, 298. Fischer, 1968:197-198.

Limnophilus subguttatus; Hagen, 1861:261. Hagen, 1873a:295. McLachlan, 1875:59. Provancher, 1877:243. Provancher, 1878b:131. Provancher, 1878a:146. Betten and Mosely, 1940:129, 132. Ross, 1944:191, 298.

Males of this species are distinguished from males of other species of the group and genus by distally flared or expanded cerci (Fig. 298); and by short, narrow, tapered, median lobes of segment X. Females are distinguished by right-angled, ventro-lateral lobes of segment IX (Fig. 302); and by long, thin, acute-triangular cerci of segment X closely appressed to the dorso-lateral surface of segment X.

Description. – Antennae pale yellow; scapes darker, with longitudinal band of fine, short setae on antero-mesal faces. Vertex of head reddish brown, warts paler. Thorax yellow, tending to light reddish brown dorsally. Spurs dark reddish yellow. Fore wing length of male 14.9 mm; yellow to pale brown. Costal area clear to distal end of costa. Venation identical to that of *L. sublunatus*; with short area of short, black hairs on vein R2 of male hind wing (as in Fig. 140b); absent in female. Abdominal sterna VI and VII of male with short, triangular lobes in middle of posterior edges; similarly in female, but on sterna V and VI.

Male genitalia. (Specimen from Gorge Creek, 20 miles west of Turner Valley, Alberta). Postero-dorsal process of tergum VIII with short, black spines. Dorsal strap of segment IX not arched highly, directed postero-dorsad, with distinct, spatulate ventro-mesal process (Fig. 298, 301) connected to segment X. Body of segment IX wide dorsally, narrowed ventrad; with distinct black band of varied width along anterior edges. Clasper short, blunt, with high, narrow base. Median lobes of segment X conical, short, thin, tapered distad, black; attached to mesal edges of basal plates; directed slightly dorso-laterad. Cercus broadened distad; short, with distal rim black, dentate; with row of heavy, black teeth vertically on mesal face (Fig. 301); with tufts of black setae at distal corners. Lateral arms of aedeagus bilobed, with bifid bases (Fig. 299); ventral lobe rounded, spatulate, with fringe of heavy, dark setae on dorsal edge; dorsal lobe directed dorso-mesad (Fig. 300), with black, spiniform tip and hyaline lateral flange; posterior edge with four very heavy, black spines.

Female genitalia. (Specimen from Gorge Creek, 20 miles west of Turner Valley, Alberta). Vulval scale with two triangular lateral lobes, uniformly tapered median lobe. Ventro-lateral lobes of segment IX distinct, discrete (Fig. 302), bent at right angles around base of segment X. Dorsal portion of segment IX small, almost indistinguishable from segment X. Supragenital plate small, smoothly curved (Fig. 303). Segment X deeply cleft dorsally; conical in ventral aspect, situated between cerci. Cerci closely appressed to dorso-lateral surfaces of segment X, tapered to finger-like tips.

Notes on biology. – I have frequently taken adults of this species in the vicinity of small lakes or sloughs which are thickly bordered by cattail rushes, or coarse sedges. The adult flight period extends from July 14 to September 30; records are insufficient to determine a peak.

Geographical distribution. – The known range of this species extends from British Columbia to Illinois, Nova Scotia and Quebec (Fig. 614). In Alberta it is found in the plains, foothills, and low mountain passes.

I have examined 25 specimens, 15 males and 10 females, from the study area.

Limnephilus infernalis (Banks), 1914
(Fig. 304-308, 613)

Anisogamus infernalis Banks, 1914:154-156. (Type locality: Pinnacle Mountain, Fulton County, New York).

Stenophylax infernalis; Betten, 1926:529. Betten, 1934:343-344.

Limnephilus infernalis; Milne, 1935:46, 51. Milne (D. J.), 1943:192, 194, 195. Ross, 1944: 298. Leonard and Leonard, 1949a:18. Ross and Merkley, 1952:448. Etnier, 1965:149. Nimmo, 1965:783-786. Fischer, 1968:198. Clifford, 1969:582.

Limnophilus infernalis; Schmid, 1955:136.

Males of this species are distinguished by antero-dorsally directed median lobes of segment X (Fig. 304); by large, mesally concave cerci heavily clothed on mesal faces with long setae; and by meso-ventral process of dorsal strap of segment IX connected to segment X (Fig. 305). Females are distinguished by large ventro-lateral lobes of segment IX (Fig. 307); and by large, triangular cerci fused to posterior edges of segment IX.

Description. – Antennae uniformly pale yellow. Vertex of head yellow except for darker area mesad of lateral ocelli. Thorax pale yellow, to brownish yellow. Brush of male fore leg extended barely half length of femur; composed of very stout, black spines.

Male genitalia. (Specimen from Sturgeon River, St. Albert, Alberta). Postero-dorsal lobe of tergum VIII small, bulbous distally; with short, stout, sparsely scattered, black spines. Segment IX with very high, thin dorsal strap; strap with large, ventro-mesally directed horn

connected to segment X; main body of segment small, irregular (Fig. 304, 305). Clasper thumb-like, widened slightly at high, very narrow base. Median lobes of segment X attached to mesal edges of slightly concave, basal plates; curved antero-dorsad, with slight distal swelling. Cercus very large, concave mesally; mesal face thickly clothed with long setae. Aedeagus simple; ejaculatory duct terminated at extreme tip, lateral arms attached to dorsal membranous base of aedeagus, with slightly dilated, setose tips (Fig. 306).

Female genitalia. (Specimen from Sturgeon River, St. Albert, Alberta). Vulval scale with short, tapered, blunt median lobe (Fig. 308); lateral lobes deeply channelled on mesal faces. Ventro-lateral lobes of segment IX triangular in lateral aspect (Fig. 307); main body of segment relatively large, not distinct from segment X. Segment X inconspicuous, ventrad of massive, triangular cerci; of simple, triangular dorso-lateral lobes fused to ventral surfaces of cerci (Fig. 308), and ventral, concave, triangular plate ventrad of anal orifice. Supra-genital plate visor-like, arched dorsad.

Notes on biology. – Adults of this species emerge from lakes, sloughs and quiet streams bordered with thick growths of sedges and cattail reeds. The adult flight period extends from August 14 to September 22.

Geographical distribution. – The known range of this species extends from Alaska to Alberta, Michigan and Maine (Fig. 613). In Alberta it is confined to the plains, low foothills, and low mountain passes.

I have examined 256 specimens, 206 males and 50 females, from the study area and Great Slave Lake.

The *ornatus* group

Males of the single species of this group are characterised by massive, distally bifid cerci (Fig. 309); by claspers with high, narrow bases and short, stubby dorsal processes; and by simple aedeagus (Fig. 311). Females are characterised by massive segment IX without ventro-lateral lobes (Fig. 313); by segment X which is discrete from segment IX; and by long, tapered cerci well separated from segment X.

Limnephilus ornatus Banks, 1897
(Fig. 309-314, 615)

Limnephilus ornatus Banks, 1897:27. (Type locality: Sherbrook, Canada). Banks, 1899: 208. Banks, 1900b:467. Banks, 1907a:37. Banks, 1908b:63. Betten, 1926:529. Banks, 1930b:128. Neave, 1934:167. Betten, 1934:329-330. Milne, 1935:46, 51. Ross, 1944: 186, 189-190, 298. Proctor, 1946:211. Leonard and Leonard, 1949a:18. Ross and Merkly, 1952:441. Morse and Blickle, 1953:98. Robert, 1960:59. Wiggins, 1961:700. Etnier, 1965:149. Nimmo, 1966a:692. Nimmo, 1966b:224. Fischer, 1968:249-250. Lindroth and Ball, 1969:138. McConnochie and Likens, 1969:150.

Limnophilus ornatus; Betten, 1901:573. Ulmer, 1905a:19. Ulmer, 1907a:44. Nakahara, 1915:95. Sibley, 1926:107, 191. Essig, 1926:176. Forsslund, 1932:57-59. Mosely, 1932: 573. Ulmer, 1932:213. Carpenter, 1938:530, 534. Henricksen, 1939:23. Fristrup, 1942: 20. Schmid, 1955:136. (See Fischer, 1968:249-250, for Palaearctic literature).

Limnophilus elegans Mosely (not Curtis), 1929:502, 504, 507. Fischer, 1968:250.

Description. – Antennae yellow. Vertex of head uniformly yellow. Thorax pale yellow to light reddish brown. Brush of male fore leg narrow row of black setae along mesal face of basal half of femur. Spurs yellow. Fore wing length of male 14.3 mm; pale yellow to light reddish brown, with large hyaline areas. Costal area clear except for opaque area in distal

third of stigma. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Indian Head, Saskatchewan). Tergum VIII without postero-dorsal process. Segment IX with short, thin dorsal strap. Main body with large, blunt lobe at postero-dorsal angle; with distinct row of heavy setae along ventral half of posterior edge (Fig. 309). Clasper with high, narrow base and short, blunt, thumb-like dorsal process. Median lobes of segment X attached to complexly folded baso-lateral plates; ventral edges and lateral faces minutely dentate; lobes black distally. Cercus large, bifurcated distally; distal lobes black, heavily sclerotized at tips (Fig. 310). Lateral arms of aedeagus slightly expanded distally (Fig. 311); distal half warped, concave mesally (Fig. 312) with fringe of setae along posterior edge.

Female genitalia. (Specimen from Indian Head, Saskatchewan). Vulval scale with short, rectangular median lobe; lateral lobes narrow, distinctly separated distally from median lobe (Fig. 314). Segment IX without discrete latero-ventral lobes (Fig. 313); curved slightly to embrace segment X. Supra-genital plate small, rounded, almost elliptical, set into ventral depression of segment IX. Segment X of inter-leaved dorsal and ventral parts distally; dorsal lobes darker, fused basally to ventral trough. Cerci long, thin, tapered, well separated from dorsal surface of segment X.

Notes on biology. – I have not taken individuals of this species in the study area, but the records available indicate that they inhabit sloughs and small lakes. The adult flight period extends from July 13 to September 10.

Geographical distribution. – The known range of this species extends from Alaska to Illinois and Greenland (Fig. 615) in North America. It is actually a Holarctic species with records extending west to Europe and Iceland. In Alberta it is confined to the plains or long, low mountain valleys leading to the plains.

I have examined 11 specimens, three males and eight females, from the study area.

The *picturatus* group

Males of the single species are characterised by large, mesally concave claspers with disto-mesal spine (Fig. 315, 316); by absence of postero-dorsal process of tergum VIII; and by short, relatively wide dorsal strap dorsad of large, trapezoidal segment IX. Females are distinguished by massive ventro-lateral lobes of segment IX (Fig. 318); by complete lack of separation of segments IX and X dorsally; and by minute, triangular cerci closely appressed to dorso-lateral surfaces of segment X.

Limnephilus picturatus McLachlan, 1875
(Fig. 315-319, 616)

Limnophilus picturatus McLachlan, 1875:78-79. (Type locality: Europe). Brauer, 1876:286. Ulmer, 1905a:19. Ulmer, 1907a:42. Ulmer, 1932:213. Schmid, 1955:136. (See Fischer, 1968:256-259, for Palaearctic literature).

Limnephilus picturatus; Ross and Merkley, 1952:449, 454-455. Fischer, 1968:256-259. (See Fischer, 1968:256, 258, for Palaearctic literature).

Limnophilus exulans McLachlan, 1876, (See Fischer, 1968:258).

Limnophilus miyadii Tsuda, 1924, (See Fischer, 1968:258).

Phryganea notatus Zetterstedt, 1840, (See Fischer, 1968:258-259).

Description. – Antennae dark brown; scapes and pedicels black; yellowish brown throughout in females. Head entirely black. Thorax black; brush of male fore leg on basal two-thirds of femur; opposing face of tibia minutely spinate. Spurs yellow. Fore wing length of male

9.1 mm; pale brownish yellow; costal area clear; not patterned. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Bow Pass, Banff National Park, Alberta). Segment IX with short dorsal strap; main body robust (Fig. 315). Clasper with long, narrow base; dorsal process short, with irregular edges, directed dorso-posterad. Median lobes of segment X narrow basally, widened at mid-point, narrowed distally to dorso-lateral hooks (Fig. 315, 316); black throughout. Median lobes attached to simple latero-basal plates. Lateral arms of aedeagus simple, gradually widened distad to narrow, acuminate tips with several tufts of setae or spines (Fig. 317).

Female genitalia. (Specimen from Sunwapta Pass, Jasper National Park, Alberta). Vulval scale triangular in general outline (Fig. 319); median lobe blunt, almost rectangular; lateral lobes semi-triangular, with straight posterior and mesal edges. Segment IX with massive, rectangular, ventro-lateral lobes (Fig. 318); dorsal body of segment small, indistinguishable from segment X. Supra-genital plate small, crescentic. Segment X small, with two minute dorsal lobes and single ventral lobe. Cerci small, triangular, immovable, closely appressed to dorso-lateral surfaces of segment X.

Notes on biology. – Adults of this species are found near shallow, sedge-fringed sloughs or small pools. The adult flight period extends from August 5 to September 22. There appears to be a peak at about the end of August and beginning of September.

Geographical distribution. – The nearctic range of this holarctic species extends from Alaska to Hudson's Bay, and to Colorado (Fig. 616). In Alberta it is confined to the mountains and foothills, ranging in altitude from about 5,000' to 6,880'.

I have examined 71 specimens, 42 males and 29 females, from the study area.

The *externus* group

Males of the single species of this group present in the study area are distinguishable by small, triangular cerci (Fig. 320); by black-spinate postero-dorsal bulb of tergum VIII; and by small, vertical, posteriorly hooked median lobes of segment X. Females are distinguished by massive ventro-lateral lobes of segment IX (Fig. 324); and by large, roughly triangular cerci of segment X very close to segment X.

Limnephilus externus Hagen, 1861
(Fig. 320-325, 617)

Limnophilus externus Hagen, 1861:257. (Type locality: North Red River, Canada). Ulmer, 1905a:19. Ulmer, 1907a:44. Ulmer, 1932:212. Schmid, 1955:137. (See Fischer, 1968: 99, for Palaearctic literature).

Limnephilus externus; Hagen, 1864:835. Banks, 1892:636. Banks, 1907a:36. Betten, 1934: 152. Neave, 1934:167. Milne, 1935:44, 51. Ross, 1938b:36. Knowlton and Harmston, 1939:286. Banks, 1943:342. Ross, 1944:298. Leonard and Leonard, 1949a:17. Schmid and Guppy, 1952:42. Ross and Merkley, 1952:447. Ross and Spencer, 1952:48. Flint, 1960:5. Wiggins, 1961:701. Denning, 1963:261. Etnier, 1965:149. Fischer, 1968:99-101. (See Fischer, 1968:99-100, for Palaearctic literature).

Limnophilus congener McLachlan, 1875:56-57. (See Fischer, 1968:100, for Palaearctic literature).

Limnephilus congener; (Palaearctic; see Fischer, 1968:100).

Limnephilus luteolus Banks, 1899:207, 208. (Type locality: Washington State). Banks, 1907a:36. Milne, 1935:44, 51. Fischer, 1968:101.

Limnophilus luteolus Ulmer, 1905a:19. Ulmer, 1907a:44. Essig, 1926:176.
Limnephilus oslari Banks, 1907b:121-122. (Type locality: Colorado). Banks, 1907a:37. Dodds and Hisaw, 1925b:286. Betten, 1934:337. Milne, 1935:51. Ross, 1938b:38. Fischer, 1968:101.
Limnophilus oslari; Essig, 1926:176.
Limnephilus tersus Betten, 1934:334. (Type locality: Old Forge, New York). Milne, 1935: 48, 52. Milne, 1936:62. Ross, 1944:298. Ross and Merkley, 1952:447. Fischer, 1968: 101.

Description. – Antennae uniform yellowish brown. Vertex of head black immediately mesad of lateral ocelli, otherwise brown. Thorax light reddish brown. Brush of male fore leg single row of black spines on basal half of mesal face of femur. Spurs hyaline to yellow. Fore wing length of male 21.6 mm; greyish brown, with hyaline areas. Costal area clear to distal end of sub-costa. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Wapta Lake, Kicking Horse Pass, Yoho National Park, British Columbia). Postero-dorsal process of tergum VIII distinctly bulbous, with mesal band of dark spines. Dorsal strap of segment IX arched posterad, with ventro-mesal process (Fig. 320). Main body of segment rectangular, slightly curved, with distinct groove at postero-dorsal angle. Clasper short, slender, with virtually non-existent base; dorsal process with single, dorsally directed distal tooth. Median lobes of segment X black distally, each with two small distal teeth, dorsally and ventrally; lobes vertical, hooked posterad; bases bifid. Cercus triangular, with dorsal angles produced posterad; distal edges with row of prominent, black teeth (Fig. 321). Lateral arms of aedeagus distally fringed with dorsal row of setae directed anterad (Fig. 322, 323).

Female genitalia. (Specimen from Wapta Lake, Kicking Horse Pass, Yoho National Park, British Columbia). Vulval scale with evenly tapered median lobe; lateral lobes widely spaced (Fig. 325). Segment IX with massive, triangular ventro-lateral lobes in contact ventrad of segment X (Fig. 324, 325); dorsal portion of segment small, triangular in dorsal aspect. Supra-genital plate straight-edged in ventral aspect, with triangular distal edge. Segment X small, discrete from segment IX, with deep dorsal cleft, sinuate ventral edge. Cerci large, triangular, close to segment X.

Notes on biology. – Adults of this species are associated with smaller, sedge-fringed ponds and sloughs. The adult flight period extends from July 24 to October 4; I have one record from June 15, also. The peak appears to occur from mid-August to mid-September.

Geographical distribution. – The nearctic range of this holarctic species extends from Great Slave Lake to California and Newfoundland in North America (Fig. 617). In Alberta it occurs in the mountains and plains. It ranges in altitude from 2,000' to 5,340'.

I have examined 276 specimens, 108 males and 168 females, from the study area.

The *sericeus* group

Males of species of this group are characterised by high, narrow claspers with little or no dorsal process; by long, acute-triangular median lobes of segment X; and by meso-ventrally directed, relatively long, tubular, postero-dorsal process of tergum VIII (Fig. 326). Females of this group are characterised by segment IX without discrete ventro-lateral lobes; by very acuminate dorsal blade of segment X; and by rectangular, free cerci (Fig. 330, 331).

Limnephilus sericeus (Say), 1824
(Fig. 326-331, 618)

Phryganea sericea Say, 1824:309. (Type locality: Northwest Territories). Harris, 1835:582. Say, 1859:207.

Limnophilus sericeus; Hagen, 1861:256. Ulmer, 1905a:19. Ulmer, 1907a:44. Schmid, 1955: 137.

Limnephilus sericeus; Hagen, 1864:839. Banks, 1892:363. Banks, 1907a:37. Betten, 1934: 337. Milne, 1935:21. Milne, 1936:61. Ross, 1941a:110. Ross, 1944:186, 192, 298. Leonard and Leonard, 1949a:19. Ross and Merkley, 1952:443. Ross and Spencer, 1952: 48. Schmid and Guppy, 1952:42. Morse and Blickle, 1953:98. Flint, 1960:51-52. Robert, 1960:59. Etnier, 1965:149. Flint, 1966:380. Fischer, 1968:297-298.

Anabolia decepta Banks, 1899:208-209. (Type locality: Washington State).

Description. – Antennae yellow-brown. Vertex of head dark chocolate-brown, except for lighter warts. Thorax yellow-brown, with darker areas. Male with very small brushes on anterior femora. Spurs yellow. Fore wing length of male 10.6 mm; light brown, clear areas hyaline. Costal area clear for most of distance to end of costa. Venation with humeral cross-vein either missing in both wings or reduced, otherwise as in *L. sublunatus*.

Male genitalia. (Specimen from Crimson Lake, Alberta). Postero-dorsal process of tergum VIII lengthened to cylindrical column directed meso-ventrad between cerci. Dorsal strap of segment IX narrow, high; main body of segment very slim in lateral aspect, with postero-dorsal angles blunt, curved mesad (Fig. 326). Clasper very acute-triangular with no dorsal process. Median lobes of segment X long, narrow, acuminate blades with dorsal edges dentate, black; attached to mesal edges of basal, convex plates which extend laterad to cercal bases. Cercus trapezoidal in lateral aspect; mesal edge massively dentate, black. Median shaft of aedeagus short, stout, tapered; distal aspect of tip of median shaft as in Fig. 329. Lateral arm with sclerotized, dorsally rugose base, membranous distal part (Fig. 327); tips lanceolate, fringed with short setae.

Female genitalia. (Specimen from Crimson Lake, Alberta). Vulval scale long, tapered, distally rounded median lobe (Fig. 330); lateral lobes small, with concave ventral faces (Fig. 331). Segment IX without discrete ventro-lateral lobes; larger ventrally, extending postero-ventrad under segment X (Fig. 331). Segment X with tubular body; dorsal edge of anal orifice extended posterad as very thin, black blade (Fig. 331); slightly cleft distally (Fig. 330). Cerci long, quite free from body of segment X; parallel sided in lateral aspect.

Notes on biology. – Adults of this species emerge from a variety of habitats, ranging from ponds, lakes or sloughs fringed with sedges, cattail rushes, or horse-tails, to small or large streams and rivers of a quiet or smooth flowing nature. The flight season extends from June 15 to October 3, with no evident peak.

Geographical distribution. – The known range of this species extends from Alaska to Oregon, and east to Quebec and the New England States (Fig. 618). In Alberta it is found indiscriminately in the mountains, foothills and plains. In the mountain areas it is found to altitudes of 6,675'.

I have examined 81 specimens, 44 males and 37 females, from the study area.

The *luridus* group

Males of this group are characterised by minute claspers; by long, narrow cerci; by massive postero-dorsal bulbs of tergum VIII; and by ventrally narrow segment IX (Fig. 332). Females are characterised by massive segment IX without discrete ventro-lateral lobes; by small segment X; and by small, triangular cerci (Fig. 336).

Limnephilus femoralis Kolenati, 1848
(Fig. 332-336, 620)

Limnephilus nebulosus Kirby, 1837:253. (Preoccupied). (Type locality: British America). Walker, 1852:50. McLachlan, 1863:157, 161. Banks, 1899:208. Banks, 1900b:469. Banks, 1907a: plate 18, Fig. 9. Banks, 1908b:61, 63. Betten, 1934:327-328. Milne, 1935:46, 51. Ross, 1944:298. Ross and Merkley, 1952:448, 453-454. Wiggins, 1961: 701. Fischer, 1968:113-115. Lindroth and Ball, 1969:138. (See Fischer, 1968:113-115, for Palaearctic literature).

Limnophilus nebulosus; Kolenati, 1848:26. Hagen, 1861:259. McLachlan, 1876b:6. Brauer, 1876:286. Meinert, 1897:160-161. Jacobsen, 1898:215. Ulmer, 1905a:19, 80. Ulmer, 1907a:42, 45. Kolbe, 1912:41. Essig, 1926:176. Mosely, 1929:502-507. Forsslund, 1932: 59. Ulmer, 1932:212, 217. Betten and Mosely, 1940:121-127. Schmid, 1955:138. (See Fischer, 1968:113-115, for Palaearctic literature).

Goniotaulius nebulosus; Kolenati, 1859a:157, 173. Hagen, 1864:816. Banks, 1892:363. (See Fischer, 1968:113, for Palaearctic literature).

Limnophilus femoralis Kolenati, 1848:26. Hagen, 1861:260. Ulmer, 1905a:19. Ulmer, 1932: 214, 217. (See Fischer, 1968:112-113, for Palaearctic literature).

Limnephilus femoralis; Walker, 1852:50. Hagen, 1864:835. Banks, 1892:363. Ulmer, 1907a: 42, 44. Banks, 1907a:36. Betten,1934:324. Milne, 1935:20. Milne, 1936:61. Betten and Mosely, 1940:121, 122-126. Fischer, 1968:112-115. (See Fischer, 1968:112-113, for Palaearctic literature).

Goniotaulius femoralis; Kolenati, 1859a:157, 173. Hagen, 1864:815. Banks, 1892:363. (See Fischer, 1968:112, for Palaearctic literature).

Limnephilus perforatus Walker, 1852:33. (Type locality: McKenzie and Slave Rivers area of Arctic America). Johnson, 1927:49. Betten and Mosely, 1940:121, 123, 126. Fischer, 1968:115.

Limnephilus stipatus Walker, 1852:29. (Type locality: McKenzie and Slave Rivers area). Betten and Mosely, 1940:121, 123, 126. Ross and Merkley, 1952:448. Fischer, 1968:115.

Limnophilus stipatus; Provancher, 1877:243, 244. Provancher, 1878b:131, 132. Provancher, 1878a:146. Ulmer, 1907a:42.

Limnophilus subpunctulatus Hagen, 1861:261. (Type locality: Canada). Packard, 1869:161. Packard, 1876:617-618. Fischer, 1968:115.

Description. – Antennae light brown; scapes and pedicels darker. Vertex of head brown, warts paler. Thorax light to dark brown. Spurs yellow. Fore wing length of male 13.5 mm; light brown, irrorate, Costal area entirely clear. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Simpson Islands, Great Slave Lake, Northwest Territories). Postero-dorsal edge of tergum VIII developed as massive, globular bulb clothed distally with small, stout, black spines. Dorsal strap of segment IX short, arched posterad; main body of segment roughly triangular in lateral aspect, with very narrow sternum (Fig. 332). Clasper minute, triangular. Median lobes of segment X black, long, acute-triangular, with rugose lateral faces; intermediate lobes of segment X small, cylindrical, black, rugose pegs laterad of median lobes (Fig. 333). Cercus long, narrow, distally rounded, with distal half of mesal faces black, rugose. Lateral arms of aedeagus expanded distally (Fig. 334), with toothed dorsal edges with four heavy setae; distal part fringed with short, dark setae, with thicker setae on mesal faces.

Female genitalia. (Specimen from Simpson Islands, Great Slave Lake, Northwest Territories). Vulval scale broad, triangular, with triangular lateral lobes well separated from blunt, tapered, median lobe (Fig. 335). Segment IX large, curved in lateral aspect; without discrete

ventro-lateral lobes (Fig. 336). Supra-genital plate short, narrow, lunate in ventral aspect. Segment X small, with two triangular dorsal lobes well separated from ventral channel of anal orifice. Cerci short, triangular, closely parallel to dorso-lateral surfaces of segment X; segment X as a whole discrete from segment IX.

Notes on biology. – The only collection made by myself was at the Vermilion Lakes, Banff National Park. These lakes are broad, shallow, sedge-fringed, swampy bodies of water. Adult flight season in July (July 1-19).

Geographical distribution. – The nearctic range of this holarctic species extends from Alaska to Greenland, Newfoundland, and Washington (Fig. 620), in North America. In Alberta the species appears to be a plains species found in the mountains only in the larger, low valleys. However, records are presently too few to allow proper conclusions.

I have examined 11 specimens, five males and six females, from the study area.

The *nogus* group

Males of the single known species of this group are characterised by wide dorsal strap in lateral aspect (Fig. 337); by narrow ventral region; by median lobes of segment X set dorsad of cerci; and by short claspers with short bases. Females are characterised by lack of discrete ventro-lateral lobes of segment IX (Fig. 340); and by curious triangular ventral lobe formed by fusion of segment IX ventrad of segment X (Fig. 341).

Limnephilus nogus Ross, 1944
(Fig. 337-341, 619)

Limnephilus nogus Ross, 1944:281-282, 298. (Type locality: McMinnville, Oregon). Ross, 1947:152. Schmid and Guppy, 1952:42. Ross and Spencer, 1952:48. Ross and Merkley, 1952:445. Denning, 1963:261. Fischer, 1968:246-247.
Limnophilus nogus; Schmid, 1955:139.

Description. – Antennae uniform deep red-brown; antero-mesal faces of scapes without stout, heavy setae. Vertex of head uniform dark red-brown. Thorax dark chocolate-brown. Brush of male fore leg on basal third of femur; of short, black spines. Fore wing length of male 13.3 mm; dark red-brown, irregularly irrorate, with scattered larger hyaline areas. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Oregon; Illinois Natural History Survey). Main body of segment IX robust, narrowed gradually dorsally and ventrally (Fig. 337); dorsal strap very thin only at meso-dorsal portion (Fig. 338). Clasper small, fused to segment IX; with short base and body; with disto-mesal tooth. Median lobes of segment X long, parallel-sided in lateral aspect; lyre-shaped in dorsal aspect, with distal dilations; attached to rectangular, sclerotized bases dorsad of cerci. Cercus long, narrow, slightly tapered, with disto-mesal tooth. Lateral arms of aedeagus bilobed distally (Fig. 339); dorsal edges of each lobe setose.

Female genitalia. (Specimen from Hosmer, British Columbia). Vulval scale roughly quadrangular (Fig. 341); with acute-triangular lateral lobes, long, rectangular median lobe. Segment IX of single unit; main body vertically narrow; with large, trapezoidal lateral lobes laterad of segment X (Fig. 340); with large, dorsally curved ventro-mesal processes fused ventrad in form of large triangular lobe (Fig. 341). Supra-genital plate wide, very small, short. Segment X massive, with lateral edges folded dorso-mesally to partly enclose dorsal surface of segment; in ventral aspect broad, rectangular plate with sinuate lateral edges and short, mesal cleft (Fig. 341) continued as ventro-mesal channel.

Notes on biology. – I have not collected specimens of this species. The only record within

the study area is a single female from Hosmer, British Columbia. The other records available to me from elsewhere indicate a flight season divided into two parts; the earliest flight occurs in May, the second in September and October.

Geographical distribution. – The known range of this species extends from British Columbia to California (Fig. 619). In the study area the single record is from an altitude of about 3,000'.

I have examined 18 specimens, two males and 16 females, from British Columbia. Seventeen of these specimens are from southwestern British Columbia and Oregon.

The *sitchensis* group

Males of this group are characterised by long, narrow cerci (Fig. 342); by short, wide-based, placoid claspers; by long, wide-based, triangular median lobes of segment X; and by aedeagi with tips of median shaft and lateral arms curved markedly dorsad; tip of median shaft flattened ventrally, occupied by ejaculatory duct pore (Fig. 344). Females are characterised by segment IX with ventro-lateral lobes distinct but not discrete from dorsal body; by large, thumb-like cerci fused solidly to segment IX, directed ventro-posterad along sides of segment X; and by thin walled, tubular segment X (Fig. 346, 353).

Limnephilus moestus Banks, 1908
(Fig. 342-346, 621)

Limnephilus moestus Banks, 1908b:61, 62. (Type locality: Grand Lake, Newfoundland). Johnson, 1927:107. Banks, 1930b:128. Betten, 1934:327. Milne, 1935:46, 51. Ross, 1938b:37. Ross, 1944:6, 14, 186, 189, 191-192, 298. Proctor, 1946:211. Leonard and Leonard, 1949a:18. Ross and Merkley, 1952:445. Morse and Blickle, 1953:98. Robert, 1960:59. Wiggins, 1961:701. Etnier, 1965:149. Nimmo, 1966a:692. Nimmo, 1966b:224. Fischer, 1968:236-237. McConnochie and Likens, 1969:150.

Limnophilus hingstoni Mosely, 1929:502, 504-507. Forsslund, 1932:56. Ulmer, 1932:213, 217. Ross, 1944:191, 298. Fischer, 1968:236-237.

Males of this species are distinguished by exceptionally long cerci (Fig. 342); by massive claspers deeply indented into segment IX; and by presence of lightly setose, incipient postero-dorsal process of tergum VIII. Females are distinguished by cerci projected well posterad of ventral extremity of segment X (Fig. 346); and by short tip to ventro-lateral extension of dorsal body of segment IX.

Description. – Antennae light brown; scapes dark brown, with antero-mesal faces paler, glabrous. Vertex of head dark brown. Thorax light brown, darker dorsally. Spurs yellow. Fore wing length of male 11.6 mm; medium brown. Costal area clear to mid-point of wing. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Lethbridge, Alberta). Postero-dorsal edge of tergum VIII slightly protuberant, lightly setose. Segment IX overall rather narrow (Fig. 342); dorsal strap relatively thick, with distinct ventro-mesal process; ventral edge of segment with several stout setae. Clasper large, fused to posterior edge of segment IX; directed postero-mesad, with slight basal declivity; with three very distinct, long, black setae on ventral edge. Median lobe of segment X large, triangular (Fig. 342), with swollen bases (Fig. 343); black distally, light brown basally; minutely dentate disto-laterally; attached to mesal edges of basal plates which fit closely with bases of claspers and cerci. Cercus very long, narrow, tapered very gradually distad; mesally concave, with narrow meso-basal shelf (Fig. 343); distal half of mesal surface tuberculate. Median shaft of aedeagus without discrete head (Fig. 344); curved

dorsad, with three minute spines in orifice of ejaculatory duct. Lateral arms bifid basally; mesal branches fused together dorsally across base of median shaft; arms dilated slightly distally, curved dorsad, fringed ventrally and distally with seate.

Female genitalia. (Specimen from Bow Pass, Banff National Park, Alberta). Vulval scale with short, squat, slightly tapered median lobe; lateral lobes each rectangular (Fig. 345). Dorsal body of segment IX small, indistinguishable from segment X (Fig. 346); divided by lateral grooves from much larger, roughly triangular, ventro-lateral processes, with posterior process short. Supra-genital plate very wide, short, with straight posterior edge. Segment X small, tubular, darker than remainder of genitalia; deeply cleft ventrally, with short, v-cleft dorsally (Fig. 345); thin walled. Cerci relatively long, finger-like, dark brown, directed ventro-posterad, beyond ventral extremity of segment X.

Notes on biology. – Specimens of this species emerge from ponds or sloughs dominated by sedges. The adult flight period extends from July 19 to September 12.

Geographical distribution. – The known range of this species extends from British Columbia and Utah to Greenland and Newfoundland (Fig. 621). In Alberta most specimens were collected in the mountains, but I have one record from Lethbridge, well out in the plains. In the mountains it may attain altitudes of up to 6,878'.

I have examined 44 specimens, 35 males and nine females, from the study area and the Northwest Territories.

Limnephilus cockerelli Banks, 1900
(Fig. 347-349, 622)

Limnophilus cockerelli Banks, 1900c:124. (Type locality: Sapello, New Mexico). Ulmer, 1905a:19. Ulmer, 1907a:44. Essig, 1926:175. Schmid, 1955:137.

Limnephilus cockerelli; Banks, 1904a:107. Betten, 1934:335. Milne, 1935:46, 51. Ross, 1938b:34-35. Ross, 1941a:109. Ross, 1944:298. Ross and Merkley, 1952:445. Fischer, 1968:65.

Males of this species are distinguished by wide dorsal strap of segment IX (Fig. 347); by short, parallel-sided, bilobed claspers, with dorsal lobe thin, sharp, and ventral lobe thick, rounded; by short, triangular median lobes of segment X; and by relatively short aedeagus (Fig. 348).

Description. – Antennae brown; scapes darker except for paler, glabrous antero-mesal faces. Vertex of head mottled dark and light brown. Thorax light red-brown; brushes of male fore leg of thin, black spines along basal third of anterior edge of femur. Spurs brown. Fore wing length of male 14.9 mm; light yellow brown, irrorate; anterior half of wing virtually hyaline. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Eisenhower Junction, Banff National Park, Alberta). Segment IX high, narrow, with wide dorsal strap (Fig. 347); narrow ventrally; postero-lateral angles of segment folded, directed mesad as finger-like process. Clasper articulated to segment IX; distally bilobed, with acuminate dorsal lobe, full, rounded, ventral lobe; setose. Median lobes of segment X black, with dentate disto-lateral faces (Fig. 349); short, triangular in lateral aspect (Fig. 347); attached to lateral edges of two deeply concave basal plates. Cercus long, narrow, parallel-sided, with concave, dentate mesal face. Median shaft of aedeagus curved sharply dorsad to large, slanted tip; lateral arms similarly curved, with slightly expanded tips fringed with setae (Fig. 348) extended part way across lateral faces.

Female genitalia. Unknown.

Geographical distribution. – The known range of this species extends from Alberta, south

along the Rocky Mountains to New Mexico. In Alberta it is known from a single locality, at Eisenhower Junction, Banff National Park, at an altitude of 4,600' (Fig. 622).

I have examined a single male specimen from the study area, in the Canadian National Collection, Ottawa.

Limnephilus valhalla Nimmo n. sp.
(Fig. 350-354, 622)

Males of this species are distinguished by exceptionally long cerci, bowed ventrad half way from base (Fig. 350); by distinct spinate process of tergum VIII; and by massive, triangular median lobes of segment X. Females are distinguished by distinct posterior process of ventro-lateral body of segment IX (Fig. 353); and by high, narrow, rectangular dorsal body of segment IX.

Description. – Antennae brown; scapes darker, with antero-mesal faces lighter, glabrous. Vertex of head black except for postero-lateral angles. Thorax light red-brown. Brush of male fore leg of thin, dark spines on basal third of anterior face of femur. Spurs yellow. Fore wing length of male 11.6 mm; dark brown, clear areas hyaline. Costal area clear. Venation identical to that of *L. sublunatus*; costa hyaline basad of humeral cross-vein.

Male genitalia. (Specimen from Mt. Edith Cavell, Jasper National Park). Postero-dorsal process of tergum VIII small, hemispherical, with short black spines. Dorsal strap of segment IX high, narrow. Main body of segment small, with postero-dorsal angle directed posterad; with fringe of setae on postero-ventral edge (Fig. 350). Clasper small, fused to segment IX, with several long, irregular setae on posterior edge. Median lobes of segment X with distal halves black; massive, triangular, thin plates. Cercus long, narrow, bowed ventrad at midpoint; slightly concave mesally, with black mesal faces on distal halves (Fig. 351). Median shaft of aedeagus curved strongly dorsad; lateral lobes similar, with distal portion at right angles to basal arm, fringed with setae (Fig. 352).

Female genitalia. (Specimen from Mt. Edith Cavell, Jasper National Park, Alberta). Vulval scale with very broad, short, slightly tapered median lobe (Fig. 354); lateral lobes rectangular, with concave distal faces. Segment IX high, narrow, with acute-triangular processes at postero-ventral angle (Fig. 353). Supra-genital plate short, wide, rectangular. Segment X relatively large, with scalloped posterior edges; lateral edge with large tooth dorsally; deeply cleft dorsally and ventrally (Fig. 354). Cerci short, thumb-like, directed postero-ventrad beside segment X.

Notes on biology. – Adults of this species were collected from small, sedge-lined, mountain lakes or pools.

Geographical distribution. – This species is known from only two localities; one in Alberta, at an altitude of 6,800'; the second is in British Columbia, at 5,220', 1 mile west of the continental divide (Fig. 622).

Holotype. – Male. First pools on trail to Mt. Edith Cavell alpine meadows, Jasper National Park, Alberta; July 25, 1966; A. Nimmo.

Allotype. – Female. Same data as holotype.

Paratypes. – Same data as holotype; one male, one female. Wapta Lake beaver pond, Kicking Horse Pass, Yoho National Park, British Columbia; August 10, 1967; A. Nimmo; one female.

The type series is in the Canadian National Collection, Ottawa, and has been assigned the number 10,587.

This species is named for 'Valhalla', home for those fallen in battle, as noted in my readings in Norse mythology.

Limnephilus lopho Ross, 1949
(Fig. 355-359, 623)

Limnephilus lopho Ross, 1949b:119-120. (Type locality: Hood River Meadows, Mt. Hood, Oregon). Schmid and Guppy, 1952:42. Ross and Merkley, 1952:445. Ross and Spencer, 1952:48. Fischer, 1968:201.
Limnophilus lopho; Schmid, 1951:2-6. Schmid, 1955:137.

Description. – Antennae with basal two-thirds brown; distal third yellow; scapes, pedicels dark brown except for yellow, glabrous, antero-mesal faces of scapes. Vertex of head dark brown between lateral ocelli. Thorax black or dark brown; brush of male fore leg of long, fine, black spines on basal third of femur. Spurs yellow. Fore wing length of male 12.7 mm; brown to dark reddish brown. Costal area clear. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Mt. Edith Cavell, Jasper National Park, Alberta). Dorsal strap of segment IX high, thick (Fig. 355). Main body of segment roughly triangular, with narrow sternum; anterior edges with distinct flanges. Clasper short, broad, thin plate with rounded tips. Median lobes of segment X large, triangular, black on distal halves, with tips directed dorso-laterally. Intermediate lobes small, rugose, bulbous pegs; black, heavily sclerotized. Cercus thumb-like in lateral aspect, with tip minutely dentate mesally, black (Fig. 356). Median shaft and lateral arms of aedeagus curved sharply dorsad (Fig. 357); lateral arms fringed distally, with short fringe on meso-ventral edges.

Female genitalia. (Specimen from Mt. Edith Cavell, Jasper National Park, Alberta). Vulval scale almost square (Fig. 358); lateral lobes rectangular; median lobe short, narrow, well separated from lateral lobes. Dorsal body of segment IX small, rectangular, separated dorsally from segment X by slight declivity (Fig. 359); ventro-lateral extremities triangular in lateral aspect, fused ventrally. Supra-genital plate wide, very short, sinuate. Segment X in lateral aspect plough-like; deeply cleft ventrally; shallowly but widely cleft dorsally (Fig. 358). Cerci short, broad, rounded lobes located baso-laterad to segment X.

Notes on biology. – Adults of this species are found adjacent to small alpine pools or seepage slopes heavily clothed with sedges. The flight period extends from July 25 to August 5.

Geographical distribution. – The known range of this species extends from Oregon to British Columbia and Alberta (Fig. 623). I have taken it at altitudes of 6,600' and 6,800', on the east slope of Tonquin Valley, and at Mt. Edith Cavell, both in Jasper National Park.

The *assimilis* group

There are two species of this group present in the study area (see Fig. 360, 365). In genitalic characters these two species are so divergent that I cannot provide a list of common characters. Each species is characterised below.

Limnephilus parvulus (Banks), 1905
(Fig. 360-364, 623)

Stenophylax ? parvulus Banks, 1905:9-10. (Type locality: New Hampshire).
Parachiona parvulus; Banks, 1907a:39.
Hypnotranus ? parvulus; Ulmer, 1907a:72.
Algonquina parvula; Banks, 1916:121, 122. Betten, 1934:370. Milne, 1935:31, 49.
Limnephilus parvulus; Ross, 1938b:39. Ross, 1944:298. Ross and Merkley, 1952:449. Morse and Blickle, 1953:98. Etnier, 1965:149. Fischer, 1968:253-254.

Limnophilus parvulus; Schmid, 1955:141.
Apolopsyche pallida Banks, 1924:442. (Type locality: Manitoba). Betten, 1934:370.
Anolopsyche pallida; Criddle, 1925:16.
Limnephilus pallida; Banks, 1930a:226-227. Milne, 1935:49. Ross, 1938b:38-39.
Limnephilus pallidus; Fischer, 1968:254.
Limnephilus roberti Banks, 1930a:226-227. (Type locality: Lake Winnipeg, Manitoba). Betten, 1934:337. Neave, 1934:167. Milne, 1935:46, 51. Ross, 1938b:39. Fischer, 1968: 254.

Males of this species are distinguished from males of other species of *Limnephilus* by massive, distally toothed claspers; by thin-bladed, black median lobes of segment X which are curved slightly ventrad (Fig. 360); and by lack of postero-dorsal process on tergum VIII. Females are distinguished by discrete ventro-lateral lobes of segment IX; and by small, tapered, thin segment X (Fig. 363).

Description. – Antennae light brown; scapes brown, with paler antero-mesal faces. Vertex of head with two dark areas between lateral ocelli. Thorax medium to light brown. Male fore leg with very slight brush of short, brown spines at base of femur. Spurs pale yellow. Fore wing length of male 10.5 mm; light yellowish brown; clear areas smoky white; coloured areas closely following venation; irrorate. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Great Slave Lake, Northwest Territories). Dorsal strap of segment IX wide, with acuminate meso-ventral spine (Fig. 360). Main body of segment large, tapered slightly ventrad, with straight posterior edge, sinuate dorsal edge. Clasper with disto-dorsal tooth; mesal face of tooth concave, fringed with small, black dentations; base of clasper short. Median lobes of segment X long, tapered, bowed slightly ventrad; lateral faces black, ventral edges minutely dentate; lobes thin, with disto-lateral teeth (Fig. 361). Cercus short, sub-triangular in lateral aspect, fringed distally with long setae. Lateral arms of aedeagus hardly expanded distally, fringed along dorsal edges with setae (Fig. 362).

Female genitalia. (Specimen from Great Slave Lake, Northwest Territories). Vulval scale with distinct, straight base (Fig. 364); lateral lobes simple, curved mesad; median lobe rectangular. Dorsal body of segment IX small, tapered abruptly at junction with segment X (Fig. 363); ventro-lateral lobes large. Supra-genital plate with simple, curved posterior edge; small. Segment X small, long, tapered; deeply cleft mesally (Fig. 364). Cerci acute-triangular in lateral aspect; closely appressed to lateral surfaces of segment X.

Notes on biology. – Adults of this species are associated with lakes and sloughs with a heavy growth of sedges or *Typha*. The flight season extends from May 25 to July 5.

Geographical distribution. – The known range of this species extends from Alberta and Great Slave Lake to Quebec and New Hampshire (Fig. 623). In Alberta it is found largely in the plains, and in the low, major mountain valleys.

I have examined 38 specimens, 27 males and 11 females, from the study area and Great Slave Lake.

Limnephilus spinatus Banks, 1914
(Fig. 365-369, 624)

Limnephilus spinatus Banks, 1914:149-150. (Type locality: Vineyard, Utah). Betten, 1934: 337. Ross, 1938b:40. Ross, 1944:299. Ross and Merkley, 1952:451. Denning, 1963:261. Fischer, 1968:314.
Limnophilus spinatus; Essig, 1926:176. Schmid, 1955:141.
Anabolina spinata; Milne, 1935:41, 49.

Males of this species are distinguished from males of other species of *Limnephilus* by very

long base of the clasper (Fig. 365); by high, thin, dorso-anteriorly hooked, acuminate median lobes of segment X; and by presence of small, black-spinate, postero-dorsal lobe of tergum VIII. Females are distinguished by very massive ventro-lateral lobe of segment IX (Fig. 369); by minute dorsal body of segment IX; and by postero-ventrally slanted segment X.

Description. – Antennae dark brown; scapes dark chocolate-brown, with antero-mesal faces lighter, setaless. Vertex of head uniform dark brown. Thorax light brown, with darker areas. Brush of male fore leg well developed, of short, stout, black spines along entire length of femur. Spurs yellow. Fore wing length of male 10.8 mm; warm chocolate-brown. Costal area entirely clear. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Hound Creek, 25 miles southeast of Cascade, Montana). Tergum VIII with small, black-spinate, postero-dorsal process. Dorsal strap of segment IX directed postero-dorsad (Fig. 365). Main body of segment of irregular outline, narrowed ventrad. Clasper with very high, narrow base, with long, thin, dorso-posteriorly directed dorsal process. Median lobes of segment X square in lateral aspect, with postero-dorsal angles produced as long, anteriorly curved, acuminate spines; lobes attached to mesal edges of rectangular, basal plates (Fig. 366). Cercus squat, distally rounded, with concave mesal face. Lateral arms of aedeagus very long, slender, spiniform (Fig. 367).

Female genitalia. (Specimen from Crowsnest Pass, 8 miles west of Coleman, Alberta). Vulval scale with broad, abruptly tapered median lobe (Fig. 368); lateral lobes with blunt lateral horns. Segment IX with minute dorsal body (Fig. 369), massive ventro-lateral lobes of indeterminate form. Segment X large, of two sets of sclerites; basal set longer, rectangular; distal set short, each roughly triangular in lateral aspect. Supra-genital plate wide, short, with almost straight posterior edge.

Notes on biology. – Adults of this species were found near small ponds or sloughs, and slow streams. The flight period extends from July 25 to August 30.

Geographical distribution. – The known range of this species extends from Alberta to California and Colorado (Fig. 624). In Alberta specimens have been collected in the plains and low mountain valleys of the southwestern corner of the province.

I have examined 22 specimens, 21 males and one female, from the study area and Montana (one male).

The *incisus* group

Four species of this group are known from the study area. As with the *assimilis* group there appears to be no significant community of characters to define the group (Fig. 370-398).

Limnephilus hyalinus Hagen, 1861
(Fig. 370-374, 627)

Limnophilus hyalinus Hagen, 1861:258. (Type locality: North Red River, Canada). McLachlan, 1876b:7. Ulmer, 1907a:44. Schmid, 1955:140.

Limnephilus hyalinus; McLachlan, 1863:157. Banks, 1892:363. Banks, 1899:208. Banks, 1907a:36. Betten, 1934:336. Neave, 1934:167. Milne, 1935:51. Ross, 1938b:36. Banks, 1943:342. Ross, 1944:186, 189, 191, 298. Leonard and Leonard, 1949a:18. Ross and Merkley, 1952:441. Ross and Spencer, 1952:48. Morse and Blickle, 1953:98. Robert, 1960:59. Wiggins, 1961:701. Etnier, 1965:149. Nimmo, 1966a:692. Nimmo, 1966b:224. Fischer, 1968:179-180.

Limnephilus species 1; Betten, 1934:335. Ross, 1938b:36. Fischer, 1968:180.

Males of this species are distinguished by close conjunction between distal edge of each median lobe of segment X and black line of teeth on mesal face of each cercus (Fig. 370, 371). Females are distinguished by scoop-shaped ventro-median lobes of segment IX (Fig. 373), which are discrete from dorsal body of segment; by large, triangular dorsal body of segment IX; and by long, thin cerci flanked laterally by latero-dorsal lobes of segment X.

Description. – Entire body and wings very pale, straw-yellow; warts, and costal area of fore wings almost white. Fore wing length of male 9.8 mm. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Vermilion, Alberta). Postero-dorsal edge of tergum lightly setose. Dorsal strap of segment IX relatively short, thick. Main body of segment relatively narrow, slightly narrowed ventrad (Fig. 370). Clasper short, with wide base; triangular in lateral aspect. Median lobes of segment X short, distal halves black, tapered slightly distad (Fig. 371); distal edges vertical, straight, coincident with vertical line of black teeth on mesal faces of cerci. Cercus widened distad, slightly concave mesally, with vertical row of black teeth at mid-point of mesal face. Lateral arms of aedeagus long, expanded distad (Fig. 372), each with dorsal spine basad of membranous, irregular distal half.

Female genitalia. (Specimen from Manyberries, Alberta). Vulval scale almost circular, with curved, parallel-sided lateral lobes (Fig. 373), longer, tapered, median lobe. Segment IX with large, triangular dorsal body, larger, scoop-shaped, discrete, ventro-lateral lobes (Fig. 374). Supra-genital plate small, evenly rounded distally. Segment X composed of two dorso-lateral, rectangular lobes laterad of long, thin cerci, with small ventral lobe.

Notes on biology. – Adults of this species are found near sloughs and lakes which are thickly vegetated with sedges and cattail rushes. The flight season extends from July 5 to September 24, with a possible peak in August.

Geographical distribution. – This species is transcontinental, extending from Alaska to Oregon, Colorado, Illinois, and Newfoundland (Fig. 627). In the study area it occurs throughout the plains regions, and through the mountains along the low, major valleys reaching altitudes of 5,200'.

I have examined 91 specimens, 48 males and 43 females, from the study area and Great Slave Lake.

Limnephilus secludens Banks, 1914
(Fig. 375-379, 625)

Limnephilus secludens Banks, 1914:152. (Type locality: Penticton, British Columbia). Betten, 1934:337. Milne, 1935:50. Ross, 1938b:39. Ross, 1944:299. Ross and Spencer, 1952:48. Ross and Merkley, 1952:436, 450. Denning, 1963:261. Denning, 1965b:697. Etnier, 1965:149. Fischer, 1968:297.

Limnophilus secludens; Essig, 1926:176. Schmid, 1955:140.

Colpotaulius secludens; Milne, 1936:60. Schmid and Guppy, 1952:48.

Males of this species are distinguishable by very short, membranous, distally spinate lateral arms of aedeagus (Fig. 377). Females are distinguished by short, tubular segment X with short, peg-like cerci solidly fused to dorso-lateral surfaces of segment (Fig. 378, 379).

Description. – Antennae brown; scapes lighter, setaless on antero-mesal faces. Vertex of head dark brown; lighter laterally. Thorax dark reddish brown; brush of male fore leg of short, black spines along full length of femur; opposing face of tibia with corresponding brush. Spurs very long, yellow-brown. Fore wing length of male 14.2 mm; light yellow-brown with darker areas; costal area clear except for slight distal darkening. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Lethbridge, Alberta). Dorsal strap of segment IX short, with ventro-mesal process connected to segment X (Fig. 375, 376). Main body of segment tall, narrow, rectangular in lateral aspect. Clasper high, narrow, tapered, ventrad, acute-triangular. Median lobes of segment X short, narrow, black; tips directed dorso-laterad. Cercus short, irregular, deeply concave mesally. Median shaft of aedeagus with straight, thick basal portion (Fig. 377); distal third turned sharply dorsad, thin, narrow, acuminate. Lateral arms short, stubby, membranous; each with cluster of short, black spines distally.

Female genitalia. (Specimen from Lethbridge, Alberta). Vulval scale with median lobe longer than lateral lobes, tapered from wide base (Fig. 379); lateral lobes concave ventrally; Mesal edges sinuate, black. Dorsal body of segment X distinguished from segment X by posterior declivity (Fig. 378); ventro-lateral lobes almost separated from dorsal body; large, with straight, angular edges. Supra-genital plate squat, triangular. Segment X large, tubular, with minor dorsal and ventral projections. Cerci short, finger-like, fused solidly to dorso-lateral faces of segment X.

Notes on biology. – Adults of this species are found near lakes and sloughs with heavy growths of sedges and cattail reeds. The flight period extends from June 3 to September 23, with a possible peak in late July and August.

Geographical distribution. – The known range of this species extends from Great Slave Lake to Wisconsin, New Mexico, and California (Fig. 625). In Alberta it seems to be restricted to the plains, with occasional records from the foothills.

I have examined 372 specimens, 178 males and 194 females, from the study area and Great Slave Lake.

Limnephilus janus Ross, 1938
(Fig. 380-384, 626)

Colpotaulius minusculus Banks, 1924:439. (Preoccupied). (Type locality: Tolland, Colorado). Betten, 1934:339. Milne, 1935:42, 50. Milne, 1936:60. Ross, 1938b:37. Fischer, 1968:199.

Limnephilus janus Ross, 1938b:37. (Type locality: Tolland, Colorado). Ross, 1944:299. Ross and Merkley, 1952:451. Etnier, 1965:1.

Limnophilus janus; Schmid, 1955:140.

Males of this species are distinguished by high, very thin dorsal strap of segment IX (Fig. 380); by large, relatively long cerci with concave mesal faces and irregular dorso-mesal edges (Fig. 381); and by long, distally thin and acuminate median lobes of segment X. Females are distinguished by trilobed dorsal shield of segment X; and by absence of discrete ventro-lateral lobes of segment IX (Fig. 383).

Description. – Antennae pale yellow. Vertex of head pale yellow-brown, with dark areas adjacent to ocelli. Thorax pale yellow with some slightly darker areas. Brush of male fore leg composed of black spines along basal two-thirds of femur. Spurs pale yellow. Fore wing length of male 7.2 mm; greyish white, with scattered brown areas tending to follow veins. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from 6 miles south of Elk Point, Alberta). Dorsal strap high, narrow, with sharp dorsal edge (Fig. 380). Main body of segment IX wide, with distinct antero-ventral bulge. Clasper short, with short base; almost rectangular with dorso-distal tooth. Median lobes of segment X long, thin, each with wide base abruptly narrowed to thin distal process with tip directed dorso-laterad (Fig. 381). Cercus long, with disto-dorsal edge curled mesad, irregular, black. Aedeagus simple, with short, tapered median lobe, and long, dorsally curved, distally expanded, acuminate lateral arms, clothed on ventral edges with

setae (Fig. 382).

Female genitalia. (Specimen from 6 miles south of Elk Point, Alberta). Vulval scale with wide based, strongly tapered median lobe (Fig. 384); lateral lobes large, with concave lateral faces. Segment IX large, with no separate ventro-lateral lobes (Fig. 383). Supra-genital plate rectangular, set well ventrad of segment IX to which it is connected by band of folded membrane. Segment X large, separate from segment IX, with cylindrical ventral portion surmounted by trilobed dorsal roof, with lateral lobes.

Notes on biology. – I have collected specimens of this species only in the vicinity of large or small, shallow, sedge-edged lakes, ponds or sloughs. The flight season extends from July 12 to September 13, with peak about mid-August.

Geographical distribution. – This species is known from Alberta, Saskatchewan, Minnesota, and Colorado (Fig. 626). In Alberta it is a species of the plains and low foothills.

I have examined 40 specimens, 20 males and 20 females, from Alberta and Saskatchewan.

Limnephilus perpusillus Walker, 1852
(Fig. 385-389, 628)

Limnephilus perpusillus Walker, 1852:35. (Type locality: St. Martin's Falls, Albany River, Hudson's Bay). Hagen, 1861:254. Ross, 1941a:107. Ross, 1944:298. Ross and Merkley, 1952:436, 450. Etnier, 1965:149. Fischer, 1968:255-256. Clifford, 1969:582.

Colpotaulius perpusillus; McLachlan, 1863:161. Hagen, 1864:809. McLachlan, 1874:36. Banks, 1892:363. Ulmer, 1905a:18. Ulmer, 1907a:37. Banks, 1907a:37. Banks, 1908b: 61. Kolbe, 1912:42. Milne, 1935:42, 50. Milne, 1936:60.

Limnophilus perpusillus; Packard, 1876:617. Schmid, 1955:140.

Anabolina perpusillus; Betten, 1934:338.

Anabolina perpusilla; Betten and Mosely. 1940:140-142.

Colpotaulius rhaeus Milne, 1935:42, 50. (Type locality: Guelph, Ontario). Milne, 1936:60. Ross, 1941a:107. Ross, 1944:298. Fischer, 1968:256.

Limnephilus merinthus Ross, 1938c:166. (Type locality: Churchill, Manitoba). Ross, 1941a: 107. Ross, 1944:298. Fischer, 1968:256.

Males of this species are distinguished by small postero-dorsal, spinate lobe of tergum VIII (Fig. 385); by square median lobes of segment X with postero-dorsal angles developed as anteriorly hooked spines; and by large, black spine on dorso-mesal edge of cerci (Fig. 285, 386). Females are distinguished by massive, fleshy ventral body of segment IX (Fig. 388); and by vertically oriented segment X.

Description. – Antennae light reddish brown; scapes and pedicels darker, antero-mesal faces setaless. Vertex of head with circular dark brown area between lateral ocelli. Thorax light brown, with darker areas. Brush of male fore leg composed of short, fine black spines along entire length of femur. Spurs yellow. Fore wing length of male 7.9 mm; light yellowish brown; very lightly irrorate in posterior regions. Costal area entirely clear. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from camp 3 miles east of Nordegg, Alberta). Postero-dorsal edge of tergum VIII with small, free, black-spinate lobe. Dorsal strap of segment IX narrow (Fig. 385). Main body of segment narrow, tapered ventrad; tapered dorsad to merge gradually with dorsal strap. Clasper with very long, narrow base produced dorso-posterad as finger-like dorsal process. Median lobes of segment X with square bases; postero-dorsal angles produced dorso-anterad as short, slender, hooked spines. Cercus short, triangular in lateral aspect, with dorso-mesal edge curled ventrad with single large spine (Fig. 385, 386).

Median shaft of aedeagus simple, short, tapered; lateral arms curved dorsad, each with distally expanded, acuminate tip fringed along ventral edge with setae (Fig. 387).

Female genitalia. (Specimen from pond 10 miles south of McLeod River, Forestry Trunk Road, Alberta). Vulval scale with squat, short median lobe tapered distad (Fig. 389). Lateral lobes almost rectangular, with deep channel on mesal edge of each lobe. Dorsal body of segment IX small; ventro-lateral extensions massive, fused ventrally (Fig. 388, 389). Supra-genital plate membranous, lunate, of two wide lateral plates fused ventrally to form channel, with short, narrow, distal extension. Cerci short, thin, almost rectangular lobes attached between lateral plates of segment X.

Notes on biology. – Specimens of this species are collected near ponds with large quantities of sedge or bullrushes, or smaller creeks. The flight season extends from July 2 to September 6.

Geographical distribution. – The known range of this species extends from Alberta to Colorado and Newfoundland. In Alberta it occurs primarily in the plains and low foothills (Fig. 628).

I have examined 12 specimens, three males and nine females, from the study area.

The *argenteus* group

Males of the single species in this group are characterised by presence of spinate postero-dorsal lobe of tergum VIII; by large segment IX with short dorsal strap; by short, broad claspers; and by long, narrow, evenly tapered median lobes of segment X (Fig. 390). Females are characterised by discrete ventro-lateral lobes of segment IX; by segments IX and X being fused; and by minute, thin cerci (Fig. 394).

Limnephilus argenteus Banks, 1914
(Fig. 390-394, 629)

Limnephilus argenteus Banks, 1914:152. (Type locality: Nipigon, Ontario). Betten, 1934: 320. Milne, 1935:46, 51. Ross, 1938b:34. Ross, 1944:14, 298. Ross and Merkley, 1952: 447. Fischer, 1968:25. Lindroth and Ball, 1969:138.

Limnophilus argenteus; Schmid, 1955:143.

Description. – Antennae brown; scapes with antero-mesal faces lighter, almost glabrous. Vertex of head with two dark brown areas mesad of lateral ocelli. Thorax brown with darker areas. Spurs light brown. Fore wing length of male 16.8 mm; light to dark brown, irrorate, clear areas very pale brown, not hyaline. Costal area sparingly irrorate. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Vermilion Lakes, Banff). Postero-dorsal edge of tergum VIII produced posterad as small, black-spinate bulb. Dorsal strap of segment IX short, with sharp dorsal edge (Fig. 390). Main body of segment massive, irregular. Clasper short, broad, very stout, with short base. Median lobes of segment X long, narrow at bases, tapered evenly to acuminate tips; curved dorso-laterad (Fig. 391). Cercus short, almost square in lateral aspect, with wide baso-mesal extension dorsally; concave mesally. Median shaft of aedeagus attached to folded, membranous base, curved dorsad (Fig. 392); lateral arms straight basally, curved dorsad distally to expanded, flared, mesally concave tips.

Female genitalia. (Specimen from Worsley, Alberta). Vulval scale large, trapezoidal in general outline (Fig. 393); median lobe long, gradually tapered; lateral lobes thin, arched laterad. Dorsal body of segment IX small, fused imperceptibly to segment X (Fig. 394); ventro-lateral lobes discrete from dorsal body, high, narrow. Supra-genital plate large, evenly

rounded distally. Segment X small, distally dark; deeply narrowly cleft mesally (Fig. 393). Cerci two minute, thin, papillate structures attached to dorsal surface of segment X.

Notes on biology. – The single record which I have of this species from the study area is from large, sedge marshes just west of Banff, Alberta. The dates of capture in Alberta range from July 1 to July 12.

Geographical distribution. – The known range of this species extends from Alaska to Illinois and Ontario (Fig. 629).

I have examined 10 specimens, two males and eight females, from the study area and Great Slave Lake.

The *alberta* group

The single species known in this group is characterised by high, narrow segment IX (Fig. 395), with virtually no dorsal strap; by short, slender, tapered claspers; and by massive, thick, heavily sclerotized cerci (Fig. 396). Females are characterised by high, narrow segment IX (Fig. 400); and by vulval scale almost completely demarcated from sternum VIII (Fig. 401).

Limnephilus alberta Denning, 1958
(Fig. 395-401, 629)

Limnephilus alberta Denning, 1958:96. (Type locality: Pipestone River, Lake Louise, Alberta). Denning, 1965b:698.

Description. – Antennae dark brown; scapes with pale, glabrous antero-mesal faces. Vertex of head very dark brown, warts paler. Thorax dark brown; warts very pale. Spurs yellow. Fore wing length of male 14.9 mm; light brown, with darker areas; clear areas mostly hyaline. Costal area clear on basal two-thirds. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from 11 miles west of Banff, on Trans-Canada Hwy.). Dorsal strap of segment IX virtually non-existent (Fig. 395). Main body of segment sinuate, widened gradually dorsad from narrow ventral area. Clasper small, narrow, tapered, finger-like, with very short base. Median lobes of segment X small, trapezoidal, slanted dorso-mesad (Fig. 396). Cercus rectangular in lateral aspect, tapered basad from flat, black distal face, in dorsal aspect (Fig. 397). Median shaft of aedeagus short, stout, with large, discrete, distal head (Fig. 398). Lateral arms curved smoothly dorsad, not widened, each fringed along mesal face with long setae (Fig. 398, 399).

Female genitalia. (Specimen from 11 miles west of Banff, on Trans-Canada Hwy.). Vulval scale with angular anterior edge, almost separate from sternum VIII (Fig. 401); median lobe long, acute-triangular; lateral lobes stout, close to median lobe. Segment IX high, narrow, with slightly wider ventro-lateral area (Fig. 400). Supra-genital plate short, broad, suspended from segment IX by wide, wrinkled membrane. Segment X with hemi-cylindrical ventral portion short, and dorsal, mesally flattened, dorsally deeply cleft portion (Fig. 401) much longer, tapered. No evident cerci.

Notes on biology. – Specimens of this species are found near sedge lakes, ponds, and sloughs. The flight period extends from July 5 to September 10.

Geographical distribution. – The known range of this species is restricted largely to the continental divide area of Alberta and British Columbia (Fig. 629). In altitude it ranges from about 3,700' to 5,350'.

I have examined 28 specimens, eight males and 20 females, from the study area.

The *asiaticus* group

Males of this group are characterised by presence of postero-dorsal lobe on tergum VIII; by large, smooth tooth on dorso-mesal edge of cercus; and by wide-based claspers, with short, stout dorsal processes (Fig. 402). Females are distinguished by massive segment IX of single piece, without ventro-lateral lobes; and by massive, short lobed vulval scale (Fig. 406, 407).

Limnephilus labus Ross, 1941
(Fig. 402-407, 630)

Limnephilus labus Ross, 1941a:105-106. (Type locality: Wood Lake, Boulder, Colorado).
Ross, 1944:298. Ross and Merkley, 1952:436, 451. Flint, 1960:5. Fischer, 1968:200.
Limnophilus labus; Schmid, 1955:141.

Description. – Antennae reddish brown, scapes darker. Vertex of head dark brown between ocelli and posterad to posterior edge of cranium. Thorax reddish brown; brush of male fore leg composed of dense, stout, black setae along entire length of femur. Spurs reddish. Male fore wing length 9.5 mm; grey-brown, with darker areas close to posterior edge. Costal area clear to distal end of subcosta. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Waterton, Alberta). Postero-dorsal edge of tergum VIII with small, thin, spinate lobe. Dorsal strap of segment IX short, wide (Fig. 402); main body of segment high, narrow, with anterior lobes; with short, blunt peg at postero-dorsal angles. Clasper with rectangular dorsal process and high, narrow base. Median lobes of segment X with broad bases tapered abruptly to small, acuminate postero-dorsal hooks. Cercus with very concave mesal face, with dorsal edge arched meso-ventrad (Fig. 403); with large, smooth, black spine. Median shaft of aedeagus long, irregular, curved dorsad (Fig. 404); lateral arms long, each curved sharply dorsad at mid-point, with expanded, acuminate distal lobe fringed ventrally with long setae (Fig. 404, 405).

Female genitalia. (Specimen from Waterton, Alberta). Vulval scale with massive, short lobes (Fig. 407); lateral lobes rectangular; median lobe very broad, blunt, with very little space between it and lateral lobes. Segment IX massive, of one rectangular piece (Fig. 406); segment X completely enclosed. Supra-genital plate very wide, short. Segment X distinct from segment IX; dorsal surface steep, terminated in two small, black-tipped dorsal lobes. Cerci large, stout, attached to dorsal surface of segment X; short, blunt.

Notes on biology. – Adults of this species are found near sedge or cattail ponds, lakes or sloughs. A very few (three) records indicate that this species may also inhabit rivers and smaller creeks. The flight season extends from July 25 to September 13, with a possible peak in late August.

Geographical distribution. – The known range of this species extends from Alberta and Saskatchewan to Idaho and Colorado (Fig. 630). In Alberta it is confined to the southern and central plains and lower foothills.

I have examined 40 specimens, 23 males and 17 females, from the study area.

The *fenestratus* group

Diagnostic genitalic characters are not available because of a too great diversity. Two species of the group are known from the study area.

Limnephilus minusculus (Banks), 1907
(Fig. 408-413, 631)

Stenophylax minusculus Banks, 1907b:120. (Type locality: Olympia, Washington). Banks, 1907a:39.
Apolopsyche minusculus; Banks, 1916:121. Betten, 1934:370.
Algonquina minuscula; Milne, 1935:31, 49.
Limnephilus minusculus; Ross, 1938b:37. Ross, 1944:298. Ross and Merkley, 1952:445. Fischer, 1968:234. Clifford, 1969:582. Lindroth and Ball, 1969:138.
Limnophilus minusculus; Schmid, 1955:139.

Males of this species are distinguished from males of other species of *Limnephilus* by presence of postero-dorsal lobe of tergum VIII; by warped cerci with mesal projection and cross-axial ventral ridge (Fig. 408, 409); and by form of aedeagus, especially lateral arms (Fig. 410). Females are distinguished by single unit segment IX; by discrete segment X; and by double-lunate groove ventrad of segment X as seen in ventral aspect (Fig. 412, 413).

Description. – Antennae very dark brown; scapes darker. Vertex of head black. Thorax very dark brown; brush of male fore leg sparse, only on basal third of femur. Spurs dark yellow. Fore wing length of male 8.4 mm; pale chocolate-brown; costal area clear. Venation identical to that of *L. sublunatus.*

Male genitalia. (Specimen from Flatbush, Alberta). Postero-dorsal edge of tergum VIII with prominent, lightly spinate lobe. Dorsal strap of segment small, relatively narrowed, especially ventrally. Clasper short, with very short base; tapered evenly to rounded tip; directed postero-dorsad. Median lobes of segment X small, thin plates, with black tips; with wide bases, narrowed abruptly to small dorsal hooks; basal plates square, concave (Fig. 409). Cercus small, slender in lateral aspect, with tip at right angles, directed mesad, with black, dentate ventral edge (Fig. 409). Median shaft of aedeagus short, stout, tapered, with slightly dilated tip (Fig. 410, 411); lateral arms long, with very slender, sclerotized basal halves; distal halves membranous, extensible, with zigzag at bases; fringed distally, mostly on dorsal edges, with long setae (Fig. 410).

Female genitalia. (Specimen from Flatbush, Alberta). Vulval scale large, with short, stout median lobe, rectangular lateral lobes with groove along each median face (Fig. 413). Segment IX of one piece, roughly rectangular (Fig. 412); with slight postero-ventral lobes. Supra-genital plate membranous, wide, short, rectangular except for posteriorly indented edge. Segment X very small, discrete from segment IX in lateral aspect; tubular, short. Cerci short, dorso-ventrally flattened, rounded in ventral aspect; fused solidly to segment X.

Notes on biology. – Adults of this species are found associated with sedge or cattail reed sloughs or small lakes, and small streams or rivers on gravel beds. The flight season extends from May 25 to July 16, with peak in late June and early July.

Geographical distribution. – The known range of this species extends from Alaska to Washington, Colorado, New York, and Labrador (Fig. 631). In Alberta it is confined to the plains, low foothills, and major, low mountain valleys, up to about 4,500' altitude.

I have examined 106 specimens, 93 males and 13 females, from the study area.

Limnephilus kennicotti Banks, 1920
(Fig. 414-420, 632)

Limnephilus kennicotti Banks, 1920:344. (Type locality: Great Slave Lake, Northwest Territories). Betten, 1934:336. Milne, 1935:44, 51. Milne (D. J.), 1943:298. Ross, 1944: 298. Ross and Merkley, 1952:441. Ross, 1953:155. Wiggins, 1961:701. Ross, 1965:593.

Fischer, 1968:199.

Limnophilus kennicotti; Schmid, 1955:139.

Males of this species are distinguished by massive claspers with very long bases (Fig. 414). mesally directed, thin, body (Fig. 418), and black-toothed dorsal edges. Females are distinguished by massive, mesally cleft dorsal body of segments IX and X combined (Fig. 419, 420).

Description. – Antennae dark brown; scapes darker, with pale, setaless, antero-mesal faces. Vertex of head very dark brown, warts paler. Thorax very dark brown, warts paler. Spurs brownish yellow. Fore wing length of male 8.9 mm; light brown; costal margin clear to end of subcosta; clear areas white. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Canmore, Alberta). Dorsal strap of segment IX equal in height to main body; wide. Main body of segment very wide dorsally, narrowed ventrad (Fig. 414); with slight concavities at postero-ventral margins. Clasper massive, thin, directed mesad; with dorsal edges black-toothed (Fig. 418). Median lobes of segment X large, long, with wide bases tapered distad to rounded tips; very wide in dorsal aspect, with low, black-toothed ridge just basad of tips (Fig. 415). Cercus large, long, arched dorsad in lateral aspect; with slight declivity on mesal face, produced mesad as triangular ledge (Fig. 415). Median shaft of aedeagus long, slender; lateral arms shorter, slender, sclerotized, attached to dorsal surface of aedeagus; each with cluster of three spines distally, spines crossed over dorsal surface of aedeagus (Fig. 416, 417).

Female genitalia. (Specimen from Lethbridge, Alberta). Vulval scale small, with short, distally rounded median lobe (Fig. 420); lateral lobes very small, irregular, narrow, directed postero-laterad. Segment IX with discrete ventro-lateral lobes (Fig. 429); dorsal body indistinguishable from segment X. Supra-genital plate large, rectangular, visor-like in lateral aspect. Segment X massive, solidly fused to segment IX; rectangular in lateral aspect, with meso-dorsal hooks distally; in ventral aspect of two large, quite separate plates (Fig. 420).

Notes on biology. – Adults of this species are found near lakes and rivers. The flight period extends from June 24 to October 3, with a possible peak in August and September.

Geographical distribution. – The known range of this species extends from British Columbia to Newfoundland, and north to Greenland (Fig. 632). In Alberta it is found both on the plains, and in the foothills and mountains, to altitudes of about 6,675'.

I have examined 45 specimens, 10 males and 35 females, from the study area.

The *nigriceps* group

Males of the single species of this group are characterised by massive segment IX with short, narrow, dorsal strap (Fig. 421); by massive claspers with large, heavily sclerotized, black, dorsal tooth; and by small, light-coloured median lobes of segment X (Fig. 422). Females are characterised by discrete ventro-lateral lobes of segment IX (Fig. 426); and by solid, large segment X and dorsal body of segment IX fused.

Limnephilus nigriceps (Zetterstedt), 1840
(Fig. 140a, 140b, 421-426, 633)

Phryganea nigriceps Zetterstedt, 1840:1066. (Type locality: Lapland).

Limnophilus nigriceps; Ross and Merkley, 1952:443, 453. Schmid, 1955:142. (See Fischer, 1968:237, 245, for Palaearctic literature).

Limnephilus nigriceps; Betten, 1934:56, 87. Fischer, 1968:237-246. (See Fischer, 1968: 238, for Palaearctic literature).

Limnophilus affinis Hagen (not Curtis), 1858. (See Fischer, 1968:245, for Palaearctic literature).
Limnephilus affinis; Fischer, 1968:245.
Pryganea pilosula (See Fischer, 1968:245).
Limnephilus pilosulus; (See Fischer, 1968:245).
Chaetotaulius striola Kolenati. (See Fischer, 1968:245, 246, for Palaearctic literature).
Limnophilus striola; (See Fischer, 1968:246, for Palaearctic literature).
Limnephilus striola; (See Fischer, 1968:245-246, for Palaearctic literature).
Limnephilus forcipatus Banks, 1924:439-440. Criddle, 1925:16. Betten, 1934:336. Milne, 1935:46, 51. Milne (D. J.), 1943:192, 194, 195. Ross, 1944:298. Ross and Merkley, 1952:443. Fischer, 1968:139.

Description. – Antennae dark brown; scapes black in males, pale yellow in females; antero-mesal faces paler, setaless. Vertex of head black except for paler warts. Thorax deep black; brush of male fore leg composed of short, stout, black spines on basal half of femur. Spurs yellow. Fore wing length of male 11.6 mm; pale brown; anterior half of wing clear, posterior half irrorate. Venation of fore and hind wings as in Fig. 140a, 140b; R2 of hind wing with row of short, black hairs on ventral surface.

Male genitalia. (Specimen from Exshaw, Alberta). Postero-dorsal edge of tergum VIII lightly setose. Dorsal strap of segment IX short, curved posterad (Fig. 421). Main body of segment massive, widened ventrad, with postero-dorsal angle rounded, large. Clasper massive, short, wide, with large, black, heavily sclerotized disto-dorsal tooth. Median lobes of segment X small, directed dorso-posterad, with slight lateral hooks at tips (Fig. 422). Cercus large, parabolic, with large, black, heavily sclerotized disto-mesal tooth (Fig. 422, 423). Lateral arms of aedeagus long, slender, sclerotized, spinate distally, curved sharply dorsad (Fig. 424); large, wing-like, spinate, lobe on disto-ventral margin.

Female genitalia. (Specimen from Exshaw, Alberta). Vulval scale relatively small, with short, slender, tapered median lobe (Fig. 425); lateral lobes large, roughly triangular. Ventro-lateral lobes of segment IX discrete, large, irregular in outline (Fig. 426). Dorsal body of segment indistinguishable from massive segment X. Supra-genital plate triangular, large. No evident cerci.

Notes on biology. – Adults of this species are found near small sedge ponds or sloughs. The flight season is from August 23 to September 22.

Geographical distribution. – The nearctic range of this holarctic species extends from Alaska to Alberta and Manitoba (Fig. 633). In Alberta I have collected specimens in the foothills and mountains, in the low valleys.

I have examined 20 specimens, 15 males and five females, from the study area.

The *rhombicus* group

Males of this group are characterised by postero-dorsal lobe on tergum VIII; by large, curved claspers with black, heavily sclerotized distal teeth; and by relatively small median lobes of segment X. Females are characterised by long distinct cerci; discrete ventro-lateral lobes of segment IX; and by separate segment X.

Limnephilus rhombicus (L.), 1758
(Fig. 427-432, 634)

Phryganea rhombica Linnaeus, 1758:548. (Type locality: Sweden). (See Fischer, 1968: 270-294, for Palaearctic literature).

Phryganea rhomboides; (See Fischer, 1968:271).
Friganea rhomboea; (See Fischer, 1968:271).
Chaetotaulius rhombicus; (See Fischer, 1968:272-273, for Palaearctic literature).
Limnephila rhombica; (See Fischer, 1968:272).
Limnophila rhombica; (See Fischer, 1968:282, 283).
Leimnephila rhombica; (See Fischer, 1968:274).
Limnophilus rhombicus; Hagen, 1861:254. Kolbe, 1912:41. Sibley, 1926:107, 191, 194. Ulmer, 1932:212. Betten and Mosely, 1940:132-134. Schmid, 1955:134. (See Fischer, 1968:270-294, for Palaearctic literature).
Limnephilus rhomnicus; (See Fischer, 1968:278).
Limnephilus rhombicus; Walker, 1852:22. Vorhies, 1909:661-666. Betten, 1926:529. Rawson, 1930:46. Betten, 1934:331-333. Ross, 1944:8, 14, 185, 186, 189, 190, 198. Leonard and Leonard, 1949a:19. Flint, 1960:5, 49. Robert, 1960:59. Wiggins, 1961:701. Denning, 1965b:698. Etnier, 1965:149. Fischer, 1968:270-294. (See Fischer, 1968:270-294, for Palaearctic literature).
Goniotaulius combinatus Walker, 1852:28-29. (Type locality: St. Martin's Falls, Albany River, Hudson's Bay). Hagen, 1864:815, 834. Banks, 1892:363. Banks, 1899:208. Banks, 1907a:36. Ulmer, 1907a:44. Lloyd, 1915:203-205. Johnson, 1927:49. Brues, 1930:393. Banks, 1930b:128. Milne, 1935:44, 47, 51. Elkins, 1936:668-669. Betten and Mosely, 1940:132, 134. Ross, 1944:190, 298. Proctor, 1946:211. Fischer, 1968:294.
Limnophilus combinatus; Hagen, 1861:255. McLachlan, 1875:50. Ulmer, 1905a:19. Lloyd, 1921:44-47. Muttkowski and Smith, 1929:259. Balduf, 1939:172, 174, 178. Pennak, 1953: Fig. 361b, 361d. Fischer, 1968:294.

Description. – Antennae yellow-brown. Vertex of head uniformly deep red-brown. Thorax uniform reddish brown; brush of male fore leg composed of fine, reddish hairs along basal half of anterior face of femur. Fore wing length of male 17 mm; reddish brown, partly irrorate, with large, irregular, hyaline areas. Vein A3 of fore wing dark brown, with heavy vestiture of stout, brown setae. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from 2 miles west of Lake Louise, Alberta). Postero-dorsal edge of tergum VIII extended sharply ventrad as rectangular, slightly bulbous, black-spinate screen (Fig. 427, 428). Dorsal strap of segment low, wide vertically; main body of segment stout, narrowed ventrad. Clasper small, with high, narrow base; dorsal process triangular. Median lobes of segment X small, short, black, with square-cut tips directed postero-laterad. Cercus massive, long, arched dorsad, with parallel sides; distal edge straight in lateral aspect, with ventral edge black, heavily sclerotized, dentate (Fig. 428). Lateral arms attached dorsally on aedeagal base; distally bifid; ventral lobe large, flap-like, fringed dorsally (Fig. 429) with long spines; dorso-median lobes folded mesad, armed with several stout, black, distal teeth (Fig. 429, 430).

Female genitalia. (Specimen from Whitehorse. Yukon; in Canadian National Collection, Ottawa). Vulval scale large, deeply imbedded in sternum VIII (Fig. 432); median lobe short, truncate-triangular; lateral lobes clavate in ventral aspect. Ventro-lateral lobes of segment IX large, roughly triangular in lateral aspect (Fig. 431), discrete from dorsal body of segment; dorsal body small, triangular in dorsal aspect. Supra-genital plate large, semi-circular, hyaline. Segment X separable from segment IX; long, tubular, shallowly cleft mesally; with shallow groove on dorso-lateral surfaces, ventrad of cercal bases. Cerci long, with wide bases each abruptly tapered at mid-point.

Notes on biology. – The single male specimen examined was probably taken in the sedge sloughs just west of Lake Louise townsite, in Banff National Park. Date of capture was July 20.

Geographical distribution. – The nearctic range of this holarctic species extends from Yukon Territory to Colorado, Illinois, Newfoundland and Greenland (Fig. 634).

The *diversus* group

Males of this group are characterised by black-spinate, postero-dorsal lobes of tergum VIII; by short, stout, triangular, thick cerci and median lobes of segment X; and by wide-based claspers with long, distally heavily sclerotized, black-toothed tips (Fig. 433). Females are characterised by discrete, ventro-lateral lobes of segment X; and by segment X separate from segment IX (Fig. 438).

Limnephilus canadensis Banks, 1908
(Fig. 433-438, 635)

Limnephilus canadensis Banks, 1908a:264. (Type locality: Laval County, Canada). Betten, 1934:321. Ross, 1938b:34. Denning, 1941b:201-202. Milne (D. J.), 1943:192, 193, 194, 195. Ross, 1944:299. Ross and Merkley, 1952:450. Flint, 1960:5. Etnier, 1965:148. Fischer, 1968:53. Clifford, 1969:582.

Anabolina canadensis; Milne, 1935:41, 49. Denning, 1937:23.

Limnophilus canadensis; Schmid, 1955:142.

Description. – Antennae dark brown; scapes darker, with antero-mesal faces yellow, glabrous. Vertex of head dark brown, faded to brownish yellow laterad of lateral ocelli. Thorax dark brown; brush of male fore leg along entire length of femur; anterior tibiae with similar brushes on opposing faces. Spurs yellow, to brown. Fore wing length of male 7.0 mm; light reddish brown; costal area clear to end of subcosta; clear areas white; dark areas irrorate. Venation identical to that of *L. sublunatus*.

Male genitalia. (Specimen from Nordegg, Alberta). Postero-dorsal edge of tergum VIII with slender, prominent, black-spinate lobe. Dorsal strap of segment IX short, sharp edged dorsally (Fig. 433); main body of segment wide, narrowed ventrad, with sinuate dorsal edges. Clasper with high, narrow base; dorsal process long, directed dorsad, with distal edge black, heavily sclerotized, with two distinct teeth. Median lobes of segment X small, short, triangular, wide (Fig. 433, 434). Cercus similar, with dorsal angle setose, with long setae. Median shaft of aedeagus long, tapered, with distinct head; lateral arms shorter, expanded distally, acuminate, with disto-ventral edges fringed with short setae (Fig. 435, 436).

Female genitalia. (Specimen from Athabasca River, Grosmont, Alberta). Vulval scale rectangular (Fig. 437); median lobe short, tapered from wide base; lateral lobes longer, rectangular, each with slight distal widening. Dorsal body of segment IX small, high, narrow, with postero-dorsal process (Fig. 438); ventro-lateral lobes discrete, large, irregular. Supra-genital plate roughly rectangular, with squat triangular distal edge. Segment X large, tubular, conical in ventral aspect (Fig. 437), black disto-dorsally. No evident cerci.

Notes on biology. – Adults of this species are found near lakes, and slower, smoothly flowing rivers. The flight period extends from June 9 to August 12.

Geographical distribution. – The known range of this species extends from Alberta to Maine (Fig. 635). In Alberta it is confined to the plains or low foothills.

I have examined 12 specimens, five males and seven females, from the study area.

The Genus *Clistoronia* Banks

One species of this genus is known from the study area; it belongs to the subgenus

Clistoronia Banks.

Synopsis of characters. – Cephalic macrochaetae short, fine, sparse; pronotal macrochaetae very strong, abundant. Spur formula 1,3,3. Wings large; fore wings clearly widened at chord, truncated apically; hind wings rather narrow. Fore wing coloration varied, quite patchy. Fore wing venation much as in *Limnephilus* spp. but chord weakly disrupted, almost straight, oblique anteriorly; f3 narrowed basally. Hind wing chord strongly disrupted, distinctly concave to body.

Male genitalia with tergum VIII non-spinate. Segment IX very short, high (Fig. 439); postero-lateral angles prominent, support to segment X mesally. Cerci large, strong, heavily sclerotized; in lateral aspect triangular, bilobed distally. Median lobes of segment X spur-like, horizontal. Clasper weakly developed; distal portion long, conical, simple, directed mesad. Aedeagus large; median shaft much folded basally (Fig. 442); lateral arms spinate, each simple or bilobed.

Female genitalia with dorsal body of segment IX vestigial. Ventro-lateral lobes of segment IX quite large, convex plates, in close contact ventrally (Fig. 443, 444). Supra-genital plate large, ogival, prominent. Segment X varied, short, long, slender. Cerci or cercus-like lobes large, strongly flattened dorso-ventrally, fused to segment IX, or segment X, which is immediately ventrad. Median lobe of vulval scale varied in size; lateral lobes sub-quadrangular or rounded (Fig. 444).

Clistoronia magnifica (Banks), 1899
(Fig. 439-444, 635)

Halesus magnifica Banks, 1899:209. (Type locality: Olympia, Washington). Banks, 1907a: 38.

Halesus magnificus; Ulmer, 1905a:21. Ulmer, 1907a:56. Essig, 1926:176.

Clistoronia magnus; Banks, 1916:119.

Clistoronia magnifica; Betten, 1934:371. Banks, 1943:343. Ross, 1944:297. Ross and Merkley, 1952:436. Schmid and Guppy, 1952:42. Schmid, 1955:156. Fischer, 1969:55-56.

Stenophylax magnificus; Milne, 1935:32, 52.

Limnephilus magnificus; Ross and Merkley, 1952:441, 451.

Anabolia caroli Denning, 1941b:196-197. (Type locality: Robson, British Columbia).

Limnephilus caroli; Ross, 1944:298.

Males of this species are distinguished from males of other species of Limnephilidae by large, triangular cerci (Fig. 439); by fused median lobes of segment X (Fig. 440); and by mesally directed black teeth on mesal faces of cerci. Females are distinguished by long, thin, acuminate dorsal lobes of segment X, ventro-mesad of cerci (Fig. 443).

Description. – Antennae yellow-brown; antero-mesal faces of scapes with few setae. Vertex of head deep red-brown. Thorax deep reddish brown. Fore wing length of male 18.1 mm; light chocolate-brown, irrorate, with larger hyaline areas. Venation identical to that of *Limnephilus* spp.

Male genitalia. (Specimen from Waterton, Alberta). Dorsal strap of segment IX very slim, incomplete dorsally (Fig. 439). Main body of segment vertically narrow, moderately expanded laterally, with postero-dorsal angles produced mesad as long, narrow processes. Clasper with narrow base, dorsal process long, tapered, acute-triangular in lateral aspect. Median lobes of segment X fused throughout length (Fig. 440), conical, rounded. Cercus massive, thick, triangular in lateral aspect, with short ventral tooth; mesal face with black, heavily sclerotized tooth. Median shaft of aedeagus short, stout, curved gently dorsad (Fig. 442); lateral arms parallel to median shaft, greatly widened distally; each distally bilobed, with

dorsal lobe longer, narrower, more acuminate than ventral. Both lobes fringed with setae.

Female genitalia. (Specimen from Waterton, Alberta). Vulval scale with squat, conical median lobe; lateral lobes triangular distally, well clear of median lobe (Fig. 444). Dorsal body of segment IX small, fused to segment X (Fig. 443); ventro-lateral lobes large, triangular in lateral aspect, fused ventrad of segment X; not discrete from dorsal body. Supra-genital plate small, semi-circular. Segment X large, tubular, deeply cleft laterally, not so deeply in vertical plane; dorsal lobes long, narrow; ventral lobes shorter, wide, darker. Cerci short, acuminate in lateral aspect, wide in ventral aspect.

Notes on biology. – Adults of this species are collected near sedge lakes or ponds. The flight period extends from June 11 to August 16, with a peak in mid-July.

Geographical distribution. – The known range of this species extends from Alberta and British Columbia to Utah (Fig. 635). In Alberta it is confined strictly to the area of the continental divide, but in the lower major valleys.

I have examined 17 specimens, 13 males and four females, from the study area.

The Genus *Grammotaulius* Kolenati

This genus is represented in the study area by a single species.

Synopsis of characters. – Head somewhat elongated, eyes small. Posterior cephalic warts very large, oval. Posterior ocelli surrounded by many hairs. Spur formula 1,3,4. Pronotum at least half as long as head. Wings large; fore wings uniformly, or patchily coloured. R5 of fore wing darkened in some species; always so on hind wing. Chord of fore wings very oblique anteriorly to body, not strongly disrupted. Hind wing chord parallel to body, strongly disrupted.

Male genitalia rigid, very large. Tergum VIII not spinate. Segment IX long longitudinally and vertically. Cerci very thick, to very large, slender; in some species short, massive, thick; dentate. Claspers poorly developed, not projected. Aedeagus very thick, similar to that of *Limnephilus*; lateral arms not erectile or setose, but simple or bilobed.

Female genitalia without discrete ventro-lateral lobes; dorsal body of segment IX narrow, elongated, with two free appendages. Segment X tubular, very large, short, sclerotized, barely cleft mesally. Supra-genital plate small. Vulval scale large, with three large, sub-equal, projected lobes in most species.

Grammotaulius interregationis (Zetterstedt), 1840
(Fig. 445-450, 636)

Phryganea interregationis Zetterstedt, 1840:1063-1064. (Type locality: Greenland). Kolenati, 1848:25, 26, 30, 40-41. (See Fischer, 1967:212-213, for Palaearctic literature).

Limnephilus interregationis; Walker, 1852:19.

Limnophilus interregationis; Hagen, 1861:254-255. (See Fischer, 1967:213, for Palaearctic literature).

Grammotaulius interregationis; Banks, 1892:363. Banks, 1907a:36. Ulmer, 1907a:38. Mosely, 1929:502, 507, 508-509. Ulmer, 1932:212, 217. Betten, 1934:316. Milne, 1935:27, 50. Denning, 1941a:232-233. Ross, 1944:185, 297. Schmid, 1950a:348-351. Ross and Spencer, 1952:47. Schmid, 1955:145. Schmid, 1964:914, 917. Etnier, 1965:148. Fischer, 1967:212-214. Clifford, 1969:582. (See Fischer, 1967:213, for Palaearctic literature).

Grammotaulius praecox Hagen, 1873c:451-452. (Type locality: British America). Banks, 1892:363. Jacobson, 1898:215. Ulmer, 1905a:18. Ulmer, 1907a:39. Banks, 1907a:36. Kolbe, 1912:42. Betten, 1934:316. Milne, 1935:50. Ross, 1938b:32. Fischer, 1967:214.

Limnophilus praecox; Ross, 1941a:110.
Grammotaulius sibiricus Mosely, 1929:502, 507.

Description. – Antennae light brown; scapes cream-white with glabrous antero-mesal faces. Vertex of head with black mesal diamond limited by lateral ocelli and median warts; remainder cream-white. Thorax black, shaded in areas to dark brown. Spurs brown. Fore wing length of male 20.9 mm; chocolate-brown to light reddish brown. Hind wing stigma light brown; R5 set in light brown band. Venation essentially identical to that of *Limnephilus sublunatus*.

Male genitalia. (Specimen from Wapta Lake, Kicking Horse Pass, Yoho National Park, British Columbia). Segment IX massive, rectangular; dorsal strap short, narrow to point of extinction dorsally (Fig. 445). Clasper small, blunt, short. Median lobes of segment X very small, short, with meso-dorsal black edges (Fig. 446). Cercus huge, thick, armed with heavily sclerotized teeth along distal edge; with ventral, black tooth directed postero-mesad. Median shaft of aedeagus simple. Lateral arms long, expanded slightly distally, each with two distal lobes (Fig. 447, 448); basal or dorsal lobe minute, with distal tuft of spines; ventral lobe large, lanceolate, fringed dorsally with short spines.

Female genitalia. (Specimen from Banff, Alberta). Vulval scale massive, triangular (Fig. 450); median lobe short, parallel-sided, lateral lobes with narrow bases, widened distally. Segment IX large, inseparably fused to segment X dorsally; ventral lobes much larger, with straight edges (Fig. 449). Supra-genital plate short, broad, with evenly curved posterior edge. Segment X relatively small, short, with pair of meso-lateral lobes. No evident cerci.

Notes on biology. – Adults of this species are found near sedge ponds, lakes or sloughs, and mountain streams of a turbulent and rocky nature. Flight season of the adults extends from July 4 to September 27.

Geographical distribution. – The nearctic range of this holarctic species extends from Yukon Territory to British Columbia, Minnesota, Nova Scotia, and Greenland (Fig. 636). In Alberta it is confined to the foothills and mountains, ranging in altitude from 4,500' to 6,800'.

I have examined 25 specimens, 13 males and 12 females, from the study area.

The Genus *Nemotaulius* Banks

A single species, of the subgenus *Macrotaulius*, is known from the study area.

Synopsis of characters. – Eyes quite small. Head quite elongate, with toothed ridge along occipital border. No cephalic warts present. Pronotum twice length of head in certain species. Spur formula 1,3,4. Fore wings coriaceous, apically indented (Fig. 141a). Hind wings very large, slightly indented. Fore wings very reddened, not irrorate. Venation of fore wings with very large discoidal cell; chord feebly disrupted, hardly oblique to body; hind wings similar.

Male genitalia with postero-dorsal edge of tergum VIII developed as large, black-spinate bulb. Segment IX usually large, well developed laterally. Claspers of medium size, massive in appearance, thick, concave, unarmed, not close to border of segment IX. Aedeagus large, strong, similar to that of *Limnephilus* spp.; lateral arms non-erectile, simple, fringed distally with setae or spines.

Female genitalia with dorsal part of segment IX narrowed, triangular, weakly developed; no free appendages. Segment X continuous with segment IX, tubular; short, massive, poorly cleft mesally. Ventro-lateral lobes of segment IX huge, largely continguous ventrally. Supra-genital plate small. Vulval scale very large, plate-like, entirely flanked by sternum VIII; median lobe very small, sunk between two sub-quadrangular lateral lobes.

Nemotaulius hostilis (Hagen), 1873
(Fig. 141a, 141b, 451-455, 637)

Glyphotaelius hostilis Hagen, 1873c:444-446. (Type locality: Saskatchewan). Banks, 1892: 363. Ulmer, 1905a:18. Ulmer, 1907a:40. Banks, 1907a:36. Lloyd, 1921:41, 43-44. Dodds and Hisaw, 1925a:124-125. Dodds and Hisaw, 1925b:386. Betten, 1926:529. Sibley, 1926:107, 193. Berry, 1927:3. Banks, 1930b:127. Betten, 1934:313. Milne, 1935:28, 50. Ross, 1938b:32. Balduf, 1939:122. Ross, 1941a:113. Ross, 1944:183, 297. Leonard and Leonard, 1949a:16. Ross and Spencer, 1952:47. Morse and Blickle, 1953: 97. Pennak, 1953:580. Robert, 1960:59. Wiggins, 1961:700. Etnier, 1965:148.

Nemotaulius (Macrotaulius) hostilis; Schmid, 1952a:229-231. Schmid, 1955:149. Flint, 1960:5, 54, 55-56. Nimmo, 1966a:691. Fischer, 1967:250-251. Clifford, 1969:583. Lindroth and Ball, 1969:138.

Description. – Antennae brown; scapes darker, with antero-mesal faces pale, almost glabrous. Vertex of head deep red-brown; flat, evenly covered with large pustulate bumps. Thorax pale yellow, with slightly darker areas laterally; dorsal areas flat, pustulate. Spurs yellow. Fore wing length of male 22.8 mm; grey-brown to almost black in mixture of solid blocks of colour, and irrorate areas. Costal area hyaline except for slight basal irroration. Venation as in Fig. 141a, 141b; distal edge of fore wing crenulate.

Male genitalia. (Specimen from George Lake, near Busby, Alberta). Postero-dorsal edge of tergum VIII developed as large, black-spinate bulb. Dorsal strap of segment IX short; complex, of sclerotized flanges merged gradually with main body (Fig. 451). Main body of segment high, spindle-shaped, not wide. Clasper with long, narrow base; dorsal process massive, short, thick; claw-like distally. Median lobes of segment X small, short, dorso-laterally hooked spines (Fig. 451, 452). Cercus small, wide, lobe without mesally concave face. Aedeagus large, with simple median shaft (Fig. 453); lateral arms long, with wide bases and distal tips; tips acuminate, fringed on edges with long setae.

Female genitalia. (Specimen from George Lake, near Busby, Alberta). Vulval scale relatively small, with very short, rounded, median lobe, massive, triangular lateral lobes (Fig. 455). Dorsal body of segment IX and segment X solid tapered tube, deeply cleft dorsally (Fig. 454). Ventro-lateral lobes of segment IX huge, discrete from dorsal body, irregular, fused solidly ventrally. Supra-genital plate small, triangular, membranous with sclerotized edges.

Notes on biology. – Adults of this species are found near lakes and sloughs overgrown with sedges or, particularly, cattail reeds. The flight period extends from June 3 to August 10.

Geographical distribution. – The known range of this species extends from Alaska to Colorado and Newfoundland (Fig. 637). In Alberta it is confined to the plains region.

I have examined 39 specimens, 28 males and 11 females, from the study area.

The Genus *Anabolia* Stephens

This genus is represented in the study area by three species.

Synopsis of characters. – Cephalic warts small, pronotum somewhat elongate. No dorsal line. Spur formula 1,3,4. Fore wings large, slightly truncated, rounded, or parabolic apically; hind wings variable in size. Coloration of wings characteristic, fairly constant; fore wings reddish brown, with no hyaline or darker areas; uniformly coloured or minutely irrorate. Venation somewhat variable; chord rectilinear, anteriorly oblique, weakly disrupted, concave to body; hind wing chord posteriorly oblique, disrupted.

Male genitalia with tergum VIII non-spinate. Segment IX generally well developed laterally, rigid, sclerotized; dorsal strap slender, with blunt elongate, median process in some species, dentate in most species. Median lobes of segment X more or less triangular, sclerotized lamellae. Claspers with slender, pad-like basal part fused to segment IX, sometimes twisted helically; dorsal process horizontal, slender, cylindrical. Aedeagus large; median shaft short, thick, folded at base; lateral arms slender, normally bilobed, spinate.

Female genitalia very stubby, not projected. Segment IX of two pieces in lateral aspect; dorsal part small, with appendages which are free, or fused at base of segment X. Segment X small, conical, cleft vertically. Ventro-lateral lobes of segment IX very large, massive, contiguous or separated ventrally. Supra-genital plate small. Vulval scale variable.

Key to the Males of species of *Anabolia* found in Alberta and eastern British Columbia

1a. Median shaft of aedeagus very short, stubby, with distal head recessed into basal part (Fig. 458) ..... *A. consocia* (Walker), p. 125.

1b. Median shaft of aedeagus long, slender (Fig. 463, 468) 2a

2a.(1b) Clasper with minute dorsal process and high, very slender base (Fig. 461) ..... *A. ozburni* (Milne), p. 126.

2b. Clasper with large, conical, black-tipped dorsal process (Fig. 466) ..... *A. bimaculata* (Walker), p. 127.

Key to the Females of species of *Anabolia* found in Alberta and eastern British Columbia

1a. Segment X with cerci or cercus-like lobes; vulval scale with median lobe longer than lateral lobes (Fig. 459, 460, 469, 470) 2a

1b. Segment X without such lobes; median lobe of vulval scale not longer than lateral lobes (Fig. 464, 465) ..... *A. ozburni* (Milne), p. 126.

2a.(1a) Ventro-lateral lobes of segment IX massive, fleshy, with triangular posterior edge (Fig. 459) *A. consocia* (Walker), p. 125.

2b. Ventro-lateral lobes of segment IX small, roughly rectangular in lateral aspect, except for triangular postero-ventral lobe projected well posterad under segment X (Fig. 469) *A. bimaculata* (Walker), p. 127.

Anabolia consocia (Walker), 1852
(Fig. 456-460, 638)

Limnephilus (Goniotaulius) consocius Walker, 1852:33. (Type locality: North America).

Limnephilus consocius; Ross, 1944:185, 186, 189, 190-191, 298. Sprules, 1947:30, 78. Leonard and Leonard, 1949a:17. Ross and Merkley, 1952:449. Morse and Blickle, 1953: 98. Pennak, 1953: Fig. 361. Etnier, 1965:148. McConnochie and Likens, 1969:150.

Stenophylax consocius; Hagen, 1859:134. Hagen, 1864:885. Ulmer, 1905a:21.

Goniotaulius consocius; Hagen, 1864:815.

Anabolia consocia; Hagen, 1861:264. McLachlan, 1863:157, 161. Hagen, 1864:803. Banks, 1892:363. Banks, 1897:28. Banks, 1905:9. Ulmer, 1905a:20. Schmid, 1950b:319-322. Schmid, 1955:150. Flint, 1960:5, 56, 58. Fischer, 1969:13-15.

Limnephilus consocia; Proctor, 1946:211. Wray, 1950:21.

Colpotaulius consocia; Banks, 1905:9. Banks, 1907a:37. Martynov, 1914:221. Banks, 1916: 122. Johnson, 1927:49.

Arctoecia consocia; Ulmer, 1907a:47. Lloyd, 1921:53-56. Banks, 1923:146. Betten, 1926: 528. Sibley, 1926:190. Berry, 1927:3. Banks, 1930b:127. Ulmer, 1932:214. Betten, 1934:90, 91, 314-315. Milne, 1935:39-49. Balduf, 1939:152. Betten and Mosely, 1940:

111-113. Proctor, 1946:210.

Arctocia consocia; Sibley, 1926:107.

Arctoecia consicia; Muttkowski and Smith, 1929:259.

Colpotaulius medialis Banks, 1905:8. (Type locality: Ontario). Banks, 1907a:37. Banks, 1908c:154. Martynov, 1914:221. Brimley, 1938:253.

Arctoecia medialis; Ulmer, 1907a:47. Krafka, 1915: plate 7. Lloyd, 1921:42. Krafka, 1923: plate 31. Milne, 1935:49.

Limnephilus medialis; Ross, 1938b:36. Ross, 1944:190, 298.

Males of this species are distinguished from males of other species of the genus by short, blunt median shaft of aedeagus (Fig. 458) with distal head recessed into basal portion; by distally flared, black-edged claspers with deeply concave mesal faces (Fig. 456, 457); and by rectangular median lobes of segment X. Females are distinguished by massive, fleshy, ventro-lateral lobes of segment IX (Fig. 459), with triangular posterior edge; by minute dorsal body of segment IX; and by median lobe of vulval scale slender, tapered, much longer than lateral lobes (Fig. 460).

Description. – Antennae yellowish brown. Vertex of head red-brown, with mesal longitudinal stripe of dark brown. Thorax pale yellow; with mesal longitudinal stripe of dark brown along terga. Thoracic warts fragmented to individual setal bases in some specimens. Male anterior femur without brush. Spurs pale yellow. Fore wing length of male 14.1 mm; light brownish yellow; faintly irrorate basally; veins irregularly darkened. Venation identical to that of *Limnephilus* spp.

Male genitalia. (Specimen from Cold Creek, Nojack, Alberta). Dorsal strap of segment IX with dorso-mesal process lightly setose (Fig. 456). Main body of segment wide dorsally, tapered gradually ventrad. Clasper small, with high, narrow base; dorsal process short, originated gradually from base, with distally black, clawed tip. Median lobes of segment X large, rectangular in lateral aspect, thick in dorsal aspect (Fig. 457), with distal third black; basal plates large, complexly folded. Cercus massive, distal edge black, with disto-ventral angle attenuated as black tooth (Fig. 457). Median shaft of aedeagus short, stout, with wrinkled base (Fig. 458); distal head recessed into basal body. Lateral arms stout, curved dorsad, tapered slightly distad; distally fringed on dorsal and ventral edges with short setae.

Female genitalia. (Specimen from Chicago, Illinois; in Illinois Natural History Survey). Vulval scale large; median lobe longer than lateral lobes (Fig. 460), narrow, evenly tapered distad; lateral lobes curved, widened distad, with concave mesal faces. Dorsal body of segment IX minute, narrow, strap-like (Fig. 459); ventro-lateral lobes massive, fleshy, with triangular posterior edges, discrete from dorsal body. Supra-genital plate small, wide, tapered posterad, truncated distally; convex ventrally. Segment X completely cleft ventro-mesally, dorsally two edges joined by sheet of membrane (Fig. 460); triangular in lateral aspect. Cerci roughly triangular, held closely to dorso-lateral faces of segment X; fused solidly to segment X.

Geographical distribution. – The known range of this species extends from Alberta to Virginia and Quebec (Fig. 638). The two records from Alberta available to me are from the plains region, at about 2,100'.

I have examined two specimens of this species from the study area, one adult and one pupal male. I have also examined a female from Illinois.

Anabolia ozburni (Milne), 1935
(Fig. 142a, 142b, 461-465, 639)

Arctoecia ozburni Milne, 1935:39, 49. (Type locality: Guelph, Ontario).

Anabolia ozburni; Ross, 1944:298. Schmid, 1950b:325-327. Schmid, 1955:151. Nimmo, 1966a:692. Nimmo, 1966b:224. Fischer, 1969:34-35.

Limnephilus ozburni; Leonard and Leonard, 1949a:18. Leonard and Leonard, 1949b:6. Ross and Merkley, 1952:450. Morse and Blickle, 1953:98. Etnier, 1965:149.

Males of this species are distinguished from males of other species of *Anabolia* by massive, thick cerci (Fig. 461); by minute dorsal process of claspers; and by dorso-mesal process of dorsal strap large, projected well posterad (Fig. 462). Females are distinguished by large segment IX fused solidly to segment X dorsally (Fig. 464); and by lack of cerci or cercus-like lobes.

Description. – Antennae dark brown; scapes very dark, with antero-mesal faces lighter, glabrous. Vertex of head very dark brown. Thorax dark to very dark brown. Spurs yellow. Fore wing length of male 10.8 mm; light reddish brown, irrorate; costal area clear. Venation as in Fig. 142a, 142b; leading edge of fore wing truncate and R1 straight to edge, not bowed. Hind wing with deep indentation at Cu.

Male genitalia. (Specimen from Cold Lake, Cold Lake, Alberta). Dorsal strap of segment IX laterally narrow, dorsally expanded to large triangular, horizontal plate with single seta in distal clear area. Main body of segment robust, narrowed abruptly ventrad (Fig. 461). Clasper with high, very narrow base surmounted by minute dorsal process. Median lobes of segment X massive, triangular, with distal halves black; tips hooked laterad as small teeth (Fig. 462). Cercus massive, rectangular in lateral aspect, with distal face wide, black, fringed with setae; attached to wide internal bases. Median shaft of aedeagus long, narrowed slightly at mid-point (Fig. 463), expanded to folded distal head. Lateral arms each of uniform width for two-thirds length, then widened slightly to thin, spatulate tip cleft distally as two acuminate spines; dorsal and ventral edges of tips setose; mesal faces with pair of heavy spines.

Female genitalia. (Specimen from Michigan; in Illinois Natural History Survey). Vulval scale small, with rectangular median lobe (Fig. 465); lateral lobes with concave mesal edges curved, lateral edges distinctly angular. Dorsal body of segment IX large, wide, fused to segment X dorsally, but divided from it ventrally by suture (Fig. 464). Ventro-lateral lobes of segment IX massive, almost square in lateral aspect, discrete from dorsal body of segment. Supra-genital plate minute, short, not projected laterally beyond distal extremities of lateral lobes of vulval scale. Segment X cylindrical internally, triangular in lateral aspect, with dorsal edges of mesal cleft sinuate; median cleft deep, with dorsal cleft angular, ventral cleft rounded (Fig. 465).

Geographical distribution. – The known range of this species extends from Alberta to Quebec, New Hampshire and Michigan (Fig. 639). In Alberta it is known only from Edmonton and Cold Lake to the northeast; both are plains localities, and Cold Lake is in the boreal forest region.

I have examined two males from the study area, and one female from Michigan. Dates of capture of the Alberta specimens were July 11 and 17.

Anabolia bimaculata (Walker), 1852
(Fig. 466-470, 640)

Limnephilus (Goniotaulius) bimaculatus Walker, 1852:30. (Type locality: St. Martin's Falls, Albany River, Hudson's Bay). Ross, 1941a:110. Milne (D. J.), 1943:192, 194, 196. Ross, 1944:186, 189, 298. Leonard and Leonard, 1949a:17. Ross and Spencer, 1952:48. Ross and Merkley, 1952:449. Morse and Blickle, 1953:98. Pennak, 1953: Fig. 362R. Robert, 1960:59. Etnier, 1965:148.

Limnephilus (Desmotaulius) bimaculatus; Hagen, 1861:263.

Anabolia bimaculata; McLachlan, 1863:157, 161. Hagen, 1864:803. Banks, 1892:363. Banks 1897:28. Ulmer, 1905a:20. Ulmer, 1905b:61-62. Ulmer, 1907a:46. Banks, 1907a: 37. Martynov, 1914:209. Krafka, 1923: plate 8. Dodds and Hisaw, 1925a:124. Dodds and Hisaw, 1925b:386. Betten, 1926:529. Banks, 1930b:128. Ricker, 1932:132. Ricker, 1934:54. Betten, 1934:353-354. Neave, 1934:167. Milne, 1935:43, 49. Denning, 1937: 34-37. Betten and Mosely, 1940:142-144. Denning, 1941b:195. Schmid, 1950b:88-95. Schmid, 1955:151. Flint, 1960:5, 56, 57, 114. Fischer, 1969:4-5.

Desmotaulius bimaculatus; Hagen, 1864:811.

Anabolia maculata; Dodds and Hisaw, 1925a: Fig. 1. Balduf, 1939:121.

Males of this species are distinguished from males of other species of *Anabolia* in the study area by conical dorsal processes of claspers with black tips; by dorsal strap of segment IX without dorso-mesal process; and by small, triangular median lobes of segment X (Fig. 466). Females are distinguished by relatively small ventro-lateral lobes of segment IX with small, triangular ventro-posterior lobes; by ventro-lateral lobes in contact mesally (Fig. 470); and by small, low, dorsal body of segment IX (Fig. 469).

Description. – Antennae brown; antero-mesal faces of scapes paler, glabrous. Vertex of head dark brown. Thorax dark brown dorsally but with paler meso-longitudinal line; laterally pale yellow. Spurs pale brown. Fore wing length of male 15.8 mm; deep chocolate-brown to pale yellowish brown; lightly irrorate; costal area clear, pale yellow. Venation not significantly different from that of *Limnephilus* spp.

Male genitalia. (Specimen from George Lake, near Busby, Alberta). Dorsal strap of segment IX short, slender, directed anterad (Fig. 466). Main body of segment roughly inverted-triangular. Clasper with long, narrow base; dorsal process short, conical, heavily sclerotized, black distally. Median lobes of segment X short, triangular, black distally, each with minute disto-lateral tooth (Fig. 467). Cercus of medium size, rounded-triangular distally; with concave mesal face, thick base. Median shaft of aedeagus slender, tapered evenly distad, with distinct distal head small (Fig. 468); lateral arms shorter than median shaft, each basally curved sharply dorsad, divided distally to long, acuminate dorsal lobe and small, triangular ventral lobe; short setae located only along edge between lobes.

Female genitalia. (Specimen from George Lake, near Busby, Alberta). Vulval scale with three lobes well separated (Fig. 470); median lobe longer than laterals, conical in ventral aspect, rugose at base; lateral lobes with channelled mesal faces. Dorsal body of segment IX small, with short, triangular, dorsal extension; main part of dorsal body fused to segment X (Fig. 469). Ventro-lateral lobes of segment IX relatively small, rectangular in lateral aspect except for triangular postero-ventral angles; discrete from dorsal body. Segment X of irregular outline in lateral aspect; distally acuminate, deeply cleft mesally. Cerci short, fused at bases to dorso-lateral surfaces of segment X. Supra-genital plate small, rectangular.

Notes on biology. – Adults of this species are found near cattail sloughs, lakes, or ponds, or smaller, quietly flowing, rivers and creeks. The flight period extends from June 11 to August 29 with a possible peak at end of July and beginning of August.

Geographical distribution. – The known range of this species extends from Great Slave Lake to British Columbia, New Mexico, Michigan, and Maine (Fig. 640). In Alberta it is fairly ubiquitous throughout the plains and lower major mountain valleys.

I have examined 417 specimens, 274 males and 143 females, from the study area.

The Genus *Asynarchus* McLachlan

This genus is represented in the study area by three species belonging to two groups.

Synopsis of characters. – Head slightly elongate; eyes not prominent. Dorsal line barely

visible. Spur formula 1,3,4. Pronotum short. Wings of normal size, shortened in female of some species and cold adapted forms. Fore wings much as in *Limnephilus* spp. but more expanded at chord; hind wings somewhat larger than fore. Fore wings basically brown, with small irrorations and larger clear areas at thyridial cells, chord, and distally along M4+5.

Male genitalia with tergum VIII non-spinate. Segment IX laterally strongly convex and sclerotized. Cerci medium to large, varied; in certain species slender, strongly concave; distal edge heavily sclerotized, mesal faces with massive tooth or ridge in some species. Median lobes of segment X small, ventrad of cerci. Claspers with prominent basal pieces fused to segment IX; distal processes bifid, pincer-like, black. Aedeagus large, quite similar to that of *Limnephilus* spp.; lateral arms slender, bilobed.

Female genitalia with dorsal body of segment IX short, inconspicuous; with two large, laterally flattened, appendages fused basally to each other in some species. Segment X ventrad of these appendages; with thin, hardly cleft walls. Ventro-lateral lobes of segment IX huge, high, massive; in most species contiguous meso-ventrally. Supra-genital plate large. Vulval scale partly recessed into sternum VIII; lateral lobes long, oblique straps.

Key to the Males of species of *Asynarchus* found in Alberta and eastern British Columbia

1a. Clasper very large, blade-like, triangular (Fig. 471); median lobes of segment X large, triangular; dorsal strap relatively wide ..... *A. mutatus* (Hagen), p. 129.

1b. Claspers small, distally bifid (Fig. 476, 482); median lobes of segment X small hooks; dorsal strap very narrow 2a

2a.(1b) Cercus hooked meso-ventrad distally, with second, ventral, black tooth distinct (Fig. 482) ..... *A. aldinus* (Ross), p. 131.

2b. Disto-dorsal angle of cercus triangular in lateral aspect (Fig. 476), not divided from disto-ventral angle ..... *A. curtus* (Banks), p. 130.

Key to the Females of species of *Asynarchus* found in Alberta and eastern British Columbia

1a. Segment IX a single, massive unit, grossly enlarge ventrad (Fig. 474).....
..... *A. mutatus* (Hagen), p. 129.

1b. Segment IX with clear, almost discrete ventro-lateral lobes (Fig. 480).....
..... *A. curtus* (Banks), p. 130.
..... *A. aldinus* (Ross), p. 131.

The *contumax* group

A single species of this group is known in the study area.

Males of this group are distinguished by short, thin-walled, mesally concave cerci; and by massive median lobes of segment X. Females are distinguished by very large ventro-lateral lobes of segment IX; and by narrow, oblique lateral lobes of vulval scale.

Asynarchus mutatus (Hagen), 1861
(Fig. 471-475, 641)

Hallesus mutatus Hagen, 1861:267. (Type locality: Labrador). Hagen, 1864:818. Banks, 1892:364. Ulmer, 1905a:21. Ulmer, 1907a:56. Banks, 1907a:38. Ross, 1938b:32.
Stenophylax mutatus; Betten, 1934:345.
Anabolia mutata; Milne, 1935:43, 49.
Limnephilus mutatus; Ross, 1938b:37-38. Ross, 1944:298. Ross and Merkley, 1952:449. Etnier, 1965:149.

Asynarchus mutatus; Schmid, 1954b:65-67. Schmid, 1955:153. Fischer, 1969:50-51.

Males of this species are distinguished from males of other species of *Asynarchus* by large, triangular, blade-like claspers (Fig. 471); by high, short, triangular median lobes of segment X; and by short, irregular cerci. Females are distinguished by massive, unit segment IX (Fig. 474) which completely encircles segment X (Fig. 475).

Description. – Antennae brown; antero-mesal faces of scapes darker, glabrous. Vertex of head dark brown, warts yellowish. Thorax warm yellowish brown. Brush of fore leg of male slight, on basal third of femur only. Spurs dark brown. Fore wing length of male 15.0 mm; dark brownish grey, irrorate, with larger patches of solid colour; two major areas of clear membrane just distad of chord and immediately anterad of Cu1+2; veins of chord darker than others. Venation identical to that of *Limnephilus* spp.

Male genitalia. (Specimen from George Lake, near Busby, Alberta). Dorsal strap of segment IX simple, broad; main body of segment almost elipsoidal. Clasper long, thin, triangular blade with black tip (Fig. 471). Median lobes of segment X short, with denticulate dorsal edges; distal areas black, each with distinct disto-lateral tooth (Fig. 472). Cercus short, with cup-like disto-mesal faces, black, toothed posterior edges. Median shaft of aedeagus tapered slightly distad; directed postero-dorsad from base (Fig. 473); lateral arms curved in semicircle, each with lanceolate, spinate distal lobe; two small, spatulate lobes on ventral edge of each arm; each lobe distally fringed with stout spines.

Female genitalia. (Specimen from Indian Head, Saskatchewan). Vulval scale with short, conical median lobe (Fig. 475); lateral lobes long, narrow, tapered, directed postero-laterad, well separated from median lobe. Segment IX massive, of one piece; dorsal portion slightly narrowed; ventral portion swollen, fused ventrad of segment X (Fig. 474, 475). Supra-genital plate very wide, short, hyaline. Segment X very short, tubular, not cleft. Cercal lobes not evident.

Notes on biology. – Adults of this species are found near sedge and cattail sloughs and lakes. The flight season extends from June 3 to July 23.

Geographical distribution. – The known range of this species extends from British Columbia to Great Slave Lake, Minnesota and Ontario (Fig. 641). In Alberta it is confined to the plains and eastern edges of the foothills in the lower valleys.

I have examined 11 males of this species from the study area and Great Slave Lake, and a female from Saskatchewan.

The *lapponicus* group

Two species of this group are known from the study area.

Males of this group are distinguished by large, projected, lanceolate cerci; and by small median lobes of segment X. Females are distinguished by discrete ventro-lateral lobes of segment IX; and by large, triangular lateral lobes of vulval scale.

Asynarchus curtus (Banks), 1920
(Fig. 476-481, 642)

Anabolia curta Banks, 1920:345. (Type locality: Massachusetts). Betten, 1934:354. Ross, 1938b:28.

Limnephilus curtus; Ross, 1938b:35. Ross, 1944:298. Ross, 1947:152. Ross, 1950b:428. 429, Fig. 18, 18a. Ross and Merkley, 1952:443. Etnier, 1965:148. Ross, 1966:592.

Limnephilus curtis; Milne (D. J.), 1943:192, 194. Morse and Blickle, 1953:58.

Asynarchus curtus; Schmid, 1954b:60, 81-84, 85, 86. Schmid, 1955:154. Fischer, 1969: 44-45. Flint, 1960:60, 104, 114.

Anabolia planifrons; Milne, 1935:43, 44, 49. Schmid, 1954b:60.

Limnephilus batchewana Denning, 1949b:90-91. (Type locality: Batchewana Bay, Lake Superior). Ross, 1950b:426. Ross and Merkley, 1952:443. Ross and Spencer, 1952:48. Schmid, 1954b:60. Ross, 1965:592.

Limnephilus conerus Ross, 1950b:426, 428-429. (Type locality: Thunder Bay, Ontario).

Males of this species are distinguished from males of other species of *Asynarchus* by short, distally bifid claspers; by massive, disto-ventrally toothed claspers (Fig. 476); and by uncleft distal edge of claspers. Females are distinguished by partially separate ventro-lateral lobes of segment IX (Fig. 480); and by laterally cleft segment X, with wide, triangular dorsal cerci. Females of this species are, however, inseparable from those of *A. aldinus*, except by association with the male in the field.

The males are of the form *batchewana* Denning (syn., *conerus* Ross) and differ consistently from the eastern *curtus* as illustrated by Ross (1950b). The synonymy followed here is that of Schmid (1952c), although Ross and Denning still consider *batchewana* a distinct species (*in litt.*).

Description. – Antennae clothed with black hairs, of overall dark brown colour; scapes clear yellow, glabrous. Vertex of head dark brown except for narrow area mesad of compound eyes. Thorax reddish brown, with intermixed darker areas. Brush of male fore leg sparse, pale, confined to basal quarter of femur. Spurs reddish yellow. Fore wing length of male 14.8 mm; red-brown, irrorate, with very few larger areas clear. Costal area also irrorate. Venation identical to that of *Limnephilus* spp.

Male genitalia. (Specimen from Gorge Creek beaver pond, 20 miles west of Turner Valley, Alberta). Dorsal strap of segment IX short, narrow (Fig. 476). Main body of segment massive, with narrow sternal area. Clasper short, stout, distally bifid, black. Median lobes of segment X small, distally hooked dorsad, black. Cercus massive, with heavy longitudinal ridge along mesal face (Fig. 477); distally black. Median shaft of aedeagus long, curved dorsad from base (Fig. 478); lateral arms shorter, with disto-dorsal lobe long, scythe-like, curved dorso-anterad; with small ventral lobe setose (Fig. 479).

Female genitalia. (Specimen from Gorge Creek beaver pond, 20 miles west of Turner Valley, Alberta). Vulval scale large, with narrow median lobe slightly longer than large, triangular, lateral lobes (Fig. 481). Dorsal body of segment IX small, wide, partially separated from segment X (Fig. 480); ventro-lateral lobes large, rectangular, partially discrete from dorsal body. Supra-genital plate wide, incised on posterior edge, partly sunken in ventral depressions of segment IX. Segment X small, shallowly incised laterally, deeply incised dorsally; tubular. Cerci massive, set well dorsad of segment X, blunt distally.

Notes on biology. – Adults of this species are found in a wide variety of habitats, from small plains sloughs and lakes, to high mountain pass bogs, and smaller, quieter creeks. The flight period extends from July 5 to Sept. 25, with peak about the beginning of September.

Geographical distribution. – The known range of this species extends from Alaska to Colorado and Labrador (Fig. 642). In Alberta it is found throughout the plains, foothills, and mountains, to altitudes of around 7,350'.

I have examined 246 specimens, 96 males and 150 females, from the study area and Great Slave Lake.

Asynarchus aldinus (Ross), 1941
(Fig. 482-483, 643)

Limnephilus aldinus Ross, 1941b:19. (Type locality: Rowe Lakes, Waterton National Park, Alberta). Ross, 1944:298. Ross and Merkley, 1952:443.

Asynarchus aldinus; Schmid, 1954b:84-86. Schmid, 1955:154. Nimmo, 1965:786-787. Fischer, 1969:42.

Males of this species are distinguishable from males of *A. curtus* by lateral aspect of cerci, with meso-distal angle separated from ventral tooth by lunate cleft, in form of distinct, postero-ventrally hooked tooth (Fig. 482). Females can only be determined in association with males.

Description. – Antennae light brown, with yellow, glabrous stripe along antero-mesal faces of scapes. Vertex of head dark brown, with lighter mesal band joining area between compound eyes with postero-mesal warts. Thorax warm reddish brown; terga lighter dorsally. Brush of male fore leg of short, black spines in narrow band on basal third of femur. Spurs yellow. Fore wing length of male 11.2 mm; brownish grey, sparsely irrorate. Venation identical to that of *Limnephilus* spp.

Male genitalia. (Specimen from Bow Pass, Banff-Jasper Hwy., Alberta). Dorsal strap of segment IX very narrow, short. Main body of segment large, angular, almost trapezoidal (Fig. 482). Clasper large, short, stout; distal extremity black, bifid; base long, tapered ventrad. Median lobes of segment X small, hooked dorsad distally. Cercus massive, with large ventro-distal tooth produced basad along mesal face (Fig. 483); in lateral aspect dorso-mesal extremity separated from ventral tooth as postero-ventrally curved hook (Fig. 482). Aedeagus essentially identical to that of *A. curtus*.

Female genitalia. This sex is known (Nimmo, 1965), but is indistinguishable from female of *A. curtus*.

Notes on biology. – Adults of this species are found in high alpine meadow and mountain pass areas, emerging from shallow, quiet pools or streams in sedge meadows. The flight period extends from July 25 to August 27.

Geographical distribution. – The known range of this species extends from Great Slave Lake to Idaho (Fig. 643). In Alberta it attains altitudes of up to 7,000'.

I have examined 16 specimens, eight males and eight females, from the study area.

Asynarchus lapponicus Zetterstedt, 1840

This species has been reported recently from the study area (Clifford, 1969), but I have been unable to confirm the record as the specimens involved are missing. Therefore I do not include full details on this species, but draw the reader's attention to the above record, and refer to Schmid (1954b:78-81) for figures and full description.

The Genus *Philarctus* McLachlan

A single species of this genus is known from the study area.

Synopsis of characters. – Head rather elongate, eyes and cephalic warts small. Antennae thick, shorter than wings. Anterior femora of male very thick; anterior tibiae equally thick, slightly flattened, each terminated by ridge; both clothed with brushes of stout spines along opposing faces; apical spur short, flat, triangular. Spur formula 1,3,4. Wings various in size; some species with *Limnephilus*-like wings; others quite shortened, apically parabolic. Coloration dark brown. Venation of fore wing with chord weakly disrupted, slightly oblique; hind wing chord strongly disrupted, parallel to body.

Male genitalia with well developed segment IX; dorsal strap short, wide, setose. Cerci very large, bulky, strongly sclerotized, fused ventrad of anal aperture and located laterad of it. Intermediate lobes of segment IX triangular or horizontal discs, ventrad of cerci. Claspers well developed, with long, slender dorsal process. Aedeagus similar to *Limnephilus* spp.; lateral arms very slender, expanded distally, finely spinate.

Female genitalia with dorsal body of segment IX short, blunt, projected, expanded laterad

at base; ventro-lateral lobes quite small, not contiguous ventrally. Supra-genital plate large, short. Segment X large, blunt, thick, weakly sclerotized, pilose; deeply cleft tube, more or less open ventrally. Cerci large, prominent, free. Median lobe of vulval scale long, narrow; lateral lobes short, thick, sub-quadrangular.

Philarctus quaeris (Milne), 1935
(Fig. 484-489, 644)

Colpotaulius quaeris Milne, 1935:41, 45. (Type locality: Quesnel Lake, British Columbia). Milne, 1936:60.

Limnephilus quaeris; Ross, 1944:298. Etnier, 1965:149.

Philarctus quaeris; Ross and Merkley, 1952:436. Ross and Spencer, 1952:47. Schmid, 1955: 158. Wiggins, 1963:103-105. Clifford, 1969:583. Fischer, 1969:58.

Description. – Antennae dark brown; antero-mesal faces of scapes yellow-brown, glabrous. Vertex of head dark reddish brown in triangular area between three ocelli; lighter peripherally. Thorax light brown laterally, dorsally. Brush of male fore leg confined to distal three-quarters of femur; anterior tibia also with brushes on entire length of opposite face. Spurs reddish brown. Fore wing length of male 8.7 mm; dark chocolate-brown, heavily irrorate; costal area hyaline throughout. Venation identical to that of *Limnephilus* spp.

Male genitalia. (Specimen from 17 miles north of Langdon Corner, on Hwy. 9, Alberta). Dorsal strap high, wide (Fig. 484); heavily setose. Main body of segment irregular in lateral aspect, with low, triangular postero-dorsal angles. Clasper with parallelogram-like base surmounted by short, thin, acuminate dorsal process. Median lobes of segment X not evident. Ventrad of dorsally fused cerci are two placoid lobes which appear to be intermediate lobes (Fig. 484, 485). Cercus large, fused at base to segment IX; distally acuminate plate fused dorsally as roof to anal passage. Median shaft of aedeagus long, very slender, with distinct, long distal head (Fig. 486, 487); lateral arms shorter, slightly expanded from narrow bases to shovel-like distal blades concave on mesal faces.

Female genitalia. (Specimen from 17 miles north of Langdon Corner, on Hwy. 9, Alberta). Vulval scale with roughly rectangular median lobe; lateral lobes triangular, close to median (Fig. 489). Dorsal body of segment IX high, narrow, distinct from segment X (Fig. 488); ventro-lateral lobes small, irregular, flap-like. Supra-genital plate trapezoidal. Segment X tubular, with lateral bulges; slightly cleft mesally; recessed slightly into segment IX. Cerci short, narrow, fused at base, projected clear of remainder of segment X.

Notes on biology. – Adults of this species are found near sedge and horse-tail sloughs or lakes of the plains or low mountain valleys. The flight period extends from June 18 to September 13, with a peak toward the end of August.

Geographical distribution. – The known range of this species extends from Great Slave Lake to Oregon, Colorado, and Minnesota (Fig. 644). In Alberta it is known from the plains and low mountain valleys.

I have examined 142 specimens, 69 males and 73 females, from the study area.

The Genus *Arctopora* Thomson

Schmid (1952c) erected the genus *Lenarchulus* to contain two species, with *Phryganea trimaculata* Zetterstedt as type species. Fischer (1966) pointed out that in fact Thomson (1891) erected the genus *Arctopora* to contain the single species *Phryganea trimaculata* Zetterstedt. *Arctopora* is therefore used here as the correct name for this genus which contains three species, one of which is known from Alberta.

Synopsis of characters. – Head rather elongated. Pronotum short. Spur formula 1,3,3. Wings quite large, fore wings large, truncated apically; hind wings not large, indented postero-apically. Fore wings with large brown patches; chord weakly disrupted, concave, slightly oblique to body posteriorly.

Male genitalia with tergum VIII setose at postero-dorsal edge. Segment IX elongated laterally, about as wide as sides dorsally. Cerci small, heavily sclerotized, thick, rounded. Median lobes of segment X small, blunt, heavy. Aedeagus of average size; median shaft slender; lateral arms similarly very slender except for widened tips.

Female genitalia with dorsal body of segment IX well developed, prominent, almost entirely overhanging small, inconspicuous, collar-like segment X. Ventro-lateral lobes of segment IX large, ovoid, closely contiguous ventrally. Supra-genital plate large, inconspicuous. Vulval scale large, partly flanked by sternum VIII; median lobe long, narrow; lateral lobes sub-quadrangular, divergent.

Arctopora pulchella (Banks), 1908
(Fig. 490-494, 645)

Limnephilus pulchellus Banks, 1908b:63. (Type locality: Grand Lake, Newfoundland). Betten, 1926:529. Betten, 1934:331. Milne, 1935:44, 51. Ross, 1938b:39. Ross, 1944: 298. Robert, 1960:59.

Limnophilus pulchellus; Sibley, 1926:107, 191, 216-217.

Limnephilus (Goniotaulius) Pulchellus; Milne, 1935:44, 51.

Lenarchus pulchellus; Ross and Merkley, 1952:438.

Lenarchulus pulchellus; Schmid, 1952c:165, 167-169. Schmid, 1955:160. Flint, 1960:61, 62, 104, 106. Smith, 1969:50.

Arctopora pulchella; Fischer, 1969:59-60.

Males of this species are distinguished by massive, dorsal lobes of dorsal strap of segment IX (Fig. 490, 491); and by short, rounded, blunt median lobes of segment X. Females are distinguished by fused, inseparable segments IX and X (Fig. 493); by discrete ventro-lateral lobes of segment IX fused ventrally; and by minute segment X recessed into segment IX (Fig. 494).

Description. – Antennae dark brown, to dark reddish brown. Vertex of head very dark brown to black. Thorax deep red brown to black. Spurs red-brown. Fore wing length of male 9.5 mm; grey-brown, with large hyaline areas. Venation identical to that of *Limnephilus*.

Male genitalia. (Specimen from Wapta Lake, Kicking Horse Pass, Yoho National Park, British Columbia). Postero-dorsal edge of tergum VIII slightly bulbous, sparsely setose (Fig. 490). Dorsal strap of segment IX massive, thick, projected well posterad over remainder of genitalia; distally narrowed, bilobed (Fig. 491); each lobe supported by only very slight antero-lateral straps to main body of segment. Main body of segment roughly rectangular, narrowed ventrad, curved slightly posterad. Clasper small, triangular, mesally concave. Lobes of segment X short, blunt, rounded distally; median lobes closely appressed along mesal edges (Fig. 491); intermediate lobes attached to lateral extensions of median lobes; cerci small, peg-like. Median shaft of aedeagus long, straight, hardly tapered, with slight, distinct distal head (Fig. 492); lateral arms longer, thinner, each expanded distally to clawed tip, with short, lightly spinate baso-dorsal lobe, and long, curved tapered distal lobe.

Female genitalia. (Specimen from Wapta Lake, Kicking Horse Pass, Yoho National Park, British Columbia). Vulval scale large, with median lobe basally narrow, expanded distally to slightly bilobed tip (Fig. 494); lateral lobes triangular, well separated. Dorsal body of segment IX large, high, rectangular, fused to segment X which it partly overshadows (Fig. 493); ventro-lateral lobes discrete, polygonal, fused ventrad of segment X. No apparent supra-

genital plate. Segment X minute, difficult to distinguish from segment IX; cleft ventrally.

Notes on biology. – Adults of this species are found near sedge sloughs or ponds and quiet streams. The flight period extends from June 28 to September 25.

Geographical distribution. – The known range of this species extends from British Columbia to Newfoundland (Fig. 645). In Alberta it is confined largely to the mountains and foothills, to altitudes of 6,675', it is however also found well away from the mountains, at Edmonton (2,000'), and at the Hay River, in northern Alberta.

I have examined 90 specimens, 47 males and 43 females, from the study area.

The Genus *Lenarchus* Martynov

Four species belonging to this genus, in two subgenera, are known from the study area.

Synopsis of characters. – Head short, in most species large, with prominent eyes. Spur formula 1,3,4. Wings large or of average size; fore wings clearly widened at chord; hind wings much larger. Fore wings strongly irrorate, brown or red; venation with chord strongly disrupted, somewhat concave, anteriorly oblique to body. Hind wing chord strongly disrupted, concave, parallel to body.

Male genitalia with segment IX elongate laterally, robust; short ventrally, produced dorsad as equally wide dorsal strap, developed posterad as massive, wide lobe over rest of genitalia (Fig. 495); lobe in some species formed from dorsal strap, but in others formed from fused cerci. Cerci large, thick, heavily sclerotized, dentate, when free. Median lobes of segment X elongate plates in most species. Claspers not prominent, fused so solidly to segment IX that suture not easily seen; dorsal process very slender in some species, long, horizontal. Aedeagus long, strong; median shaft folded basally; lateral arms slender, distally bilobed.

Female genitalia various. Segment IX of some species of two distinct parts. Ventro-lateral lobes very large, blunt, ventrally contiguous, or long, slender, not contiguous. Supra-genital plate large, short. Segment X tubular, variously cleft. Cerci long, slender, or fused to segment X. Vulval scale quite large; lateral lobes somewhat quadrangular; oblique, divergent.

Key to the Males of species of *Lenarchus* known from Alberta and eastern British Columbia

1a. Dorsal plate formed of posterior process of dorsal strap of segment IX (Fig. 495) ..... *L. (Lenarchus) crassus* (Banks), p. 136.

1b. Dorsal plate formed from fused cerci (Fig. 501) 2a

2a.(1b) Clasper with long, very thin dorsal process (Fig. 504) ..... *L. (Paralenarchus) vastus* (Hagen), p. 137.

2b. Clasper otherwise (Fig. 501, 510) 3a

3a.(2b) Dorsal plate with rectangular median cleft (Fig. 502) ..... *L. (Paralenarchus) fautini* (Denning), p. 136.

3b. Dorsal plate with narrow, v-shaped, median cleft (Fig. 511) ..... *L. (Paralenarchus) brevipennis* Banks, p. 138.

Females of only two species are known, so that a key to the females of the species present in the study area is impracticable at present.

The Subgenus *Lenarchus* Martynov

This subgenus, of which one species is known from the study area, is characterised by large, irrorate fore wings; by dorsal plate formed from dorsal strap of segment IX of male; and by median lobes of segment X of male well developed.

Lenarchus crassus (Banks), 1920
(Fig.495-500, 646)

Limnephilus crassus Banks, 1920:343. (Type locality: Massachusetts). Betten, 1934:321. Milne, 1935:46, 51. Ross, 1944:298.

Lenarchus crassus; Ross and Merkley, 1952:438. Flint, 1960:62.

Lenarchus (Lenarchus) crassus; Schmid, 1952c:177, 181-183. Schmid, 1955:163. Fischer, 1969:62-63.

Males of this species are distinguished from other species of *Lenarchus* by dorsal plate formed from dorsal strap of segment IX (Fig. 495); and by long, irregularly dorsally directed, black spine attached to dorso-mesal faces of claspers. Female unknown.

Description. – Antennae yellow-brown. Vertex of head red-brown, to dark brown mesally. Thorax dark yellowish brown to red-brown. Spurs red-brown. Fore wing length of male 15.1 mm; warm chocolate-brown, irrorate, with larger hyaline areas. Venation identical to that of *Limnephilus* spp.

Male genitalia. (Specimen from Eisenhower Junction, Banff National Park, Alberta). Segment IX massive, of roughly equal width throughout, curved anterad in lateral aspect (Fig. 495). Postero-dorsal edge produced posterad as wide, thick plate dorsad of remainder of genitalia, and weakly bilobed on posterior edge (Fig. 496). Clasper high, narrow, partly fused to segment IX; dorsal extremity with long, thin, heavily sclerotized spine attached to mesal face, curved angularly dorsad. Median lobes of segment X high, thin, polygonal, dark plates set vertically laterad of anus, connected ventrally by small sub-anal plate (Fig. 496, 497). Cercus rounded-triangular, fused to postero-ventral edges of dorsal plate of segment IX. Median shaft of aedeagus slender, tapered (Fig. 498), with tip deeply cleft (Fig. 499); lateral arms with long, narrow bases each abruptly widened to distal, spatulate tip fringed on dorsal edge with long setae; with small, spiniform, meso-dorsal lobe visible in dorsal aspect (Fig. 500).

Female genitalia. Not known.

Geographical distribution. – This species is known from few, widely separated localities in Alberta, Quebec, and New Hampshire (Fig. 646). In Alberta the single record is from a point along the Bow River Valley in the mountains, in an area of valley-bottom sedge marshes.

I have examined a single male of this species from Alberta; in the Canadian National Collection, Ottawa.

The Subgenus *Paralenarchus* Schmid

This subgenus, three species of which are known from the study area, is characterised in males by clear discontinuity between segment IX and dorsal plate, formed from fused cerci (Fig. 501); median lobes of segment X very long, or reduced.

Lenarchus fautini (Denning), 1949
(Fig. 501-503, 647)

Limnephilus fautini Denning, 1949a:46-47. (Type locality: Libby Flats, Albany County, Wyoming).

Lenarchus fautini; Ross and Merkley, 1952:439. Ross and Spencer, 1952:47.

Lenarchus (Paralenarchus) fautini; Schmid, 1952c:204, 205-207. Schmid, 1955:164. Fischer, 1969:65.

Males of this species are distinguished from males of other species of *Lenarchus* by short,

blunt, rounded claspers (Fig. 501); and by dorsal plate, attached to fused cerci, with deep, rectangular median cleft (Fig. 502). The female is unknown.

Description. – Antennae dark brown, joints yellow; scapes very dark, with slightly lighter, glabrous antero-mesal faces. Vertex of head uniformly black. Thorax dark brown to almost black. Spurs reddish brown. Fore wing length of male 8.6 mm; dark chocolate-brown; irregularly irrorate, especially along anterior edge. Venation identical to *Limnephilus* spp.

Male genitalia. (Specimen from Bow Pass, Banff National Park, Alberta). Segment IX high, narrow, except for large, rounded, latero-anterior lobes (Fig. 501); dorsal strap hardly narrower than remainder. Clasper scoop-like, with concave mesal face; rounded-rectangular in lateral aspect. Median lobes of segment X minute, short, hooked ventrad (Fig. 501, 502). Intermediate lobes massive, each bilobed; mesal lobes heavily sclerotized, dorsally curved, acuminate, black teeth; lateral lobes placoid, curved latero-dorsad to flank cercal bases laterally. Cercus massive, thick, long, fused mesally for half length (Fig. 502); decreased in width, directed weakly postero-laterad distad of fused bases. Median shaft of aedeagus long, slightly narrowed distad, with distinct, discrete distal head (Fig. 503); lateral arms sinuate, of uniform width to widened, bilobed, distal tips; dorso-mesal lobe curved, acuminate; latero-ventral lobe spatulate, fringed distally with short setae.

Female genitalia. Not known.

Notes on biology. – I have collected a single specimen from a small, sedge-fringed, peat-based, alpine pool at 6,878'. Flight season extends from July 17 to August 10.

Geographical distribution. – The known range of this species extends from Great Slave Lake to Alberta and British Columbia (Fig. 647). In Alberta it appears to be confined to alpine situations, but records are too scanty to be certain.

I have examined two males of this species from the study area, and one from farther west in British Columbia.

Lenarchus vastus (Hagen), 1861
(Fig. 504-509, 646)

Limnophilus vastus Hagen, 1861:257-258. (Type locality: Kenai Peninsula, Alaska). Ulmer, 1905a:19. Ulmer, 1907a:44. Essig, 1926:176. Ulmer, 1932:213, 217.

Limnephilus vastus; Hagen, 1864:840. Banks, 1892:363. Banks, 1907a:37. Banks, 1918:19. 20. Betten, 1934:337. Milne, 1935:45, 52. Ross, 1938b:40. Ross, 1944:298. Schmid and Guppy, 1952:42.

Lenarchus vastus; Ross and Spencer, 1952:48. Ross and Merkley, 1952:439. Schmid, 1952c: 193, 194, 199-201. Schmid and Guppy, 1952:42. Morse and Blickle, 1953:98. Schmid, 1955:164. Lindroth and Ball, 1969:138. Fischer, 1969:67.

Limnephilus intermedius Banks, 1918:20. (Type locality: Olympia, Washington). Betten, 1934:336. Ross, 1944:298. Ross and Merkley, 1952:439.

Males of this species are distinguished by very wide dorsal strap (Fig. 504); by long, very thin, tubular dorsal process of claspers; and by long, tapered blades of segment X median lobes. Females are distinguished by almost entirely separated dorsal body and ventro-lateral lobes of segment IX (Fig. 508); and by large, pedicellate, trapezoidal cerci (Fig. 508, 509).

Description. – Antennae brown; scapes darker, with lighter, glabrous, antero-mesal faces. Vertex of head dark brown to black. Thorax dark brown dorsally; laterally reddish brown. Tibiae with alternating dark and light bands. Spurs brown. Fore wing length of male 18.7 mm; dark brown, heavily irrorate; some darker bars posterad of Cu1, with colour intensified by localised patches of black hairs. Venation identical to *Limnephilus* spp.

Male genitalia. (Specimen from Eisenhower Junction, Banff National Park, Alberta; in

Canadian National Collection, Ottawa). Segment IX massive, sub-rectangular in lateral aspect, with large, rounded lobes on antero-lateral edges (Fig. 504); posterior edges sinuate. Clasper at ventral angle of segment IX (Fig. 505), triangular, with long, very narrow dorsal extension with long, thin, tubular dorsal process. Median lobes of segment X long, narrow, tapered blades curved gently dorsad, each with black, minutely dentate dorsal edges (Fig. 504); intermediate lobes massive, thick, twisted plates ventrad of fused cerci (Fig. 504, 505). Cerci massive, fairly short, fused along most of mesal edges (Fig. 506); directed slightly postero-ventrad, with black extremities; somewhat concave on ventral surfaces. Median shaft of aedeagus stout, with wrinkled basal portion (Fig. 507); with distinct, discrete distal head partly recessed into basal part. Lateral arms longer, each of even width, narrow, with cleft tips.

Female genitalia. (Specimen from Eisenhower Junction, Banff National Park, Alberta; in Canadian National Collection, Ottawa). Vulval scale large, triangular in general outline (Fig. 509); with large, rectangular median lobe; lateral lobes with long, rectangular bases, rounded-triangular lobes on distal three-quarters of mesal edges. Segment IX with small, triangular, ventro-lateral lobes connected to acute-triangular (in lateral aspect) dorsal body by very narrow lateral bands (Fig. 508). Supra-genital plate wide, short, rounded. Segment X of two major parts, ventral part wide basally, tapered slightly posterad; posteriorly bilobed (Fig. 509); with ventral carina; dorsal part narrow strap of varied width, bent at right angles, widened laterad; black, pointed distally.

Notes on biology. – Adults of this species are found near smaller mountain or alpine sloughs or ponds fringed with sedges. They have also been collected from low, major valley systems of the Cordillera. The flight season extends from June 6 to August 24.

Geographical distribution. – The known range of this species extends from Alaska to Alberta, Idaho, and California (Fig. 646). In Alberta it is confined to the mountain areas, ranging in altitude from about 3,000' to about 6,800'.

I have examined 28 specimens, nine males and 19 females, from the study area. I have never taken males myself, but many females; all males recorded are in the Canadian National Collection, Ottawa.

Lenarchus brevipennis (Banks), 1899
(Fig. 510-514, 647)

Stenophylax brevipennis Banks, 1899:209. (Type locality: Colorado). Ulmer, 1905a:21. Ulmer, 1907a:50. Ross, 1938b:41.

Anabolia brevipennis; Banks, 1907a:37. Dodds and Hisaw, 1925b:386. Essig, 1926:176. Betten, 1934:356.

Arctoecia brevipennis; Milne, 1935:39, 49.

Limnephilus brevipennis; Ross, 1938b:34. Ross, 1944:298.

Lenarchus brevipennis; Schmid, 1950b:301. Ross and Merkley, 1952:439. Smith, 1965:244.

Lenarchus (Paralenarchus) brevipennis; Schmid, 1952c:201-205, 207. Schmid, 1955:164. Fischer, 1969:65.

Males of this species are distinguishable from males of other species of *Lenarchus* by dorsal plate formed of fused cerci; by dorsal plate with v-shaped median cleft (Fig. 511); by small, pale, thin-bladed, median lobes of segment X (Fig. 510); and by orbicular, distal concavities of cercal mesal surfaces. Females are distinguished by massive vulval scale with short, thin, median lobe (Fig. 514); by discrete, trapezoidal ventro-lateral lobes of segment IX (Fig. 513); and by acute-triangular cerci.

Description. – Antennae brown; antero-mesal faces of scapes lighter, glabrous. Vertex of

head very dark brown, except lighter laterally. Thorax very dark brown throughout. Spurs brown. Fore wing length of male 11.2 mm; pale chocolate-brown; densely and minutely irrorate; costal area clear. Venation not differing significantly from *Limnephilus* spp.

Male genitalia. (Specimen from Lewis Lake, Wyoming; in Illinois Natural History Survey). Segment IX high, relatively narrow, except widened laterally (Fig. 510). Ventro-lateral angles with tapered suture. Clasper small, with large, triangular ventral lobe, small, acuminate, dorsal lobe. Median lobes of segment X small, digitate, thin blades (Fig. 510). Intermediate lobes of segment X massive, folded plates; each meso-distal lobe short, thick, distally black-toothed spike; each latero-basal lobe rectangular in lateral aspect, curved dorsad. Cerci massive, fused along mesal edges for two-thirds of length (Fig. 511); with mesal carina, and orbicular distal concavities. Two short, thin, clavate papillae (Fig. 510, 511) baso-dorsad of cerci. Median shaft of aedeagus massive, thick throughout, with discrete distal head recessed into basal portion (Fig. 512); lateral arms attached to median shaft, not tapered distad, with disto-dorsal lobe curved, spiniform; disto-ventral lobe blunt, fringed with long setae.

Female genitalia. (Specimen from Waterton, Waterton National Park, Alberta). Vulval scale huge; median lobe long, thin, shorter than lateral lobes (Fig. 514); lateral lobes massive, almost trapezoidal. Dorsal body of segment IX high, narrow, merged indistinguishably to acute-triangular cercal lobes (Fig. 513); ventro-lateral lobes discrete, trapezoidal in lateral aspect; small. Supra-genital plate large, slightly angular laterally. Segment X small, recessed into segment IX; essentially cylindrical, with lateral edges incised, ventral surface flat, plate-like.

Geographical distribution. – The known range of this species extends from southern Alberta to Oregon and Colorado (Fig. 647). In Alberta it is known from a single female taken in the far southwest corner of the province.

I have examined two specimens of this species; one male from Wyoming, and a female from the study area.

The Genus *Hesperophylax* Banks

Three species of this genus are known from the study area.

Synopsis of characters. – Head short, very large, eyes large. Spur formula 1,2,2. Wings large, similar to *Limnephilus* spp. except hind wings rather narrow, not indented postero-apically. Fore wings densely pilose, patterned; sub-radial cell with silvered line; distad of cell line trebles in width, tapered gradually to wing tip, silver line bordered with grey or black. Venation of fore wings with weakly disrupted chord, concave, anteriorly oblique to body; hind wing similar.

Male genitalia with narrow segment IX. Cerci very large, blunt, thin, weakly sclerotized. Median lobes of segment X fused as single lobe over membranous anal orifice. Claspers fairly large, not prominent; with long bases narrow; dorsal processes long, slender. Aedeagus fairly large, short, curved dorsad; median shaft slender, simple; lateral arms much shorter, each with short, thick base with two bundles of slender, sclerotized blades.

Female genitalia with dorsal body of segment IX short, weakly developed; ventro-lateral lobes very small, inconspicuous, fused to lateral edges of very large, thick, supra-genital plate. Segment X short, tubular, finely pilose. Cerci long, thin, fused to dorsal surfaces of segment X. Median lobe of vulval scale long, narrow; lateral lobes large, triangular.

Key to the Males of the species of *Hesperophylax* found in Alberta and eastern British Columbia

1a. Clasper long, narrow, acute triangular (Fig. 515, 525); median lobe of segment X

with distinct dorso-anterad hook acuminate 2a

1b. Clasper with truncate tip, dorsal portion of uniform width (Fig. 520); median lobe of segment X not acuminately hooked, clavate... *H. incisus* (Banks), p. 142.

2a.(1a) Disto-dorsal edge of cercus with slight indentation (Fig. 515); clasper base wide throughout entire height ..... *H. occidentalis* (Banks), p. 140.

2b. Cercus without distal indentation (Fig. 525); clasper base evenly tapered ventrad ..... *H. consimilis* (Banks), p. 141.

Key to the Females of species of *Hesperophylax* found in Alberta and eastern British Columbia

1a. Median lobe of vulval scale narrow; at least as long as lateral lobes (Fig. 523, 529) 2a

1b. Median lobe of vulval scale very short, wide, with truncate tip (Fig. 519) ..... *H. occidentalis* (Banks), p. 140.

2a.(1a) Ventro-lateral lobes of segment IX large, irregular, prominent (Fig. 524) ..... *H. incisus* (Banks), p. 142.

2b. Ventro-lateral lobes of segment IX small, barely evident (Fig. 528)..... *H. consimilis* (Banks), p. 141.

Hesperophylax occidentalis (Banks), 1908
(Fig. 515-519, 648)

Platyphylax designata var. *occidentalis* Banks, 1908a:265. Ross, 1938b:41. Flint, 1960:64.
Platyphylax designatus var. *occidentalis*; Betten, 1934:363.
Hesperophylax occidentalis; Banks, 1916:118. Banks, 1918:21. Dodds and Hisaw, 1925b: 386. Neave, 1929:189. Brues, 1930:394. Knowlton and Harmston, 1938:286. Ross, 1938b:33. Banks, 1943:348-349. Ross, 1944:297. Ross, 1947:151. Ross and Spencer, 1952:47. Schmid and Guppy, 1952:42. Schmid, 1955:169. Flint, 1960:64. Denning, 1963:261. Fischer, 1969:86-87.
Hesperophylax designata (Walker) form *occidentalis*; Milne, 1935:26.
Platyphylax designata var. *alaskensis* Banks, 1908a:265. Ross, 1938b:41.
Hesperophylax alaskensis; Ross, 1938b:32.
Hesperophylax designata (Walker) form *alaskensis*; Milne, 1935:26.
Grammotaulius designatus (Walker) form *occidentalis*; Milne, 1935:26, 51.

The major distinguishing characters of the two sexes of this species are given in the above keys.

Description. – Antennae brownish yellow; antero-mesal faces of scapes glabrous. Vertex of head yellow-brown. Thorax reddish orange. Spurs yellow-brown. Fore wing length of male 14.8 mm; pale yellow, with longitudinal silver line. Venation as in *Limnephilus* spp.

Male genitalia. (Specimen from Logan, Utah; in Illinois Natural History Survey). Postero-dorsal edge of tergum VIII minutely spinate. Dorsal strap of segment IX thin, warped antero-mesally round cercal bases (Fig. 515). Main body of segment spindle-like in lateral aspect. Clasper with high, wide base; large, acute-triangular. Median lobe of segment X in lateral aspect widened distally, tapered abruptly to dorso-anterad directed, acuminate tip; posterior aspect as in Fig. 516. Cercus large, concave on mesal face, with distinct indentation on distal edge. Median shaft of aedeagus bent dorso-posterad at mid-point, at about 45°; lateral arms with dorsal cluster of close-packed spines curved dorso-anterad (Fig. 517), each with two small, separate groups of ventral spines; the whole attached to wide, membranous base.

Female genitalia. (Specimen from High River, Alberta). Vulval scale equilateral-triangular in ventral aspect (Fig. 519); median lobe shorter than large triangular lateral lobes. Dorsal body of segment IX high, thin, indistinguishable from segment X; ventro-lateral lobes small, irregular, setose ventrally (Fig. 518). Supra-genital plate large, with rectangular base, triangular posterior edge. Segment X cylindrical, deeply cleft ventrally, with disto-dorsal angles flanged laterally. No evident cercal lobes.

Geographical distribution. – The known range of this species extends from Alberta and British Columbia to California and New Mexico (Fig. 648). It is known from a single locality in the plains of southwestern Alberta.

I have examined two specimens of this species, one of each sex.

Hesperophylax consimilis (Banks), 1900
(Fig. 525-529, 648)

Limnophilus consimilis Banks, 1900a:253. (Type locality: South Park, Colorado). Ulmer, 1905a:19. Ulmer, 1907a:44. Essig, 1926:175.

Limnephilus consimilis; Ross, 1938b:35. Banks, 1907a:36. Betten, 1934:336.

Hesperophylax consimilis; Milne, 1935:26, 51. Knowlton and Harmston, 1938:286. Ross, 1938b:32. Ross, 1944:297. Ross, 1947:152. Schmid, 1955:169. Fischer, 1969:82.

Grammotaulius consimilis; Milne, 1935:51.

The major distinguishing characteristics of each sex of this species are outlined in the keys above.

Description. – Antennae yellow; scapes slightly darker with glabrous, antero-mesal faces. Vertex of head reddish yellow. Thorax light reddish yellow, with mesonotum flanked by dark brown bars. Spurs yellow. Fore wing length of male 8.1 mm; light reddish yellow, with longitudinal silver line. Venation identical to *Limnephilus* spp.

Male genitalia. (Specimen from Little Bow Creek, High River, Alberta). Postero-dorsal edge of tergum VIII sparsely clothed with short setae. Dorsal strap of segment IX very thin, incomplete dorsally; main body of segment spindle-shaped (Fig. 525). Clasper with wide base tapered evenly ventrad; dorsal process long, thin, tapered distad, acuminate. Median lobe of segment X with dorso-anterad process acuminate; with membranous folds about anus; high, narrow, triangular in posterior aspect (Fig. 526). Cercus large, polygonal, with concave mesal face. Median shaft of aedeagus much longer than lateral arms (Fig. 527), curved gently dorsad; lateral arms of dorsal sheaf of spines, several separate ventral spines; spines long, lamellar; attached to membranous base.

Female genitalia. (Specimen from Little Bow Creek, High River, Alberta). Vulval scale equilateral-triangular (Fig. 529); median lobe long, narrow, tapered evenly distad, rounded; lateral lobes acute-triangular, with carinae bisecting anterior angles. Dorsal body of segment IX small, high, narrow, separated from segment X by posterior declivity (Fig. 528); ventro-lateral lobes barely visible in lateral aspect, small. Segment X large, plate-like over anal aperture, bilobed, rounded, with distinct lateral lobes. No evident cerci. Supra-genital plate semicircular.

Notes on biology. – Adults of this species are collected near creeks of varied velocities, from mountain streams to sedge-choked plains streams. Flight season ranges from June 10 to August 15.

Geographical distribution. – The known range of this species extends from Alberta to Nevada (Fig. 648). In Alberta it is found primarily in the plains region, but has been taken at 5,000' altitude at Cameron Creek, Waterton National Park.

I have examined 24 specimens, 18 males and six females, from the study area.

Hesperophylax incisus (Banks), 1943
(Fig. 520-524, 649)

Hesperophylax incisus Banks, 1943:348. (Type locality: Wallace, Idaho). Ross, 1944:297. Ross, 1947:151. Ross and Spencer, 1952:47. Schmid, 1955:169. Flint, 1960:64. Denning, 1963:260. Fischer, 1969:85-86.

The major distinguishing characters are outlined in the keys to the species of *Hesperophylax.*

Description. – Antennae light yellow-brown; each article with distinct brown band distally; scapes darker, antero-mesal faces lighter, glabrous. Vertex of head light to dark brown; warts lighter. Thorax reddish brown, with darker brown laterally on mesonotum. Spurs yellowish brown. Fore wing length of male 12.7 mm; light brown, darker postero-basally; with longitudinal, silver line. Venation as in *Limnephilus* spp.

Male genitalia. (Specimen from Simpson Islands, Great Slave Lake, Northwest Territories). Postero-dorsal edge of tergum VIII lightly setose. Dorsal strap not developed, replaced by web of membrane (Fig. 520); main body of segment narrow, spindle-shaped. Clasper long, slender, of uniform width distally, with rectangular tip. Median lobe of segment X blunt, rounded distally; tripod-like in posterior aspect, high, narrow (Fig. 521). Cercus large, with disto-dorsal indentation; tip curved mesad (Fig. 521). Median shaft of aedeagus straight, thin basally, turned abruptly dorsad at 45° for final third of length; lateral arms each of single, large cluster of lamellate spines curved dorsad (Fig. 522).

Female genitalia. (Specimen from Simpson Islands, Great Slave Lake, Northwest Territories). Vulval scale with long, rectangular median lobe (Fig. 523); lateral lobes directed postero-laterad, each triangular, narrow. Dorsal body of segment IX high, narrow, tapered ventrad; ventro-lateral lobes large, prominent (Fig. 524). Supra-genital plate large, square, rounded distally. Segment X large, separated from segment IX by shallow declivity; with ventrad curtains lateral of anal aperture; laterally with warped, large, rounded lobes (Fig. 523, 524). No evident cerci.

Notes on biology. – Adults of this species are collected near lakes, and occasionally slow, gravelly streams. The flight dates extend from June 30 to August 30.

Geographical distribution. – The known range of this species extends from Great Slave Lake to California and Colorado (Fig. 649). In Alberta it is confined to the mountains and foothills, ranging in altitude to 6,450'. An outlying population is found in the Cypress Hills in southeastern Alberta.

I have examined 165 specimens, 113 males and 52 females, from the study area and Great Slave Lake.

The Tribe Stenophylacini Schmid

Synopsis of characters. – Head short, very large, with large, prominent eyes. Pronotum short; macrochaetae fine. Spur formula 1,2,2; 1,3,3; or 1,3,4; and 0,3,4 in males of some species. Male anterior femur of most species with brushes. Wings very varied; sexually dimorphic. Fore wings apically truncated; hind wings somewhat indented postero-apically, with large anal areas. Venation constant in most taxa. Fore wing chord only slightly disrupted, concave and posteriorly oblique to body. Hind wing chord markedly disrupted, very oblique posteriorly.

Male genitalia less massive than in Limnephilini; more varied. Tergum VIII finely spinate. Segment IX slightly enlarged laterally, tapered dorsad. Cerci with little ventral support. Intermediate appendages not large, spur-like in most species, directed dorsad; paired except

in *Clostoeca* Banks. Claspers varied in size; rarely armed or toothed; not as prominent as in Limnephilini. Aedeagus very varied, median shaft long, simple, non-membranous. Lateral arms simple filaments to spinate, dentate plates.

Female genitalia with segment IX composed of two quite distinct parts in most species; dorsal body large, without appendages; ventro-lateral lobes prominent, produced laterad or posterad. Segment X simple, continuous prolongation of segment IX; entirely cleft to two lateral, ventral, and dorsal parts, or not. Supra-genital plate present or absent. Vulval scale medium or small, variable; three lobes often of different sizes; lateral lobes fused to sternum VIII.

Key to the Males of genera of Stenophylacini found in Alberta and eastern British Columbia

1a.	Maxillary palpus very long	*Chyranda* Ross, p. 143.
1b.	Maxillary palpi normal	2a
2a.(1b)	Clasper ventrad on segment IX, projected (Fig. 545)	*Philocasca* Ross, p. 147.
2b.	Clasper long, projected little, vertical (Fig. 535, 540)	*Pycnopsyche* Banks, p. 144.

The Genus *Chyranda* Ross

One species of this genus is known from the study area.

Synopsis of characters. – Antennae fine, longer than fore wings in male; much shorter in female. Maxillary palpi of male remarkably long, with very small basal article; female palpi normal. Spur formula 1,3,3. Male wings narrow, long; female wings wide, short.

Male genitalia with short segment IX. Cerci, median lobes of segment X of average size; thin, vertically oriented to form deep cavities. Claspers very large, fused to segment IX, not projected. Aedeagus very small; lateral arms spiniform, asymmetrical.

Female genitalia with dorsal body of segment IX short. Segment X small, produced as two large, dorsal, and one very small, ventral, lobes. Supra-genital plate small. Vulval scale of two lateral lobes separated by median cleft.

Chyranda centralis (Banks), 1900
(Fig. 530-534, 650)

Asynarchus centralis Banks, 1900a:253-254. (Type locality: South Park, Colorado). Ulmer, 1905a:20. Ulmer, 1907a:48. Ross, 1938b:29. Knowlton and Harmston, 1939:285. Ross, 1941a:111.

Parachiona centralis; Banks, 1907a:39. Dodds and Hisaw, 1925b:386. Essig, 1926:176.

Algonquina centralis; Milne, 1935:30, 49.

Chyranda centralis; Ross, 1944:283, 299. Denning, 1948c:121. Ross, 1949b:123. Schmid, 1951:223-226. Schmid and Guppy, 1952:42. Ross and Spencer, 1952:48. Schmid, 1955:190. Denning, 1963:259. Wiggins, 1963:105-107. Lindroth and Ball, 1969:138. Fischer, 1969:221-223.

Chyranda cordon Ross, 1949b:122-124. (Type locality: Oregon). Schmid, 1951:224-226.

Asynarchus pallidus Banks, 1903:242. (Type locality: South Park, Colorado). Ulmer, 1905a:20. Ulmer, 1907a:48. Ross, 1938b:29.

Parachiona pallidus; Banks, 1907a:39. Essig, 1926:176.

Algonquina pallida; Betten, 1934:370.

Chyranda pallida; Milne, 1935:49. Ross, 1944:299.

Chyranda parvula Denning, 1948c:121. (Type locality: Quebec). Schmid, 1951:224, 226.

Parachiona signata Banks, 1907b:120-121. (Type locality: Idaho).
Parachiona signatus; Banks, 1907a:39. Essig, 1926:176.
Algonquina signata; Betten, 1934:370.
Chyranda signata; Milne, 1935:49. Ross, 1944:299.

Males of this species are distinguished by short, high, mesally directed claspers (Fig. 530); by left lateral arm of aedeagus corkscrewed dorsally over aedeagal tip (Fig. 531); and by cercal bases very little in contact with segment IX. Females are distinguished by segment X well separated from segment IX (Fig. 533); and by massive, bilobed vulval scale (Fig. 534).

Description. – Antennae warm reddish brown; scapes banded vertically, alternately black and yellow; scapes with antero-mesal faces very dark brown, glabrous. Vertex of head dark brown, except for warts. Thorax bright yellowish brown. Spurs light brown. Fore wing length of male 12.9 mm; pale yellow to light brown. Venation identical to *Limnephilus* spp.

Male genitalia. (Specimen from Sunwapta Pass, Jasper National Park, Alberta). Dorsal strap of segment IX very thin, almost to point of extinction dorsally (Fig. 530); main body of segment high, narrow, trapezoidal in lateral aspect. Clasper short, parallelogram-like in lateral aspect, with thin, acuminate dorsal angle; directed mesad (Fig. 532). Median lobes of segment X short, slightly tapered, blunt, rounded, with concave lateral faces. Cercus large, rounded, mesally concave flap. Median shaft of aedeagus short, stout, attached to membranous base (Fig. 531); lateral arms asymmetrical; left arm in form of corkscrew, curved dorsad over aedeagal tip.

Female genitalia. (Specimen from Sunwapta Pass, Jasper National Park, Alberta). Vulval scale massive, angular, with only two lobes, both lateral (Fig. 534). Dorsal body of segment IX large, high, narrow, curved (Fig. 533), of uniform width; ventro-lateral lobes distinct, but fused to dorsal body, triangular. Supra-genital plate semi-circular, hyaline, membranous, small. Segment X of two lateral, ear-like flaps; open dorsally; connected ventrally by warped plate with semi-circular projection between lateral plates.

Notes on biology. – Adults of this species are found near mountain ponds with heavy sedge growth, and occasionally mountain streams of some rapidity. They are also taken on seepage slopes on valley sides. Flight dates range from July 19 to October 8.

Geographical distribution. – The known range of this species extends from Alaska to Oregon, Colorado, and Quebec (Fig. 650). The Quebec record is curiously isolated, and may be of interest. In Alberta the species occurs in the mountains, foothills, and the Cypress Hills. Specimens have been found at altitudes as high as 6,880'.

I have examined 220 specimens, 118 males and 102 females, from the study area.

The Genus *Pycnopsyche* Banks

Two species belonging to this genus are known from the study area.

Synopsis of characters. – Spur formula 1,2,2; 1,3,3; 1,3,4. Wings not very large, variable in shape. Chord in both fore and hind wings markedly concave.

Male genitalia tergum VIII with posterior edge produced as two dorsal lobes, as two lateral lobes parallel to cerci, or as two dorso-lateral lobes; these lobes are specifically characteristic. Segment IX short, rather attenuated dorsally. Cerci varied, enclosing anal aperture to form horizontal platform. Median lobes of segment X conical or spiniform, or small to vestigial. Claspers vertical, not projected, with high bases fused to segment IX, and well developed dorsal processes. Aedeagus small; median shaft large, membranous; lateral arms each with bulbous base and group of fine spines or hairs distally.

Female genitalia with ventro-lateral lobes of segment IX large, blunt, fused to ventral surfaces of segment X. Vulval scale rather conspicuous, single fleshy lobe.

Key to the Males of species of *Pycnopsyche* found in Alberta and eastern British Columbia

1a. Tergum VIII with large, black-spinate, ventro-lateral lobes on posterior edge (Fig. 540); clasper without lamellate dorso-mesal process ..... *P. guttifer* (Walker), p. 146.

1b. Tergum VIII without ventro-lateral lobes of any kind on posterior edge (Fig. 535); clasper with high, thin lamellar process at meso-dorsal edge ..... *P. subfasciata* (Say), p. 145.

Key to the Females of species of *Pycnopsyche* found in Alberta and eastern British Columbia

1a. Segments IX and X solidly fused as simple tube without lobes or processes (Fig. 543) ..... *P. guttifer* (Walker), p. 146.

1b. Segments IX and X distinctly separate (Fig. 538) with dorso-lateral cercal lobes..... *P. subfasciata* (Say), p. 145.

Pycnopsyche subfasciata (Say), 1824
(Fig. 535-539, 651)

Phryganea subfasciata Say, 1824:308. Say, 1825: plate 44. Harris, 1835:582. Say, 1859:97.
Neuronia ? subfasciata; Walker, 1852:11.
Enoicyla subfasciata; Hagen, 1861:269. Hagen, 1864:813.
Platyphylax subfasciatus; McLachlan, 1871:110. Hagen, 1873a:296. Provancher, 1878a: 146. Ulmer, 1905a:21. Ulmer, 1907b:25-26. Ulmer, 1907a:54. Vorhies, 1909:678-681. Muttkowski, 1918:404, 475, 478, 480. Betten, 1926:529. Betten, 1934:351-352.
Platyphilax subfasciatus; Provancher, 1877:259-260. Provancher, 1878b:135.
Platyphylax subfasciata; Banks, 1892:364. Smith, 1900:62. Banks, 1904b:211. Banks, 1907a:39. Snodgrass, 1909:565. Essig, 1926:176.
Allegophylax subfasciata; Banks, 1916:118. Betten and Mosely, 1940:153, 157.
Stenophylax subfasciata; Milne, 1935:32, 52. Elkins, 1936:669-670.
Stenophylax subfasciatus; Milne, 1935:52.
Pycnopsyche subfasciatus; Ross, 1941a:113. Ross, 1944:194-195, 299.
Pycnopsyche subfasciata; Leonard and Leonard, 1949a:20. Betten, 1950:510, 511, 512, 522. Wray, 1950:21. Morse and Blickle, 1953:98. Schmid, 1955:200. Flint, 1960:6, 75. Etnier, 1965:150. Unzicker, 1968:4, 20, 54. Fischer, 1969:307-309.

The major distinguishing characters are given in the keys above.

Description. – Antennae brown; antero-mesal faces of scapes slightly lighter, with fewer setae than remainder. Vertex of head red-brown, warts paler; dark brown spots mesad of each lateral ocellus. Thorax red-brown. Spurs yellow. Fore wing length of male 18.7 mm; light yellow-brown, with distinct darker areas between f2 and f3, and in middle of discoidal, sub-radial and thyridial cells. Venation almost as in *Limnephilus* spp.

Male genitalia. (Specimen from Lethbridge; in Illinois Natural History Survey). Posterior edge of tergum VIII warped, with minute, hyaline spines (Fig. 535); small, acute-triangular lobes ventrad of spinate area. Dorsal strap thread-like in dorsal aspect (Fig. 537); main body of segment IX spindle-shaped with narrow ventral area. Clasper with high, thick base; postero-mesal edge with dorsal process long, lamellar, thin, tapered dorsad, with anteriorly directed distal hook. Median lobes of segment X minute spikes; intermediate lobes smaller, on bases of medians (Fig. 537). Cercus long, thin, narrow, with irregular dorsal edge. Median shaft of aedeagus of varied widths, abruptly narrowed to very thin distal stem (Fig. 536); lateral arms each with swollen base, and single, very slender distal spine.

Female genitalia. (Specimen from Illinois: in Illinois Natural History Survey). Vulval scale large, semi-circular except doubly-indented distally (Fig. 539); single lobe. Dorsal body of

segment IX high, narrow, abruptly declivous posteriorly to segment X (Fig. 538); ventro-lateral lobes minute, rounded. Supra-genital plate large, triangular, with sinuate edges. Segment X tubular, with rounded disto-lateral edges, with small, plate-like dorsal lobe. Cerci small, on dorso-lateral surfaces of segment IX.

Geographical distribution. – The known range of this species extends from Alberta to Illinois and New Hampshire (Fig. 651). It is known from only one locality in Alberta.

I have examined a single male from Alberta, and a single female from Illinois.

Pycnopsyche guttifer (Walker), 1852
(Fig. 540-544, 652)

Halesus guttifer Walker, 1852:16. (Type locality: North America). Hagen, 1861:266. McLachlan, 1863:162. Hagen, 1864:817. Hagen, 1878:295. Banks, 1892:364. Smith, 1900: 62. Ulmer, 1905a:21. Ulmer, 1906:24-25. Ulmer, 1907a:56. Lloyd, 1921:42, 67-68. Sibley, 1926:107, 191, 194, 218. Betten, 1926:529. Muttkowski and Smith, 1929:259. Rawson, 1930:46. Ricker, 1932:88. Ricker, 1934:24-26, 54, 58-59, 61-62, 64-65. Needham and Lloyd, 1937: Fig. 104. Balduf, 1939:153.

Pycnopsyche guttifer; Banks, 1907a:38. Banks, 1907b: plate 9. Döhler, 1915:408-409. Johnson, 1927:49. Banks, 1930b:129. Betten, 1934:309, 348. Ross, 1938b:41. Betten and Mosely, 1940:150-153. Ross, 1941a:113. Ross, 1944:194, 196, 299. Proctor, 1946: 212. Hyland, 1948:39. Leonard and Leonard, 1949a:19. Betten, 1950:510, 511, 512, 516-518. Morse and Blickle, 1953:98. Schmid, 1955:200. Flint, 1960:6, 71, 76, 108, 116. Robert, 1960:59. Wiggins, 1961:700. Etnier, 1965:150. McConnochie and Likens, 1969:150. Fischer, 1969:301-303.

Stenophylax guttifer; Milne, 1935:33, 52. Sprules, 1947:78.

Pychnopsyche guttifer; Milne (D. J.), 1943:192.

Pycnopsyche similis Banks, 1907b:122. (Type locality: Michigan). Banks, 1907a:38. Ross, 1938b:41. Betten and Mosely, 1940:150. Ross, 1944:196, 299.

Halesus similis; Betten, 1926:529. Betten, 1934:349-350.

Halesus species no. 2; Betten, 1901:568-569.

The major distinguishing characters are given in the keys to species above.

Description. – Antennae reddish brown. Vertex of head reddish brown. Thorax yellow to light reddish brown. Spurs darker. Fore wing length of male 17.2 mm; dull greyish brown; distal and anal edges, chord area, and area of bifurcation of M all darker than remainder. Venation identical to that of *Limnephilus* spp.

Male genitalia. (Specimen from La Biche River, Charron Bridge, Alberta). Postero-dorsal edge of tergum VIII thinly spinate; postero-lateral angles developed as black-spinate pads laterad of segment IX (Fig. 540, 541). Dorsal strap of segment IX very fine; main body of segment very narrow, high; spindle-shaped. Clasper with high, relatively wide base; prolonged dorsad as thin, acuminate, dorsally directed blade. Median lobes of segment X minute, peg-like, attached well dorsad of anal aperture, to mesal processes of cerci (Fig. 541). Cercus large, almost square in lateral aspect; mesally concave. Median shaft of aedeagus ventrally straight, dorsally sinuate, with abruptly tapered distal quarter recurved dorsad (Fig. 542); lateral arms attached dorsad of median shaft, each with short basal section terminated in sheaf of four or five fine spines.

Female genitalia. (Specimen from Blindman River, Hwy. 2, Alberta). Vulval scale simple, trapezoidal plate (Fig. 544). Segments IX and X fused, demarcated by slight dorsal declivity (Fig. 543); no ventro-lateral lobes of segment IX. Supra-genital plate triangular, with warped lateral extremities, attached to invagination dorsad of vulval scale (Fig. 544). Segment X

simple, tubular, with slight disto-lateral clefts.

Notes on biology. – Adults of this species are found near larger, fast flowing rivers with pebble bottoms. Flight dates range from August 23 to October 3.

Geographical distribution. – The known range of this species extends from Washington to Newfoundland, North Carolina, and possibly Georgia (Fig. 652). In Alberta it is found in the plains regions.

I have examined a total of one male and six females from the study area.

The Genus *Philocasca* Ross

A single species of this genus is known from the study area; it is here described as new.

Synopsis of characters. – Wings large, rounded; hind wings with very large anal area, R1 fused to Sc. Spur formula 1,3,4; 1,2,4; or 1,2,2.

Male genitalia with very short segment IX not attenuated dorsally. Cerci very large, horizontal plates. Median lobes of segment X ventrad of cerci; large, thick. Claspers blunt, projected, without free parts. Aedeagus entirely membranous, with internal sclerites; lateral arms spiniform.

The following characterisation of the females is derived from an examination of the drawings of females of the various species of *Philocasca* given by Wiggins and Anderson (1968). Segment IX of two parts; dorsal body tapered ventrad; ventro-lateral lobes large, blunt, not projected or contiguous ventrally. Segment X small, bilobed, lobes tapered. Supra-genital plate parabolic, distinct. Vulval scale with short, stubby lateral lobes; no median lobe; two small lobes laterad of lateral lobes.

Philocasca thor Nimmo n. sp.
(Fig. 143a, 143b, 545-547, 653)

Males of this species are similar to those of *Philocasca antennata* Banks (see Fig. 17, Wiggins, 1968), but differ in smaller, more tapered cerci (Fig. 545); in wider median lobes of segment X arched dorsad, evenly tapered; in wider ventral area of segment IX; in longer, slightly tapered claspers; and in larger lateral plates between median lobes and cerci (Fig. 546).

Description. – Antennae pale straw-yellow; scapes dark reddish-brown, with antero-mesal faces pale, setaless. Vertex of head uniform red-brown; all setae hyaline, except for intense black setae of warts at posterior edge of compound eyes. Thorax pale yellow laterally; red-brown dorsally, with slight mesal stripe. Spur formula 1,2,4; spurs red-brown. Fore wing length of male 16.7 mm; pale greyish brown, uniformly and densely irrorate except for much paler costal area. Venation as in Fig. 143a, 143b; quite similar to *Limnephilus* spp.

Male genitalia. (Specimen from alpine meadows east of Mt. Edith Cavell, Jasper National Park, Alberta). Segment IX high, almost acute-triangular as dorsal strap and main body merge almost imperceptibly (Fig. 545). Clasper small, distally triangular, blunt, fused to segment IX, with two distinct tufts of setae. Median lobes of segment X smoothly arched, tapered disto-dorsad; attached to posterior edge of large, hemi-spherical cup in segment VIII (Fig. 546), from which large, short, rounded, slightly tapered cerci arise laterally. Median shaft of aedeagus short, stubby; ejaculatory duct terminated between two smooth, rounded, distal valves (Fig. 547); lateral arms short, stout, black, acuminate, spiniform; aedeagal base surmounted by heavy, black, sclerotized hood. Aedeagal straps from claspers triangular, with meso-ventral interconnection small, hook-like in lateral aspect.

Geographical distribution. – This species is known from a single locality (Fig. 653).

Holotype. – Male. Alpine meadows, east of Mt. Edith Cavell, Jasper National Park, Alberta; July 4, 1965; A. Nimmo. Type number 10,588 in the Canadian National Collection.

This species is named for Thor, a character encountered in my reading of Norse mythology.

The Tribe Chilostigmini Schmid

Synopsis of characters. – Head of most species rather short, large, with very prominent eyes. Pronotum short, with relatively thin macrochaetae. Anterior femora of males with or without brushes. Spur formula 1,1,1; 1,2,2; 1,3,3; or 1,3,4. Wings varied, not sexually dimorphic. Fore wings quite narrow basally, with expanded, rounded, truncated, indented tips. Hind wings much larger than fore wings, indented posterad of apex or not. Venation of fore wings with large, coriaceous stigma in both sexes. R1 strongly arched, connected to Sc by cross-vein or not. R2 arched, parallel to R1. Chord anteriorly oblique to body, disrupted, or almost rectilinear. Posterior wing chord strongly disrupted, very oblique to body posteriorly.

Male genitalia with tergum VIII finely spinate posteriorly or not. Segment IX lengthened laterally; concave in some species. Ventrally produced as plaque ventrad of claspers and aedeagus; dorsally narrow, developed anterad as two lateral, internal cavities. Cerci varied in size; large, sclerotized, or small, flexible, bilobed, and largely fused to bases of intermediate lobes of segment X. Claspers simple, conical, more or less concave on mesal faces; or bipartite, with prominent external lobe, and internal lobe.

Female genitalia with segment IX devoid of appendages; composed of one piece, or with poorly developed ventro-lateral lobes evident. Segment X short, tubular, or composed of two dorsal scales and ventral lobe. Supra-genital plate present or absent. Vulval scale varied in size, but usually very large; trilobed; triangular or quadrangular, concave or thick; lateral lobes large, fused to median basally; median lobe very small.

Key to the Genera of Chilostigmini found in Alberta and eastern British Columbia

1a.	f3 petiolate on fore and hind wings ..... *Phanocelia* Banks, p. 155.
1b.	f3 sessile 2a
2a.(1b)	Chord of fore and hind wings with regular, pronounced zigzag. Apical area very short ..... *Chilostigmodes* Martynov, p. 150.
2b.	Chord of both wings with irregular, weak zigzag. Pronotum sparsely setose 3a
3a.(2b)	Fore wing dusky brown, irrorate, with hyaline patches .... *Glyphopsyche* Banks, p. 148.
3b.	Fore wing reddish, with longitudinal white or silver line .... *Psychoglypha* Ross, p. 151.

The Genus *Glyphopsyche* Banks

A single species of this genus is known from the study area.

Synopsis of characters. – Spur formula 1,2,2. Wings very large; much larger in male than female. Hind wings very large. Fore wing chord virtually rectilinear, parallel to body or slightly oblique anteriorly; incomplete cross-vein between R1 and R2, at apex of discoidal cell.

Male genitalia with postero-dorsal edge of tergum VIII trilobed, densely spinate. Cerci small, bilobed, fused to segment X. Median lobes of segment X fused, curved dorsad. Claspers quadrangular, very prominent. Aedeagus of average size, robust, sclerotized; lateral

arms small, thick.

Female genitalia with dorsal portion of segment IX very short. Ventro-lateral lobes scarcely discernible. Segment X short, tubular, as large as segment IX; segments IX and X indistinguishable. Vulval scale small, quite thick with lateral lobes massive, large; median lobe slender.

Glyphopsyche irrorata (Fabricius), 1781
(Fig. 551-556, 654)

Phryganea irrorata Fabricius, 1781:389. Fabricius, 1787:245. Fabricius, 1793:77.
Enoicyla irrorata; Hagen, 1864:812.
Glyphotaelius ? irrorata; McLachlan, 1864:657-658.
? irrorata; McLachlan, 1871:110.
Platyphylax irroratus; Hagen, 1873a:296.
Ecclisopteryx irrorata; Banks, 1892:364.
Glyphopsyche irrorata; Ulmer, 1906:7-9. Ulmer, 1907a:71. Banks, 1907a:38. Martynov, 1914:257, 260, 263, 265, 266, 267. Betten, 1926:530. Essig, 1926:176. Betten, 1934: 365-366. Betten and Mosely, 1940:171-174. Ross, 1944:200, 299. Leonard and Leonard, 1949a:20. Schmid and Guppy, 1952:42. Schmid, 1952b:20-29. Ross and Spencer, 1952: 48. Lepneva, 1953:418. Morse and Blickle, 1953:99. Schmid, 1955:217. Flint, 1960:84, 110, 116. Robert, 1960:59. Denning, 1963:261. Fischer, 1969:314-315.
Glyphopsyche irroratus; Milne, 1935:24, 50. Ross, 1938b:31.
Glyphopsyche bryanti Banks, 1904b:141-142. (Type locality: British Columbia). Ulmer, 1905a:19. Martynov, 1914:264, 265, 267. Milne, 1935:50. Ross, 1938b:31.
Limnephilus (Goniotaulius) intercissus Walker, 1852:30-31. (Type locality: Canada).
Enoicyla intercissa; Hagen, 1861:268. McLachlan, 1863:158, 162.
Chilostigma intercissa; McLachlan, 1876a:188.
Ecclisopterix intercissa; Provancher, 1877:259. Provancher, 1878a:146.
Ecclisopteryx intercissa; Provancher, 1878b:134-135.
Chilostigma intercisum; Ulmer, 1905a:22.
Glyphopsyche intercissa; Milne, 1935:50. Betten and Mosely, 1940:171-174.

Males of this species are distinguished by peculiar aedeagus (Fig. 553, 554); by trilobed postero-dorsal edge of tergum VIII; and by very prominent claspers (Fig. 551). Females are distinguished by virtual absence of ventro-lateral lobes of segment IX; and by massive unit formed by fused segment IX and X (Fig. 555, 556).

Description. – Antennae light reddish brown; scapes dark brown, with yellow, glabrous, antero-mesal faces. Vertex of head dark brown, posterior edge yellow. Thorax brown to light brown laterally, very dark brown dorsally, with reddish yellow median band except on metathorax. Spurs brown. Fore wing length of male 16.6 mm; greyish chocolate-brown, irrorate, with larger, hyaline patches scattered throughout; costal area lighter. Venation not significantly different from that of *Limnephilus* spp.

Male genitalia. (Specimen from Cold Creek, Nojack, Alberta). Postero-dorsal edge of tergum VIII with fine, short, black spines arranged in rough triangle (Fig. 551, 552). Dorsal strap of segment IX high, narrow, folded anterad; main body of segment irregular, with pyramidal peak, ventral area segregated by lateral folds. Clasper columnar in posterior aspect, with concave distal face flanked by small, semi-circular, knife-like ridge on mesal edge. Median lobes of segment X almost completely fused, black, each set high, hooked anterad; produced ventro-laterad as two lateral straps terminated just dorsad of clasper bases (Fig. 552). Cercus bilobed, smoothly rounded. Large, rectangular, concave shelf with flanged

edges ventrad of anal aperture. Median shaft of aedeagus large, distally cleft, ventrally black plate with lateral edges folded dorsad (Fig. 553, 554); membranous hood dorsad of base with small, short, conical, setose lateral arms.

Female genitalia. (Specimen from Cold Creek, Nojack, Alberta). Vulval scale large, with short, wide median lobe; lateral lobes roughly rectangular, slightly sinuate distally (Fig. 556). Segment IX relatively small, with antero-dorsal prolongation (Fig. 555); channelled ventrally as two ventro-lateral bulges. Supra-genital plate semi-circular, traversed dorsally by fold of membrane. Segment X fused to segment IX, large, with concave depressions dorso-laterally.

Notes on biology. – Adults of this species are found in a variety of habitats, including small, slow streams, but primarily sedge or cattail sloughs, ponds and lakes. The flight dates extend from September 9 to October 4. I also have records from March, April, and May, which, I suspect, represents adults which have overwintered to emerge in periods of warm spring sunlight.

Geographical distribution. – The known range of this species extends from Alaska to California in the west, and New Hampshire in the east (Fig. 654). In Alberta it is found in the plains, foothills, and mountains, but at low altitudes, in the low valleys and passes.

I have examined 37 specimens, 19 males and 18 females, from the study area.

The Genus *Chilostigmodes* Martynov

One species of this genus is known from the study area.

Synopsis of characters. – Spur formula, 1,1,1. Wings quite large; fore wings with quite large, rounded apex; hind wings strongly indented. Fore wing chord close to apex, parallel to body, strongly disrupted; apical cells short. Chord of hind wing clearly disrupted, even closer to apex than in fore wing.

Male genitalia with segment IX elongate laterally. Cerci large, very prominent, convergent, pincer-like; fused basally to segment X. Claspers conical, lanceolate. Aedeagus long, thin; median shaft without basal tubercles; lateral arms very slender.

Female genitalia unknown.

Chilostigmodes areolata (Walker) 1852
(Fig. 548-550, 655)

Limnephilus areolatus Walker, 1852:35. (Type locality: St. Martin's Falls, Albany River, Hudson's Bay).

Enoicyla areolata; Hagen, 1861:267. McLachlan, 1863:162. Hagen, 1864:812. McLachlan, 1876a:207. Banks, 1892:364.

Enoecyla areolata; McLachlan, 1871:110. Banks, 1892:364.

Chilostigma areolatum; McLachlan, 1880:xliii. Ulmer, 1905a:22. Ulmer, 1907a:70. Betten, 1934:366. Betten and Mosely, 1940:164-165. Ross, 1944:299. Schmid, 1952b:94. Krivda, 1961:68-70.

Platyphylax areolata; Banks, 1907a:39.

Chilostigma areolaris; Banks, 1943:353.

Glyphopsyche areolatus; Milne, 1935:24, 50.

Chilostigmodes areolatus; Fischer, 1969:316-317.

Chilostigmodes areolata; Schmid, 1952b:96-97. Schmid, 1955:218.

Description. – Antennae dark brown; antero-mesal faces of scapes almost white, glabrous. Vertex of head totally black. Thorax very dark brown to black. Spur formula 1,1,1; brown.

Fore wing length of male 12.7 mm; membrane hyaline with scattered patches of light grey-brown; veins brown, narrowly flanked by brown membrane. Venation not different from *Limnephilus* spp. except for chord advanced somewhat apically.

Male genitalia. (Specimen from George Lake, near Busby, Alberta). Segment IX large, produced well posterad (Fig. 548); with suture located just below cerci, as continuation of posterior edge. Dorsal strap very low, thread-like (Fig. 549). Clasper with wide base, narrowed rapidly to mid-point, with finger-like distal portion. Median lobes of segment X minute, vertically oriented hooks directed posterad. Horizontal, concave plates laterad of median lobes fused laterally to cercal bases. Cercus large, widened distally, with finger-like disto-ventral process, with concave baso-mesal face. Aedeagus delicate, hyaline; median shaft simple, of uniform width, curved slightly ventrad; orifice of ejaculatory duct in disto-dorsal channel (Fig. 550); lateral arms long, very slender, each tapered distad, with ventrally directed distal spine; attached to dorsal surface of aedeagal base.

Female genitalia. Unknown.

Notes on biology. – This species is known from one locality in the study area which is a large *Typha* lake. Flight dates range from April 27 to May 13, with one record from October 25. It seems that this species emerges in late fall, overwinters, and reappears in early spring.

Geographical distribution. – The known range of this species is represented by scattered records from Alaska to Alberta to Labrador (Fig. 655). In Alberta it appears to be confined to the northern plains and boreal forest.

I have examined 10 males from the study area.

The Genus *Psychoglypha* Ross

Four species of this genus are known from the study area.

Synopsis of characters. – Cephalic and pronotal warts densely hirsute. Spur formula 1,2,2; 1,3,3. Wings quite large; fore wings narrow, truncated, or indented apically; costal area cleft basally. Hind wings fairly large, variously indented. Fore wings characteristically yellowish red with longitudinal silver line along sub-radial and fourth apical cells. Chord of fore wings oblique anteriorly to body, strongly disrupted.

Male genitalia with tergum VIII with one or two black-spinate zones along posterior edge. Segment IX laterally elongate as large, distinct cavity in conjunction with claspers; ventrally segment produced posterad as large shelf. Cerci not large, with two well separated lobes. Median lobes of segment X fairly well sclerotized, of varied size, concave dorsally; fused or connected by membrane; flared dorso-laterad of anal aperture; produced laterad to walls of segment IX. Claspers prominent, concave plates, fused to edges of segment IX with line of fusion indistinct; bilobed, laterally large, mesally small. Aedeagus very long, thin; lateral arms very thin, spiniform; median shaft bilobed distally, bulbous, spinate basally.

Female genitalia with segment IX large; dorsal part large, bilobed, segment X almost completely enclosed; ventro-lateral lobes small, fused to dorsal part as simple lateral flaps. Supragenital plate large. Vulval scale large, thick, quadrangular, with two large, lateral lobes, and very small, median lobe.

Key to the Males of species of *Psychoglypha* found in Alberta and eastern British Columbia

1a. Disto-dorsal portions of median lobes of segment X longitudinally oriented plates (Fig. 572, 578) 2a

1b. Disto-dorsal portions of median lobes of segment X cross-axially oriented, anteriorly concave plates (Fig. 563, 567) 3a

2a.(1a) Disto-dorsal portions of median lobes of segment X smoothly rounded (Fig. 562);

claspers convergent toward median lobes; pattern of spines of tergum VIII as in Fig. 563 ..... *P. prita* (Milne), p. 152.

2b. Disto-dorsal portions of median lobes acuminate in lateral aspect (Fig. 566); claspers parallel to median lobes; pattern of spines of tergum VIII as in Fig. 567 ..... *P. schmidi* Nimmo, p. 153.

3a.(1b) Median lobes of segment X small; segment IX high, narrow (Fig. 572); lateral arms of aedeagus short, thick, asymmetrical (Fig. 575) .. *P. alaskensis* (Banks), p. 153.

3b. Median lobes huge (Fig. 578); segment IX short, wide; lateral arms of aedeagus very long, thin, symmetrical (Fig. 580, 581) ..... *P. ulla* (Milne), p. 155.

Key to the Females of two species of *Psychoglypha* found in Alberta and eastern British Columbia

1a. Segment X small, bell-shaped in lateral aspect (Fig. 570), little projected; lateral lobes of vulval scale in ventral aspect very large, square (Fig. 571)..... ..... *P. schmidi* Nimmo, p. 153.

1b. Segment X larger, acute-triangular in lateral aspect (Fig. 576), well projected posterad; lateral lobes of vulval scale smaller, almost triangular, with sinuate posterior edges in ventral aspect (Fig. 577) ..... *P. alaskensis* (Banks), p. 153.

Psychoglypha prita (Milne), 1935
(Fig. 562-565, 657)

Glyphopsyche pritus Milne, 1935:25, 50. (Type locality: Banff, Alberta).
Psychoglypha prita; Ross, 1944:299. Fischer, 1969:324.
Psychoglypha prithus; Schmid, 1952b:121-123. Nimmo, 1965:783. Denning, 1970:16, 17, 119.
Psychoglypha pritus; Schmid, 1955:222. Smith, 1965:244-245.

Males of this species are distinguishable from males of other species of *Psychoglypha* in the study area by realtively orbicular segment IX in lateral aspect (Fig. 562); by pattern of spines on posterior edge of tergum VIII (Fig. 563); and by cross-axially oriented, anteriorly concave, distally rounded median lobes of segment X. The female is unknown, but probably similar to that of *P. schmidi* Nimmo (Fig. 570, 571).

Description. – Antennae dark brown; antero-mesal faces of scapes yellow, glabrous. Vertex of head almost black, with paler posterior warts. Thorax dark brown. Spur formula 1,2,2; dark reddish brown. Fore wing length of male 18.3 mm; pale orange-brown, irrorate; longitudinal silver line faint, merged with background; costal area clear. Venation not significantly different from *Limnephilus* spp.

Male genitalia. (Specimen from alpine meadows, east of Mt. Edith Cavell, Jasper National Park). Postero-dorsal edge of tergum VIII with short, stout, black spines; less dense anteriorly (Fig. 562, 563), mesally. Dorsal strap of segment IX wide, high, irregular, projected posterad over segment X. Main body of segment curved ventro-posterad, with deep notch on postero-lateral edges. Clasper small, fused to segment IX; directed dorsad toward median lobes of segment X; lateral lobe acuminate in lateral aspect; median lobe short, rounded. Median lobes of segment X directed dorso-posterad; oriented cross-axially, with concave anterior faces, rounded tips. Cercus small, with lanceolate ventral lobe; dorsal lobe simple, lightly setose. Median shaft of aedeagus long, curved dorsad, with distal lobes one-third of length (Fig. 564, 565); ventral surface of shaft minutely spinate; lateral arms each shorter, also curved slightly dorsad, long, thin, tapered to acuminate tips.

Female genitalia. Unknown.

Notes on biology. – The single locality in which I collected adults of this species is a very small, shallow, alpine pool at about 6,800', surrounded by sparse, short sedges. The specimens were all taken on October 3, crawling about on about 2 to 3 feet of fresh snow.

Geographical distribution. – The known range of this species extends from Alberta to Idaho (Fig. 657).

I have examined 17 males from the study area.

Psychoglypha schmidi Nimmo, 1965
(Fig. 566-571, 658)

Psychoglypha schmidi Nimmo, 1965:781-783. (Type locality: Kicking Horse Camp, Yoho National Park, British Columbia). Denning, 1970:17, 20.

Males of this species are distinguishable from males of *P. prita* (Milne) by pattern of spines on posterior edge of tergum VIII (Fig. 567); by claspers parallel to median lobes of segment X (Fig. 566); and by median lobes of segment X with acuminate tips in lateral aspect. Females are distinguishable from those of other species of *Psychoglypha* by small, bell-shaped segment X (Fig. 570); and by large, square, lateral lobes of vulval scale (Fig. 571).

Description. – Antennae orange-brown; scapes dark brown, with creamy, glabrous antero-mesal faces. Vertex of head orange-brown. Thorax dark reddish brown laterally, with pale yellow mesal stripe dorsally. Spur formula 1,2,2; spurs dark orange-brown. Fore wing length of male 20.3 mm; pale to dark orange-brown, faintly irrorate; stigmatic area grey-brown, costal area clear. Venation identical to *Limnephilus* spp.

Male genitalia. (Specimen from Bow Pass, Banff National Park, Alberta). Postero-dorsal edge of tergum VIII very densely clothed with short, black spines; depressed slightly, with two lateral protrusions (Fig. 566, 567). Segment IX relatively small, trapezoidal in lateral aspect. Clasper acute-triangular in lateral aspect, parallel to median lobes of segment X. Median lobes of segment X oriented cross-axially, with concave anterior faces, acuminate disto-anterad hook. Cercus bilobed; ventral lobe thumb-like; dorsal lobe inconspicuous, setose. Aedeagus very similar to that of *P. prita*, above, but lateral arms darker; base of median shaft pinched in (Fig. 568, 569).

Female genitalia. (Specimen from Bow Pass, Banff National Park, Alberta). Vulval scale very large, with massive, almost square lateral lobes (Fig. 571); median lobe very small, conical. Segment IX relatively small, irregular in outline, with ventro-lateral spines internally, directed anterad (Fig. 570); without ventro-lateral lobes. Supra-genital plate inconspicuous, with two median extensions directed posterad; very small. Segment X small, dark brown, bell-shaped in lateral aspect, open ventrally, with short, dorsal strap.

Notes on biology. – Adults of this species are found near small mountain and alpine streams ranging from trickles in alpine meadows to boulder strewn torrents. Flight dates range from September 10 to October 30.

Geographical distribution. – The known range of this species is in the western mountains of Alberta, close to the continental divide, and in British Columbia (Fig. 658). It ranges in altitude from 3,500' to 6,870'.

I have examined 31 specimens, 18 males and 13 females, from the study area.

Psychoglypha alaskensis (Banks), 1908
(Fig. 572-577, 659)

Platyphylax alascensis Banks, 1908a:265. (Type locality: Alaska). Betten, 1934:363. Milne, 1935:26, 51.

Psychoglypha alascensis; Schmid, 1952b:118-121. Schmid and Guppy, 1952:42.
Psychoglypha alaskensis; Schmid, 1952b:118-121. Schmid, 1955:222. Flint, 1960:82, 83, 110, 116. Denning, 1963:261. Anderson, 1967:508, 510-512, 520. McConnochie and Likens, 1969:150. Fischer, 1969:322-323.
Chilostigma subborealis Banks, 1924:441. (Type locality: Alaska). Criddle, 1925:16. Betten, 1934:369. Ross, 1938b:29.
Chilostigma subboreale; Ulmer, 1932:215. Milne, 1935:35, 50.
Glyphopsyche subborealis; Knowlton and Harmston, 1938:285.
Glyphopsyche subboreale; Ross, 1938b:31. Schmid, 1952b:121.
Psychoglypha subborealis; Ross, 1944:202, 299. Leonard and Leonard, 1949a:20-21. Ross and Spencer, 1952:50. Morse and Blickle, 1953:99. Denning, 1970:17, 18.

Males of this species are distinguishable by short, thick, asymmetrical lateral arms of aedeagus (Fig. 574, 575); and by segment IX high, narrow in lateral aspect (Fig. 572). Females are distinguishable by long, projected, acute-triangular segment X (Fig. 576); by vulval scale massive, high, in lateral aspect; and by larger triangular lobes of segment IX laterad of segment IX.

Description. – Antennae pale yellow-brown; antero-mesal faces of scapes glabrous. Vertex of head pale yellow-brown. Thorax straw, to dark brown; dorsum of mesothorax with median, reddish yellow band. Spur formula 1,2,2; spurs dark brown. Fore wing length of male 16.6 mm; pale reddish brown. Venation essentially as in *Limnephilus* spp.; with large, pink stigmatic area.

Male genitalia. (Specimen from Wrigley Harbour, Mackenzie River, Northwest Territories). Postero-dorsal edge of tergum VIII with short, fine, dark brown setae dispersed in pattern shown in Fig. 572. Dorsal strap of segment IX narrow; main body of segment roughly rectangular in lateral aspect; high, narrow. Clasper short, flat posteriorly, fused to segment IX, short, high. Median lobes of segment X small, oriented longitudinally, directed mesodorsad (Fig. 573). Cercus bilobed, ventral lobe large, rectangular, slightly widened distally, setose; dorsal lobe small, bulbous. Median shaft of aedeagus thickset, minutely spinate basoventrally, with short, membranous distal lobes (Fig. 574, 575); lateral arms short, thick, asymmetrical in dorsal aspect (Fig. 575).

Female genitalia. (Specimen from Wrigley Harbour, Mackenzie River, Northwest Territories). Vulval scale large, truncate-triangular in ventral aspect; lateral lobes with lateral angles turned slightly dorsad, rounded, clothed with short setae; median lobe very short, triangular (Fig. 577). Segment IX quite small, sheathed laterally by rounded, triangular cerci (Fig. 576). Supra-genital plate short, very wide, crescentic in ventral aspect; with short setae. Segment X acute-triangular in lateral aspect; deeply incised dorsally; open ventrally.

Notes on biology. – Adults of this species are found near every sort of aquatic habitat from small, slow creeks to very large mountain rivers, and from sedge fringed ponds or sloughs. Flight dates range from September 10 to May 23 of the following year. I have records from the months of September, October, November, January, March, April and May, from the Banff area, collected by N. B. Sanson. Adults probably overwinter. The winter records presumably represent specimens emerging from hiding places in warm weather.

Geographical distribution. – The known range of this species extends from Alaska to Nevada and Michigan (Fig. 659). In Alberta it is found primarily in the mountains, but is also known from a very few localities well east of the mountains, which seem to contain a partly mountain fauna intermixed with a plains fauna. It has been recorded at altitudes up to 5,600'.

I have examined 51 specimens, 18 males and 33 females, from the study area and Northwest Territories.

Psychoglypha ulla (Milne), 1935
(Fig. 578-581, 660)

Glyphopsyche ullus Milne, 1935:24, 50. (Type locality: Wellington, British Columbia).
Psychoglypha ulla; Ross, 1944:299. Ross and Spencer, 1952:50. Schmid and Guppy, 1952: 42. Fischer, 1969:324.
Psychoglypha ullus; Schmid, 1952b:129-132. Schmid, 1955:223.
Psychoglypha alascensis; Denning, 1970:17, 20-22.

Males of this species are distinguished by massive, dorsally directed, longitudinally oriented, median lobes of segment X (Fig. 578); by setose postero-dorsal edge of tergum VIII; and by lateral arms of aedeagus attached well dorsad of median shaft, on membranous base (Fig. 580). Female unknown.

Description. – Antennae yellow; scapes slightly darker, with glabrous antero-mesal faces. Vertex of head red-brown, with yellow posterior warts. Thorax reddish, pale yellow laterally, to red-brown dorsally. Spur formula 1,3,3; dark reddish brown. Fore wing length of male 17.7 mm; stigmatic area pale rose; area anterad of longitudinal silver line pale yellow, with slightly darker areas between veins; immediately posterad of silver line is an area of chocolate brown posterad of which is an area of reddish brown to pale yellow. Venation identical to that of *Limnephilus* spp.

Male genitalia. (Specimen from Kicking Horse Camp, Yoho National Park, British Columbia). Postero-dorsal edge of tergum VIII protuberant, with mesal notch; with short, silky, somewhat hyaline setae. Dorsal strap of segment IX complex, with blunt, posteriorly directed process mesally (Fig. 578, 579); markedly truncate on ventral area. Clasper short, blunt, with concave inner face; with slight lateral flange. Median lobes of segment X large, distally black, oriented in vertical, longitudinal plane. Cercus distinctly bilobed; ventral lobe long, thin, clavate; dorsal lobe thumb-like, setose. Median shaft of aedeagus long, slender, widened slightly from very thin base; distal lobes long, membranous, held close together (Fig. 580, 581); lateral arms very long, thin, each of almost uniform thickness except for acuminate tip; black, attached well dorsad of base of median shaft.

Female genitalia. Unknown.

Notes on biology. – Adults are found near mountain creeks and rivers, with gravel beds. Flight dates of adults range from August 19 to October 3, with one record from May 23, which may be indicative of adult overwintering.

Geographical distribution. – The known range of this species extends from Alaska to California, and east to Alberta, where it appears to be confined to the vicinity of the continental divide (Fig. 660).

I have examined five males from the study area.

The Genus *Phanocelia* Banks

There is a single species in this genus, which is here recorded from Alberta.

Synopsis of characters. – Spur formula 1,2,2. Wings large, narrow, elongate; fore wing rounded apically; hind wing not so large, clearly indented postero-apically. R1 of fore wing poorly arched, united to Sc by cross vein; chord zigzag as in *Chilostigmodes.* Hind wing chord less disrupted than in fore wing.

Male genitalia with tergum VIII slightly cleft mesally, clothed with fairly large spines. Segment IX well developed. Cercus cup-like, horizontal. Median lobes of segment X long, vertical, fused at bases to cerci. Clasper large, massive, concave mesally. Aedeagus large; median shaft thin, unarmed; lateral arms very slender.

Female genitalia with very large vulval scale; median lobe minute; lateral lobes large, triangular, suspended laterally by tapered lateral strap to segment IX. Segment IX large; ventro-lateral lobes evident, fused to dorsal body. Segment X small, recessed into segment IX.

Phanocelia canadensis (Banks), 1924
(Fig. 557-561, 656)

Apatania canadensis Banks, 1924:442. (Type locality: Manitoba). Criddle, 1925:16. Neave, 1934:168. Betten, 1934:380. Ross, 1938b:28. Schmid, 1952b:135.

Glyphopsyche canadensis; Milne, 1935:24, 50. Ross, 1938b:31.

Phanocelia canadensis; Banks, 1943:354. Ross, 1944:201, 300. Schmid, 1952b:136-138. Morse and Blickle, 1953:99. Schmid, 1955:223. Schmid, 1968:693-694. Fischer, 1969: 324-325.

Description. – Antennae dark brown to almost black; scapes short, swollen, with antero-mesal faces lighter, especially in females. Vertex of head black. Thorax very dark brown to black. Spurs almost black, shorter, stouter than usual in Limnephilidae. Fore wing length of male 11.2 mm; clear, tinted dark brown; veins dark brown. Venation not significantly different from that of *Limnephilus* spp.

Male genitalia. (Specimen from 2 miles east of Nordegg, Alberta). Postero-dorsal edge of tergum VIII minutely spiculate on two rectangular, lateral areas. Segment IX narrow, bowed anterad (Fig. 557); dorsal strap narrow, tapered dorsad. Claspers large, each triangular in lateral aspect, with large lateral lobes and minute mesal lobes; fused together at midline of body (Fig. 558). Median lobes of segment X short, rectangular processes curved dorsad from posterior edges of concave basal plates which are partly fused mesally. Cercus small, triangular, fused to segment X (Fig. 557). Median shaft of aedeagus long, thick, of roughly uniform width except for slight distal widening, curved strongly ventrad (Fig. 559); lateral arms attached to membranous pouch dorsad of aedeagal base; long, very slender, curved ventrad, distally acuminate.

Female genitalia. (Specimen from 2 miles east of Nordegg, Alberta). Vulval scale with minute, triangular median lobe; lateral lobes massive, triangular (Fig. 561) suspended from segment IX by tapered lateral strap (Fig. 560). Dorsal body of segment IX large, trapezoidal; ventro-lateral lobes discernible, not entirely discrete; trapezoidal also, fitted at right angles to base of dorsal body; fused ventrally. No evident supra-genital plate. Segment X of two distal lobes of posterior edges of segment IX, and ventral median lobe connected by lateral flanges to lateral lobes.

Notes on biology. – I have taken adults of this species at one locality: a deep, man-made swamp with thick growths of horse-tails (*Equisetum*) throughout, except at deepest parts, and with thick growths of sedges around edges. Dates of capture are September 22 and October 9.

Geographical distribution. – The known range of this species extends from Alberta and Northwest Territories to New Hampshire (Fig. 656). In Alberta it is known only from near Nordegg, at 4,470' altitude.

I have examined seven specimens, four males and three females, from the study area.

Unidentifiable Species of Limnephilidae

Under this title are described the females of five species of Limnephilidae for which no certain identity can be given, even to genus. The males are, of course, unknown, or at least unassociated.

Limnephilidae species 1
(Fig. 582-583, 661)

Description. – Antennae yellow-brown; antero-mesal faces of scapes glabrous. Vertex of head deep red-brown. Thorax deep brownish yellow laterally, deep red-brown dorsally. Spur formula 1,2,4; spurs brown. Fore wing length of female 19.5 mm; light brown, evenly and minutely irrorate; costal area clear. Venation similar to *Limnephilus* spp.

Female genitalia. (Specimen from Rapids Creek, Gap, Alberta). Vulval scale massive, parallelogram-like (Fig. 583); lateral lobes rounded-triangular; median lobe shorter, blunt, rounded distally. Segment IX large dorsally, with ventro-lateral lobes evident but imperceptibly fused to dorsal portion (Fig. 582). Supra-genital plate of medium size, slightly bilobed distally. Segment X deeply cleft mesally, with lateral lobes curved slightly ventrad, rounded dorsally.

Notes on biology. – The single specimen was taken at a concrete culvert over a rocky, fast, smoothly flowing mountain stream on May 7.

Geographical distribution. – The only known locality of this species is at Gap, Alberta, at about 4,250' (Fig. 661).

Limnephilidae species 2
(Fig. 584-585, 661)

Description. – Antennae brown. Vertex of head deep brown. Thorax dark red-brown, to almost black dorsally. Spur formula 1,3,4; spurs brown. Fore wing length of female 13.1 mm; pale greyish brown, faintly irrorate; costal area clear. Venation essentially identical to *Limnephilus* spp.

Female genitalia. (Specimen from Blindman River, at Hwy. 2, Alberta). Vulval scale with median lobe projected well posterad of laterals; strongly tapered distally, with truncate tip; lateral lobes triangular, concave ventrally (Fig. 585). Segment IX high, narrow, spindle-shaped in lateral aspect (Fig. 584); no evident ventro-lateral lobes. Supra-genital plate wide, high, arched dorsad, hyaline. Segment X cylindrical, with black, deeply divided dorsal arch, and clear, bilobed ventral trough which is recessed into dorsal arch.

Notes on biology. – The single female was taken under a concrete bridge over a small, slow, mud-bottom river on August 29.

Geographical distribution. – The locality at which this species was collected is well east of the foothills, in the plains (Fig. 661).

Limnephilidae species 3
(Fig. 144a, 144b, 586-587, 662)

Description. – Antennae light brown, scapes chocolate. Vertex of head deep chocolate-brown. Thorax chocolate-brown, darker dorsally. Spurs pale yellow. Fore wing length of female 6.9 mm; pale grey-brown, with distinct hyaline areas. Venation as in Fig. 144a, 144b.

Female genitalia. (Specimen from 26 miles south of Teepee Creek, Forestry Trunk Road, north of Hinton, Alberta). Vulval scale with median lobe much longer than angular lateral lobes; parallel-sided, rounded distally (Fig. 587). Segment IX high, parallel-sided in lateral aspect (Fig. 586); bowed anterad; without discrete ventro-lateral lobes. Supra-genital plate minute, short, hyaline. Segment X small, cylindrical, fused to segment IX but distinct due to pronounced declivity; cerci long, acute-triangular, fused at bases to dorso-lateral faces of

segment X.

Notes on biology. – The single female specimen was obtained by sweeping long, dense *Equisetum* stands in shallow water of a small swamp, on July 3.

Geographical distribution. – The locality at which this species was taken is in the northwestern foothills of Alberta (Fig. 662).

Limnephilidae species 4
(Fig. 145a, 145b, 588-589, 662)

This species bears a strong resemblance to the females of some species of *Lenarchus* as illustrated by Schmid (1952c), as does the species following (Fig. 590, 591).

Description. – Antennae brown, scapes darker, with antero-mesal faces paler, glabrous. Vertex of head dark chocolate-brown. Thorax dark brown dorsally, slightly lighter laterally. Spur formula 1,3,4; spurs brown. Fore wing length of female 14.1 mm; chocolate-brown, heavily irrorate, with larger areas of hyaline membrane. Costal area hyaline. Venation as in Fig. 145a, 145b.

Female genitalia. (Specimen from Amethyst Lakes, Jasper National Park; collected by H. Goulet). Vulval scale with massive, irregularly rounded lateral lobes (Fig. 589); median lobe short, rounded-rectangular. Segment IX high, wide dorsally, separated from segment X dorsally by weak declivity (Fig. 588); ventro-lateral lobes large, polygonal, not delimited from dorsal body. Supra-genital plate wide, lunate, membranous. Segment X bilobed; roughly triangular in lateral aspect, held roof-like dorsad of anal aperture.

Notes on biology. – The single specimen was taken under a rock close by the sedge pools just east of Amethyst Lakes, in near-alpine meadow, on July 7.

Geographical distribution. – The locality at which this specimen was taken is at 6,450' altitude (Fig. 662).

Limnephilidae species 5
(Fig. 590a-590b, 663)

As with species 4 above, the female described here bears a strong resemblance to females of certain species of *Lenarchus.*

Description. – Antennae red-brown; antero-mesal faces of scapes lighter, glabrous. Vertex of head dark red-brown. Thorax dark red-brown dorsally, lighter laterally. Spur formula 1,3,4; spurs brown. Fore wing length of female 15.0 mm; chocolate-brown, distinctly irrorate, with larger hyaline areas; costal area clear. Venation essentially identical to that of *Limnephilus* spp.

Female genitalia. (Specimen from 3 miles east of Nordegg, Alberta). Vulval scale large, triangular; median lobe slightly tapered, thin, recurved distally (Fig. 590a, 590b); lateral lobes roughly triangular. Segment IX large, wide dorsally; separated from segment X by shallow declivity; ventro-lateral lobes large, triangular, not discrete from dorsal body. Supra-genital plate short, wide, evenly semi-circular. Segment X small, cylindrical at base, surmounted by two large, triangular, roof-like distal lobes held roof-like over anal aperture.

Notes on biology. – The single female was taken from a large man-made pond thick with *Equisetum*, and fringed with thick growths of sedges. Date of capture was August 8.

Geographical distribution. – The species is known from a single locality at Nordegg, Alberta, at 4,470' altitude on the eastern edge of the Rocky Mountains (Fig. 663).

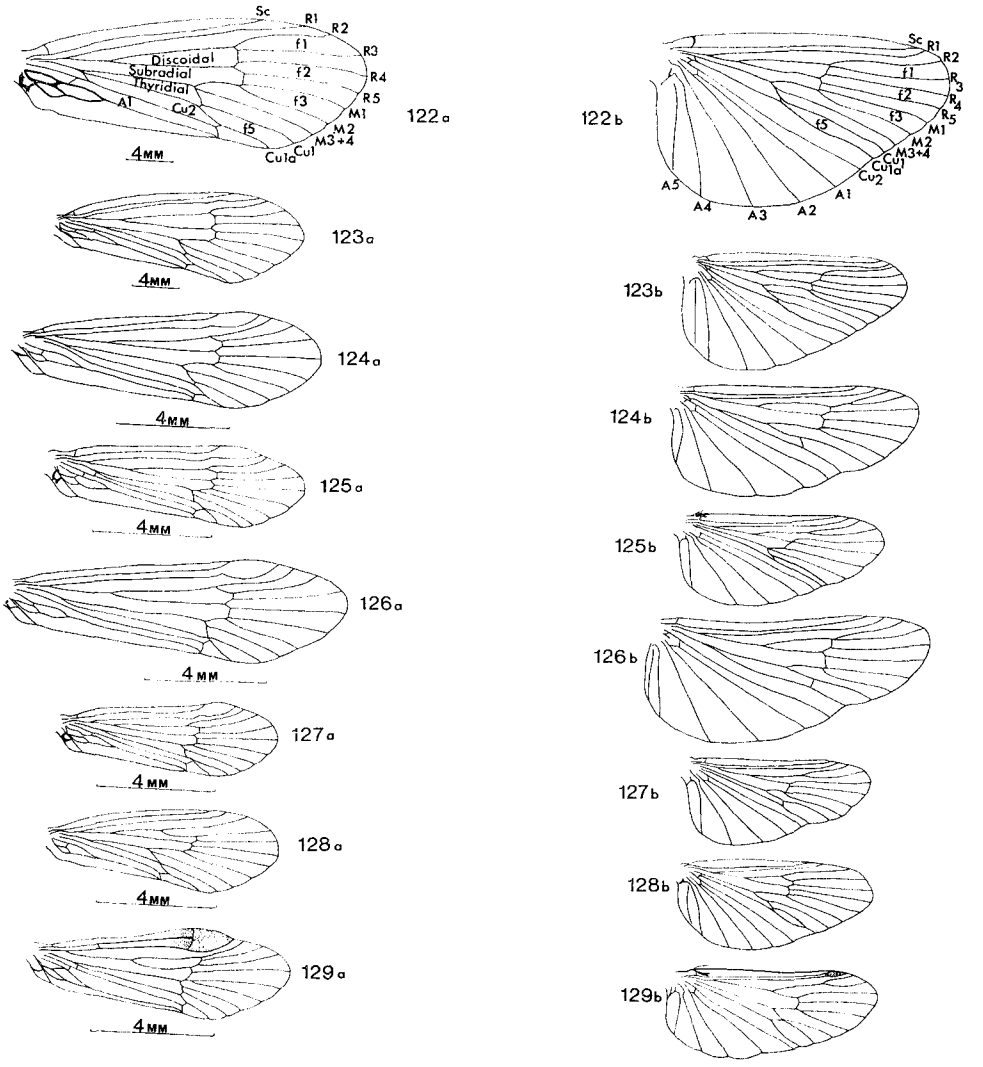


Fig. 122-129. Fore (a) and hind (b) wings of males of species of Limnephilidae. 122. *Discomoecus jucundus* Banks. 123. *Amphicosmoecus canax* (Ross). 124. *Imania cascadis* Ross. 125. *I. bifosa* Ross. 126. *I. tripunctata* (Banks). 127. *I. hector* Nimmo n. sp. 128. *Ecclisomyia maculosa* Banks. 129. *Apatania zonella* (Zetterstedt).

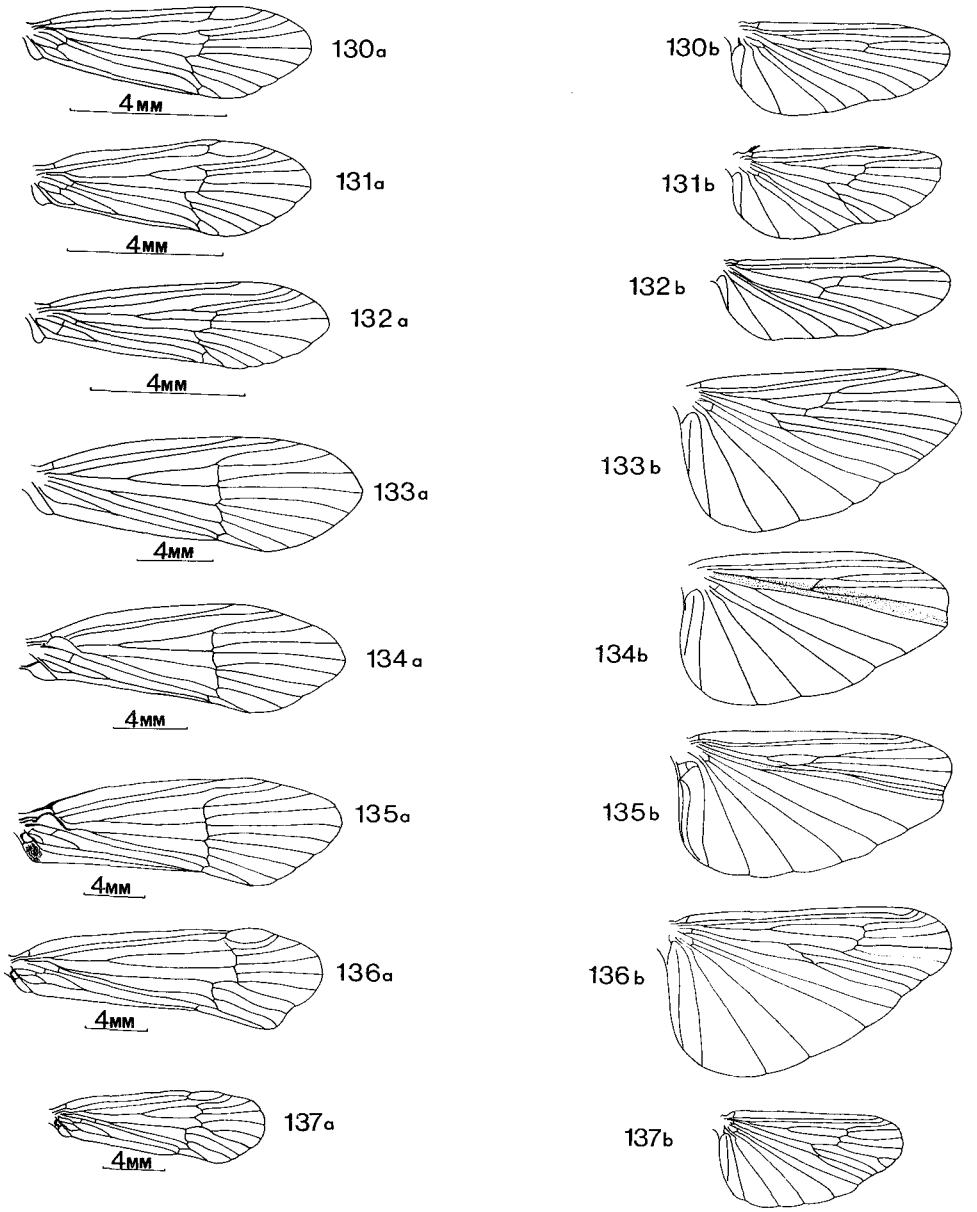


Fig. 130-137. Fore (a) and hind (b) wings of males, and females where indicated, of species of Limnephilidae. 130. *Oligophlebodes ruthae* Ross. 131. *O. ruthae* Ross (female). 132. *Neothremma alicia* Banks. 133. *Homophylax crotchi* Banks. 134. *H. acutus* Denning. 135. *H. baldur* Nimmo n. sp. 136. *Glyphopsyche irrorata* (Fabricius). 137. *Phanocelia canadensis* (Banks).

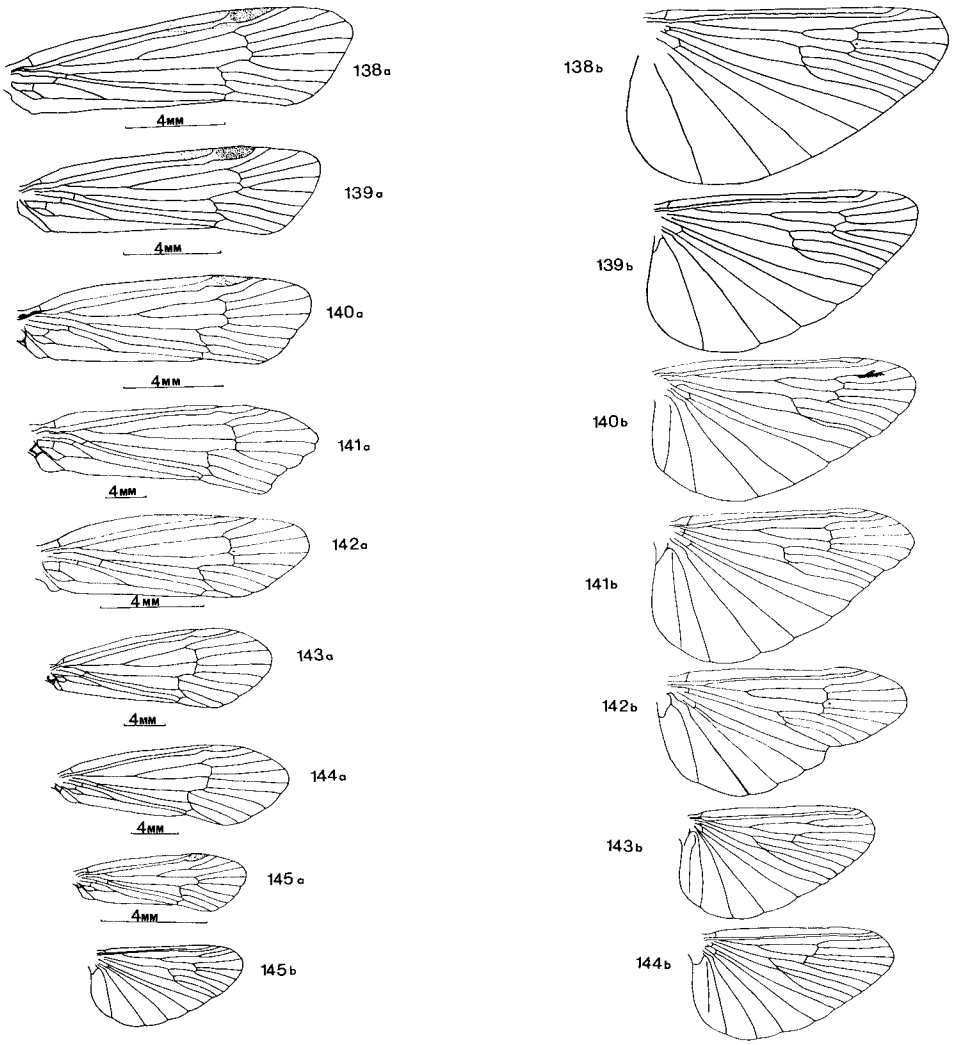


Fig. 138-145. Fore (a) and hind (b) wings of males, and females where indicated, of species of Limnephilidae. 138. *Limnephilus sublunatus* Provancher. 139. *L. partitus* Walker. 140. *L. nigriceps* (Zetterstedt). 141. *Nemotaulius hostilis* (Hagen). 142. *Anabolia ozburni* (Milne). 143. *Philocasca thor* Nimmo n. sp. 144. Limnephilidae species 3 (female). 145. Limnephilidae species 4 (female).

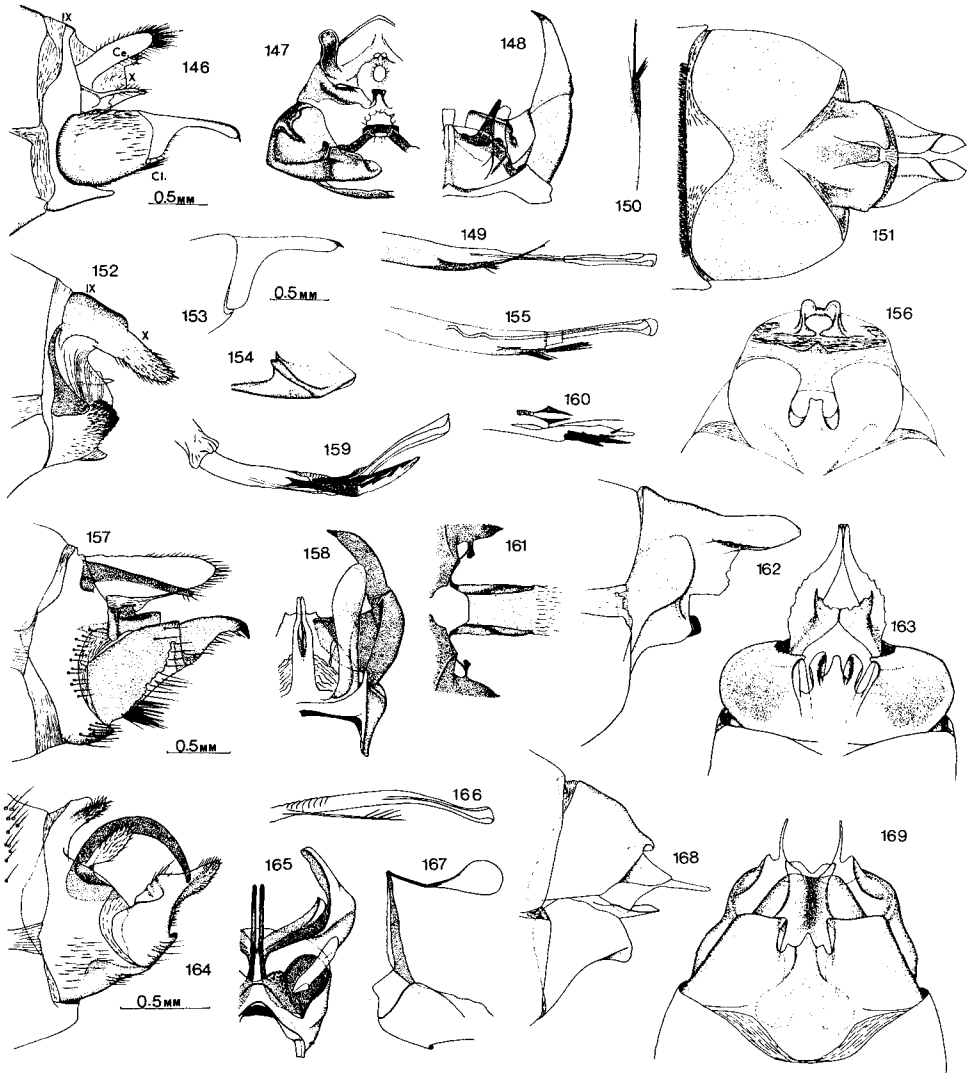


Fig. 146-169. *Dicosmoecus jucundus* Banks, 146. Male genitalia, lateral aspect. 147. Male genitalia, posterior aspect (partial). 148. Male genitalia, dorsal aspect (partial). 149. Aedeagus, lateral aspect. 150. Aedeagus, lateral arm, dorsal aspect. 151. Female genitalia, ventral aspect. 152. Female genitalia, lateral aspect. *D. atripes* (Hagen), 153. Lateral aspect, distal article of clasper, male genitalia. 154. Mesal face of clasper base, posterior aspect. 155. Aedeagus, lateral aspect. 156. Female genitalia, ventral aspect. *Onocosmoecus unicolor* (Banks), 157. Male genitalia, lateral aspect. 158. Male genitalia, dorsal aspect (partial). 159. Aedeagus, lateral aspect. 160. Aedeagus, lateral arm, dorsal aspect. 161. Aedeagal straps and clasper bases, dorsal aspect. 162. Female genitalia, lateral aspect. 163. Female genitalia, ventral aspect. *Amphicosmoecus canax* (Ross), 164. Male genitalia, lateral aspect. 165. Male genitalia, dorsal aspect (partial). 166. Aedeagus, lateral aspect. 167. Right aedeagal strap and clasper base, lateral aspect. 168. Female genitalia, lateral aspect. 169. Female genitalia, ventral aspect. Ce. – Cercus. Cl. – Clasper. Scale bar for each species adjacent to lateral aspect of male genitalia; scale uniform for all drawings of a species. No scale given when only female known.

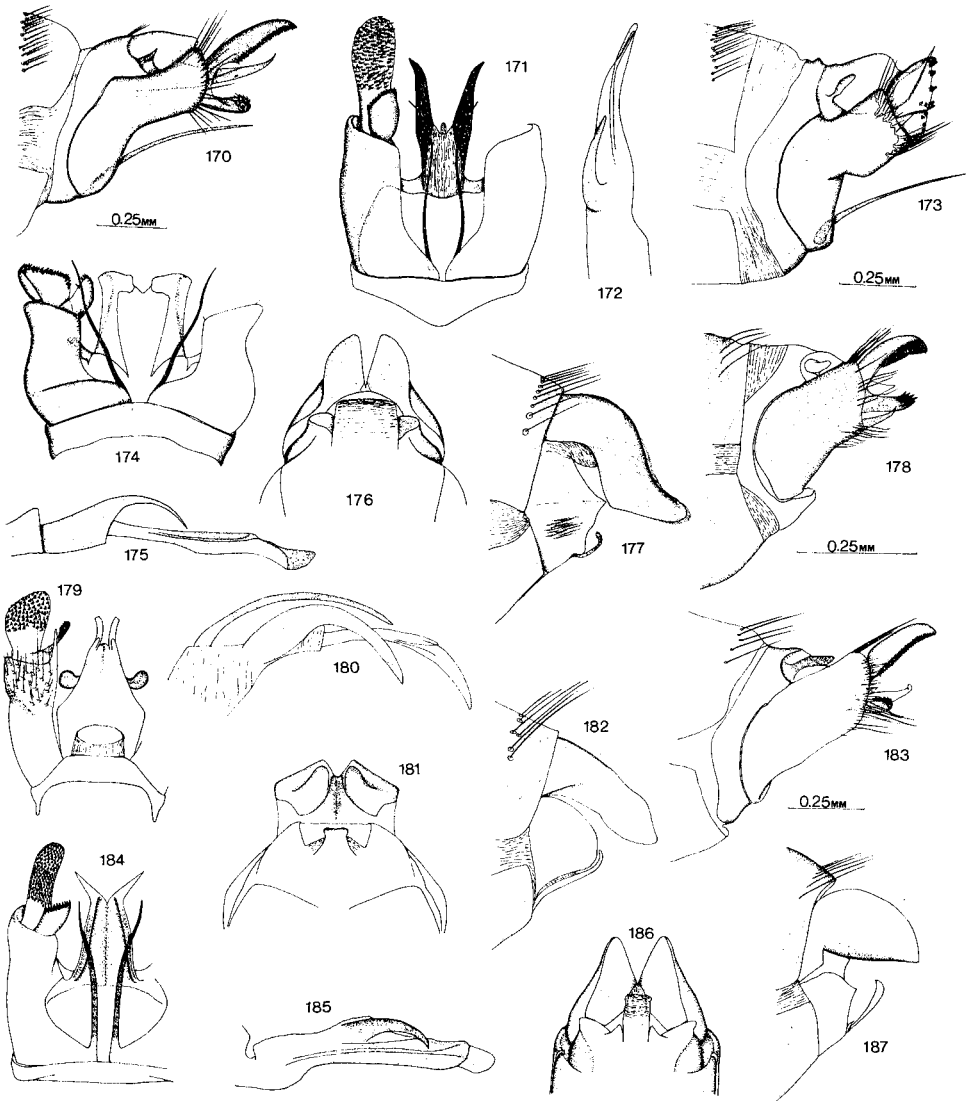


Fig. 170-187. *Imania tripunctata* (Banks), 170. Male genitalia, lateral aspect. 171. Male genitalia, ventral aspect (partial). 172. Aedeagus, lateral aspect. *I. cascadis* Ross, 173. Male genitalia, lateral aspect. 174. Male genitalia, ventral aspect (partial). 175. Aedeagus, lateral aspect. 176. Female genitalia, ventral aspect. 177. Female genitalia, lateral aspect. *I. bifosa* Ross, 178. Male genitalia, lateral aspect. 179. Male genitalia, ventral aspect (partial). 180. Aedeagus, lateral aspect. 181. Female genitalia, ventral aspect. 182. Female genitalia, lateral aspect. *I. hector* Nimmo n. sp., 183. Male genitalia, lateral aspect. 184. Male genitalia, ventral aspect (partial). 185. Aedeagus, lateral aspect. 186. Female genitalia, ventral aspect. 187. Female genitalia, lateral aspect.

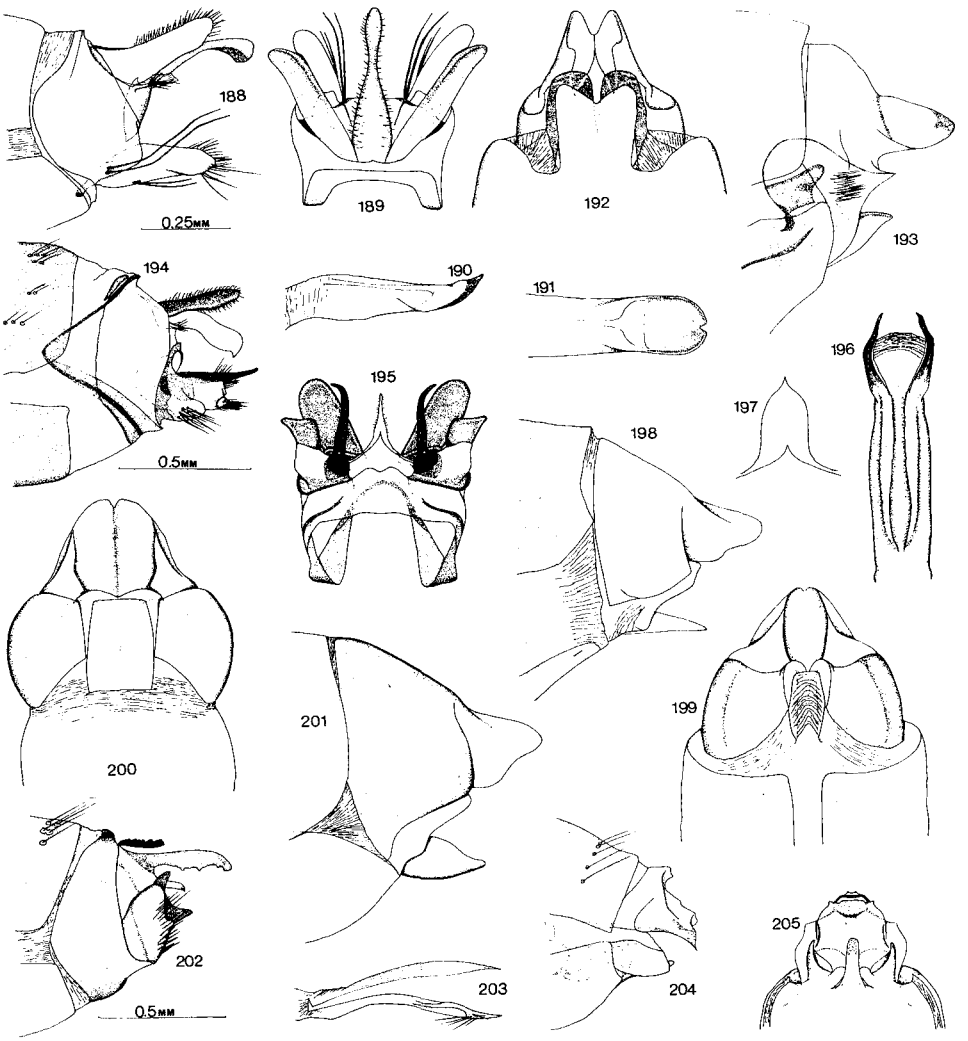


Fig. 188-205. *Ecclisomyia maculosa* Banks, 188. Male genitalia, lateral aspect. 189. Male genitalia, dorsal aspect. 190. Aedeagus, lateral aspect. 191. Aedeagus, dorsal aspect. 192. Female genitalia, ventral aspect. 193. Female genitalia, lateral aspect. *E. conspersa* Banks, 194. Male genitalia, lateral aspect. 195. Male genitalia, ventral aspect. 196. Aedeagus, dorsal aspect. 197. Aedeagal strap, ventral aspect. 198. Female genitalia, lateral aspect. 199. Female genitalia, ventral aspect. *Ecclisomyia* species 1, 200. Female genitalia, ventral aspect. 201. Female genitalia, lateral aspect. *Apatania zonella* (Zetterstedt), 202. Male genitalia, lateral aspect. 203. Aedeagus, lateral aspect. 204. Female genitalia, lateral aspect. 205. Female genitalia, ventral aspect.

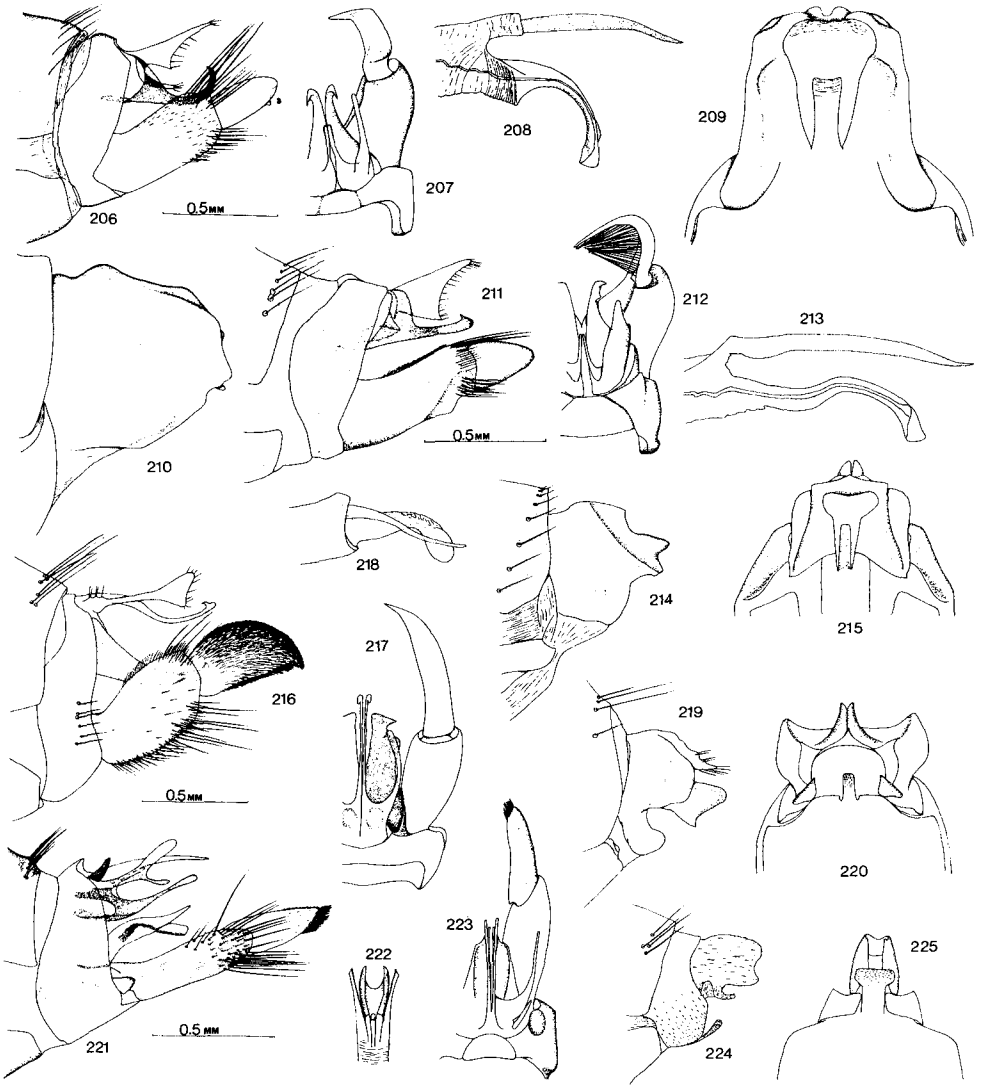


Fig. 206-225. *Apatania shoshone* Banks, 206. Male genitalia, lateral aspect. 207. Male genitalia, dorsal aspect (partial). 208. Aedeagus, lateral aspect. 209. Female genitalia, ventral aspect. 210. Female genitalia, lateral aspect. *A. stigmatella* (Zetterstedt), 211. Male genitalia, lateral aspect. 212. Male genitalia, dorsal aspect (partial). 213. Aedeagus, lateral aspect. 214. Female genitalia, lateral aspect. 215. Female genitalia, ventral aspect. *A. crymophila* McLachlan, 216. Male genitalia, lateral aspect. 217. Male genitalia, dorsal aspect (partial). 218. Aedeagus, lateral aspect. 219. Female genitalia, lateral aspect. 220. Female genitalia, ventral aspect. *A. alberta* Nimmo n. sp. 221. Male genitalia, lateral aspect. 222. Aedeagal tip, dorsal aspect. 223. Male genitalia, dorsal aspect (partial). 224. Female genitalia, lateral aspect. 225. Female genitalia, ventral aspect.

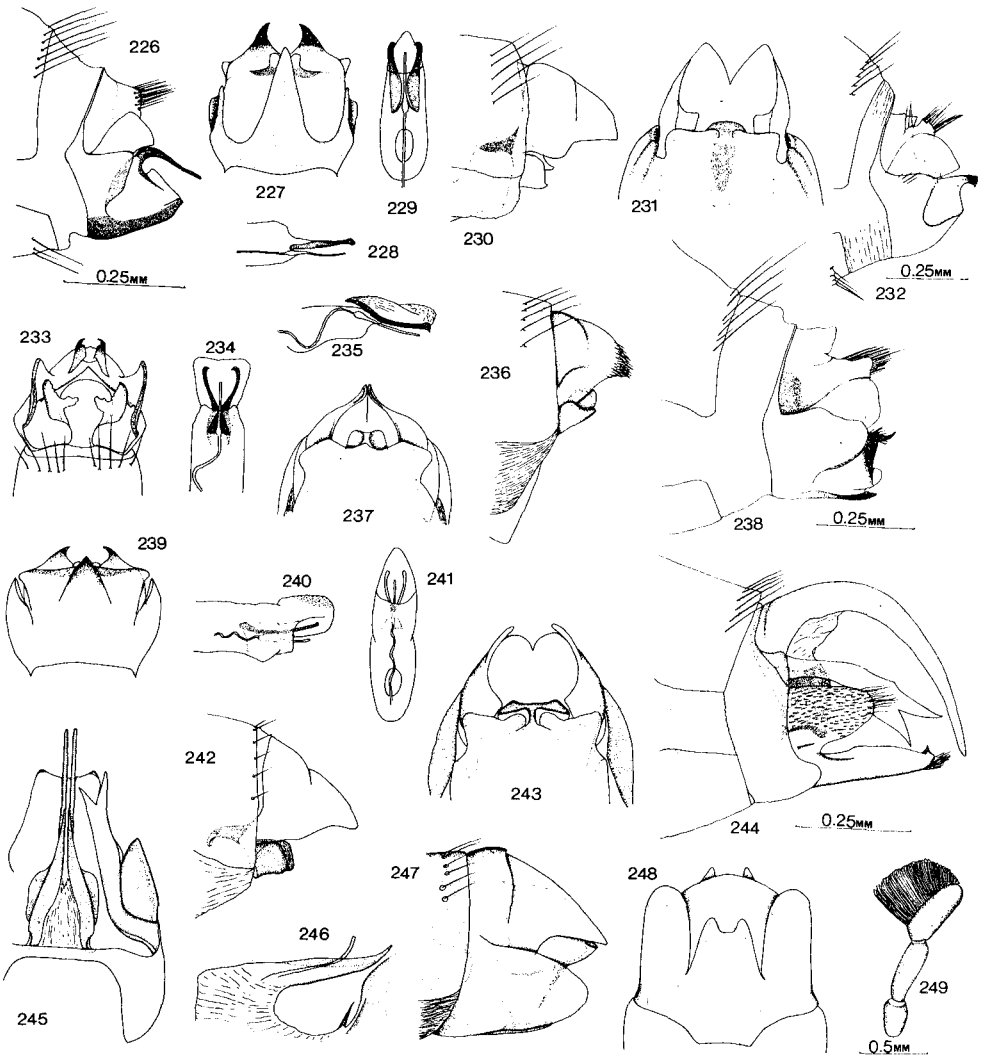


Fig. 226-249. *Oligophlebodes ruthae* Ross, 226. Male genitalia, lateral aspect. 227. Male genitalia, ventral aspect. 228. Aedeagus, lateral aspect. 229. Aedeagus, ventral aspect. 230. Female genitalia, lateral aspect. 231. Female genitalia, ventral aspect. *O. sierra* Ross, 232. Male genitalia, lateral aspect. 233. Male genitalia, dorsal aspect. 234. Aedeagus, ventral aspect. 235. Aedeagus, lateral aspect. 236. Female genitalia, lateral aspect. 237. Female genitalia, ventral aspect. *O. zelti* Nimmo n. sp., 238. Male genitalia, lateral aspect. 239. Male genitalia, ventral aspect. 240. Aedeagus, lateral aspect. 241. Aedeagus, ventral aspect. 242. Female genitalia, lateral aspect. 243. Female genitalia, ventral aspect. *Neothremma alicia* Banks, 244. Male genitalia, lateral aspect. 245. Male genitalia, dorsal aspect (partial). 246. Aedeagus, lateral aspect. 247. Female genitalia, lateral aspect. 248. Female genitalia, ventral aspect. 249. Maxillary palpus of male.

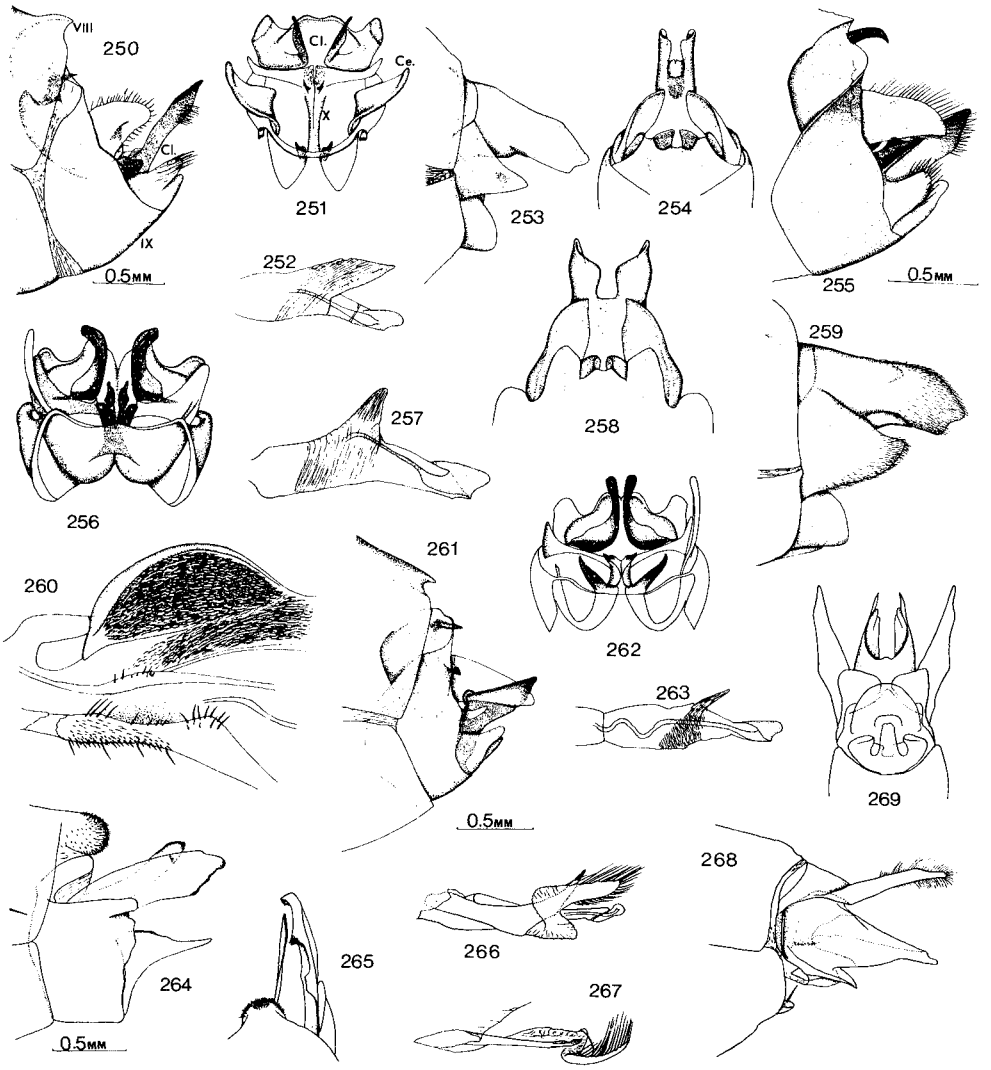


Fig. 250-269. *Homophylax crotchi* Banks, 250. Male genitalia, lateral aspect. 251. Male genitalia, dorsal aspect. 252. Aedeagus, lateral aspect. 253. Female genitalia, lateral aspect. 254. Female genitalia, ventral aspect. *H. acutus* Denning, 255. Male genitalia, lateral aspect. 256. Male genitalia, dorsal aspect. 257. Aedeagus, lateral aspect. 258. Female genitalia, ventral aspect. 259. Female genitalia, lateral aspect. *H. baldur* Nimmo n. sp., 260. Basal flap and scaled pocket at base of wing, male. 261. Male genitalia, lateral aspect. 262. Male genitalia, dorsal aspect. 263. Aedeagus, lateral aspect. *Limnephilus sublunatus* Provancher, 264. Male genitalia, lateral aspect. 265. Male genitalia, dorsal aspect (partial). 266. Aedeagus, lateral aspect. 267. Right lateral arm, dorsal aspect. 268. Female genitalia, lateral aspect. 269. Female genitalia, ventral aspect. Ce. – Cercus. Cl. – Clasper.

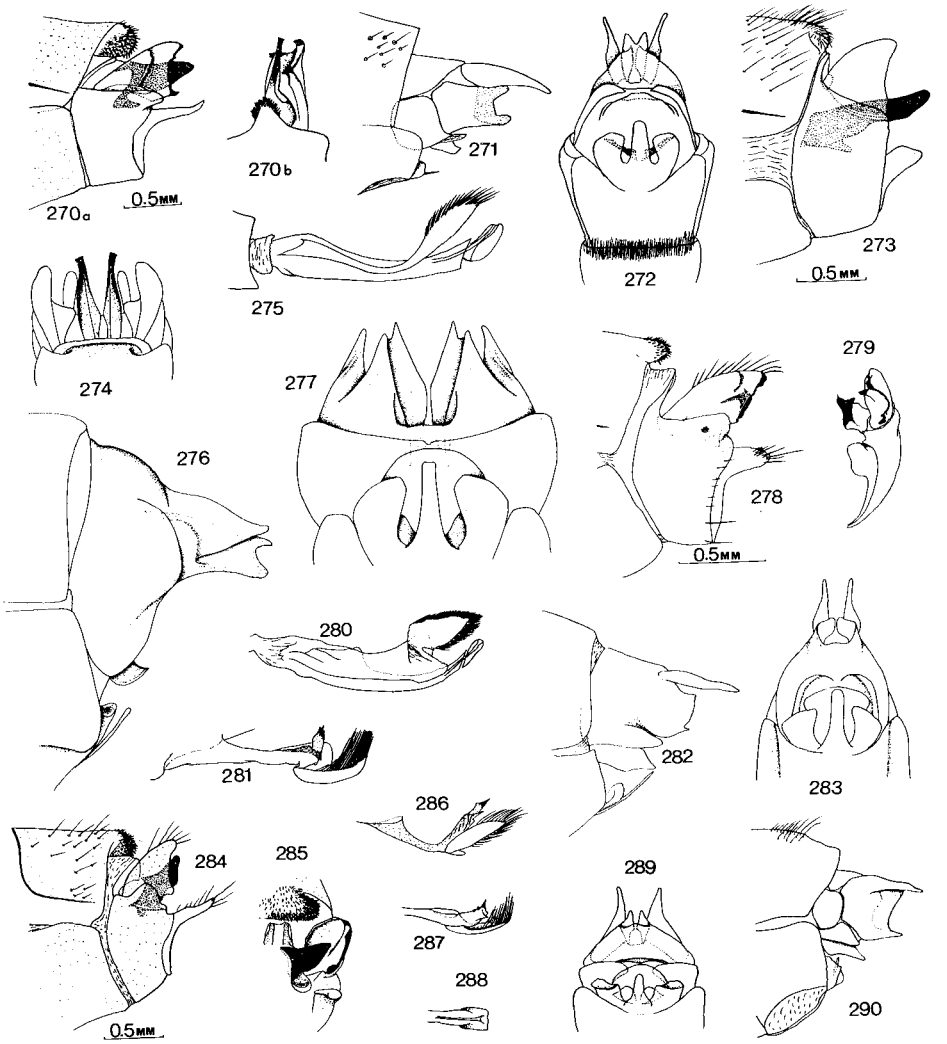


Fig. 270a-290. *Limnephilus sansoni* Banks, 270a. Male genitalia, lateral aspect. 270b. Male genitalia, dorsal aspect (partial). 271. Female genitalia, lateral aspect. 272. Female genitalia, ventral aspect. *L. extractus* Walker, 273. Male genitalia, lateral aspect. 274. Male genitalia, dorsal aspect. 275. Aedeagus, lateral aspect. 276. Female genitalia, lateral aspect. 277. Female genitalia, ventral aspect. *L. hageni* Banks, 278. Male genitalia, lateral aspect. 279. Male genitalia, posterior aspect (partial). 280. Aedeagus, lateral aspect. 281. Right lateral arm, dorsal aspect. 282. Female genitalia, lateral aspect. 283. Female genitalia, ventral aspect. *L. partitus* Walker, 284. Male genitalia, lateral aspect. 285. Male genitalia, posterior aspect (partial). 286. Right lateral arm of aedeagus, lateral aspect. 287. Right lateral arm, dorsal aspect (partial). 288. Tip of aedeagus, dorsal aspect. 289. Female genitalia, ventral aspect. 290. Female genitalia, lateral aspect.

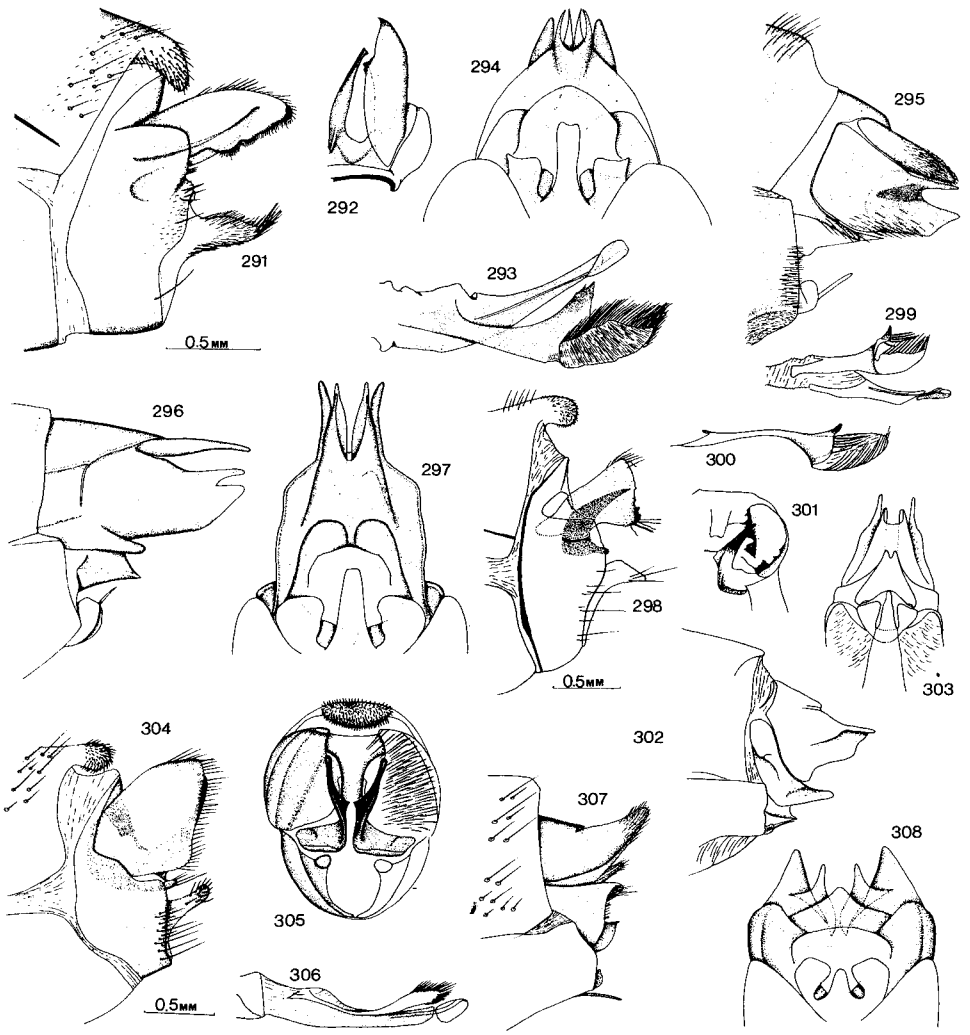


Fig. 291-308. *Limnephilus susana* Nimmo n. sp., 291. Male genitalia, lateral aspect. 292. Male genitalia, dorsal aspect (partial). 293. Aedeagus, lateral aspect. 294. Female genitalia, ventral aspect. 295. Female genitalia, lateral aspect. *L.* species 1, 296. Female genitalia, lateral aspect. 297. Female genitalia, ventral aspect. No scale given. *L. indivisus* Walker, 298. Male genitalia, lateral aspect. 299. Aedeagus, lateral aspect. 300. Right lateral arm of aedeagus, dorsal aspect. 301. Male genitalia, posterior aspect (partial). 302. Female genitalia, lateral aspect. 303. Female genitalia, ventral aspect. *L. infernalis* (Banks), 304. Male genitalia, lateral aspect. 305. Male genitalia, posterior aspect. 306. Aedeagus, lateral aspect. 307. Female genitalia, lateral aspect. 308. Female genitalia, ventral aspect.

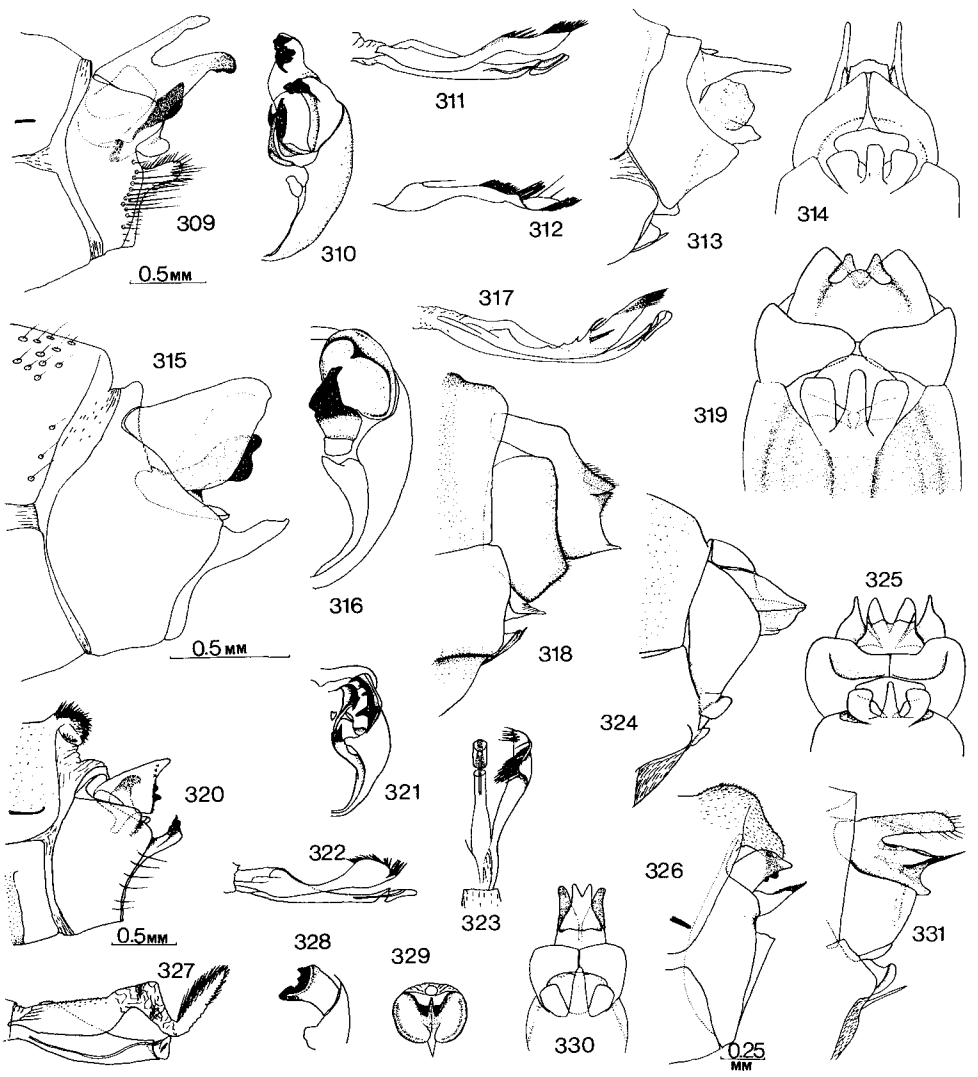


Fig. 309-331. *Limnephilus ornatus* Banks, 309. Male genitalia, lateral aspect. 310. Male genitalia, posterior aspect (partial). 311. Aedeagus, lateral aspect. 312. Right lateral arm of aedeagus, dorsal aspect. 313. Female genitalia, lateral aspect. 314. Female genitalia, ventral aspect. *L. picturatus* McLachlan, 315. Male genitalia, lateral aspect. 316. Male genitalia, posterior aspect (partial). 317. Aedeagus, lateral aspect. 318. Female genitalia, lateral aspect. 319. Female genitalia, ventral aspect. *L. externus* Hagen, 320. Male genitalia, lateral aspect. 321. Male genitalia, posterior aspect (partial). 322. Aedeagus, lateral aspect. 323. Aedeagus, dorsal aspect (partial). 324. Female genitalia, lateral aspect. 325. Female genitalia, ventral aspect. *L. sericeus* (Say), 326. Male genitalia, lateral aspect. 327. Aedeagus, lateral aspect. 328. Left clasper, posterior aspect. 329. Aedeagal tip, distal aspect. 330. Female genitalia, ventral aspect. 331. Female genitalia, lateral aspect.

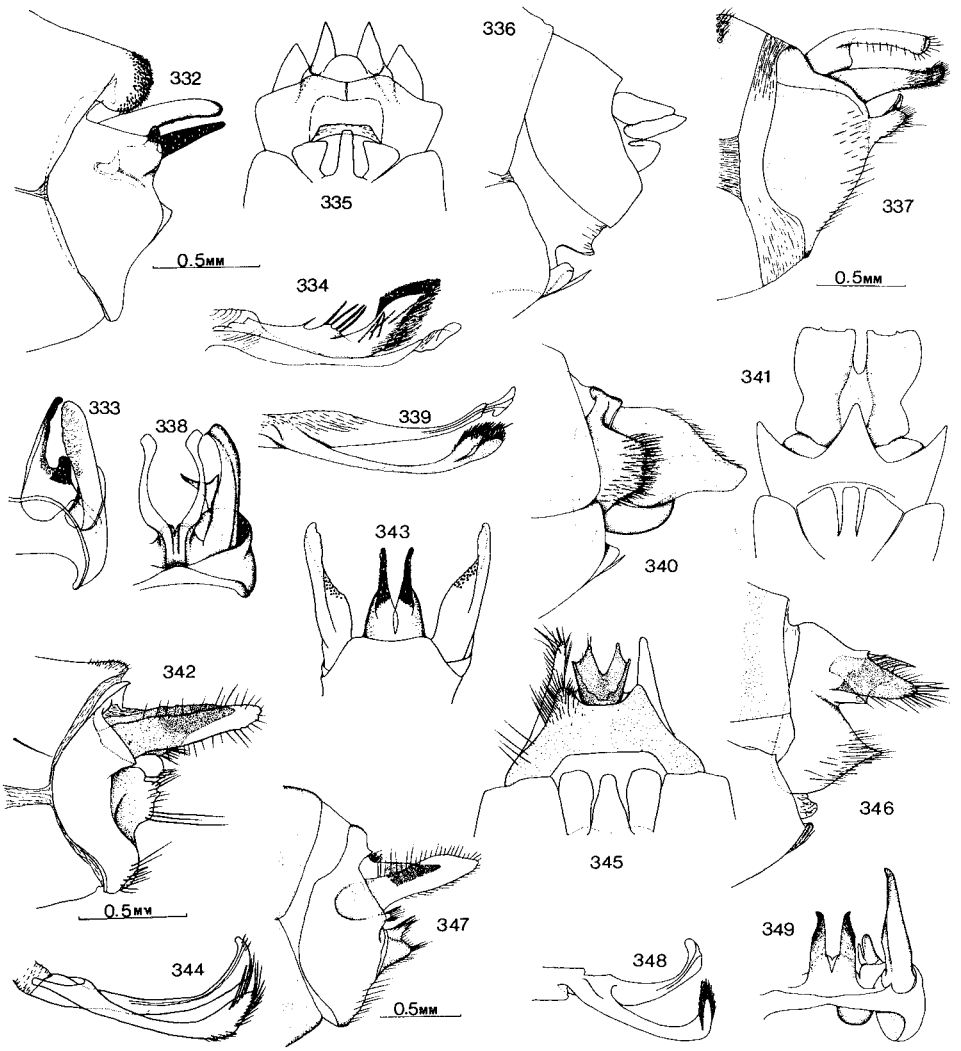


Fig. 332-349. *Limnephilus femoralis* (Kirby), 332. Male genitalia, lateral aspect. 333. Male genitalia, dorsal aspect (partial). 334. Aedeagus, lateral aspect. 335. Female genitalia, ventral aspect. 336. Female genitalia, lateral aspect. *L. nogus* Ross, 337. Male genitalia, lateral aspect. 338. Male genitalia, dorsal aspect (partial). 339. Aedeagus, lateral aspect. 340. Female genitalia, lateral aspect. 341. Female genitalia, ventral aspect. *L. moestus* Banks, 342. Male genitalia, lateral aspect. 343. Male genitalia, dorsal aspect. 344. Aedeagus, lateral aspect. 345. Female genitalia, ventral aspect. 346. Female genitalia, lateral aspect. *L. cockerelli* Banks, 347. Male genitalia, lateral aspect. 348. Aedeagus, lateral aspect. 349. Male genitalia, dorsal aspect (partial).

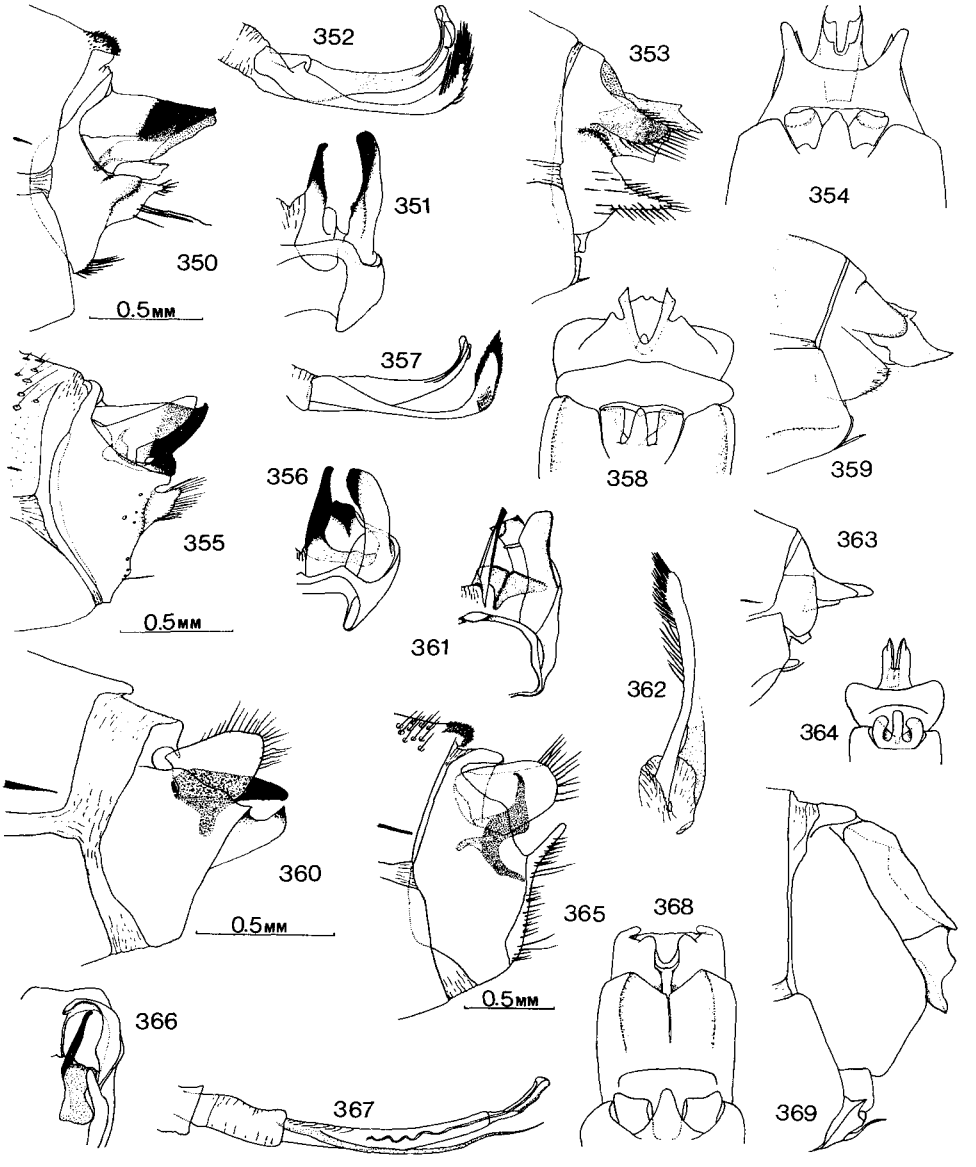


Fig. 350-369. *Limnephilus valhalla* Nimmo n. sp., 350. Male genitalia, lateral aspect. 351. Male genitalia, dorsal aspect (partial). 352. Aedeagus, lateral aspect. 353. Female genitalia, lateral aspect. 354. Female genitalia, ventral aspect. *L. lopho* Ross, 355. Male genitalia, lateral aspect. 356. Male genitalia, dorsal aspect (partial). 357. Aedeagus, lateral aspect. 358. Female genitalia, ventral aspect. 359. Female genitalia, lateral aspect. *L. parvulus* (Banks), 360. Male genitalia, lateral aspect. 361. Male genitalia, dorsal aspect (partial). 362. Right lateral arm of aedeagus, lateral aspect. 363. Female genitalia, lateral aspect. 364. Female genitalia, ventral aspect. *L. spinatus* Banks, 365. Male genitalia, lateral aspect. 366. Male genitalia, posterior aspect (partial). 367. Aedeagus, lateral aspect. 368. Female genitalia, ventral aspect. 369. Female genitalia, lateral aspect.

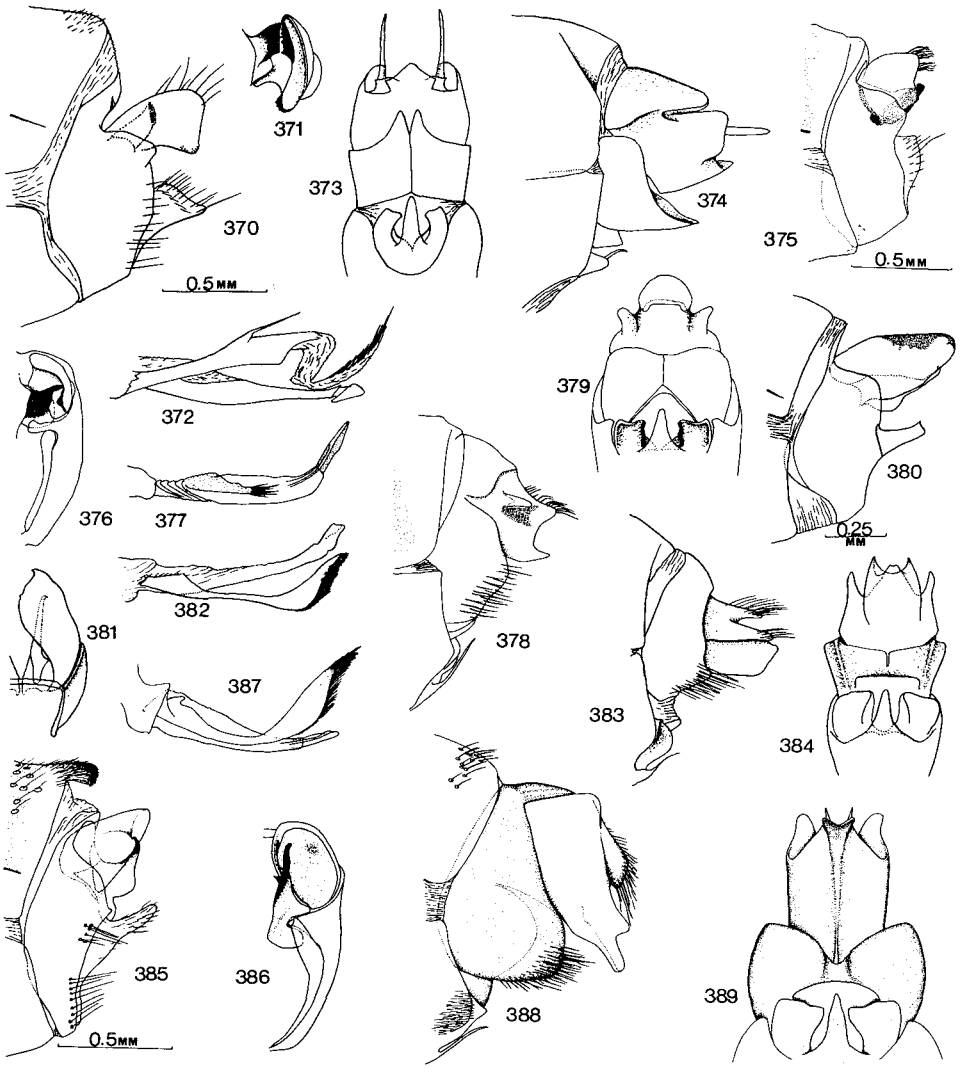


Fig. 370-389. *Limnephilus hyalinus* Hagen, 370. Male genitalia, lateral aspect. 371. Right cercus and median lobe of segment X, posterior aspect. 372. Aedeagus, lateral aspect. 373. Female genitalia, ventral aspect. 374. Female genitalia, lateral aspect. *L. secludens* Banks, 375. Male genitalia, lateral aspect. 376. Male genitalia, posterior aspect (partial). 377. Aedeagus, lateral aspect. 378. Female genitalia, lateral aspect. 379. Female genitalia, ventral aspect. *L. janus* Ross, 380. Male genitalia, lateral aspect. 381. Male genitalia, dorsal aspect (partial). 382. Aedeagus, lateral aspect. 383. Female genitalia, lateral aspect. 384. Female genitalia, ventral aspect. *L. perpusillus* Walker, 385. Male genitalia, lateral aspect. 386. Male genitalia, posterior aspect (partial). 387. Aedeagus, lateral aspect. 388. Female genitalia, lateral aspect. 389. Female genitalia, ventral aspect.

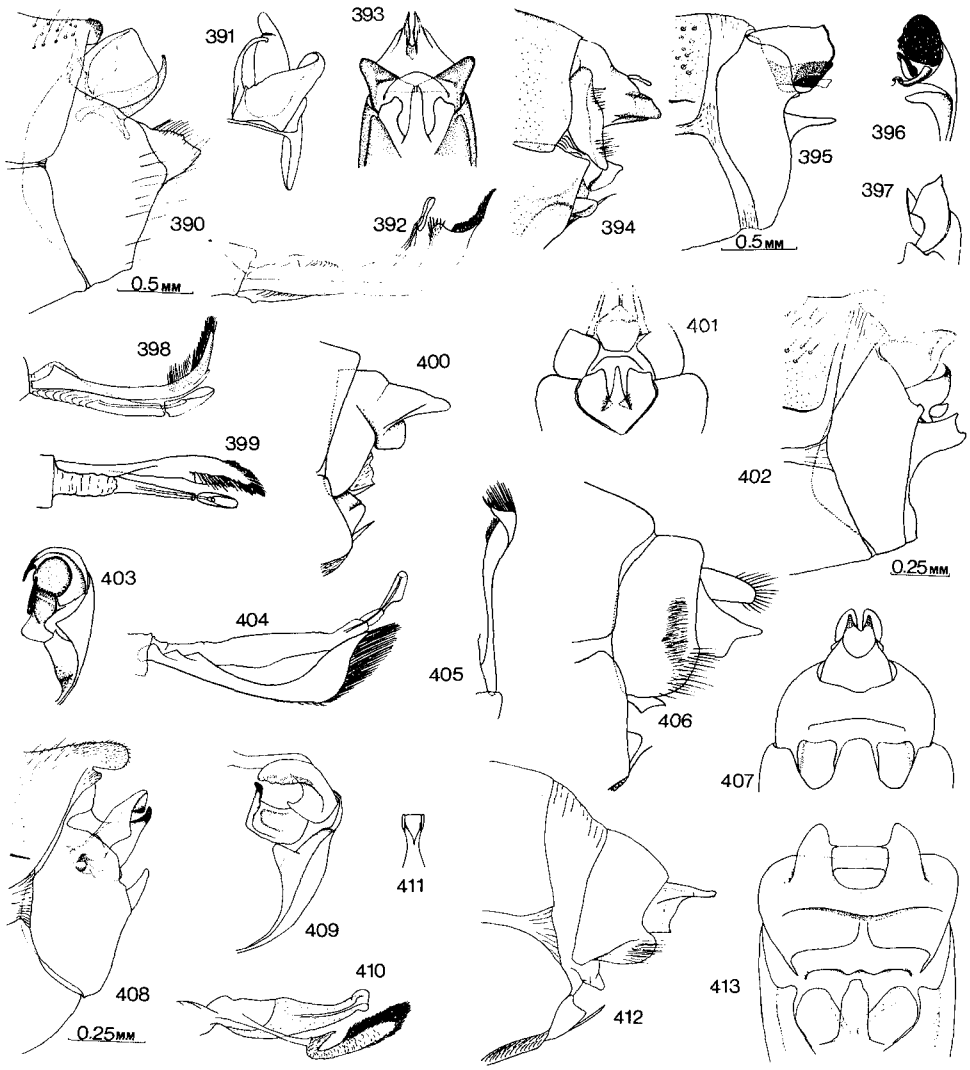


Fig. 390-413. *Limnephilus argenteus* Banks, 390. Male genitalia, lateral aspect. 391. Male genitalia, dorsal aspect (partial). 392. Aedeagus, lateral aspect. 393. Female genitalia, ventral aspect. 394. Female genitalia, lateral aspect. *L. alberta* Denning, 395. Male genitalia, lateral aspect. 396. Male genitalia, posterior aspect (partial). 397. Male genitalia, dorsal aspect (partial). 398. Aedeagus, lateral aspect. 399. Aedeagus, dorsal aspect (partial). 400. Female genitalia, lateral aspect. 401. Female genitalia, ventral aspect. *L. labus* Ross, 402. Male genitalia, lateral aspect. 403. Male genitalia, posterior aspect (partial). 404. Aedeagus, lateral aspect. 405. Right lateral arm, dorsal aspect. 406. Female genitalia, lateral aspect. 407. Female genitalia, ventral aspect. *L. minusculus* (Banks), 408. Male genitalia, lateral aspect. 409. Male genitalia, posterior aspect (partial). 410. Aedeagus, lateral aspect. 411. Tip of aedeagus, dorsal aspect. 412. Female genitalia, lateral aspect. 413. Female genitalia, ventral aspect.

Fig. 414-438. *Limnephilus kennicotti* Banks, 414. Male genitalia, lateral aspect. 415. Male genitalia, dorsal aspect. 416. Aedeagus, lateral aspect. 417. Tip of aedeagus, dorsal aspect. 418. Clasper of male, posterior aspect. 419. Female genitalia, lateral aspect. 420. Female genitalia, ventral aspect. *L. nigriceps* (Zetterstedt), 421. Male genitalia, lateral aspect. 422. Male genitalia, posterior aspect (partial). 423. Male genitalia, dorsal aspect (partial). 424. Aedeagus, lateral aspect. 425. Female genitalia, ventral aspect. 426. Female genitalia, lateral aspect. *L. rhombicus* (L.), 427. Male genitalia, lateral aspect. 428. Male genitalia, posterior aspect (partial). 429. Aedeagus, lateral aspect. 430. Right lateral arm of aedeagus, dorsal aspect. 431. Female genitalia, lateral aspect. 432. Female genitalia, ventral aspect. *L. canadensis* Banks, 433. Male genitalia, lateral aspect. 434. Male genitalia, posterior aspect (partial). 435. Aedeagus, lateral aspect. 436. Aedeagus, dorsal aspect. 437. Female genitalia, ventral aspect. 438. Female genitalia, lateral aspect.

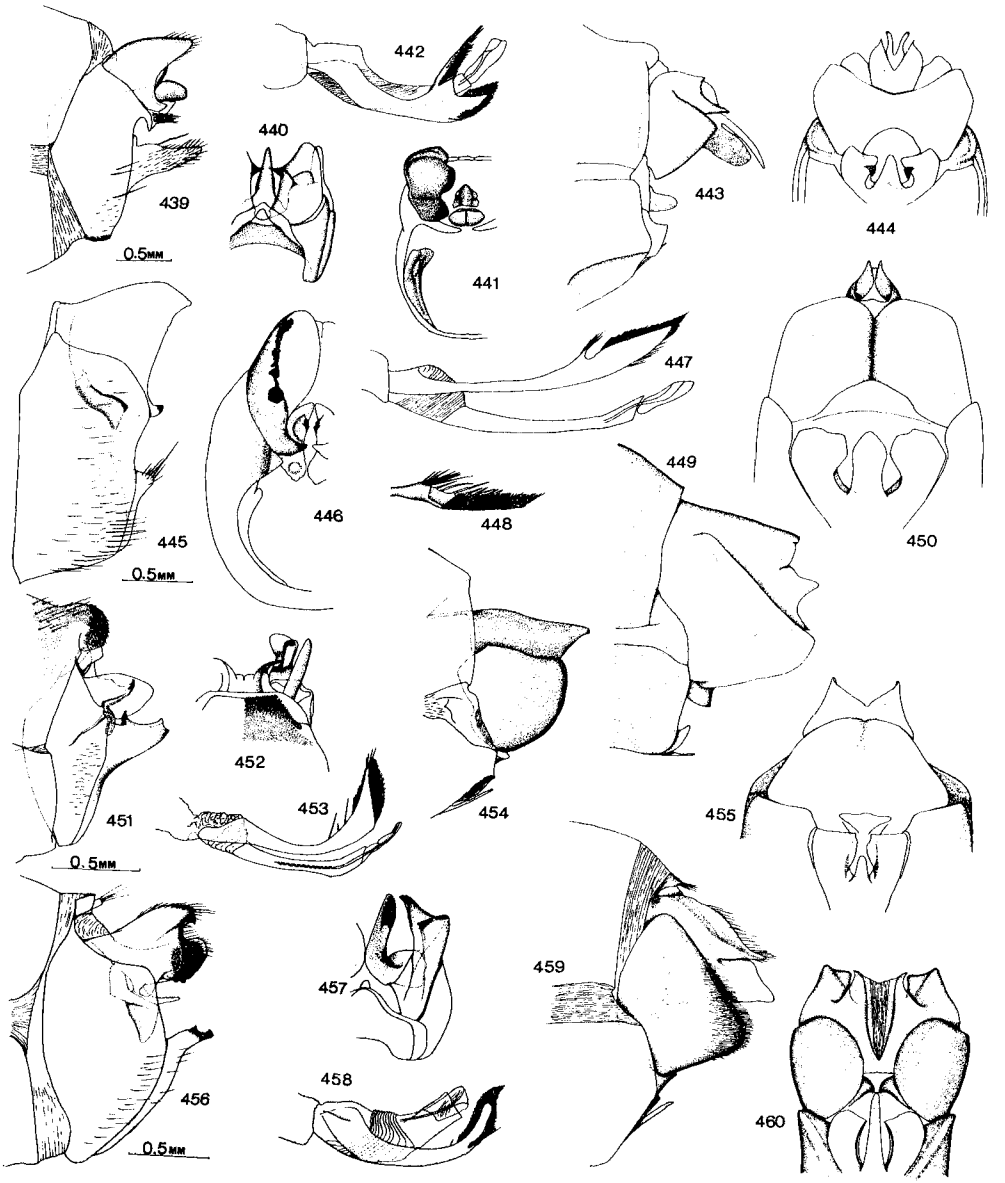


Fig. 439-460. *Clistoronia magnifica* (Banks), 439. Male genitalia, lateral aspect. 440. Male genitalia, dorsal aspect (partial). 441. Male genitalia, posterior aspect (partial). 442. Aedeagus, lateral aspect. 443. Female genitalia, lateral aspect. 444. Female genitalia, ventral aspect. *Grammotaulius interregationis* (Zetterstedt), 445. Male genitalia, lateral aspect. 446. Male genitalia, posterior aspect (partial). 447. Aedeagus, lateral aspect. 448. Right lateral arm, dorsal aspect of tip. 449. Female genitalia, lateral aspect. 450. Female genitalia, ventral aspect. *Nemotaulius hostilis* (Hagen), 451. Male genitalia, lateral aspect. 452. Male genitalia, dorsal aspect (partial). 453. Aedeagus, lateral aspect. 454. Female genitalia, lateral aspect. 455. Female genitalia, ventral aspect. *Anabolia consocia* (Walker), 456. Male genitalia, lateral aspect. 457. Aedeagus, lateral aspect. 458. Aedeagus, lateral aspect. 459. Female genitalia, lateral aspect. 460. Female genitalia, ventral aspect.

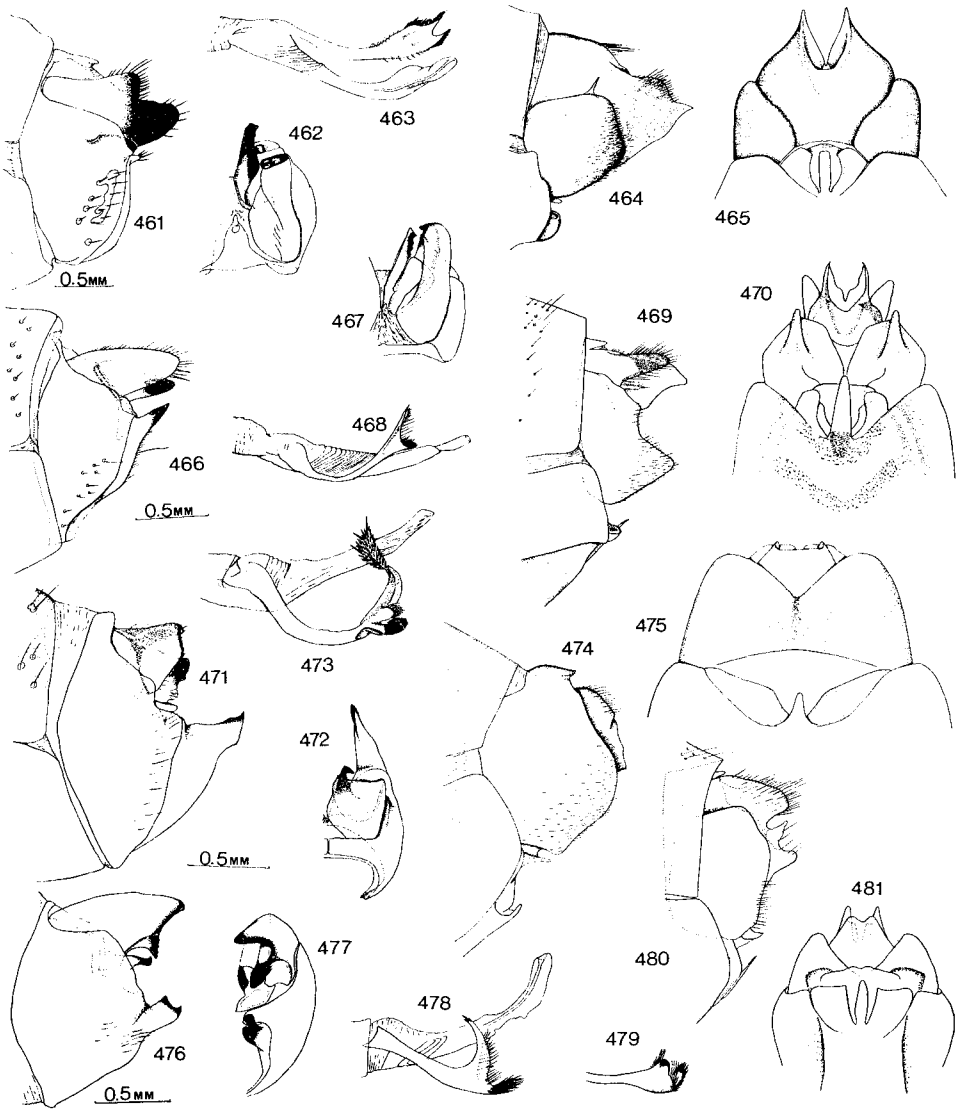


Fig. 461-481. *Anabolia ozburni* (Milne), 461. Male genitalia, lateral aspect. 462. Male genitalia, dorsal aspect (partial). 463. Aedeagus, lateral aspect. 464. Female genitalia, lateral aspect. 465. Female genitalia, ventral aspect. *A. bimaculata* (Walker), 466. Male genitalia, lateral aspect. 467. Male genitalia, dorsal aspect (partial). 468. Aedeagus, lateral aspect. 469. Female genitalia, lateral aspect. 470. Female genitalia, ventral aspect. *Asynarchus mutatus* (Hagen), 471. Male genitalia, lateral aspect. 472. Male genitalia, dorsal aspect (partial). 473. Aedeagus, lateral aspect. 474. Female genitalia, lateral aspect. 475. Female genitalia, ventral aspect. *A. curtus* (Banks), 476. Male genitalia, lateral aspect. 477. Male genitalia, posterior aspect (partial). 478. Aedeagus, lateral aspect. 479. Right lateral arm of aedeagus, dorsal aspect. 480. Female genitalia, lateral aspect. 481. Female genitalia, ventral aspect.

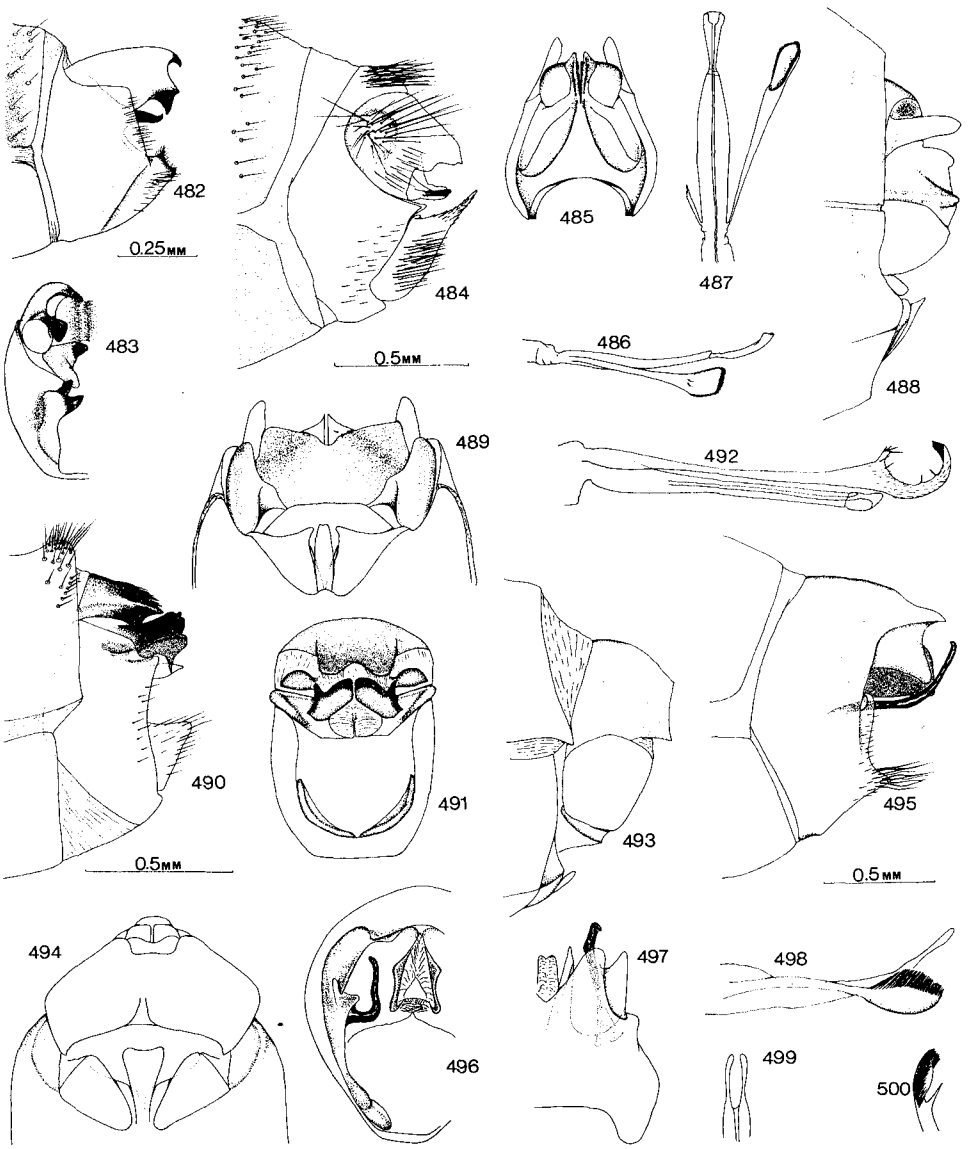


Fig. 482-500. *Asynarchus aldinus* (Ross), 482. Male genitalia, lateral aspect. 483. Male genitalia, posterior aspect (partial). *Philarctus quaeris* (Milne), 484. Male genitalia, lateral aspect. 485. Male genitalia, dorsal aspect. 486. Aedeagus, lateral aspect. 487. Aedeagus, dorsal aspect (partial). 488. Female genitalia, lateral aspect. 489. Female genitalia, ventral aspect. *Arctopora pulchella* (Banks), 490. Male genitalia, lateral aspect. 491. Male genitalia, posterior aspect. 492. Aedeagus, lateral aspect. 493. Female genitalia, lateral aspect. 494. Female genitalia, ventral aspect. *Lenarchus crassus* (Banks), 495. Male genitalia, lateral aspect. 496. Male genitalia, posterior aspect (partial). 497. Male genitalia, ventral aspect. 498. Aedeagus, lateral aspect. 499. Tip of aedeagus, dorsal aspect. 500. Tip of left lateral arm of aedeagus, dorsal aspect.

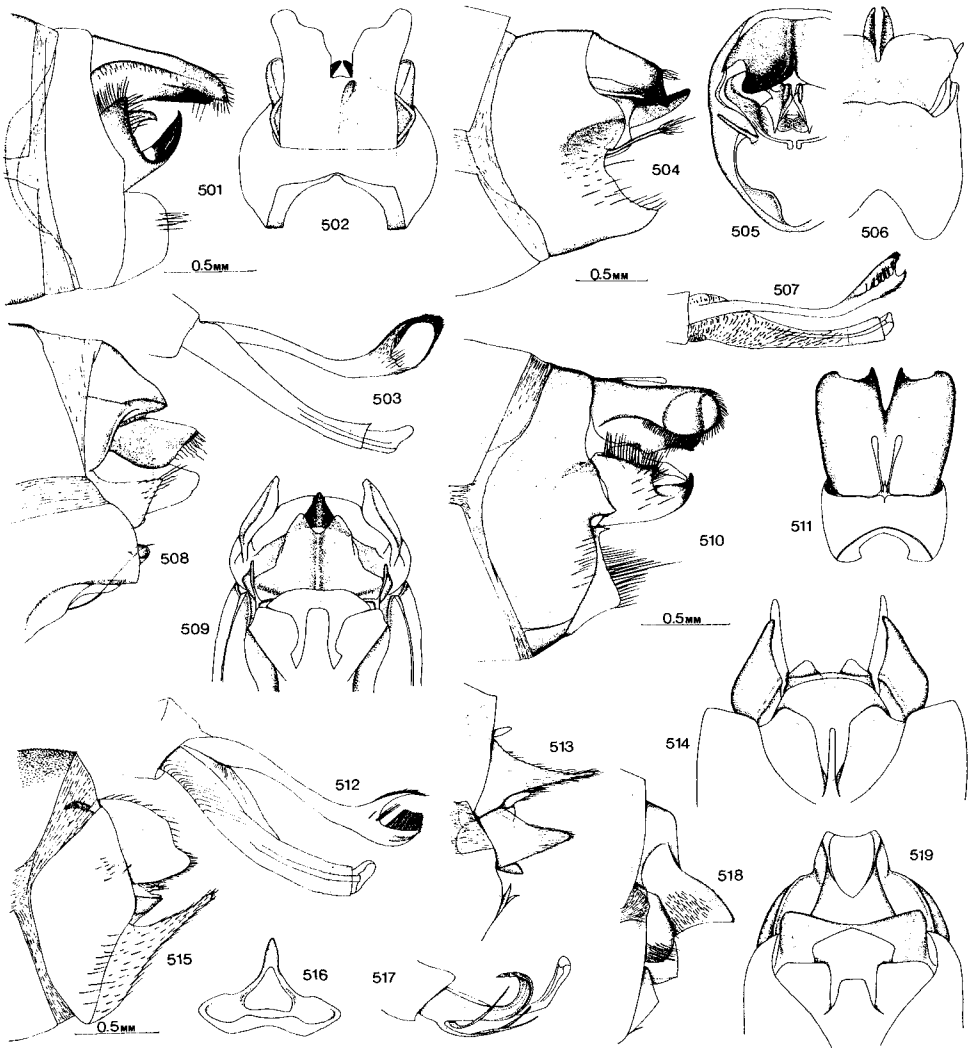


Fig. 501-519. *Lenarchus fautini* (Denning), 501. Male genitalia, lateral aspect. 502. Male genitalia, dorsal aspect. 503. Aedeagus, lateral aspect. *L. vastus* (Hagen), 504. Male genitalia, lateral aspect. 505. Male genitalia, dorsal aspect (partial). 506. Male genitalia, dorsal aspect. 507. Aedeagus, lateral aspect. 508. Female genitalia, lateral aspect. 509. Female genitalia, ventral aspect. *L. brevipennis* Banks, 510. Male genitalia, lateral aspect. 511. Male genitalia, dorsal aspect. 512. Aedeagus, lateral aspect. 513. Female genitalia, lateral aspect. 514. Female genitalia, ventral aspect. *Hesperophylax occidentalis* (Banks), 515. Male genitalia, lateral aspect. 516. Segment X, posterior aspect. 517. Aedeagus, lateral aspect. 518. Female genitalia, lateral aspect. 519. Female genitalia, ventral aspect.

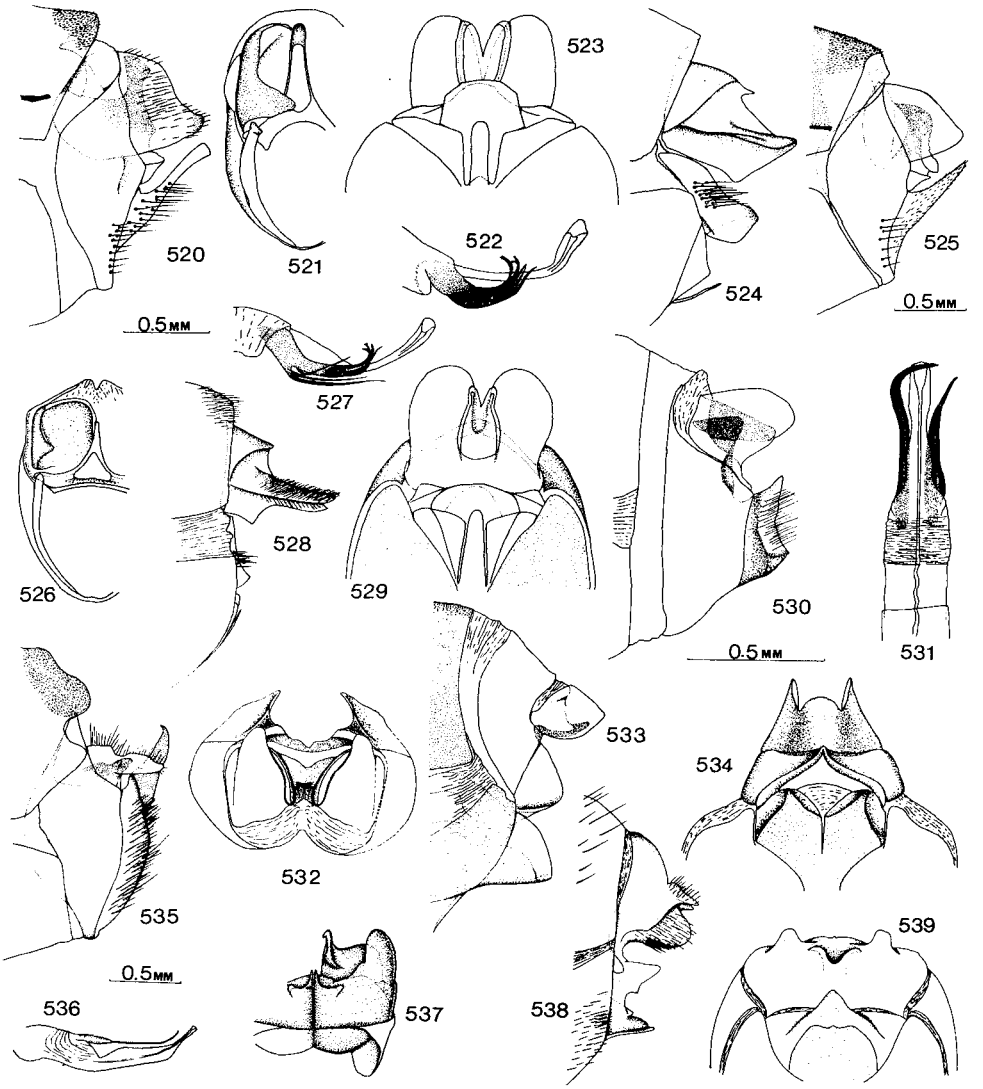


Fig. 520-539. *Hesperophylax incisus* (Banks), 520. Male genitalia, lateral aspect. 521. Male genitalia, posterior aspect (partial). 522. Aedeagus, lateral aspect. 523. Female genitalia, ventral aspect. 524. Female genitalia, lateral aspect. *H. consimilis* (Banks), 525. Male genitalia, lateral aspect. 526. Male genitalia, posterior aspect (partial). 527. Aedeagus, lateral aspect. 528. Female genitalia, lateral aspect. 529. Female genitalia, ventral aspect. *Chyranda centralis* (Banks), 530. Male genitalia, lateral aspect. 531. Aedeagus, dorsal aspect. 532. Male genitalia, dorsal aspect. 533. Female genitalia, lateral aspect. 534. Female genitalia, ventral aspect. *Pycnopsyche subfasciata* (Say), 535. Male genitalia, lateral aspect. 536. Aedeagus, lateral aspect. 537. Male genitalia, dorsal aspect (partial). 538. Female genitalia, lateral aspect. 539. Female genitalia, ventral aspect.

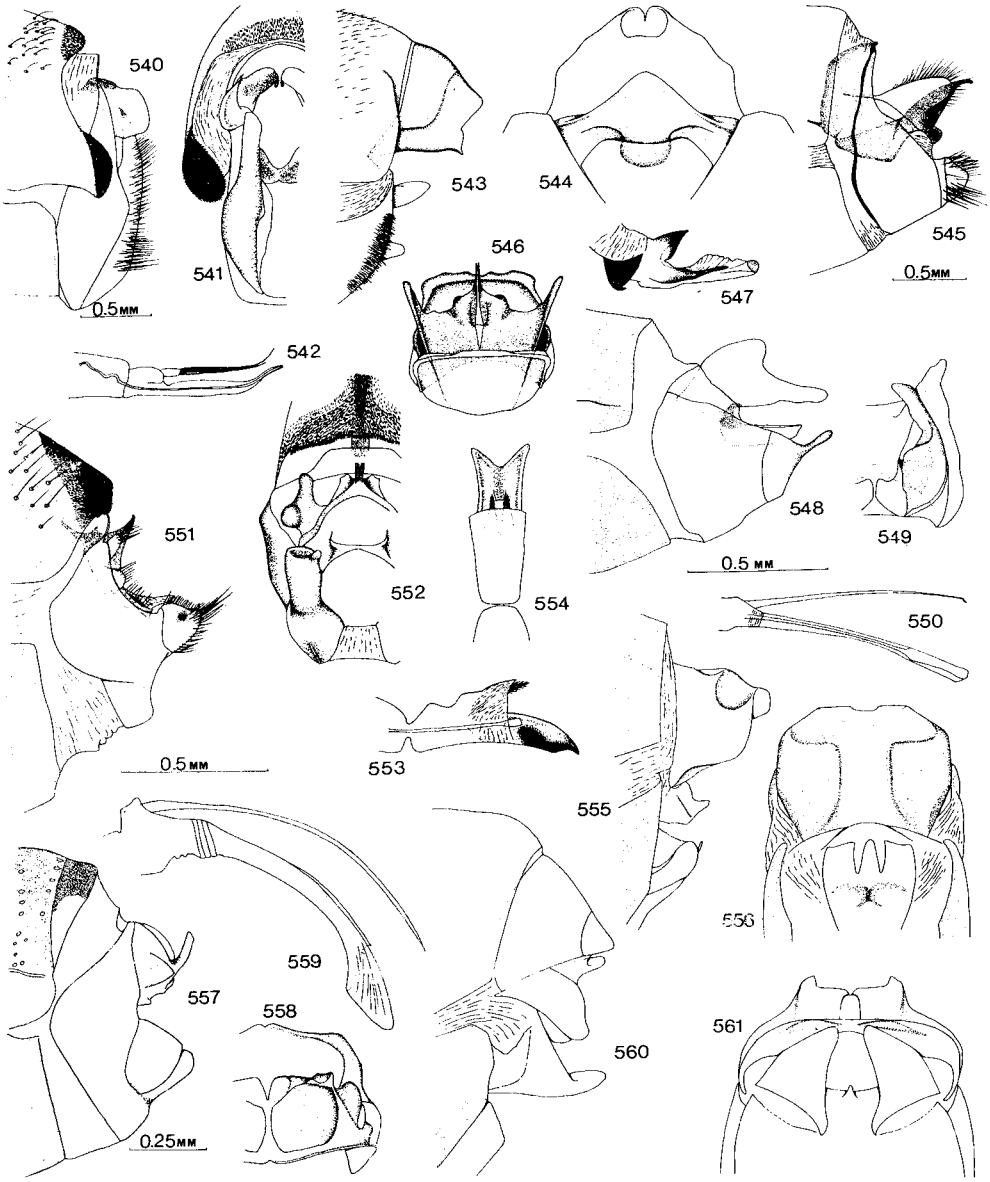


Fig. 540-561. *Pycnopsyche guttifer* (Walker), 540. Male genitalia, lateral aspect. 541. Male genitalia, posterior aspect (partial). 542. Aedeagus, lateral aspect. 543. Female genitalia, lateral aspect. 544. Female genitalia, ventral aspect. *Philocasca thor* Nimmo n. sp., 545. Male genitalia, lateral aspect. 546. Male genitalia, dorsal aspect. 547. Aedeagus, lateral aspect. *Chilostigmodes areolata* (Walker), 548. Male genitalia, lateral aspect. 549. Male genitalia, dorsal aspect (partial). 550. Aedeagus, lateral aspect. *Glyphopsyche irrorata* (Fabricius), 551. Male genitalia, lateral aspect. 552. Male genitalia, posterior aspect (partial). 553. Aedeagus, lateral aspect. 554. Aedeagus, dorsal aspect. 555. Female genitalia, lateral aspect. 556. Female genitalia, ventral aspect. *Phanocelia canadensis* (Banks), 557. Male genitalia, lateral aspect. 558. Male genitalia, dorsal aspect (partial). 559. Aedeagus, lateral aspect. 560. Female genitalia, lateral aspect. 561. Female genitalia, ventral aspect.

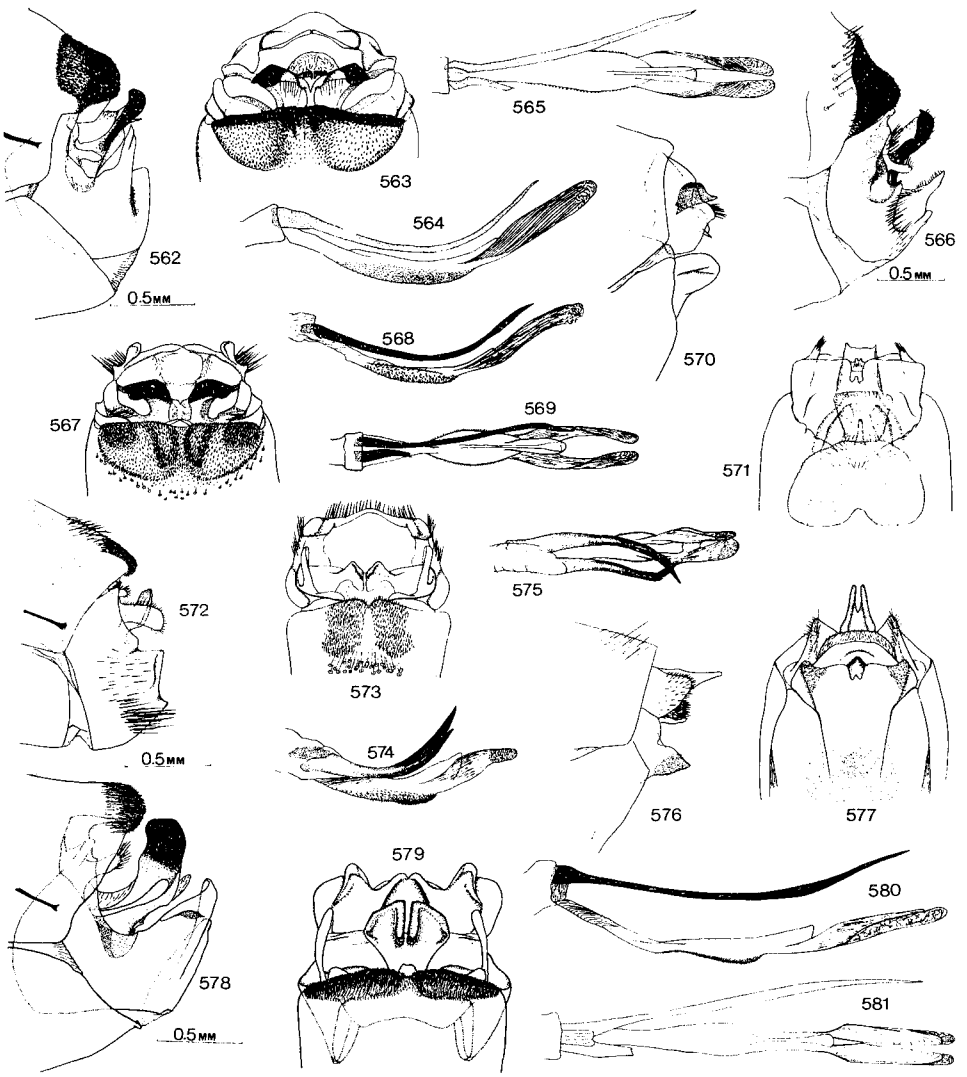


Fig. 562-581. *Psychoglypha prita* (Milne), 562. Male genitalia, lateral aspect. 563. Male genitalia, dorsal aspect. 564. Aedeagus, lateral aspect. 565. Aedeagus, dorsal aspect (partial). *P. schmidi* Nimmo, 566. Male genitalia, lateral aspect. 567. Male genitalia, dorsal aspect. 568. Aedeagus, lateral aspect. 569. Aedeagus, dorsal aspect (partial). 570. Female genitalia, lateral aspect. 571. Female genitalia, ventral aspect. *P. alaskensis* (Banks), 572. Male genitalia, lateral aspect. 573. Male genitalia, dorsal aspect. 574. Aedeagus, lateral aspect. 575. Aedeagus, dorsal aspect. 576. Female genitalia, lateral aspect. 577. Female genitalia, ventral aspect. *P. ulla* (Milne), 578. Male genitalia, lateral aspect. 579. Male genitalia, dorsal aspect. 580. Aedeagus, lateral aspect. 581. Aedeagus, dorsal aspect (partial).

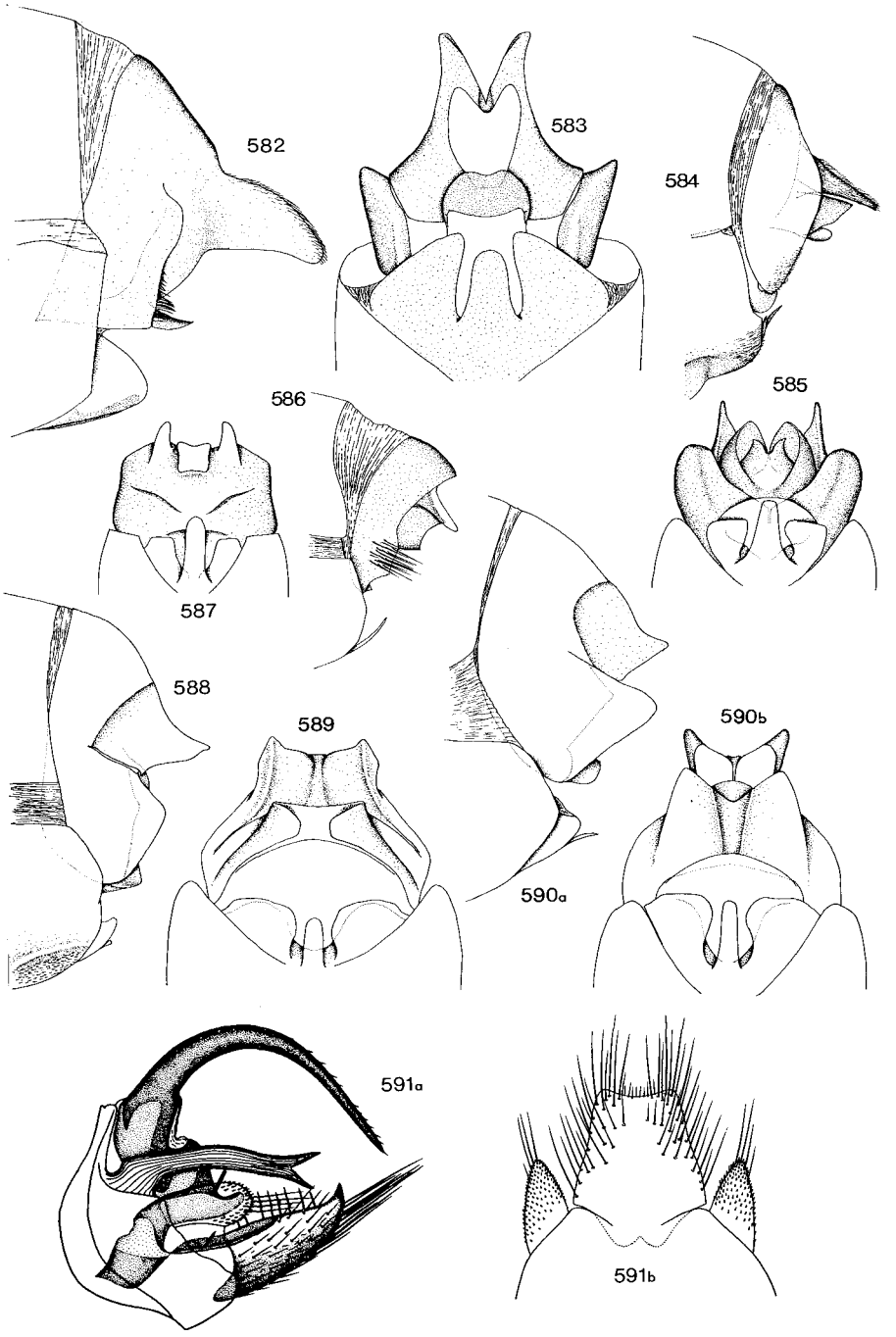


Fig. 582-591b. Limnephilidae species 1, 582. Female genitalia, lateral aspect. 583. Female genitalia, ventral aspect. Limnephilidae species 2, 584. Female genitalia, lateral aspect. 585. Female genitalia, ventral aspect. Limnephilidae species 3, 586. Female genitalia, lateral aspect. 587. Female genitalia, ventral aspect. Limnephilidae species 4, 588. Female genitalia, lateral aspect. 589. Female genitalia, ventral aspect. Limnephilidae species 5, 590a. Female genitalia, lateral aspect. 590b. Female genitalia, ventral aspect. No scale given when only females known. *Neothremma laloukesi* Schmid, 591a. Male genitalia, lateral aspect. 591b. Male genitalia, ventral aspect. (From Schmid, 1968).

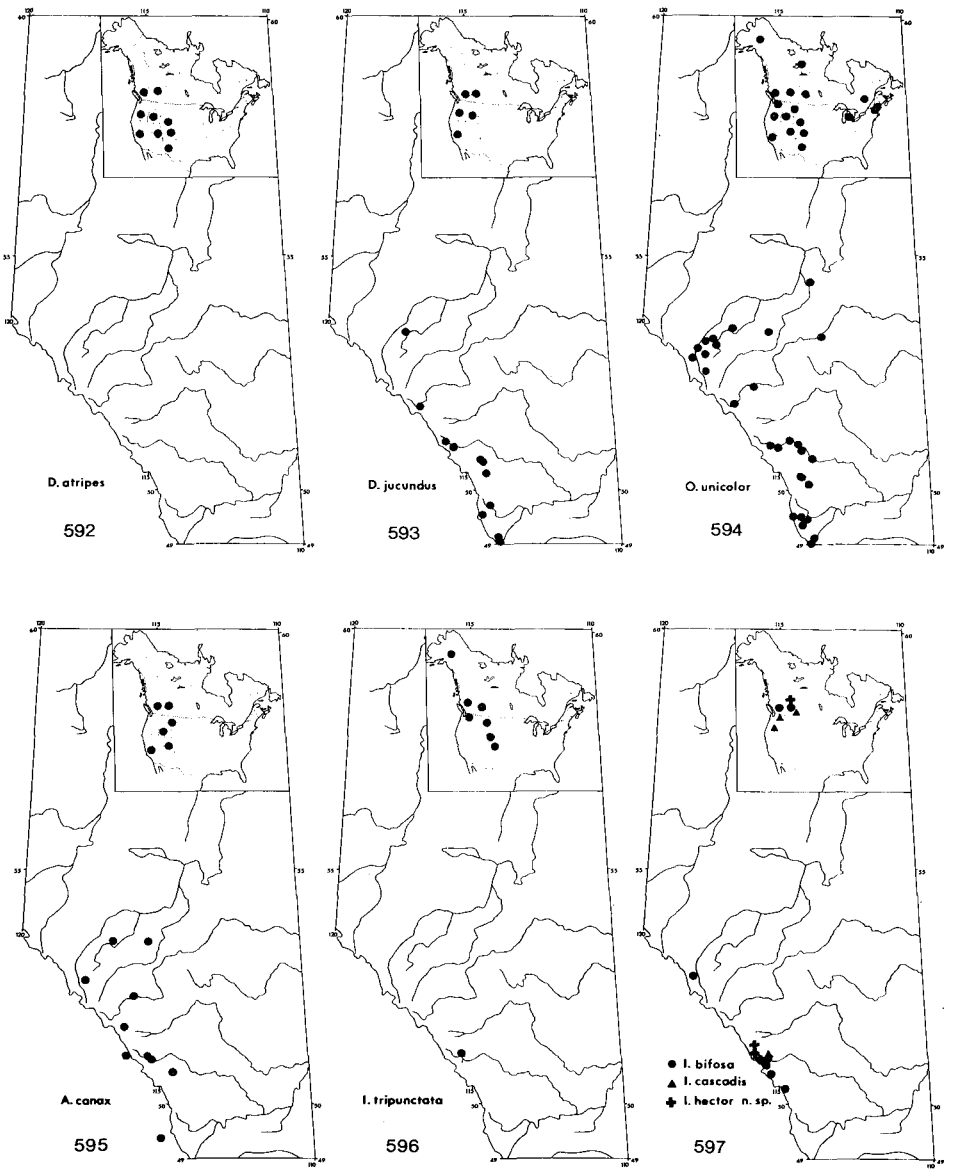


Fig. 592-597. Maps of distribution in Alberta and North America of: 592. *Dicosmoecus atripes* (Hagen). 593. *D. jucundus* Banks. 594. *Onocosmoecus unicolor* (Banks). 595. *Amphicosmoecus canax* (Ross). 596. *Imania tripunctata* (Banks). 597. *I. bifosa* Ross, *I. cascadis* Ross, and *I. hector* Nimmo n. sp.

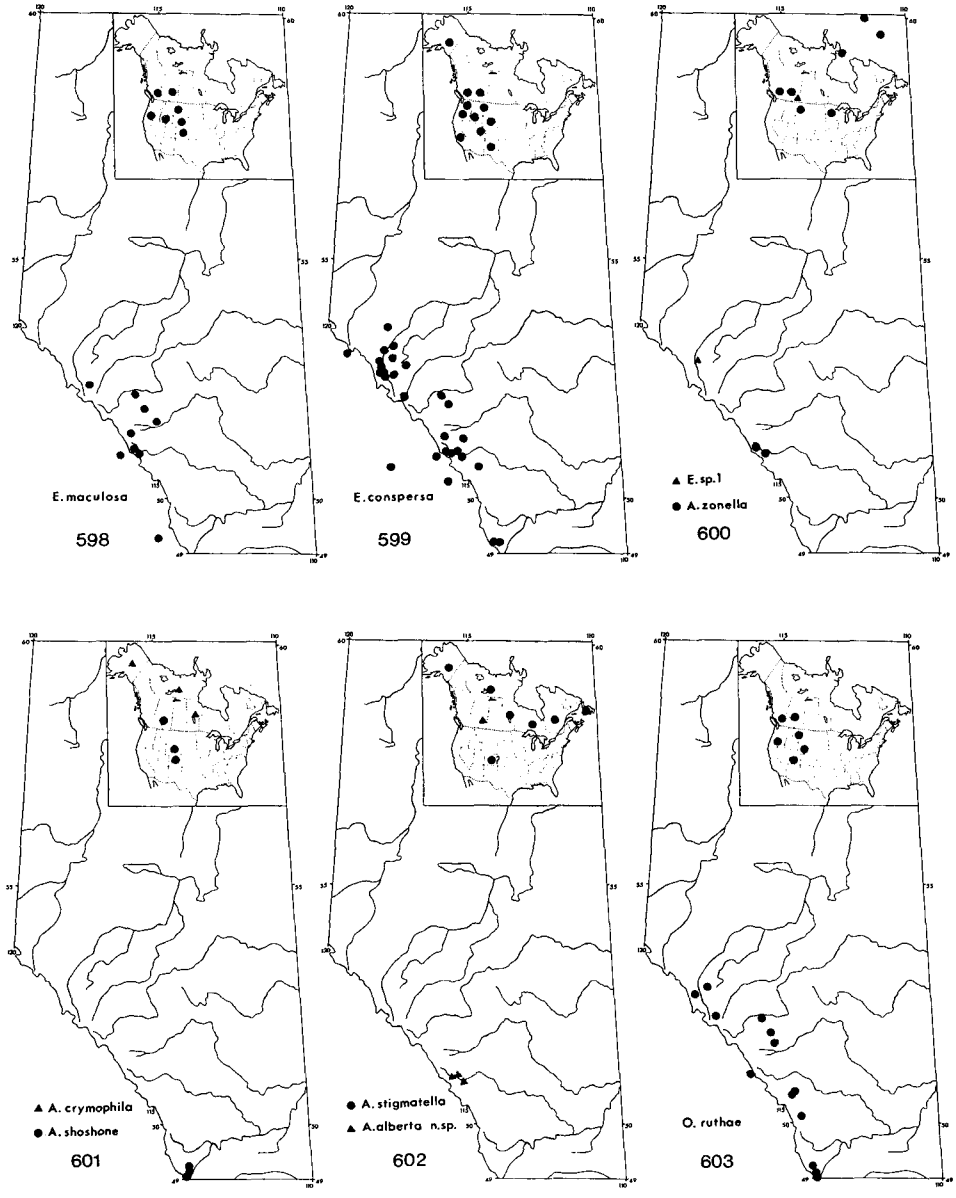


Fig. 598-603. Maps of distribution in Alberta and North America of: 598. *Ecclisomyia maculosa* Banks. 599. *E. conspersa* Banks, 600. *E.* species 1, *Apatania zonella* (Zetterstedt). 601. *A. crymophila* McLachlan, *A. shoshone* (Banks). 602. *A. stigmatella* (Zetterstedt), *A. alberta* Nimmo n. sp. 603. *Oligophlebodes ruthae* Ross.

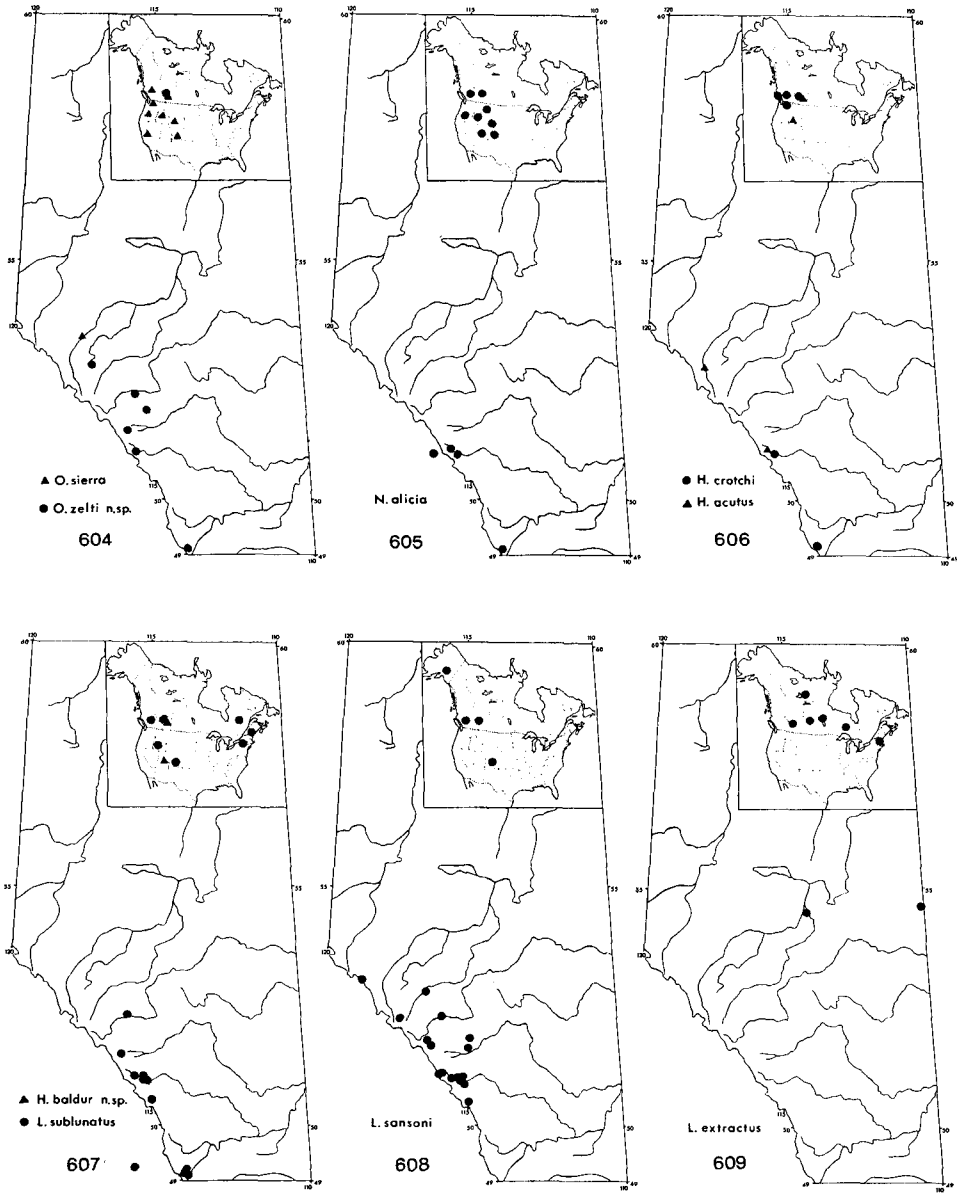


Fig. 604-609. Maps of distribution in Alberta and North America of: 604. *Oligophlebodes sierra* Ross, *O. zelti* Nimmo n. sp. 605. *Neothremma alicia* Banks and *Neothremma laloukesi* Schmid. 606. *Homophylax crotchi* Banks, *H. acutus* Denning. 607. *H. baldur* Nimmo n. sp., *Limnephilus sublunatus* Provancher. 608. *L. sansoni* Banks. 609. *L. extractus* Walker.

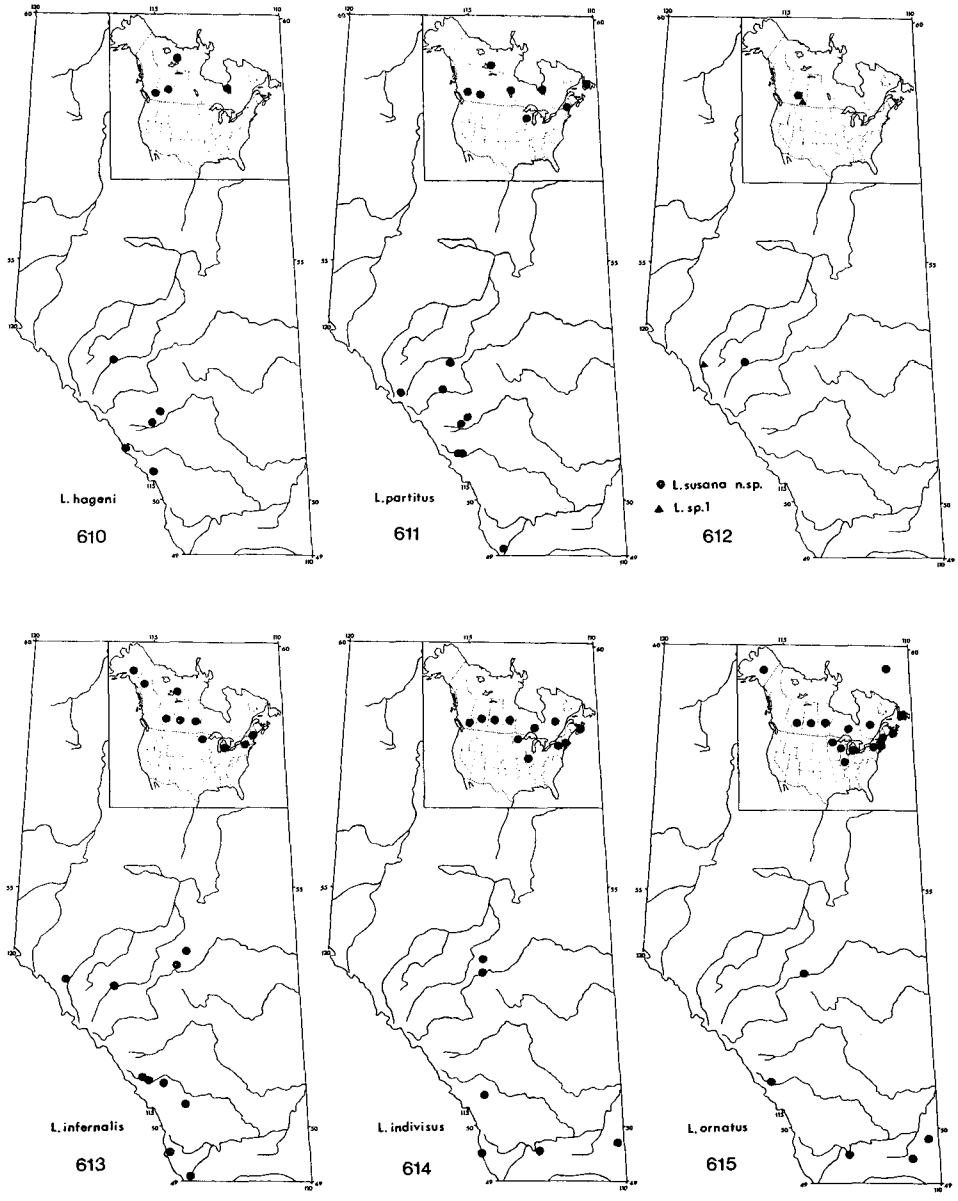


Fig. 610-615. Maps of distribution in Alberta and North America of: 610. *Limnephilus hageni* Banks. 611. *L. partitus* Walker. 612. *L. susana* Nimmo n. sp., *L.* species 1. 613. *L. infernalis* (Banks). 614. *L. indivisus* Walker. 615. *L. ornatus* Banks.

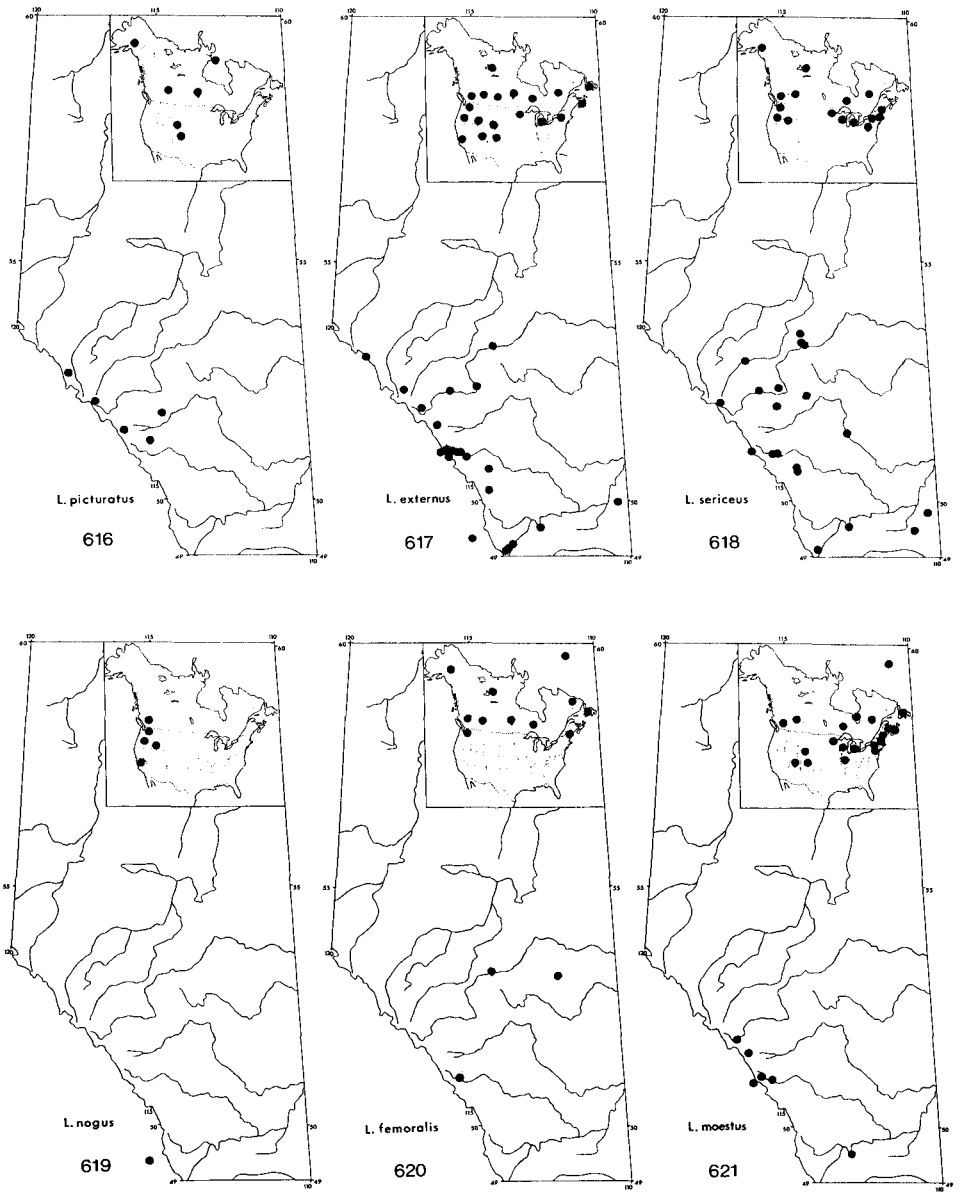


Fig. 616-621. Maps of distribution in Alberta and North America of: 616. *Limnephilus picturatus* McLachlan. 617. *L. externus* Hagen. 618. *L. sericeus* (Say). 619. *L. nogus* Ross. 620. *L. femoralis* (Kirby). 621. *L. moestus* Banks.

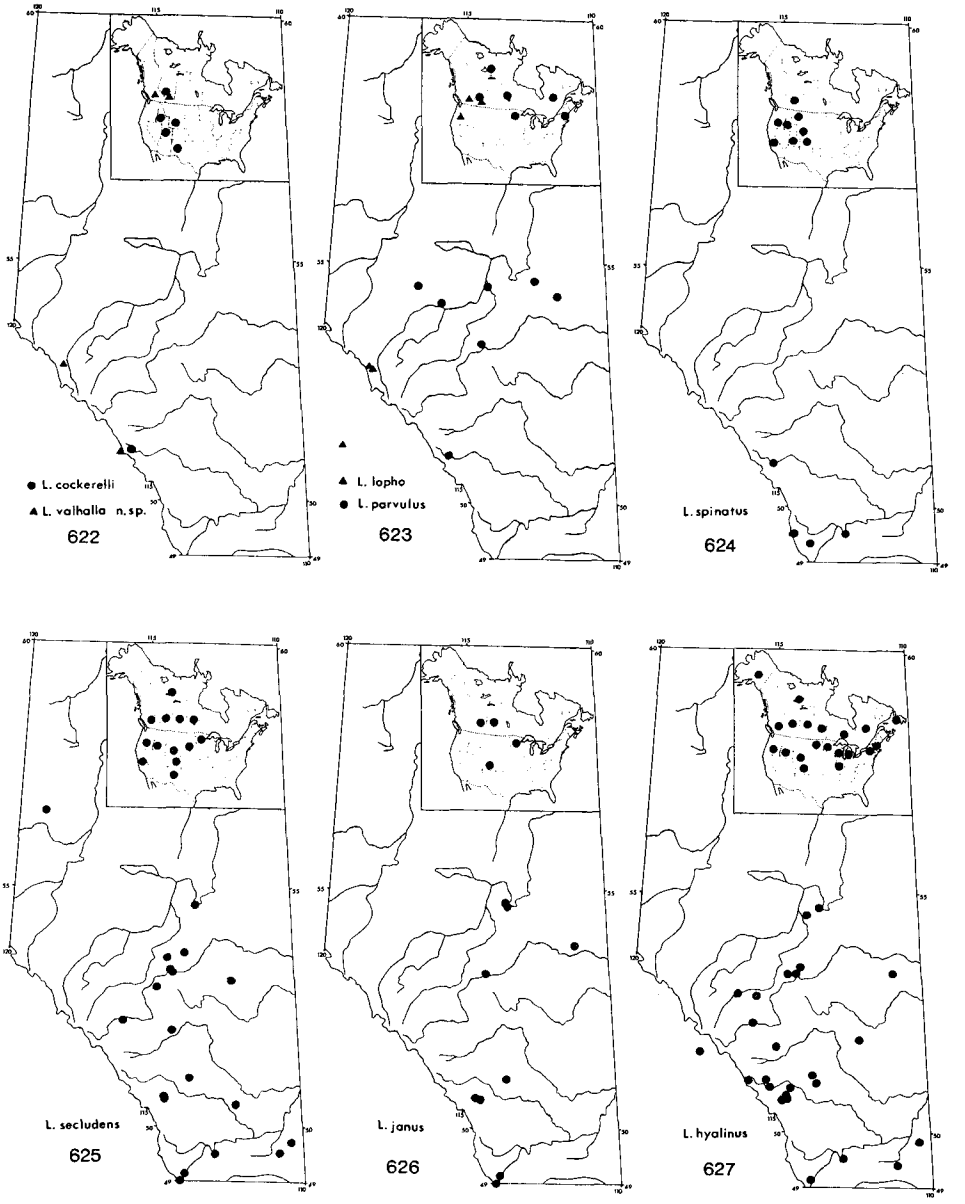


Fig. 622-627. Maps of distribution in Alberta and North America of: 622. *Limnephilus cockerelli* Banks, *L. valhalla* Nimmo n. sp. 623. *L. lopho* Ross, *L. parvulus* (Banks). 624. *L. spinatus* Banks. 625. *L. secludens* (Banks). 626. *L. janus* Ross. 627. *L. hyalinus* Hagen.

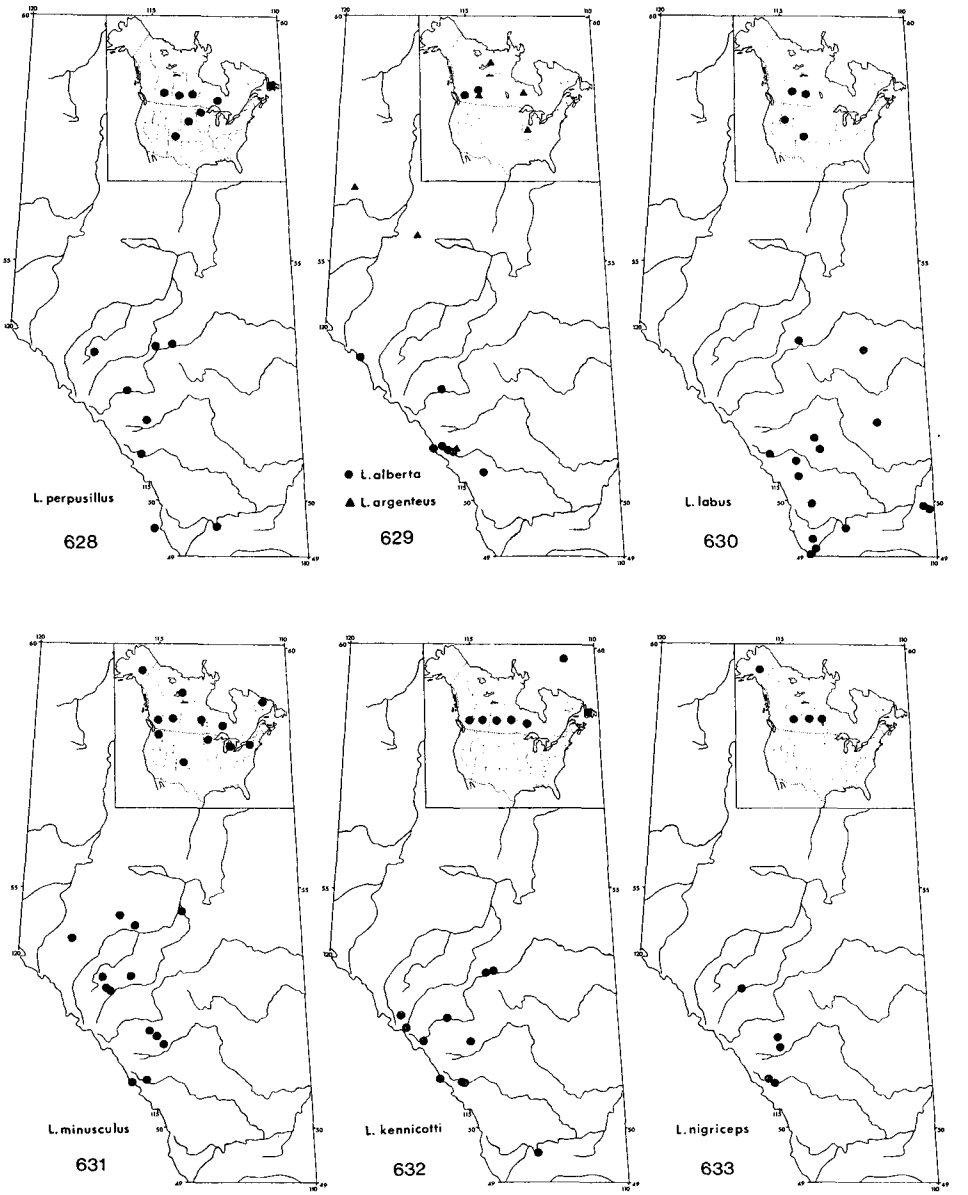


Fig. 628-633. Maps of distribution in Alberta and North America of: 628. *Limnephilus perpusillus* Walker. 629. *L. alberta* Denning, *L. argenteus* Banks. 630. *L. labus* Ross. 631. *L. minusculus* (Banks). 632. *L. kennicotti* Banks. 633. *L. nigriceps* (Zetterstedt).

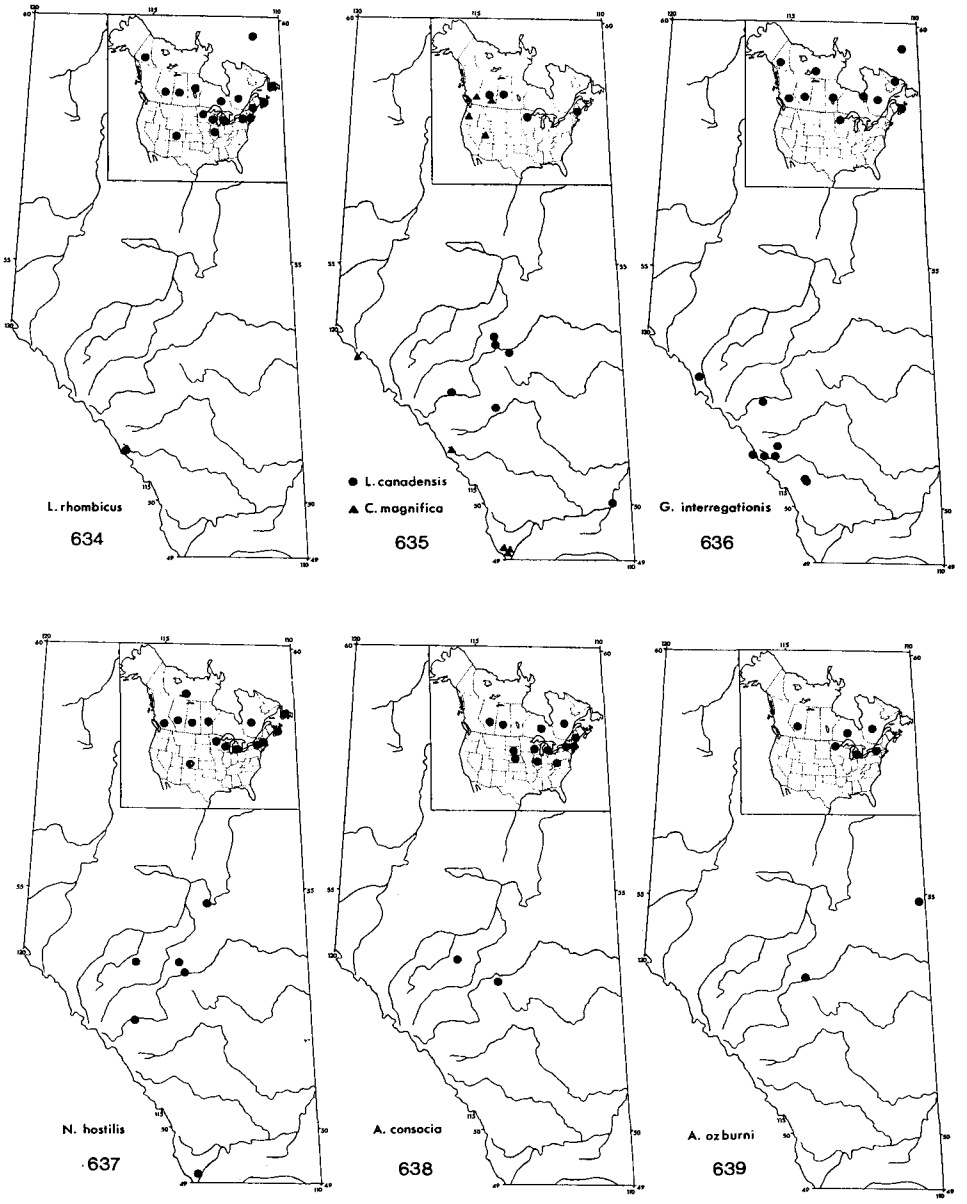


Fig. 634-639. Maps of distribution in Alberta and North America of: 634. *Limnephilus rhombicus* (L.). 635. *L. canadensis* Banks, *Clistoronia magnifica* (Banks). 636. *Grammotaulius interregationis* (Zetterstedt). 637. *Nemotaulius hostilis* (Hagen). 638. *Anabolia consocia* (Walker). 639. *A. ozburni* (Milne).

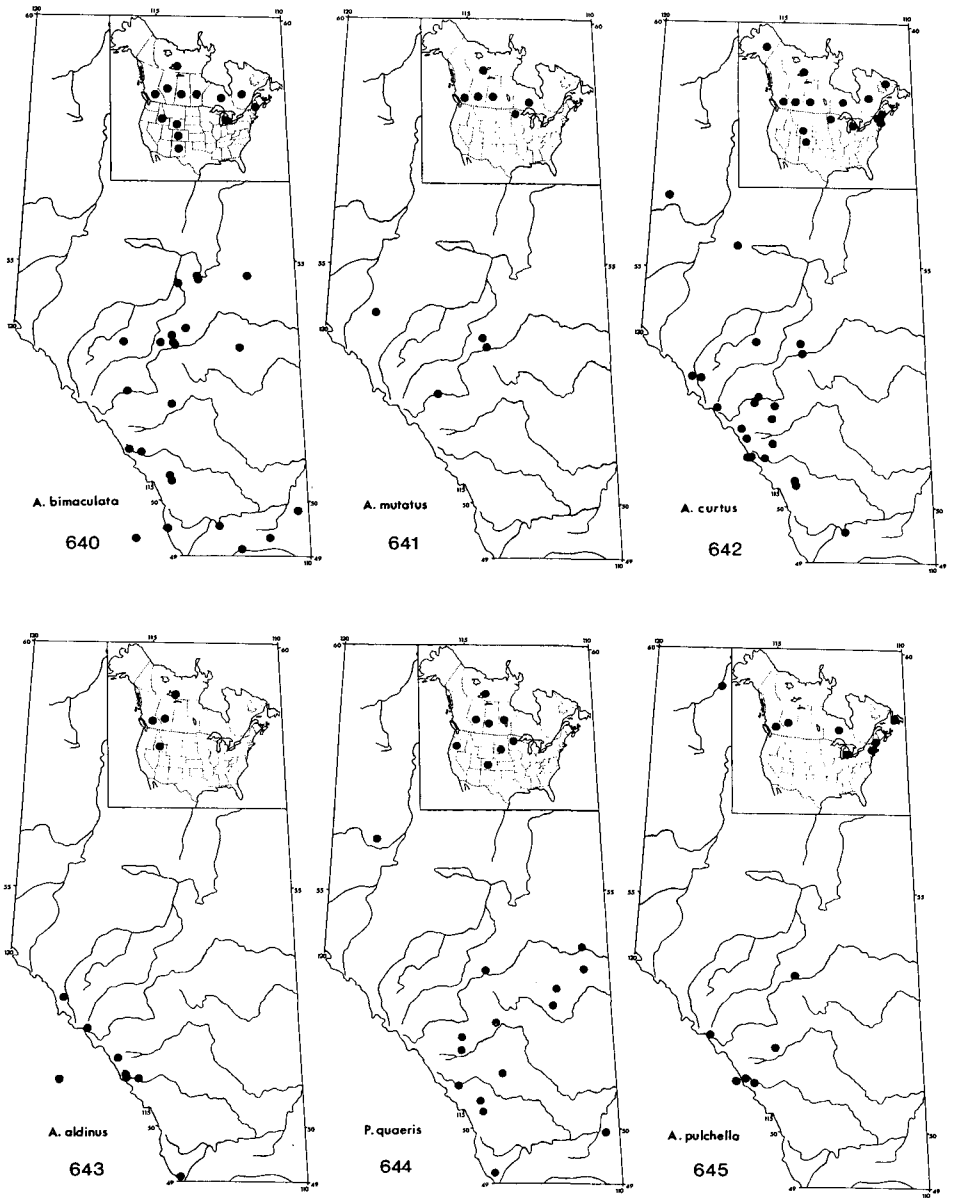


Fig. 640-645. Maps of distribution in Alberta and North America of: 640. *Anabolia bimaculata* (Walker). 641. *Asynarchus mutatus* (Hagen). 642. *A. curtus* (Banks). 643. *A. aldinus* (Ross). 644. *Philarctus quaeris* (Milne). 645. *Arctopora pulchella* (Banks).

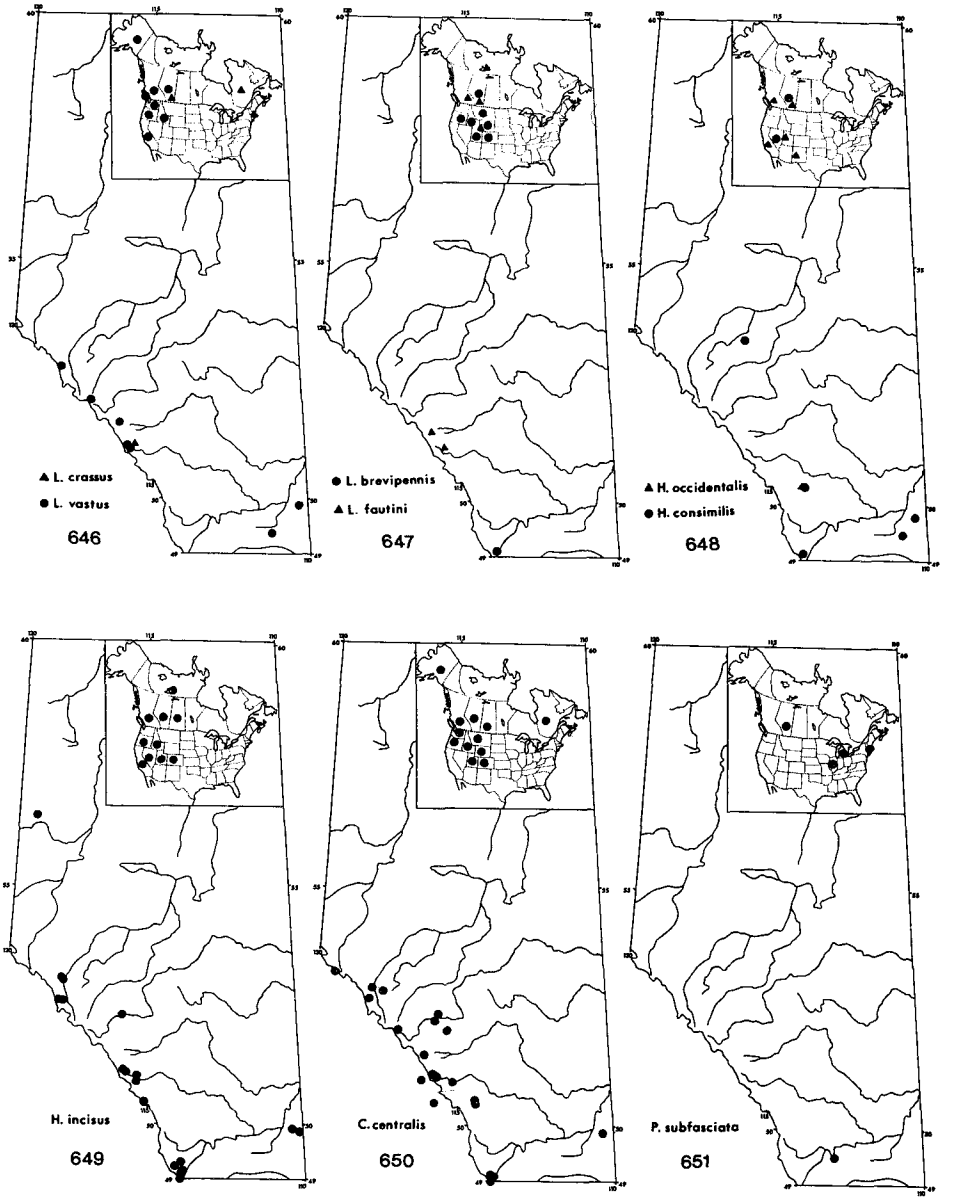


Fig. 646-651. Maps of distribution in Alberta and North America of: 646. *Lenarchus crassus* (Banks), *L. vastus* (Hagen). 647. *L. brevipennis* Banks, *L. fautini* (Denning). 648. *Hesperophylax occidentalis* (Banks), *H. consimilis* (Banks). 649. *H. incisus* (Banks). 650. *Chyranda centralis* (Banks). 651. *Pycnopsyche subfasciata* (Say).

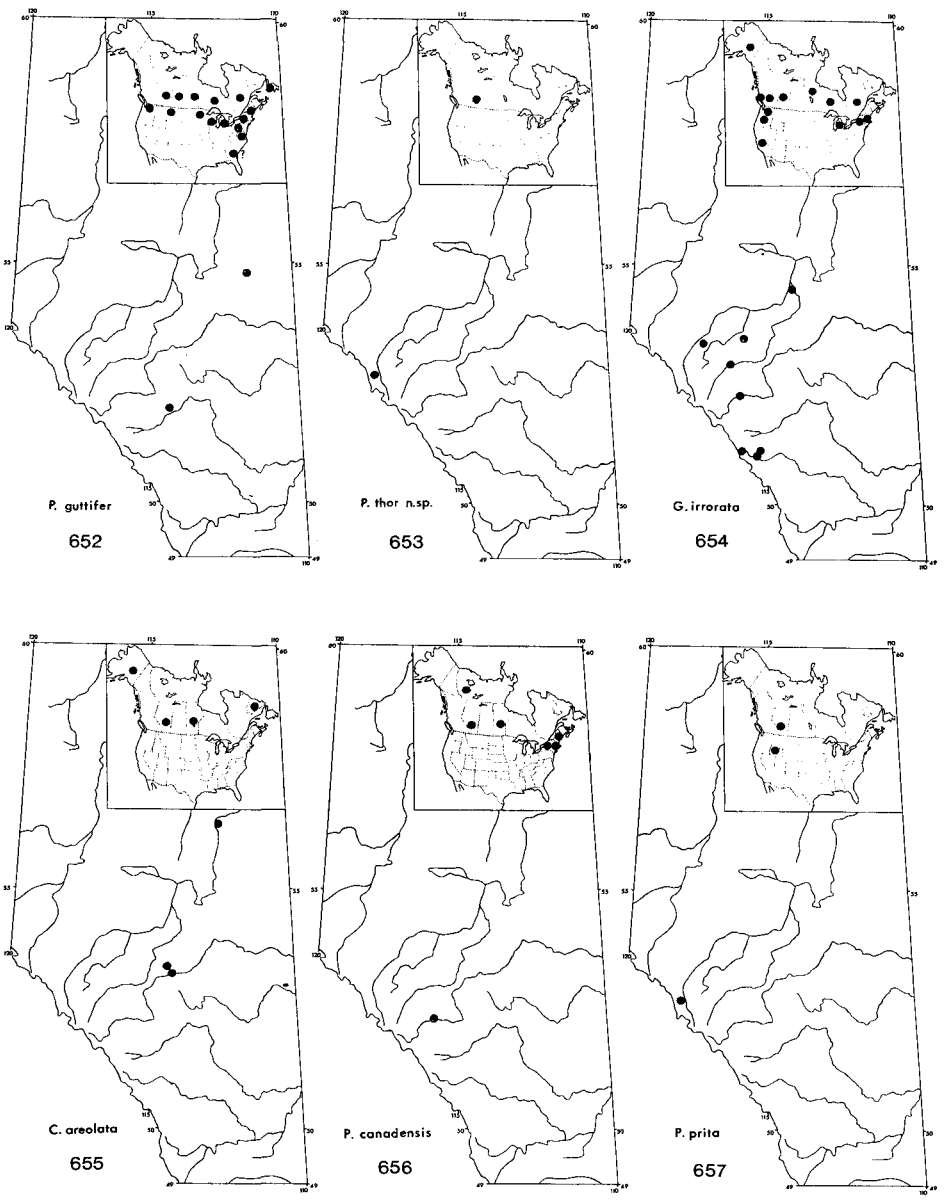


Fig. 652-657. Maps of distribution in Alberta and North America of: 652. *Pycnopsyche guttifer* (Walker). 653. *Philocasca thor* Nimmo n. sp. 654. *Glyphopsyche irrorata* (Fabricius). 655. *Chilostigmodes areolata* (Walker). 656. *Phanocelia canadensis* (Banks). 657. *Psychoglypha prita* (Milne).

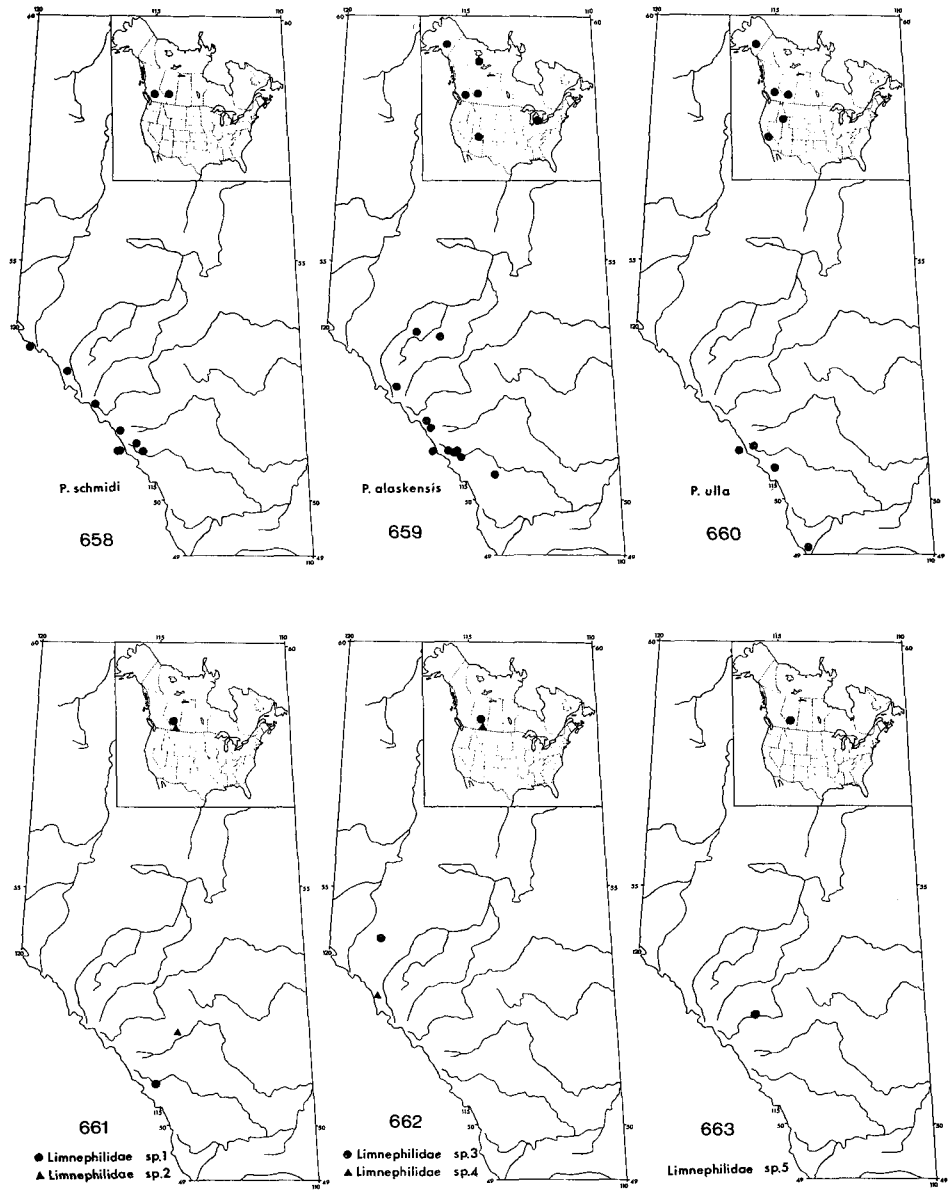


Fig. 658-663. Maps of distribution in Alberta and North America of: 658. *Psychoglypha schmidi* Nimmo. 659. *P. alaskensis* (Banks). 660. *P. ulla* (Milne). 661. Limnephilidae species 1, Limnephilidae species 2. 662. Limnephilidae species 3, Limnephilidae species 4. 663. Limnephilidae species 5.

ORIGINS AND RELATIONSHIPS OF THE FAUNA

Aims of the study. – The putative origins and relationships of the fauna of Rhyacophilidae and Limnephilidae, represented by 22 and 91 species respectively, of Alberta and eastern British Columbia, are described. Dispersal into the study area from unglaciated areas, or refugia, after the last major glaciation of North America, the Wisconsin, is discussed, and an attempt is made to determine the contributions of the glacial faunas of possible source areas to the present day fauna.

At the glacial peak the study area was, to all intents and purposes, a slate wiped clean by total ice cover. There was at least one minor exception to this, mentioned below. Such faunal movements should be amenable to clarification to a greater extent than pre-Wisconsin faunas at the species level and provide a very convenient unit with which to work due to the essentially clean sweep of the study area by the ice.

Procedures employed. – I shall attempt to arrive at a reasonable answer to the problem thus stated by an examination of a variety of factors. Firstly, the Wisconsin and post-Wisconsin history of North America is reviewed, especially the full extent of the ice sheets and major outliers, the locations of possible refugia, the subsequent retreat of the ice fronts, and the major post-glacial lakes and river systems and their development to the present. Secondly, a brief review of the major weather systems at the Wisconsin peak and at the present time is presented. Thirdly, an examination is made of the ranges of the Alberta and eastern British Columbia Rhyacophilidae and Limnephilidae, and of Alberta's position with respect to the range areas, and each species is relegated to the range pattern which it best fits. Also, the species are examined as to groupings by similar habitats, to determine how this may be instructive. Lastly, an examination is made of the range relationships of each species to the remainder of its genus, or species group within a genus.

Literature on aquatic orders of North American insects. – While there have been many major faunal works on the wholly aquatic orders of North American insects, such as Betten *et al.* (1934), Milne (1934, 1935, 1936), Ross (1944), Flint (1960), and Denning (1963) on Trichoptera, Needham and Heywood (1929), Needham and Westfall (1955), and Walker (1953, 1958) on Odonata, Needham and Claassen (1925), and Frison (1935) on Plecoptera, and Burks (1953) on Ephemeroptera, none has attempted to elucidate the zoogeography or origins of the fauna dealt with.

Ross (1967) presented a study of evolution and dispersal of the world Trichoptera as a whole. In 1956 he dealt more fully with three families of Trichoptera. He also dealt (1953, 1958, 1965) with the effects of the Pleistocene and subsequent events on various nearctic insect groups, utilising primarily members of the wholly aquatic orders.

Various smaller papers dealing with members of discrete groups within wholly aquatic orders in North America also exist, such as those by Ross (1951, 1959) on Trichoptera, Ricker (1963), and Ross, Rotramel, Martin, and McAlpine (1967) on Plecoptera. But there is none, so far as I am aware, which deals with the aquatic fauna, or part of it, of a distinct geographical area such as I deal with here.

While reference is made in the following to papers which deal with non-aquatic groups of insects, where appropriate, in the elucidation of the problem before us, I make no reference to any such papers at this point. In dealing with fresh water insects, more especially the wholly aquatic orders, one is dealing with insects of a distinctly circumscribed habitat, at least in the immature stages, which would seem to set distinct limits to their dispersal patterns and pose problems peculiar to such groups. Ross (1956) mentions this especially with reference to the cool-adapted Trichoptera.

Synopsis of the glacial history of North America from the peak of the Wisconsin glaciation to the presnt

Extent of Wisconsin glaciation. – Figure 664 (from Flint, 1957 and Prest, 1969) outlines the maximum extent of ice cover at the peak of the Wisconsin glaciation in North America. While the continental ice cover originated from several centers to form a series of coalescing ice fields, in effect the land mass of northern North America appears to have been under a single mass of ice which connected, by way of the Arctic archipelago, to the still extant Greenland ice cap. In the west the southern ice margin closely but irregularly paralleled the Canada-United States boundary. South of this margin were located many ice fields (as many as 70 according to Flint, 1957) of varied extents scattered throughout the Cordillera. In the east the ice margin extended further south. Both coasts and their outlying islands were apparently icebound, as was also the Arctic archipelago. Alaska was only partly glaciated, most of the Yukon valley being ice free; this condition extended over into north east Siberia. The line passing north west from southern Alberta to the Arctic Ocean is the location of the line of coalescence between the Laurentide ice sheet to the east and the Cordilleran ice sheet to the west, the eastern edge of which flowed east through the Rocky Mountains to the Great Plains, there to be forced south east by the Laurentide sheet.

The time of initiation of final degradation of the Wisconsin ice is uncertain, and could have varied from place to place, but evidence suggests an average value of about 10,000 B. P., despite at least some readvances in certain areas. Gravenor and Bayrock (1961) estimate the final recession, or melting back, of the Wisconsin ice from southern Alberta to have started about 11,000 years B. P. In that area they consider the ice to have receded in a northerly or north easterly direction. This refers to the Laurentide ice sheet retreating from the line of coalescence with the Cordilleran ice sheet of the Rocky Mountains. The Laurentide sheet is now extinct but the Cordilleran sheet still exists in the scattered glaciers and ice fields of the Rocky Mountains, and can be assumed to have melted much more slowly than the Laurentide, presumably due to higher altitudes and location in deeper valleys which might be supposed to provide some protection from ablation processes. Presumably, also, the ice would be deeper in the major valleys and simply take longer to melt. It is interesting to speculate on the possibility that, at the time of general recession, while the greater part of Canada may still have been under ice, a corridor of deglaciated territory may have opened between the northwestern United States, western Canada, and the Arctic Ocean, possibly even through to the unglaciated part of Alaska, as this was relatively close to the line of coalescence (Fig. 664). Such a corridor would, in all probability, permit biotic interchange between Alaska and southern North America prior to complete deglaciation, possibly with results different from those that might be expected if the ice were to disappear uniformly, leaving the northern half of North America open to unimpeded colonisation. I have been unable to discover any record of such a corridor in the literature.

Locations of possible unglaciated areas. – Areas which were unglaciated during the Wisconsin, or any other glaciation, are of prime interest to the biogeographer, as they may have acted as refugia or foci of redispersal for plants and animals at a later date. In Fig. 664 roman numerals indicate the locations of known, or postulated, unglaciated areas and, therefore, possible refugia.

The Beringian refugium (I) is known definitely to have existed and includes the unglaciated areas of Alaska and northeast Siberia (Ball, 1963; Munroe, 1956). Prest, Grant, and Rampton (1968) in their 'Glacial map of Canada', and Prest (1969), show the western areas of the Yukon to have been unglaciated also. As Péwé, Hopkins, and Giddings (1965),

in their Fig. 2, show the unglaciated area of central Alaska to have extended widely to the Alaska-Yukon boundary, to coincide at least approximately with the unglaciated portion of the western Yukon, this area must have formed part of the Beringian unglaciated area and, therefore, of the Beringian refugium. Flint's map of Eurasia (1957: Fig. 24-1, and plate 3) shows a large unglaciated area between northeast Siberia and the remainder of Eurasia. From his map, however, it also appears that, at least in the Wisconsin glaciation, corridors may have existed to north or south of the glaciated area of Siberia, by which biotic movements may have occurred.

Flint (1957) shows all of northern Canada under ice, but three areas are thought to have been unglaciated and acting as refugia, at least for plants, at the time of the Wisconsin peak (Ball, 1963). There is some doubt as to the existence of the Mackenzie refugium (II) which, if it existed, was small. A refugium has been postulated for the western Arctic islands (III) but Savile (1961) and Munroe (1956) both express doubt on this point, for rather different reasons. Savile believed the islands to have been unglaciated but covered with snow for too long periods to permit survival. However, Leech (1966) does not believe that periods of snow cover, of one or more years, necessarily eliminate life. Munroe states that the islands were under such a load of ice that they were very largely submerged, as evidenced by pronounced emergence from the sea in recent times. Prest (1969) shows areas II and III to have been unglaciated. Leech (1966) is of the opinion that a refugium existed in northern Ellesmere Island, having investigated the spider fauna of the Lake Hazen area. The third possible refugium of the high Arctic is Peary Land in northern Greenland (IV), which seems definitely to have been unglaciated and to have acted as a refugium, for plants at least (Savile, 1961). Leech (1966), without limiting his statement to any one part of the biota, upholds the existence of the Peary Land refugium. As he decides that adjacent northern Ellesmere Island was a refugium for spiders, it is logical to assume that Peary Land would have been capable of supporting other animal life also.

One or more unglaciated areas have been postulated for eastern North America (V) (Fernald, 1925; Munroe, 1956; Lindroth, 1963) but, again it is uncertain whether they existed at all and, if so, where.

One other area within the ice sheet is known to have been unglaciated. This is the height of land of the Cypress Hills of southeastern Alberta and southwestern Saskatchewan (VI) (Westgate, 1964; Gravenor and Bayrock, 1961). The remaining unglaciated area, undoubtedly a refugium, is the entire southern half of North America (VII), except for the highland glaciers of the Cordillera.

Ross (1965) surmises that small, very local, refugia may have existed within the Cordilleran ice mass, on the higher mountain peaks rising above the ice.

Ball (1963) states that the distributions of most of the northern biota are explainable by dispersal from the two major unglaciated areas of central Alaska (I) and the area south of the main ice sheet (VII).

The distribution of the present day nearctic glaciers is given in Fig. 665.

Lakes of Wisconsin and post-Wisconsin time. – As an aid to understanding present distributions and dispersal routes of aquatic insects, the distribution and drainage patterns of the lakes of North America during the Wisconsin glaciation and after are examined. The information presented is derived from Flint (1957), Elson (1967), and Prest, Grant, and Rampton (1968). Figure 666 outlines the major lakes of North America during and after Wisconsin time. Lakes Lahontan and Bonneville lay south of the ice sheet. The remainder were covered by ice at the peak of the Wisconsin and formed along the southern edges of the ice as it retreated northward. In most cases each lake is reduced in size at the present time but only Lakes Ojibway-Barlow and Lahontan have essentially disappeared.

There were multitudes of small lakes, then and now, but they do not concern us here. The outlets of each lake are indicated, each having had several over a period of time as the ice edge retreated or readvanced.

Flint (1957) presents a history of the Great Lakes. Briefly, they drained south to the Mississippi River by various routes until eventually they were allowed to take their natural course east to the St. Lawrence River by the final recession of the ice. Lake Ojibway-Barlow was relatively small and drained south and east via the Ottawa valley. It was at one time joined to Lake Agassiz.

A history of Lake Agassiz is given by Elson (1967) in some detail. The lake varied greatly in size and position, draining first to the south and the Mississippi, then through several outlets, to the south as before, to the Great Lakes via Lake Nipigon, and to the north west and the Athabasca River. Finally, as the ice receded, it drained northeast to Hudson Bay and shrank to the present Lake Winnipeg. The Saskatchewan River drained eastward to Lake Agassiz and may at various times, though Elson does not provide information on this, have successively formed part of the Gulf of Mexico, Arctic, and finally the Hudson Bay watersheds. Prest, Grant, and Rampton (1968), in their 'Glacial map of Canada', show all western Canada, virtually to the western mountains, to have been under lake water at one time or the other since Wisconsin time. Presumably, apart from Lake Agassiz, small lakes or sloughs were involved.

Lake Lahontan apparently had no outlet. Lake Bonneville at one stage in its history drained north west to the Columbia River and the Pacific Ocean.

The study area of Alberta and eastern British Columbia embraces the headwaters of large rivers important to each of the major watersheds of North America except the Atlantic (Fig. 666; the darkened rivers). This curious juxtaposition of major watersheds seems to provide ideal conditions for dispersal of those aquatic organisms which, having their immature stages in aquatic habitats are, nevertheless, able to fly between neighbouring bodies of water as adults.

The large post-glacial lake system of North America, temporary though some of its constituents may have been, probably provided very suitable pathways for dispersal of aquatic organisms from east to west and vice versa, more particularly for still water forms. The entire system stretching from Alberta to Ontario, Quebec, and the northeastern United States has, at various times since the last glaciation, formed a gigantic, shifting network of waterways. It seems possible that the distribution patterns of Trichoptera may at least partially reflect this, and the point is examined below.

Synopsis of climatic history of North America from Wisconsin time to the present

Bryson and Wendland (1967) proposed a sequence of weather pattern shifts from the peak of the Wisconsin glaciation to the present. They describe the effects of the shrinking Laurentian ice mass on air masses and the subsequent effects on weather. They consider the effects of climatic changes on the biota, largely the forest and grassland biotas along the southern edges of the ice sheet as it contracted. They do not consider it reasonable to regard vegetation zones to be controlled and located where they are simply by single factors, no matter how closely the boundaries of the zone and any value of the factors may coincide. The control must be the result of a variety of factors acting as annual, or at least seasonal, means. They utilise the mean positions of the various frontal zones and determine the possible past positions by an examination of what is known about former and present vegetation zones. I summarize their plotting of the postulated winter and summer mean positions

of the Arctic frontal zones for the period about 10,000-13,000 years B. P., and for the present time (Fig. 667). The general trend towards the present was for the frontal zones to migrate north as the ice sheet dwindled. In the period 3,500-5,000 years B. P. they estimate that the fronts were actually further north of their present positions, but have readvanced slightly southward.

The Arctic frontal means are used as indicators of cooler areas of the continent, and hence of increasing warmer conditions south of the mean frontal zones as they tended northward. The result, as shown in Bryson and Wendland, has been a shift northward of the North American biotic zones, more particularly, for the central plains of North America, of the boreal forest, and the grasslands. At about the time of retreat of the glaciers from Alberta the area was under boreal forest, which has since moved northward to make way for the present day grasslands of the southern part of the province. A similar effect can be expected in the mountains, except that it would be an altitudinal shift. Bryson and Wendland indicate that there was essentially no tundra belt between the receding ice front and the encroaching boreal forest belt; that, in fact, the forest may have established itself immediately icebound moraine was uncovered. Exactly where tundra may have survived as such is not indicated, but it may reasonably be expected to have existed in the various far northern unglaciated areas, or refugia. The overall result was a general shift of the various floras and faunas northward, and upward in the Cordillera, with subsequent isolation of at least some species on scattered mountain ranges.

As to the speed with which the biota responded to climatic shifts, Bryson and Wendland indicate that deglaciation is due to climatic changes and lags behind these changes. The result is that the areas beyond, and close to the edges of the ice sheet, were climatically suitable for vegetation prior to removal of the ice. That is, there is no reason to doubt that, for example, there could be forest right up to the edges of the ice (see preceding paragraph). Lindroth (1965), investigating the vegetated area of Skaftafell adjacent to a receding glacier in Iceland, concludes that there is nothing unusual in vegetation occurring in immediate proximity to glacial ice, whether advancing or receding. Presence or absence of vegetation in such a situation is dependent on macro-climate rather than on the presence of the ice itself. A superb example of dense *Nothofagus* forest in Argentina within feet of an active glacier is given in plate 14 of Tilman (1957). Westgate (1964) presents evidence of ponds with vegetation and animals not only at the ice edge, but on the ice itself, wherever debris was sufficiently accumulated to provide a substrate for the biota.

In the west the mean frontal zones clearly trend north west toward Alaska or the Mackenzie delta area (Fig. 667). This is true of both the ancient and modern frontal zones, and for the zones of intermediate periods postulated by Bryson and Wendland. This appears probably to be due to the presence of the western Cordillera, which acts as a barrier, preventing the fronts from extending westward to the coast. Bryson and Wendland show the remaining ice mass (at about 8,000 years B. P.) to be located between Great Slave Lake and Labrador, and between northern Baffin Island and northern Ontario. It is reasonable then to suppose that the ice tended, at least at its southern and western boundaries, to retreat along the frontal zones. Here is some support for the corridor between Alaska and the unglaciated portion of North America, east of the mountains, and right through the study area, as postulated above.

Distribution of the Rhyacophilidae and Limnephilidae of Alberta and eastern British Columbia

The species of Rhyacophilidae and Limnephilidae known from the study area have been

found to fall into 12 basic distribution patterns. These are outlined in Fig. 668 and 669. I have grouped them into two primary types for convenience. The first type comprises those species which are confined strictly to western North America, tending generally to follow the various ranges of the western Cordillera (Fig. 668). The second type comprises those species which extend beyond, or exist only east of the Cordillera (Fig. 669). The patterns as illustrated outline the general area occupied by the species from which they are drawn. They are not exact delineations of species ranges.

The ranges of Trichoptera in North America are, as yet, relatively poorly known, and much intensive collecting is required before accurate statements can be made about range patterns. However, for the present study, current knowledge will have to suffice. The species ranges used in determining these range patterns do not necessarily extend throughout the full extent of the patterns to which they belong. The boundaries are really composites of species ranges which appear to follow a common pattern, however incompletely.

Table 2 lists the range patterns in numerical order, giving the species known from each, and the range map number of each species in the taxonomic portion of this study. Following is presented a brief outline of each range pattern, in numerical order.

Range pattern 1. This pattern extends from central Alaska south, embracing the enitre western Cordillera, as far south as the southwestern United States. The Alberta species included are mostly mountain stream species, but a few are usually found at higher altitudes, in the bogs or pools of the high passes and alpine meadows. This pattern is equivalent to Munroe's (1956) type W5.

Range pattern 2. This pattern extends from central Alaska to Colorado, along the eastern ranges of the Cordillera. Only three Alberta species are included, two of which are species of the lower mountain streams; the third, *Imania tripunctata*, is found at higher altitudes and is rather uncommon.

Range pattern 3. This pattern is similar to type 1, but without the extension to the Yukon and Alaska. It contains a large number of species, most of which are inhabitants of mountain streams of varying degrees of rapidity and turbulence. This pattern is equivalent to Munroe's type W3.

Range pattern 4. This pattern extends from the Alberta Cordillera to California, via Idaho, Washington, and the Cascade ranges. It contains a small selection of species which inhabit the lower mountain streams and lakes.

Range pattern 5. Species included in this pattern follow the eastern ranges of the Cordillera from Alberta to Colorado, and inhabit mountain streams. This pattern is equivalent to Munroe's type W2.

Range pattern 6. This pattern embraces species which are either very restricted in range, largely to the Cordillera of Alberta, or are known only from the type localities; several are described above as new. It is not so much a pattern as a collection of species which cannot yet be assigned to any of the other patterns. Specimens of several of the species may simply be rarely taken, and thus are poorly known. The range pattern embraces the Cordillera of Alberta, British Columbia, Washington, and Idaho. The great majority of included species are found near mountain creeks or ponds ranging to the higher alpine meadows, and largely comprise members of genera which are reputedly rare (Ross, 1950b; Denning, 1964; Wiggins and Anderson, 1968).

Range pattern 7. This pattern embraces the greater part of North America, extending from Alaska east to Newfoundland and Greenland, and south east to New Mexico. In the United States it is restricted largely to the eastern ranges of the Cordillera. The species included in this pattern inhabit streams and rivers.

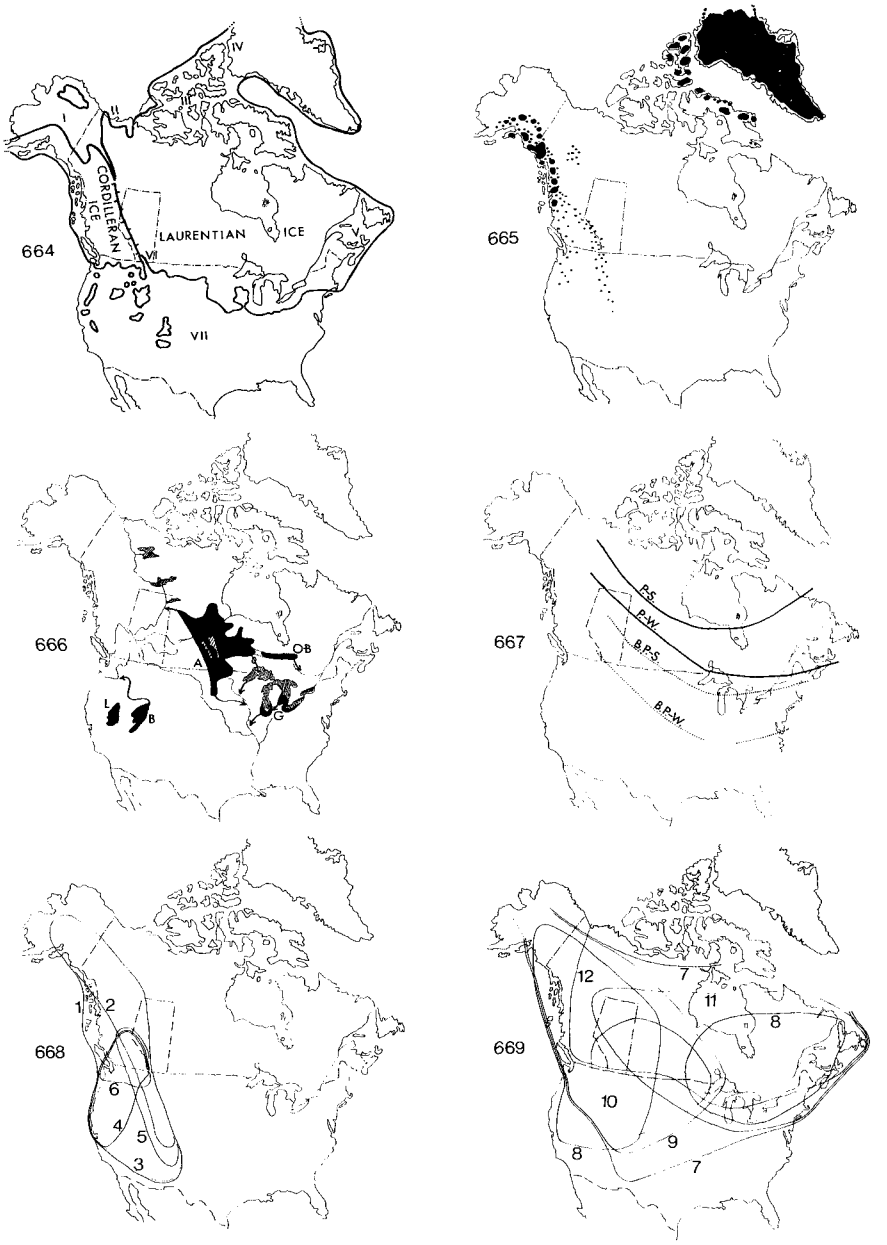


Fig. 664-669. 664. Maximum distribution of glacial ice in North America at the peak of the Wisconsin glaciation, showing locations of known and suspected unglaciated areas (roman numerals), and line of coalescence between the major ice masses (toothed line). Compiled from Flint (1957), Westgate (1964), and Prest, Grant, and Rampton (1968). 665. Present day distribution of nearctic glaciers. From Flint (1957). 666. Composite map of major periglacial and pluvial lakes of North America (black areas) and present major lakes (hatched areas), showing various drainage patterns which existed post-glacially and which are now extinct (arrows). A – Lake Aggasiz; B – Lake Bonneville; G – Great Lakes; L – Lake Lahontan; O-B – Lake Ojibway-Barlow. Compiled from Flint (1957), and Elson (1967). 667. Map of North America showing the mean positions of the Arctic frontal zone 10,000-13,000 years B. P. in summer (B. P. – S.) and winter (B. P. – W.). Derived from Bryson and Wendland (1967). 668. Range patterns 1-6 exhibited by Alberta species of Rhyacophilidae and Limnephilidae. 669. Range patterns 7-12 as exhibited by Alberta species of Rhyacophilidae and Limnephilidae.

Table 2. Species of Rhyacophilidae and Limnephilidae from the study area listed under the range pattern to which each belongs.

Pattern no.	Species	Map Fig.
1	*Rhyacophila vobara* Milne	115
	Rhyacophila rickeri Ross	112
	Rhyacophila vepulsa Milne	113
	Rhyacophila tucula Ross	105
	Rhyacophila vofixa Milne	107
	Rhyacophila verrula Milne	118
	Psychoglypha ulla (Milne)	660
	Ecclisomyia conspersa Banks	599
	Lenarchus brevipennis Banks	647
	Lenarchus fautini Denning	647
	Lenarchus vastus (Hagen)	646
	Asynarchus aldinus (Ross)	643
	Hesperophylax incisus (Banks)	649
2	*Rhyacophila alberta* Banks	104
	Limnephilus sansoni Banks	608
	Imania tripunctata (Banks)	596
3	*Rhyacophila hyalinata* Banks	111
	Rhyacophila vaccua Milne	116
	Rhyacophila pellisa Ross	114
	Rhyacophila bifila Banks	109
	Rhyacophila coloradensis Banks	110
	Dicosmoecus atripes (Hagen)	592
	Oligophlebodes sierra Ross	604
	Oligophlebodes ruthae Ross	603
	Limnephilus spinatus Banks	624
	Neothremma alicia Banks	605
	Hesperophylax occidentalis (Banks)	648
	Ecclisomyia maculosa Banks	598
	Amphicosmoecus canax (Ross)	595
	Clistoronia magnifica (Banks)	635
4	*Limnephilus nogus* Ross	619
	Limnephilus lopho Ross	623
	Dicosmoecus jucundus Banks	593
	Hesperophylax consimilis (Banks)	648
5	*Limnephilus cockerelli* Banks	622
	Homophylax baldur Nimmo	607
	Rhyacophila vagrita Milne	119
	Apatania shoshone Banks	601
6	*Rhyacophila vemma* Milne	120
	Rhyacophila belona Ross	112
	Rhyacophila glaciera Denning	106
	Rhyacophila milnei Ross	119
	Rhyacophila chilsia Denning	115
	Rhyacophila species 1	121
	Rhyacophila species 2	121
	Homophylax crotchi Banks	606
	Homophylax acutus Denning	606
	Oligophlebodes zelti Nimmo	604
	Neothremma laloukesi Schmid	605
	Limnephilus susana Nimmo	612
	Limnephilus valhalla Nimmo	622
	Limnephilus alberta Denning	629
	Limnephilus species 1	612
	Philocasca thor Nimmo	653
	Apatania alberta Nimmo	602
	Psychoglypha prita (Milne)	657
	Psychoglypha schmidi Nimmo	658
	Ecclisomyia species 1	600
	Imania bifosa Ross	597
	Imania cascadis Ross	597
	Imania hector Nimmo	597
	Limnephilidae species 1	661
	Limnephilidae species 2	661
	Limnephilidae species 3	662
	Limnephilidae species 4	662
	Limnephilidae species 5	663
7	*Limnephilus infernalis* (Banks)	613
	Limnephilus ornatus Banks	615
	Limnephilus externus Hagen	617
	Limnephilus femoralis (Kirby)	620
	Limnephilus minusculus (Banks)	631
	Limnephilus hyalinus Hagen	627
	Limnephilus rhombicus (L.)	634
	Limnephilus sublunatus Provancher	607
	Limnephilus perpusillus Walker	628
	Pycnopsyche guttifer (Walker)	652
	Nemotaulius hostilis (Hagen)	637
	Asynarchus curtus (Banks)	642
	Anabolia bimaculata (Walker)	640
	Apatania stigmatella (Zetterstedt)	602

Table 2 (continued)

Pattern no.	Species	Map Fig.
8	*Rhyacophila acropedes* Banks	108
	Rhyacophila angelita Banks	117
	Lenarchus crassus (Banks)	646
	Onocosmoecus unicolor (Banks)	594
	Limnephilus sericeus (Say)	618
	Limnephilus moestus Banks	621
	Glyphopsyche irrorata (Fabricius)	654
	Arctopora pulchella (Banks)	654
	Chyranda centralis (Banks)	650
9	*Limnephilus nigriceps* (Zetterstedt)	633
	Limnephilus secludens (Banks)	625
	Limnephilus picturatus McLachlan	616
	Asynarchus mutatus (Hagen)	641
	Philarctus quaeris (Milne)	644
	Psychoglypha alaskensis (Banks)	659
	Apatania crymophila McLachlan	601
10	*Limnephilus labus* Ross	630
	Limnephilus janus Ross	626
11	*Limnephilus indivisus* Walker	614
	Limnephilus argenteus Banks	629
	Limnephilus extractus Walker	609
	Limnephilus canadensis Banks	635
	Limnephilus parvulus (Banks)	623
	Anabolia consocia (Walker)	638
	Anabolia ozburni (Milne)	639
	Phanocelia canadensis (Banks)	656
	Pycnopsyche subfasciata (Say)	651
12	*Limnephilus kenicotti* Banks	632
	Limnephilus hageni Banks	610
	Limnephilus partitus Walker	611
	Chilostigmodes areolata (Walker)	655
	Grammotaulius interregationis (Zetterstedt)	636
	Apatania zonella (Zetterstedt)	600

Range pattern 8. This pattern comprises an eastern and a western region. The western region extends from Alaska to California and Colorado, and eastward almost to Manitoba. The eastern region extends from Manitoba eastward to Newfoundland. There are no records known, for any of the species which are included within this pattern, for the intermediate area, which variously includes all or parts of at least Saskatchewan and Manitoba. The species included here variously inhabit, in the study area, mountain creeks, the swamps of the lower mountain valleys, and the higher passes.

Range pattern 9. This pattern extends from Alaska southeastward, in a widening belt, to Colorado and Ontario. In the United States Cordillera it is confined to the eastern ranges south of Idaho. The included species inhabit primarily lakes, sloughs, or streams in low mountain valleys.

Range pattern 10. This pattern embraces the great central plains of North America and includes only two species. The pattern is equivalent to Munroe's (1956) type C4.

Range pattern 11. This pattern extends from the eastern edges of the Cordillera in Alberta, to the Great Lakes states of the United States, Labrador, and Newfoundland. Alberta represents the western limits for all the included species of this type. These species occur in lakes, sloughs, and slower streams. This pattern coincides with Munroe's (1956) type B.

Range pattern 12. This pattern embraces virtually all of Canada, with its southern boundary extending into the United States south of the Great Lakes. At least one species, *Apatania zonella*, is known to extend northward to the Arctic archipelago. The included species emerge from lakes, sloughs and, perhaps, the slower rivers.

Distributional relationships of Alberta species of Rhyacophilidae and Limnephilidae to the remainder of their respective genera or species group

In this section are examined the spatial relationships of the Alberta Trichoptera dealt with in this study to other species of their respective genera, or species groups within genera. The purpose in so doing is to determine whether it is possible to educe the provenance of the Alberta species after the Wisconsin glaciation.

The Rhyacophilidae. – None of the North American species of *Rhyacophila* is known to be holarctic. With the exception of two transcontinental species, the Alberta species are restricted to the western Cordillera.

The *alberta* group. Of the four species known to belong to this group, *kincaidi*, *alberta*, *tucula*, and *glaciera*, the last three are represented in the study area; *kincaidi* is known only from the Cascade ranges of Washington (Ross, 1956); *glaciera* is known only from Montana and Alberta (Fig. 106). The two species *alberta* and *tucula* are known from Alaska to the Rocky Mountains of the United States (Fig. 104, 105). These two species are very similar and occupy somewhat mutually exclusive ranges, *tucula* to the west, *alberta* to the east; there are no records from the Yukon.

The *vofixa* group. Of the two very similar species of this group only *vofixa* is known from the study area; its range extends from Alaska and the Yukon to Idaho (Fig. 107). The other species, *harmstoni*, is known only from Colorado and Utah.

The *acropedes* group. Ross (1956) lists 11 species in this group, three of which are eastern Asiatic. According to Ross (1956) the seven North American species are confined to the western Cordillera, except for *acropedes*, which is also known from eastern North America. Ross considers that the group originated in eastern Asia, spread to western North America, whence a second, reverse, interchange occurred, back to Asia, to give the present set of species. As this undoubtedly occurred prior to the Wisconsin glaciation it is of little interest at present. According to Ross the North American species of the group are restricted to the western coastal ranges, except for *acropedes* (Fig. 108). Smith (1968) records *vao* from as far east as Idaho. I record *vemna* from Alberta; Smith records it from Idaho (Fig. 120). Thus these two species are not as restricted as Ross supposed. Ross derives *acropedes* from *vao* as the result of an eastward spread, after which *acropedes* spread west to coincide with *vao*. Thus the origin of the North American species of this group is apparently located in the coastal mountain ranges. It may be supposed that the ranges of the species prior to the Wisconsin glaciation were much as they are today, south of the southern limit of ice.

The *invaria* group. This group has an Appalachian branch of six species, and a Cordilleran branch of five species. Two of the western species, *bifila* and *coloradensis*, are known from the study area (Fig. 109, 110) and are general throughout the Cordillera. Two other species, *amabilis* and *kernada*, are known only from southern California, and the fifth, *insularis*, is known only from Vancouver Island.

The *hyalinata* group. This group, comprising four species, is of peculiar distribution; three species are located in western North America, while the fourth is known from the Caucasus. Ross (1956) cannot be certain that this European species belongs to this group, as he has seen only drawings. Only one North American species, *hyalinata*, is known from the study area; it is widely distributed in the Cordillera as a whole (Fig. 111). Of the remaining two species, *sonoma* is known only from California, and *vocala* from the Cascade ranges from Oregon to British Columbia.

The *sibirica* group. This is a large group of 26 species, four of which are known from the study area. These four species are rather dissimilar belonging to different lineages within the

group (Ross, 1956:95). One species is known from Europe, several more from eastern Asia, and the greater number from North America, being divided into eastern and western groups. Ross (1956) postulates a western North American origin for the group, with dispersal in time to Asia and eastern North America. There are no holarctic species. Of the Alberta species, two, *vepulsa* and *pellisa*, are widespread; *vepulsa* ranges from Alaska to California (Fig. 113); *pellisa* appears to be limited to Alberta in the north, is not recorded from British Columbia, though it almost certainly occurs there, and extends south by both the coastal and eastern ranges of the Cordillera (Fig. 114). Of the other two species, *belona* is restricted to the Idaho-Alberta area, and *rickeri* extends from the Alberta-British Columbia Cordillera to Alaska.

The *betteni* group. This group comprises eight species, all confined to the Cordillera of western North America. All but the two species known from the study area are confined to the Cascade ranges of California and Oregon. Of the two known from Alberta one, *chilsia*, is known only from the Alberta Cordillera (Fig. 115); the second, *vaccua*, is widespread, but barely extends south along the eastern ranges of the Cordillera (Fig. 116). Ross (1956) is of the opinion that the group originated in the coastal ranges and has spread eastward from there.

The *vobara* group. Two species comprise this group, *iranda* and *vobara*, of which the latter is known from the study area. The other species is known from the coastal ranges of Oregon.

The *angelita* group. This group contains three species, two of which, *perplana* and *vuzana*, are known only from the Cascade ranges of the coast; the third species, *angelita*, is widespread throughout the Cordillera, from the Yukon to California and Colorado (Fig. 117). It is also recorded from the northern Appalachians, in what must surely be an isolated population; it seems reasonable to suppose that isolation occurred post-glacially.

The *verrula* group. Only one species, *verrula*, is known in this group. It ranges widely from Alaska to California and Colorado (Fig. 118).

The *vagrita* group. The two very similar species of this group are both known from the study area. These are *vagrita* and *milnei* (Fig. 119). Only *vagrita* is widespread, extending to Utah; *milnei* is known only from the type locality at Banff, Alberta.

The Limnephilidae. – The 91 species known from the study area are not distributed so narrowly as the Alberta Rhyacophilidae. Some species are known only from the western Cordillera of North America; others are widespread transcontinentally, and from north to south; others are holarctic, if not circumpolar.

The genus *Dicosmoecus*. Of the 10 species of *Dicosmoecus* (Schmid, 1955), two are known from the study area. Of these two, *atripes* is widespread throughout the Cordillera, from Alberta and British Columbia to California and New Mexico (Fig. 592); *jucundus* (Fig. 593) has a similar distribution except that it is unknown from the eastern ranges. The remainder of the genus is distributed between eastern Asia (two species) and western North America (eight species). Of the North American species, the general distributional pattern is centered on the coastal ranges from California to British Columbia, with one species known only from Alaska.

The genus *Onocosmoecus*. Of the eight species of *Onocosmoecus* (Schmid, 1955) only one is known from the study area (*unicolor*). This species is distributed from Alaska to California, New Mexico (Fig. 594), and eastern North America, with a large gap between the eastern and western ranges. As this species is known from streams of the plains regions of Alberta the gap must be viewed with suspicion, as being due to insufficient collecting. One species of *Onocosmoecus* is known from eastern Asia, the remainder being North American and confined to the Cordillera with the exception of *quadrinotatus*,

which ranges from Newfoundland to Michigan and the White Mountains of New Hampshire.

The genus *Imania*. Of the 10 known species of *Imania*, Schmid (1955) lists eight; the ninth is described above as new; the tenth is described by Schmid (1968) as new. Four species are known from the study area: *bifosa*, *cascadis*, *tripunctata*, and *hector*. Of these, *hector* is known only from Alberta (Fig. 597); *bifosa* is known only from Alberta and British Columbia; *cascadis* from Washington, Oregon, and Alberta (Fig. 597); and *tripunctata* is widespread from Colorado and Washington to Alaska (Fig. 596). Ross (1950b) refers to *tripunctata* as occurring as isolated, higher altitude, populations, particularly in the southern extremities of its range. Of the genus as a whole one species is known from eastern Asia; the remaining four species are known from isolated localities in Colorado (*gnathos*), Nevada (*renoa*), and Washington (*acanthis* and *cidoibes*).

The genus *Amphicosmoecus*. This genus is represented by a single species, *canax*, which is widespread from Alberta and British Columbia to California and Utah (Fig. 595).

The genus *Ecclisomyia*. Of the six species of this genus (Schmid, 1955), two are known from the study area (*maculosa* and *conspersa*); a third, undescribed species is represented by a single female. Both Alberta species are widespread in the Cordillera. The species *conspersa*, which ranges from Alaska to California and New Mexico (Fig. 599), has a more extensive known range than *maculosa*. The latter ranges from Alberta and British Columbia to Colorado (Fig. 598). Of the remaining four species two, *digitata* and *kamtshatica*, are known only from eastern Asia, and the other two, *scylla* and *bilera*, are known only from British Columbia to Oregon, and California respectively.

The genus *Apatania*. This genus contains 50 species, five of which are known from the study area; one is described above as new. Twelve species are recorded from North America; of these, three are holarctic and known from Alberta or just north of Alberta. The remaining species of the genus are widespread through Eurasia. The species known from the study area, or closely adjacent areas, are *zonella*, *stigmatella*, *shoshone*, *crymophila*, and *alberta*. Of these species *zonella* (Fig. 600), *stigmatella* (Fig. 602), and *crymophila* (Fig. 601) are northern in distribution in North America, and holarctic in total. *A. stigmatella* has been recorded from Colorado; this is either an error, or represents a peculiarly isolated population. Of the remaining two species *shoshone* is known from Alberta south, along the eastern Cordillera, to Colorado; *alberta* is known only from around Banff, Alberta.

The genus *Oligophlebodes*. Of the seven species of *Oligophlebodes* three are known from the study area, one being described above as new. Of the Alberta species *zelti* is known only from several localities in Alberta (Fig. 604); *sierra* is widespread from Alberta and British Columbia to Colorado and California (Fig. 604); and *ruthae* is confined to the eastern ranges of the Cordillera, from Alberta and British Columbia to Oregon and Utah (Fig. 603). Of the four remaining species of the genus one is known only from Colorado (*ardis*), another is known only from New Mexico and Utah (*sigma*), the third is widespread from New Mexico to Wyoming and South Dakota, and is the most easterly species of *Oligophlebodes* (*minuta*), and the fourth (*mostbento*) is known only from Oregon.

The genus *Neothremma*. Of the four species of *Neothremma* (Schmid, 1955; 1968) two, *alicia* and *laloukesi*, are known from the study area; the total known range of *alicia* extends from Alberta and British Columbia to Oregon and Colorado (Fig. 605). At present *laloukesi* is known only from Alberta. The other two species (*didactyla* and *galena*) are known only from Washington.

The genus *Homophylax*. Denning (1964) revised this genus, and listed eight species. One further species was described above as new, raising the total to nine. Three species are

known from the study area (*crotchi*, *acutus*, and *baldur*). Of these *crotchi* is known only from a very small range, from southern Alberta to Vancouver Island and Washington (Fig. 606); *acutus* is known only from Idaho and Alberta (Fig. 606) but, being only recently described by Denning (1964) will almost certainly be found to extend further; and *baldur* is known only from Utah and far southwestern Alberta (Fig. 607). Of the remaining six species *andax* is known from southeast Alaska to Oregon; *flavipennis* is known from Colorado to Montana; *insulas* is known only from California; *rentzi* only from California; *nevadensis* from California and Nevada; and *adriana* only from New Mexico. More so than other rare genera, *Homophylax* appears to be divided into distinct eastern and western species groups. Much more almost certainly remains to be known of the range of species of *Homophylax*. The genus is rarely represented in collections and appears to be rare in nature. This apparent rarity may, however, be due to secretive habits and high altitude distribution, thus making collection difficult.

The genus *Limnephilus*. This is one of the larger genera of Trichoptera, and the largest of the Limnephilidae. Schmid (1955) lists 140 species in the genus of which seven are *incertae sedis*. In this study two new species of *Limnephilus* are described, raising the total to 142. Of this number of species one is listed from South America, 63 from North America only, and seven are holarctic. Of the 33 species known to occur in the study area one is undescribed (the female only is known), and six are holarctic.

Of the *rhombicus* group only one species, *rhombicus*, is known from the study area. This species is holarctic in distribution with an extensive North American range (Fig. 634); the remaining four species are variously known from Asia and eastern Europe, but one is known from Spain (Schmid, 1955). This group would appear to be decidedly Eurasian in origin.

Of the 11 species of the *subcentralis* group six are known from the study area, including one new species. These species are *sansoni*, *extractus*, *hageni*, *sublunatus*, *partitus*, and *susana*. One other species is undescribed as only the female is known. None of the Alberta species are holarctic; *sansoni* extends from Alaska to Colorado, along the eastern ranges of the Cordillera (Fig. 608); *extractus* extends from Alberta and Great Slave Lake to New Hampshire (Fig. 609); *sublunatus* extends from British Columbia to Colorado and Quebec (Fig. 607); *partitus* extends from British Columbia to the Northwest Territories and Newfoundland (Fig. 611); and *susana* is known only from the type locality in Alberta (Fig. 612). The remaining five species are known variously from Europe to Siberia, with one species, *elongatus*, from the Northwest Territories.

Of the seven species of the *stigma* group two, *infernalis* and *indivisus*, are known from the study area. Both are distributed in a northern transcontinental pattern, *infernalis* from Alaska to New Hampshire (Fig. 613), and *indivisus* from British Columbia to Illinois and Nova Scotia (Fig. 614). The remaining five species are variously known from Europe to eastern Siberia.

Only one species, *ornatus*, is known in the *ornatus* group. Its range in North America is northern transcontinental, from Alaska to Illinois, Newfoundland and Greenland (Fig. 615). Schmid (1955) also reports it from Japan.

One of the two species of the *picturatus* group is known from the study area. This species, *picturatus*, is holarctic, ranging from Sweden to North America, where it extends from Alaska to Colorado and Hudson Bay (Fig. 616). The second species is known only from British Columbia.

Of the two species of the *externus* group, like the *picturatus* group, one, *thorus*, is isolated in North America, in Utah; the second species, *externus*, is holarctic, ranging from Europe to North America. In North America it ranges from Great Slave Lake to California

and Newfoundland (Fig. 617).

The *sericeus* group, with two species, is limited to North America. The species known from the study area, *sericeus*, is northern transcontinental in range, from Alaska to Oregon and Maine (Fig. 618) with an apparent mid-continental gap. The second species, *fagus*, is known only from Oregon.

Of the three species of the *morrisoni* group one, *lopho*, is known from the study area. This species is restricted to Oregon, British Columbia, and Alberta (Fig. 623). The remaining two species, *castor* and *morrisoni*, are restricted to the western ranges of the Cordillera.

The *sitchensis* group contains seven species, of which three are known from the study area. These are *moestus*, *cockerelli*, and *valhalla*. The group is restricted to North America. With the exception of *moestus*, all are restricted to the western Cordillera. Of the Alberta species *moestus* is most widespread, ranging from British Columbia to Colorado, Newfoundland, and Greenland (Fig. 621); *cockerelli* is restricted to the eastern ranges of the Cordillera (Fig. 622); and *valhalla* is known only from the area of the Albertan continental divide (Fig. 622).

The single species of the *luridus* group known from the study area, *femoralis*, is holarctic in distribution, ranging from Europe to North America. It ranges from Alaska to Washington, Maine, and Greenland (Fig. 620) in North America. The other known species, *luridus*, is known only from northwest Europe.

Of the six species of the *fenestratus* group two, *minusculus* and *kennicotti*, are known from the study area. Of these two *minusculus* is widespread, ranging from Alaska to Colorado and Labrador (Fig. 631); *kennicotti* ranges from British Columbia to Newfoundland (Fig. 632), with records from Greenland, so it is probably also present in northern Canada, though there are no records known to me. The remaining four species are palaearctic (*dispar*), known only from Oregon (*sylviae*), restricted to the eastern ranges of the Cordillera (*coloradensis*), or holarctic (*fenestratus*).

The *nogus* group contains one species, *nogus*. It is not known from Alberta, but has been taken at Hosmer, British Columbia, only 30 miles from Alberta, and within the study area. Its known range extends from southern British Columbia south, along the western coastal ranges of the Cordillera (Fig. 619).

Of the nine species of the *incisus* group four, *secludens*, *janus*, *hyalinus*, and *perpusillus*, are known from the study area. Of these four *secludens* ranges from Great Slave Lake to Wisconsin, New Mexico and California (Fig. 625); *janus* ranges across the central plains of North America, from Alberta to Wisconsin and Colorado (Fig. 626); *hyalinus* is transcontinental, ranging from Alaska to Colorado and Newfoundland (Fig. 627); and *perpusillus* is distributed through the central plains (Fig. 628). Of the remaining five species in the group two are European, one is known only from Colorado (*tarsalis*), one from New Brunswick (*ademus*), and the last from California (*acnestus*).

The *asiaticus* group contains 12 species, of which eight are known variously from Europe and different parts of Asia, and four are North American. None are holarctic. Of the four North American species only one, *labus*, is known from the study area. It ranges from Alberta to Idaho and Colorado (Fig. 630). The remaining three species are restricted to the western ranges of the Cordillera (*lunonus*), to the southwestern United States and Mexico, and, according to Schmid (1955), has been reported from Oregon and Washington (*frijole*), and to Alaska and the Northwest Territories (*pallens*).

The four species of the *diversus* group are restricted to North America. The single species known from the study area, *canadensis*, is known only from scattered records from Alberta to Maine (Fig. 635). Of the remaining species in the group, *diversus* is known only from

Arizona and Colorado, *productus* from California and Utah, and *acula* simply from the western United States (Schmid, 1955).

Of the seven species of the *assimilis* group two are known from the study area. Of these two *parvulus* ranges from Alberta and Great Slave Lake to Quebec and New Hampshire (Fig. 623); *spinatus* is strictly western, ranging from Alberta to California and Colorado (Fig. 624). The remaining five species are restricted to North America; *assimilis* is known only from Arizona and California; *taloga* from Oklahoma and Utah; *acrocurvus* from Minnesota; *arreto* from the western ranges of the Cordillera in California, Oregon and Washington; and *occidentalis* from Oregon, Washington and British Columbia.

Of the *nigriceps* group one species, *nigriceps*, is known, ranging from Alaska to Manitoba (Fig. 633).

Only one species, *alberta*, is known for the *alberta* group. This species is known only from the Cordillera of Alberta and adjacent areas of British Columbia.

Again only one species, *argenteus*, is known in the *argenteus* group, ranging from Alberta and Great Slave Lake to Illinois (Fig. 629).

The genus *Grammotaulius*. Of the nine species of *Grammotaulius* only three are known in North America. The remainder are known variously from Europe and Asia. Of the North American species only one, *interregationis*, is known from the study area. This species ranges throughout northern North America (Fig. 636), from the Yukon to Nova Scotia and Greenland. Of the other two species *lorettae* is known only from Colorado, and *betteni* from Oregon and British Columbia. Schmid (1955) queries a record of *betteni* from Shanghai, as would I.

The genus *Nemotaulius*. Of the six species of *Nemotaulius* only one, *hostilis*, is known from North America, and the study area. It ranges across central North America from British Columbia to Newfoundland, and from Great Slave Lake to Colorado (Fig. 637). The remaining species are European or Asian in distribution.

The genus *Anabolia*. Of the three groups, and series of ungrouped species in this genus, members of only two groups are known from the study area, totalling three species. There are 15 species in *Anabolia* (Schmid, 1955) of which only four are nearctic. The remainder are Eurasian species. Two species, *consocia* and *ozburni*, are known from the study area; the remaining two species are palaearctic. *A. consocia* ranges from Alberta to South Dakota, Maine, and Quebec (Fig. 638); *ozburni* ranges throughout the same area but is less well recorded (Fig. 639). One species, *bimaculata*, of the *bimaculata* group, is known from the study area; it ranges extensively throughout North America (Fig. 640). The second species of the group, *sordida*, is very similar to *bimaculata* and ranges throughout central North America (Schmid, 1955).

The genus *Asynarchus*. Of the 17 species of *Asynarchus* (Schmid, 1955) two are *incertae sedis*, from North America, eight are strictly North American, and two are holarctic. The five strictly palaearctic species are variously distributed from northern Europe to Japan and Siberia. Of the species known from North America three, *aldinus*, *mutatus*, and *curtus*, are known from the study area. Of these three *aldinus* ranges from Great Slave Lake to Idaho (Fig. 643); *curtus* is northern transcontinental, from Alaska to Labrador and Colorado (Fig. 642); and *mutatus* ranges from British Columbia to Great Slave Lake and Ontario (Fig. 641). The remaining seven North American species are variously known from Utah, Michigan, British Columbia, the western Cordillera, Washington, or are northern holarctic.

The genus *Clistoronia*. All four species of *Clistoronia* are strictly North American; only one species, *magnifica*, is known from the study area, ranging from British Columbia and Alberta to Oregon and Utah (Fig. 635). Of the remaining three species *flavicollis* is known

only from Alaska and British Columbia; *formosa* from Utah and Idaho; and *maculata* from Arizona and New Mexico.

The genus *Philarctus*. This genus appears to be definitely Oriental in origin; of the seven species (Schmid, 1955) six are known from various parts of Siberia, central Asia, China, and the Himalaya. The seventh species, *quaeris*, is known only from North America, ranging from Great Slave Lake to Oregon, Colorado, and Minnesota (Fig. 644).

The genus *Arctopora*. The three species of *Arctopora* are known from North America. One, *trimaculata*, is northern holarctic, and unknown from the study area. The second species, *pulchella*, limited to North America, is known from the study area, and ranges from British Columbia to Michigan, Maine, and Newfoundland (Fig. 645). The third species, *salmon* Smith (1969), is known only from Iadho.

The genus *Lenarchus*. Three subgenera, *Prolenarchus*, *Lenarchus*, and *Paralenarchus*, are recognized by Schmid (1955). The second and third are represented in the study area by four species. The subgenus *Prolenarchus* contains two species, one northern European, the other known only from Michigan and Ontario. The subgenus *Lenarchus* contains six species, one of which, *expansus*, is known from Siberia and Alaska; three others are known from various parts of Eurasia; and two, *crassus* and *rho*, are known only from North America. Of these two *rho* is known only from the coastal ranges from Oregon to British Columbia; *crassus* is known from the study area, ranging from Alberta to Quebec and Maine (Fig. 646). The nearctic *Paralenarchus* contains five species, three of which, *fautini*, *brevipennis*, and *vastus*, are known from the study area. *L. fautini* ranges from Great Slave Lake to Wyoming (Fig. 647); *brevipennis* is widespread from Alberta to Oregon and Colorado (Fig. 647); and *vastus* ranges from Alaska to Alberta and California (Fig. 646). The remaining two species of the subgenus are known from California (*gravidus*) and Oregon and Montana (*rillus*).

The genus *Hesperophylax*. This genus contains six species, three of which, *occidentalis*, *consimilis*, and *incisus*, are known from the study area. *H. occidentalis* ranges from Alberta and British Columbia to California and New Mexico, but intermediate records are poor (Fig. 648); *consimilis* is known only from Alberta and Utah (Fig. 648); and *incisus* is widespread from Great Slave Lake to California and Colorado (Fig. 649). Of the remaining three species *designatus* is known from central and southern North America, *magnus* from Arizona and Mexico, and *minutus* from the coast ranges of California and Oregon.

The genus *Chyranda*. Only one species, *centralis*, is known in this genus; it is known from the study area and ranges from Alaska south to Oregon and Colorado (Fig. 650) and has also been recorded from Quebec.

The genus *Pycnopsyche*. The 14 species are arranged in five species groups (Schmid, 1955). Two groups and two species are represented in the study area: *guttifer*, of the *guttifer* group, and *subfasciata* of the *lepida* group. With the exception of these two species the genus is restricted to northeastern North America: *subfasciata* ranges from New Hampshire to Alberta (Fig. 651), and *guttifer* is transcontinental, ranging from Washington to Georgia and Newfoundland (Fig. 652). The origin of this group appears to center on northeastern North America.

The genus *Philocasca*. Six species of *Philocasca* are known of which one occurs in the study area. This species, *thor*, is known only from a single male taken at the alpine meadows of Mt. Edith Cavell, Jasper, Alberta (Fig. 653). Wiggins (1968) revised the genus, listing five species which are known only from scattered localities in the Alberta-Washington-northern California area.

The genus *Glyphopsyche*. Two species of *Glyphopsyche* are known, *irrorata* and *missouri*.

Only *irrorata* is known from the study area, ranging from Alaska and California to New Hampshire, but with a gap in Saskatchewan (Fig. 654). The second species, *missouri*, is known from a single area in Missouri.

The genus *Chilostigmodes*. Only two species of *Chilostigmodes* are known, *areolata* and *forcipata*. Only *areolata* is known from the study area, ranging from Alaska to Labrador (Fig. 655); *forcipata* is known only from Siberia.

The genus *Psychoglypha*. This genus contains eight species of which four are recorded from the study area. Of these four (*prita*, *schmidi*, *alaskensis*, and *ulla*) *prita* is known only from Alberta and Idaho (Fig. 657); *schmidi* is known only from the area of the continental divide of Alberta and British Columbia (Fig. 658); *alaskensis* is widespread from Alaska to Utah and Michigan (Fig. 659); and *ulla* ranges throughout the Cordillera from Alaska to California (Fig. 660). Of the remaining four species of the genus, *avigo* and *ormiae* are known only from Utah and Oregon; *rossi* is known only from British Columbia; *bella* is known from British Columbia and California. With the exception of *alaskensis*, which is transcontinental, the genus is confined to the western Cordillera of North America.

The genus *Phanocelia*. The one species of this genus, *canadensis*, is known from the study area, at a single locality (Nordegg, Alberta). It ranges from Alberta and the Northwest Territories to Maine (Fig. 656) but is poorly known.

Altitudinal distribution of the Alberta species of Rhyacophilidae and Limnephilidae

The purpose of this section is to examine the altitudinal distributions of the Alberta species of the two families dealt with, and to relate this information in some manner to their geographical distributions. Table 3 presents a list of the Alberta species in order of increasing lower altitudinal limits. The altitudes given apply only to the study area, and are derived from adult records.

The species of range patterns 7-12 (more extensive ranges) occur primarily at the lower altitudes, and the species of range patterns 1-6, which are confined to the Cordillera, are found at the higher altitudes. Also, the species of range patterns 7-12 have a much greater altitudinal range, and many attain similar altitudes to the species of range patterns 1-6. However, as the lower altitudinal limit of a species is raised, the total range tends to decrease; similarly with the altitudinal range. It is of interest that those species of range patterns 7-12 which are found only at higher altitudes tend to have more northern total ranges.

The conclusion to be drawn from the above would appear to be that, under present ecological conditions, the high altitude species of range patterns 1-6 occupy relatively narrow zones. These zones are presently found only in the mountains. At the last glaciation (Wisconsin), their altitudinal distribution was probably greater, extending to lower altitudes. Probably some species extended to lower altitudes of the study area. Some, in fact, did and spread eastward across North America, south of the ice sheets. Post-glacial warming forced these species upward into the mountains, some so high that they are represented by what appear to be isolated relict populations. The species presently restricted to the Cordillera are so restricted simply because it is the only area which is capable of satisfying their ecological requirements. Many of the Cordilleran species inhabit turbulent, cold, glacial-melt streams; other, still-water forms, are restricted by undetermined factors. It should also be pointed out that the species which extend from the lower to the higher altitudes are still-water forms which inhabit lakes, ponds, or sloughs.

Table 3. Altitudinal distribution of the Alberta species of Rhyacophilidae and Limnephilidae based on adult records.

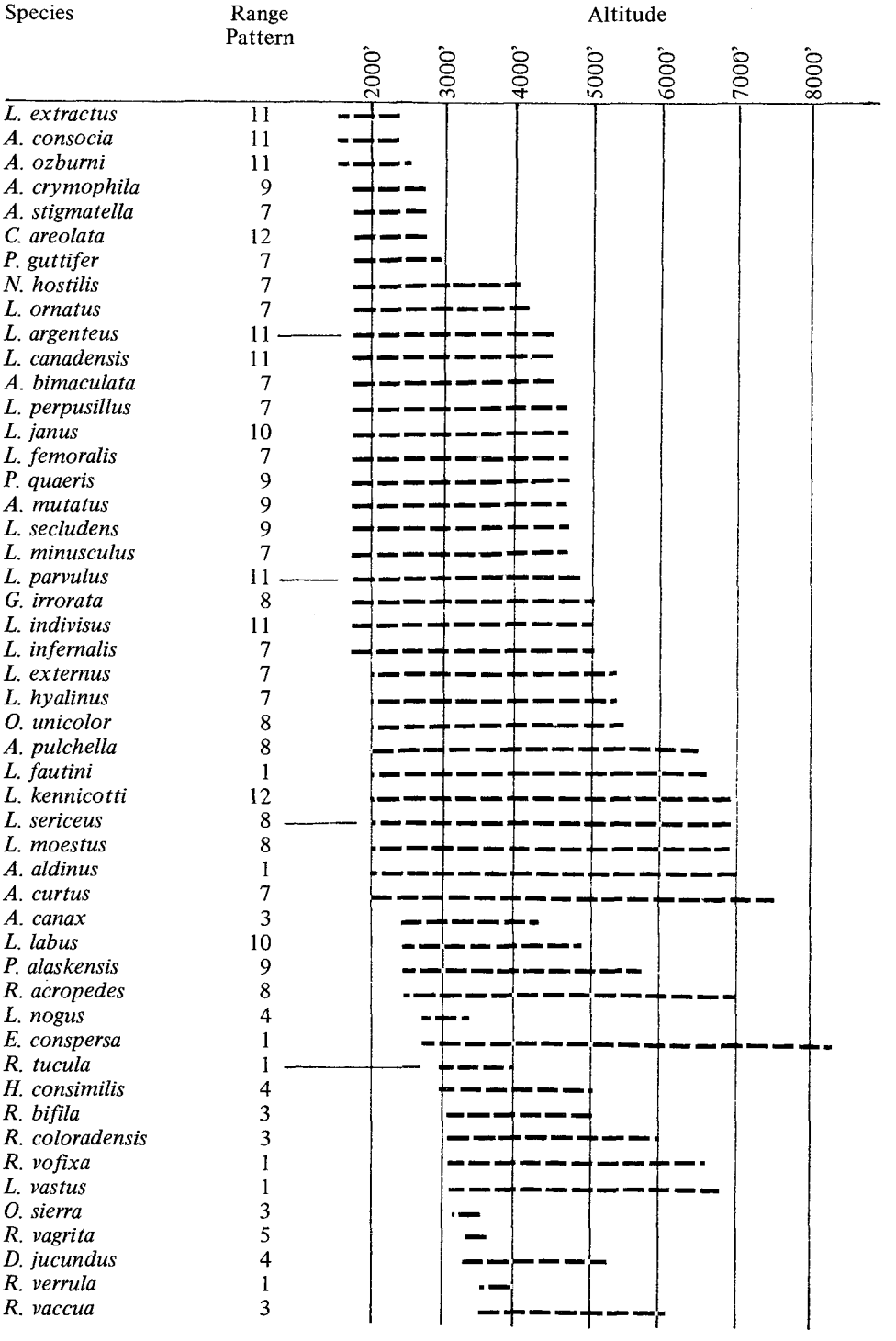
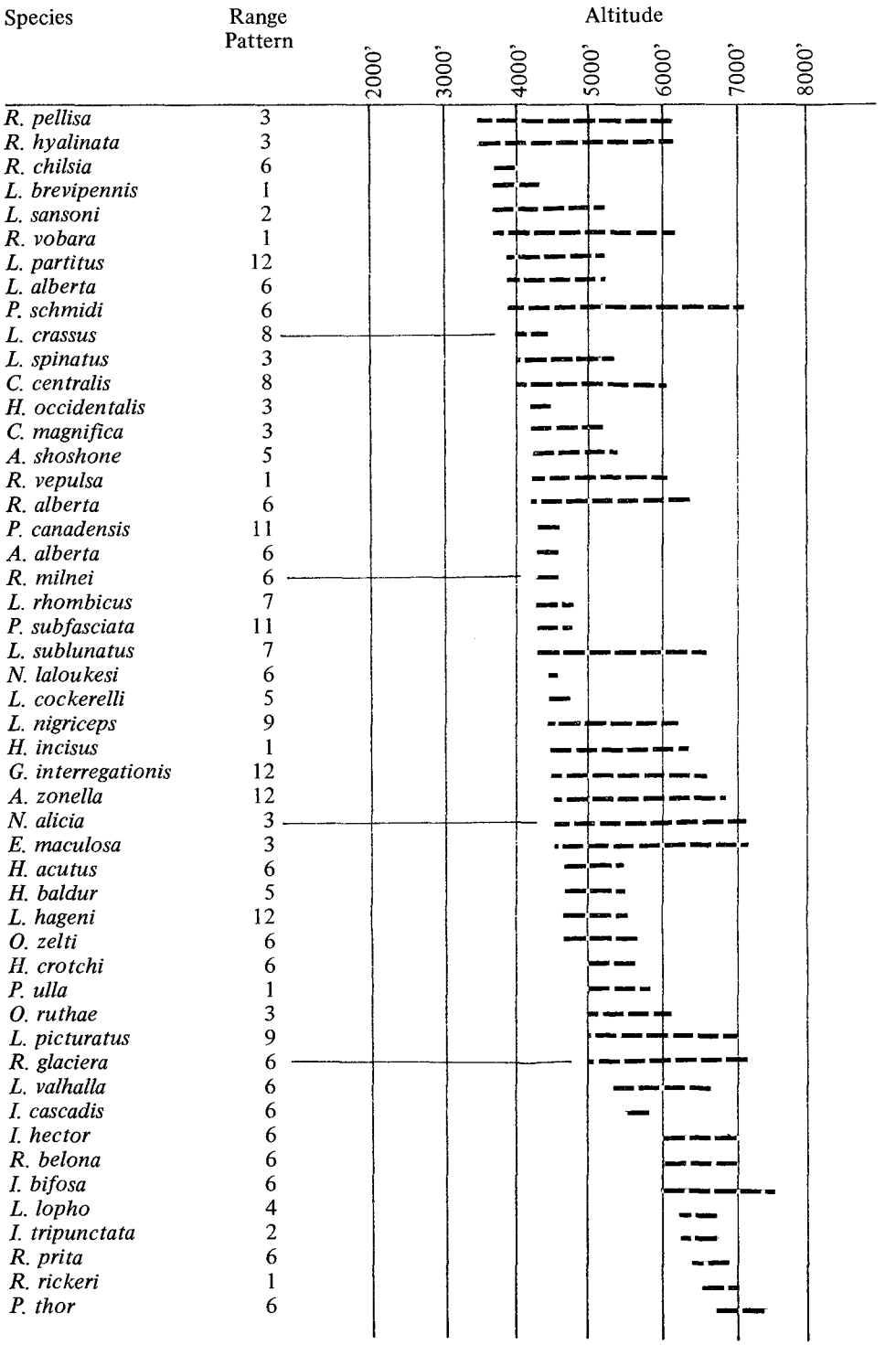


Table 3 (continued)



Discussion

Introduction. – The problem now presented is to elucidate the source areas of the present Alberta fauna of Rhyacophilidae and Limnephilidae after the essentially clean sweep of the study area by the Wisconsin ice sheets. By 'source areas' I refer to those areas outside the study area in which populations of Alberta species survived the glaciation, and from which they were able to re-disperse at dissipation of the ice, to wider distributions, including the study area. I examine below the origins of the Alberta species in the sense of relationships in space with closest relatives, usually to the other species of their respective genera, or to the remaining species of their species groups in genera which are too large and diverse to be treated as single units.

Given above are data concerning the maximum extent of the Wisconsin ice; the possible unglaciated areas, or refugia, from which the fauna may have dispersed post-glacially, of which there are only two of any consequence; the retreat of the ice sheets; the locations and extent of glacial and post-glacial lakes and rivers; the possible effects of post-glacial climates on biotic movements and retreat of the ice sheets; the common range patterns exhibited by groups of species of the two families; and, finally, the relationships of each species known from the study area to the remaining species of their respective genera or species groups within genera.

It only remains to examine this information, *in toto*, and to determine, as far as possible, whence the present Alberta fauna of the two families dispersed into the study area post-glacially, and to examine briefly their broader relationships in space to their presumed closest relatives. The purpose in examining these spatial relationships is to attempt to educe the pre-glacial sources, or origins of the fauna. Are there, for example, Eurasian, Cordilleran, or eastern North American elements in the Alberta fauna, and what are they? The basis of decision in this matter is simply that a genus, or species group, is presumed to have originated in the geographical area which harbours the greater number of species of the group in question. In the context of this study this appears to be the only reasonable course. As has been stated elsewhere this study is not a revision and it is simply impossible to critically examine here the total of all species of all higher taxa represented in Alberta with a view to determining dispersals and phylogeny within each taxon. The foregoing presumption is based on the idea that the longer the period of time during which representatives of a group occupy a given geographical area the greater the amount of diversity, or speciation, which may occur. Thus, if a supraspecific taxon is represented in North America by fewer species than occur in Asia, it is presumed that the fewer North American species indicate that the taxon in question has been present in North America for a shorter time than in Asia, hence it originated in Asia. Undoubtedly this argument will prove to be incorrect in at least some cases, but it should be adequate for a broad general outline of pre-glacial faunal origins.

In certain cases, however, studies on the phylogeny and distribution of discrete taxa are available, with conclusions regarding geographical affinities or origins. These conclusions are used here.

Pre-Wisconsin affinities of the Alberta fauna. – The relationships of the Alberta species, or genera, of the two families are examined here by a consideration of the distribution of species related to the Alberta species. The ground has already been prepared above (pp. 205-212) and it only remains to condense the information presented to more manageable form.

The family Rhyacophilidae is represented in the study area by 11 species groups of the genus *Rhyacophila*. The family Limnephilidae is represented by 26 genera and 91 species. Eight of these species are represented by unidentifiable females and are not considered further. The distribution of the species in each genus or species group, and the putative

geographical area of origin of each genus or group is given in Table 4. From this table it would appear that the relationships of the Alberta fauna of *Rhyacophila* are primarily with North American groups, especially with western North American groups, and with one group of Asian ancestry.

Table 4. Geographical distribution of the higher taxa of the Alberta fauna of Rhyacophilidae and Limnephilidae and their probable source areas.

Name of taxon	Number of species						
	Holarctic	Palaearctic	Nearctic			Total	Probable source area
			West	Transcontinental	East		
Family Rhyacophilidae							
Genus *Rhyacophila*							
Group							
alberta			4			4	Cordillera
vofixa			4			4	Cordillera
betteni			8			8	Cordillera
vobara			2			2	Cordillera
verrula			1			1	Cordillera
vagrita			2			2	Cordillera
angelita			2	1		3	Cordillera
invaria			5		6	10	?
hyalinata		1(?)	3			4	Cordillera
acropedes		3	7	1		11	Asia*
sibirica		11	12		3	26	Cordillera*
Family Limnephilidae							
Genus							
Amphicosmoecus			1			1	Cordillera
Oligophlebodes			7			7	Cordillera
Neothremma			3			3	Cordillera
Homophylax			9			9	Cordillera
Clistoronia			4			4	Cordillera
Philocasca			6			6	Cordillera
Hesperophylax			5	1		6	Cordillera
Chyranda				1		1	Cordillera
Glyphopsyche			1			1	Cordillera
Psychoglypha			7	1		8	Cordillera
Phanocelia				1		1	Eastern
Pycnopsyche				2	12	14	Eastern
Dicosmoecus		2	8			10	Cordillera

Table 4 (continued)

Name of taxon	Number of species						
	Holarctic	Palaearctic	Nearctic			Total	Probable source area
			West	Transcon-tinental	East		
Onocosmoecus		1	5	1	1	8	Cordillera
Imania			10			10	Cordillera
Ecclisomyia		2	4			6	Cordillera
Philarctus		6		1		7	Asia
Chilostigmodes		1		1		2	?
Arctopora	1		1	1		3	?
Grammotaulius		6	2	1		9	Eurasia
Nemotaulius		5		1		6	Eurasia
Anabolia		11		4		15	Eurasia
Asynarchus	2	5	5	2	1	15	?
Lenarchus							
(Prolenarchus)		1			1	2	?
(Lenarchus)	1	3	1	1		6	Eurasia
(Paralenarchus)			5			5	Cordillera
Limnephilus							
Group							
ornatus	(1)**			1		1	?
nigriceps	1					1	?
argenteus				1		1	Cordillera
nogus			1			1	Cordillera
alberta			1			1	Cordillera
diversus			3		1	4	Cordillera
assimilis			5		2	7	Cordillera
morrisoni			3			3	Cordillera
sitchensis			6	1		7	Cordillera
rhombicus	1	4				5	Eurasia
subcentralis		5	3	3		11	?
stigma		5		2		7	Eurasia
asiaticus		8	4			12	Eurasia
externus	1		1			2	Cordillera
picturatus	1		1			2	Cordillera
sericeus			1	1		2	Cordillera
luridus	1	1				2	Eurasia
incisus		2	3	3	1	9	North America
fenestratus	1	1	2	2		6	North America
Genus							
Apatania	3	38		9		50	Eurasia

(?) – Ross (1956).
* Ross (1956).
** Schmid (1955)

The affinities of the Alberta species of Limnephilidae are varied and complex. Most of the taxa appear to be of western North American origin, with some elements from eastern North America, North America generally, Eurasia, and some indefinite.

Post-Wisconsin sources of the Alberta Rhyacophilidae and Limnephilidae. – There are several possible routes whereby the study area may have been reinvaded post-glacially by species of the two families considered here. These routes are suggested both by the distribution patterns as set forth in Fig. 667, 668, and by the spatial relationships or affinities of the Alberta species to their respective genera or species groups as described above. These routes are examined below and an attempt made to fit each of the 113 Alberta species of the two families to them. Some species fall easily and convincingly into their allotted route of post-glacial dispersal; others do not, and impart a measure of uncertainty to the conclusions.

As mentioned earlier, the range patterns of the Alberta species are grouped into two major classes. Those species belonging to the first major class are restricted entirely to the Cordillera, and those belonging to the second class range throughout North America in a variety of patterns, the only common feature of which is that each pattern embraces the study area.

The nine possible routes of post-glacial dispersal of species into the study area are as follows:

a). From the entire Cordillera, south of the ice.
b). From the coastal ranges of the Cordillera only.
c). From the eastern ranges of the Cordillera only.
d). From the area immediately south of, and adjacent to, the Cordilleran ice sheet.
e). From all of North America south of the ice sheets.
f). From the central plains of North America.
g). From eastern North America, to the northwest.
h). From Alaska, to the south and east.
i). From Alaska and the southern, unglaciated, portion of North America simultaneously, provided that the species involved maintained populations in both areas throughout the Wisconsin.

Dispersal route *i* is not seriously considered here, as the end result would be distributions similar to those which could result from any of the other eight routes, and intensive investigations, which are beyond the scope of this study, would be required to detect such a dispersal route. In any such investigations a first step would be intensive collecting in Alaska, the Yukon, and northern British Columbia, as records are very poor from these areas. In conjunction with, and following such collecting, morphological variation, possibly indicative of prolonged isolation of two populations from each other, would have to be searched for and examined in detail. If any species did in fact disperse post-glacially from the two foci, such an investigation might provide supporting evidence.

Prior to attempting to determine the dispersal routes of the Alberta species, several points of interest to the inquiry require examination. Habitat preferences of each species are important in elucidating past dispersal patterns. Suitable climatic conditions are inconsequential to individuals of a species if the habitat which they require is missing, for whatever reason. This is especially so in the Trichoptera, due to the very restricted habitat of the larvae: fresh water. Fresh water abounds in most of the area under consideration but in different forms: it may be fast and turbulent, fast and smooth flowing, slow flowing, standing, as in lakes, ponds, and sloughs, and it may be deep or shallow, permanent or intermittent, cold or warm. All types of fresh water bodies have their particular complement of trichopteran species.

The distribution of the various types of fresh water bodies has undoubtedly changed greatly since the beginning of the Wisconsin glaciation. While I can find no specific reference, it seems reasonable to assume that the area south of, but adjacent to, the southern edges of the ice sheets was occupied by lakes, creeks, and rivers sustained by glacial meltwater. This would result in cold water streams which, in all probability, were swift and turbulent. South of this band, in non-glacial drainage systems, were warmer bodies sustained by precipitation alone. Farther south still, conditions were different again, and so on. As the ice sheets melted and the southern edges retreated northward, the various types of fresh water habitats would alter and assume the character of the next southern type. In effect I propose that the water habitat types appeared to migrate northward behind the retreating ice sheets, just as the various biota are believed to have done. As the Laurentian ice sheet is now quite extinct, and retreated in a northerly direction, it follows that some of the water habitat types which followed behind it are now found only in the far north or are extinct, except in mountainous areas to east or west. This point is raised, as the transcontinental belt of cold water stream habitats created during glaciation would provide a means of dispersal of mountain species from west to east, or from east to west, with the possible result of isolated populations of species with large range gaps between the populations. There are in fact some such species known from the study area.

The post-glacial lakes and drainage patterns have altered greatly since the retreat of the ice and, in total, must have acted as a great network, in time, throughout central North America. This system is now essentially defunct, as glacial control has ceased and each watershed is now distinct and well separated from the next, with minimal, if any, variation. This post-glacial network of lakes and streams extended, in time, as well as space, from the Great Lakes to Great Bear Lake (Fig. 665), and probably provided an open road from eastern and central North America to the north west and northern North America, and possibly from Alaska to the south east. Such a 'road', consisting largely of lakes, ponds, and sloughs, but with streams of unknown character surrounding them, would probably be of greatest assistance to lake and pond species, of which there are many known from the study area. These species have range patterns which belong to the second major division of the range pattern series (Fig. 668).

The western Cordilleran species exhibit two dispersal routes. Species isolated south of the ice advanced northward, ultimately to Alaska, and the species isolated in the Alaska-Yukon refugium spread southward. Ordinarily the species spreading south from Alaska would be low altitude forms or, at least, forms which would not be forced to retreat upward to higher, colder, mountain areas to form isolated populations as the climate warmed following glacial retreat. High altitude forms would be isolated in the Alaskan highlands instead. Present day high altitude forms which, during the glacial maximum, would be enabled to survive at low altitudes south of the ice sheets, and form continuous populations, would advance northward behind the retreating glaciers, but would also advance, at the southern extremities of their ranges, higher into the mountains. Eventually they would attain such altitudes, at least in the south, so that isolated populations would result. Species exhibiting such isolated distributions can generally be assumed to have advanced from the south of the ice sheets. However, some present day high altitude forms may have dispersed from Alaska south, along the eastern slopes of the Cordillera. This is barely conceivable if one considers the slower disappearance of the Cordilleran ice sheet from southern British Columbia, and the presence of a corridor between northwestern United States and Alaska, along the eastern face of the Cordillera as the Laurentian ice sheet retreated to the north east. This dispersal would occur at low altitudes initially, and in a narrow band of suitable territory. As the Cordilleran ice sheet vanished, dispersal would then occur upward into the

high mountains, again resulting in isolated populations. At the present time, however, I cannot provide evidence of such a dispersal route.

To begin the detailed examination of the post-glacial origins of the Alberta Rhyacophilidae and Limnephilidae I shall first examine the groups of species included in range patterns 1-6 (Fig. 667). Table 2 (pp. 203-204) lists the species in each range pattern.

The species of range patterns 1-6 are confined to the Cordillera. They are largely fast, cool, mountain stream species, whose members would find it difficult, if not ecologically impossible, to disperse beyond the Cordillera post-glacially. Despite the limitations imposed by present knowledge of species ranges it seems reasonable to assume that the species belonging to range patterns 3-6 were confined to the Cordillera south of the Cordilleran ice sheet in British Columbia, and that they spread northward post-glacially, reaching their northern limits in the southern half of British Columbia and the Cordillera of Alberta. The species of range pattern 3 are widespread throughout the Cordillera, on both sides of the Great Basin of Utah and Nevada and northward. Despite the inclusion of that area within the pattern, in fact very few species are recorded therefrom. It may be they extended into the area during the Wisconsin pluvial and have since been driven out by increasingly drier conditions (see Ricker, 1963). This also applies to the species of range pattern 1. The species of range pattern 3 belong to dispersal route *a*.

The four species of range pattern 4 are confined to the coastal Cordillera, attaining the same northern limits as those of range pattern 3; they belong to dispersal route *b*.

The four species of range pattern 5 are confined to the eastern ranges of the Cordillera, with similar northern limits; they belong to dispersal route *c*.

The 28 species of range pattern 6 are known only from the very restricted area which includes Oregon, Washington, Idaho, Montana, southern British Columbia, and western Alberta. Many of these species are described as new, or are represented only by unidentifiable females. Others belong to genera which are rare, either because of intrinsic rarity, or difficulty in collecting specimens. Still others are restricted to isolated high altitude populations; these are species which were apparently unable to migrate northward post-glacially. It seems reasonable to suppose that many, at least, of these species have dispersed very little since retreat of the ice, simply moving northward into southern British Columbia and Alberta. They belong to dispersal route *d*.

The species included in range patterns 1 and 2 present greater difficulty as they could represent examples of dispersal patterns *a*, *h*, and *i* (range pattern 1) or *c*, *h*, and *i* (range pattern 2). For reasons given above the postulated dispersal pattern *i* is omitted from further consideration at this time. *I. tripunctata*, of range pattern 2 may represent an example of dispersal south of the Cordilleran ice sheet south of Alaska along the north-south corridor prior to melting of the Cordilleran ice sheet. In the study area it is now found isolated only at high altitudes, and does not extend south of Alberta. However, it might also represent dispersal from south to north, and upward, as the ice retreated. The remaining two species of range pattern 2 are low altitude forms and certainly belong to dispersal route *c*.

The 13 species of range pattern 1 exhibit a variety of altitudinal ranges but none could be referred to as high altitude isolates. All are known from the southern extremities of the Cordillera to, or almost to, Alaska. As most of the close relatives of each species are found largely in the area south of the former ice sheets it is reasonable to assume that the species of range pattern 1 belong to dispersal route *a*.

The species of range patterns 7-12 present greater problems for which less clear cut answers are available. They belong variously to dispersal routes *e-i*.

Many of the species included in these range patterns have far northern distributions in conjunction with southern extensions. Several are holarctic. Ross (1965) states that it

would be difficult to elucidate the loci of post-glacial dispersal of these species.

The species of range pattern 7 are the most widespread of the Alberta species. They are still water forms. Of these, four (*L. externus*, *L. femoralis*, *L. rhombicus*, and *A. stigmatella*) are holarctic, and can reasonably be assumed to have dispersed south and east from Alaska. While about half of the other species involved are recorded from Alaska, they are all very well represented from the southern limits of the pattern. Of particular interest is the heavy representation in the western Cordillera. This would be difficult territory to disperse into or through, and the process would indubitably take longer than in the plains. Also of interest is the fact that these species are found on both sides of the now arid Great Basin. It is most probable that at least the greater number of these species were well established, transcontinentally, south of the ice sheets, and spread northward behind the ice. With the exceptions of the four holarctic species, which appear to belong to dispersal route *h*, the species included in range pattern 7 appear to belong to dispersal route *e*.

The species included in range pattern 8 are a curious mixture of fast and still water forms. The fast water forms belong to *R. acropedes*, *R. angelita*, and *O. unicolor*. This pattern comprises two separate ranges for each included species, one eastern, the other western. The dispersal route involved here would appear to be *e*. Apparently the ice sheets created conditions along their southern edges which were suitable for these species and they were enabled to migrate eastward and become transcontinental in distribution (Ross, 1956). Ross (1958) mentions such a possibility in the Pleistocene as a whole. On recession of the ice these conditions became more and more restricted to the highlands of the east and west, and an intervening range gap resulted. Ricker (1963) proposes a similar situation for Plecoptera and also mentions, as is the case here, the few species which exhibit this distribution.

The seven species included in range pattern 9 are primarily low mountain valley forms of marshes or slow streams in Alberta. These conditions extend beyond the mountains to the plains in the east, however. These species, with the exception of the holarctic species *L. picturatus* and *A. crymophila*, appear to belong to dispersal route *f*. *L. picturatus* and *A. crymophila* may have followed dispersal route *h*.

The two species of range pattern 10 evidently belong to dispersal route *f*. Either their restricted ranges are due to incomplete knowledge of their distribution, or they are restricted ecologically.

The species included in range pattern 11 are primarily centered in northeastern North America; Alberta apparently represents the western extremities of their ranges. On the whole they appear to belong to dispersal route *g*, and to have spread both west and north from the eastern United States.

The six species included in range pattern 12 are still or slow water forms, transcontinental, and restricted almost entirely to Canada, with the exception of *A. zonella* which is circumpolar, though unknown from the western Arctic and Alaska at present. *L. kennicotti* and *G. interregationis* are also known from Greenland. *A. zonella* is known from the high Arctic Islands and Greenland, to British Columbia, but is primarily a far northern species. The post-glacial source of this species is uncertain, but it may well have spread from several foci, one of which is northern Ellesmere Island, and Peary Land. It may also have survived south of the ice sheets and spread north. The remaining species, on the whole, appear to have survived south of the ice sheets and spread northward; they belong to dispersal route *e*. None attain the high latitudes of *A. zonella*.

On a percentage basis the probable post-glacial sources of the Alberta fauna of Rhyacophilidae and Limnephilidae are as follows: from the western Cordillera south and west of the study area – 61%; from Alaska – 5%; from eastern North America – 8%; from trans-

continental species south of the ice – 18%; and from the central plains – 7%.

While certain of the preceding conclusions, with regard to some species, are doubtful, one species is more dubious than any other – *A. zonella*. This species is not included in any of the preceding figures but represents less than 1% of the total.

Four transcontinental species of range pattern 8 are nonetheless considered to be of western Cordilleran provenance. They are represented in the east in relatively isolated highland areas and are thought to have dispersed eastward during the Wisconsin glaciation itself, when suitable ecological conditions prevailed just south of the ice sheets, and to have been isolated there post-glacially.

The total of 33% of species thought to have dispersed into and through Alberta from the central plains, eastern North America, and southern transcontinental localities, are essentially all still water forms which almost certainly utilised the myriad lakes, ponds, and sloughs created during deglaciation, and as they exist at present.

In conclusion, only 5%, or possible 6%, of the Alberta fauna of the two families is derived from northern glacial refugia. The remaining 95 (94)% is derived from south of the major ice sheets, the greater portion being indubitably western Cordilleran.

While it is not part of the stated objectives of this study, it seems appropriate to examine briefly the broader implications of the data presented here, for the post-glacial recolonisation of northern North America as a whole. Ross (1965) examines this problem in detail. The holarctic species of Limnephilidae seem, on the whole, to have dispersed east and south from Alaska, or other possible far northern refugia. All other species appear to have redispersed northward post-glacially, from south of the ice sheets. There is a distinct western Cordilleran element which has remained restricted to the Cordillera. The eastern areas of North America also have a distinctive endemic fauna. There has been little interchange between the two areas, especially in the montane elements. What interchange there has been is restricted to west to east dispersals (Ross, 1956, 1965) when glacially imposed ecological factors were suitable. The remainder of the fauna has shuttled back and forth in a north-south pattern, with perhaps some northwestward dispersal by the eastern lowland fauna, to the northern Great Plains.

Conclusions

1. The affinities of the Alberta species of *Rhyacophila* are primarily with the western Cordillera of North America. One species group, while with a large North American complement, is apparently Asian in origin.

2. The affinities of the Alberta species of Limnephilidae are varied and complex. Regarding genera and species groups within larger genera indiscriminately, 21 taxa have their closest affinities with western North America, two with eastern North America, five with North America, but indefinite within the area, 12 with Eurasia, and three are indefinite between Eurasia and North America. The greater part, then, of the Alberta fauna appears to be North American in origin.

3. The post-glacial source of the Alberta fauna of the two families studied is almost entirely from the southern half of North America south of the former ice sheets, with a minor Beringian, or Alaskan, element. The greater part of the southern element is derived from the western Cordillera.

4. The western element is composed largely of cool stream species, which largely precludes their post-glacial dispersal eastward. The remainder are plains lake, pond, or slough forms, which were undoubtedly assisted in their northward dispersal by the great network of post-glacial lakes, ponds, and sloughs created by the retreating glaciers, and which are

now much diminished in size, and altered in drainage patterns. However, the remnants still provide a multitude of areas in which these species thrive.

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Vingt-deux espèces de Rhyacophilidae et 91 espèces de Limnephilidae, faisant un total de 113 espèces, sont rapportées pour cette région. Chaque espèce est décrite et accompagnées de clefs permettant d'identifier les spécimens adultes par rapport aux espèces.

Dans les Lymnephilidae sept espèces sont décrites comme nouvelles: Imania hector; Apatania alberta; Homosphylax baldur; Oligophlebodes zelti; Limnephilus susana; Limnephilus valhalla; *et* Philocasca thor.

L'origine postglaciaire de cette faune est étudiée, considerant les effets probables des systèmes climatiques présents et passés, l'étendue des masses glaciaires et la position des refuges probables, et la position et le système de drainage des principaux lacs glaciaires et postglaciaires. De plus 12 modèles de distribution démontrés par les espèces, et la distribution de chaque espèce en relation à d'autres espèces dans leur genre et dans leur groupe, sont étudiés. Les 12 modèles de distribution se divisent en deux sections principales: la première, composée de six modèles, est entièrement limitée à la cordillère occidentale de l'Amérique du nord; et les six derniers sont transcontinentalement distribués. La distribution en fonction de l'altitude est brièvement examinée.

Les conclusions démontrent, d'un côté, que 5% de la faune contemporaine provient du refuge de Beringia après les glaciations, et d'un autre côté, que 95% provient de régions de l'Amérique du nord au sud de la limite sud des glaces. En divisant davantage cette dernière portion, 61% provient de la cordillère occidentale de l'Amérique du nord, 8% de l'est de l'Amérique du nord, 7% du centre des grandes plaines, 18% de toute l'Amérique du nord au sud des glaces, i.e. *d'espèces transcontinentales, et 1% demeure incertain.*