

AN ABSTRACT OF THE THESIS OF

JANET LEE WOLD for the MASTER OF SCIENCE
(Name of student) (Degree)
in Entomology presented on Aug 9, 1973
(Major) (Date)

Title: SYSTEMATICS OF THE GENUS RHYACOPHILA (TRICHOPTERA; RHYACOPHILIDAE) IN WESTERN NORTH AMERICA WITH SPECIAL REFERENCE TO THE IMMATURE STAGES

Abstract approved: Signature redacted for privacy.
N. H. Anderson

Rhyacophila is one of the largest genera of caddisflies, containing about 465 species. Approximately 100 species are found in North America with 83 occurring in the west. The larvae of 24 western North American species are associated for the first time, making a total of 38 species for which larvae are now associated. Two more larvae are tentatively associated with the adults. Larvae of another 19 species, although at present unassociated, are so closely related to other species in the adult stage that it is probable that the larvae are nearly identical to various of the described larvae.

The immature stages were associated with the adult by use of the metamorphotype method. The larval descriptions are then based on the sclerites of the metamorphotype and on the corresponding mature larvae from the same area. Laboratory rearing of eggs,

larvae, and pupae was used on a small scale.

The known Rhyacophila larvae in western North America have been described and figured. A key was developed for the mature larvae of the associated species of the subfamily Rhyacophilinae occurring in western North America. Eggs of a Nearctic species of Rhyacophila (R. norcuta Ross) are described for the first time. The published data and the newly acquired information on the distribution and bionomics of Rhyacophila spp. in western North America is discussed.

Characteristics of the larvae were found to support the classification system of Schmid (1970) better than that of Ross (1956). In most instances larvae can be readily placed in Schmid's species groups. However, in terms of his hierarchy of divisions and branches, the larvae often cannot be grouped in the adult classification system.

Systematics of the Genus Rhyacophila (Trichoptera:
Rhyacophilidae) in Western North America with
Special Reference to the Immature Stages

by

Janet Lee Wold

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

June 1974

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to the following individuals of the staff at Oregon State University:

Dr. N. H. Anderson for serving as my major professor, for his many collections of Rhyacophila, and for his very helpful review of the manuscript.

Drs. J. D. Lattin and P. O. Ritcher for their critical review of the manuscript and for acting as members of my committee.

Dr. H. A. Scullen for many informative discussions and much encouragement.

Dr. C. E. Warren for acting as my minor professor.

I am also very grateful to Dr. G. B. Wiggins and Mr. Tosh Yamamoto, and their staff, of the Royal Ontario Museum, Toronto, Canada, for collecting countless Rhyacophila throughout most of the study area and for making their entire collection available to me for study. This material has been the backbone of much of this investigation.

Dr. E. D. Evans, Department of Natural Resources, Lansing, Michigan, also deserves my thanks and appreciation for making a special attempt to collect Rhyacophila on his many collecting trips throughout California and Oregon.

The following individuals also deserve my thanks for collecting

Rhyacophila, the loan of their collections, or the loan of their records: Mr. Stanley G. Jewett, Jr., West Linn, Oregon; Dr. S. D. Smith, Central Washington State College, Ellensburg, Washington; Mr. M. P. Tew, Oregon State University, Corvallis, Oregon; Dr. Eric Charnov, University of Utah, Salt Lake City, Utah; Dr. S. Frommer, University of California, Riverside, California; Dr. G. Kraft, Western Washington State College, Bellingham, Washington; Dr. A. Nimmo, University of Alberta, Edmonton, Alberta; Mr. R. Thut, Weyerhaeuser Company, Longview, Washington; Mr. C. D. Kerst, Oregon State University, Corvallis, Oregon; and Dr. O. S. Flint, United States National Museum, Washington, D.C.

Many of the illustrations of the heads and anal prolegs were done by Mrs. Bonnie Hall. The remainder that were not done by me, were done by Mr. Harold Zimmerman.

Financial support for this investigation was received from a National Science Foundation Undergraduate Research Participation Grant, number GY-228, and from a grant from the United States Department of Agriculture, Agricultural Research Service, grant number 12-14-100-9160 (33). For this assistance I am grateful.

Finally, I wish to thank my parents, Mr. and Mrs. Emery Bedea for their help and continuing encouragement; my husband, Ron, for his assistance on collecting trips, and my sister, Judi Hassoun, for typing some parts of the rough draft.

TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	1
LITERATURE REVIEW	4
PROCEDURE	9
Study Area	9
Collection and Preservation	9
Association of Life Stages	10
Determination of Instar	13
Material Examined	13
Classification System	15
Key and Illustrations	18
GENUS <u>RHYACOPHILA</u>	19
Key to the Larvae of Rhyacophilinae	19
<u>VULGARIS</u> DIVISION	25
1. <u>Rotunda</u> Group	25
<u>Rhyacophila</u> <u>ebria</u> Denning	26
<u>Rhyacophila</u> <u>latitergum</u> Davis	26
<u>Rhyacophila</u> <u>norcuta</u> Ross	28
<u>Rhyacophila</u> <u>rotunda</u> Banks	31
<u>Rhyacophila</u> <u>tralala</u> Schmid	32
2. <u>Oreta</u> Group	33
<u>Rhyacophila</u> <u>basalis</u> Banks	34
<u>Rhyacophila</u> <u>oreta</u> Ross	34
3. <u>Viquaea</u> Group	38
<u>Rhyacophila</u> <u>lineata</u> Denning	38
<u>Rhyacophila</u> <u>viquaea</u> Milne	38
4. <u>Vagrita</u> Group	39
<u>Rhyacophila</u> <u>milnei</u> Ross	39
<u>Rhyacophila</u> <u>vagrita</u> Milne	40

PHILOPOTAMOIDES DIVISION

43

Castanea Branch

43

5. Alberta Group

43

Rhyacophila alberta Banks

44

Rhyacophila glaciera Denning

45

Rhyacophila kincaidi Schmid

46

Rhyacophila tucula Ross

47

Invaria Branch

52

6. Hyalinata Group

53

Rhyacophila hyalinata Banks

57

Rhyacophila vocala Milne

59

7. Coloradensis Group

60

Rhyacophila amabilis Denning

61

Rhyacophila bifila Banks

62

Rhyacophila coloradensis Banks

64

Rhyacophila insularis Schmid

66

Rhyacophila kernada Ross

66

Rhyacophila reana Denning

66

Rhyacophila sierra Denning

67

8. Angelita Group

67

Rhyacophila angelita Banks

70

Rhyacophila newelli Denning

72

Rhyacophila perplana Ross and Spencer

73

Rhyacophila vuzana Milne

74

9. Rayneri Group

75

Rhyacophila rayneri Ross

75

10. Sibirica Group

77

Rickeri Subgroup

77

Rhyacophila rickeri Ross

77

Colonus Subgroup

78

Rhyacophila colonus Schmid

78

Rhyacophila pellisa Ross

78

Rhyacophila valuma Milne

79

Blarina Subgroup

82

Rhyacophila blarina Ross

82

Narvae Subgroup

85

Rhyacophila narvae Navas

85

Unimaculata Subgroup

90

Rhyacophila unimaculata Denning

90

Rhyacophila unipunctata Schmid

91

Belona Subgroup

91

Rhyacophila belona Ross

91

Rhyacophila vetina Milne

92

11.	<u>Vofixa</u> Group	92
	<u>Vobara</u> Subgroup	93
	<u>Rhyacophila vobara</u> Milne	93
	<u>Rhyacophila iranda</u> Ross	94
	<u>Vofixa</u> Subgroup	95
	<u>Rhyacophila vofixa</u> Milne	95
	<u>Rhyacophila harmstoni</u> Ross	95
	<u>Ophrys</u> Subgroup	96
	<u>Rhyacophila ophrys</u> Ross	96
	<u>Rhyacophila velora</u> Denning	96
12.	<u>Betteni</u> Group	98
	<u>Rhyacophila ardala</u> Denning	101
	<u>Rhyacophila betteni</u> Ling	102
	<u>Rhyacophila cerita</u> Denning	102
	<u>Rhyacophila chilsia</u> Denning	103
	<u>Rhyacophila fenderi</u> Ross	103
	<u>Rhyacophila karila</u> Denning	104
	<u>Rhyacophila malkini</u> Ross	104
	<u>Rhyacophila perda</u> Ross	106
	<u>Rhyacophila spinata</u> Denning	108
	<u>Rhyacophila vaccua</u> Milne	108
	<u>Rhyacophila vedra</u> Milne	112
	<u>Rhyacophila willametta</u> Ross	116
13.	<u>Verrula</u> Group	117
	<u>Rhyacophila potteri</u> Denning	118
	<u>Rhyacophila verrula</u> Milne	118

DIVARICATA DIVISION

<u>Nigrocephala</u> Branch	128
14. <u>Ecosa</u> Group	128
<u>Rhyacophila ecosa</u> Ross	129
<u>Acropedes</u> Branch	130
15. <u>Vemna</u> Group	130
<u>Rhyacophila gemona</u> Ross	130
<u>Rhyacophila robusta</u> Schmid	131
<u>Rhyacophila vemna</u> Milne	131
16. <u>Acropedes</u> Group	132
<u>Acropedes</u> Subgroup	132
<u>Rhyacophila acropedes</u> Banks	136
<u>Rhyacophila brunnea</u> Banks	139
<u>Rhyacophila inculta</u> Ross and Spencer	140
<u>Rhyacophila vao</u> Milne	142
<u>Rhyacophila wallowa</u> Denning	144

<u>Grandis</u> Subgroup	145
<u>Rhyacophila grandis</u> Banks	146
<u>Rhyacophila neograndis</u> Denning	154
<u>Rhyacophila sequoia</u> Denning	156
<u>NAVICULATA DIVISION</u>	158
17. <u>Lieftincki</u> Group	158
<u>Rhyacophila arnaudi</u> Denning	158
<u>SPECIES OF UNCERTAIN STATUS</u>	162
18. <u>Nevadensis</u> Group	162
<u>Rhyacophila jewetti</u> Denning	163
<u>Rhyacophila nevadensis</u> Banks	163
<u>Rhyacophila vaefes</u> Milne	164
19. <u>Oreia</u> Group	
<u>Rhyacophila oreia</u> Ross	169
<u>Rhyacophila visor</u> Milne	171
Unplaced Species	173
<u>Rhyacophila alexanderi</u> Denning	173
<u>Rhyacophila chandleri</u> Denning	174
<u>Rhyacophila haddocki</u> Denning	174
<u>Rhyacophila mosana</u> Denning	174
<u>Rhyacophila pacifica</u> Banks	175
<u>Rhyacophila pichaca</u> Denning	175
<u>Rhyacophila</u> species #1 (larva) -probably <u>ecosa</u> Ross	176
<u>DISCUSSION AND CONCLUSIONS</u>	178
<u>BIBLIOGRAPHY</u>	189
<u>APPENDIX</u>	196

SYSTEMATICS OF THE GENUS RHYACOPHILA (TRICHOPTERA:
RHYACOPHILIDAE) IN WESTERN NORTH AMERICA
WITH SPECIAL REFERENCE TO
THE IMMATURE STAGES

INTRODUCTION

The study of aquatic biology has become increasingly important due to public concern about pollution problems and recreational uses of water. One problem in aquatic biology is the lack of systematic knowledge of the immature stages of certain aquatic insects. As in many of the insect orders, the study of the immature stages of caddisflies (Trichoptera) has received relatively little attention while study of the adult taxonomy has been stressed. Since the aquatic immature stages of the holometabolous caddisflies make up the greatest portion of the life cycle and have a more restricted habitat than do the adults, they must be studied if one is to obtain a complete understanding of the distribution and abundance of each species.

The major objectives of this investigation of the genus Rhyacophila Pictet (Trichoptera: Rhyacophilidae) occurring in western North America are:

- (1) to associate the aquatic immature stages of the various species with the previously described adults.
- (2) to provide adequate keys to the mature larvae.
- (3) to determine the distribution of the various species.
- (4) to provide life history information.

The Rhyacophilidae are considered to be one of the more primitive families of caddisflies by Ross (1956). He states that the Rhyacophilidae resemble a postulated ancestor of the Trichoptera since the adult has ocelli, the most complete wing venation in the order, and segmented maxillary palps, the pupa is unspecialized, and the active free living larva has membranous meso- and metanotum and simple anal legs.

The majority of the Rhyacophilidae occur in montane streams. There are two subfamilies in the family, the cool-adapted Rhyacophilinae, which apparently do not occur south of the equator except locally in the East Indies, and the more warm-adapted Hydrobiosinae, which are most common below the equator in the Oriental and Australian regions, and in the Neotropical region. The Hydrobiosinae do occur in western North America, in Arizona, Texas, and Mexico.

The subfamily Rhyacophilinae contains three genera, Rhyacophila Pictet (1834), Himalopsyche Banks (1940), and Philocrena Lepneva (1956). The genus Philocrena has only one species, trialetica Lepneva (1956), which occurs only in Russia. The genus Himalopsyche has one species (phryganea (Ross)) in the study area, the larva (Figure 5) of which has been associated (Flint, 1961).

The genus Rhyacophila, one of the largest genera of caddisflies, contains about 465 species (Schmid, 1970). Approximately 100 species are found in North America, 83 of these being western.

Larval associations have been made for 29 of the North American species by Milne and Milne (1940), Ross (1944), Flint (1962), Lepneva (1964), Smith (1968), and Sherberger and Wallace (1971).

The larvae of 24 species are herein associated with the adults for the first time. In addition, two species are tentatively associated with the adult. Larvae of another 19 species, although unassociated, are so closely related to other species in the adult stage that it is probable that the larvae are nearly identical to various of the associated larvae.

LITERATURE REVIEW

The immature stages of the Eurasian species of Rhyacophila have been studied to a far greater degree than have those of the Nearctic species but this literature will be considered in this review only when pertinent to the North American fauna. The larvae of this genus have been accurately described by Betten (1934), Nielsen (1942), Ross (1944), Ulmer (1957), Flint (1962), Lepneva (1964), Smith (1968) and others.

Few papers have been published associating and describing the larvae of the North American species of Rhyacophila. Vorheis (1909) associated the larva of one eastern species. Lloyd (1921) included two descriptions of eastern species, one of which was questionable since it was not associated with the adult. Milne and Milne (1940) described the larva and adult of a western species of Rhyacophila from the male metamorphotype. Ross (1944) included three new associations of eastern species. Flint (1962) added ten new associations of larvae of eastern species, one of which is found as far west as Oregon. He described another species found as far west as the Pacific Coast, but was unable to actually associate it with the adult. Smith (1968) added larval associations, keys and bionomics of eleven more species of Rhyacophila that were found in the Salmon River drainage of Idaho. Sherberger and Wallace (1971) associated

the larva with the adult for one additional eastern species.

Two recent major works on the phylogeny of the Rhyacophila of the world are by Ross (1956) and Schmid (1970). A third paper by Nimmo (1971) covers the origins and relationships of the Rhyacophila, including altitudinal distribution of the species, in Alberta and eastern British Columbia.

The eggs of Rhyacophila nubila Zetterstedt, a European species, have been described by Kolenati (1848), Siltala (1906), and Neilsen (1942). Silfvenius (Balduf, 1939) observed R. nubila ovipositing eggs in an aquarium. The eggs were laid both singly and in groups on a piece of decaying wood. Nielsen (1942) also observed egg masses of R. nubila. Most masses contained from 500-950 eggs in an irregular order. He also collected some additional smaller masses. The egg masses were underwater on stones and on half-submerged tree branches at the edge of the stream. The laying of some eggs singly, as observed by Silfvenius, may have been an unnatural occurrence due to captivity. However, a habit of laying eggs singly would certainly help to explain the lack of observations on the eggs of this genus.

Rhyacophila generally have been said to be predacious, but review of the available literature on gut analysis suggest that most Rhyacophila larvae are carnivores with a few that are omnivores and herbivores. Muttkowski and Smith (1929) studied the food of 32

Rhyacophila larvae in three trout streams in Yellowstone National Park. They recorded the various gut contents as percentages of the total content of each gut. The approximate percentages were: algae (including diatoms) and moss, 20%; detritus, 30%; insect fragments, 16%; and Chironomidae, Plecoptera, Ephemeroptera, and Trichoptera in lesser percentages.

Slack (1936) made gut analyses of seven larvae of Rhyacophila dorsalis (Curtis), a European species, finding diatoms, Trichoptera larvae, Simulium (Diptera: Simuliidae) larvae, and Chironomidae (Diptera) larvae. Badcock (1949) examined the gut contents of larvae of R. dorsalis and found they contained primarily Chironomidae larvae and Baetis (Ephemeroptera: Baetidae) nymphs, and a few Plecoptera, Hydropsyche (Trichoptera) and Simulium larvae. Jones (1950) examined eight larvae from October to June, five of which contained food, including Leuctra (Plecoptera), Hydropsyche, and Velia (Hemiptera: Veliidae). Scott (1950) studied larvae of dorsalis from the River Dean, Cheshire, England, finding nymphs of Baetis in 23% of the stomachs, Chironomidae larvae in 19%, and Simulium larvae in 13%. Trichoptera larvae, oligochaetes, copepods, and hydrachnids were also found in small numbers.

Chapman and Demory (1963) attempted to determine the food components for the aquatic insect larvae and nymphs in two small Oregon Coast Range streams. The 10 larvae of Rhyacophila spp.

studied were carnivorous.

Smith (1968) found that Rhyacophila verrula Milne larvae, in the Salmon River drainage in Idaho, were always associated with Prasiola, a green alga. The guts contained this alga, watercress and other unidentifiable plant matter.

Rudolph Thut, working at the Weyerhaeuser Company Experimental Streams near Kalama, Washington, has completed two reports concerning Rhyacophila. The first (1967) included information from a stream sampling program on the life cycle and habitat of the seven species of Rhyacophila occurring in the streams. Assuming that interspecific competition would be operating in this homogeneous environment, the second paper (1969) discussed behavioral differences in feeding habits that would aid in enabling these seven species to co-exist. He quantified the stomach contents of 245 larvae by the method used by Mecom and Cummins (1964). The five categories of food distinguished were (1) animal, (2) detritus, (3) diatom, (4) vascular plant, and (5) filamentous algae. He found that Rhyacophila arnaudi Denning, R. vagrita Milne, R. vepulsa Milne, R. vaccua Milne, and R. grandis Banks were carnivorous, R. vaefes Milne was omnivorous, and R. verrula Milne was herbivorous. The most important organisms in the diets of the carnivorous species were Acari, Chironomidae, and Copepoda. He suggested that the Rhyacophila larvae were selective in their feeding because Copepoda and Acari were fed

upon in excess of their abundance in the benthos.

Anderson (1967) studied the biology and downstream drift of six species of Rhyacophila in the Metolius River, Oregon. Anderson and Wold (1972) studied emergence of caddisflies, including 11 species of Rhyacophila, over 2 and 3/4 year period in Oak Creek, near Corvallis, Oregon. The species of Rhyacophila were: ecosa, fenderi, grandis, iranda, pellisa, vaccua, vao, vedra, vepalsa, vuzana, and willametta. There were four traps ranging in elevation from 225 feet to 700 feet. Rhyacophila were not collected in the trap at the lowest elevation. This trap exhibited more extreme temperature variations throughout the year, more silting, and some pollution from agricultural runoff.

PROCEDURE

Study Area

The study area included the western nearctic from Colorado, Wyoming, Montana, and Alberta west to the Pacific Ocean and from Alaska to part of Baja California, Mexico. The author collected extensively throughout Oregon and to a lesser extent in Washington, British Columbia, and Alberta. A great deal of the material studied from outside of Oregon was kindly loaned by Dr. Glenn B. Wiggins, Royal Ontario Museum, Toronto, Canada, who along with his staff, have made extensive collecting trips throughout nearly the entire study area. Dr. Elwin D. Evans, Oregon State University, also collected many Rhyacophila in Oregon and California which contributed to this study. Many specimens were also collected by Dr. Norman H. Anderson, Oregon State University, from throughout Oregon.

Collection and Preservation

The major collecting technique for larvae and pupae was hand-picking from the substrate in stream situations. Aquatic and aerial nets were also used during field collection. A "black" light was used for night collection of adults.

The Rhyacophila larvae, pupae, and adults were killed and

preserved in 75% ethyl alcohol. If the vials contained many individuals, the liquid was replaced with fresh alcohol a few hours after collection. Larvae and pupae that were to be reared were placed in separate, small, plastic or glass containers which contained some damp moss or other vegetation. These were transported back to the laboratory on ice.

It was often necessary to clear the adult genitalia to better see the diagnostic characters. Following the method of Ross (1944), the apical half or third of the abdomen was soaked in a cool 10-15% caustic soda solution for six to 12 hours. It was then placed in distilled water and the softened viscera pressed out. After soaking, the cleared genital capsule was placed in a shell vial containing 75% ethyl alcohol, plugged with cotton, and inverted inside the vial containing the donor adult.

Association of Life Stages

The association of the immature stages with the adult was accomplished by use of the metamorphotype method (Milne, 1938) and by rearing. The metamorphotype method consists of using the adult characters, such as the genitalia on the mature pupa, to associate it with the adult. The larval exuvium is shed during pupation and retained in the caudal end of the cocoon. The larval sclerites can then be used to associate the larva with the corresponding pupa

and adult. This method assures correct association, permanent proof of the association, and eliminates the need for cumbersome rearing programs. The descriptions were then based on the sclerites from the metamorphotype and on the corresponding mature larvae from the same locality.

Laboratory rearing was used on a small scale for the eggs, larvae, and pupae. The only eggs obtained, those of Rhyacophila norcuta Ross, were placed in divided plastic petri dishes on damp strips of paper towel in a cold room (13° C) and in a refrigerator (9° C).

Larvae were reared in flowing water troughs, in which the water level, rate of flow, and water exchange could be regulated, at the aquatic entomology laboratory at Oak Creek, five miles northwest of Corvallis. They were also reared in troughs in a cold room (13° - 16° C) in Cordley Hall, Oregon State University. The cold room was found to be far more conveniently located and could be maintained under more constant temperature and light regimes than at the Oak Creek laboratory. The larvae of Rhyacophila had to be reared in separate cages because of cannibalism. It was also helpful if only one larva or pupa was placed in each container to eliminate the possibility of mixing up the larval exuvia and the emerging adults.

The larvae were reared in two types of containers: single cylindrical bronze screen cages and multiple plastic cages. The screen cages were approximately 9 cm in diameter by 10 cm in

height. Clear plastic petri dishes served as the removable lid and the stationary base. A substrate of small rocks and sand was placed in each cage to provide a footing for the larvae and case building material for the prepupae. The cages were placed in troughs of flowing water and the water level regulated until the bottom few centimeters of the cage was submerged.

The acrylic plastic cages, constructed by Evans (1972), were 28.5 cm long, 8 cm wide, and 6.5 cm high, with ten separate compartments, each with a 2 cm opening at both ends which were covered by a piece of Nitex mesh to allow for water exchange. The cages were placed at right angles to the direction of water flow and provided with substrate as were the wire cages.

Live Chironomidae, Daphnia, and Tubificidae were used as prey for the Rhyacophila larvae. Moss was also available in the cages since some species are herbivorous or omnivorous (Smith, 1968; Thut, 1969).

The Rhyacophila pupae were held in a refrigerator and in the cold room in small jars containing damp moss or paper towel. It was preferable to place only one pupa in each container to simplify adult association. Using this method, each newly emerged adult can be placed in a vial with the pupal skin and the cocoon containing the sclerites. The pupae were kept from one day to as long as 80 days before transformation. This difference may be due to the degree of

maturity of the pupae when collected, the temperature at which they were maintained, and the difference in the original habitat, varying from cold, snow-fed streams to warmer water (21° C).

Determination of Instar

Larval head capsule measurements were made to determine the instar. The length of the head capsule, observed dorsally, was measured, rather than the width, as it gave a larger measurement than the width since the majority of the larvae have elongate heads. This method was consistent with the method used by Thut (1969). Additionally, the section of the head that was the widest was variable between species, so a different area of the head would have to be measured from species to species if one was to measure the head at the widest point.

In the text concerning the larval head capsule measurements, the number of the instar is listed as I, II, III, IV, and V. The measurements are in millimeters.

Material Examined

Approximately 9,500 specimens of Rhyacophila were examined. Complete lists of the material examined have been included since I feel they are useful to others who do survey and ecological studies. The abbreviations for the collector's name, listed in parentheses

under the material examined, are:

- W Janet Lee Wold, Oregon State University
- WW Janet Lee Wold and Ronald A. Wold
- A Norman H. Anderson, Oregon State University
- GW Glenn B. Wiggins, Royal Ontario Museum, Toronto,
Canada
- Y Tosh Yamamoto, Royal Ontario Museum, Toronto,
Canada
- S Ian Smith, Royal Ontario Museum, Toronto, Canada
- R Royal Ontario Museum Field Party, Toronto, Canada
- E Elwin Evans, Oregon State University
- J Stanley G. Jewett, Jr., West Linn, Oregon
- O Anker Odum, Royal Ontario Museum, Toronto, Canada
- T Michael Tew, Oregon State University
- K Cary D. Kerst, Oregon State University
- C Eric Charnov, Oregon State University
- L Phil Lohrenz, Oregon State University
- WWSC Western Washington State College--material loaned
by them without collectors listed.

The life stage is denoted at the end of each locality listing as follows:

- L Larva, the parentheses following this symbol contains
the number of the instar

PP Prepupa--a larva that has spun the pupal cocoon, but
 has not yet transformed to the pupa

P Pupa

M Metamorphotype, as defined earlier

A Adult

The larvae of some of the closely related species could not be distinguished from one another. When this was the case, one description was used for all species that were indistinguishable and they are listed under "material examined" below the group heading. These lists have been simplified to include only the counties and states where they have been collected since any more detailed information would be of little use if it includes more than one species.

Collection record cards will be retained by the writer with a duplicate set remaining at the Department of Entomology, Oregon State University, Corvallis, Oregon 97331.

Classification System

Dohler (1950) divided the genus Rhyacophila into what he termed subgenera, based on the morphology of the larvae in Europe. Lepneva (1964) studied the forms of larvae of Rhyacophila in Russia finding them markedly more diverse than those studied by Dohler. She considered Dohler's subgenera as being only species groups and used these six groups to classify the larvae of Russia.

Phylogenetic schemes, based in most part on the male genitalia of Rhyacophila, have been presented by Ross (1956) and Schmid (1970). Ross (1956) proposed the first phylogenetic scheme for the genus Rhyacophila, dividing the genus into nine main divisions and 44 groups, of which 18 groups occur in western North America. Schmid in his 1970 monograph of the world Rhyacophila has considerably modified the Ross classification and has described an additional 150 species. Schmid (1970) uses four main divisions and 72 groups, of which 17 occur in western North America. With a few minor modifications based on the relationships between larvae, I have followed Schmid's (1970) classification in this study. All of the divisions, branches, and groups which do not occur in western North America have been deleted from the following summary of Schmid's (1970) classification (*- indicates a change made in Schmid's classification by the writer):

I. Vulgaris Division

1. Rotunda Group
2. Oreta Group
3. Viquaea Group
4. Vagrita Group

II. Philopotamoides Division

A. Castanea Branch

5. Alberta Group

B. Invaria Branch

6. Hyalinata Group
7. Coloradensis Group
8. Angelita Group
9. Rayneri Group*
10. Sibirica Group
11. Vofixa Group
12. Betteni Group
13. Verrula Group

III. Divaricata DivisionA. Nigrocephala Branch

14. Ecosa Group

B. Acropedes Branch

15. Vemna Group
16. Acropedes Group

IV. Naviculata Division

17. Lieftincki Group

V. Uncertain Status

18. Nevadensis Group
19. Oreia Group*
20. Isolated Species

Key and Illustrations

The key to the mature larvae of the subfamily Rhyacophilinae in western North America was developed by the writer. The subfamily Rhyacophilinae in the study area includes the two genera, Rhyacophila and Himalopsyche. The genus Himalopsyche has only one species, phryganea (Ross), that occurs in western North America (Flint, 1961). This species was included in the key so that all of the known larvae in the entire subfamily in the study area could be keyed out.

The larvae of closely related species in the genus Rhyacophila often cannot be separated. Consequently, in the key some of the sections of couplets have more than one species listed.

Most of the illustrations were drawn to approximately the same finished size, rather than all to the same scale. The actual size variation between the mature larvae of different species is apparent from the lengths of the mature larvae given in the descriptions.

4. Abdominal segments II-VII with three pairs of branching
gills (Figure 59) acropedes Banks
inculta Ross and Spencer
vao Milne
wallowa Denning

Abdominal segments II-VII with two pairs of branching
gills 5
5. Viewed dorsally, head narrowed anteriorly, posterior
20% wider than anterior sequoia Denning

Viewed dorsally, head not narrowed anteriorly, width
of anterior and posterior of head subequal (Figure 64)
. 6
6. Head and pronotum light brown with many dark brown
muscle scars; without darkened area along median suture
of pronotum neograndis Denning

Anterior 2/3 of head brown, posterior 1/3 of head lighter
yellow-brown, muscle scars indistinct (Figure 64);
pronotum with darker brown area bordering median
suture (Figure 65) grandis Banks
7. Head elongate, over twice as long as width at widest
point (Figure 79) Species #1--probably ecosa Ross

Head not elongate as above, less than twice as long as
width at widest point 8

8. Abdomen with fleshy lateral protuberances (Figures 21, 23, 24) 9
- Abdomen without fleshy lateral protuberances (Figure 49) 10
9. Fleshy lateral protuberances of abdomen bilobed
 - bifila Banks
 - coloradensis Banks
- Fleshy lateral protuberances of abdomen with a single lobe (Figures 23, 24)
 - hyalinata Banks
 - vocala Milne
10. Head nearly spherical, mandibles with a mesal clump of more than two setae (Figure 57) verrula Milne
- Head not spherical, usually somewhat flattened dorsally, mandibles without a mesal clump of more than two setae (Figure 30) 11
11. Anal proleg with an apicolateral spur (Figures 31, 35, 38, 70) 12
- Anal proleg without an apicolateral spur (Figures 28, 41, 48) 15
12. Head with V-shaped dark brown area covering entire frontoclypeus (Figure 68) arnaudi Denning
- Head without a dark brown V-shaped area covering entire frontoclypeus 13
13. Right mandible with three apical teeth (Figure 37)
 - valuma Milne

- Right mandible with fewer than three apical teeth
(Figures 30, 57) 14
14. Right mandible with one apical tooth and a large subapical
tooth (Figure 34) rayneri Ross
- Right mandible with one apical tooth, subapical tooth
absent (Figure 30) angelita Banks
perplana Ross and Spencer
15. Head with a darkened V-shaped area on the posterior part
of the frontoclypeus, extending part way along frontal
sutures (Figure 71); ventral blade of left mandible wavy,
with three broad, rounded tooth-like processes basally
and a smaller one apically (Figure 72) vaefes Milne
nevadensis Banks
- Head without a darkened V-shaped area on the posterior
angle of the frontoclypeus; ventral blade of the left
mandible not wavy as above 16
16. Right mandible with one or two apical teeth (Figures 9, 53) . . 18
- Right mandible with three apical teeth, or if two, one
truncate (Figures 40, 43) 17
17. Head dark brown or black dorsally with posterior 1/4
light yellow (Figure 42); pronotum with fewer than 40
setae along anterior margin narvae Navas

- Head entirely light brown (Figure 39); pronotum with
more than 60 setae along anterior margin blarina Ross
18. Length of maxillary palpus about ten times width
of second segment (Figure 52) 19
Length of maxillary palpus less than eight times width
of second segment (Figure 66) 20
19. Anterior 2/3 of dorsum of head dark brown, posterior
1/3 yellow (Figure 55) malkini Ross
Entire head approximately same shade of brown
(Figure 50) chilsia Denning
fenderi Ross
vaccua Milne
vedra Milne
willametta Ross
20. Head widest posteriorly as in Figures 46 and 76 21
Head widest medially as in Figures 8, 11, and 14 23
21. Frontoclypeus darkened anteriorly and shaped as in
Figure 46 velora Denning
Frontoclypeus not darkened anteriorly and is shaped
as in Figure 76 22
22. Head yellow-brown with dark brown, distinct muscle scars;
basoventral hook small, as in Figure 78 visor Milne
Head yellow-brown with indistinct muscle scars;
basoventral hook large, as in Figure 75 oreia Ross

23. Head dark brown ventrally oreta Ross

Head not dark brown ventrally, about the same

color as dorsum of head 24

24. Dorsum of head with many darkened muscle scars

(Figure 8); claw of anal proleg with two ventral teeth

(Figure 10) norcuta Ross
rotunda Banks

Dorsum of head uniform color without darkened muscle

scars (Figure 14); claw of anal proleg without ventral

teeth, or, if present, very minute (Figure 16).

. vagrita Milne

VULGARIS DIVISION

In western North America, the vulgaris division contains the rotunda group, the oreta group, the viquaea group, and the vagrita group. Larvae are associated in all but the viquaea group. The larvae have simple mandibles with an apical tooth on the right and left mandible and a smaller mesal tooth on the right mandible. They do not have gills or fleshy lateral protuberances on the abdomen. The anal proleg is without an apicolateral spur.

1. Rotunda Group

The rotunda group of Schmid (1970) includes Rhyacophila ebria Denning, R. latitergum Davis, R. norcuta Ross, R. rotunda Banks, and R. tralala Schmid. Ross (1956) also placed all of these species in a rotunda group. However, he also included R. oreta Ross and R. basalis Banks in this group.

Metamorphotypes have been obtained for R. norcuta, tralala and rotunda. Smith (1968) described the larva of rotunda based on a metamorphotype from the Salmon River drainage in Idaho. There are no distinct morphological characters with which to separate larvae of norcuta, tralala and rotunda. Generally, the head of norcuta and tralala is somewhat lighter in color than that of rotunda and the muscle scars are much more distinct than in rotunda.

Adults and metamorphotypes of this group are listed under the appropriate species. The larvae and prepupae of the species of this group cannot be readily separated. Consequently, all records of larvae of this group collected in western North America are listed below, having been simplified to include only the states and counties in which they occurred.

Material Examined:

Canada: British Columbia (including Vancouver Island)

California: Los Angeles

Nevada

San Bernadino

Shasta

Ventura

Idaho: Idaho

Oregon: Benton

Clackamas

Hood River

Josephine

Klamath

Lane

Lincoln

Linn

Multnomah

Utah: Zion Nat. Park

Washington: Chelan

Clallam

Grays Harbor

King

Lewis

Pierce

Whatcom

Rhyacophila ebria Denning

Rhyacophila ebria Denning, 1949b:37-8; Ross, 1956:86, 118; Schmid,
1970:43, 122.

Type Locality: Glacier Nat. Park, Logan Pass, 6660',
Montana, Aug. 27, 1947 (C. P. Alexander).

Larva: Unknown.

Distribution: Montana and British Columbia.

Material Examined: None.

Biology: Unknown.

Rhyacophila latitergum Davis

Rhyacophila latitergum Davis, 1950:448; Ross, 1956:86, 118; Schmid,
1970:43, 122.

Type Locality: Tomyhoy Lake, Whatcom Co., Washington,
Aug. 4, 1946 (J. J. Davis).

Larva: Unknown. It is probably extremely close to those of R. norcuta, rotunda and tralala on the basis of the many similarities between the adults of these species.

Distribution: Known only from the type locality in Washington.

Material Examined: None.

Biology: Unknown.

Rhyacophila norcuta Ross

(Figures 8, 9, 10)

Rhyacophila norcuta Ross, 1938a:117-8; Davis, 1948:42-3; Denning, 1948b:102; Schmid & Guppy, 1951:41; Ross & Spencer, 1951:44; Ross, 1956:86, 118; Smith, 1968:664; Schmid, 1970:43, 122.

Type Locality: Ilwaco, Washington, May 26, 1918 (A. Spuler).

Rhyacophila novarotunda Ling, 1938:61; Ross, 1941:39.

Larva: The association of the larva of this species is based on mature male metamorphotypes collected in Benton and Linn Counties, Oregon. The description of this larva is the same as that for R. rotunda, except that the head is light brown with more distinct muscle scars.

Distribution: This species occurs in the western sections of British Columbia (including Vancouver Island), California, Oregon, and Washington. Smith's (1968) record from Idaho is questionable; the genitalia of the single specimen were lost so the record cannot be confirmed.

Material Examined: The larvae of this species are listed under the rotunda group heading since there are other species in this group from which they cannot be separated. All adults and metamorphotypes of norcuta are included in the following list:

OREGON: Benton Co: Marys Peak: July 11, 1967 (W), 1 ♀ A; stream crossing Marys Pk. Rd., .4 mi. from Rt. 34, June 6, 1968 (Y & S), 1 ♂ M; stream crossing Marys Pk. Rd. 2 mi. from Hwy. 34, June 16, 1966 (W), 1 ♂ A; Feb. 26, 1966 (W), 1 ♀ M; May 6, 1966 (W), 1 ♂ M; temp. stream crossing Marys Pk. Rd. 7.7 mi. from Rt. 34, 2830', June 16, 1966 (W), 1 ♀ M, 5 ♂ M; Aug. 7, 1968 (E), 2 ♂ M; Sept. 16, 1968, at black light (W), 1 ♂ A; May 21, 1966 (W), 2 ♂ M; July 30, 1968, reared, emerged as ♂ A on Oct. 17, 1968 (W), 1 L; July 30, 1968, reared, emerged Jan. 20 to ♂ A (W), 1 L; Parker Crk. nr. campground at top of Marys Pk., June 16, 1966 (W), 1 ♂ M.

Clackamas Co: Stream 2.7 mi. N. McNeil For. Camp Jct. on Mt. Hood Rd. #N12, 61°F, July 7, 1968 (W), 1 ♂ M. Lincoln Co: Newport, March 30, 1930, 1 ♂ A. Linn Co: Trib. streams Carmen Reservoir, July 7, 1966 (W), 8 ♂ M. 12 mi. E. Green Peter Dam on Quartzville Rd., July 24, 1968, reared, emerged Oct. 17, 1968 (W), 1 ♂ M. Small streams from 1.6 to 1.8 mi. E. Yellowstone Guard Sta. on Quartzville Rd., nr. Green Peter Reservoir, Aug. 6, 1970 (W & A), 2 ♂ M. Multnomah Co: Multnomah Falls, Apr. 8, 1939 (J), 1 ♂ A. WASHINGTON: Ellsworth, Jan. 21, 1941 (J), 2 ♂ A.

Biology: Rhyacophila norcuta is one of the few species that has adapted to temporary streams through its ability to bridge the period when the stream is dry in both the pupal and adult stages. It was found during two consecutive years in a small intermittent stream (Tew, 1971), near Corvallis, Oregon, that flowed from late October to mid-April. Tew (1971) found the larvae concentrated in riffle areas where grass was growing. Pupation occurred from late March to early April when the stream began drying up. Emergence occurred just before, and for several weeks after the stream-bed had no water showing on the surface. Tew (1971) found the larvae living in moist areas under rocks up to two weeks after the surface water was gone, but noted that these larvae were unable to pupate.

Live pupae have also been observed in the sand and gravel in the dry stream-bed of a temporary stream on Marys Peak in Benton County, Oregon for up to one month after the stream became dry. The adults are in flight during part of this dry period. Adults were observed emerging from the pupal case, even though the stream was dry. The eggs may also be able to withstand some drying, helping insure the survival of the species during the period the stream is dry.

Until now there have been no observations made on the eggs of Rhyacophila in North America. On Marys Peak, September 12, 1968, the females of norcuta were observed entering cool, damp

cracks in the rock in the dry stream-bed, remaining for a few minutes, and then flying off. They may have been laying eggs at this time. One captured female laid approximately 45 single eggs in a jar. Water or moisture seemed to stimulate oviposition.

The cream colored eggs of Rhyacophila norcuta were slightly oblong measuring 0.46 mm by 0.36 mm. (Figure 1). They were divided into two groups and placed in water in petri dishes, one group being held at 13°C and the other at 9°C. After one month the eye spots and egg burster on the head were present as pigmented areas in those eggs held at 9°C. The body form was also slightly visible. The incubation period lasted four weeks at 13°C and six weeks at 9°C. Within a day of hatching the larvae fed on Tubificidae. Many of the eggs held at both temperatures did not hatch. Many were covered with fungi, but a few of these were still able to develop and hatch in its presence. Ten larvae hatched, six from the group held at 13°C, and four of those held at 9°C. Two larvae in the 13°C group molted to the second instar, but the rest died. The first instar lasted approximately one month for these two larvae.

The adults of norcuta were collected from late February through early September.

Rhyacophila rotunda Banks

Rhyacophila rotunda Banks, 1924:443; Milne, 1936:111; Ross, 1938b:6;

Denning, 1948b:102; Ross, 1956:86, 118; Smith, 1968:666;
Schmid, 1970:43, 122.

Type Locality: Reno, Nevada, 1878 (Morrison).

Larva: Smith (1968) described the larva of rotunda:

Head brown, with many small darkened muscle scars (like Figure 8); maxillary palpus short, second segment between 1 1/2 and 2 times longer than first segment; left mandible short and broad with one apical tooth and one small blunt mesal tooth, right mandible short and broad, with one apical tooth and one small blunt mesal tooth (like Figure 9). Pronotum slightly paler than head with darkened muscle scars. Abdomen without gills or fleshy protuberances. Anal proleg with a small baso-ventral hook that usually does not protrude from the membrane, no apicolateral spur, and anal claw with two ventral teeth (like Figure 10). Length of mature larvae ranged from 20 to 22mm.

Distribution: This species has been recorded from California, Colorado, Idaho, Nevada and Utah.

Material Examined: CALIFORNIA: Riverside Co: Millard Canyon, 2840-3000', April 20, 1968 (C. Beesley), 1♂ A.

Biology: Smith (1968) discussed the seasonal occurrence in Idaho, finding pupae and adults during March, April, and September, and the larvae during the spring. This species was only found in permanent streams that were choked with silt. At the onset of pupation, larvae constructed mud cells on submerged rocks (Smith, 1968).

Rhyacophila tralala Schmid

Rhyacophila tralala Schmid, 1970:43, 122, 142-3.

Type Locality: Stimson Crk., Mason County, Washington,
April 3, 1949 (D. Frechin).

Larva: Larval sclerites from the metamorphotype of this species, from Yakima County, Washington, are morphologically inseparable from those of R. norcuta and R. rotunda.

Distribution: This species is known to occur only in the high Cascades of Oregon and Washington.

Material Examined: WASHINGTON: King Co: Small run on detour Rt. 2, just W. Stevens Pass, ca. 4000', June 17, 1969 (R), 3♂ A. Yakima Co: Streams crossing Rd. 84.1 ca. 12 mi. n. Trout Lk., June 11, 1969 (R), 1♂ A. Very sm. trickles crossing rd. 12.3 mi. n. Trout Lk., on Rd. N84.1 (R), 1♂ M.

2. Oreta Group

This group, containing Rhyacophila basalis Banks and R. oreta Ross, is closely related to the rotunda group. Ross (1956) included the species of this group in his rotunda group, in branch four, along with the species of Schmid's (1970) rotunda group.

The larva of oreta, associated by Smith (1968), can be separated from those of the rotunda group by its smaller size and the presence of a darkened area on the venter of the head. The larva of basalis has not been associated, but it is probably very similar in general appearance to the larva of oreta.

Rhyacophila basalis Banks

Rhyacophila basalis Banks, 1911:352; Milne, 1936:97, 105; Denning,

1948b:98; Ross, 1956:86, 118; Schmid, 1970:44, 122.

Type Locality: Claremont, California (Baker).

Larva: Unknown.

Distribution: California, Utah, and Wyoming.

Material Examined: None.

Biology: Unknown.

Rhyacophila oreta Ross

(Figures 11, 12, 13)

Rhyacophila oreta Ross, 1941:39-40; Davis, 1948:39-40; Denning,

1948b:102; Ross & Spencer, 1952:44; Schmid & Guppy, 1952:

41; Ross, 1956:86, 118; Smith, 1968:664-6; Schmid, 1970:44,

122.

Type Locality: Scout Camp, Logan Canyon, Utah, April 17,
1938 (D. E. Hardy).

Larva: Smith's (1968) association of the larva of oreta was based solely on distribution records. I have examined two metamorphotypes and they confirm the association. Smith (1968) described the larva:

Similar to R. rotunda. Head dark brown dorsally and ventrally, with many darker muscle scars (Figure 11); maxillary palpus short, second segment slightly longer than first; mandibles short and broad (Figure 12), same as in rotunda. Pronotum somewhat paler than head,

with darkened muscle scars, disc dark. Abdomen without gills or fleshy protuberances. Anal proleg with a small baso-ventral hook that does not protrude from the membrane, no apicolateral spur, and anal claw with two stout ventral teeth (Figure 13). Length of mature larva approximately 13mm.

Distribution: This species occurs in the mountainous areas of British Columbia (including Vancouver Island), California, Idaho, Oregon, Utah, Washington, and Wyoming.

Material Examined: CANADA: ALBERTA: Spring run (A) on rd. to Sundance Canyon, Banff, July 27, 1963 (GW), 1L (5). UNITED STATES: CALIFORNIA: Mono County: Spring area, Big Spring Cpgd., Hwy. 95 nr. Monmouth, 7300' (E), 1♂ A. NEVADA COUNTY: Springs entering Sagehen Crk, at Univ. Calif. Station, 8 mi. N. Truckee, Nov. 4, 1965 (A. L. Sheldon), 2L (5). Boca Spring, 6 mi. N. E. Truckee, July 19, 1966 (GW), 1♂ M, 1L (4). OREGON: BENTON COUNTY: Marys Peak: May 26, 1967, 1♂ A. W. of Corvallis, July 21, 1968 (W), 1L (4). Bluff Springs on Rd. #1243, July 16, 1970 (W & T), 2L (4) (in decaying bark submerged in stream). Stream 2 mi. off Hwy. 34 on Marys Pk. Rd., June 16, 1966 (W), 1L (4); Aug. 9, 1967 (K), 2L (4). Temporary stream crossing Marys Pk. Rd. below Parker Crk. Falls, July 16, 1970 (W & T), 2L (4, 5). Parker Falls, July 27, 1966 (W & L), 4L (4). Stream 1/2 mi. off Marys Pk. Rd. on Rd. #1296, July 11, 1968 (W) 1L (5). CLACKAMAS COUNTY: Still Crk., Still Crk. For. Camp, Mt. Hood, July 17, 1963

(GW), 2♂ A. Streams crossing rd. to Timberline Lodge, nr.

Government Camp, Mt. Hood, Sept. 28-9, 1966 (GW, Y & O), 1L

(5). JEFFERSON COUNTY: Riverside F.C., Metolius River, June

27, 1964 (A), 1L (5). KLAMATH COUNTY: Annie Crk., Crater Lk.

Nat. Pk., June 9, 1968 (Y & S), 1L (5). LANE COUNTY: Silver

Crk. Boat Landing, W. of Blue River, July 17, 1970 (W & E), 1L

(3). Streams crossing Rt. 126, 2 1/2 mi. W. Blue River, June 10,

1968 (Y & S), 1L (5). Stream crossing Rt. 126, ca. 2 mi. W. Blue

River, July 17, 1970 (W & E), 2L (5). Stream crossing Rt. 126, ca.

1 mi. W. Blue River, July 17, 1970 (W & E), 3L (4, 5). LINCOLN

COUNTY: spring on rd. #1209 along Bull Run Crk. 6/10 mi. N. W.

Rd. #1342 (Fall Crk. Rd.), June 21, 1970 (WW), 1L (5). LINN

COUNTY: Streams crossing Rt. 22, 13.3 mi. E. Idanha, June 12,

1968 (Y & S), 1L (5). Small trib. Snow Crk. at Rt. 20, Willamette

Natl. For., June 1, 1968 (Y & S), 1PP. Small streams 1.6-1.8 mi.

E. Yellowstone Guard Station on Quartzville Rd., nr. Green Peter

Reservoir, Aug. 6, 1970 (W & A), 18L (4, 5), 1PP (larvae in crevices

in shale-like rock in seep area). Small runs crossing Quartzville

Rd., 1.6 mi. e. Yellowstone Guard Sta., June 16, 1968 (GW, Y, S),

2L (4); June 17, 1968 (GW, Y, S), 1L (5). Small streams crossing

Quartzville Rd., 1.7 mi. w. Yellowstone Guard Sta., June 16, 1968

(GW, Y, S), 1L (4). Small stream 12 mi. e. Green Peter Dam on

Quartzville Rd., 1340', 63°F, July 24, 1968 (W). Marion Co:

Niagara, N. Fk. Santiam Riv., Oct. 26, 1968 (E), 1♂ A. UTAH:
Cache Co: Logan Canyon, Oct. 18, 1962 (G. F. Knowlton), 16L
 (1, 2, 3, 4, 5). WASHINGTON: Cowlitz Co: Weyerhaeuser Arti-
 ficial Streams, 3 mi. n. Lk. Merrill, Kalama River drainage,
 June 18, 1968 (A), 1♂ A. Pierce Co: 7 mi. n. Cayuse Pass, Mt.
 Rainier Natl. Pk., July 25, 1969 (WW), 1L (5). Seepage streams
 crossing Westside Rd., Longmire, Mt. Rainier Natl Pk., 2500',
 June 13, 1969 (R), 2L (5). Skamania Co: Small stream crossing
 Rd. N84.1 nr. Eckhart Pk., June 10-11, 1969 (R), 3L (5).
WYOMING: Teton Co: Spring run entering pond, Hoback Crk.
 Cpgrd., ca. 30 mi. S. Jackson on Rt. 187, June 2, 1969 (R), 1 PP,
 1♂ P, 2♀ P, 1♂ M.

Biology: The larvae of Rhyacophila oreta are frequently found
 in seep areas and springs, often in submerged pieces of wood and
 in crevices of rock. Smith (1968) found this species along small
 permanent streams in Idaho. He found no specific seasonal distri-
 bution of the life stages.

The lengths of the head capsules of the instars were (in mm):
 I, .26 to .28 (3 larvae); II, .40 (3 larvae); III, .50 to .60 (5 larvae);
 IV, .70 to .88 (21 larvae); and V, .94 to 1.20 (40 larvae). A sea-
 sonal pattern of progression of instars is not evident as first and
 second instars are recorded from Utah in October, while in other
 areas third instars were collected during June and October, fourth

instars in June, July, August, and October, and the fifth instar from June through November. The adults have been collected from March through October. Smith (1968) collected one adult in Idaho as late as December.

3. Viquaea Group

This group contains the western species Rhyacophila viquaea Milne and R. lineata Denning (Schmid, 1970). Ross (1956) also used this grouping, placing it in his branch five. The larvae are not associated for either of these species.

Rhyacophila lineata Denning

Rhyacophila lineata Denning, 1956:75; Schmid, 1970:44, 122.

Type Locality: Castle Crags State Park, Shasta Co., California, June 13, 1950 (L. W. Quate).

Larva: Unknown.

Distribution: Known only from the type locality.

Material Examined: None.

Biology: Unknown.

Rhyacophila viquaea Milne

Rhyacophila viquaea Milne, 1936:92; Ross, 1956:118; Schmid, 1970: 44, 122.

Type Locality: Salmon River, Welches, Oregon, June 18, 1933 (R. E. Dimick).

Rhyacophila celina Denning, 1954:57; Ross, 1956:87, 118 (synonymy).

Larva: Unknown.

Distribution: Oregon and Washington.

Material Examined: None.

Biology: Unknown.

4. Vagrita Group

This group, which includes Rhyacophila vagrita Milne and R. milnei Ross, occurs in the western montane region (Schmid, 1970). Ross (1956) concluded that this group was far removed from any of the others, but may have been an offshoot of his branch nine, containing the groups willametta, vobara, angelita, alexanderi, naviculata, nigrocephala, and verrula. Schmid (1970) placed this group in the vulgaris division with the Nearctic groups rotunda, oreta, and viquaea. The larvae seem to fit well with the arrangement used by Schmid (1970), since they have mandibles that are quite similar to those of larvae in the rotunda and oreta groups.

Rhyacophila milnei Ross

Rhyacophila milnei Ross, 1950a:264; Ross, 1956:108, 122; Schmid, 1970:45, 122; Nimmo, 1971:17, 36-7.

Type Locality: Banff, Alberta, Sept. 5, 1922 (C. B. D. Garrett).

Larva: The larva of this species is unknown, but it is likely that it will very closely resemble the larva of vagrita.

Distribution: At present, even after the extensive collecting of Nimmo (1971) in Alberta, this species has only been recorded from the type locality.

Material Examined: None.

Biology: Unknown.

Rhyacophila vagrita Milne

(Figures 14, 15, 16)

Rhyacophila vagrita Milne, 1936:91-2, 105, 111; Ross, 1944:291; Denning, 1948b:105; Ross, 1950a:264; Ross & Spencer, 1952: 45; Ross, 1956:108, 122; Schmid, 1958:12; Smith, 1968:658, 668-70, 673; Thut, 1969:894-898; Schmid, 1970:45, 122; Nimmo, 1971:17, 19, 35-6.

Type Locality: Cultus Lake, B. C., Aug. 24, 1934 (W. E. Ricker).

Larva: Smith (1968) described the larva of vagrita:

Head light tan, anterior margin darker, occasionally with a slightly darkened discal area, no muscle scars (Figure 14); maxillary palpus short, first segment subequal to second; left mandible with one apical tooth, right mandible with one apical and one small mesal tooth (Figure 15). Pronotum yellow, muscle scars light and indistinct, or absent, hind margin not strongly notched medially. Abdomen without gills or fleshy protuberances. Anal proleg with a baso-ventral hook, no apico-lateral spur, and anal claw with two extremely small setalike teeth ventrally, or none (Figure 16). Length of mature larvae approximately 12mm.

Distribution: Records for this species include Alberta, British Columbia, California, Idaho, Oregon, Montana, Utah, and Washington.

Material Examined: CALIFORNIA: Shasta Co: Lost Crk., Lassen Volcanic Nat. Pk., 6000', Sept. 18, 1946 (H. P. Chandler), 2PP, 3♂ M. MONTANA: Mineral Co: Denna Mora Crk., Denna Mora Cpgrd., on Rt. 10, w. of Saltese, u. v. light, Sept. 16, 1966 (GW, Y, O), 1♂ A. OREGON: Clackamas Co: Lost Crk. For. Camp, nr. Mt. Hood, 2050', 51°F, July 17, 1968 (W), 3L (5). Two sm. str., 2.7 mi. n. McNeil For. Camp Jct. on Mt. Hood Rd. #N12, 2300', 50°F, Aug. 27, 1968 (W), 3L (5). Jefferson Co: Metolius River, Bridge 99, Sept. 23, 1965 (A), 3♂ A. Josephine Co: Cave Crk., Oregon Caves Nat. Mon., 4000', Aug. 5, 1967 (WW), 2L (5). Wallowa Co: Wallowa Lake, Sept. 12, 1949 (V. Roth), 1♂ A. WASHINGTON: Cowlitz Co: Weyerhaeuser Co. experimental streams, nr. Lk. Merrill, July, 1966 (R. Thut), 1L (smashed head). Jefferson Co: Hoh Riv. at Hoh Riv. Cpgrd., Olympic Nat. Pk., June 30-July 1, 1969, (R), 1L (5).

Biology: Thut (1969) demonstrated that R. vagrita was univoltine in spring-fed streams near Kalama, Washington. The carnivorous larvae of vagrita occurred for only five months, from April through August, with the fifth instar present for two months. The adults emerged during November. The remainder of the year

was possibly spent in the egg stage. Larval head capsule measurements made by Thut (1967) were (in mm.): I, .20 to .24; II, .34 to .36; III, .48 to .52; IV, approximately .78; and V, .94 to 1.02. The larvae were predominately found in the more rapid areas of the streams, where the current velocity ranged from 1.4 to 1.75 ft./sec. It was one of the less common species in the streams, with $36/m^2$ the maximum number of larvae found in benthos samples.

Thut (1969) found that plant material made up only 7% of the diet of R. vagrita. The dominant prey were Copepoda and Trichoptera, especially R. verrula. Ephemeroptera and Plecoptera were not eaten at all, even though they composed 15% of the benthic fauna.

In Idaho, Smith (1968) collected larvae in August and a mature male pupa in September. Nimmo (1971) found this species to be uncommon in Alberta. He only collected it at the floors of major valleys at about 3,500 feet elevation.

Prepupae, mature pupae, and adults were collected in California during mid-September. Fifth instars were collected from mid-July to late August and adults in late September in Oregon. Thus, the scattered records indicate that this is a late season species.

PHILOPOTAMOIDES DIVISION

The philopotamoides division is composed of the castanea branch and the invaria branch, with a total of nine groups occurring in western North America. In the study area the castanea branch has only four species, all in the alberta group. The invaria branch is composed of 44 species included in eight groups: hyalinata group, coloradensis group, angelita group, rayneri group, sibirica group, vofixa group, betteni group, and verrula group. None of these groups of the invaria branch have gills.

Castanea Branch

In western North America the castanea branch includes only the one group, alberta.

5. Alberta Group

This group contains Rhyacophila alberta Banks, R. glaciera Denning, R. kincaidi Schmid, and R. tucula Ross (Schmid, 1970). Ross (1956) proposed the use of this same group, placing it in his branch one.

Smith (1968) associated the larva of tucula, based on a metamorphotype from Idaho. A metamorphotype is now also available for kincaidi, but the larva cannot be easily separated from that of tucula. The larvae of this group can be recognized by the dorsal,

single, finger-like gills distributed as follows: mesothorax, one pair; metathorax, two pairs; abdominal segments I-VI, four pairs; segment VII, three pairs; and segment VIII, either one very small pair or none. They do not have lateral, fleshy protuberances on the abdomen or an apicolateral spur on the anal proleg.

The larvae of R. tucula tend to have shorter gills than do the larvae of R. kincaidi collected on the Kenai Peninsula, Alaska. The larvae of kincaidi apparently always have a small gill on segment VIII. Smith (1968) stated that in tucula, gills were absent on segment VIII. However, I have found that the length of the gills and their presence or absence on segment VIII is variable in larvae of the tucula type. It is possible some of these slight variants are the larvae of alberta or glaciera. At any rate, the larvae of alberta and glaciera, which at present are not associated, would be expected to be nearly identical to the larvae of tucula and kincaidi. Perhaps these problems can be resolved when metamorphotypes of alberta and glaciera become available.

Rhyacophila alberta Banks

Rhyacophila alberta Banks, 1918:21; Dodds & Hisaw, 1925b:386;

Ulmer, 1932:209; Betten, 1934:135; Milne, 1936:98, 106;

Ross, 1944:291; Ross, 1950a:261; Ross, 1956:76, 116; Schmid,

1958:13; Ross, 1965:591; Schmid, 1970:55, 124; Nimmo, 1971:

19-20.

Type Locality: Banff, Alberta, Canada, Sept. 27 (N. B. Sanson).

Rhyacophila mirus Denning, 1948b:21-2; Ross, 1950a:261 (synonymy).

Larva: Unknown.

Distribution: This species occurs in Alaska, Alberta, British Columbia, Colorado, Utah, and Wyoming. It is confined largely to the Rocky Mountains (Nimmo: 1971). See discussion of tucula.

Material Examined: None.

Biology: Nimmo (1971) reported a flight season from August 12 to October 9 in Alberta at elevations of 4,000 to 6,500'. In Colorado it occurred from 9,000 to 11,000' (Dodds & Hisaw, 1925).

Rhyacophila glaciera Denning

Rhyacophila glaciera Denning, 1965a:263, 265; Schmid, 1970:55, 124;

Nimmo, 1971:21-2.

Type Locality: Glacier Nat. Park, Montana, Sept. 13, 1964 (Joe Schuh and W. C. Peters).

Larva: Unknown.

Distribution: Rocky Mountains in Montana and Alberta.

Material Examined: None.

Biology: The flight season in Alberta is from August 12 to October 9 (Nimmo, 1971).

Rhyacophila kincaidi Schmid

(Figures 17, 18, 19)

Rhyacophila kincaidi Schmid, 1970:55, 124, 157-8.

Type Locality: Skagit River Camp, British Columbia, July 3, 1965 (F. Schmid).

Rhyacophila kincaidi nom. nud. Ross, 1965:76.

Larva: The larva is difficult to separate from that of tucula. Specimens from the Kenai Peninsula, Alaska tend to have more elongate gills than do those of tucula, but this character is not adequate to allow one to make correct determinations.

Distribution: Oregon, Washington, British Columbia, and Alaska.

Material Examined: Since larvae of kincaidi cannot be easily separated from those of tucula, some of the larvae of kincaidi may be included in the list of tucula examined.

ALASKA: Kenai Peninsula: Small tributary stream to Lower Russian Lk., June 27, 1969 (C), 1♀ P. Torrential mountain trib. to Lower Russian Lk., July 18, 1969 (C), 6L (5), 12PP, 2♂ P; July 15, 1969 (C), 1♂ P, 1♀ M, 1♂ M; July 28, 1969 (C), 5L (5), 20PP, 14♂ M, 1♀ M; Aug. 4, 1969 (C), 3♂ A, 2♀ A; Aug. 14, 1969 (C), 2♂ A, 2PP, 7♀ M, 6 ♂ M; at base of falls, Aug. 4, 1969 (C), 7PP, 12♀ M, 4♂ M.

Other Areas: Ugiak Bay, trib. str., July 17, 1969 (R. Russell) 1L (5). OREGON: Hood River Co: No. Fk. Iron Crk., nr. Bennett Pass,

4400', July 11, 1968, emerged Aug. 9, 1968 (A), 1♂ M.

Biology: In Oregon this species was collected in a very cold (5°C in summer), rapid stream on Mt. Hood. The characteristics of this stream and the high elevation probably allow this species to occur at this southern extreme. During the past this species may have been common at lower latitudes but as the climate warmed they may have become confined in the lower latitudes to mountain "islands" which had conditions similar to the higher latitudes.

Fifth instars have been collected in July, pupae during June, July, and August, and the adults during July and August.

Rhyacophila tucula Ross

Rhyacophila tucula Ross, 1950a:261; Ross & Spencer, 1952:45; Ross, 1956:116; Ross, 1965:591; Anderson, 1967:508; Smith, 1968:658, 666-8; Schmid, 1970:55, 124; Nimmo, 1971:17, 20-1.

Type Locality: Gardner Riv., Yellowstone Nat. Park, Wyoming, Aug. 22, 1946 (W. E. Ricker),

Larva: Smith (1968) described the larva:

Head narrow, light brown, with many darkened muscle scars dorsoposteriorly (like Figure 17; frontoclypeus with hind margin dark brown; maxillary palpus stout, second segment slightly longer than first; left mandible with one apical tooth and one sub-apical tooth, mesal margin smooth (like Figure 18), right mandible with one apical tooth and one small mesal tooth [right mandible, if not worn, has a small dorsal subapical tooth]. Pronotum brown with a few darkened muscle scars posteriorly; mesothorax with one pair of single gills on dorsum; metathorax with two pairs of single gills on dorsum. Abdomen with four pairs

of single gills on segment VII, no gills on segment VIII. Anal proleg with a baso-ventral hook, no apico-lateral spur, and anal claw with two large, stout ventral teeth (like Figure 19). Length of mature larvae approximately 13mm.

Distribution: This species occurs primarily in the Coast Ranges, but extends as far east as the Rocky Mountains. It has been recorded from Alaska, lower elevations in Alberta and British Columbia, and from Idaho, Oregon, Washington, and Wyoming. Ross (1950) stated that:

Records for alberta are available from Banff, Alberta (type of alberta); Tolland and Silverton, Colorado; Unitah Mountains, Utah; and Snowy Range Mountains, Albany County, Wyoming. Comparison of these localities with those for tucula indicated that alberta is apparently restricted to the eastern montane region of the west, whereas tucula appears to be the dominant species of the group in the western ranges. The ranges of the two species overlap, at least in Wyoming, and subsequent collecting may demonstrate that this occurs over a fairly wide area.

Material Examined: Since the larvae of tucula and kincaidi cannot be readily separated, it is possible that some of the latter may also be included in this list. All larvae are the fifth instar, unless listed otherwise.

ALBERTA: Little Red Deer Riv. at Forest Trunk Rd., July 26, 1963 (A. Nimmo), 1L. Edson, roadside campsite, June 19, 1962 (GW), 4L. BRITISH COLUMBIA: Stream nr. Mt. Wardle on Hwy. 93, Kootenay Nat. Pk., June 23, 1962 (GW), 18L. Small str. crossing Trans Canada Hwy., ca. 22 mi. n. Golden, July 25, 1969 (R), 1L. Small str. crossing T. Can. Hwy., ca. 12.1 mi. e. western boundary

Glacier Nat. Pk., July 26, 1969 (R), 5L. Small str. crossing T. C. Hwy., ca. 4.1 mi. e. western boundary Glacier Nat. Pk., July 26, 1969 (R), 1PP. Large str. in Coldspring Cpgrd., E. C. Manning Prov. Pk., July 6, 1969 (R), 1L. Small rapid str., 1.2 mi. w. Allison Pass Summit, E. C. Manning Prov. Pk., 4400', July 6, 1969 (R), 2L. Stream 3 mi. w. of east entrance to Revelstoke Natl. Park, June 30, 1967 (WW), 5L.

CALIFORNIA: El Dorado Co: Upper Truckee River, W. of Meyers, Hwy. 50, July 26, 1968 (E), 2L. Nevada Co: Sagehen Crk. above Univ. Calif. Sta. 8 mi. N. Truckee, July 19, 1966 (GW), 1L. IDAHO: Idaho Co: Holly Crk. at Rt. 12, N. E. of Lowell, June 24, 1968 (GW, Y, S), 1L. MONTANA: Flathead Co: Park Crk., Glacier Natl. Park, July 14, 1969 (J. M. Stauffer), 11L. Wolf Crk., Aug. 9, 1968 (R. L. Newell), 1L. Missoula Co: Spring runs crossing Rt. 12, at Lolo Pass, June 25, 1968 (GW, Y, S), 1L (fourth instar). OREGON: Clackamas Co: Salmon River, Hwy. 35, 2 mi. from Gov't. Camp Jct., 3500', July 11, 1968 (A), 1L. Deschutes Co: Elk Creek, nr. Elk Lk., on Hwy. 46, July 9, 1969 (W), 16L (two may be the fourth instar). Douglas Co: Foster Crk., 10 mi. N. Union Crk., Sept. 11, 1966 (J. P. Lohrenz), 1♂ M. Grant Co: Canyon Crk., 2 mi. E. Ochoco Ranger Sta., July 27, 1963 (A), 2L. Hood River Co: Iron Crk., nr. Bennett Pass, 4400', 41°F, July 11, 1968 (W), 4L. Jefferson Co: Metolius River, Bridge 99, Sept. 23, 1965 (A), 1♂ A. Josephine Co:

Lake Crk., 1.2 mi. below Oregon Caves Natl. Mon., 3650', Aug. 5, 1967 (WW), 1L. Lane Co: Scott Crk., on Hwy. 126, July 17, 1970 (W & E), 1L. Linn Co: Tributary streams, Carmen Reservoir, July 7, 1966 (W), 1L; July 19, 1966 (W), 1PP. Marion Forks and vicinity, Sept. 21, 1968 (EE), 1♂ A. Downing Crk., Hwy. 22, S. of Marion Forks, Sept. 20, 1968 (E), 7♂ A. Marion Co: Niagara, Sept. 21, 1968 (E), 3♂ A. Multnomah Co: At Salmon Hatchery, July-Aug. 1956 (Bob Bjorkman), 1L. Wallowa Co: Wallowa River, Immigration Cutoff, Joseph, July 26, 1967 (A), 1L (probably fourth instar). S. end of Wallowa Lake, July 23, 1967 (A), 3L. Wallowa Crk., S. end of Wallowa Lake, July 16, 1970 (A), 3L.

WASHINGTON: Clallam Co: Stream 1.7 mi. below Hurricane Ridge Lodge on Hurricane Ridge Rd., July 23, 1969 (WW), 1PP. Lewis Co: Stream 1/2 mi. W. Paradise Jct. on Stevens Canyon, Mt. Rainier Natl. Park, July 25, 1969 (WW), 1L. Fall Crk., Stevens Canyon entrance to Mt. Rainier Natl. Park, 2225', July 25, 1969 (WW), 4L. Pierce Co: Stream 2 mi. S. W. Mt. Rainier Natl. Park entrance on Chinook Pass Rd., July 25, 1969 (WW), 2L. Whatcom Co: North Fork Devils Crk., E. of Ross Lake at crossing trail #753, ca. 1 1/2 mi. below and W. of Anacortes Crossing, Aug. 10, 1966 (WWSC), 10L. Devils Crk. Trib. E. of Ross Lake, opposite and immediately W. of Cascade Crk., 5600', Aug. 10, 1966 (WWSC), 2L. Swamp Crk., Mt. Baker Natl. Forest, 4000', Aug. 6, 1966 (WWSC), 1L. Middle Fork Nooksack Riv. at Sisters Crk., 1500', July 13, 1966 (WWSC),

4L. Wallace Crk., Middle Fork, Nooksack Riv. tributary, 1900', July 13, 1966 (WWSC), 1L. Canyon Crk., N. W. of Welcome, 2300', July 27, 1966 (WWSC), 17L (one is probably fourth instar). Lightening Crk. crossing trail #733, E. of Ross Lake, ca. 1 mi. below Nightmare Crk., 2200', Aug. 5, 1966 (WWSC), 1L. Big Face Crk., at crossing of trail #749, E. of Ross Lake, 1 mi. S. E. Joker Mtn., 5000', Aug. 8, 1966 (WWSC), 6L. Yakima Co: Union Crk., E. of Chinook Pass, Mt. Rainier Natl. Park, July 25, 1969 (WW), 1L. WYOMING: Cub Crk., nr. Sylvan Lake, Yellowstone Natl. Pk., July 8, 1967 (D. M. Lehmkuhl), 1L. Leign Crk., 44 mi. W. of Buffalo on Hwy. 16, Big Horn Natl. Forest, June 27, 1963 (GW), 1L.

Biology: Head capsules were measured for 189 larvae and all but five were fifth instars. Head capsule lengths were (in mm.): IV, .80 to .94; and V, 1.02 to 1.46. Fourth instars occurred from late June through late July. Fifth instars were collected from late July through mid-August and prepupae from mid- and late July. One mature pupa was collected in mid-September. Smith (1968) collected pupae in Idaho in August.

The flight season of tucula occurs during the early fall. In Alberta and British Columbia, Nimmo (1971) found the flight season occurred from August 24 to October 12. Smith (1968) collected the adults during September and October along the Salmon River drainage in Idaho. Additional records of adults are from Oregon during late

September.

Invaria Branch

The invaria branch has by far the largest representation in western North America, with 44 species containing in eight groups (Schmid, 1970). These groups include: hyalinata, coloradensis, angelita, rayneri, sibirica, vofixa, betteni, and verrula. A great deal of variety can be seen between these groups at the larval stage. The only thing they all have in common is the lack of gills. The hyalinata and coloradensis groups alone have fleshy lateral protuberances on the abdomen (Figures 23, 24). The larvae of the angelita, rayneri, and hyalinata groups all have apicolateral spurs on the anal proleg as does one of the larvae (valuma) of the sibirica group (Figures 25, 31, 35, 38).

After studying the male genitalia of Rhyacophila rayneri Ross, Schmid (1970) placed it in a "catch-all" group of isolated species. Ross (1956) placed it in a group by itself in an entirely different branch than the one containing angelita and perplana, or the one containing valuma of the sibirica group. R. rayneri was placed in the invaria branch by the writer on the basis of the many similarities between its larva and the larvae of angelita and perplana of the angelita group and valuma of the sibirica group. The apicolateral spurs on the anal prolegs and the head shape are nearly identical for

all four species. There are also similarities between the mandibles, with those of rayneri being intermediate between those of the angelita group (angelita and perplana) and those of valuma. Larvae of all four species have a small mesal tooth on the right mandible. In addition, angelita and perplana have one apical tooth on both mandibles, which is the most simplified type (Figure 30). R. rayneri has an apical tooth and a dorsal subapical tooth on the left mandible and two apical teeth on the right mandible (Figure 34). The left mandible of valuma has the same arrangement as rayneri but the right mandible has three apical teeth (Figure 37), rather than two.

6. Hyalinata Group

This group contains Rhyacophila hyalinata Banks and R. vocala Milne. Ross (1956) proposed the use of this group, including both hyalinata and vocala in the group. Rhyacophila hyalinata occurs principally in the Rocky Mountains, and vocala is more common in the Coast and Cascade Ranges (Schmid, 1970).

The larvae of hyalinata and vocala were associated and described by Smith (1968). They are characterized by single, fleshy, lateral protuberances on the abdomen (Figures 23, 24). In Idaho, where the ranges of hyalinata and vocala overlap, Smith (1968) found that the venter of the head of vocala was consistently dark whereas in hyalinata this area was usually pale; however, he found some larvae of hyalinata

with this area darkened as in vocala. Smith (1968) suggested the possibility that these two forms could be geographically distinct populations or one extremely variable species. Consequently, these larvae cannot be consistently separated and are listed together.

Material Examined: CALIFORNIA: Humboldt Co: Stream s. of Orelans, Hwy. 96, hard substrate, July 20, 1967 (E), 1L (2 probably). Inyo Co: W. Fk. Coyote Crk., 2.1 mi. n. e. Coyote Lk., Sierra Nevada, Sept. 15-16, 1969 (S. Frommer, G. Malin, L. LaPre, and S. Hurlbert), 1L (4). Shasta Co: Stream crossing Rt. 89, ca. 15 mi. n. of McArthur-Burney St. Pk., June 18, 1967 (Y), 2L (4). Lost Crk., Lassen Vol. Nat. Pk., June 19, 1967 (Y), 3L (5); Oct. 4, 1966 (GW, Y, O), 8L (4, 5); 6000', Sept. 18, 1946 (H. P. Chandler), 3L (5). Siskiyou Co: Bear Crk., w. Bartle, 3.2 mi. w. Shasta Co. line, 4200', June 18, 1967 (E), 1L (4). OREGON: Benton Co: 11.1 mi. w. Alpine, Jan. 1, 1968 (WW), 1L (5). 7.9 mi. w. Alpine, Jan. 1, 1968 (WW), 1L (4). Marys Peak: Parker Falls, July 27, 1966 (W & L), 1L (4); Mar. 12, 1963 (A), 1L (5). 2.5 mi. up Marys Pk. Rd., Aug. 19, 1967 (K), 1L. Temporary stream crossing Marys Pk. Rd., below Parker Crk., July 16, 1970 (W & T), 1L (4). Stream crossing Marys Pk. Rd. 1.3 mi. from Rt. 34, June 3, 1968 (Y & S), 1L (4). Rd. #1296, 1 1/2 mi. off Marys Pk. Rd., July 2, 1968 (W), 1L (4). Woods Crk., N. side Marys Pk., April 4, 1964 (A), 1L (3). Clackamas Co: Mc Neil For. Camp, Mt. Hood, 2020', July 17, 1968

(W), 1L (5). 2.7 mi. N. McNeil For. Camp Jct. on Mt. Hood Rd.
 N12, 2300', 50°F, Aug. 27, 1968 (WW), 1L (5). Clatsop Co: Quartz
 Crk., E. Elsie, Hwy. 18, Aug. 30, 1967 (E), 1L (4). Hood River Co:
 N. Fk. Iron Crk., Rt. 35, nr. Gov't. Camp, Mt. Hood, June 13, 1967,
 (Y), 1L (4). E. Fk. of Hood River at Olallie For. Camp, Mt. Hood,
 June 8-9, 1967 (Y), 1L (5). Clark Crk. at Rt. 35, nr. Robin Hood
 For. Camp, Mt. Hood, June 11, 1967 (Y), 7L (3, 4, 5). Jefferson
Co: Spring Crk., April 19-20, 1952 (V. Roth), 1L (4). Josephine Co:
 Oreg. Caves Natl. Mon., Cave Crk., 4000', Aug. 5, 1967 (WW), 1L
 (4). Oreg. Caves Natl. Mon., Cave Crk. at Sucker Crk., Aug. 5,
 1967 (WW), 1L (4). Klamath Co: Annie Crk., Crater Lake Natl.
 Pk., June 9, 1968 (Y & S), 16L (4, 5); Oct. 1, 1966 (GW, Y, & O),
 8L (4, 5). Lake Co: 25 mi. N. Lakeview, Deadhorse Crk., July 31,
 1965 (A), 1L (4). Lincoln Co: Big Elk For. Camp, 2 mi. E. Harlan,
 July 5, 1970 (A), 2L (3). Linn Co: Moon Crk., E. of Marion Forks,
 Aug. 12, 1968 (E), 1L (4). Ice Cap Crk. at Carmen Reservoir,
 July 7, 1966 (W), 1L (4). 13.8 mi. E. Green Peter Dam on Quartz-
 ville, Yellowstone Guard Station, 1410', 62°F, July 24, 1968 (W),
 2L (2, 3). Streams crossing Rt. 22, 13.3 mi. E. Idanha, June 12,
 1968 (Y & S), 1L (3). Marion Co: Humbug Crk. on way to
 Breitenbush, E. of Detroit Reservoir, Aug. 28, 1967 (E), 1L (4).
Multnomah Co: Wahkeena Falls, April 20, 1967 (GW & S), 1L (5).

Columbia Gorge Rd., east of Crown Pt., nr. Corbett, Sept. 27, 1966 (GW, Y, & O), 1L (4). At Salmon Hatchery, July-Aug., 1956 (Bob Bjorkman), 4L (3, 4). Wallowa Co: Hurricane Crk., nr. Joseph, July 16, 1970 (A), 2L (3, 4). Wallowa River above Wallowa Lk., July 26, 1967 (A), 1L (3, 4). Wallowa Riv., Immigration Cutoff, Joseph, 66°F, July 26, 1967 (A), 2L (3, 4). Hurricane Crk. Camp Site, July 25, 1967 (A), 4L (4).

MONTANA: Ole Crk. at Walton Ranger Sta., Glacier Natl. Park, July 16, 1969 (J. M. Stauffer), 7L (4). Powell Co: Morrell Crk., Sept. 11, 1967 (R. L. Newell), 2L (4).

WASHINGTON: Dosewallups, May 29, 1939 (L. Lambuth), 1L (5). Chelan Co: Creek 13.3 mi. E. Stevens Pass Ski Area, July 24, 1969 (WW), 2L (3, 4). Clallam Co: Stream 4.2 mi. below Hurricane Ridge Lodge, Hurricane Ridge Rd., July 23, 1969 (WW), 9L (3, 4, 5). Jefferson Co: Hell Roaring Crk., 1/4 mi. from Jct. Hoh River Rd. & Hwy. 101, July 22, 1969, (WW), 1L (3). King Co: 1.2 mi. W. Stevens Pass Ski Area on old Hwy., July 24, 1969 (WW), 3L (5). Lewis Co: Stream 1.8 mi. E. Stevens Crk. Bridge on Stevens Canyon Rd., Mt. Rainier Natl. Prk., July 25, 1969 (WW), 2L (5). Pierce Co: 1.6 mi. S. Cayuse Pass, Mt. Rainier Natl. Prk., July 25, 1969 (WW), 1L (2). Skagit Co: Jordon Crk. at Rockport Cascade Rd., S. E. Marblemount, July 31, 1966 (WWSC), 1L (4). Whatcom Co: Glacier Crk., 2000', June 22, 1966 (WWSC), 3L (3, 4). Swamp Crk., 3400', June 25, 1966 (WWSC), 7L (3, 4, 5). Middle

Fork Nooksack Riv. at Sisters Crk., 1500', July 13, 1966 (WWSC), 4L (3, 4). Lightening Crk., E. of Ross Lk. at Nightmare Camp, Jct. trails #748 and 733, 2300', Aug. 5, 1966 (WWSC), 1L (4). Canyon Crk. E. of Ross Lk. approx. 3/4 mk. W. Holman Pass. on trail to Sky Pilot Pass, 5000', Aug. 9, 1966 (WWSC), 1L (5). S. slope Crater Mtn. E. of Ross Lake on trail #736, 5000', Aug. 11, 1966 (WWSC), 2L (4). Wallace Crk., middle Fk. Nooksack R. tributary, 1900', July 13, 1966 (WWSC), 1L (4). WYOMING: Cub Crk., nr. Sylvan Lk., Yellowstone Nat. Pk., July 8, 1967 (D. M. Lehmkuhl), 2L (5) Teton Co: Black Rock Crk. at Rt. 287, 20 mi. e. Moran Jct., Sept. 13, 1966 (GW, Y, O), 29L (3, 4, 5).

Biology (Group): Head capsule measurements were variable, but apparently are (in mm.): II, .54 to .66. (6 larvae); III, .84 to 1.10 (54 larvae); IV, 1.18 to 1.80 (177 larvae); and V, 1.90 to 2.48 (104 larvae). A distinct seasonal succession of life stages was not apparent.

Rhyacophila hyalinata Banks

Rhyacophila hyalinata Banks, 1905a:10; Banks, 1907a:41; Ulmer, 1907a:201; Banks, 1911:354; Dodds & Hisaw, 1925:386; Essig, 1926:177; Betten, 1934:135; Milne, 1936:96, 104, 111; Ross, 1938b:6; Ross, 1944:291; Davis, 1948:37-9; Denning, 1948b:101-2; Ross, 1956:88, 92, 118; Schmid, 1958:17; Smith, 1968:658, 663-4; Schmid, 1970:59, 124; Nimmo, 1971:17, 18, 27.

Type Locality: S. W. Colorado, July 23, 1899.

Rhyacophila sonoma Denning, 1948b:110-113; Schmid, 1970:124.

Larva: Smith (1968) described the larva of hyalinata:

Head dark brown, paler anteriorly, and with darkened muscle scars posteriorly, ventral surface usually light brown with a few pale muscle scars (like Figure 20); maxillary palpus with second segment equal in length to first; left mandible long and slender, with apical tooth long, subapical tooth small, mesal area with a very small tooth that appears to be no more than an emargination of the mesal margin in most individuals, right mandible long and slender, with an apical tooth, 1 small subapical tooth ventrally, 1 subapical tooth dorsally, and 1 mesal tooth, mesal margin between mesal tooth and subapical dorsal tooth minutely serrate (like Figure 22). Pronotum brown, paler anteriorly. Abdomen with lateral, single, fleshy protuberances on segments II-VIII (like Figures 23, 24); anal proleg with a small baso-ventral hook, apico-lateral spur elongate and stout, projecting away from the body, and anal claw with distal tooth furcate, 2- to 4- branched, basal tooth when present small, not furcate (Figure 25). Length of mature larvae 20-25 mm.

Distribution: This species is especially common in the Rocky Mountains. It has been recorded in Alberta, British Columbia, California, Colorado, Idaho, Oregon, Utah, Washington, and Wyoming.

Material Examined: Adults of this species were not examined, and the larvae are listed under the discussion of the hyalinata group.

Biology: Smith (1968) records the adult flight season in Idaho from late June to early August. Nimmo (1971) recorded it from July 5 to September 12 in Alberta. It occurs from 9,000 to 11,000' in Colorado (Dodds & Hisaw, 1925b) and from 3,500 to 6,000' in Alberta

(Nimmo, 1971).

Rhyacophila vocala Milne

(Figures 20, 21, 22, 23, 24, 25)

Rhyacophila vocala Milne, 1936:99-100; Denning, 1948b:106; Ross & Spencer, 1952:41; Ross, 1956:92, 118; Smith, 1968:672; Schmid, 1970:59, 124.

Type Locality: Cultus Lake, B. C., July 14, 1935 (W. E. Ricker).

Larva: Smith (1968) associated this larva with the adult, stating that:

Similar to hyalinata, except that vocala larvae differed by having the head consistently darkened ventrally. R. vocala showed little variation in its anatomical features, in contrast to the closely related hyalinata.

Distribution: This species has been recorded from British Columbia, California, Idaho, Oregon, Utah, and Washington.

Material Examined: This list includes only adults. The larvae are listed under the group discussion.

OREGON: Clackamas Co: Clackamas Riv., 23 mi. n. e. Detroit, 2600', July 11, 1968 (A), 1♂ A. Stream 2.7 mi. n. McNeil For. Camp Jct. on Mt. Hood Rd. N12, 2300', 50°F, Aug. 27, 1968 (WW), 1♂ M. Klamath Co: Annie Crk., Crater Lk. Nat. Pk., June 9, 1968 (Y & S), 1♂ M. Linn Co: Ollalie Crk. For. Camp, Rt. 126, June 30, 1966 (W), 2♂ A, 1♀ A (mating pair); July 17, 1970 (W & E),

1♂ A. Marion Co: Niagara, May 31, 1970 (E & T), 2♂ A. Wallowa Co: Bridge over W. Fk. Wallowa Crk., nr. Wallowa Lk., July 9, 1968 (A), 2♂ A.

Biology: The adults of this species were collected by Smith (1968) in the Salmon River drainage of Idaho during July and August. In Oregon the flight period was from late May through July. The pupae were collected from June through August.

7. Coloradensis Group

This group includes Rhyacophila amabilis Denning, R. bifila Banks, R. coloradensis Banks, R. insularis Schmid, R. kernada Ross, R. reana Denning (placed in this group by Denning and Schmid, 1971), and R. sierra Denning. Schmid (1970:60) stated (in translation):

This group is largely restricted to the mountains of western North America. Rhyacophila coloradensis and bifila populate all of this region, the latter advancing in the north as far as the Yukon Territory; kernada is only known from California and Nevada; amabilis in California, and insularis described from Vancouver Island.

Denning (1968) described R. sierra from California. R. reana is known only from Riverside County, California. Schmid (1970) groups coloradensis and kernada together, bifila and insularis together, and amabilis by itself; he did not include sierra or reana in his discussion.

Smith (1968) associated and described the larvae of Rhyacophila bifila and coloradensis. The descriptions of the two are all but

identical with the exception of the color pattern of the head, which tends to intergrade. The head of bifila is generally darker, particularly the frontoclypeus, and the muscle scars are also darker and more distinct. Since bifila and coloradensis larvae cannot be easily separated one can predict that the larvae of kernada, insularis, amabilis, reana, and sierra would also not be readily separable. Due to this problem of identification, all larvae, prepupae, and immature pupae of the coloradensis group examined are listed together:

Material Examined: BRITISH COLUMBIA: Loon Crk., Clinton Fish Hatchery on Loon Lk. Rd., July 12-14, 1969, (R), 1L. CALIFORNIA: Nevada Co: Creek at Grass Valley, 2000', Oct. 10, 1966 (GW, Y, O), 1L. OREGON: Benton Co: S. Fk., Alsea River, 8 mi. W. Glenbrook, May 31, 1970 (A), 1L. Jackson Co: 3/4 mi. N. McLeod (L), 1L. UTAH: Fremont Riv., Fruita, 7000', Aug. 13, 1947 (A. W. Grundman), 1L.

Rhyacophila amabilis Denning

Rhyacophila amabilis Denning, 1965a:692.

Type Locality: Castle Lake, Siskiyou Co., Calif., May 20, 1953.

Larva: Unknown.

Distribution: Known only from the type locality.

Material Examined: None.

Biology: Unknown

Rhyacophila bifila Banks

Rhyacophila bifila Banks, 1914:201; Essig, 1926:176; Betten, 1934:

135; Ross, 1944:291; Ross, 1947:127; Davis, 1948:50-1; Denning, 1948b:98; Ross & Spencer, 1952:43; Ross, 1956:88, 118; Denning, 1963:244; Denning, 1965b:694; Smith, 1965a:242-3; Smith, 1968: 658, 660-1, 673; Schmid, 1970:60, 125; Nimmo, 1971:18, 25.

Type Locality: Vernon, B. C., August (Bryant).

Larva: The larva of this species was described by Smith (1968):

Head brown with darker muscle scars and a yellow band just behind the anterior margin, maxillary palpus short, second segment twice as long as first; left mandible stout, with one apical and one very small subapical tooth, right mandible stout with two apical teeth, the single mesal tooth small and blunt (like Figure 27). Abdomen with lateral, bilobed, fleshy protuberances on segments II-VIII, sclerites of segments IX and X black or nearly so. Anal proleg with a small baso-ventral hook, without apico-lateral spur, and anal claw with distal tooth forked or rarely trifid, forks large, basal tooth smaller, not forked (like Figure 28).

The larva of bifila is similar to that of coloradensis Banks and the color pattern of the head and thorax of these species tend to intergrade. Generally the head of bifila is darker, especially on the fronto-clypeus, and darker and more distinct muscle scars are present.

Distribution: This species has been recorded from Alberta, British Columbia, California, Idaho, Montana, Oregon, Washington, and Wyoming.

Material Examined: CALIFORNIA: El Dorado Co: Upper

Truckee Riv., W. of Meyers, Hwy. 50, June 26, 1968 (E), 8♀ M,

6♂ M. IDAHO: Payette Riv., 3 mi. N. Cougar Lodge, Aug. 8, 1948

(J), 2♂ A. Boise Co: Mores Crk., Boise Nat. For., 7 mi. N. Idaho City on Rt. 21, July 7, 1961 (GW), 4♀ P, 10♂ P. OREGON: Benton Co: Marys Riv., Philomath, July 6, 1963 (GW), 1♂ M. Deschutes Co: Pringle Falls, Deschutes Riv., June 7, 1949 (J), 1♂ A. Jackson Co: Gold Hill, June 5, 1949 (J & Morton), 1♂ A. Klamath Co: Williamson Riv., Hwy. 97, Mar. 27, 1970 (E), 1♀ A, 5♂ A. Spring Crk. Hwy., Collier Mem. State Pk., Apr. 14, 1967 (E), 7♀ A, 7♂ A. Linn Co: Ollalie Crk., Ollalie Crk. For. Camp, Rt. 126, July 17, 1970 (E & W), 1♀ A, 1♂ A. Tillamook Co: 15 mi. E. Beaver, Nestucca Riv., July 24, 1966 (A), 1♂ M. Wallowa Co: Little Sheep Crk., 54°F, 9 mi. N. E. Joseph, Jct. of Big Sheep Crk. Rd., 4200', July 10, 1968 (A), 1♂ P, 2♂ M, 15 ♂ A. Little Sheep Crk., 9 mi. S. Imnaha, 69°F, 3000', July 10, 1968 (A), 1♀ M, 1♂ M. Wasco Co: Deschutes Riv., Maupin, Apr. 22, 1948 (J), 3♂ A. Iron Crk., 41°F, nr. Bennett Pass, 4400', July 17, 1968 (W), 2♂ M.

Biology: Smith (1968) collected a few pupae in late May or early June, but most pupae occurred in late June. Adult flight periods were from late June to mid-September, peaking in July, in Idaho (Smith, 1968) and from May 22 to Aug. 23 in Alberta and British Columbia (Nimmo, 1971). My records show pupae from late June through July and adults from late March through April and from June through August.

Rhyacophila coloradensis Banks

(Figures 26, 27, 28)

Rhyacophila stigmatica Banks, 1904:108 (Preoccupied, nec., R. stigmatica Kolenati); Ulmer 1905a:72; Banks, 1905:10.

Type Locality: Las Vegas, New Mexico, July 10.

Rhyacophila coloradensis Banks, 1905:10; Banks, 1907a:41; Ulmer, 1907a:210; Banks, 1911:354; Dodds and Hisaw, 1925:386; Essig, 1926:176; Muttkowski, 1929:192; Betten, 1934:135; Milne, 1936:91, 111; Ross, 1938b:5; Ross, 1944:291; Ross, 1956:88, 118; Denning, 1965b:691; Smith, 1968:658, 661, 663, 673; Unzicker, 1968:4, 18, 44; Schmid, 1970:60, 125; Nimmo, 1972:18, 26.

Rhyacophila anomala Banks, 1924:444; Dodds and Hisaw, 1925:386; Betten, 1934:135; Milne, 1936:111.

Larva: Smith (1968) described the larva of coloradensis:

Head light brown, occasionally with darkened muscle scars dorsally (Figure 26); frontoclypeus with a dark brown area on the posterior margin; maxillary palpus short and stubby, second segment twice as long as first; mandibles as in bifila (Figure 27). Pronotum with indistinct brown maculations. Abdomen with lateral, bilobed, fleshy protuberances on segments II-VIII. Anal proleg as in bifila with short baso-ventral hook, without an apico-lateral spur, and anal claw with distal tooth forked, both forks large, basal tooth smaller, not forked (Figure 28).

Distribution: Alberta, Arizona, British Columbia, Colorado, Idaho, Montana, New Mexico, Oregon, Washington, and Wyoming.

Material Examined: CALIFORNIA: Shasta Co: Little Castle, S. Dunsmuir, April 25, 1943 (J), 2♂ A. OREGON: Clackamas Co: Roselyn Lk., nr. Bull Run, Sept. 19 (J), 6♀ A. Clatsop Co: Big Crk., Sept. 8, 1949 (J), many ♀ & ♂ A. Youngs Riv., May 10, 1947 (J), 1♂ A. Deschutes Co: Deschutes Riv., 1 1/2 mi. below Little Lava Lk., Sept. 17, 1948 (J), 4♂ A. Pringle Falls, June 7, 1949 (J), 3♂ A. Pringle Falls, Deschutes Riv., July 13, 1948 (J), many ♀ and ♂ A. Lane Co: McKenzie Riv., at Rt. 126, Buck Bridge at Frissel Carpenter Rd., July 17, 1970 (E & W), 3♀, 1♂ A. Sherman Co: Deschutes Riv., mouth, Mar. 2, 1948 (J), 1♀ A, 1♂ A. WYOMING: Brooklyn Lk., w. of Centennial, Aug. 23, 1946 (D. G. Denning), 2♀ A, 1♂ A.

Biology: Denning (1948b) stated that adults were collected in Wyoming in August and September. Smith (1968) studied coloradensis in the Salmon River drainage of Idaho. He found the peak emergence of adults in September with a second peak from March through May. Pupae were collected in March, April, and July. Nimmo (1971) reported a single extended period of emergence in Alberta, from 3000 to 6000', from early May to late August, with the peak in May. My records show adults collected from early March through September. Dodds and Hisaw (1925) recorded this species in Colorado from 6000 to 11,000'.

Rhyacophila insularis Schmid

Rhyacophila insularis Schmid, 1970:159.

Type Locality: Qualicum Falls, British Columbia, Vancouver Island, Aug. 6, 1951 (F. Schmid).

Larva: Unknown.

Distribution: Known only from the type locality.

Material Examined: None.

Biology: Unknown.

Rhyacophila kernada Ross

Rhyacophila kernada Ross, 1950a:264; Ross, 1956:88, 118; Denning, 1965b:691-2; Schmid, 1970:60, 125.

Type Locality: Kern Riv., Road's End, Calif., Sept. 25, 1940, at light.

Larva: Unknown.

Distribution: California and Nevada.

Material Examined: None.

Biology: Unknown.

Rhyacophila reana Denning

Rhyacophila reana Denning (and Schmid), 1971:1555-6.

Type Locality: Tahquist Canyon, Agua Caliente Indian Reservation, Riverside Co., Calif., Feb. 22, 1970 (Paul H. Arnaud).

Larva: Unknown.

Distribution: Known only from the type locality.

Material Examined: None.

Biology: Unknown.

Rhyacophila sierra Denning

Rhyacophila sierra Denning, 1968:63-4.

Type Locality: Truckee River, Nevada Co., Calif., Aug. 12, 1966 (D. G. Denning).

Larva: Unknown.

Distribution: California.

Material Examined: None.

Biology: Unknown.

8. Angelita Group

The angelita group of Schmid (1970) contains four Nearctic species: Rhyacophila vuzana Milne and R. perplana Ross and Spencer, occurring from the Pacific Coast east into the Cascade Mountains, R. angelita Banks which is one of the two species occurring transcontinentally, being found throughout the western montane region and also in the northern Appalachian Mountains, and R. newelli Denning, which has only been collected from Missoula County, Montana. Ross (1956) proposed this same angelita group and included the same species, except for newelli, which was not yet described.

Flint (1962) and Smith (1968) described the larva of angelita

and a metamorphotype is now available for perplana also, but the larvae cannot be separated. The larva of vuzana will probably also be quite similar to those of angelita and perplana.

Two hundred and eighty larvae and pupae of angelita and perplana were examined. Since these two species cannot be separated, only the states and counties from which they were collected are listed.

Material Examined:

Canada:	Alberta
	British Columbia (including
	Vancouver Island)
California:	Mendocino
Idaho:	Boise
	Bonneville
	Kootenai
Montana	Glacier
	Meagher
	Mineral
Nevada:	Humboldt
Oregon:	Baker
	Benton
	Clackamas
	Clatsop
	Curry

Oregon:

Douglas

Grant

Jackson

Jefferson

Josephine

Lane

Lake

Lincoln

Linn

Marion

Multnomah

Polk

Tillamook

Umatilla

Union

Wallowa

Yamhill

Washington:

Jefferson

Skagit

Whatcom

Wyoming:

Yellowstone National Park

Rhyacophila angelita Banks

(Figures 4, 29, 30, 31, 32)

Rhyacophila angelita Banks, 1911:352, 355; Essig, 1926:176; Betten, 1934:135; Milne, 1936:92, 110, 103; Davis, 1948:46-7; Ross, 1944:291; Denning, 1948b:97; Schmid & Guppy, 1952:41; Ross & Spencer, 1952:43; Ross, 1956:102, 121; Schmid, 1958:12; Denning, 1963:244; Smith, 1968:660, 673; Schmid, 1970:62, 125; Nimmo, 1971:18-9, 33-4.

Type Locality: Pasadena, Los Angeles Co., California, May 1 (F. Grinnell).

Rhyacophila bipartita Banks, 1914:201-2; Betten, 1934:135; Milne, 1936:110 (synonymy).

Rhyacophila sp. 1, Flint, 1962:478-9.

Description: Flint (1962) described the larva of "species number one" which he correctly presumed to be that of Rhyacophila angelita Banks. Smith (1968) obtained a metamorphotype and also described the larva of angelita:

Head yellow, with a variable color pattern. Transverse dark brown band present across the gena of most specimens; in some, band broken or absent; in others darkened muscle scars may be present also (Figure 29). Pronotum yellow anteriorly and brown posteriorly, but some specimens without a distinctly darker posterior area. Abdomen without gills and fleshy protuberances. Anal proleg with a baso-ventral hook and an apico-lateral spur, and anal claw with a single ventral tooth (Figure 31). Length of mature larvae approximately 16 mm.

The mandibles are as in Figure 30.

Distribution: This species is one of the two Rhyacophila that occur in both western and eastern North America. It occurs in the northern Appalachian Mountains in the East, having been recorded from New Hampshire. In the West it has been recorded from: Yukon Territory, Alberta, British Columbia (including Vancouver Island), California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming. Nimmo (1971) considered the specimen from New Hampshire to be a very isolated record probably representing a past glacier remnant of a previously truly trans-continental species.

Material Examined: BRITISH COLUMBIA: Haney, Univ. Brit. Col. Res. For., str. draining Marion Lk., crossing rd. on e. side of Lake, July 10, 1969 (R), 3♂ A. OREGON: Baker Co: Rt. 7, 12 mi. N. Hereford, intermittent stream, May 31, 1970 (E & T), 1♂ M. 11 mi. W. Baker, Jim Baker's Cabin, 4000', July 14, 1967 (E), 2♂ M. Benton Co: Berry Crk., 9 mi. N. W. Corvallis, at blacklight, June 21-29, 1968 (E), 5♂ A; July 1-3, 1968 (E), 2♂ A; July 12-18, 1968 (E), 1♂ A. Stream on rd. #1296 on Marys Pk., July 11, 1968 (W), 1♂ A. Clackamas Co: Salmon River, Hwy. 35, 2 mi. from Gov't. Camp Jct., 3500', July 11, 1968 (A), 1♂ M. Two small streams, 2.7 mi. N. McNeil For. Camp Jct. on Mt. Hood rd. #N12, 2300', Aug. 27, 1968 (WW), 1♂ M. Grant Co: Dixie Crk. For. Camp, July 11,

1953 (Roth & Beer), 2♂ A. Jefferson Co: Metolius River, Bridge 99, Sept. 23, 1965 (A), 6♂ A; Sept. 24, 1965 (A), 5♂ A. Umatilla Co: 20 mi. N. Long Creek, Hwy. 395, Jct. Bone Pt. Rd., 3900', July 15, 1967 (E), 2♂ A. Union Co: Phillips Crk., 6 mi. NW Elgin 4000', July 9, 1968 (A), 2♂ M. Small rd. side stream trib. to Catherine Crk., 8 mi. N. Medical Springs, Hwy. 203 at Milk Crk. Rd., May 30, 1970 (E & T), 1♂ M.

Biology: Mature pupae occurred in Idaho (Smith, 1968) from late May through early August. Pupation occurred in July, August and September. Smith (1968) thought this species overwintered as small- to medium-sized larvae, but may have also overwintered as eggs in some other sections of Idaho. Smith (1968) collected adults in the Salmon River drainage in July, but found them to be more numerous during September and October. In other sections of Idaho he found emergence to be concentrated in late June and early July.

Nimmo (1971) found the majority of the adults in flight in Alberta from early July to mid-October. Pupae have been collected during late May, July and late August in Oregon. Adults were collected in Oregon during late June, July, and late in September.

Rhyacophila newelli Denning

Rhyacophila newelli Denning, 1971:203.

Type Locality: Rattlesnake Crk., Hungry Horse Reservoir, Missoula Co., Montana, Oct. 17, 1966 (R. A. Newell).

Larva: Unknown.

Distribution: Known from where the one male, the type, was collected.

Material Examined: None.

Biology: Unknown.

Rhyacophila perplana Ross and Spencer

Rhyacophila perplana Ross and Spencer, 1952:44-5; Ross, 1956:102, 121; Schmid, 1970:62, 125.

Type Locality: Cultus Lake, South Crk., British Columbia, Nov. 1, 1936 (W. E. Ricker).

Larva: The association of this species is based on a mature male metamorphotype from a stream in the Coast Range near Yamhill, Oregon. Anatomical features with which to separate this species from angelita have not been found. For a description of this larva see the description of angelita and Figures 29, 30, 31, and 32.

Material Examined: OREGON: Yamhill Co: Stream ca. 14 mi. W. Yamhill, Aug. 8, 1966 (W), 1♂ M.

Distribution: This species has only been recorded from the Coast and Cascade Ranges of British Columbia and Oregon.

Biology: The adults apparently occur quite late in the fall.

Rhyacophila vuzana Milne

Rhyacophila vuzana Milne, 1936:97; Denning, 1948b:109; Ross and Spencer, 1952:45; Schmid and Guppy, 1952:41; Ross, 1956:102, 121; Denning, 1965b:697; Schmid, 1970:62, 125; Anderson and Wold, 1972:192-3.

Type Locality: McKenzie Bridge, Oregon, Sept. 21, 1934

(R. E. Dimick).

Larva: There is no metamorphotype available for this species, but the larva could be expected to be nearly identical to those of angelita and perplana.

Material Examined: OREGON: Benton Co: Oak Crk., site #2, 650', July 30-Aug. 6, 1968 (K), 1♂ A. Oak Crk., site #3, 500', July 7-10, 1968 (K), 2♂ A; July 23-30, 1968 (K), 1♂ A. Lane Co: Mack Crk., H. J. Andrews Exp. For., 11 mi. from Blue River, Sept. 2, 1972 (A), 1♂ A. Winberry Crk., 8 mi. n. e. Jasper, July 18, 1964 (Melinda Shultis), 1♂ P. Linn Co: Downing Crk., Hwy. 22, s. of Marion Forks, Sept. 20, 1968 (E), 1♂ A. Marion Co: N. Fk. Santiam Riv., Niagara, Oct. 26, 1968 (E), 1♂ A.

Distribution: British Columbia (including Vancouver Island), California, Idaho, Oregon, and Washington.

Biology: The adults of this species have been collected in all months from May through October.

9. Rayneri Group

This group contains the one species, Rhyacophila rayneri Ross. The larva is described here for the first time, based on a metamorphotype from Riverside County, California.

Rhyacophila rayneri was placed in this group by itself by the writer on the basis of the similarities between it and the larvae of the angelita group and valuma of the sibirica group. These relationships are discussed under the invaria branch heading. Ross (1956) also used this group for rayneri, but placed it in an entirely different branch than the one containing the angelita group or the one containing the sibirica group. Schmid (1970) was unable to place this species, so he put it in a "catch-all" group of what he termed isolated species.

Rhyacophila rayneri Ross

(Figures 33, 34, 35)

Rhyacophila rayneri Ross, 1951a:66-7.

Type Locality: Valadares, Lower California, Mexico, Rio Santo Domingo, about 1000', May 24, 1937 (H. J. Rayner).

Larva: The association of the larva of this species is based on a mature male metamorphotype from the P. L. Boyd Desert Research Center, 3.5 mi. S. Palm Desert, California, made available by S. Frommer, University of California at Riverside.

Description: Head, yellow, with few yellow-brown muscle

scars, narrowing slightly anteriorly; $1 \frac{1}{3}$ times as long as wide (Figure 33); yellow-brown patches posteriorly on genae; frontoclypeus yellow except yellow-brown V-shaped area posteriorly, running along frontal sutures; left mandible with large apical tooth, smaller dorsal subapical tooth, ventral blade with small subapical tooth; right mandible with large apical tooth, large dorsal subapical tooth, ventral blade with large mesal tooth (Figure 34). Thorax, pronotum, same color as head with few yellow-brown muscle scars. Abdomen, no fleshy lateral protuberances or gills; anal prolegs, basoventral hook large, pointed, and curved, free from membrane apically; long apicolateral spur; claw with three large, narrow, ventral teeth, apical one usually longest (Figure 35). Length, mature larva, 19 mm.

Distribution: This species was previously recorded from Baja California, Mexico and from Riverside and Los Angeles Counties in southern California. An additional record is available from Orange County, California.

Material Examined: CALIFORNIA: Orange Co: Silverado Canyon, Mar. 14, 1965 (M. Irwin), 2L. Riverside Co: P. L. Boyd Des. Res. Center, 3.5 mi. S. Palm Desert, April 22, 1969 (S. Frommer, G. Malin, and M. Kogan), 1♀ M, 1♂ M; May 23, 1969 (S. Frommer), 2L; 70°F May 9, 1969 (S. Frommer), 23 L; Feb. 24, 1970 (S. Frommer), 1 L. Mayhew Canyon, Feb. 12, 1966 (G. W. Forrister), 1 L.

Biology: This species has apparently adapted to the warmer

climates of Southern California and Lower California, Mexico, occurring in water up to 70°F.

10. Sibirica Group

This is the only group of Rhyacophila which is essentially holarctic. Of the 26 species included in this group (Schmid, 1970), 15 are nearctic, with R. belona Ross, R. colonus Schmid, R. narvae Navas, R. pellisa Ross, R. rickeri Ross, R. unimaculata Denning, R. unipunctata Schmid, R. valuma Milne, and R. vetina Milne occurring in western North America. Ross (1956) proposed this same grouping, placed in his branch seven, but also included R. velora, R. oreia, and R. visor in the group. Schmid (1970) excluded these three species in his revision of the group. Schmid further divides this group into subgroupings: (1) rickeri, (2) colonus, pellisa, valuma, (3) blarina, (4) narvae, (5) unimaculata, unipunctata, and (6) belona, vetina.

Rickeri Subgroup

Rhyacophila rickeri Ross

Rhyacophila rickeri Ross, 1956:120-1; Schmid, 1970:63, 126; Nimmo, 1971:17, 19, 28.

Type Locality: Babine Riv. at Slide, 50 mi. N. of Hazelton, B.C. (W. E. Ricker).

Larva: Unknown.

Distribution: Alaska, Alberta, and British Columbia.

Material Examined: None.

Biology: Nimmo (1971) found adults along small, shallow alpine streams over 7,000 feet elevation in Alberta.

Colonus Subgroup

Rhyacophila colonus Schmid

Rhyacophila colonus Schmid, 1970:64, 125, 159-60.

Type Locality: O'Brien, Josephine Co., Oregon, June 5, 1965 (F. Schmid).

Larva: The larva of this species is probably similar to that of R. valuma.

Distribution: Known only from the type locality in Oregon.

Material Examined: None.

Biology: Unknown.

Rhyacophila pellisa Ross

Rhyacophila pellisa Ross, 1938a:118; Ross, 1944:291; Davis, 1948:47-8; Denning, 1948b:102; Ross, 1956:95, 97, 120; Denning, 1963:244; Anderson, 1967:508; Smith, 1968:666; Schmid, 1970:64, 125; Nimmo, 1971:17, 19, 30-1; Anderson and Wold, 1972:192-3.

Type Locality: Cascade Lodge, Rocky Mountain Nat. Pk.,

Description: Head, light brownish yellow, with a slightly darker patch on the posterior of the frontoclypeus and overlapping a short distance onto gena (Figure 36); second segment maxillary palpus about 1 1/2 times as long as first; left mandible with a large apical tooth and a smaller subapical tooth; right mandible with three apical teeth, dorsal one smallest (Figure 37). Thorax, pronotum brownish yellow, sometimes slightly darker areas posteriorly. Abdomen, without gills or fleshy lateral protuberances; anal proleg with large basoventral hook and long apicolateral spur; claw without ventral teeth (Figure 38). Length, mature larva, 7 mm.

Distribution: British Columbia (including Vancouver Island), California, Colorado, Oregon, and Utah.

Material Examined: OREGON: Baker Co: Paramont Mt., Cornucopia, Mar. 25, 1936 (R. E. Reider), 3♂ A. Benton Co: Yew Crk., May 18, 1938 (J), 1♂ A. Rock Crk., May 1, 1941 (C. Whitmore), 1♂ A. Rock Crk., 5 mi. W. Philomath, June 9, 1949 (V. Roth & Mrs. Chiang), 1♂ A. Oak Crk., April 24, 1936, 1♂ A; June 10, 1966 (A), 1♂ M; April 11, 1966 (A), 1L; site #3, Mar. 19-23, 1969 (A), 1L. Clackamas Co: Eagle Crk., June 27, 1948 (J), 18♂ A. Clatsop Co: Big Crk., July 4, 1949 (J), 3♂ A; May 28, 1949 (J), 1♂ A. Deschutes Co: Pringle Falls, Deschutes Riv., July 13, 1948 (J), 1♂ A. Jefferson Co: Metolius Riv., 1/2 mi. S. Camp Sherman, under bridge, Aug. 13, 1966 (A), 7♂ A. Metolius Riv., Riverside

For. Camp, Sept. 18, 1967 (W), 1♂ A; May 1, 1965 (A), 1♂ A.

Metolius Riv., Wizard Falls, Aug. 12, 1966 (W), 1♂ A. Metolius

Riv., Bridge 99, Sept. 23, 1965 (A), 2♂ A; Sept. 24, 1965 (A), 1♂ A.

Metolius Riv., at mouth of Lake Crk., July 2, 1969 (W), 1♂ A.

Josephine Co: Grayback Crk. St. Pk., 15 mi. e. Cave Jct., June 13,

1963 (A), 1♂ A. Lane Co: Frissel Carpenter Rd., Buck Bridge at

McKenzie Riv., Rt. 126, July 17, 1970 (W & E), 1♂ A. Linn Co:

Ollalie Crk. at Ollalie Crk. For. Camp, Rt. 126, July 17, 1970

(W & E), 9♂ A; June 30, 1966 (W), 1♀ A, 1♂ A (mating pair); July 2,

1969 (W), 4♂ A. Small stream just n. of Trailbridge & Smith Riv.

Reservoir Rds., Hwy. 126, July 2, 1969 (W), 1♂ A. Wallowa Co:

Hurricane Crk. Camp Site, July 25, 1967 (A), 1PP. UTAH: Johnson's

Reservoir nr. Fishlake, July 14, 1948 (Jean Duspiva), 1♂ A. WASH-

INGTON: Jefferson Co: Hoh Riv. at Hoh Riv. Cpgrd., Olympic Nat.

Pk., June 30-July 1, 1969 (R), 1PP, 1P. WYOMING: Carbon Co:

South Brush Crk., South Brush Crk. Cpgrd., Rt. 130, 54 mi. nw.

Laramie, June 29, 1968 (GW, Y, S), 1L.

Biology: Larvae have been collected during late March, April, and late June. Pupae have been recorded during late June and July. Adults were collected from late March through late September.

Blarina Subgroup

Rhyacophila blarina Ross

(Figures 39, 40, 41)

Rhyacophila blarina Ross, 1941:36; Davis, 1948:48-9; Ross, 1956:97, 120; Schmid, 1970:65, 125.

Type Locality: Clatskanie, Oregon, May 9, 1936 (K. Gray and J. Schuh).

Larva: The description of this larva is based on metamorphotypes from streams in Benton County, Oregon.

Description: Head, light brown with some slightly darker muscle scars, length and width at widest part subequal, from dorsal view anterior half of head nearly parallel-sided, narrowing posteriorly (Figure 39); left mandible with large apical tooth, smaller, dorsal subapical tooth, ventral blade with small subapical tooth and slightly larger mesal tooth; right mandible with three apical teeth, the ventral tooth the largest and the dorsal tooth the smallest, ventral blade with large pointed mesal tooth (Figure 40); second segment of maxillary palpus approximately 1 1/2 times longer than first.

Thorax, pronotum slightly lighter than head with dense (more than 60) setae along anterior margin. Abdomen, no gills or lateral protuberances present; anal proleg with basoventral hook, no apicolateral spur; claw without teeth (Figure 41). Length, mature larva, 10 mm.

Pupa: The cocoon of blarina is covered with loose silken thread and does not have the smooth, shiny appearance of those of most of the other Rhyacophila.

Distribution: This species is most common in the Coast Range, but also occurs in the Cascade Range in Oregon and Washington.

Material Examined: OREGON: Benton Co: Oak Crk., n. w. of Corvallis, Jan. 12-13, 1968 (A), 1L (5); Feb. 9-10, 1965 (A), 1L (5); Feb. 14, 1966 (A), 1L (4); April 23, 1963 (A), 2♂ A; July 14, 1967 (A), 2L (1, 2); Sept. 6, 1966 (A), 5L (3); Sept. 15, 1966 (A), 32L (2, 3); Sept. 25, 1965 (A), 3L (4); Oct. 3-4, 1967 (A), 2L (3); Oct. 5-6, 1965 (A), 1L (3); Oct. 13-14, 1966 (A), 2L (3); Oct. 15, 1967 (A), 1L (2); Oct. 20-21, 1965 (A), 31L (2, 3, 4); Oct. 22-23, 1966 (A), 12L (3, 4); Oct. 24, 1966 (A), 2L (4); Oct. 27, 1965 (A), 1L (4). Other Areas of County: Berry Crk., 8 mi. n. Corvallis, April 3, 1964 (A), 2♂ M, 1PP; April 10, 1964 (GW & S), 1L (5), 2PP, 1♀ P, 1 ♂ P. Rock Crk., W. of Philomath, April 9, 1938, 4♂ A, 1♀ A; April 26, 1939 (Don Derlin), 1♂ A; June 4, 1938 (Sabo), 1♀ A, 1♂ A; April 26, 1938 (Don Derlin), 4♂ A; 5.5 mi. S. Philomath, under bridge, May 2, 1970 (E), 4♂ A. Woods Crk., W. of Philomath, May 13, 1937 (Smith), 2♂ A; April 3, 1964 (GW & S), 1PP; sm. streams joining Woods Crk., April 12, 1964 (GW & S), 3♂ M. Wells Crk., nr. Philomath, April 7, 1964 (GW & S), 1L (5). Tributary of Marys River, 5 mi. S.W. Philomath, May 23, 1959 (J), 3♂ A.

Yew Crk., May 18, 1938 (J), 1♂ A. Rest stop, Hwy. 34, 1 mi. W. Marys Pk., 12 mi. sw. Philomath, Nov. 4, 1964 (A), 1L (4). Tributary creek of Luckiamute Riv., 1/2 mi. W. Hoskins, March 23, 1966 (W), 1L (5). Clackamas Co: Eagle Crk., April 16, 1940 (J), 1♀ A, 1♂ A. Eagle Fern Park, April 12, 1958 (J), 3♀ A, 1♂ A. Clatsop Co: Big Crk., May 28, 1949 (J), 1♂ A; May 28, 1949 (J), 1♂ A; April 16, 1949 (J), 3♀ A, 2♂ A; April 21, 1957 (J), 1♀ A, 2♂ A. Youngs Riv., April 17, 1949 (J), 2♂ A; April 17, 1949 (J), 1♀ A, 4♂ A. E. Fk. Humbug Crk., May 30, 1964 (J), 1♂ A; April 19, 1964 (J), 1♂ A; April 26, 1966 (J), 3♂ A. N. Fk. Clatskanie Riv., May 2, 1961 (R. J. Ellis), 2♂ A. Osweg Crk., May 3, 1964 (J), 1♂ A. Columbia Co: Scappose Crk., May 8, 1948 (J), 4♀ A, 5♂ A. N. Fk. Scappose Crk., April 5, 1940 (J), 5♂ A. Beaver Crk., April 17, 1954 (J), 1♀ A. Jackson Co: Bybee Crk., trib Rogue Riv., June 17, 1949 (J), 2♀ A, 1♂ A. Rogue Riv. at Foster Crk., June 17, 1949 (J), 2♀ A, 4♂ A. Lincoln Co: Deer Crk., 10 mi. S. Toledo, Feb. 23, 1963 (A), 1L (2). Needle Branch Crk., 9 mi. S. Toledo, April 6, 1963, 1L (5). Washington Co: Wolf Crk., April 21, 1946 (J), 1♀, 1♂ A. Gales Crk., April 26, 1947 (J), 1♂ A.

Biology: Larval head capsule lengths were (in mm.): I, .22 (1 larva); II, .30 to .36 (14 larvae); III, .44 to .58 (47 larvae); IV, .68 to .86 (44 larvae); and V, 1.06 to 1.24 (9 larvae).

The information on the life cycle of blarina is based largely

on studies done on Oak Creek, Benton County, Oregon, which included drift and benthos collections. This species is univoltine. Records of seasonal occurrence of the instars were: I, early July; II, July through October (one larva was recorded during February from the western side of the Oregon Coast Range), III, August through October; IV, late September through February; and V, January through April. Pupae occurred in April. The flight period of the adults occurred from April through mid-June. Eggs were probably present during May and June.

Although this species is apparently fairly common in Oak Creek, the adults were not collected from emergence traps over a period of 32 months (Anderson & Wold, 1972). Since all emergence traps were placed over riffles, this species may emerge from a different area of the stream.

Narvae Subgroup

Rhyacophila narvae Navas

(Figures 5, 42, 43, 44, 45)

Rhyacophila narvae Navas, 1926:57; Martynov, 1934:39, 53-4, 323-4;

Martynov, 1935:206; Lepneva, 1955:271-7; Ross, 1956:97, 120;

Lepneva, 1964:5, 118, 143, 192, 258, 262-5, 275-6; Schmid,

1970:65, 125. Anderson and Wold, 1972:192-3.

Type Locality: Not known.

Rhyacophila vepulsa Milne, 1936:96, 102, 111; Ross, 1944:291;

Davis, 1948:45-6; Denning, 1948b:106; Ross and Spencer, 1952:45; Ross, 1956:97-8, 120; Denning, 1963:245; Anderson, 1967:508, 517, 518; Smith, 1968:670; Thut, 1969:894-8; Schmid, 1970:125, 161; Nimmo, 1971:17, 19, 28-9.

Larva: Smith (1968) described the larva of Rhyacophila vepulsa which Schmid (1970) placed in synonymy with narvae. Lepneva (1955, 1964) also described the larva of R. narvae. The description, taken from Smith (1968) follows:

Head dark brown or black dorsally, posterior quarter light yellow with the line between the two areas distinct, no distinct muscle scars, ventral surface paler (Figure 42); maxillary palpus short, second segment twice as long as first; left mandible stout, with one apical tooth and one large sub-apical tooth, mesal margin slightly irregular, right mandible stout with two large apical teeth, dorsal tooth shorter and truncate apically, single mesal tooth small (Figure 43). Pronotum light yellow without distinct muscle scars. Abdomen without gills or fleshy protuberances. Anal proleg with a baso-ventral hook, no apico-lateral spur, and anal claw without ventral teeth (Figure 45). Length of mature larvae approximately 13 mm.

Distribution: This species has been recorded in North America from Alaska, Alberta, British Columbia, California, Idaho, Montana, Oregon and Washington. It is also recorded from the Amur Region and Maritime Territory, U.S.S.R.

Material Examined: OREGON: Benton Co: Oak Crk., Mar. 13, 1966 (A), 1L (4); May 24, 1970 (E), 1♂ A; Sept. 6, 1966 (A), 2L (3); Sept. 11, 1967 (D. Lehmkuhl), 6L (2, 3); Sept. 15, 1966 (A), 1L (1);

Oct. 13-14, 1966 (A), 1L (4); Oct. 14, 1967 (D. Lehmkuhl), 2L (2, 3); Oct. 15, 1967 (A), 1L (1); Oct. 27, 1965 (A), 1L (4); Dec. 16, 1966 (A), 1L (4); Site 1, 700', June 5-9, 1969 (W), 1♂ A; June 22-25, 1970 (W), 2♂ A; Site 2, 650', May 4-7, 1969 (W), 1♂ A; May 13-16, 1969 (W), 1♂ A; June 5-9, 1970 (W), 1♂ A. 3.2 mi. W. Marys Pk. Jct. on Hwy. 34, Crooked Crk., trib. N. Fk. Alsea Riv., 260', Sept. 9, 1967 (W), 2L (4). Clackamas Co: Mt. Hood, spr. str., 3.3 mi. below Timberline Lodge, July 16, 1963 (GW), 1♂ A. Deschutes Co: Deschutes Riv. at Bridge on Rd. #2022 nr. Crane Prairie Resv., 60°F, 4620', Aug. 31, 1968 (WW), 2L (5). Quinn Riv., nr. Crane Prairie Resv., 41°F, 4580', Aug. 31, 1968 (WW), 1♂ M, 133L (3, 4, 5). Browns Crk. nr. Wickiup Resv., July 19, 1969 (W), 10L (4, 5). Cultus Riv., nr. Cultus Lk., 47°F, 4600', Aug. 31, 1968 (WW), 32L (4, 5). Jefferson Co: Pioneer Crossing F. C., Aug. 12, 1966 (W), 2L (4). Riverside F.C., Jan. 20, 1968 (D. Lehmkuhl), 12L (2, 3, 4); Feb. 27, 1966 (A), 8L (5); Mar. 22, 1967 (A), 3L (5); April 30, 1965 (A), many ♂ and ♀ A; May 1, 1965 (A), many ♀ and ♂ A; May 21, 1964 (A), 1L (4), many ♀ and ♂ A; June 15-16, 1966 (A), 13L (3, 4, 5), 25♂ A, 16♀ A; June 27, 1964 (A), 2PP, 5♂ A; July 23, 1964 (A), 1L (5); July 26, 1965 (A), 1♂ M. Aug. 12, 1966 (A), 148L (1, 2, 4, 5); Aug. 24, 1967 (D. Lehmkuhl), 191L (2, 4, 5), 1 male A; Sept. 3, 1964 (A), 1♂ A; Sept. 18, 1968 (D. Lehmkuhl), 57L (1, 2, 3, 5); Sept. 23-4, 1965 (A), 73L (1, 2, 3, 4, 5); Dec. 26, 1966 (A), 14L (2, 3, 4, 5).

Linn Co: Ollalie Crk., Hwy. 126, Ollalie Crk. For. Camp, June 30, 1966 (W), 1♂ A; July 2, 1969 (W), 1♂ A; July 17, 1970 (W & E), 3♂ A.

Wasco Co: Iron Crk. nr. Bennett Pass, July 17, 1968 (W), 1♂ A.

WASHINGTON: Cowlitz Co: Kalama Riv. drainage, Weyerhaeuser Co. Artificial Streams, 3 mi. n. Lk. Merrill, June 18, 1968 (A), 1♂ A.

Biology: Thut (1969) studied the life cycle and feeding habits of narvae in spring-fed streams in Washington. This species was univoltine with the first and second instars present from July through September (Thut, 1967). The third and fourth stadia slightly exceeded one month in duration and the fifth lasted three months. The adults emerged from May through August. Rhyacophila narvae larvae preferred the slower current velocities, ranging from 1.0 to 1.4 ft./sec. The maximum number of larvae occurring in the benthos was $240/m^2$. The diet consisted of only 3% plant material with the remainder being of animal origin. Larvae of Chironomidae were the most important food item, but Acari and Copepoda were fed upon in numbers greatly exceeding their relative abundance in the benthos. Ephemeroptera (Baetis sp.) and Plecoptera (Nemoura sp.) nymphs were ingested in small numbers as were early instars of R. verrula. The third and fourth instars of narvae fed on a higher percentage of Copepoda than did the fifth instars. The first and second instars were not dissected due to their small size.

Smith (1968) collected the adults in the Salmon River drainage of Idaho during late July and stated that this species over-wintered as medium-sized to mature larvae. Smith (1968) found the larvae in small rubble-bottomed riffles. Nimmo (1971) collected adults in early August in Alberta, from 4000 to 6000'.

Head capsule measurements for the larvae were (in mm.): I, .20 to .26 (41 larvae); II, .30 to .38 (97 larvae); III, .46 to .62 (44 larvae); IV, .80 to .94 (64 larvae); and V, 1.09 to 1.34 (402 larvae).

In the study of caddisfly emergence from Oak Creek (Anderson and Wold, 1972) narvae was collected from the two upstream traps (650 and 700 feet elevation). A total of only six specimens were collected during the two year study. For both years the emergence was earlier at the downstream trap than at the upstream trap, where the temperature was lower in the summer months. This suggests that emergence of this species is temperature dependent. The life cycle apparently lasts one year with emergence only in May and June in Oak Creek. In Oak Creek the first, second, and third instars were collected in September and October, the fourth instars in October, and the fifth instars in December.

In the spring-fed Metolius River first instars were collected in August and September, second instars in January, August and September, third instars in January, June, and September, fourth instars in

January, May, June, August, and September, and fifth instars in February, March, June, August, and September. Pupae were collected in June and July. Adults were in flight from April through September. Apparently there are two peaks of emergence, one in spring and one in fall. The individuals hatching in the spring probably overwinter in the last instars and pupate in early spring, while those hatching later in the summer overwinter in the earlier instars and pupate in the summer.

From all of the records available to the writer, the adult flight period occurs from late April through early September, with pupae being collected during June and July.

Unimaculata Subgroup

Rhyacophila unimaculata Denning

Rhyacophila unimaculata Denning, 1941:198-9; Ross & Spencer, 1952:

45; Ross, 1956:97, 120; Schmid, 1970:65, 126.

Type Locality: Robson, B. C., April 16, 1939 (H. R. Foslee).

Larva: Unknown.

Distribution: British Columbia.

Material Examined: None.

Biology: Unknown.

Rhyacophila unipunctata Schmid

Rhyacophila unipunctata Schmid, 1970:65, 126, 160-1.

Type Locality: Hemlock Butte Pass, Lane County, Oregon,
June 10, 1965 (F. Schmid).

Larva: Unknown.

Distribution: This species has been collected in the Cascade
Range in Oregon.

Material Examined: None.

Biology: Unknown.

Belona Subgroup

Rhyacophila belona Ross

Rhyacophila belona Ross, 1948:19-20; Ross, 1956:97, 120; Schmid,
1970:65, 125; Nimmo, 1971:18, 29-30.

Type Locality: East of summit of Logan Pass, 6000', Glacier
National Park, Montana, July 12, 1940 (J. A. & H. H. Ross).

Larva: Unknown.

Distribution: Alberta and Montana.

Material Examined: None.

Biology: Nimmo (1971) stated that belona is found in high
alpine brooks, from 6000 to 7000 feet, with a flight season from
July 1 to July 21.

Rhyacophila vetina Milne

Rhyacophila vetina Milne, 1936:91; Davis, 1948:31; Denning, 1948b: 106; Ross, 1956:97, 98, 120; Schmid, 1970:65, 126.

Type Locality: White River, Mt. Rainier, Washington, May 12, 1934 (W. E. Ricker).

Larva: Unknown.

Distribution: This species occurs in the high Cascades of Oregon and Washington.

Material Examined: OREGON: Clackamas Co: Mt. Hood, trib. Salmon River, July 13, 1963 (J), 1♂ A, 2♀ A.

Biology: Unknown.

11. Vofixa Group

Schmid (1970) divided this group into three complexes on the basis of the adult genitalia: (1) Rhyacophila vobara Milne and R. iranda Ross, (2) R. vofixa Milne and R. harmstoni Ross, and (3) R. ophrys Ross and R. velora Denning. Larval associations are available only for velora.

Ross (1956) originally proposed the vofixa group, placing it in his branch two, but he did not include ophrys and velora in the group. He placed these two species in his sibirica group in branch seven. After study of the larva of velora it does not appear to bear

any close relationship to the known larvae in the sibirica group.

When the larvae of the other five species of the vofixa group are associated then perhaps they will shed some light on the placement of the species of the vofixa grouping of Schmid.

Vobara Subgroup

Rhyacophila vobara Milne

Rhyacophila vobara Milne, 1936:94, 102, 111; Ross, 1944:291;

Denning, 1948b:106; Ross & Spencer, 1952:45; Ross, 1956:101-2, 116, 121; Schmid, 1958:17; Smith, 1968:672; Schmid, 1970:67, 126; Nimmo, 1971:17, 19, 32-3.

Type Locality: Cultus Lake, B. C., Aug. 12, 1934.

Larva: Unknown.

Distribution: This species has been recorded most commonly from the Rocky Mountain regions of Alberta, British Columbia, Idaho, and the Yukon Territory. It has also been recorded from the Cascades in Oregon.

Material Examined: ALBERTA: Banff, spring run, July 27, 1963 (GW), 2♂ A. OREGON: Linn Co: Small stream just n. of Trailbridge & Smith Riv. Reservoirs Rd., July 2, 1969 (W), 1♂ A.

Biology: Smith (1968) collected one female and one male in the Salmon River drainage in Idaho during July. Nimmo (1971) recorded a flight season in Alberta from July 3 to September 10,

at an altitude of 3,500 to over 6,000 feet.

Rhyacophila iranda Ross

Rhyacophila iranda Ross, 1938c:103; Davis, 1948:49-50; Ross, 1956:

101-2, 116, 121; Schmid, 1970:67, 126; Anderson and Wold, 1972:192-3.

Type Locality: Razorhone Crk., Mt. Baker, Washington, July 21, 1936 (H. H. Ross).

Larva: Unknown.

Distribution: This species is found from the Cascade Range westward in Oregon and Washington.

Material Examined: OREGON: Benton Co: Oak Crk., Site #1, 700', May 19-22, 1969 (W), 1♂ A. Oak Crk., Site #2, 650', May 14-17, 1970 (W), 1♂ A; May 17-21, 1970 (W), 1♂ A. Deschutes Co: Green Lk., Sisters Mtns., Aug. 28-30, 1952 (V. Roth), 1♂ A. Klamath Co: Annie Crk., Crater Lk. Nat. Pk., Oct. 1, 1966 (GW, Y, O), 3♂ A. Linn Co: Ollalie Crk. at Ollalie Crk. For. Camp, Rt. 126, July 17, 1970 (W & E), 1♂ A.

Biology: The adults of iranda were collected from emergence traps at Oak Creek (Anderson and Wold, 1972) only during May. However, all of the other adults of this species were collected from July through October.

Vofixa Subgroup

Rhyacophila vofixa Milne

Rhyacophila vofixa Milne, 1936:95, 102, 111; Ross, 1944:291; Ross, 1956:80, 101, 116; Schmid, 1958:17; Smith, 1968:672-3; Schmid, 1970:67, 126; Nimmo, 1971:17, 18, 22.

Type Locality: Edmonton, Alberta, July 18, 1923.

Larva: Unknown.

Distribution: This species has been recorded from Alaska, Alberta, British Columbia, Idaho, Yukon Territory, and Washington.

Material Examined: None.

Biology: Nimmo (1971) recorded the flight season in Alberta from July 15 to August 31.

Rhyacophila harmstoni Ross

Rhyacophila harmstoni Ross, 1944:268-9; Denning, 1948b:101; Ross, 1956:80, 116; Denning, 1963:244; Schmid, 1970:67, 126.

Type Locality: Strawberry Valley, Utah, July 15, 1938 (Knowlton & Harmston).

Larva: Unknown.

Distribution: Rhyacophila harmstoni has been collected in California, Colorado, New Mexico, and Utah.

Biology: Unknown.

Ophrys Subgroup

Rhyacophila ophrys Ross

Rhyacophila ophrys Ross, 1948:19; Ross, 1956:93, 98, 120; Schmid, 1970:67, 126.

Type Locality: E of summit of Logan Pass, Glacier Nat. Park, Montana, July 12, 1940 (J. A. & H. H. Ross).

Larva: Unknown.

Distribution: This species has only been collected from the Rocky Mountains in Montana.

Material Examined: None.

Biology: Unknown.

Rhyacophila velora Denning

(Figures 46, 47, 48)

Rhyacophila velora Denning, 1954:58-9; Ross, 1956:93, 120; Schmid, 1970:67, 126.

Type Locality: Burney Falls State Park, Shasta County, California, July 27, 1952 (D. G. Denning).

Larva: This is one of the smallest species of Rhyacophila described. The metamorphotypes, upon which the larval association is based, are from a small stream east of Blue River, Lane Co., Oregon.

Description: Head, light brown, somewhat darker area

ventrally; dark brown on anterior of frontoclypeus, often extending short distance along frontal sutures; narrowed anteriorly, $1 \frac{1}{3}$ times wider posteriorly than anteriorly (Figure 46); length $1 \frac{1}{3}$ times longer than width at widest point; right mandible with one large apical tooth, one small, blunt mesal tooth; left mandible with one large apical tooth (Figure 47). Thorax, pronotum brown, some darkened patches along median suture. Abdomen, without gills or fleshy lateral protuberances; anal claw with large basoventral hook, no apicolateral spur, two large teeth on claw, apical one longest (Figure 48). Length, mature larva, 8 mm.

Distribution: This species has been collected only from the Cascade Mountains at Burney Falls, California, and in Oregon near Blue River.

Material Examined: OREGON: Lane Co: Small stream ca. 2 mi. w. Blue River, nr. McKenzie Riv., July 17, 1970 (W & E), 2PP, 1 ♀ P, 1 ♂ M, 1 ♀ M; June 10, 1968 (Y & S), 1L.

Biology: The adults of Rhyacophila velora were collected during late June, July, and September from the California site. This species was collected in Oregon in July as prepupae, immature, and mature pupae. The pupae were all collected in the root area of thick moss on bedrock in an area of rapid flow, within cases that were a combination of sand and moss. Pupae were found only in this type of an area in the stream, even though other areas were thoroughly searched.

12. Betteni Group

The betteni group of Schmid (1970) consists of 12 species:

Rhyacophila ardala Denning, R. betteni Ling, R. cerita Denning, R. chilsia Denning, R. fenderi Ross, R. karila Denning, R. malkini Ross, R. perda Ross, R. spinata Denning, R. vaccua Milne, R. vedra Milne, and R. willametta Ross. Ross (1956) proposed the betteni group and placed it in his branch eight. He included the same species in his group except for willametta, which was placed in a group of its own in his branch nine. On the basis of the similarities between the larvae, the Schmid (1970) revision of this grouping is an improvement upon that of Ross (1956).

The larva of R. vaccua was associated by Smith (1968). Metamorphotypes are now available for chilsia, malkini, perda, spinata, vedra, and willametta. The larva, presumed to be that of fenderi, is also discussed. Of the species for which larvae have been associated, only those of malkini can be easily separated from the others. In the remaining seven species, there are some variations in head shape, and color, ranging from light brown to dark brown. However, none of these variations is distinct enough to allow for ready identification. The description of vaccua serves for the associated larvae of the remaining species except for that of malkini, which is described separately.

All larvae and immature pupae of the betteni group, except for

those of malkini, are listed below. Only the counties and states are given; the list of all localities for over 1,000 specimens would be prohibitive and of little use until the species can be separated.

Material Examined:

Canada:

Alberta

British Columbia (including

Vancouver Island)

California:

Calaveras

Eldorado

Humboldt

Lake

Lassen

Los Angeles

Marin

Mariposa

Mendocino

Modoc

Monterey

Napa

Nevada

Plumas

San Bernadino

San Luis Obispo

California:

Shasta

Sierra

Siskiyou

Tehama

Tulare

Tuolumne

Idaho:

Boise

Bonneville

Idaho

Kootenai

Montana:

Flathead

Missoula

Powell

Oregon:

Benton

Clackamas

Clatsop

Curry

Deschutes

Douglas

Jackson

Jefferson

Josephine

Lane

Oregon:

Lake

Lincoln

Linn

Marion

Multnomah

Polk

Tillamook

Wallowa

Yamhill

Washington:

Clallam

Jefferson

Lewis

Pierce

Skamania

Yakima

Wyoming:

Teton

Yellowstone Nat. Park

Rhyacophila ardala Denning

Rhyacophila ardala Denning, 1965a:696; Schmid, 1970:68, 126.

Type Locality: Johnsville, Plumas County, California, Sept. 27,
1963 (H. J. Pini).

Larva: Unknown.

Distribution: California.

Material Examined: None.

Biology: Unknown.

Rhyacophila betteni Ling

Rhyacophila betteni Ling, 1938:59; Ross, 1956:99, 121; Schmid, 1970:
68, 126.

Type Locality: Mt. Tamalpais, Marin County, California,
Feb. 24, 1907 (F. X. Williams).

Larva: Unknown.

Distribution: California and Oregon.

Material Examined: None.

Biology: Unknown.

Rhyacophila cerita Denning

Rhyacophila cerita Denning, 1971:202.

Type Locality: Buckthorn Campgrounds, Little Rock Crk.,
Angeles Nat. For., 6800', San Gabriel Mts., Los Angeles Co.,
Calif., July 18, 1969 (J. A. Honey).

Larva: Unknown.

Distribution: This species is known only from the Coastal
Mountains north and northwest of Los Angeles, California.

Material Examined: None.

Biology: The adults occurred in May, June, and July.

Rhyacophila chilsia Denning

Rhyacophila chilsia Denning, 1950a:115-6; Ross, 1956:99, 100, 121;

Schmid, 1970:68, 126; Nimmo, 1971:17, 32.

Type Locality: Malign Cyn., Jasper, Alb. Jul. 23, 1949

(C. P. Alexander).

Larva: See group discussion and description of vaccua.

Distribution: Alberta, British Columbia, and Oregon.

Material Examined: OREGON: Linn Co: Scott Crk., McKenzie Riv. area, June 30, 1966 (W), 1♂ M.

Biology: Unknown.

Rhyacophila fenderi Ross

Rhyacophila fenderi Ross, 1948:18-9; Ross, 1956:99, 121; Schmid,

1970:68, 126; Anderson and Wold, 1972:192-3.

Type Locality: Peavine Ridge, nr. McMinnville, Oregon, Aug. 6, 1947 (K. M. Fender).

Larva: This larva is presumed to be fenderi due to the similarities between it and the associated larvae of the other species in the betteni group and also because it has been collected from the type locality of fenderi. Its head length and width are subequal. Otherwise, it is approximately the same as the description of vaccua.

Distribution: This species occurs in the Coast Ranges of Oregon and California.

Material Examined: OREGON: Benton Co: Oak Crk., site #1,

700', June 22-25, 1968 (K), 1♂ A; Sept. 8-11, 1970 (W), 1♂ A.

Yamhill Co: Peavine Rdg., McMinnville, July 9, 1963 (Fender), 7L.

Biology: Adults were collected during late June, August, and early September. Anderson and Wold (1972) reported this species in emergence trap collections from Oak Creek, Benton Co., Oregon. Only two adults were collected, both at the trap at the highest elevation (700'), which had the coolest summer temperature.

Rhyacophila karila Denning

Rhyacophila karila Denning, 1948b:109.

Type Locality: Dyerville, Calif., June 17, 1935 (H. Rayner).

Larva: Unknown.

Distribution: California.

Material Examined: None

Biology: Unknown.

Rhyacophila malkini Ross

Rhyacophila malkini Ross, 1947:126-7; Ross, 1956:99, 121; Schmid, 1970:68, 126.

Type Locality: Eugene, Oregon, Sept. 26, 1946 (B. Malkin).

Larva: The association of this larva is based on male metamorphotypes from Oregon, from the Nehalem River, Clatsop Co.; Hunter Creek, Curry Co.; and Santiam River, Linn Co.

Description: Head, depressed dorsally, without distinct muscle scars, anterior 3/4 dark brown, posterior 1/4 yellow (Figure 55); maxillary palpus long and slender, second segment three times as

3.3 mi. S. Galice, 740', Aug. 6, 1967 (WW), 8L (5). Lane Co: McKenzie R. at Hendricks Bridge, Aug. 4, 1965, 1L (5). Turner Ck., Turner Crk. Rec. Area, nr. Rt. 126, June 23, 1966 (W), 1L (5). Lincoln Co: Big Elk For. Camp, 2 mi. E. Harlan, July 5, 1970 (A), 5L (5). Linn Co: Santiam River, 10 mi. E. Sweet Home, Aug. 24, 1966 (W), 8L (5); Oct. 9, 1966 (A), 1♂ M. Tillamook Co: Nestucca Riv., 15 mi. E. Beaver, July 24, 1966 (A), 21 L (4, 5). Farmer Crk., 2 mi. N. Hebo, July 23, 1966 (A), 1L (5).

Biology: Head capsule measurements of 99 fourth and fifth instars were (in mm.): IV, .82 to 1.14, and V, 1.29 to 1.62. Fourth instars were collected from June to August and fifth instars occurred from June to September. Pupae were collected in September and October; adults were collected in July, August, and October.

Rhyacophila perda Ross

Rhyacophila perda Ross, 1938c:105; Davis, 1948:32-3; Ross & Spencer, 1952:45; Ross, 1956:121; Schmid, 1970:68, 126.

Type Locality: Along Razorhone Crk., Mt. Baker, Washington, July 21, 1936 (H. H. Ross).

Larva: See group discussion and the description of vaccua.

Distribution: This species occurs in the Cascade Range in southern British Columbia, Oregon, and Washington.

Material Examined: OREGON: Clackamas Co: 14 mi. S.

Timothy Lk., Warm Springs Riv., 54°F, 3750', July 11, 1968 (A),
 1♂ M. Mt. Hood nr. Gov't Camp, streams crossing rd. to Timberline
 Lodge, June 12, 1967 (Y), 1♂ M, 2♂ P. N. Fk. Iron Crk., at Rt. 35,
 nr. Gov't Camp, June 13, 1967 (Y), 2♂ M. Mt. Hood, str. crossing
 rd., 3.3 mi. below Timberline Lodge, June 8, 1969 (R), 1♂ A. Mt.
 Hood, Still Crk., Still Crk. For. Camp, Sept. 28-9, 1966 (GW, Y,
 O), 2♂ M; June 10-11, 1967 (Y), 4♂ M; June 21, 1968 (GW, Y, S),
 1♂ M. Deschutes Co: Satan Crk., nr. Devils Garden Cpgrd., Cen-
 tury Drive Area, Hwy 46, July 9, 1969 (W), 1♂ M. Jefferson Co:
 Springs of Metolius River, June 26, 1954 (F. F. Hasbrouck), 1♂ A.
Lane Co: Scott Crk. on Hwy. 126, Clear Lk. cutoff, July 17, 1970
 (W & E), 1♂ M. Mack Crk., Andrews Experimental Forest, July 30,
 1970 (A), 1♂ M. Linn Co: Crk. nr. bridge at end of road on So.
 side Green Peter Reservoir, ca. 14 mi. from Dam, July 4, 1969
 (W), 1♂ M. Ice Cap Crk. at Carmen Reservoir, July 7, 1966 (W),
 1♂ A. Tributary streams, Carmen Reservoir, July 7, 1966 (W),
 2♂ M. Marion Forks, nr. Detroit Reservoir, Aug. 28, 1967, emerged
 Sept. 12, (E), 1♂ M. Streams crossing Rt. 22, 13.3 mi. e. Idanha,
 June 12, 1968 (Y & S). Marion Co: Niagara, May 31, 1970 (E & T),
 3♂ A. Multnomah Co: Trapper Crk., 30 mi. E. Portland, Larch
 Mtn. Rd., July 25, 1964 (A), 1♂ M. Stream crossing rd. on Larch
 Mtn., .5 mi. below summit, nr. Corbett, Sept. 27, 1966 (GW, Y, O),

1♂ M.

WASHINGTON: Pierce Co: Sm. stream entering Fish Crk., Westside Rd., Longmire, Mt. Rainier Nat. Park, July 3, 1969 (R), 1♂ M. Sm. trickles on rock cut, 1.6 mi. S. Crystal Mtn. Rd. on Rt. 410, Mt. Rainier Nat. Pk., June 16, 1969 (R), 1♂ A.

Biology: Pupae of perda are recorded from June to late September and adults from the end of May through July.

Rhyacophila spinata Denning

Rhyacophila spinata Denning, 1965b:696; Schmid, 1970:68, 126.

Type Locality: New York Ravine, Downie Riv., nr. Hwy. 49, Yuba County, California, May 24, 1964 (D. G. Denning).

Larva: See discussion under group heading and description of vaccua.

Distribution: This species has only been recorded from the Sierra Nevada Mountains in California.

Material Examined: CALIFORNIA: Plumas Co: Granite Gulch entering Injun Jim Cpgrd., nr. Tobin, May 30, 1961, emerged June 9, 1961 (GW), 1♂ M.

Biology: Unknown.

Rhyacophila vaccua Milne

(Figures 2, 49, 50, 51, 52, 53, 54)

Rhyacophila vaccua Milne, 1936:94, 102; Davis, 1948:40-1; Denning,

1948b:102; Ross & Spencer, 1952:45; Schmid & Guppy, 1952:41;
 Ross, 1956:99-100, 121; Smith, 1968:668; Thut, 1969:894-898;
 Schmid, 1970:68, 126; Anderson and Wold, 1972:192-3.

Type Locality: Cultus Lake, B. C., Aug. 25, 1934 (W. E. Ricker).

Rhyacophila complicata Ling, 1938:60; Ross, 1944:291 (synonymy).

Rhyacophila bruesi Milne and Milne, 1940:154; Ross, 1944:291
 (synonymy).

Larva: The larva of bruesi, placed in synonymy with vaccua,
 was associated and described by Milne and Milne (1940). Smith (1968)
 described the larva of this species as follows:

Head depressed, flat dorsally (Figures 49, 51), brown without distinct muscle scars (Figure 50); maxillary palpus long and slender, second segment three times as long as first (Figure 52); right mandible short and triangular with two small apical teeth, the single mesal tooth bilobed, with basal lobe small, left mandible short and triangular with one apical tooth, mesal margin irregular (Figure 53). Pronotum brown, no distinct muscle scars. Abdomen without gills or fleshy protuberances. Anal proleg with a small baso-ventral hook that does not project free of the membrane, no apico-lateral spur and anal claw with one small ventral tooth (Figure 54). Length of mature larvae 18-20 mm.

Distribution: This species has been collected in Alberta, British Columbia (and Vancouver Island), California, Idaho, Montana, Oregon and Washington.

Material Examined: CALIFORNIA: Madera Co: Boggy Meadows, 6000', July 15, 1946 (H. P. Chandler), 2♂ M. Sagehen

Crk., above Univ. Calif. Sta., 8 mi. n. Truckee, July 19, 1966
 (GW), 1♂ M. Modoc Co: Rush Crk., Hwy. 139, June 24, 1968 (E),
 1♂ M. Shasta Co: Lost Crk., Lassen Volcanic Nat. Pk., 6000',
 Sept. 18, 1946 (H. P. Chandler), 1♂ M. OREGON: Benton Co:
 Oak Crk., site #1, 700', Sept. 10-17, 1968 (W), 1♂ A; Sept. 28,
 1970 (W), 1♀ A; Sept. 17-24, 1968 (W), 1♂ A. Oak Crk., site #2,
 650', Sept. 28, 1970 (W), 1♀ A; July 13-16, 1968 (W), 1♀ A; Sept. 10-
 17, 1968 (W), 1♀ A; Sept. 24-Oct. 1, 1968 (W), 1♂ A; Sept. 25-30,
 1969 (W), 1♂ A; July 7-12, 1970 (W), 1♂ A; Aug. 2-6, 1970 (W), 1♂ A;
 Aug. 18-21, 1970 (W), 1♂ A; Sept. 28, 1970 (W), 1♂ A. Small trib.
 str. of Alsea Riv., July 7, 1963 (A), 1♂ A. Parker Crk., Marys Pk.,
 Sept. 23, 1968 (W), 1♂ A. Deschutes Co: Browns Crk. nr. Wickiup
 Reserv., Century Dr. area, July 19, 1969 (W), 1♂ M; at light (W),
 1♂ A. Jefferson Co: Bridge 99, Metolius Riv., Sept. 24, 1965 (A),
 1♂ A. Metolius Riv., Warm Springs Reservation, Sept. 15, 1949
 (L. E. Perry), 1♀ A, 1♂ A. Lane Co: Horse Crk., S. McKenzie
 Bridge, July 13, 1966, emgd. Oak Crk. Lab., Oct. 17, 1966 (W),
 1♂ A. Lincoln Co: Stream along Trenholm Saddle Rd., Rt. 34, e.
 of Tidewater, June 6, 1968 (Y & S), 1♂ M. Linn Co: N. Fk.
 Santiam Riv., Parrish Lk. Rd., Sept. 5, 1968 (E), 1♂ A. Marion
 Fks. and vicinity, Sept. 21, 1968 (E), 1♂ A. Creek nr. bridge at
 end of rd. on s. side Green Peter Reservoir, ca. 14 mi. from dam,
 July 4, 1969 (W), 1♂ M. 7 mi. from dam on rd. on s. side Green

Peter, July 4, 1969 (W), 1♂ M. Marion Co: Niagara, N. Fk.
 Santiam Riv., Oct. 26, 1968 (E), 1♂ A. Tillamook Co: 16.7 mi.
 e. Blaine (BLM Rec. Area), Nestucca Riv., Aug. 8, 1966 (W), 1♂ M.
WASHINGTON: Clallum Co: 7 mi. off Hwy. 101 on Olympic Hot
 Springs Rd., nr. Mills Lk., July 22, 1969 (WW), 1♂ M. Pierce Co:
 Crk. w. of Nisqually entrance to Mt. Rainier Nat. Pk., July 25, 1969
 (WW), 1♂ A.

Biology: Thut (1969) studied the life cycle and feeding habits of R. vaccua in spring-fed streams near Kalama, Washington. He found that the adults emerged from July through January. The larvae occurred in similar numbers at all current velocities studied (1 ft. / sec., 1.4 ft. / sec., and 1.75 ft. / sec.). The maximum number of vaccua larvae found in a m² benthos sample was 80. Between 90 to 95% of the food ingested by vaccua was of animal origin. The larvae of vaccua preyed upon a greater variety of animals than did the other six species of Rhyacophila studied. Chironomidae were the dominant prey, although they occurred in the diet in much smaller proportions than they occurred in the benthos. Acari, Copepoda, and Plecoptera nymphs (Nemoura spp.) were fed upon in much greater numbers than they occurred in the benthos. Of the seven species of Rhyacophila studied, vaccua was the only species that showed a "preference" for Plecoptera. Baetis (Ephemeroptera: Baetidae) and Ephemerella (Ephemeroptera: Ephemerellidae) nymphs, R. verrula and Dicranota

(Tipulidae) larvae, and Oligochaeta, were preyed upon in smaller numbers. The earlier instars fed on Copepoda more often while Chironomidae made up a greater part of the diet in the later instars.

Smith (1968) collected the adults of R. vaccua in the Salmon River drainage of Idaho in September and October. Mature pupae were collected in November, which he thought might indicate late adult emergence. Larvae usually occurred in mixed rubble in riffles.

Anderson and Wold (1972) collected this species in emergence traps from Oak Creek, Benton County, Oregon. Rhyacophila vaccua occurred in small numbers (10 specimens) at the two upstream traps (700 ft. and 650 ft. elev.) but not in the two traps at lower elevations (500 ft. and 225 ft.). The emergence of vaccua in the upstream trap occurred during September and at the downstream trap during July, August, and September. The lower average temperatures during most of the year may delay emergence at the higher elevation.

Emergence of R. vaccua on Vancouver Island, B. C. (Ross & Spencer, 1952) occurred from July through October.

From publications and records, it appears that this species usually emerges from July through October. Mature pupae have been collected from June through November.

Rhyacophila vedra Milne

Rhyacophila vedra Milne, 1936:97, 102; Denning, 1948b:105; Ross, 1956:99, 121; Schmid, 1970:68, 126; Anderson and Wold,

1972:192-3.

Type Locality: Oak Crk., nr. Corvallis, Oregon, June 2, 1934
(Eldon Ball).

Rhyacophila californica Ling, 1938:60; Denning, 1948b:105 (synonymy).

Larva: See under group discussion and description of vaccua.

Distribution: California, Oregon, and Washington.

Material Examined: CALIFORNIA: Del Norte Co: Patricks Crk., trib. to Smith Riv., June 16, 1949 (J), 1♂ A. Eldorado Co: E. of Whitehall, Hwy. 50, sm. str. crossing rd., 3600', June 26, 1968 (E), 1♂ M. Marin Co: Small str. at Inverness, Reyes Pt., June 25, 1967 (Y), 1♂ M. Stream in Mt. Tamalpais St. Pk., Oct. 13, 1966 (GW, Y, O), 1♂ M. San Bernadino Co: Lytle Crk. Ranger Sta., 2700', June 24, 1968 (E), 1♂ M. Shasta Co: 4 mi. W. Viola, June 27, 1947, 1♂ M. OREGON: Benton Co: Oak Crk., site #2, 650', June 4-7, 1968 (K), 1♀ A; Aug. 20-27, 1968 (K), 1♀ A; Sept. 10-17, 1968 (K), 1♀ A; Sept. 17-24, 1968 (K), 2♀ A, 1♂ A; Oct. 1-8, 1968 (K), 1♂ A; Sept. 22-25, 1969 (W), 1♀ A; Aug. 29-Oct. 4, 1970 (W), 1♀ A; Sept. 8-11, 1970 (W), 1♂ A. Oak Crk., site #3, 500', May 29-June 1, 1968 (K), 1♀ A; June 1-4, 1968 (K), 1♀ A, 1♂ A; June 7-10, 1968 (K), 1♂ A; July 16-23, 1968 (K), 1♂ A; July 23-30, 1968 (K), 1♀ A; Aug. 6-14, 1968 (K), 1♀ A; Aug. 14-20, 1968 (K), 3♀ A; Aug. 20-27, 1968 (K), 1♂ A; Sept. 17-24, 1968 (K), 1♀ A; Aug. 20-27, 1968 (K), 1♂ A; Sept. 17-24, 1968 (K), 1♀ A; Aug. 14-25, 1969 (W), 1♀ A; June 17-22,

1970 (W), 1♀ A; Sept. 14-17, 1970 (W), 1♀ A. Oak Crk., still water and seep, 60°F, Aug. 3, 1963 (A), 1♂ M. Berry Crk., OSU Experimental Sta., 9 mi. n. w. Corvallis, Aug. 7, 1964 (A), 1♂ A; May 24, 1970 (E), 1♂ A; at black light, June 21-29, 1968 (E), 15♂ A; July 1-3, 1968 (E), 2♂ A; July 4, 1968 (E), 7♂ A; July 5-6, 1968 (E), 5♂ A; July 8-12, 1968 (E), 2♂ A; July 12-14, 1968 (E), 2♂ A; July 12-18, 1968 (E), 2♂ A; July 18-21, 1968 (E), 4♂ A; July 23-26, 1968 (E), 2♂ A; July 22-26, 1968 (E), 1♂ A; July 27-30, 1968 (E), 8♂ A; July 31-Aug. 5, 1968 (E), 3♂ A; Aug. 6-12, 1968 (E), 5♂ A; Aug. 13-17, 1968 (E), 1♂ A; Oct. 11-21, 1968 (E), 1♂ A. Stream 4.5 mi. off Marys Pk. Rd. on Rd. #1296 to Harlan, 54°F., 1,200', July 30, 1968, emgd. Aug. 12, 1968 (W), 1♂ M. Feeder Crk. N. Fk. Alsea Riv., nr. Fish Hatchery, Aug. 20, 1967 (A), 1♂ M. Roadside stream, 2.5 mi. S. on Five Rivers Rd., 20 mi. W. Alsea on Hwy. 34, July 7, 1968 (E), 1♂ M. 8 mi. w. Glenbrook, S. Fk. Alsea Riv., May 31, 1970 (A), 1♂ M. Rock Crk., 6 mi. w. Philomath, June 15, 1951 (V. Roth), 1♂ A. Rock Crk. at Rt. 34, Philomath, June 16, 1968 (GW, Y, S), 1♂ M. Clackamas Co: Oak Grove Fk. Clackamas Riv., bridge at Lk. Harrietta Rd. Jct., Aug. 9, 1968 (E), 2♂ A. Clatsop Co: Humbug Crk., July 21, 1948 (J), 1♂ A. Big Crk., Aug. 1, 1949 (J), 2♂ A; July 4, 1949 (J), 2♂ A. Curry Co: Hooskanden Crk. at Hwy. 101, Sept. 29, 1965 (H. B. Leach), 1♂ M. Creek, ca. 8 mi. above mouth Rogue Riv., June 19, 1949 (J), 1♂ A. Lane Co: Lookout Crk.,

H. J. Andrews Exp. For., 8 mi. from Blue Riv., 600 m., Aug. 13, 1971 (A), 1♂ A; Aug. 28, 1972 (A), 1♂ A. Libby Crk., June 11, 1966 (M. Schultus), 1♂ M. Lincoln Co: Deer Crk., June 23, 1967 (A), 1♂ M. Linn Co: Small str., 63°F., 12 mi. e. Green Peter Dam on Quartzville Rd., 1340', July 24, 1968 (W), 1♂ M. 1 mi. w. Roaring Riv. Fish Hatchery, Sept. 5, 1968 (E), 11♂ A. Marion Co: Niagara, Sept. 21, 1968 (E), 3♂ A. Tillamook Co: Castle Rock Park, Three Rivers, Aug. 8, 1966 (W), 2♂ M. Farmer Crk., 2 mi. n. Hebo, July 23, 1966 (A), 2♂ M. 15 mi. e. Beaver, Nestucca Riv., July 24, 1966 (A), 1♂ M.

Biology: Mature pupae of vedra have been collected from late May through August and in October. The adults occur from May through October.

Rhyacophila vedra was the most common of the 11 species of Rhyacophila occurring in the emergence traps (18 females and seven males) from Oak Creek, Benton Co., Oregon (Anderson and Wold, 1972). They emerged from the end of May through October. Of the two traps in which this species occurred, emergence averaged later in the upstream site for all three years. Mean spot readings from April to October were 11.4°C at the higher elevation trap and 12.2°C at the lower trap. One could speculate that time of emergence is temperature dependent for this species.

The flight period of vedra males at Berry Creek, near Corvallis,

Oregon, was from late May to October. They occurred continuously in black light collections from June 21 to Aug. 17 (60 specimens), with one additional specimen taken in mid-October.

Rhyacophila willametta Ross

Rhyacophila willametta Ross, 1950a:261; Ross, 1956:102, 121; Schmid, 1970:68, 126; Anderson and Wold, 1972:192-3.

Type Locality: Salt Crk. Falls, Willamette Pass, Oregon, Aug. 7, 1948 (Kenneth M. Fender).

Larva: See discussion under group heading and also see description of vaccua.

Distribution: This species occurs in the Coast, Cascade, and Siskiyou Mountains in Oregon and in the Olympic Mountains in Washington.

Material Examined: OREGON: Benton Co: 1 1/2 mi. off Marys Pk. Rd. on Rd. #1296, Parker Crk., u. v. l., Aug. 7, 1968 (E), 1♂ A. Temporary stream on Marys Pk. Rd. below Parker Falls (stream dry where collected, but pupa was still alive), Sept. 12, 1968 (W), 1♂ M. Alder Crk., Marys Pk. Rd., July 23, 1966 (L), 1♂ M. Oak Crk., site #1, 700', July 16-23, 1968 (K), 1♂ A; July 30-Aug. 6, 1968 (K), 1♂ A; Aug. 14-20, 1968 (K), 1♀ A; Aug. 27-Sept. 3, 1968 (K), 1♀ A, 1♂ A; April 25-28, 1969 (W), 1♂ A; Sept. 8-15, 1969 (W), 2♀ A; Sept. 30-Oct. 4, 1969 (W), 1♀ A; Aug. 29-Sept. 4, 1970 (W), 4♂ A;

Sept. 4-8, 1970 (W), 1♀ A. Lane Co: 4 mi. S. McKenzie Bridge, Horse Crk., June 30, 1966 (W), 1♂ M. Small stream ca. 1 mi. W. Blue River, July 17, 1970 (W & E), 1♂ M. Scott Crk. on Hwy. 126, Clear Lk. cutoff, July 17, 1970 (W & E), 1♂ A. Watershed 10, H. J. Andrews Exp. For., 6 mi. from Blue Riv., 500 m., Aug. 31, 1972 (A), 1♂ A. WASHINGTON: Clallam Co: Stream n.w. Soleduck Hot Springs, July 22, 1969 (WW), 1♂ A.

Biology: Pupae occurred in June, July, and September and the adults in late April and from July to October. This was one of the more commonly collected Rhyacophila (6♀ and 8♂) in a study of emergence at Oak Creek, near Corvallis, Oregon (Anderson and Wold, 1972). It occurred only at the upstream trap (700') where the temperature range over the year was narrower. The average temperature from April to October, taken from spot readings, was 10.6°C.

13. Verrula Group

Rhyacophila verrula Milne was the only species placed in this group by Ross (1956) and Schmid (1970). Denning and Schmid (1971) describe a new species, Rhyacophila potteri Denning, that they place in this group. The larva of verrula was associated by Smith (1968) and is the only known phytophagous species of Rhyacophila. Schmid (1970) stated that the adult of verrula was very peculiar for the genus

and could not be given a precise placement in his phylogeny. The mandibles, shape of the head, and baso-ventral hooks of the larva of verrula are also quite different from other larvae of this genus.

Rhyacophila potteri Denning

Rhyacophila potteri Denning (& Schmid), 1971:1556.

Type Locality: Swamp Creek, Elk Summit Road, Idaho Co., Idaho, Aug. 3, 1969 (D. S. Potter).

Larva: Unknown.

Distribution: Only one male, the type, has been collected.

Biology: Unknown.

Rhyacophila verrula Milne

(Figures 56, 57, 58)

Rhyacophila verrula Milne, 1936:90, 111; Knowlton and Harmston, 1938:286; Ross, 1944:291; Davis, 1948:28-9; Denning, 1948a: 22-3; Denning, 1948b:102; Schmid and Guppy, 1951:41; Ross and Spencer, 1952:45; Ross, 1956:108, 122; Schmid, 1958:12; Denning, 1963:245; Smith, 1968:671-3; Thut, 1969:894-8; Schmid, 1970:65, 126; Nimmo, 1971:17, 19, 34-5.

Type Locality: Cultus Lk., B. C., Aug. 24, 1934 (W. E. Ricker).

Rhyacophila oregonensis Ling, 1938:62; Ross, 1944:291 (synonymy).

Larva: Smith (1968) described the larva of verruca:

Head nearly spherical (Figure 56); long setae around eye, on anterior and lateral margins of frontoclypeus, and posteriorly above genae; color brown, with several nearly uniform rows of darkened muscle scars; frontoclypeus short, extending little more than half way to hind margin of head; maxillary palpus extremely short, all segments subequal; left mandible chisel-like, pyramiform, with three short apical teeth, right mandible chisel-like, pyramiform, with two short apical teeth and a single small mesal tooth which has a clump of setae at its base (Figure 57). Pronotum light brown, with darkened muscle scars; long scabrous setae along front and lateral margins; forelegs broadened. Abdomen without gills or fleshy protuberances. Anal proleg short with long scabrous setae, two baso-ventral hooks, the posterior one a separate sclerite with a short spine-like seta, no apicolateral spur, and anal claw with one large ventral tooth on basal portion, no teeth on apical portion (Figure 58). Length of mature larvae approximately 20 mm.

Distribution: This species has been recorded from Alaska, Alberta, British Columbia (including Vancouver Island), California, Colorado, Idaho, Montana, Oregon, Utah, Washington, and Wyoming.

Material Examined: ALBERTA: Little Red Doe Riv. at For. Trunk Rd., July 26, 1963 (A. Nimmo), 1L (5). Roadside spring on Rd. to Sundance Cyn., Banff, June 22, 1962 (GW), 1L (5). Stream crossing Rd. 1A, 9.2 mi. s. Johnston Cyn. Cpgrd., Banff Nat. Pk., July 29-31, 1969 (R), 18L (4, 5). BRITISH COLUMBIA: Coldspring Cpgrd., E. C. Manning Prov. Pk., July 6, 1969 (R), 1L (5). Large stream in Coldspring Cpgrd., E. C. Manning Prov. Park, July 9, 1969 (R), 2L (5). Small rapid str. in E. C. Manning Prov. Pk., 1.2 mi. w. Allison Summit Pass, 4400', July 6, 1969 (R), 1L (5). Str.

nr. Mt. Wardle on Hwy. 93, Kootenay Nat. Pk., June 23, 1962 (GW), 1L (5). Stream crossing T. C. Hwy., 4.1 mi. e. western boundary Glacier Nat. Pk., 3330', July 26, 1969 (R), 1L (5). Stream crossing T. C. Hwy., ca. 12.1 mi. e. western boundary Glacier Nat. Pk., July 26, 1969 (R), 11L (4 or 5). 10 mi. s. Moyie, June 26, 1967 (WW), 1L (5). 3 mi. w. east entrance Revelstoke Nat. Pk., June 30, 1967, emgd. Sept. 15, 1967 (WW), 1♀ A. Stream nr. s. end Cultus Lk., June 19, 1969 (R), 1L (5). Goldwater Riv., at Goldwater Cpgrd., Victoria, Vancouver Island, June 27-8, 1969 (R), 1PP. CALIFORNIA: Mariposa Co: 7ene Fish Camp, 1000', July 11, 1946 (H. P. Chandler), 1L (5). Nevada Co: Springs (upper) nr. source Sagehen Crk., 8 mi. n. Truckee, 7900', July 20, 1966 (GW), 1L (5). Shasta Co: Mt. Lassen Nat. For., in spring area, Hwy. 89, 4500', June 19, 1967 (E), 1L (5). Shasta, Hwy. 5, June 18, 1967 (E), 2L (5). Hat Crk. at Big Springs, W. Old Station, Oct. 4, 1966 (GW, Y, O), 1L (5). Hat Crk., source, Lassen Volcanic Nat. Pk., June 19, 1967 (Y), 1L (5). Siskiyou Co: Hwy. 99, Mt. Shasta City Park, headwaters Sacramento River, 3500', June 18, 1967 (E), 3L (5). Bear Crk., W. of Bartle, 3.2 mi. W. Shasta County line, 4200', June 18, 1967 (E), 1L (5). Tehama Co: Spring run in Gurnsey Crk. Cpgrd., Rt. 89, S. Childs Meadows, June 19, 1967 (Y), 1L (5). IDAHO: Idaho Co: Holly Crk. at Rt. 12, N. E. Lowell, June 24, 1968 (GW, Y, S), 1L (5). MONTANA: Flathead Co: Glacier Nat. Pk., Park Crk.,

July 14, 1969 (J. M. Stauffer), 17L (5). Lake Co: Small stream, Yellow Bay Pk., Flathead Lake, July 9, 1965 (D. L. Lehmkuhl). 1L (5). Missoula Co: Spring runs crossing Rt. 12 at Lolo Pass, June 24, 1968 (GW, Y, S), 2L (4, 5). Spring runs crossing Rt. 12 at Lolo Pass, 5187', June 25, 1968 (GW, Y, S), 4L (4, 5). Ravalli Co: Stream crossing Rt. 93, 1.2 mi. N. Lost Trail Pass, June 26, 1968 (GW, Y, S), 4L (4th or 5th). OREGON: Benton Co: Marys Peak: Stream at Jct. old Hwy. 34 and Marys Pk. Rd., Feb. 9, 1970 (W), 1L (5). Stream ca. 3 mi. off Hwy. 34 on Marys Pk. Rd., Mar. 23, 1968 (WW), 3L (4, 5). Temporary stream below Parker Crk., 7.1 mi. from end pavement (old Hwy. 34) on Marys Pk. Rd., ca. 2900', Aug. 7, 1968 (E), 3PP; 47°F., May 7, 1969 (W), 1L (5), 2PP; Sept. 12, 1968 (W), 1♂ M, 2♀ M. Parker Crk., May 12, 1967 (E), 4L (4, 5). Parker Crk. Falls, Mar. 12, 1963 (A), 6L (4, 5); July 27, 1966 (W & L), 1L (5); May 12, 1966 (W), 1L (5). Parker Crk., nr. cpgrd. at top Marys Pk., June 14, 1968 (W), 1L (5). Small spring at Jct. of Marys Pk. Rd. & rd. #1296, 2500', 46°F, May 7, 1969 (W), 1PP. 6/10 mi. off Marys Pk. Rd. on Rd. #1296, 2440', 48°F, May 7, 1969 (W), 1L (5). Stream 1 mi. off Marys Pk. Rd. on Rd. #1296, June 16, 1968 (WW), 1PP. Stream 1.5 mi. off Marys Pk. Rd. on Rd. #1296, July 2, 1968 (W), 1L (4). Chintimini Crk., on Rd. #1243, July 16, 1970 (W & T), 1PP. Chintimini Crk., 2300', June 21, 1963 (A), 1PP. N. Fk. Rock Crk., Apr. 13, 1964 (GW & Sc), 2L (5).

Other Areas of Co: Oak Crk., site #3, 500', Sept. 28, 1970 (W), 1♀ A, 1♂ A; Mar. 19-23, 1969 (A), 1L (3). Oak Crk., 1.2 mi. n.w. OSU Fisheries Lab, April 13, 1968 (Jean & Jerry Davidson), 1L (5). Stream 7.9 mi. W. Alpine, Jan. 1, 1968 (WW), 1L (5). 7 mi. E. Alsea, Alder Crk., April 4, 1964 (GW & Sc), 1L (5). Clackamas Co: Mt. Hood: Stream crossing rd. to Timberline Lodge, nr. Gov't. Camp, April 20, 1964 (GW & Sc), 1P; April 18, 1964 (GW & Sc), 4PP; Sept. 28-9, (GW, Y, O), 4L (5); June 12, 1967 (Y), 28L (4, 5); June 20, 1968 (GW, Y, S), 1L (5); April 19, 1964 (GW & Sc) 1L (5). 1 mi. up Rd. to Timberline Lodge, 45°F., June 12, 1969, (W), 42L (3, 4, 5). Second stream crossing rd. above Government Camp, April 5, 1964 (GW & Sc), 9L (5), 1PP. Spring stream 3.3 mi. below Timberline Lodge, July 13, 1963 (GW), 2L (5); July 17, 1963 (GW), 1L (5). Still Crk. For. Camp, June 10-11, 1967 (Y), 1L (5). Deschutes Co: Fall River, June 7, 1949 (Wm. Morton), 1L (5). Satan Crk., nr. Devils Cpgrd., Hwy. 46, Century Drive, July 9, 1969 (W), 7L (5). Cultus River, 58°F, on Rd. #2019 to Cow Camp, Century Drive Area, July 8, 1969 (W), 2L (5). Quinn River nr. Crane Prairie Reservoir, July 8, 1969 (W), 9L (4, 5), 1♂ M. Douglas Co: N. Umpqua River, Velsey Valley, Sept. 6, 1962 (Schuh), 1♂ A Alkali Creek, 24 mi. n. Pro, 1L (5). Hood River Co: N. Fk. Iron Crk., nr. Bennett Pass, Mt. Hood, 4400', June 13, 1967 (Y), 1L (5); 41°F, July 11, 1968 (A), 2L (5); Sept. 29, 1966 (GW, Y, O), 9L (5), 2PP; June 11, 1967 (Y),

12L (5). Josephine Co: Lake Crk., 1.2 mi. below Oreg. Caves Nat. Mon., 3650', Aug. 5, 1967 (WW), 1PP. Klamath Co: Crater Lk. Nat. Pk., Annie Crk., Oct. 1, 1966 (GW, Y, O), 12L (4, 5); June 9, 1968 (Y & S), 24L (3, 4, 5). Long Crk., 12 mi. n. e. Bly, 5200', Sept. 24, 1967 (E & J. Schuh), 1♂ A. Lane Co: Mack Crk., Andrews Exper. For. nr. Blue River, July 30, 1970 (A), 1PP; Sept. 14, 1971 (A), 2♂ A, 1♀ A; Sept. 24, 1971 (A), 2♂ A, 1♀ A; Oct. 2, 1971 (A), 1♂ A. Linn Co: Small trib. Snow Crk. at Rt. 20, Willamette Natl. Forest, June 1, 1968 (Y & S), 2L (5), 1PP. N. Fk. Santiam River, Parrish Lake Rd., Sept. 5, 1968 (E), 1♀ A, 1♂ A. Snow Crk., 10 mi. E. Upper Soda, on moss in stream, May 26, 1967 (E), 7L (4, 5). Ollalie Crk. at Ollalie Crk. For. Camp, Rt. 126, July 17, 1970 (E & W), 1L (5), 2♂ A. Downing Crk., Hwy. 22, S. of Marion Fks., Sept. 20, 1968 (E), 1♂ A. 5.8 mi. n.w. Quartzville Rd. on Yellowstone Rd., n. of Green Peter Reservoir, Aug. 6, 1970 (W & A), 1PP. Small run crossing Quartzville Rd., ca. 1.6 mi. e. Yellowstone Guard Sta., June 16, 1968 (GW, Y, S), 4L (5).

Marion Co: Niagara, N. Fk. Santiam River, Oct. 26, 1968 (E) 1♂ A.

Umatilla Co: 5 mi. W. Tollgate, 4000', July 11, 1964 (A), 2L (5). 6 mi. E. Tollgate, July 12, 1964 (A), 1L (5). Union Co: 6 mi. N. W. Elgin, Phillips Crk., 4000', July 9, 1968 (A), 2PP. Wallowa Co: Lostine River, 17 mi. S. Lostine, July 12, 1964 (A), 3L (5). Small picnic area stream, Wallowa Lake State Pk., May 30, 1970 (E & T),

10L (5). Feeder Crk. to Hurricane Crk., nr. Joseph, July 25, 1967 (A), 1L (head broken). UTAH: Cache Co: Spring runs crossing Rt. 89, ca. 24 mi. S.W. Garden City, May 28, 1968 (Y & S), 3L (5), 3PP. WASHINGTON: Chelan Co: Creek 13.3 mi. E. Stevens Pass Ski Area, July 24, 1969 (WW), 2L (5). Cowlitz Co: Kalama Riv. drainage, Weyerhaeuser Artificial Streams, 3 mi. N. Lk. Merrill, June 18, 1968 (A), 1♂ A. Creek in Kalama Riv. drainage, 3 mi. N. Lk. Merrill, June 18, 1968 (A), 1L (5). Jefferson Co: Hoh Riv. at Hoh Riv. Cpgrd., Olympic Nat. Pk., June 30-July 1, 1969 (R), 1L (5), 2PP. King Co: Small run on detour Rt. 2, just w. Stevens Pass, 4000', June 17, 1969 (R), 7L (5). Creek 1.2 mi. w. Stevens Pass Ski Area on old Hwy., July 24, 1969 (WW), 1L (5). Creek 5.8 mi. w. Stevens Pass Ski Area on old Hwy., July 24, 1969 (WW), 1L (5). Lewis Co: Fall Crk. nr. Stevens Canyon entrance to Mt. Rainier Nat. Pk., 2225', July 25, 1965 (WW), 1L (5). 1.8 mi. E. Stevens Crk. Bridge on Stevens Cyn. Rd., Mt. Rainier Nat. Pk., July 25, 1969 (WW), 1PP. Small streams just N. Ohanapecosh entrance, Mt. Rainier Natl. Pk., June 16, 1969 (R), 1L (5). Pierce Co: Longmire, Mt. Rainier Nat. Pk., seepage streams crossing Westside Rd., 2500', June 13, 1969 (R), 2L (5), 3 PP. Small trickles on rock cut on Rte. 410, 1.6 mi. S. Crystal Mt. Rd., Mt. Rainier Nat. Pk., June 16, 1969 (R), 2L (5). Creek 6.5 mi. w. Sunrise Jct. & Hwy. 410, Mt. Rainier Nat. Pk., July 25, 1969 (WW), 5L (5). Creek 2 mi.

s.w. Mt. Rainier Nat. Pk. entrance on Chinook Pass Rd., July 25, 1969 (WW), 1L (5). Whatcom Co: Falls Crk., trib. of Glacier Crk., 2000', June 22, 1966 (WWSC), 7L (5). Swamp Crk., 3400', June 25, 1966 (WWSC), 4L (4, 5). Wallace Crk., trib. Middle Fk. Nooksack Riv., 1900', July 13, 1966 (WWSC), 2L (5). Yakima Co: Very small trickles crossing rd. N. 84.1, 12.3 mi. N. Trout Lk., June 11, 1969 (R), 2L (5). Small seep crossing rd., 12.4 mi. N. Trout Lk. on rd. n. 84.1, June 11, 1969 (R), 1L (5). Wyoming: Cub Crk. nr. Sylvan Lk., Yellowstone Nat. Pk., July 8, 1967 (D. M. Lehmkuhl), 1L (5). Teton Co: Small stream crossing Rt. 33, 3/10 mi. E. Teton Pass, June 2, 1969 (R), 1L (5). Stream crossing Rt. 33, 4.8 mi. N.W. Teton Pass, June 27, 1968 (GW, Y, S), 6L (4, 5).

Biology: Smith (1968) reported peak emergence of this species during September and October in the Salmon River drainage in Idaho. Nimmo (1971) found the flight season in Alberta, at 3500 to 4000 feet elevation, to extend from August 20 to October 12.

Smith (1968) thought verrula overwintered as eggs or early instars. He also noted an overlapping of generations in a spring where temperature remained fairly constant throughout the year. The larval guts examined by Smith (1968) contained the green alga, Prasiola, watercress, and other unidentifiable plant matter.

Thut (1969) reported R. verrula as being the most common of seven species of Rhyacophila in his experimental streams, with a

density of up to $1097/\text{m}^2$. Due to its abundance and large size it made a considerable contribution to the biomass of the streams. The larvae were most common at the more rapid current velocities, from 1.4 to 1.75 ft. /sec. All of the instars were collected at nearly every sampling date. The adults were most abundant during spring and autumn but were collected nearly all year. Thut (1969) also found all plant material, with the exception of one animal fragment, in the guts of verruca larvae. Thut (1969) reported that the succession of plants in the diet followed the seasonal pattern of succession of these plants in the streams. During spring, summer, and autumn an assortment of filamentous algae (especially Tribonema bombycina Agardh, Vaucheria sp., and Zygnema sp.) dominated the diet, while during the winter months mosses were the most common component of the diet. Since the larvae of verruca were most common during the winter months, the mosses constituted the greatest part of the diet of the larvae of this species. Diatoms were also more abundant in winter and early spring, making up 20% of the diet. These diatoms were more common in the guts of fourth and fifth instars than in the earlier instars.

Larval head capsule lengths were (in mm.): III, .74 to .86 (3 larvae); IV, 1.00 to 1.24 (37 larvae); and V, 1.42 to 1.74 (358 larvae). Third instars were collected in late March and June, fourth instars in March, May, June, July, and early October, and

fifth instars occurred nearly all year, from January through September. Pupae were collected from April through September and adults from June through October.

DIVARICATA DIVISION

This division is composed of the nigrocephala branch and the acropedes branch. The nigrocephala branch, in western North America, includes only the ecosa group and the single species Rhyacophila ecosa Ross. The larva described as "species one," under the isolated species, is probably the larva of ecosa. This larva has an extremely elongate head and is without gills. The acropedes branch includes the vemna group and the acropedes group. The acropedes group larvae have branching gills. There have not been any larval associations in the vemna group.

Nigrocephala Branch

14. Ecosa Group

The ecosa group of Ross (1956) and of Schmid (1970) contains only Rhyacophila ecosa Ross, which occurs in the Coast and Cascade Ranges from northern California through Washington. Ross (1956) placed the ecosa group in his branch one. Metamorphotypes are not available for this species. The larva described as "species one" under the isolated species is probably the larva of ecosa, on the basis of relationships with other larvae in the nigrocephala branch and on the basis of its distribution records. This larva has an extremely elongate head, unique mandibles, and does not have gills, fleshy lateral protuberances, or an apicolateral spur.

Rhyacophila ecosia Ross

Rhyacophila ecosia Ross, 1941:37; Ross, 1956:77, 116; Schmid, 1970:70, 127; Anderson and Wold, 1972:192-3.

Type Locality: Near creek, Boyer, Oregon, May 6, 1934 (M. L. H.).

Larva: The larva described as "species one" under the isolated species may be the larva of this species.

Distribution: This species occurs in the Coast and Cascade Ranges in Oregon, Washington, and California.

Material Examined: OREGON: Benton Co: Oak Crk., site #1, 700', July 30-Aug. 6, 1968 (K), 2♂ A; May 7-10, 1969 (W), 1♂ A. Marys Pk., Parker Crk. Falls, July 19, 1963 (GW), 2♂ A. Clackamas Co: Still Crk. nr. Swim, July 12, 1948 (J), 1♂ A. Spring str. 3.3 mi. below Timberline Lodge, July 16, 1963 (GW), 1♂ A. Curry Co: Crk. about 8 mi. above mouth Rogue Riv., June 19, 1949 (J), 1♂ A. Lane Co: Watershed 10, H. J. Andrews Exper. For., 6 mi. n. e. Blue River, 500 m, June 22, 1972 (A), 1♂ A. Lincoln Co: 10 mi. S. Toledo, July 1, 1964 (A), 1♂ A. WASHINGTON: Pierce Co: Small trickles on rock cut, 1.6 mi. s. Crystal Mtn. Rd. on Rt. 410, Mt. Rainier Nat. Pk., June 16, 1969 (R), 8♂ A.

Biology: The adults of this species occurred during May, June, and July.

Acropedes Branch

The acropedes branch (Schmid, 1970) contains the vemna group and the acropedes group. Larvae of species in the acropedes branch have been associated. These larvae have branched gills on the abdomen. Larvae have not been associated for any of the species in the vemna group. The acropedes branch of Schmid is the same as the acropedes group used by Ross (1956).

15. Vemna Group

The vemna group includes Rhyacophila gemona Ross, R. robusta Schmid, and R. vemna Milne (Schmid, 1970). The larvae have not been associated for any of these species due to a lack of metamorphotypes. However, in a collection including an adult male of R. vemna on Mt. Hood, the larvae that were collected are larger than those of acropedes but exhibit the same gill pattern. These are quite possibly the larvae of R. vemna.

Rhyacophila gemona Ross

Rhyacophila gemona Ross, 1938a: 117; Davis, 1948:32; Ross, 1956:

83, 117; Schmid, 1970:86, 131.

Type Locality: Razorhone Crk., Mt. Baker, Washington,
July 21, 1936 (H. H. Ross).

Larva: Unknown.

Distribution: This species has been collected in the Cascades in Washington.

Material Examined: None.

Biology: Unknown.

Rhyacophila robusta Schmid

Rhyacophila robusta Schmid, 1970:205.

Type Locality: Kitchener, Kootenay District, British Columbia, May 19, 1965, 4000' (F. Schmid).

Larva: Unknown.

Distribution: Alberta and British Columbia.

Material Examined: None.

Biology: Unknown.

Rhyacophila vemna Milne

Rhyacophila vemna Milne, 1936:92, 102, 111; Ross, 1944:291; Davis, 1948a:42; Denning, 1948b:105-6; Ross, 1956:83, 117; Smith, 1965:243; Schmid, 1970:86, 131; Nimmo, 1971:17, 19, 24.

Type Locality: White River, Mt. Rainier, Washington, May 12, 1934 (W. E. Ricker).

Larva: Unknown.

Distribution: Alberta, Idaho, Washington, and Oregon.

Material Examined: OREGON: Clackamas Co: Mt. Hood, str. crossing rd. 3.3 mi. below Timberline Lodge, June 8, 1969 (R), 3♂ A.

WASHINGTON: Pierce Co: Small str. 12.1 mi. e. Longmire on Rt. 706, Mt. Rainier Nat. Pk., July 4, 1969 (R), 1♂ A.

Biology: Nimmo (1971) recorded the flight season from May 17 to July 7 in Alberta.

16. Acropedes Group

The acropedes group of Schmid (1970) can be subdivided into the acropedes subgroup, with one pair of branching gills on the first segment of the abdomen, two pair on segment eight, and three pair on segments two through seven, and the grandis subgroup with one pair of branching gills on the first and eighth segments, and two pair on segments two through seven. The former subgroup includes Rhyacophila acropedes Banks, R. brunnea Banks, R. inculta Ross and Spencer, R. vao Milne, and R. wallowa Denning. The grandis subgroup includes Rhyacophila grandis Banks, R. neograndis Denning, and R. sequoia Denning.

Acropedes Subgroup

Metamorphotypes are available for R. acropedes, inculta, vao, and wallowa. The larvae (Figure 5) of these four species, as described under acropedes, cannot be separated so they are listed together. Complete records of the over 1,900 larvae and pupae examined are not included as they would be too lengthy. Only the states and counties from which they were collected are listed.

Material Examined:

California:	El Dorado
	Inyo
	Los Angeles
	Modoc
	Mono
	Nevada
	Plumas
	Shasta
	Sierra
	Tehama
	Tuolumne
	Yuba
Colorado:	Routt
Idaho:	Boise
	Bonneville
	Custer
	Idaho
	Kootenai
	Lemhi
	Shoshone
Minnesota:	Carlton

Montana:	Deer Lodge
	Flathead
	Glacier
	Lake
	Mineral
	Missoula
Nevada:	Humboldt
New Hampshire:	at Mt. Washington
Oregon:	Benton
	Clackamas
	Clatsop
	Curry
	Deschutes
	Douglas
	Grant
	Hood River
	Jefferson
	Josephine
	Klamath
	Lake
	Lane
	Lincoln
	Linn

Oregon:

Marion

Multnomah

Polk

Tillamook

Union

Wallowa

Wheeler

Utah:

Cache

Daggett

Salt Lake

Washington:

Jefferson

King

Lewis

Pierce

Skagit

Whatcom

Yakima

Wyoming:

Albany

Carbon

Teton

Yellowstone Nat. Park

Rhyacophila acropedes Banks

(Figures 59, 60, 61, 62, 63)

Rhyacophila acropedes Banks, 1914:201; Milne, 1936:93, 102; Ross, 1938:4; Ross, 1941b:36; Davis, 1948:35-6; Denning, 1948b:97; Ross, 1956:75, 83-4, 117; Flint, 1962:479-80; Anderson, 1967:508, 517-8; Smith, 1968:658-60; Schmid, 1970:87, 131.

Type Locality: Deer Crk., Provo Canyon, Utah, Aug. 21

(Spalding).

Larva: The larva of acropedes was described by Flint (1962) and redescribed by Smith (1968). Flint (1962) described it as follows:

Length, 21 mm. Head, yellow brown, with darker muscle scars; paler on posterior quarter, this area sharply set off from darker anterior portion (Figure 59); posterior half of frontoclypeus darker along sutures; second segment of maxillary palpus twice as long as first; left mandible with two apical teeth, right with two apical teeth and a larger mesal tooth (Figure 61). Thorax, pronotum yellow brown, slightly darker anteriorly; muscle scars slightly darker posteriorly; fore femora much broadened. Abdomen, clusters of branching gills present laterally on segments 1-8; first segment with 1 pair, eighth segment with two pairs, 2-7 with three pairs; each cluster with 12-15 filaments (Figures 59, 63). Anal prolegs with a basoventral hook; claw with 1 large and one small ventral tooth (Figure 62).

Smith (1968) and I have been unable to find any characters which will separate the larvae of acropedes from those of wallowa, inculta, and vao.

Distribution: This species is one of the two Rhyacophila species

Cultus Riv. on Rd. #2019 to Cow Camp, Century Drive area, 58°F,
 July 8, 1969 (W), 1♂ M. Douglas Co: Muir Crk. Cpgrd., Rogue Riv.
 Nat. For., u. v. l., July 2, 1961 (GW), 4♂ A. Jackson Co: Rogue
 Riv. at Foster Crk., June 17, 1949 (J), 1♂ A. Jefferson Co: Camp
 Sherman, Metolius Riv., June 6, 1964 (J), 1♂ M, 22 ♂ A; May 10,
 1969 (Steve Miller), 1♂ M. Metolius Riv. 1/2 mi. S. Camp Sherman,
 under bridge, Aug. 13, 1966 (A), 2♂ A. Metolius Riv., ca. 1 mi.
 above Camp Sherman, Aug. 21, 1969 (K), 2♂ A. Metolius Riv.,
 Pioneer Crossing For. Camp, Aug. 24, 1966 (W), 1♂ A. Riverside
 F.C., ca. 1 mi. S. Camp Sherman, April 30, 1965 (A), 1♂ M; April
 30, 1966 (A), 8♂ A; Aug. 24, 1967 (A), 1♂ A; Aug. 11-12, 1966 (A),
 1♂ A; June 15, 1966 (A), 8♂ A; Sept. 18, 1967 (W), 15♂ A; Aug. 11,
 1966 (A), 2♂ A; Aug. 24, 1967 (W), 1♂ M; May 1, 1965 (A), 1♂ M;
 May 21, 1964 (A), 7♂ A; Sept. 19-23, 1966 (GW, Y, O), 16♂ A. Lake
 Crk., nr. Camp Sherman, June 6, 1964 (J), 20♂ A. Klamath Co:
 Spring Crk., Collier Mem. St. Pk., April 14, 1967 (E), 1♂ A.
Lane Co: Rt. 126, Turner Crk. Rec. Area, June 23, 1966 (W), 1♂ M.
 Lookout Crk., H. J. Andrews Exp. For., 8 mi. from Blue River,
 600 m., July 27, 1972 (A), 1♂ A. Linn Co: Stream nr. bridge at end
 of rd. on S. side Green Peter Reservoir, ca. 14 mi. from Dam,
 July 4, 1969 (W), 1♂ M. Tombstone Prairie, July 7, 1966 (W), 2♂ M.
 Hwy. 126, sm. str. n. of Trail Bridge and Smith Riv. Reservoir's
 Rd., July 2, 1969 (W), 1♂ A. Jct. Crabtree Crk. and Roaring Riv.,

April 11, 1970 (T), 25♂ A. Ollalie Crk. at Ollalie Crk. F.C., Rt. 126, July 17, 1970 (W & E), 2♂ A; June 30, 1968 (W), 1♂ A; July 2, 1969 (W), 5♂ A. 8.5 mi. S. Marion Fks., Parrish Lk. Rd., July 25, 1968 (E), 2♂ A. Parrish Crk. Rd., s. of Marion Fks., Hwy. 20, N. Fk. Santiam Riv., July 20, 1968 (E), 4♂ A. Marion Co: Niagara, Aug. 21, 1968 (E), 3♂ A. Wallowa Co: Wallowa Riv, above Wallowa Lk., July 26, 1967 (A), 2♂ M, 2♂ A. Near Joseph, July 23, 1970 (E), 1♂ M. Wallowa Riv., Joseph, Immigration cutoff, 66°F, July 26, 1967 (A), 1♂ M. WYOMING: Yellowstone Nat. Pk., Gardner Riv. at Indian Crk. Cpgrd., July 12, 1961 (GW), 1♂ M.

Biology: Smith (1968) stated that in Idaho acropedes overwintered as third or fourth instars, pupation occurred in late May and June, and adults occurred from late July to early August. Nimmo (1970) gave the flight season in Alberta at an altitudinal range from 2,500 to 7,000 feet from July 1 to August 22, with one record in British Columbia from May. From my records, pupae were collected from late April to late July and adults occurred from mid-April until mid-September.

Rhyacophila brunnea Banks

Rhyacophila brunnea Banks, 1911:352-3; Milne, 1936:93, 105; Ross, 1938c:5; Davis, 1948:33-4; Denning, 1948b:98; Schmid, 1970: 87, 131.

Type Locality: Beulah, N. Mex., July 10 (Cockerell).

Larva: Unknown, but probably very similar to R. acropedes, inculta, vao, and wallowa.

Comment: Ross and Spencer (1952) noted in the description of inculta that it had previously been referred to as brunnea Banks. They concluded that (1952:44):

The holotype of brunnea is a female from New Mexico and according to our present knowledge of the distribution of this group it is highly likely that it applies to acropedes Banks, which might, therefore, ultimately prove to be a synonym of brunnea. Rather than make this change, it seems better to await material from the type locality before making a decision as to the exact placement of brunnea. The Cascade species which has been recorded under the name brunnea is the species here described as inculta. It is a sister species of vao Milne and acropedes, differing from the former in the long projection of the ninth tergite, and from the latter by the more robust, deeper claspers. There is still some uncertainty as to the ultimate distinction between the Cascade species inculta and the more eastern acropedes. It is noteworthy, however, that inculta and vao occupy the same range, and are readily separated. Whatever the problem it seems certain that its analysis will be furthered by the retention of the species concept of inculta.

Distribution: British Columbia, California, New Mexico, Washington, and Wyoming.

Material Examined: None.

Biology: Unknown.

Rhyacophila inculta Ross and Spencer

Rhyacophila inculta Ross and Spencer, 1952:43-4; Ross, 1956:83-4,

117; Schmid, 1970:87, 131.

Type Locality: Cultus Lk., July 23, 1936 (H. H. Ross).

Larva: Metamorphotypes of this species have larval sclerites that cannot be distinguished from those of acropedes, vao, and wallowa. See quote listed under brunnea from Ross and Spencer (1952) regarding the relationship between this species and brunnea.

Distribution: British Columbia (including Vancouver Island), California, and Oregon.

Material Examined: CANADA: British Columbia: Cultus Lk., July 1, 1967 (WW), 1♂ M. Goldwater R. at Goldwater Cpgrd., Victoria, Vancouver Island, June 27-8, 1969 (R), 7♂ A. Haney, Univ. B. C. Res. For., str. draining Marion Lk. crossing rd. on E. side of Lk., July 10, 1969 (R), 4♂ A. CALIFORNIA: Madera Co: Boggy Meadows, July 15, 1946 (H. P. Chandler), 2♂ M. Shasta Co: Big Wheels, W. of Viola, Hwy. 44, 3900', May 12, 1968 (E), 5♂ A. Sierra Co: S. Sierraville, Hwy. 89, Tahoe Nat. For., Cottonwood Crk. Camp, 5500', July 9, 1967 (E), 1♂ A. OREGON: Benton Co: 9 mi. N.W. Corvallis, Berry Crk., ultra violet light, July 4, 1968 (E), 2♂ A; July 12-18, 1968 (E), 1♂ A. Clatsop Co: Osweg Crk., ca. 2 mi. E. Elsie, June 13, 1964 (J), 1♂ A. Big Crk., Sept. 8, 1949 (J), 11♂ A. 3 mi. S. Olney, 100 yds. from ft. Youngs River Falls, June 28, 1963 (A), 1♂ A. Lincoln Co: Big Elk For. Camp, 2 mi. E. Harlan, July 5, 1970 (A), 1♂ M. Marion Co: Niagara, Aug. 21, 1968 (E), 1♂ A. Yamhill Co: 14 mi. W. Yamhill, sm. stream,

Aug. 8, 1966 (W), 1♂ M.

Biology: The pupae of this species were collected from early July to early August and the adults from early May to early September.

Rhyacophila vao Milne

Rhyacophila vao Milne, 1936:93; Denning, 1948b:105; Ross & Spencer, 1952:45; Ross, 1956:83-4, 117; Smith, 1965:243; Smith, 1968:670; Schmid, 1970:87, 132; Anderson and Wold, 1972:192-3.

Type Locality: Cultus Lake, B.C., July 8, 1934 (W. E. Ricker).

Rhyacophila vu Milne, 1936:93; Ross, 1944:291 (synonymy).

Larva: Smith (1968) was unable to separate larvae of vao from those of acropedes. He noted that vao has a somewhat lighter head and pronotum than acropedes. It would also appear that the larvae thought to be vao, collected in Oregon, may have a slightly smaller head capsule than do those of acropedes. No other characters have been found for separating larvae of acropedes, inculta, vao, and wallowa.

Distribution: This species has been collected in Alaska, Alberta, British Columbia, Idaho, Oregon, and Washington.

Material Examined: BRITISH COLUMBIA: Cultus Lk., July 1, 1967 (WW), 1♂ M. Clinton, Fish Hatchery on Loon Lk. Rd., Loon Crk., July 12-14, 1969 (R), 2♂ A. Clinton, Fish Hatchery on Loon Lk. Rd., spr. run on xeric slope, July 12, 1969 (R), 1♂ M. IDAHO:

Bonneville Co: Small str. crossing Rt. 31, 1.3 mi. s.w. Pine Crk.

Pass, June 27, 1968 (GW, Y, S), 2♂ M. Idaho Co: Holly Crk. at

Rt. 12 n.e. Lowell, June 24, 1968 (GW, Y, S), 2♂ M. Bonner Co:

Trestle Crk., nr. Hope, Aug. 4, 1951 (W. M. Morton), 5♂ A.

OREGON: Benton Co: Oak Crk., site #3, 500', May 28-June 1, 1970

(W), 1♂ A. Wells Crk., nr. Philomath, Apr. 7, 1964 (GW & Sc),

1♂ M. N. side Marys Pk., Woods Crk., Apr. 4, 1966 (A), 1♂ M.

Berry Crk., 9 mi. n.w. Corvallis, Apr. 13, 1970 (T), 1♂ A.

Clackamas Co: Salmon Riv., Hwy. 35, 2 mi. from Gov't Camp

Jct., 3500', July 11, 1968 (A), 2♂ M. Lost Crk. For. Camp, 2050',

July 17, 1968 (W), 2♂ M. Mt. Hood, Still Crk. For. Camp, July 17,

1963 (GW), 3♂ A; June 21, 1968 (GW, Y, S), 5♂ M. Deschutes Co:

Crk. out of Todd Lk., Todd Lk. Cpgrd., Hwy. 46, July 9, 1969 (W),

3♂ A. Douglas Co: Stream beside Rt. 138, 43.3 mi. e. Idleyld Park,

June 9, 1968 (Y & S), 9 ♂ A. Muir Crk., Rogue Riv. Nat. For.,

July 4, 1964 (GW), 1♂ M. Hood River Co: Oxbow Sprgs., May 19,

1940 (J), 1♂ A. Linn Co: Parrish Lk. Rd., N. Fk. Santiam Riv.,

s. of Marion Fks., Hwy. 20, July 20, 1968 (E), 13♂ A. Parrish Lk.

Rd., 8.5 mi. s. Marion Fks., Hwy. 22, July 25, 1966 (E), 7♂ A;

Aug. 21, 1968 (E), 1♂ A. McKenzie Riv., 3 mi. downstream from

Clear Lk., June 25, 1966, 3♂ P (from rainbow trout gut analysis).

Ollalie Crk. For. Camp, Hwy. 126, June 30, 1966 (W), 1♂ A, 1♀ A

(mating pair). Upper McKenzie Riv., June 6, 1964 (J), 4♂ A.

Breitenbush, n. e. Detroit, July 21, 1957 (J), 5♂ A. Marion Co:
 Niagara, Aug. 21, 1968 (E), 3♂ A. 15 mi. n. w. Elgin, 5000',
 July 9, 1968 (A), 6♂ A, 6♂ M. 6 mi. e. Tollgate, July 12, 1964
 (A), 2♂ A. WASHINGTON: Chelan Co: Creek 3.7 mi. e. Stevens
 Pass Ski Area, July 24, 1969 (WW), 1♂ M. Clallam Co: Creek
 10.7 mi. off Hwy. 101 on Rd. to Olympic Hot Spgs., July 22, 1969
 (WW), 1♂ A. King Co: 5.1 mi. w. Stevens Pass Ski Area on old
 Hwy., July 24, 1969 (WW), 1♂ M. Creek 5.8 mi. w. Stevens Pass
 Ski Area on old Hwy., July 24, 1969 (WW), 1♂ M. Small str. 10 mi.
 w. Stevens Pass on Rt. 2, June 17, 1969 (R), 1♂ M, 2♂ A.

Biology: Smith (1968) found some differences in distribution
 between vao and acropedes in the Salmon River drainage in Idaho.
 He noted that the adults of vao appeared to begin emerging earlier
 than did those of acropedes. He collected the adults during June,
 July and August. My records indicate that the pupae were collected
 in April, June, and July. The adults have been collected from
 April through August.

Rhyacophila wallowa Denning

Rhyacophila wallowa Denning, 1956:73-4; Schmid, 1970:87, 132.

Type Locality: Wallowa Riv., Wallowa County, Oregon, July 15,
 1949 (Grace H. & John L. Sperry).

Larva: Metamorphotypes of this species contain sclerites
 with the same characteristics of those of acropedes, inculta, and vao.

Distribution: This species occurs in California, Oregon, Washington, and Wyoming.

Material Examined: CALIFORNIA: Sierra Co: Hwy. 89, Sagehen Crk. n. of Hobart Mills, 6100', June 27, 1968 (E), 1♂ M. IDAHO: Boise Co: Mores Crk., 7 mi. n. Idaho City, on Rt. 21, Boise Nat. For., July 7, 1961 (GW), 4♂ M. OREGON: Benton Co: Wells Crk., 3♂ A. Yew Crk., 1 mi. W. summit of Coast Range on Hwy. 34, Mar. 20, 1968 (W), 1♂ M. Clatsop Co: Canyon Crk., nr. Indian Beach, Ecola St. Pk., June 25, 1963 (A), 1♂ M. Grant Co: Dans Crk. Rd. nr. Dixie Summit, Hwy. 26, May 31, 1970 (E & T), 2♂ M. Jefferson Co: Riverside F. C., Metolius Riv., June 1, 1966 (A), 1♂ A. Marion Co: Niagara, Aug. 21, 1968 (E), 1♂ A. Wallowa Co: Wallowa Lk. St. Pk., spring area nr. bridge, May 30, 1970 (E & T), 1♂ M. WASHINGTON: Jefferson Co: Spring runs and pools beside rd. nr. Hoh Riv. Cpgrd., Olympic Nat. Pk., June 30, 1969 (R), 1♂ M. WYOMING: Yellowstone Nat. Pk., Gardner Riv. at Indian Crk. Cpgrd., July 12, 1961 (GW), 1♂ M.

Biology: The pupae of this species were collected during March, May, June, and July while the adults were collected from early June until late August.

Grandis Subgroup

This subgroup includes Rhyacophila grandis Banks, R. neo-grandis Denning, and R. sequoia Denning. Metamorphotypes are

available and the larvae have been associated for all three of these species.

Rhyacophila grandis Banks

(Figure 3, 5, 64, 65, 66, 67)

Rhyacophila grandis Banks, 1911:350-1; Milne, 1936:93, 105; Ross, 1938b:5; Davis, 1948:36-7; Schmid & Guppy, 1952:41; Ross & Spencer, 1952:43; Ross, 1956:83-4, 117; Thut, 1969:894-8; Schmid, 1970:87, 131; Anderson and Wold, 1972:192-3.

Type Locality: Bon Accord, British Columbia, June 14 (Russell).

Rhyacophila vohrna Milne, 1936:94; Ross, 1944:291 (synonymy).

Larva: The association of the larva is based on mature male metamorphotypes collected in Oregon. This larva can be distinguished from the other species in this subgroup by the combination of the darkened area bordering the median suture of the pronotum and the head shape, with the length and width subequal and the widest part being the medial area.

Description: Head, anterior 2/3 brown with posterior 1/3 lighter yellow-brown and distinctly set off from anterior portion, a few muscle scars present (Figure 64); second segment maxillary palpus approximately twice as long as first (Figure 66); left mandible with large apical tooth and smaller dorsal subapical tooth; right mandible with two large apical teeth, dorsal one slightly longer, and small mesal

tooth on ventral blade (like Figure 61). Thorax, pronotum yellow-brown, each side having darker brown area bordering median suture (Figure 65). Abdomen, clusters of branching gills present laterally on segments I-VIII, segments I and VIII with one pair, segments II-VII with two pairs, each gill cluster with 20 or more filaments; anal prolegs with a basoventral hook, claw with one large and one small ventral tooth (Figure 67). Length, mature larva, 29 mm.

Distribution: This species occurs in the Cascade Mountains west to the Pacific Coast from British Columbia (including Vancouver Island) south to Oregon and northern California.

Material Examined: BRITISH COLUMBIA: Robertson Crk., Port Alberni, Can. Dept. Fish. Spawning Channel, June 26, 1969 (R), 1L (5), 7PP, 1♂ M. Small trickle in Goldstream Cpgrd., Victoria, Vancouver Isl., June 27, 1969 (R), 1L (5), 1PP, 2♂ M. Spring fed pool beside rd. to Port Renfrew, 51.4 mi. w. Shawnigan Lk. just w. Fairy Lk. Cpgrd., June 28, 1969 (R), 1L (5). Small str. crossing rd. to Port. Renfrew, 2.3 mi. w. Shawnigan Lk., June 28, 1969 (R), 1PP.

OREGON: Benton Co: This species has been collected in great numbers (640 specimens) in virtually all of the springs and streams on Marys Peak, near Corvallis. These records are summarized: instars II, Jan. and Nov.; III, Jan., Apr., June, and July; IV, Jan. through Aug., and Oct.; V, Jan. through July and Sept. through Dec.;

prepupae, Mar. through June; pupae, Mar. through July; metamorphotypes, Apr. through Aug.; and adults, May through July.

Other Areas of County: Stream 1/2 mi. w. Hoskins, trib. of Luckiamute Riv., Feb. 26, 1966 (W). Stream 1 mi. W. Hoskins, trib. of Luckiamute River, Feb. 26, 1966 (W), 1L (5). 5 mi. N. Summit on Rd. to Nashville, Mar. 23, 1966 (W) 4L (5). 1 mi. N.E. Summit, 1 ft. wide trib. Marys River, March 23, 1966 (W) 11L (5); Jan. 21, 1967 (W & W), 5L (4). 2 mi. W. Nashville, Jan. 21, 1967 (WW), 1L (5). S. Fk. Alsea River, April 27, 1940 (O. Loelf), 1L (5). 7 mi. E. Alsea on Rt. 34, Alder Crk., April 15, 1964 (GW & Sc) 3L (4, 5). Yew Crk., 1 mi. W. summit Coast Range, Mar. 20, 1968 (W), 2P. Spring in Bellfountain Pk., 1 mi. N. Bellfountain, Mar. 21, 1967 (WW), 1L (5), 4PP; Mar. 15, 1964 (A), 2L (5); April 4, 1964 (A), 1L (5). Bellfountain, April 4, 1964 (GW & Sc), 2PP, 2L (5). Stream 7.6 mi. W. Alpine, Mar. 21, 1967 (WW), 1L (5). Stream 8 mi. W. Alpine, Mar. 21, 1967 (WW), 1L (5), 1P, 3PP. Stream 9.7 mi. W. Alpine, Mar. 21, 1967 (WW), 5L (4, 5), 8 PP. Oak Crk., site #1, 700', May 25-29, 1969 (W), 1♀ A. Oak Crk., site #2, May 16-19, 1969 (W), 1♂ A; June 5-9, 1970 (W), 1♂ A; June 28-July 3, 1970 (W), 1♂ A. Oak Crk., Apr. 1966 (R. Cardwell), 1L (5). Small Crk. in Crescent Valley, 1-2 mi. W. Lewisburg (nr. Corvallis), April 13, 1969 (C. D. Miller), 1L (5). Temporary stream across rd. from Berry Crk., N. of Corvallis, April 21, 1966, 1♂ M. Small tickle nr.

Berry Crk., April 4, 1964 (A), 6PP. 8 mi. N. Corvallis, Berry Crk., April 3, 1964 (A), 1L (5); April 10, 1964 (GW & Sc), 2PP; April 17, 1966 (W), 1L (5); June 21-29, 1968, black light (E), 2 ♂A; July 1-3, 1968, black light (E), 1 ♂A; July 27-30, 1968, black light (E), 1 ♂A. Clackamas Co: Warm Springs River (54°F), 14 mi. S. Timothy Lake, 3750', July 11, 1968 (A), 2L (4, 5), 1P, 1 ♂M. Bruin Run Crk., Camp Crk. For. Camp, nr. Mt. Hood, July 20, 1967 (WW), 1 IP. Streams crossing Rd. to Timberline Lodge, April 14, 1964 (GW & Sc), 1L (5), 1PP. Streams nr. Government Camp, Sept. 28-9, 1966 (GW, Y, O), 1L (5). Still Crk., Still Crk. For. Camp, Mt. Hood, June 10-11, 1967 (Y), 2L (5); June 21, 1968 (GW, Y, O), 1L (5), 1PP; July 17, 1963 (GW), 1 ♀A. Curry Co: 1 1/2 mi. N. Arizona Beach, Hwy. 101, N. Brookings, April 16, 1967 (E), 1L (5). Douglas Co: Spring run along Rt. 230, 1-2 mi. below Muir Crk. Cpgrd., Rogue River Nat. Forest, July 4, 1961 (GW), 1L (4); June 29, 1961 (GW), 1L (4). 4 mi. W. Scottsburg, April 17, 1967 (E), 6 L (5). Small Crk., 3 mi. N. Curtin, April 17, 1967 (E), 2L (5). Hood River Co: N. Fk. Iron Crk. at Rt. 35 nr. Government Camp, June 13, 1967 (Y), 1 ♀ IP. Iron Crk., 1 mi. W. Hood River Meadows Jct., Hwy. 35, Mt. Hood, 4400', June 12, 1969 (W), 1PP. Oxbow Springs, May 19, 1940 (J), 1 ♂A. Jackson Co: E. Ashland, 3000', at snow zone sign, Hwy. 66, April 15, 1967 (E), 3L (5). 1 mi. W. Ruch, Hwy. 238, 1400', April 15, 1967 (E), 4L (5). Josephine Co: Cave Crk., Oregon

Caves Nat. Mon. below Chateau, 3800', June 14, 1963 (A), 1L (5).
 Cave Crk., Oreg. Caves Nat. Mon., 4000', Aug. 5, 1967 (W W),
 1L (4). Lake Crk., 1.2 mi. below Oreg. Caves Nat. Mon., 3650',
 Aug. 5, 1967 (W W), 1♂ M. Cave Crk. at Sucker Crk. Rd., W.
 Oregon Caves Nat. Mon., Aug. 5, 1967 (W W), 1P. Anderson
 Crk., 2.8 mi. N. Selma, on Hwy. 199, April 16, 1967 (E), 1L (5).
Lane Co: Stream at Limberlost Cpgrd., Rt. 242, W. Sisters, June
 10-11, 1968 (Y & S), 1♂ M. Scott Crk., Hwy. 126, nr. McKenzie
 River, June 30, 1966 (W), 1♂ M. Whittaker Crk. Rd., 1 mi. W.
 Whittaker Crk. Rec. Area, S. W. Walton, Mar. 20, 1967 (W W),
 1L (5), 2PP, 2P. Turner Crk. Rec. Area, Rt. 126, June 23, 1966
 (W), 1♂ M. Archie Knowles F. Camp, ca. 2 mi. E. Mapleton,
 April 22, 1967 (R. Altig), 3L (5), 4PP, 8♂ M, 4♀ M. Horse Crk.,
 4 mi. S. McKenzie Bridge, June 30, 1966 (W), 1♂ M. Mack Crk.,
 H. J. Andrews Exp. Forest, 11 mi. from Blue River, July 7, 1972
 (A), 1♂ A. Lincoln Co: Stream along Trenholm Saddle Rd., Rt. 34,
 E. Tidewater, Feb. 23, 1964 (A), 1L (5); April 4, 1964 (GW & Sc),
 5L (5), 4PP, 1♂ P, 1♀ P; May 21, 1964 (A), 1♀ M, 1♂ M, 1L (5); June
 6, 1968 (Y & S), 1♂ M. Spring run at Slide Campground on Rt. 34,
 Tidewater, July 3, 1963 (GW), 2L (5), 2PP; April 15, 1964 (GW & Sc),
 1PP, 1♂ M, 1♀ M. Fall Crk. nr. Rd. #1342, 1.2 mi. N.E. Jct. with
 Rd. #1209, June 21, 1970 (W W), 1♂ M. Feeder stream, Deer Crk.,
 8 mi. S. Toledo, April 6, 1963 (A), 3L (5). Needle Branch Crk., 10

mi. S. Toledo, July 1, 1964 (A), 2L (5). Linn Co: Small trib. Snow Crk. at Rt. 20, Willamette Nat. For., June 1, 1968 (Y & S), 1♂ M, 2L (5), 1PP. Small stream crossing Quartzville Rd., 2 1/2 mi. W. Yellowstone Guard Sta., June 17, 1968 (GW, Y, O), 2L (5), 1PP. Stream at Jct. Trout Crk. Rd. and Quartzville Rd., nr. upper end Green Peter Reservoir, Aug. 6, 1970 (W & A), 1♂ M. Second intermittent stream nr. Crabtree, April 13, 1970 (T), 5♂ M, 7♀ M. Trib. streams, Carmen Reservoir, July 19, 1966 (W), 1♂ M; July 7, 1966 (W), 1♂ A, 1L (5). Streams crossing Rt. 22, 13.3 mi. E. Idanha, June 12, 1968 (Y & S), 1♂ M. Multnomah Co: Stream crossing Columbia Gorge Rd., E. Corbett, June 9, 1969 (R), 1L, 1PP. Streams crossing Columbia Gorge, E. of Crown Pt. nr. Corbett, Sept. 27, 1966 (GW, Y, O), 2L (4, 5). Spring run, Crown Point, July 15, 1963 (GW), 1PP. Crown Point, Corbett, April 17, 1964 (GW & Sc), 5L (4, 5), 2PP, 1♂ P, 1♀ P, 1♂ M, 1♀ M. Stream crossing rd. on Larch Mtn., 5 mi. below summit, nr. Corbett, Sept. 27, 1966 (GW, Y, O), 1L (5). Corbett, 1.7 mi. E. Crown Point, April 26, 1964 (GW & Sc), 2PP. Wahkeena Falls, stream beside rlwy., April 20, 1964 (GW & Sc), 2L (5), 5♂ P, 4♀ P. Polk Co: 2 mi. S. Airlie, April 2, 1967 (E), 6L (5), 1♀ M. Tillamook Co: Streams, Neskowin Cpgrd., Neskowin, Siuslaw Nat. For., July 10, 1963 (GW), 1L (4), 1PP, 1♀ P, 1♂ M. Spring seepage on Rt. 22, Dolph, July 11, 1963 (GW), 1PP. Washington Co: Spring fed

small stream, Banks, Mar. 23, 1963 (A), 4L (5). 1/4 mi. N. Sunset Hwy., 5 mi. S. W. Portland, April 9, 1966 (Bill Barss), 5L (5), 1P.

WASHINGTON: Clallam Co: Creek, 1.2 mi. below tunnel on Hurricane Ridge Rd., July 23, 1969 (WW), 1L (4). Cowlitz Co: Kalama Springs, Weyerhaeuser Experimental streams, 5 mi. W. Merrill Lake, May 5, 1966 (A), 3L (5), 1♂ M. Jefferson Co: Small stream and pool ca. 2 mi. E. Hoh entrance, Olympic Nat. Pk., June 29, 1969 (R), 1L (5). Spring runs and pools beside rd. nr. Hoh River Cpgrd., Olympic Nat. Pk., June 30, 1969 (R), 2♂ M. Lewis Co: Small stream, 12.1 mi. E. Longmire on Rt. 706, Mt. Rainier Nat. Pk., July 4, 1969 (R), 1L (5), 1PP. Small trickle crossing Rt. 706, 10.2 mi. E. Longmire, Mt. Rainier Nat. Pk., July 4, 1969 (R), 1PP. Small streams just N. Ohanapecosh entrance Mt. Rainier Nat. Pk., June 16, 1969 (R), 1L (4). Pierce Co: Small stream in Cayuse Pass, 1.6 mi. S. Crystal Mtn. Rd., on Rt. 410, Mt. Rainier Nat. Pk., June 16, 1969 (R), 1PP, 1♂ P. Small streams entering Fish Crk., West side Rd., Longmire, Mt. Rainier Nat. Park, June 14, 1969 (R), 1L (5). 2.4 mi. W. Hwy. 410 on Sunrise Rd., Mt. Rainier Nat. Pk., July 25, 1969 (WW), 2PP, 4♂ M. Yakima Co: Streams crossing Rd. 84, ca. 12 mi. N. Trout Lake, June 11, 1969 (R), 1PP.

Biology: First instars were not available for study. Head capsule measurements of the other instars were (in mm.): II, .62

to .67 (9 larvae); III, .88 to 1.02 (13 larvae); IV, 1.20 to 1.60 (46 larvae); and V, 1.72 to 2.32 (283 larvae).

It would appear that grandis has a bimodal one year life cycle. The adults are present from early May through September. Eggs are most likely present and hatching continuously from May through September, but eggs laid especially late may not hatch until considerably later. Larvae from eggs hatching in the early summer apparently overwinter as fifth instars while those from eggs that are laid and hatched during the late summer probably develop much more slowly during the cold winter months, overwintering as second or third, or possibly even fourth instars. Second instars have been collected in November and January. Third instars occur from November through July. The fourth instars were collected in all months except November and December (which may be due to insufficient collections during these months). Last instars were collected during all months and could probably be accounted for by the continuous hatching of individuals throughout the previous summer. Pupae occurred from February to early August. Ross and Spencer (1952) reported grandis adults occurring commonly from June to October in British Columbia while Thut (1969) found the adults emerging from July through September at his spring-fed streams in Washington.

This species has been collected in a temporary stream on Marys Peak and in two temporary streams by Tew (1971), one north of

Corvallis and one near Crabtree, Oregon. Tew (1971) collected R. grandis in very small numbers during one year of a study of a small intermittent stream near Corvallis, Oregon which had a continuous flow from late October to mid-April. During the second year of the study this species was not present. Since Berry Creek, a permanent stream, was but a short distance from the intermittent stream, the adults of this species probably were able to recolonize the intermittent stream from time to time. R. grandis apparently is less well adapted to temporary stream situations than is R. norcuta. The adults of grandis are probably able to bridge the period when the stream is dry as long as the stream-bed remained cool and damp long enough for pupation to have been completed. During drier years this species apparently dies out in these streams. It would appear that if the stream becomes dry prior to completion of pupation this species recolonizes from nearby permanent streams.

Thut (1969) dissected two fifth instars and found that about 90% of the gut contents were animal, 5% detrital and 5% plant material. Of the six organisms contained in the guts of these larvae, five were Plecoptera nymphs (Nemoura spp.) and the other a chironomid (Diptera) pupa.

Rhyacophila neograndis Denning

Rhyacophila neograndis Denning, 1948b:110; Ross, 1956:83, 117;

Schmid, 1970:87, 131.

Type Locality: Mt. St. Helena, California, April 5, 1936

(H. J. Rayner).

Larva: The larva of this species is associated on the basis of a male metamorphotype from Grass Valley, California. It can be separated from the other two species in the grandis subgroup by the coloration and shape of the head and coloration of the pronotum.

Description: Same as for Rhyacophila grandis except: Head slightly more elongate, being $1 \frac{1}{3}$ times as long as width at widest point, medially; head light brown with more darkened muscle scars than in grandis; and pronotum very slightly darker than head with darkened muscle scars and with no darkened area bordering the median suture of the pronotum.

Distribution: This species has only been collected in northern and central California.

Material Examined: CALIFORNIA: Napa Co: Intermittent stream, Hwy. 128, nr. Lk. Berryessa Boat Landing, Mar. 24, 1970 (E & K), 2L, 2♂ P. Yuba Co: Grass Valley, 2000', May 5, 1946 (H. P. Chandler), 1♂ M.

Biology: Pupae of neograndis were collected in late March and early May and adults from April through June.

Rhyacophila sequoia Denning

Rhyacophila sequoia Denning, 1950a:116; Ross, 1956:83, 117; Denning, 1963:245; Schmid, 1970:87, 132.

Type Locality: Sequoia, California, 3600', July 20, 1946
(C. P. Alexander).

Larva: Metamorphotypes from Yosemite Nat. Park were used to associate the larva of this species. It can be distinguished from the other species in the subgroup by the shape of the head and the coloration of the head and pronotum.

Description: Same as for Rhyacophila grandis except: The posterior 1/3 of the head is not as distinctly lighter yellow-brown, it is distinctly narrowed anteriorly, the posterior being 1 1/5 times wider than in the anterior, and it is 1 1/3 times as long as wide at widest point; pronotum slightly darker than in grandis.

Distribution: This species has only been recorded from the Cascade and Sierra Nevada Mountains in north and central California.

Material Examined: CALIFORNIA: Mariposa Co: Spring str. nr. Campgrd. II, Yosemite Village, Yosemite Nat. Pk., June 14, 1961 (GW), 1L, 3PP, 3♀ M, 4♂ M. Stream in Tuolumne Grove, Yosemite Nat. Pk., June 11, 1961 (GW), 1PP. Spring str. nr. Mariposa Grove, Yosemite Nat. Pk., June 12, 1961 (GW), 1L. Mosquito Crk., W. ent. Yosemite Nat. Pk., 5200', June 26, 1968 (E), 1PP, 1♀ P, 2♂ M. Nevada Co: Station spgs. entering Sagehen

Crk., above Univ. Calif. Sta., 8 mi. n. Truckee, June 20, 1967 (T),
2L, 2♂ M.

Biology: The larvae of sequoia were collected during June as
were the pupae. The adults were collected during June and July.

NAVICULATA DIVISION

In North America this division is only represented by the lieftincki group and the one species, Rhyacophila arnaudi Denning.

17. Lieftincki Group

Rhyacophila arnaudi Denning is the only species in this group occurring in North America. The larva is associated here for the first time. The larva does not have gills or fleshy lateral protuberances on the abdomen, does have a short, stout apicolateral spur, and has a darkened area covering the frontoclypeus.

Rhyacophila arnaudi Denning

(Figure 68, 69, 70)

Rhyacophila arnaudi Denning, 1948b:97; Thut, 1969:894-898; Schmid, 1970:90, 132.

Type Locality: Camp Abbot, Deschutes County, Oregon, April 2, 1944 (Paul H. Arnaud).

Larva: The association of this larva is based on a male metamorphotype collected by Rudolf Thut, in the Weyerhaeuser experimental streams near Kalama, Washington.

Description: Head, yellow-brown; V-shaped dark brown patch following frontal sutures and covering entire frontoclypeus (sometimes difficult to see in early instars due to light sclerotization)

(Figure 68); maxillary palpus short and stout, first and second segments subequal; mandibles short and broad, left mandible with one large apical tooth, mesal margin irregular, very small subapical tooth on ventral blade; right mandible with one large apical tooth and one small blunt mesal tooth (Figure 69). Thorax, pronotum yellow-brown, margins somewhat darker. Abdomen, without gills or fleshy lateral protuberances; anal prolegs with baso-ventral hook; anal claw with two or three minute ventral teeth; short, stout apicolateral spur, length subequal to length of anal claw (Figure 70). Length, mature larva, 21 mm.

Material Examined: CALIFORNIA: Shasta Co: Hat Crk. at Hat Crk. Cpgrd., nr. Old Station, Oct. 3, 1966 (GW, Y, O), 4L (5). Sierra Co: N. Yuba Riv. at Rt. 49, w. Sattley, Oct. 6, 1966 (GW, Y, O), 1L (5). OREGON: Benton Co: Roadside stream, 1/2 mi. w. Hoskins, Feb. 26, 1966 (W), 1PP. Clackamas Co: Oak Grove Fk. Clackamas Riv., bridge at Lk. Harriet Rd. Jct., Aug. 9, 1968 (E), 1L (4). Deschutes Co: Deschutes Riv., above Pringle Falls, Oct. 20, 1948 (J), 4L (5). Lane Co: Lookout Crk., Andrews Exper. For., Apr. 11, 1973 (E. Grafius), 1PP. Lincoln Co: Needle Branch Crk., 9 mi. s. Toledo, Apr. 6, 1963, 1♂ A; Deer Crk., s. of Toledo, Aug. 21, 1963 (A), 4L (3, 4). WASHINGTON: Cowlitz Co: Weyerhaeuser exp. str., Kalama Springs, 5 mi. w. Lk. Merrill, Apr. 14, 1967 (R. Thut), 1♂ A; Mar. 1966 (R. Thut), 1♂ M. Jefferson Co:

Hell Roaring Crk., 1/4 mi. from Jct. Hoh Riv. Rd. & Hwy. 101,
July 22, 1969 (WW), 1L (3).

Biology: Rhyacophila arnaudi was one of the Rhyacophila studied by Thut (1969) in Washington. It was univoltine, with peak emergence occurring during March and April. The larvae were found in currents from approximately 1.4 ft./sec. to 1.7 ft./sec. The first four stadia each lasted about one month and the fifth stadium took from three to four months. The pupal stage lasted about two months as did the adult and egg stages combined. Thut (1969) found the first and second instars during June and July, the third from June through August, the fourth from July through September, the fifth from September through January, and pupae from January to March. Adults emerged during March and April. From my records from Oregon, California, and Washington, the third instars were collected in July and August, fourth instars during August, fifth instars in October, prepupae in February and April, and the adults in April.

Thut (1969) found that arnaudi was carnivorous, with Chironomidae, particularly pupae, being fed upon in the greatest numbers. The remainder of the diet was composed of Copepoda, Oligochaeta, Acari, and Rhyacophila larvae. The percentages of the organisms in the diet were quite close to those percentages found in the benthos with the exception of a higher percentage of Chironomidae, and the complete lack of mayflies and stoneflies.

The second and third instars contained a larger percentage of detritus in the guts than did the fourth and fifth instars, but otherwise the types of organisms in the diet did not differ markedly for the different instars.

UNCERTAIN STATUS

The following groups and species of Rhyacophila were not placed in the classification by Schmid (1970): nevadensis group (including Rhyacophila jewetti Denning, R. nevadensis Banks, and R. vaefes Milne), Rhyacophila alexanderi Denning, R. oreia Ross, R. chandleri Denning, R. mosana Denning, R. pacifica Banks, R. pichaca Denning, R. visor Milne, R. haddocki Denning, and R. rayneri Ross. I have since placed R. rayneri in a group of its own in the invaria branch near the angelita and sibirica groups on the basis of similarities between the larvae. I have also placed the species R. oreia and R. visor together in the oreia group after finding that the larvae of both species are very closely related.

18. Nevadensis Group

This group is comprised of three species, Rhyacophila jewetti Denning, R. nevadensis Banks, and R. vaefes Milne, all of which occur in western North America. Ross (1956) considers this a relict group confined to a single series of mountain ranges. Rhyacophila nevadensis occurs in the Sierra Nevada Mountains, R. vaefes through the Coast and Cascade Mountains, and R. jewetti occurs only in the Cascade mountains of Oregon. The larvae of R. nevadensis and R. vaefes are associated here for the first time, but cannot be separated. The larva of jewetti is unknown. Since

nevadensis is not known to occur in Oregon, Washington, or British Columbia, the larvae from these areas are considered to be vaefes. Those collected in California are listed under nevadensis.

Rhyacophila jewetti Denning

Rhyacophila jewetti Denning, 1954:57-8; Ross, 1956:80, 116; Schmid, 1970:95, 133.

Type Locality: Ollalie Crk. Cpgrd., McKenzie Riv., Lane County, Oregon, July 15, 1952 (S. G. Jewett, Jr.).

Larva: Unknown.

Distribution: This species is rare, with records available from only two areas in Oregon, the McKenzie River area in Lane County and from Still Creek, near Mt. Hood, Oregon.

Material Examined: Mack Crk., H. J. Andrews Exp. For., 11 mi. from Blue River, Aug. 25, 1971 (A), 1♂ A; July 17, 1972 (A), 1♂ A.

Biology: Adults have been collected in mid-July and in late August.

Rhyacophila nevadensis Banks

Rhyacophila nevadensis Banks, 1924:443; Milne, 1936:99, 105; Ross, 1938b:6; Ross, 1956:80, 116; Schmid, 1970:95, 133.

Type Locality: Reno, Nevada, 1878 (Morrison).

Larva: The larva of this species has been associated from a

male metamorphotype from Hat Creek, California. The larva of nevadensis is indistinguishable from that of vaefes.

Distribution: This species has a distribution that is centered in the Sierra Nevada Mountains in California. It has been recorded from Reno, Nevada and from Butte, Lassen, Shasta, Sierra, and Siskiyou Counties in California.

Material Examined: CALIFORNIA: Shasta Co: Lost Crk., Lassen Volcanic Nat. Park, Oct. 4, 1966 (GW, Y, O), 1L (4). Hat Crk. at Big Springs, w. of Old Station, Oct. 4, 1966 (GW, Y, O), 1♂ M, 1L (5). Hat Crk. source, Lassen Volcanic Nat. Pk., Oct. 4, 1966 (GW, Y, O), 1PP. Hwy. 89, Sagehen Crk., N. of Hobart Mills, 6100', June 27, 1968 (E), 3♂ A. Shasta, Hwy. 5, June 18, 1967 (E), 1L (5). Siskiyou Co: Hwy. 99, City Pk. of Mt. Shasta, headwaters of Sacramento River, June 18, 1967 (E), 1L (5).

Biology: Fourth instars were collected in early October, fifth instars in June and October, and prepupae, pupae, and adults in October.

Rhyacophila vaefes Milne

(Figures 5, 71, 72, 73)

Rhyacophila vaefes Milne, 1936:96; Denning, 1948b:105; Schmid & Guppy, 1951:41; Ross and Spencer, 1952:45; Ross, 1956:75, 80, 116; Anderson, 1967:508, 517-8; Thut, 1969:894-8; Schmid,

1970:95, 133.

Type Locality: Cultus Lake, British Columbia, Aug. 25, 1934
(W. E. Ricker).

Rhyacophila vujuna Milne, 1936:99; Denning, 1948b:109; Ross and
Spencer, 1952:45; Ross, 1956:116 (synonymy).

Larva: The larva of vaefes is associated based on a male
metamorphotype from near Blue River, Lane Co., Oregon.

Description: Head, brown with some slightly darker muscle
scars; length and width of head subequal; slightly narrowed anteriorly;
darkened V-shaped area on posterior of frontoclypeus, extending along
frontal sutures (Figure 71); maxillary palpus short and stout, six
times longer than width of second segment, second segment $2\frac{1}{2}$
times longer than first segment; left mandible with large apical tooth,
smaller dorsal subapical tooth and large, blunt ventral subapical
tooth, mesal margin of ventral blade irregular, with wavy surface,
basally producing three broad, rounded tooth-like processes and an
apical, smaller, rounded tooth-like process; right mandible with
one large apical tooth and smaller subapical tooth, ventral blade with
large, blunt, mesal tooth (Figure 72). Thorax, pronotum same color
as head. Abdomen, without lateral protuberances or gills; anal pro-
leg without apicolateral spur; claw with one large ventral tooth and
one smaller anterior tooth; baso-ventral hook large, curved, pointed
(Figure 73). Length, mature larva, 16 mm.

Distribution: This species occurs from the Pacific Coast (including Vancouver Island) eastward, throughout the Cascade Mountains in British Columbia, Washington, and Oregon.

Material Examined: OREGON: Clackamas Co: Mollala Riv., Apr. 13, 1938 (J), 2♂ A. Bull Run Riv., Bull Run, June 21, 1933, 2♂ A. 2.7 mi. n. of McNeil For. Camp Jct. on Mt. Hood Rd. #N12, July 17, 1968 (W), 2P. Jefferson Co: Metolius Riv., Riverside F. Camp, 1 mi. s. Camp Sherman, Dec. 26, 1966 (A), 8L (1, 5); Sept. 22, 1965 (A), 1L (3); April 30, 1965 (A), 1♂ A; May 21, 1964 (A), 1L (5); June 15, 1966 (A), 3L (2, 3, 5), 1♂ A (at light); May 31, 1968 (Y & S), 1L (5); June 27, 1964 (A), 3♂ A; Aug. 11, 1966 (A), 2L (2, 4); Aug. 12, 1966 (A), 7L (1, 2, 5); Aug. 24, 1967 (D. Lehmkuhl), 1L (1); Sept. 3, 1964 (A), 1♂ A. Springs of Metolius Riv., June 26, 1954 (F. Hasbrouck), 1♂ A. Metolius River at Bridge 99 Campground Sept. 24, 1965 (A), 1♂ A; Sept. 23, 1965 (A), 2♂ A; Sept. 24, 1965 (A), 7♂ A; Aug. 12, 1966 (W), 1♂ M. Wizzard Falls, Metolius River, Aug. 12, 1966 (W), 1♂ A. Metolius River at Gorge Campground, Dec. 26, 1968 (R. Lindland & E), 5L. Josephine Co: Oregon Caves Natl. Mon., Cave Crk., 4000', Aug. 5, 1967 (WW), 1L (5). Klamath Co: Annie Crk., Crater Lake Nat. Mon., Oct. 1, 1966 (GW, Y, O), 38L (4, 5), 3PP. Lane Co: McKenzie River at Buck Bridge at Frissell Carpenter Rd. and Rt. 126, n. of Belknap Springs, July 17, 1970 (W & E), 1♂ A. Streams crossing Rt. 126, 2 1/2 mi. w.

Blue River, June 10, 1968 (Y & S), 1♂ M. Lincoln Co: Fall Crk., Tidewater, April 15, 1964 (GW & Sc), 1L (5). Linn Co: Ice Cap Crk. at Carmen Reservoir, July 7, 1966 (W), 2L (5). Ollalie Crk. Forest Camp, nr. McKenzie River, Rt. 126, July 21, 1969 (W), 1♂ A. Marion Co: Niagara, May 31, 1970 (E & T), 1♂ A.

WASHINGTON: Clallam Co: stream n. w. Soleduck Hot Spgs., July 22, 1969 (WW), 1♂ A. Crk. nr. Heart of Hills Cpgrd., Olympic Nat. Park, July 23, 1969 (WW), 1♂ P. 4.2 mi. below Hurricane Ridge Rd., July 23, 1969 (WW), 1L (5). Cowlitz Co: Weyerhaeuser Company artificial streams, Kalama River drainage, w. Lk. Merrill, June 18, 1968 (A), 1♂ A; (R. Thut), 1♂ A; July, 1968 (R. Thut), 2L (4, 5). Jefferson Co: Hoh River at Hoh River Cpgrd., Olympic Nat. Pk., June 30-July 1, 1969 (R), 1PP. King Co: Creek 1.2 mi. w. Stevens Pass Ski Area on old Hwy., July 24, 1969 (WW), 1L (4, 5). Large stream crossing Rt. 2, just w. Stevens Pass, 4000', June 17, 1969 (R), 1L (5). Small run on detour Rt. 2, just W. Stevens Pass, 4000', June 17, 1969 (R), 2L (4, 5). Pierce Co: Fish Crk. at Westside Rd., Longmire, Mt. Rainier Nat. Pk., ca. 3000', June 14-15, 1969 (R), 1L (5).

Biology: Thut (1967) studied the life history features and feeding habits of vaefes in spring-fed streams in Washington. The first, second and third instars were found in the fall and early winter. Fourth instars were most common during April. Fifth instars

occurred from March through July. In these particular streams adults emerged from July through November (Thut, 1969).

Thut (1969) found vaefes to prefer the areas of the streams with slower water velocities of 1.0 to 1.4 ft. /sec. Larvae of vaefes reached a maximum number of $180/m^2$ in the benthos, being one of the more common Rhyacophila in the study. It was the only species of the seven studied by Thut (1969) that was omnivorous. The diet was composed of 40% plant material (especially diatoms), 40% animal material, and the rest detrital. The abundance of the animals ingested was about the same as their percentage of occurrence in the benthos, except for Plecoptera nymphs, which were not fed upon at all, and Acari, which were fed upon in large numbers.

Larval head capsule measurements were (in mm.): I, .24 to .28 (13 larvae); II, .42 to .44 (6 larvae); III, .58 to .62 (4 larvae); IV, .90 to 1.00 (6 larvae); and V, 1.14 to 1.48 (60 larvae). There were two prepupae collected in Washington with head capsule lengths at 1.04 and 1.06 mm. which indicates a shady area of distinction between fourth and fifth instar larvae.

In the collections of vaefes from scattered areas in British Columbia, Oregon, and Washington, the first instars occurred in August and December, the second instars during August, the third during June, August, and September, the fourth during October, the fifth from April through August and in October and December, pupae

from June through August, and in October, and the adults from late April through October.

19. Oreia Group

The two species, Rhyacophila oreia Ross and R. visor Milne, are placed together in this group on the basis of the many similarities between their larvae. Of all of the other groups of Schmid (1970) these two larvae appear to bear the most resemblance to the larva of R. velora in the vofixa group. The relationships between R. oreia and R. visor and the vofixa group should become clear when larvae of some of the other five species in the vofixa group become known. Ross (1956) placed R. oreia, R. visor, and R. velora in the sibirica group while Schmid did not place oreia or visor in a group. R. oreia and visor do not resemble the other known larvae of the sibirica group.

The larvae of oreia and visor can be separated, with some difficulty on the shorter baso-ventral hook of visor and on the presence of darkened muscle scars on the head of visor.

Rhyacophila oreia Ross

(Figures 74, 75)

Rhyacophila oreia Ross, 1947:126; Ross, 1956:93, 120; Smith, 1968: 664; Schmid, 1970:95, 133.

Type Locality: Dunraven Pass, Mt. Washburn, Yellowstone

Nat. Park, Wyoming, Aug. 2, 1940 (T. H. Frison & T. H. Frison, Jr.).

Larva: One female and two male metamorphotypes are available from a small stream crossing Rt. 93, 4.8 mi. n. Gibbonsville, Lehmi Co., Idaho, June 26, 1968. However, larvae of this species are not available, so the description is based strictly on the sclerites remaining in the pupal case.

Description: Head, narrowed anteriorly, as viewed dorsally; yellow-brown with a slightly darker area on frontoclypeus bordering frontal sutures and anterior margin; indistinct muscle scars, or none; maxillary palpus short, length about four times width of second segment, second segment $1\frac{1}{2}$ times as long as first segment; left mandible with one large apical tooth, right mandible with one large apical tooth and small, blunt mesal tooth (Figure 74). Thorax, pronotum, same color as head, slightly darker along median suture. Abdomen, probably without gills or fleshy lateral protuberances (cannot be determined on basis of metamorphotype alone); anal proleg with basoventral hook, no apicolateral spur; two ventral teeth on claw, distal tooth longest (Figure 75). Length mature larva not known, but would be quite small, probably less than 12 mm.

Distribution: This small, uncommon species is centered in the Rocky Mountains. It was originally described from Wyoming and has since been recorded from the Salmon River drainage in Idaho by Smith

(1968). Additional records are now available from Montana.

Material Examined: MONTANA: Missoula Co: Spring runs crossing Rt. 12 at Lolo Pass, June 24, 1968 (GW, Y, S), 4♂ A.
IDAHO: Idaho Co: Spring runs crossing Rt. 12, ca. 1 mi. s. w. Lolo Pass, June 25, 1968 (GW, Y, S), 2♂ A. Lehmi Co: Small stream crossing Rt. 93, 4.8 mi. n. Gibbonsville, June 26, 1968 (GW, Y, S), 1♀ M, 2♂ M.

Biology: The pupae of oreia have been collected in June and the adults in June and August.

Rhyacophila visor Milne

(Figures 76, 77, 78)

Rhyacophila visor Milne, 1936:101; Denning, 1948b:106; Ross & Spencer, 1952:45.

Type Locality: Cultus Lake, B. C., Aug. 12, 1934 (W. E. Ricker).

Larva: The larva of visor is associated on the basis of metamorphotypes from Oregon and Washington.

Description: Head, narrowed anteriorly, as viewed dorsally; yellow-brown with mixed areas of darker brown and dark brown muscle scars (Figure 76); maxillary palpus short, second segment about 1 1/2 times as long as first; left mandible with one large apical tooth, right mandible with one large apical tooth and small, blunt

mesal tooth (Figure 77). Thorax, pronotum yellow-brown with some light brown muscle scars. Abdomen, without gills or fleshy lateral protuberances; anal proleg with small basoventral hook, without apicolateral spur; two ventral teeth on claw, distal tooth longest (Figure 78). Length, mature larva, 17 mm.

Distribution: This species occurs in the higher elevations of the Coast and Cascade Ranges of Oregon, Washington, and British Columbia.

Material Examined: OREGON: Benton Co: Marys Pk. Rd., Parker Crk. Falls, July 27, 1966 (W & L), 6♀ A, 6♂ A, 1PP, 1L; July 19, 1963 (GW), 10♂ A. Parker Crk. just above Parker Crk. Falls, June 4, 1968 (Y & S), 1PP. Crk. off Marys Pk. Rd. on Rd. #1296, June 16, 1968, emgd. July 9, 1968 (WW), 1♂ M. Crk. 1/2 mi. off Marys Pk. Rd. on Rd. #1296, July 11, 1968 (W), 2L.

Clackamas Co: Mt. Hood, spring str. 3.3 mi. below Timberline Lodge, July 16, 1963 (GW), 1♂ M; Apr. 20, 1964 (GW & Sc), 8♂ M, 1♀ P, 1PP; July 16, 1963 (GW), 6♀ A, 22 ♂ A; July 13, 1963 (GW), 2♂ A; July 17, 1963 (GW), 3♂ A; June 11-12, 1967 (Y), 4♂ A; June 19, 1968 (GW, Y, S), 7♀ A, 23♂ A; June 8, 1969 (R), 2♂ M, 24♂ A. Stream 3 1/2 mi. below Timberline Lodge on Mt. Hood, 38°F, June 12, 1969 (W), 1L. Streams 1 mi. up rd. to Timberline Lodge, 45°F, June 12, 1969 (W), 1L. Streams crossing rd. to Timberline Lodge, nr. Gov't. Camp, Mt. Hood, June 20, 1968 (GW, Y, S), 1♂ M, 1♀ A,

42♂ A; June 12, 1967 (Y), 11♀ A, 17♂ A. Trib. Salmon Riv., Mt. Hood, July 13, 1963 (J), 34♀ A, 4♂ A. Hood River Co: S. Fk. Iron Crk. at Rt. 35 nr. Gov't Camp, Mt. Hood, June 11, 1967 (Y), 10♀ A, 1♂ A; 4400', July 11, 1968 (E), 1♂ A. WASHINGTON: Clallam Co: Stream n.w. of Soleduck Hot Spr., July 22, 1969 (WW), 2♂ A. Creek 1.2 mi. below tunnel on Hurricane Ridge Rd., July 23, 1969 (WW), 1♂ M. King Co: Sm. run on detour Rt. 2, just w. Stevens Pass, 4000', June 17, 1969 (R), 1♂ A. Lewis Co: Sunbeam Crk., nr. Louise Lk., Mt. Rainier Nat. Pk., 4740', July 25, 1969 (WW), 1♂ A. Paradise Park, Mt. Rainier Nat. Pk., July 26, 1953 (K. M. Fender), 5♀ A, 22♂ A. Pierce Co: Sm. trickles on rock cut, 1.6 mi. s. Crystal Mtn. Rd., on Rt. 410, Mt. Rainier Nat. Pk., June 16, 1969 (R), 5♂ A. Crk. 6 1/2 mi. w. Hwy. 410 on Sunrise Rd., July 25, 1969 (WW), 1♂ M. 7 mi. n. Cayuse Pass, Mt. Rainier Nat. Pk., July 25, 1969 (WW), 1PP.

Biology: Larvae, pupae, and adults occurred in June and July.

Unplaced Species

Rhyacophila alexanderi Denning

Rhyacophila alexanderi Denning, 1950a:115.

Type Locality: Bitterroot Forest, Ravalli County, Montana, 6700', June 30, 1949 (C. P. Alexander).

Larva: Unknown.

Distribution: Montana.

Material Examined: None.

Biology: Unknown.

Rhyacophila chandleri Denning

Rhyacophila chandleri Denning, 1956:74-5; Schmid, 1970:134.

Type Locality: Sacramento Riv., Siskiyou Co., Calif., 3200'
Sept. 9, 1953 (H. P. Chandler).

Larva: Unknown.

Distribution: California.

Material Examined: None.

Biology: Unknown.

Rhyacophila haddocki Denning

Rhyacophila haddocki Denning, 1968:65-6.

Type Locality: Gravel Crk., Marys Peak, Benton Co., Oregon,
July 30, 1966 (James Haddock).

Larva: Unknown.

Distribution: Known only from the type locality in Oregon.

Material Examined: None.

Biology: Unknown.

Rhyacophila mosana Denning

Rhyacophila mosana Denning, 1965a:263; Schmid, 1970:134.

Type Locality: Castle Crags State Park, Shasta Co., Calif.,
Oct. 20, 1964 (D. G. Denning).

Larva: Unknown.

Distribution: California.

Material Examined: None.

Biology: Unknown.

Rhyacophila pacifica Banks

Rhyacophila pacifica Banks, 1895:316; Milne, 1936:91, 104; Davis, 1948:30-1; Ross, 1956:123; Schmid, 1970:134.

Type Locality: Olympia, Washington (Trevor Kincaid).

Larva: Unknown.

Distribution: Idaho and Washington.

Material Examined: None.

Biology: Unknown.

Rhyacophila pichaca Denning

Rhyacophila pichaca Denning, 1956:75; Schmid, 1970:134.

Type Locality: Cascade Head Experimental Forest, Tillamook Co., nr. Otis, Oregon, July 27, 1951 (K. M. Fender).

Larva: Unknown.

Distribution: Oregon and Washington.

Material Examined: None.

Biology: Unknown.

Rhyacophila species 1

(Figures 79, 80, 81)

This unusual larva has an extremely elongate head (Figure 79) and mandibles that are unique for the western North American Rhyacophila. This form I believe to be the larva of Rhyacophila ecosia Ross (nigrocephala branch, ecosa group) on the basis of the relationships with other larvae in the nigrocephala branch and on the basis of its distribution records.

Description: Head, yellow-brown, slightly lighter posteriorly, $2 \frac{1}{3}$ times as long as wide, sides of head parallel (Figure 79); maxillary palpus short and blunt, approximately $5 \frac{1}{2}$ times as long as width of second segment, first and second segment length subequal; left mandible with long narrow apical tooth directed nearly perpendicular to basal section of mandible, small pointed mesal tooth on upper blade, large truncated area mesally on ventral blade; right mandible with long, dorsal apical tooth and small, pointed, ventral subapical tooth directed perpendicular to basal section of mandible and at 45° angle from apical tooth, truncated area mesally on ventral blade (Figure 80). Thorax, pronotum same color as head; somewhat lobed in appearance, with an anterior dorsolateral lobe, a posterior dorsolateral lobe, and a mesal lateral lobe. Abdomen, without gills or fleshy lateral protuberances; anal proleg without

apicolateral spur; basoventral hook stout, but blunt; anal claw without teeth (Figure 81). Length, mature larva, 9 mm.

Material Examined: OREGON: Benton Co: North Fk. Rock Crk., Marys Pk., Apr. 13, 1964 (GW & Sc), 1PP. Parker Crk. Falls, Mar. 27, 1964 (A), 1L. WASHINGTON: Yakima Co: 12.3 mi. n. Trout Lk. on Rd. N84.1, June 11, 1969 (R), 1L.

DISCUSSION AND CONCLUSIONS

The larvae of 24 species of Rhyacophila of western North America were associated with the adults for the first time. Previously, Smith (1968) had described larvae of 14 species making a total of 38 associated species for western North America. I tentatively associated two more larvae with the adults. In another 19 species where closely related adults occur, the larvae are presently unknown, but it is probable that they are nearly identical to those of various of the associated species.

The greatest problem encountered in this investigation was the difficulty in separating the larvae of closely related species. The availability of more larval associations served to emphasize the lack of obvious morphological differences between larvae of species within a group. Descriptions of adult Rhyacophila have been based largely on the male genitalia with some species described on the basis of small differences in the shape, length, or width of one character, such as the clasper or the tenth tergite. It is possible that the small genitalic differences observed represent intraspecific variation rather than valid criteria for species separation. Perhaps this problem can be resolved by a study of larger series of adults from the same locality, collections of adults from more localities, a better knowledge of the entire life cycle, and a study of the microhabitat

and the behavior patterns of the various life stages.

The phylogeny of the genus Rhyacophila has been studied in great detail by Ross (1956) and Schmid (1970). These workers have grouped species largely on characteristics of the male genitalia and then proceeded to speculate on the origin and dispersal of the various species through time. The study of the phylogeny of Rhyacophila should benefit from the consideration of the adaptive features of the eggs, larvae, and pupae, which are important in determining whether or not an area is successfully colonized.

Although there are hundreds of species of Rhyacophila for which larvae have not yet been associated, I think it is now possible to make some deductions about the classification systems of Ross (1956) and Schmid (1970) based on the larval characteristics of the associated larvae of species occurring in western North America.

The morphological differences and similarities between larvae are useful in determining relationships between species and species groups. It is difficult to justify some of the branches and divisions used by Schmid (1970) or the branches used by Ross (1956) solely on the basis of larval morphology. However, larval characteristics do support the species group classification proposed by Schmid. In most groups the larvae of all species are so similar that they can hardly be separated, but in a few groups, such as the sibirica group, there is great variety in the form of the larvae.

Ross (1956) proposed nine main divisions within the genus and 18 species groups, while Schmid's (1970) revision recognized only four divisions and 17 groups. I added two more groups to those of Schmid on the basis of the larval morphology. I find that the groups used by Schmid provide a more realistic classification for the western North American species than the groups proposed by Ross. The differences between the groups of Ross and Schmid have been discussed throughout the body of the paper under the various group and branch headings.

The dendrograms of Ross (1956) and Schmid (1970) are figured (Figures 82, 83, 84, 85, 86). The portions of the dendrograms devoted to species and groups not occurring in western North America are deleted and will not be discussed.

The dendrograms of Schmid (1970) of the vulgaris division (Figures 83, 85), in which the rotunda, oreta, viquaea, and vagrita groups occur, are supported by the larval characters. Larvae are known for three of these groups and all have the same shape of head and very similar mandibles with one apical tooth on the left mandible and one apical tooth and a small mesal tooth on the right mandible. They all lack gills and have anal claws without apicolateral spurs.

The vulgaris division of Schmid (1970), in terms of the western North American species, includes all of Ross' (1956) branch four and branch five, and one of his groups in branch nine (Figure 82). Ross'

rotunda group was later divided by Schmid into the rotunda group and the oreta group. The division by Schmid is supported by differences in larval characteristics, though there is enough similarity in the larvae of the two groups to include both in the same branch as was proposed by Schmid. Ross placed the vagrita group in his branch nine, along with the angelita, arnaudi, willametta, and the verrula groups (Figure 82). The larval mandibles and anal proleg do not support this placement for the vagrita group. The viquaea group for which the larvae have not been associated, is in Ross' branch five.

The philoptomoides division of Schmid (1970) has two branches and the greatest number of groups (nine) with larvae in western North America (Figures 83, 84). The castanea branch includes only one group that occurs in the west, alberta. The larvae of this group are the only larvae in western North America with very distinct finger-like gills on the abdomen. They lack an apicolateral spur. The left mandible has one apical and one subapical tooth, and the right mandible has one apical and one mesal tooth.

Ross (1956) placed the alberta group in his branch one (Figure 82). The only other species in this branch that occurs in western North America is R. ecosia. The presumed larva of this species has little in common with those of the alberta group as is discussed later.

Larvae have been associated in all eight species groups in the invaria branch of Schmid's (1970) philopotamoides division. Except for lacking gills, the larvae have little in common. They have all sorts of mandibular characteristics. Most do not have fleshy lateral protuberances, though some do. Some of the larvae have apicolateral spurs on the anal proleg while others do not. This branch also contains the odd larva of R. verrula, which is herbivorous.

Schmid's (1970) dendrograms (Figures 83, 84) show the hyalinata and coloradensis groups as one line of the invaria branch. This relationship is substantiated by the presence of lateral fleshy protuberances on the abdomen of the larvae. These structures are lacking on the known larvae of all of the remaining species of Rhyacophila occurring in western North America.

The verrula group, with one species (R. verrula) for which the larva is associated, has an unusual cylindrical head and blunt, thickened mandibles. The anal proleg bears some resemblance to those of the coloradensis and hyalinata groups, but the mandibles are unique among the known Rhyacophila larvae. Schmid (1970) was unsure of the best position for verrula based on the adults due to their unusual wing venation and genitalia, so he tentatively placed it in the invaria branch. The larva does little to clarify this dilemma. It is so unusual that it could well warrant being placed in a branch

or division of its own. Ross (1956) placed the verrula group in his branch nine, along with the willametta, vobara, angelita, alexanderi, naviculata, and vagrita groups. Larval characteristics indicate that this arrangement is no more appropriate than that of Schmid.

The angelita group (Schmid, 1970) and the rayneri group, which I placed in the invaria branch, have larvae with long apicolateral spurs on the anal proleg. The relationships and placement of the angelita and rayneri groups and R. valuma of the sibirica group in terms of the larvae were detailed previously.

In the sibirica group, the larva of R. valuma has a long apicolateral spur, while R. narvae has this area slightly elongated and the remaining associated larva of this group, that of R. blarina, is without an apicolateral spur and does not have this area elongate. The variety of larval head shapes, mandibles, and characteristics of the anal proleg may justify division of the sibirica group into more than one group. The sibirica group is the only species group in western North America that Ross (1956) placed in his branch seven. I think it is best placed in a branch that includes the angelita and rayneri groups.

The larva of R. velora is the only larva associated in the vofixa group. It is without an apicolateral spur or gills. The head is narrowed anteriorly. The mandibles bear the most resemblance to the oreia and angelita groups and to the groups of the vulgaris

division. Perhaps when some of the larvae of the remaining five species in this group become known more can be determined about placement of this group in terms of the larval characters. Ross (1956) placed R. velora in the sibirica group. The larval characters contradict this placement due to the differences in the anal proleg, mandibles, and head shape.

The larvae of the betteni group all have long, narrow maxillary palps and are without an apicolateral spur on the proleg or gills on the abdomen. The head is somewhat depressed dorsally. The known larvae of this group are very similar and make up a concise grouping. The betteni groups of Ross (1956) and Schmid (1970) are identical except for the placement of R. willametta. Ross placed the betteni group in his branch eight and R. willametta in a group of its own in branch nine. The larval characters of R. willametta are nearly identical with those of the larvae in the betteni group, indicating that this is not the best arrangement. The idea of placing this group in a branch by itself as done by Ross, rather than in a branch with so many other groups as done by Schmid, has some merit on the basis of the larval characters.

The divaricata division includes four branches, with the nigrocephala branch and the acropedes branch occurring in western North America. The larvae of the nigrocephala branch and the acropedes branch do not seem to have anything in common to warrant

R. vaefes, are associated but they are indistinguishable. On the basis of the mandibles, this group is entirely different than those of larva of any other known species in the study area. They do not have gills, fleshy lateral protuberances, or an apicolateral spur.

I transferred two of the species, R. oreia and R. visor, which Schmid considered "isolated," into the oreia group. The larvae of these two species are nearly identical and they are also quite similar to the larva of R. velora of the vofixa group. Since R. velora is the only larva associated of the six species in this group, I feel that it is premature to change the placement of the oreia group.

R. rayneri was considered by Schmid (1970) to be an isolated species and was not placed by him. I placed rayneri in its own group and moved it to the invaria branch, between the angelita and sibirica groups. The reasons for this move were stated earlier.

In summary, the Schmid (1970) system of classification at the group level is usually supported on the basis of the larval characters, as are some of the groups of Ross (1956). However, the branches and divisions used by Schmid and the branches used by Ross often cannot be supported. When more larvae are associated on a world-wide basis, better founded conclusions can be made as to the validity of the branches and divisions. More knowledge about the eggs, pupae, and females also could be quite helpful in studying relationships between species.

The only classification system based on larval characters was that proposed by Dohler (1950) in which he divided the genus into six subgenera. Lepneva (1964) modified this system, proposing seven species groups (Figure 86). She stated that considering these groups as subgenera was premature, since Dohler only studied the larvae of Europe and she studied only those occurring in Russia. The presence or absence of an apicolateral spur on the anal proleg was used as the major point of division by Lepneva. This is probably not a basic separation as can be demonstrated by comparing the larvae of related species in the sibirica group. In this group, R. valuma has a long apicolateral spur, R. narvae has this area slightly elongate, but not actually formed into a spur, and R. blarina does not have this area elongated at all. The gill structure was used as the next major point of division. Many of the larvae studied from Russia have gills, but a minority of the species in North America are gilled.

A classification system based on the larvae of species occurring in western North America could follow the system of species groups of Schmit (1970) rather closely. However, the branches and divisions of Schmid can not be described by any particular set of larval characteristics. Although many of the actual branches used by Ross (1956) are not supported by larval morphology, the idea of using a greater number of branches, as Ross did, might facilitate finding a combination of larval structural characters upon which to identify these

categories above the group level.

The species groups of Rhyacophila at the larval stages could perhaps be grouped into taxa based on the presence or absence of gills. These taxa could then be subdivided using characteristics of the mandibles, head shape, mouthparts, pronotum, anal proleg, and lateral protuberances. A study of the primary and secondary setation, as was done to some degree by Lepneva (1964), might prove to be a very useful means of studying the relationships between the larvae of the species of Rhyacophila. Lepneva (1964) reported that early instars were often less modified than the later instars. A study of all of the stadia and any changes in morphology from one to the next might also be quite helpful in studying relationships between species groups.

In the future, purely morphological definitions of a few individuals of one life stage should be replaced by broader definitions of as many of the life stages and ecological factors as practical. These can then be used when proposing higher categories within the genus Rhyacophila. The describing of Rhyacophila species should be a preliminary step in more far-reaching investigations of the ecological niche of the immature stages in stream systems and of the adults in terrestrial systems.

BIBLIOGRAPHY

- Anderson, N. H. 1967. Biology and downstream drift of some Oregon Trichoptera. *Can. Ent.* 99:507-521.
- Anderson, N. H. and J. L. Wold. 1972. Emergence trap collections of Trichoptera from an Oregon stream. *Can. Ent.* 104: 189-201.
- Badcock, R. M. 1949. Studies on stream life in tributaries of the Welsh Dee. *J. Anim. Ecol.* 18:193-208.
- Balduf, W. V. 1939. The bionomics of entomophagus insects. Part 2. St. Louis. 384 p.
- Banks, N. 1895. New neuropteroid insects. *Trans. Am. ent. Soc.* 22:313-16.
- _____ 1904. Neuropteroid insects from New Mexico. *Trans. Am. ent. Soc.* 30:97-110.
- _____ 1905. Descriptions of new Nearctic neuropteroid insects. *Trans. Am. ent. Soc.* 32:1-20.
- _____ 1907. Catalogue of the neuropteroid insects (except Odonata) of the United States. *Trans. Am. ent. Soc.* 33:1-53.
- _____ 1911. Descriptions of new species of North American neuropteroid insects. *Trans. Am. ent. Soc.* 37:335-360.
- _____ 1914. American Trichoptera--notes and descriptions. *Can. Ent.* 46:148-156; 201-205; 252-258; 261-268.
- _____ 1918. New neuropteroid insects. *Bull. Mus. comp. Zool. Harv.* 62:3-22.
- _____ 1924. Descriptions of new neuropteroid insects. *Bull. Mus. comp. Zool. Harv.* 65:419-455.
- Betten, C. 1934. The caddis flies or Trichoptera of New York State. *New York State Mus. Bull.* 292:1-576.
- Chapman, D. W. and R. Demory. 1963. Seasonal changes in the food ingested by aquatic insect larvae and nymphs in two Oregon streams. *Ecology* 44:140-146.

- Davis, J. J. 1948. The caddis flies of the state of Washington. Master's thesis. Pullman, State College of Washington. 279 numb. leaves.
- _____ 1950. Two new species of caddisflies (Trichoptera) from Washington state. Ann. ent. Soc. Am. 42:448-50.
- Denning, D. G. 1941. Descriptions and notes of new and little known species of Trichoptera. Ann. ent. Soc. Am. 34:195-203.
- _____ 1948a. New and little known species of nearctic Trichoptera. Psyche 55:16-27.
- _____ 1948b. A review of the Rhyacophilidae (Trichoptera). Can. Ent. 80:97-117.
- _____ 1949. New species of nearctic caddis flies. Bull. Brooklyn ent. Soc. 44:37-48.
- _____ 1950. Records and descriptions of nearctic caddis flies. Part II. J. Kans. ent. Soc. 23:115-120.
- _____ 1954. New species of Western Trichoptera. J. Kans. ent. Soc. 29:57-64.
- _____ 1956. Several species of Western Trichoptera. Pan.-Pacif. Ent. 32:73-78.
- _____ 1963. Trichoptera. In Aquatic insects of California, ed. by R. L. Usinger. Univ. California Press, Berkeley. p. 237-270.
- _____ 1965a. New Trichoptera from United States and Mexico. Pan-Pacif. Ent. 41:262-272.
- _____ 1965b. New rhyacophilids and limnephilids (Trichoptera:Rhyacophilidae and Limnephilidae). Can. Ent. 97:690-700.
- _____ 1968. New species and notes of Western Trichoptera. J. Kans. ent. Soc. 41:63-69.
- _____ 1971. A new genus and new species of Trichoptera. Pan-Pacif. Ent. 47(3):202-210.

- Denning, D. G. and F. Schmid. 1971. Descriptions of four new Rhyacophila (Trichoptera:Rhyacophilidae). Can. Ent. 103: 1553-1556.
- Dodds, G. S. and F. L. Hisaw. 1925. Ecological studies on aquatic insects. IV. Altitudinal range and zonation of mayflies, stoneflies, and caddis flies in the Colorado Rockies. Ecology 6:380-390.
- Döhler, W. 1950. Zur Kenntnis der Gattung Rhyacophila im mitteleuropäischen Raum (Trichoptera). Arch. Hydrobiol. 44(2):271-293.
- Essig, E. O. 1926. Insects of Western North America. New York, Macmillan. 1035 pp.
- Evans, E. D. 1972. A study of the Megaloptera of the Pacific coastal region of the United States. Ph. D. thesis. Corvallis, Oregon State University. 210 numb. leaves.
- Flint, O. S. 1961. The presumed larva of Himalopsyche phryganea (Ross) (Trichoptera:Rhyacophilidae). Pan-Pacif. Ent. 37(4): 199-202.
- _____. 1962. Larvae of the caddis fly genus Rhyacophila in eastern North America (Trichoptera, Rhyacophilidae). Proc. U. S. natn. Mus. 113:465-493.
- Jones, J. R. E. 1950. A further ecological study of calcareous streams in the Black Mountain district of South Wales. J. An. Ecol. 18:142-159.
- Knowlton, G. F. and F. C. Harmston. 1938. Notes on Utah Plecoptera and Trichoptera. Ent. News 49:284-286.
- Kolenati, F. 1848. Genera et species Trichopterorum. Moscow. 108 p.
- Lepneva, S. G. 1955. Lichinki rucheinika Rhyacophila narvae Nav. (Trichoptera, Annulipalpia, Rhyacophilidae). Trudy Zool. Inst. AN SSSR. 21:271-277.
- _____. 1964. Licinki i kukolki podotriada koltchatosciupikovih (Annulipalpia). Fauna SSSR, Rucheyniki II, vip. 1, Moskva-Leningrad. 560 p.

- Ling, S. 1938. A few new caddis flies in the collection of the California Academy of Sciences. Pan-Pacif. Ent. 14(2):59-69.
- Lloyd, J. T. 1921. The biology of North American caddis fly larvae. Bull. Lloyd Libr. 21:1-124.
- Martynov, A. V. 1934. Rucheiniki. Trichoptera, Annulipalpia. I. (Caddis Flies. Trichoptera, Annulipalpia, I.). Opredeletel' po Faune SSSR, 13:1-343, Leningrad, Izd. Zoologicheskogo Instituta AN SSSR.
- _____. 1935. Rucheiniki (Trichoptera) Amurskogo kraya. Trudy Zoologicheskogo Inst. AN SSSR, 2:205-395.
- Mecom, J. O., and K. W. Cummins. 1964. A preliminary study of the trophic relationships of the larvae of Brachycentrus americanus (Banks) (Trichoptera:Brachycentridae). Trans. Am. Microscop. Soc. 83:233-43.
- Milne, L. J. 1936. Studies in North American Trichoptera. 3:56-128. Cambridge, Massachusetts.
- Milne, M. J. 1938. The "metamorphotype method" in Trichoptera. J. New York ent. Soc., 46:435-37.
- Milne, M. J. and L. J. Milne. 1940. A new species of Rhyacophila described from metamorphotypes (Rhyacophilidae:Trichoptera). Bull. Brooklyn ent. Soc. 35:153-156.
- Muttkowski, R. A. 1929. The ecology of trout streams in Yellowstone National Park. Roosevelt Wild Life Ann. 2:155-240.
- Muttkowski, R. A. and G. M. Smith. 1929. The food of trout stream insects in Yellowstone National Park. Roosevelt Wild Life Ann. 2:241-263.
- Navás, L. 1926. Veinticinco formos nuevos de insectos. Bol. Soc. iber. Cienc. Nat. Zaragossa 26:48-75.
- Nielsen, A. 1942. Über die Entwicklung und Biologie der Trichopteren mit besonderer Berücksichtigung der Quelltrichopteren Himmerlands. Arch. Hydrobiol., Suppl. 17:255-621.

- Nimmo, A. 1971. The adult Rhyacophilidae and Limnephilidae (Trichoptera) of Alberta and eastern British Columbia and their post-glacial origin. *Quaest. Ent.* 7:3-234.
- Pictet, F. J. 1834. *Recherches pour servir à l'histoire et à l'anatomie des phryganides.* Geneva. 235 p.
- Ross, H. H. 1938a. Descriptions of new North American Trichoptera. *Proc. ent. Soc. Wash.* 40:117-124.
- _____ 1938b. Lectotypes of North American caddis flies in the Museum of Comparative Zoology. *Psyche* 45:1-61.
- _____ 1938c. Descriptions of nearctic caddis flies (Trichoptera) with species reference to the Illinois species. *Bull. Ill. St. nat. Hist. Survey.* 21:101-183.
- _____ 1941. Descriptions and records of North American Trichoptera. *Trans. Am. ent. Soc.* 67:35-126.
- _____ 1944. The caddis flies, or Trichoptera, of Illinois. *Bull. Ill. St. nat. Hist. Surv.* 23:1-326.
- _____ 1947. Descriptions and records of North American Trichoptera, with synoptic notes. *Trans. Am. ent. Soc.* 73:125-168.
- _____ 1948. New nearctic Rhyacophilidae and Philopotamidae (Trichoptera). *Ann. ent. Soc. Am.* 41:17-26.
- _____ 1950. New species of nearctic *Rhyacophila* (Trichoptera, Rhyacophilidae). *J. Wash. Acad. Sci.* 40:260-265.
- _____ 1951. The Trichoptera of Lower California. *Proc. Calif. Acad. Sci.* 27:65-76.
- _____ 1956. Evolution and classification of the mountain caddis flies. University of Illinois Press, Urbana. 213 p.
- _____ 1965. Pleistocene events and insects. In Wright, H. E., Jr., and D. G. Frey, (eds.), *The Quaternary of the United States.* Princeton University Press. p. 583-595.

- Ross, H. H. and G. J. Spencer. 1952. A preliminary list of the Trichoptera of British Columbia. Proc. ent. Soc. Br. Columb. 48:43-51.
- Schmid, F. 1958. A propos de deux récents ouvrages sur la phylogénie et la zoogéographie des Trichoptères. Miscelánea zool. Barcelona. 1:1-27.
- _____. 1970. Le genre Rhyacophila et la famille des Rhyacophilidae (Trichoptera). Mem. ent. Soc. Can. 66:1-230.
- Schmid, F. and R. Guppy. 1952. An annotated list of Trichoptera collected on southern Vancouver Island. Proc. ent. Soc. Br. Columb. 48:41-42.
- Scott, D. 1950. Ecological studies on the Trichoptera of the River Dean, Cheshire. Arch. Hydrobiol. 54(3):340-392.
- Scherberger, F. F. and J. B. Wallace. 1971. Description of the larval stage of Rhyacophila vuphiphes Milne (Trichoptera: Rhyacophilidae). N. Y. ent. Soc. 79(1):43-44.
- Siltala, A. J. 1906. Trichopterologische Untersuchungen. I. Über den Laich der Trichopteren. Acta. Soc. Fauna Flora Fenn. 28:1-128.
- Slack, H. D. 1936. The food of caddis fly (Trichoptera) larvae. J. Anim. Ecol. 5:105-15.
- Smith, S. D. 1965. Distributional and biological records of Idaho caddisflies (Trichoptera). Ent. News 76:242-245.
- _____. 1968. The Rhyacophila of the Salmon River drainage of Idaho with special reference to larvae. Ann. ent. Soc. Am. 61:655-674.
- Tew, M. P. 1971. The species composition and adaptations of insects in an intermittent stream in western Oregon. Master's thesis. Corvallis, Oregon State University. 84 numb. leaves.
- Thut, R. 1967. Studies on the Weyerhaeuser experimental streams. Interim Report no. 2. 87 p.

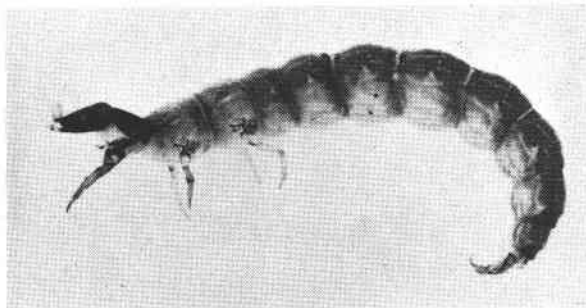
- Thut, R. 1969. Feeding habits of larvae of seven Rhyacophila (Trichoptera:Rhyacophilidae) species with notes on other life-history features. Ann. ent. Soc. Am. 62:894-898.
- Ulmer, G. 1905. Über die geographische Verbreitung der Trichopteren. Zeitschr. Wiss. Insekt Biol. 1:68-80.
- _____ 1907. Trichoptera. Genera Insect. Hamburg. 60:1-259.
- _____ 1932. Die Trichopteren, Ephemeropteren und Plecopteren der arktischen gebeits. Fauna arct. 6:207-226.
- _____ 1957. Köcherfliegen (Trichopteren) von den Sunda-Inseln. Teil III. Arch. Hydrobiol. 23:109-470.
- Unzicker, J. D. 1968. The comparative morphology and evolution of the internal female reproductive system of Trichoptera. Illinois biol. Monogr. 40:1-72.
- Vorhies, C. T. 1909. Studies on the Trichoptera of Wisconsin. Trans. Wis. Acad. Sci. Arts. Lett. 16:647-738.

APPENDIX

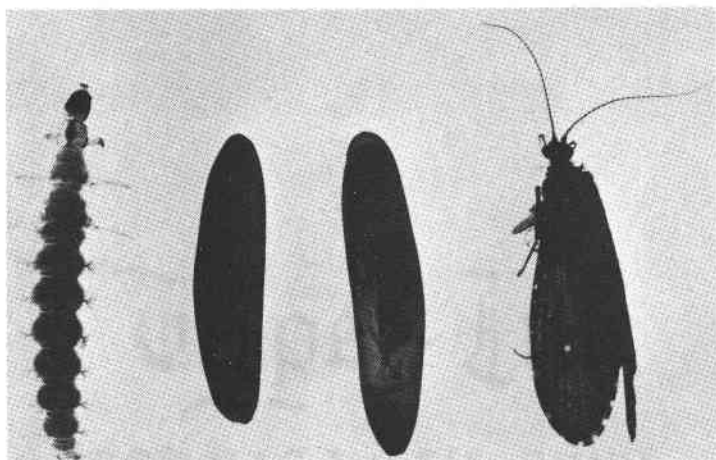
- Figure 1. Rotunda group, Rhyacophila norcuta Ross egg.
- Figure 2. Betteni group, Rhyacophila sp. larva.
- Figure 3. Acropedes group, Rhyacophila grandis Banks larva, pupae, and adult.
- Figure 4. Angelita group, Rhyacophila angelita Banks larva.
- Figure 5. Top, Himalopsyche phryganea (Ross) larva. Left to right: Sibirica group, Rhyacophila narvae Navas 2 larvae; Acropedes group, R. acropedes Banks larva; Nevadensis group, R. vaefes Milne larva; and Acropedes group, R. grandis Banks larva.



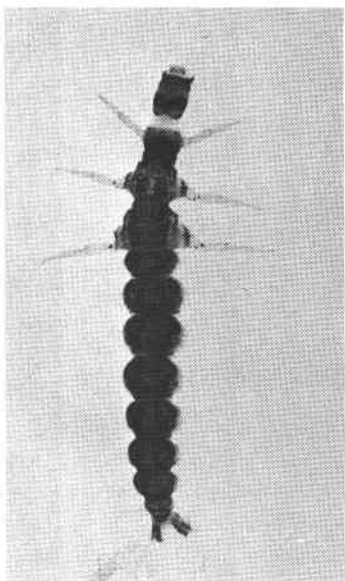
1



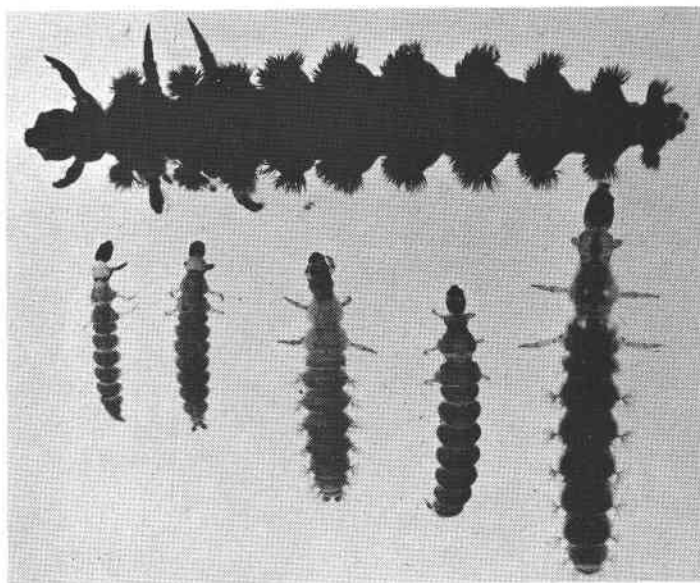
2



3



4



5

Figure 6. Rhyacophila larval head, viewed dorsally, illustrating terminology of parts.

Abbreviations: CS-coronal suture; FC-frontoclypeus; FS-frontal suture; GE-gena; and MS-muscle scars.

Figure 7. Rhyacophila larval anal proleg illustrating terminology of parts.

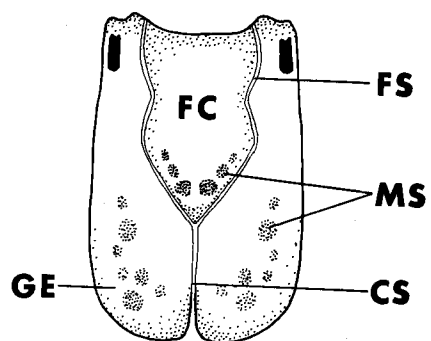
Abbreviations: ALS-apicolateral spur; BVH-basoverventral hook; CL-claw; and VT-ventral teeth of claw.

Figures 8-10. Rotunda group, Rhyacophila norcuta Ross larva.

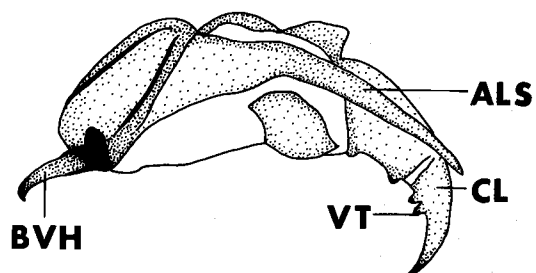
8. Head, dorsal view.
9. Mandibles, dorsal view.
10. Anal proleg, lateral view.

Figures 11-12. Oreta group, Rhyacophila oreta Ross larva.

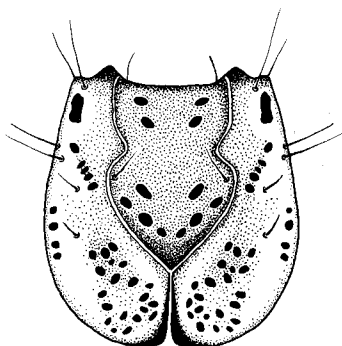
11. Head, dorsal view.
12. Mandibles, dorsal view.



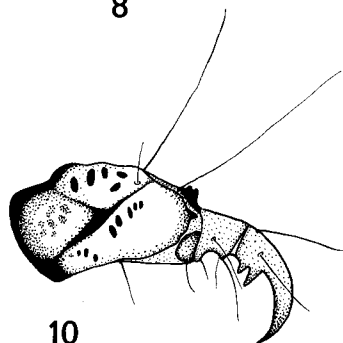
6



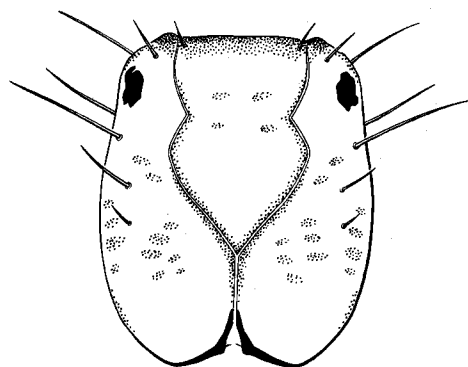
7



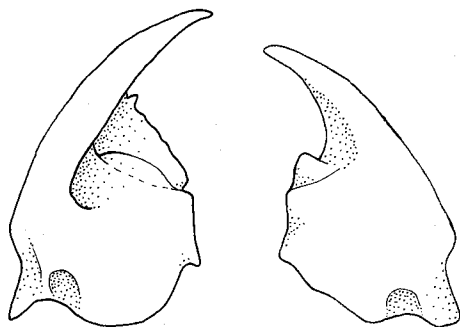
8



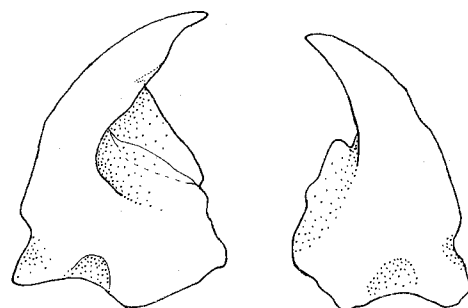
10



11



9



12

Figure 13. Oreta group, Rhyacophila oreta Ross, larval anal proleg, lateral view.

Figures 14-16. Vagrita group, Rhyacophila vagrita Milne larva.

14. Head, dorsal view.

15. Mandibles, dorsal view.

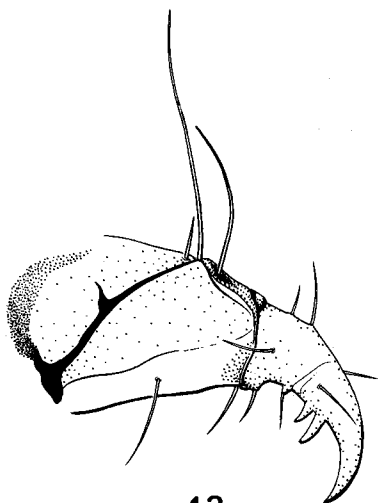
16. Anal proleg, lateral view.

Figures 17-19. Alberta group, Rhyacophila kincaidi Schmid larva.

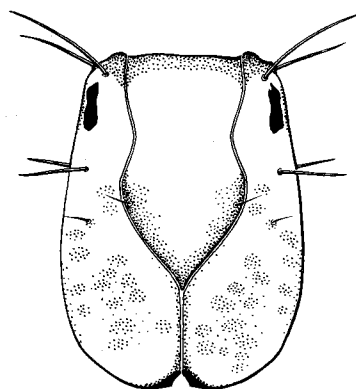
17. Head, dorsal view.

18. Mandibles, dorsal view.

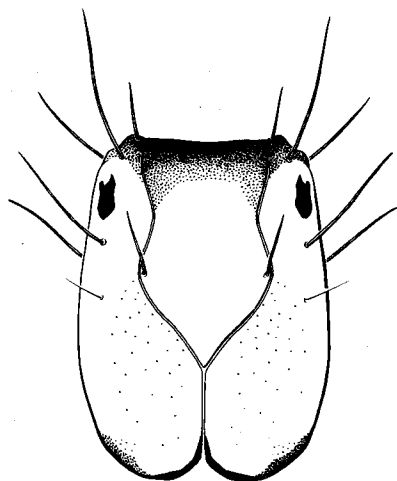
19. Anal proleg, lateral view.



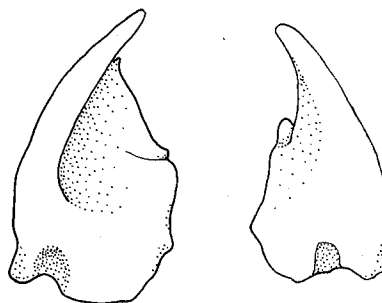
13



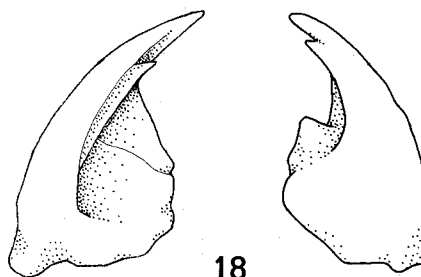
17



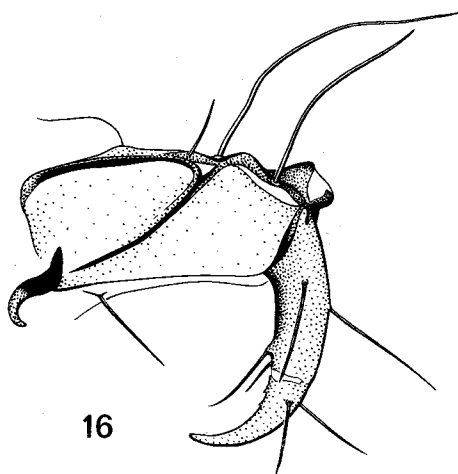
14



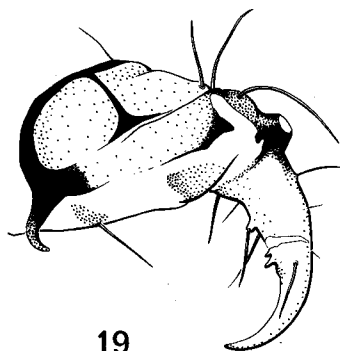
15



18



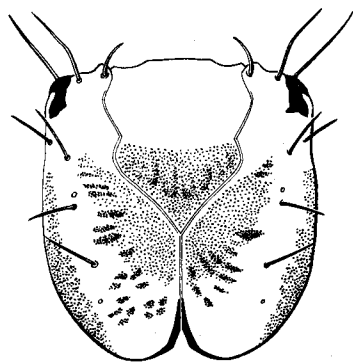
16



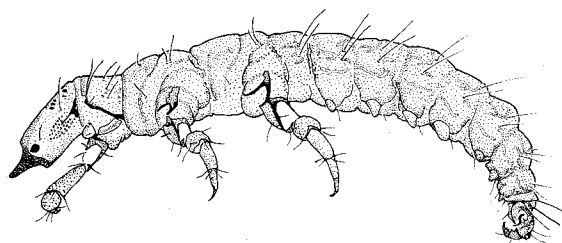
19

Figures 20-25. Hyalinata group, Rhyacophila vocala Milne larva.

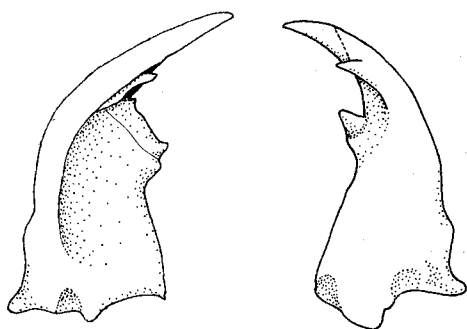
20. Head, dorsal view.
21. Mature larva, lateral view.
22. Mandibles, dorsal view.
23. Fleshy lateral protuberances, abdominal segments VII and VIII, dorsal view.
24. Fleshy lateral protuberances, third abdominal segment, lateral view.
25. Anal proleg, lateral view.



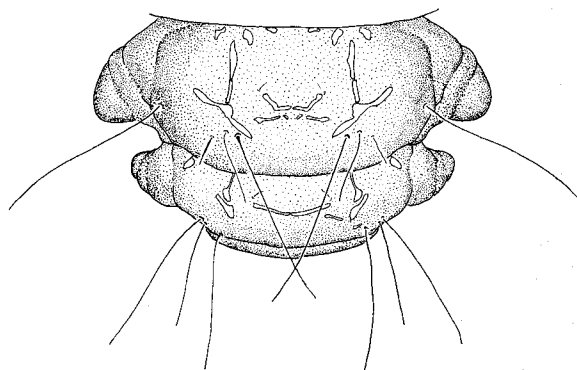
20



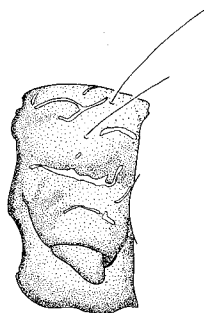
21



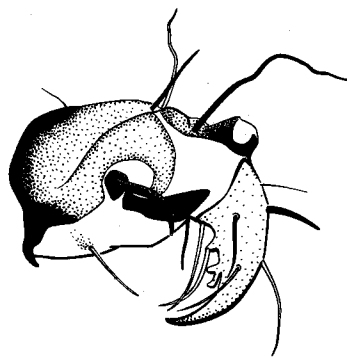
22



23



24



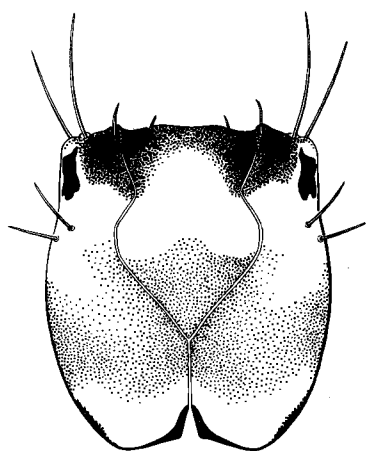
25

Figures 26-28. Coloradensis group, Rhyacophila coloradensis
Banks larva.

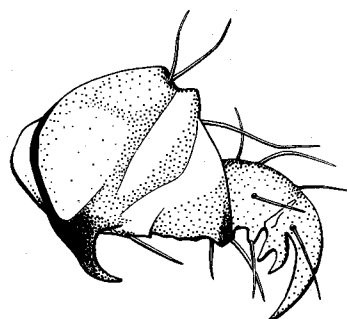
- 26. Head, dorsal view.
- 27. Mandibles, dorsal view.
- 28. Anal proleg, lateral view.

Figures 29-31. Angelita group, Rhyacophila angelita Banks larva.

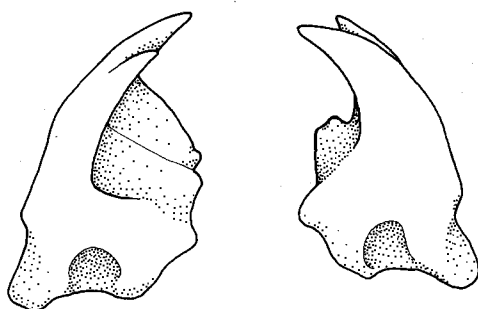
- 29. Head, dorsal view.
- 30. Mandibles, dorsal view.
- 31. Anal proleg, lateral view.



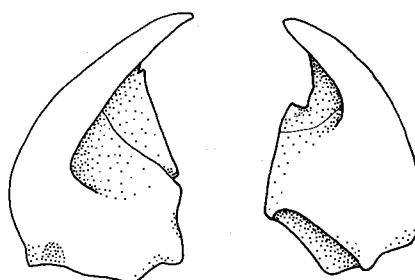
26



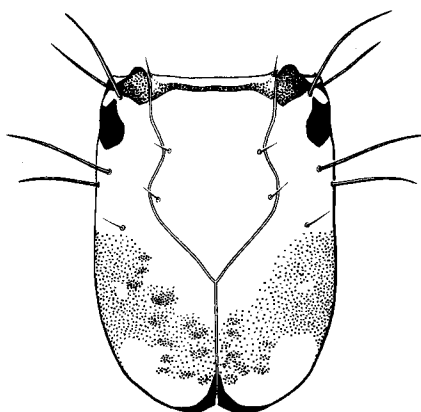
28



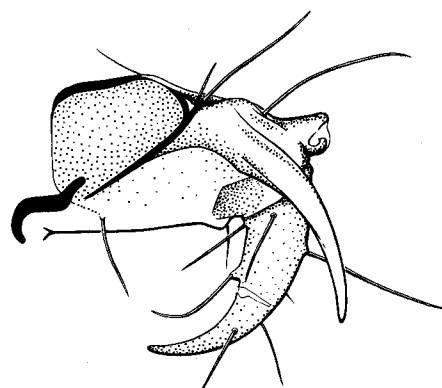
27



30



29



31

Figure 32. Angelita group, Rhyacophila angelita Banks larva, lateral view.

Figures 33-35. Rayneri group, Rhyacophila rayneri Ross larva.

33. Head, dorsal view.

34. Mandibles, dorsal view.

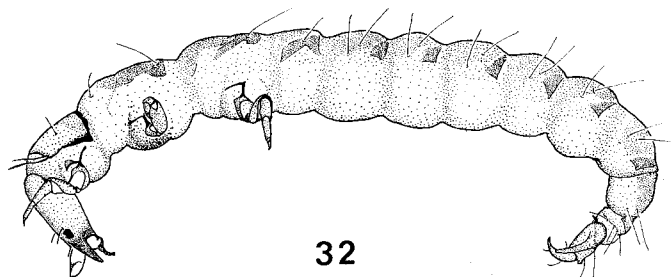
35. Anal proleg, lateral view.

Figures 36-38. Sibirica group, Rhyacophila valuma Milne larva.

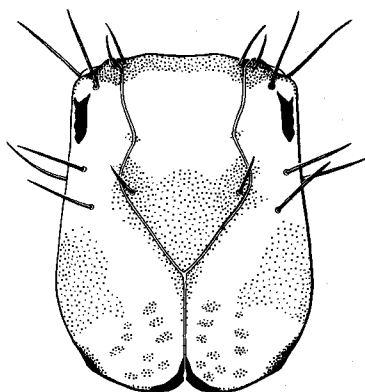
36. Head, dorsal view.

37. Mandibles, dorsal view.

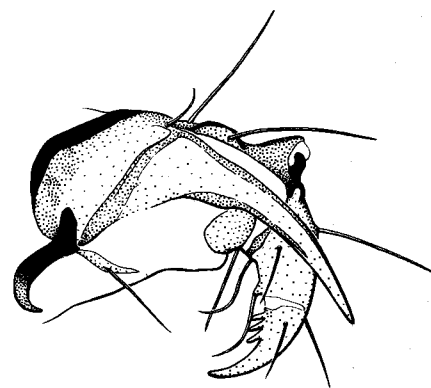
38. Anal proleg, lateral view.



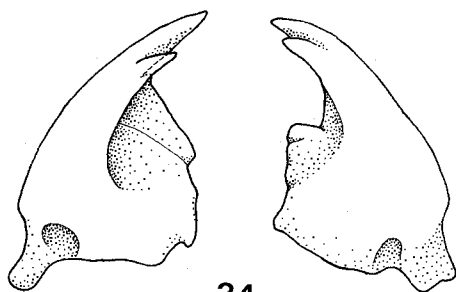
32



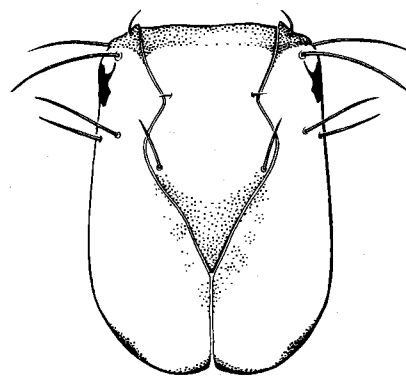
33



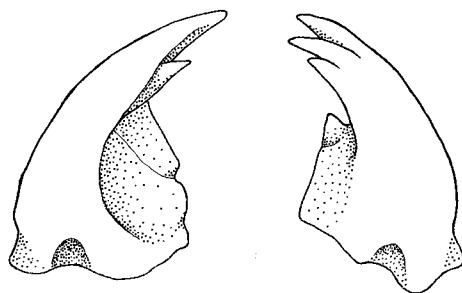
35



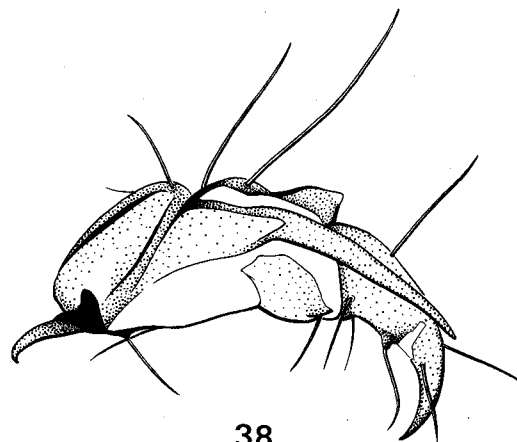
34



36



37



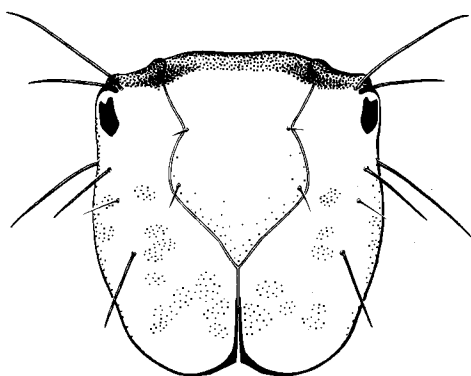
38

Figures 39-41. Sibirica group, Rhyacophila blarina Ross larva.

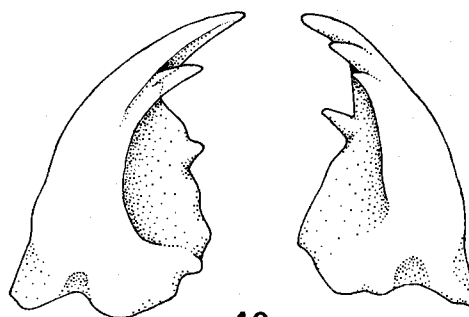
- 39. Head, dorsal view.
- 40. Mandibles, dorsal view.
- 41. Anal proleg, lateral view.

Figures 42-45. Sibirica group, Rhyacophila narvae Navas larva.

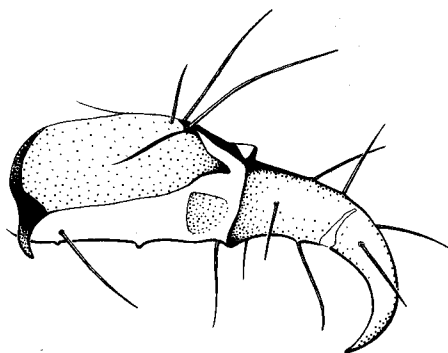
- 42. Head, dorsal view.
- 43. Mandibles, dorsal view.
- 44. Mature larva, lateral view.
- 45. Anal proleg, lateral view.



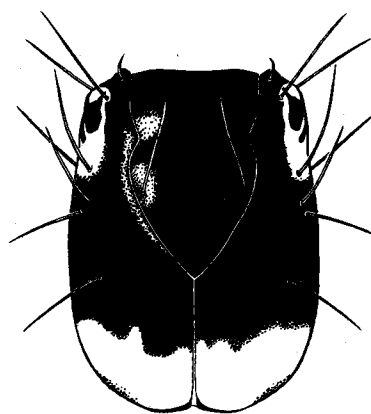
39



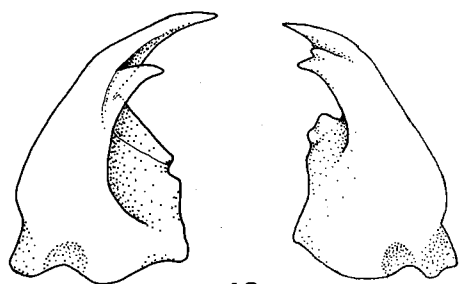
40



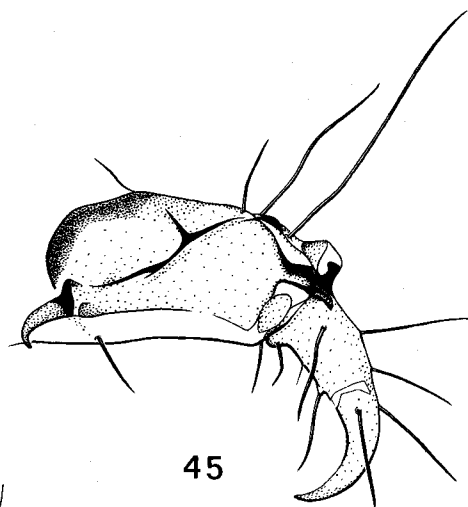
41



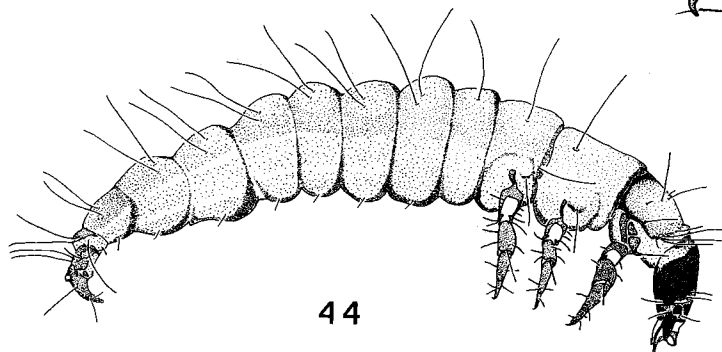
42



43



45



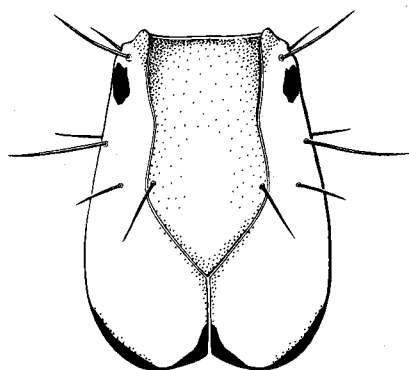
44

Figures 46-48. Vofixa group, Rhyacophila velora Denning larva.

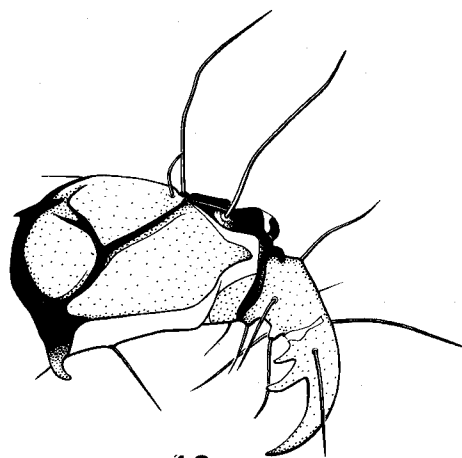
- 46. Head, dorsal view.
- 47. Mandibles, dorsal view.
- 48. Anal proleg, lateral view.

Figures 49-54. Betteni group, Rhyacophila vaccua Milne larva.

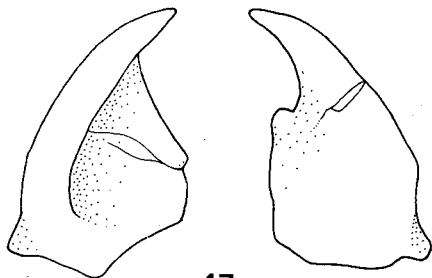
- 49. Mature larva, lateral view.
- 50. Head, dorsal view.
- 51. Head, lateral view.
- 52. Maxillary palpus.
- 53. Mandibles, dorsal view.
- 54. Anal proleg, lateral view.



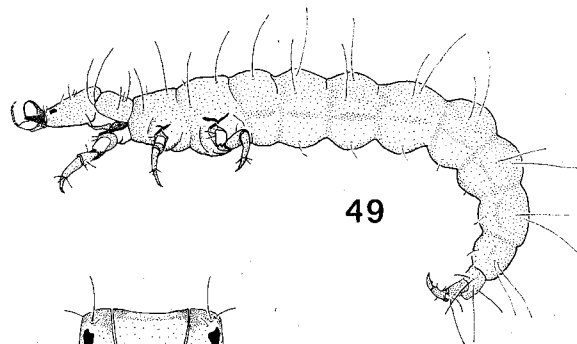
46



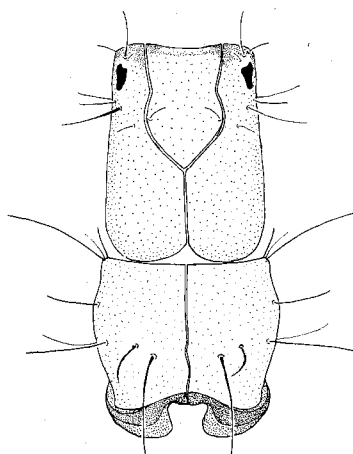
48



47



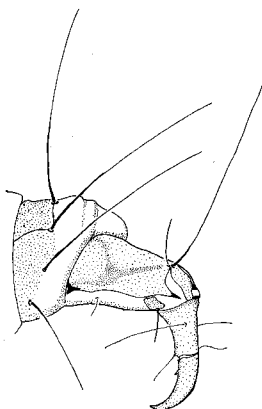
49



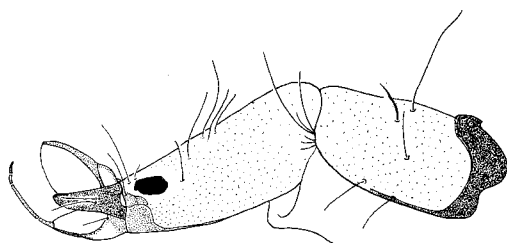
50



52



54



51



53

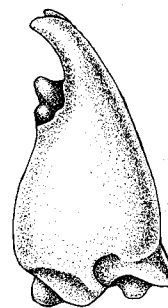


Figure 55. Betteni group, Rhyacophila malkini Ross larval head, dorsal view.

Figures 56-58. Verrula group, Rhyacophila verrula Milne larva.

56. Head, dorsal view.

57. Mandibles, dorsal view.

58. Anal proleg, lateral view.

Figures 59-63. Acropedes group, Rhyacophila acropedes Banks larva.

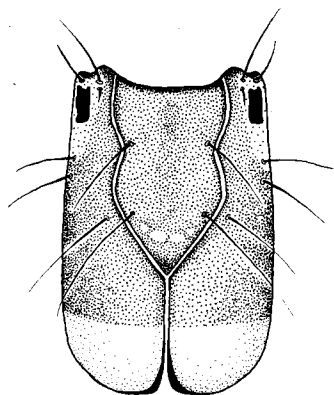
59. Mature larva, lateral view.

60. Head, dorsal view.

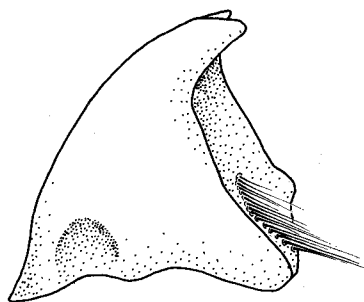
61. Mandibles, dorsal view.

62. Anal proleg, lateral view.

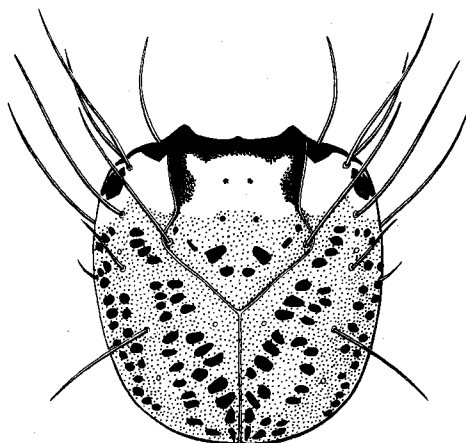
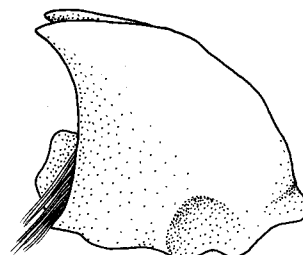
63. Abdominal gill.



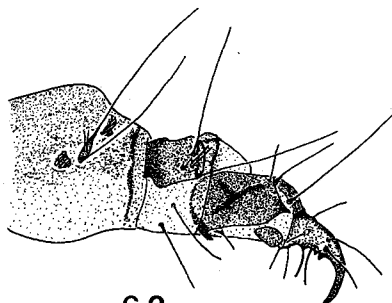
55



57



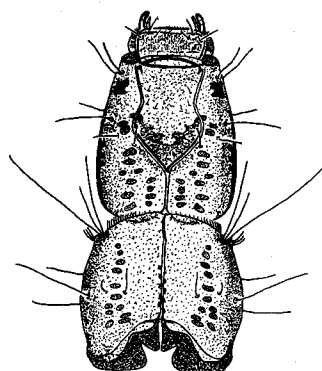
56



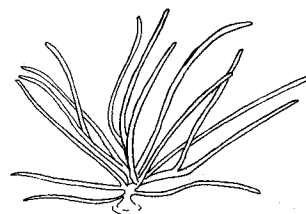
62



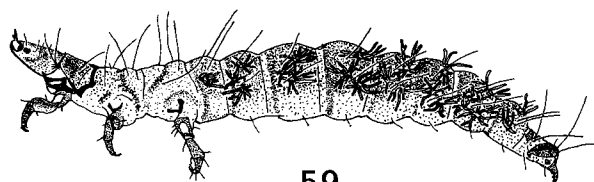
58



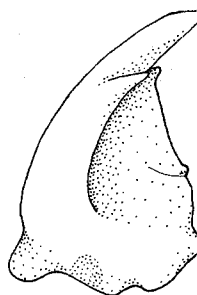
60



63



59



61

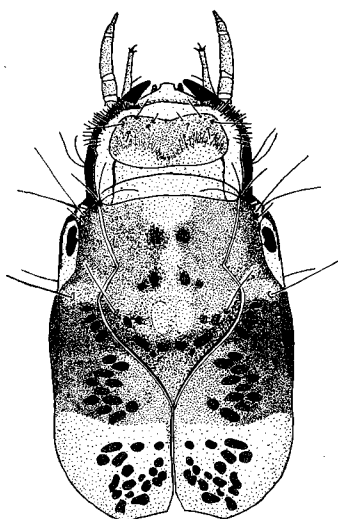


Figures 64-67. Acropedes group, Rhyacophila grandis Banks larva.

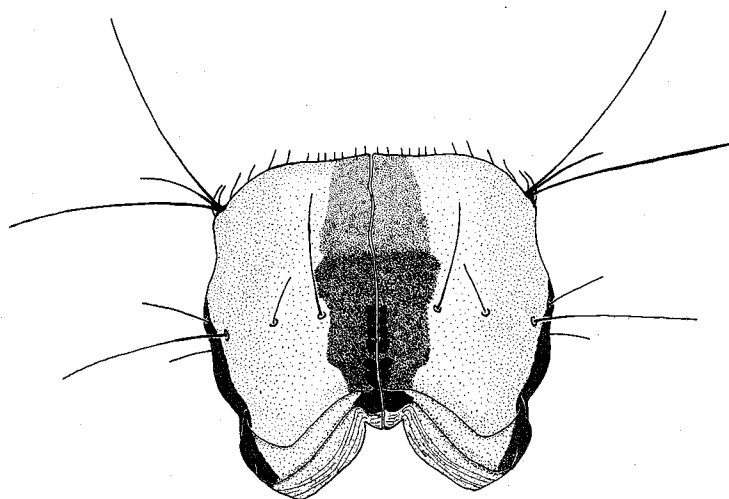
- 64. Head, dorsal view.
- 65. Pronotum, dorsal view.
- 66. Maxillary palpus.
- 67. Anal proleg, lateral view.

Figures 68-70. Lieftincki group, Rhyacophila arnaudi Denning larva.

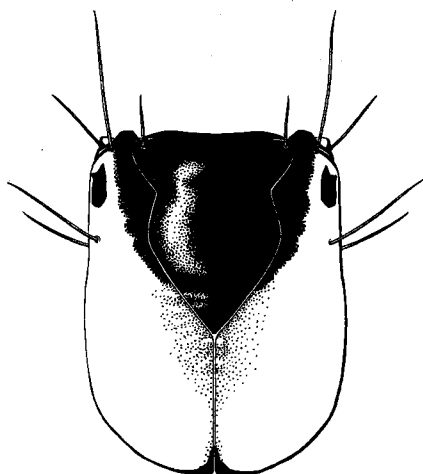
- 68. Head, dorsal view.
- 69. Mandibles, dorsal view.
- 70. Anal proleg, lateral view.



64



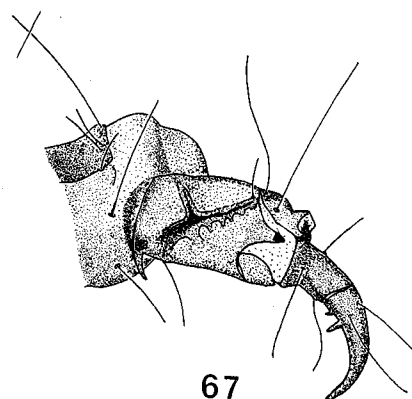
65



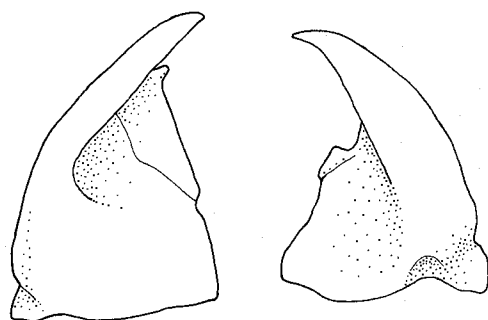
68



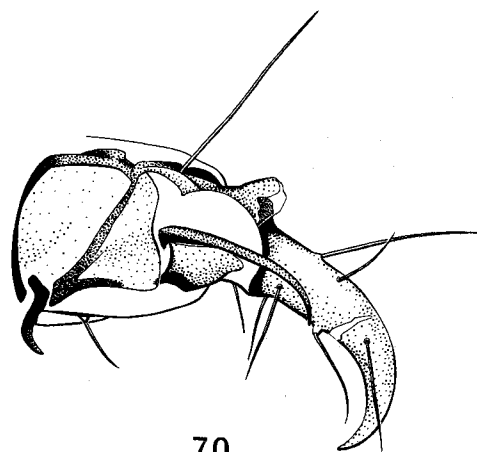
66



67



69



70

Figures 71-73. Nevadensis group, Rhyacophila vaefes Milne larva.

71. Head, dorsal view.

72. Mandibles, dorsal view.

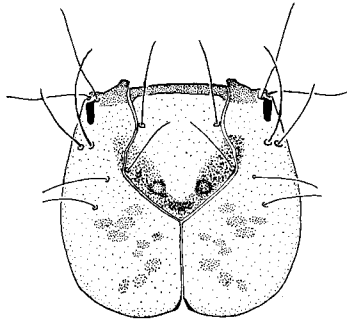
73. Anal proleg, lateral view.

Figures 74-75. Oreia group, Rhyacophila oreia Ross larval sclerites from metamorphotype.

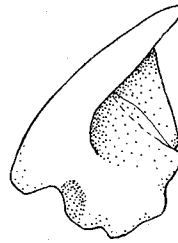
74. Mandibles, dorsal view.

75. Anal proleg, lateral view.

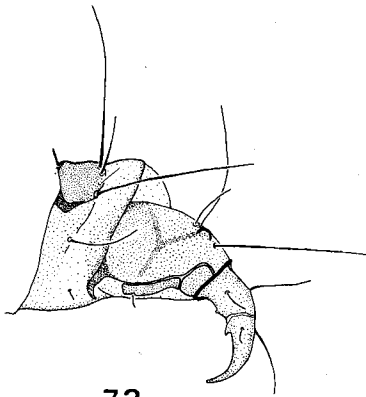
Figure 76. Oreia group, Rhyacophila visor Milne larval head, dorsal view.



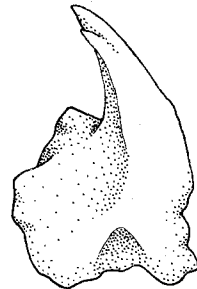
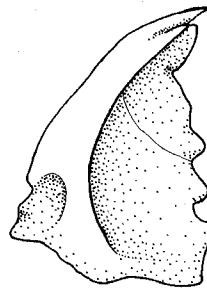
71



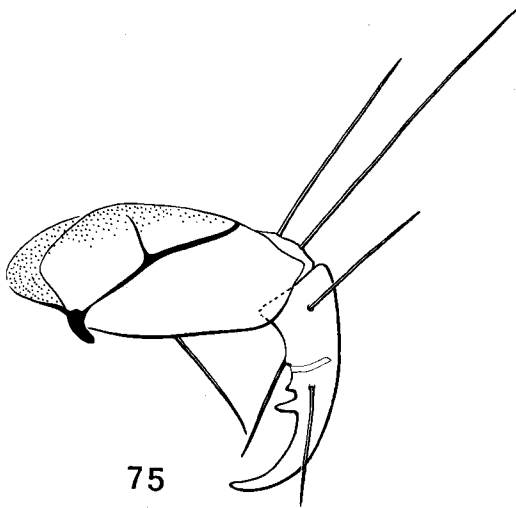
74



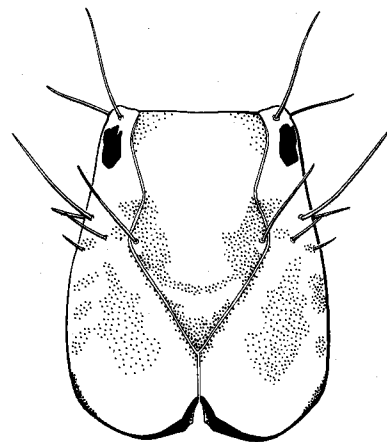
73



72



75



76

Figures 77-78. Oreia group, Rhyacophila visor Milne larva.

77. Mandibles, dorsal view.

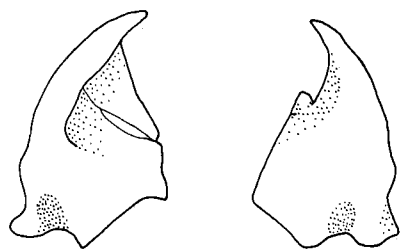
78. Anal proleg, lateral view.

Figures 79-81. Rhyacophila species #1, probably R. ecosa Ross, larva.

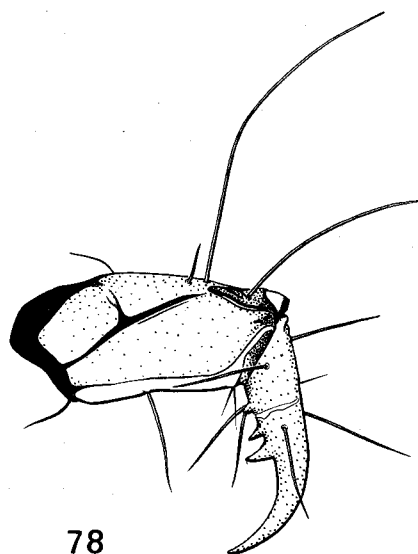
79. Head, dorsal view.

80. Mandibles, dorsal view.

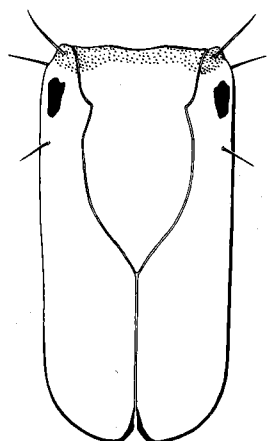
81. Anal proleg, lateral view.



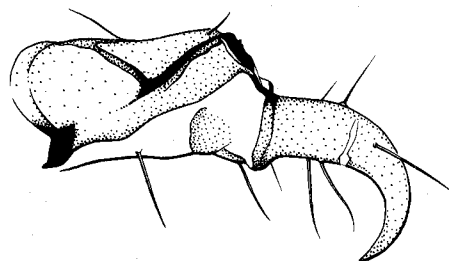
77



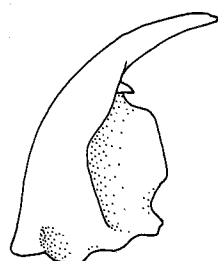
78



79



81



80

Figure 82. Ross' (1956) dendrogram showing relationships of the species groups and branches proposed for the Rhyacophila of western North America.

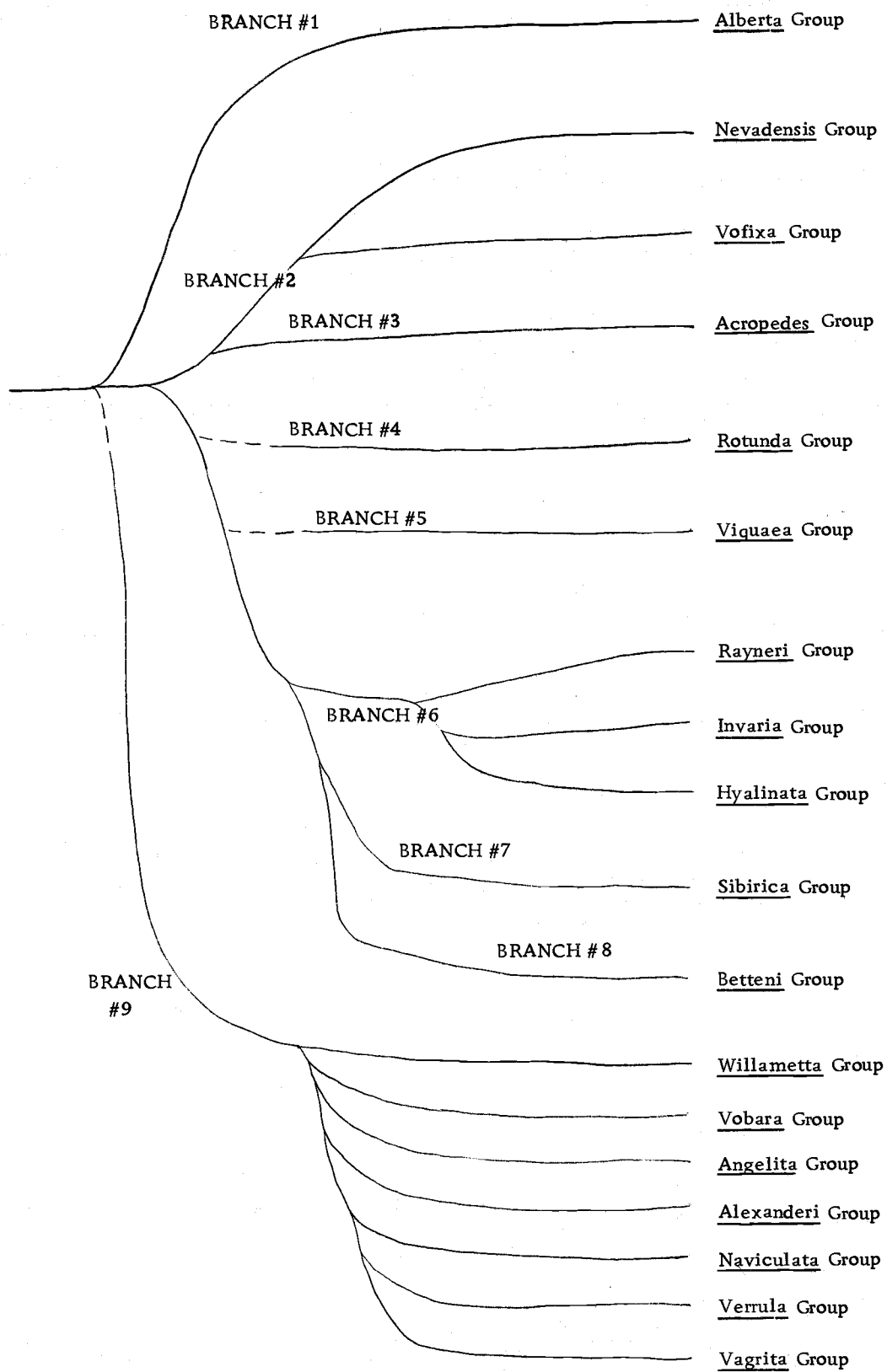


Figure 83. Schmid's (1970) dendrogram showing relationships of the species groups, branches, and divisions of Rhyacophila. Taxa not occurring in western North America are not included. Rayneri group added on basis of larval affinities.

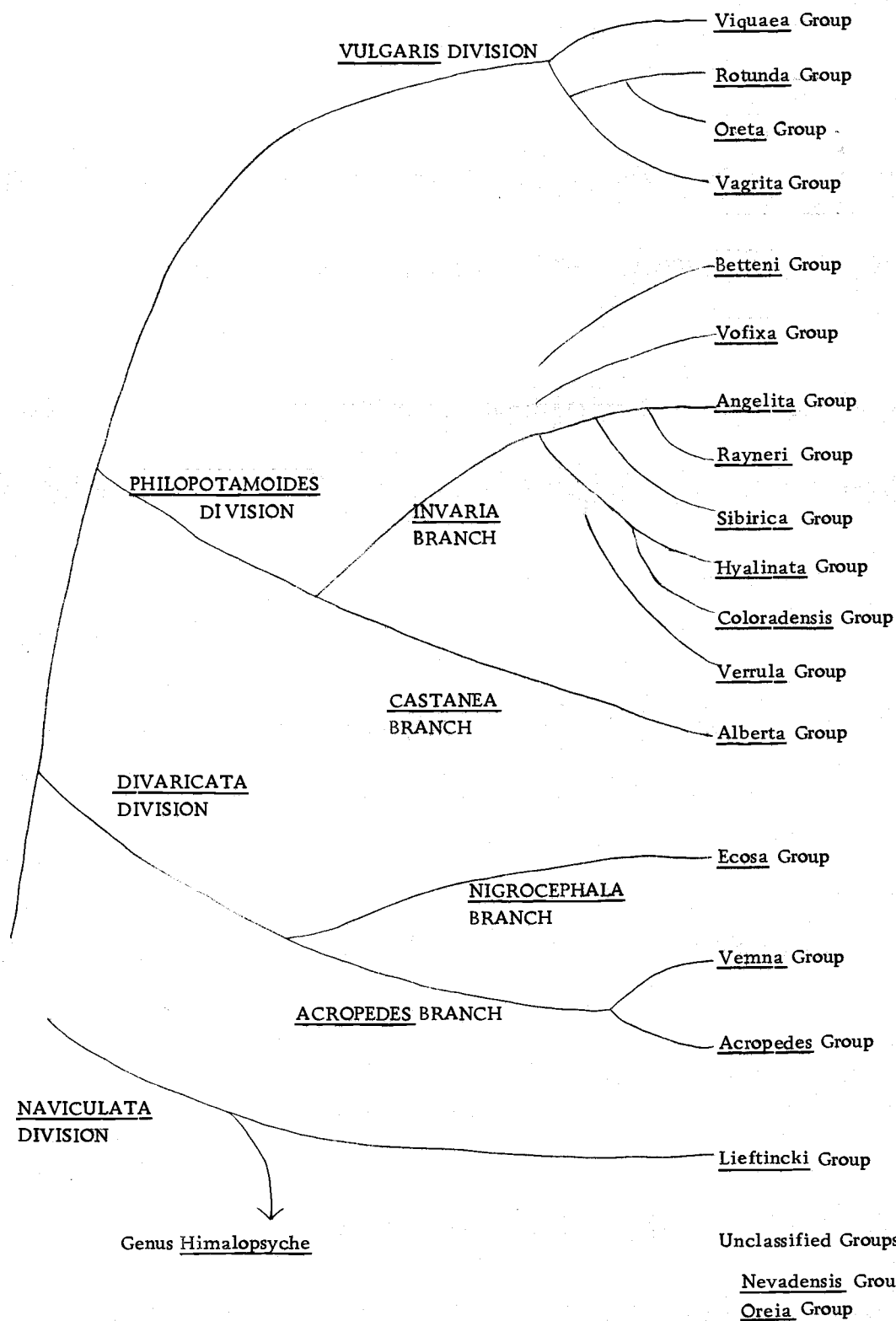


Figure 84. Dendrogram of invaria and castanea branches of the philopotamoides division of the genus Rhyacophila. Larval characters are superimposed on the arrangement proposed by Schmid (1970) for adults. Abbreviations: apl. spur-apicolateral spur on anal proleg; mand. -mandible; R-right mandible; L-left mandible; 1A-one apical tooth on mandible; 2A-two apical teeth on mandible; 3A-three apical teeth on mandible; 1SA-one sub-apical tooth on mandible; 1M-1 mesal tooth on mandible; cylin. head-cylindrical head; FLP-fleshy lateral protuberances on abdomen.

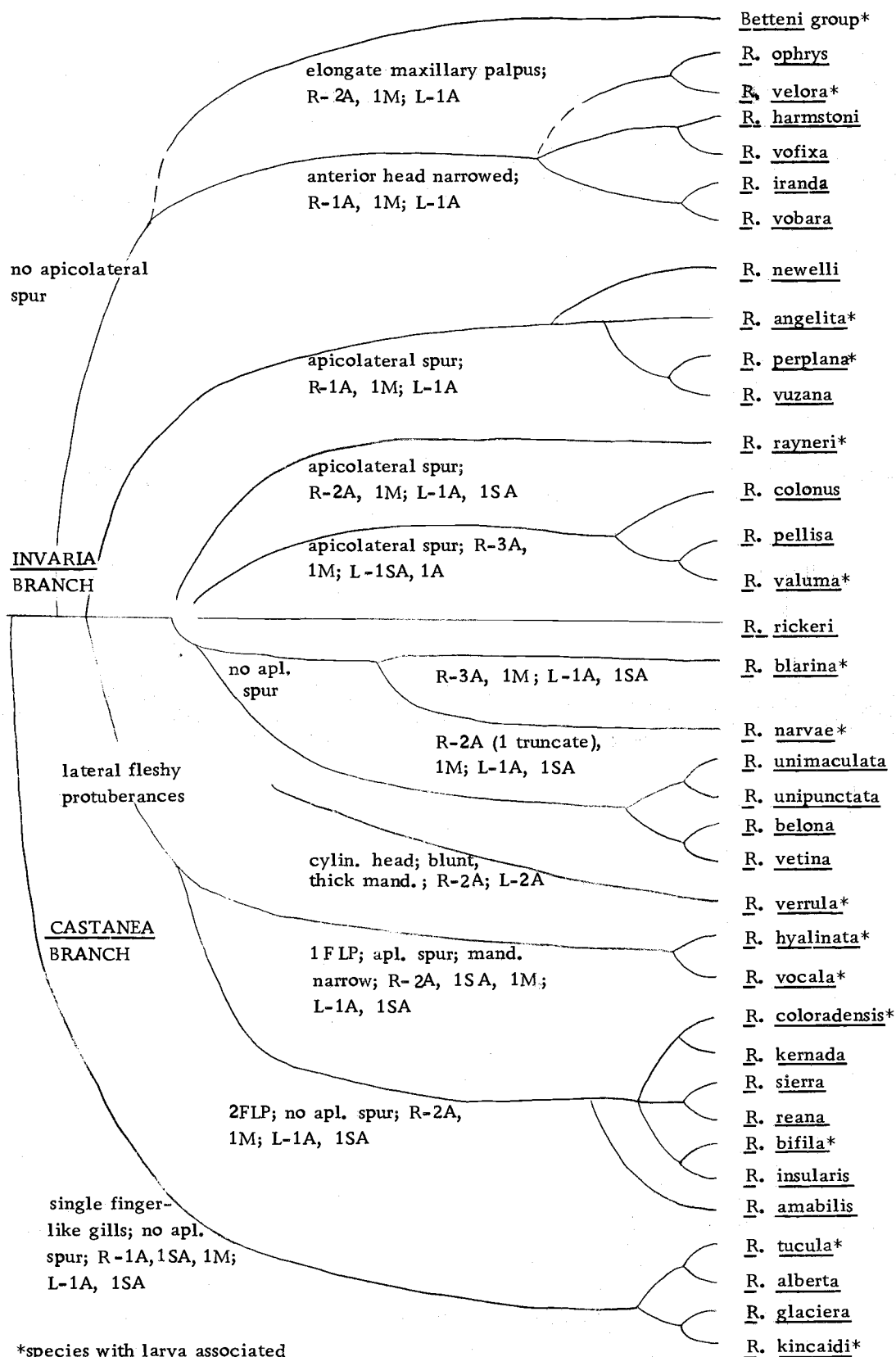
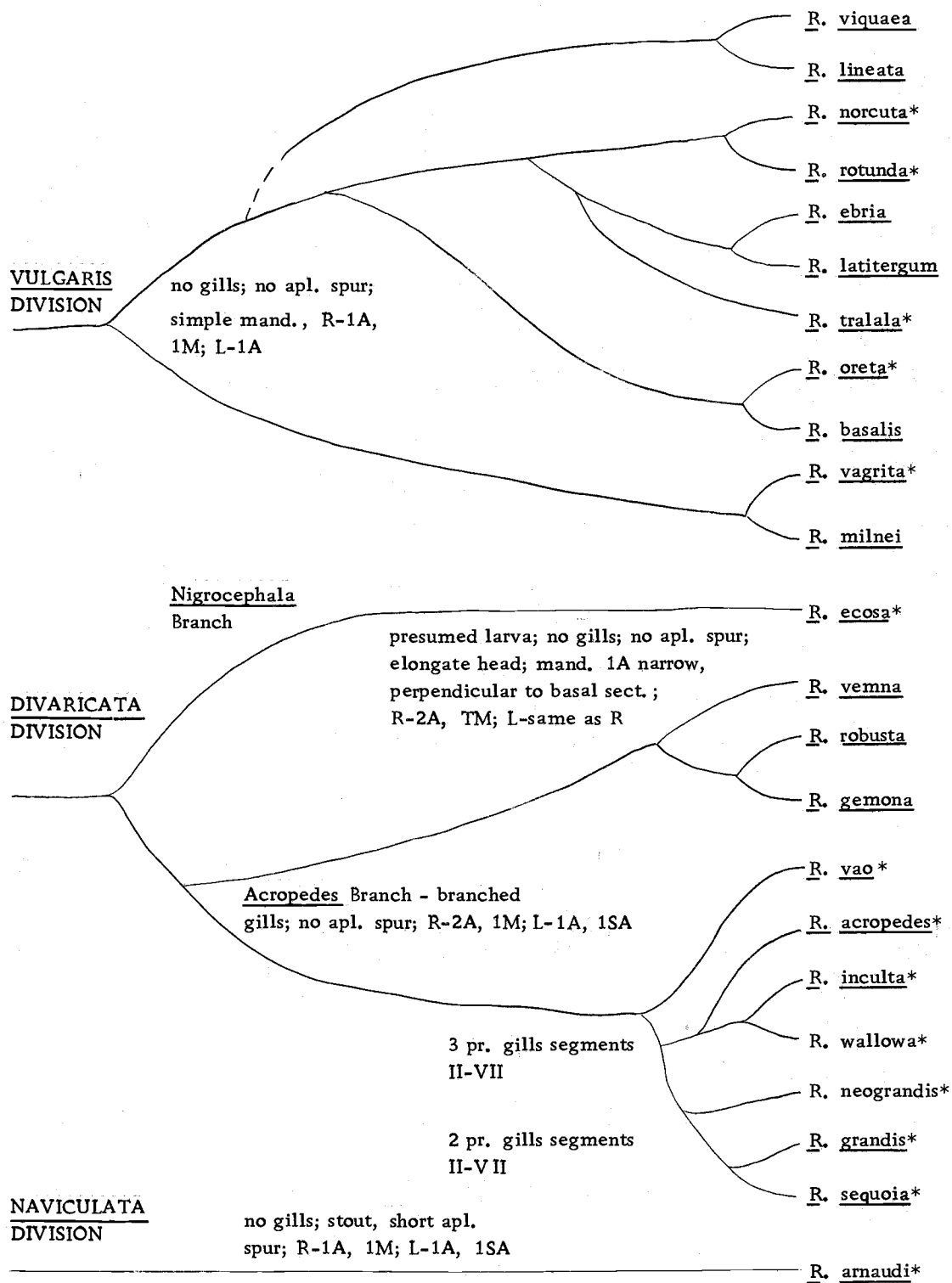


Figure 85. Dendrograms of vulgaris, divaricata, and naviculata divisions of genus Rhyacophila. Larval characters are superimposed on the arrangement proposed by Schmid (1970) for adults.

Abbreviations: apl. spur-apicolateral spur on anal proleg; mand. -mandible; R-right mandible; L-left mandible; 1A-one apical tooth on mandible; 2A-two apical teeth on mandible; 1SA-one subapical tooth on mandible; 1M-1 mesal tooth on mandible; TM-large truncated mesal tooth on mandible.



*species with larva associated

Figure 86. Dendrograms showing species groups of Rhyacophila proposed by Dohler (1950) and modified by Lepneva (1964), based on the larval characters.

