35. HEMIPTERA

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Introduction

The Hemiptera, here considered to include both the Heteroptera and the Homoptera, is the largest Order of the Exopterygota, and has characteristic piercing and sucking mouth parts. The Heteroptera and Homoptera were apparently derived from a common ancestral stock prior to the beginning of the Permian (Evans 1963).

The Heteroptera, the adults of which are characterized by the possession of hemelytra, is usually divided into two infraorders (Gymnocerata and Cryptocerata), but a recent trend is to recognize a larger number of superfamilies (Cobben 1968, 1978). Similarly, in the Homoptera, it seems advisable to consider two of the previously identified infraorders as polyphyletic and to discontinue the recognition of the Auchenorrhyncha and Sternorrhyncha.

To date 66 families (37 Heteroptera and 29 Homoptera) and about 3079 species have been recorded in Canada (Table 35). Preliminary lists are available for some provinces (Downes 1927, 1934; Lindberg 1958; Moore 1950; Parshley 1923; Strickland 1953), but most of these are out of date. Further, the fauna has not been well studied anywhere in Canada. The Miridae, Cicadellidae, Delphacidae, and Aphididae in particular need much more attention.

Most families are widely distributed across Canada, with the fauna of British Columbia being quite distinctive. In many families, the Canadian forms represent a limited northern extension of a southern fauna. Few species of Hemiptera occur in the arctic, and most of these are restricted to the low arctic. The northern grassland Cicadellidae in the Yukon and adjacent areas, and some northern Psyllidae, give some evidence of being glacial refugial relicts. However, most northern species are transarctic.

Generally, the diversity of Hemiptera species in an area is related to the diversity of the flora, and their distribution is determined by that of their host plants. In a few families (e.g. the seed bugs or Lygaeidae), climate seems to be the main factor governing range and distribution.

While all families of Homoptera are terrestrial, some of the families of Heteroptera are aquatic or semi-aquatic. The families and genera of Heteroptera in North America have been considered by Slater and Baranowski (1978); the eastern species were considered by Britton (1923) and Blatchley (1926).

Hemiptera have an incomplete metamorphosis, with usually five pre-adult stages in the Heteroptera, and three to seven in the Homoptera. The white-flies (Aleyrodidae) and male scale insects (Coccoidea) are peculiar in having a quiescent "pupa" prior to the adult, in some ways resembling the corresponding instar of the endopterygote insects: the Coccoidea also have a "pre-pupal" stage.

The early stages of the Hemiptera are inadequately known in many families, and estimates of the number of species in which early stages are described have therefore not been included in Table 35.

Although most hemipterans are oviparous, ovoviviparity and viviparity occur in the Aphidoidea and Coccoidea. Cyclic parthenogenesis is found in aphids (Kennedy and Stroyan 1959), haploid arrhenotokous parthenogenesis is found in some Aleyrodidae, while in the coccids seven different types of parthenogenesis can be recognized (Nur 1971). In Coccoidea the females have the characteristics of neotenic larvae (Beardsley and Gonzales 1975) and males exhibit heterochromatization and elimination of chromosomes at spermatogenesis (Brown 1969).

Table 35. Census of Canadian Hemiptera

	No. spp. known from Canada	Est. no. Canadian spp. undescr. or unrecorded	Distribution in Canada
Suborder Heteroptera			
Superfamily Pentatomoidea			
1. Coriomelaenidae	9	1	Trans., S
2. Cydnidae	7	0	Trans., S
3. Pentatomidae	61	2	Trans., S
4. Podopidae	2	0	E (Ont., Que.)
5. Scutelleridae	9	0	Trans., S
6. Acanthosomatidae	5	0	Trans., S
Superfamily Coreoidea			
7. Coreidae	11	0	Trans., S
8. Rhopalidae	9	0	Trans., S
9. Alydidae	10	0	Trans., S
Superfamily Lygaeoidea			
10. Lygaeidae	100	2	Trans., S
11. Piesmatidae	1	0	Trans., S
12. Berytinidae	3	0	Trans., S
Superfamily Aradoidea			
13. Aradidae	46	0	Trans., S
14. Meziridae	1	0	W (B.C.)
Superfamily Tingoidea			
15. Tingidae	46	0	Trans., S
Superfamily Reduvioidea			
16. Phymatidae	3	0	Trans., S
17. Reduviidae	13	0	Trans., S
18. Enicocephalidae	1	0	E (Que.)
19. Ploiariidae	10	0	Trans., S
Superfamily Cimicoidea			
20. Nabidae	12	1	Trans., S
21. Miridae	600	600	Trans., to tree line (2 spp. in low arctic)
22. Isometopidae	1	0	E (Que.)
23. Anthocoridae	41	0	Trans., S (1 sp. in low arctic)
24. Cimicidae	4	0	Trans., S
Superfamily Dipsocoroidea			
25. Dipsocoridae	1	0	E (Ont., Que.)
Superfamily Saldoidea			
26. Saldidae	36	4	Trans., S (2–3 spp. in low arctic)
27. Mesoveliidae	2	0	Trans., S
Superfamily Gerroidea			
28. Veliidae	6	0	Trans., S
29. Gerridae	19	0	Trans., S
30. Hydrometridae	1	0	Trans., S
31. Hebridae	4	0	Trans., S
Superfamily Gelastocoroidea			
32. Gelastocoridae	1	0	E (Man., Ont.)
Superfamily Nepoidea			
33. Nepidae	7	0	Trans., S
34. Belostomatidae	3	0	Trans., S

Table 35. (Concluded)

	No. spp. known from Canada	Est. no. Canadian spp. undescr. or unrecorded	Distribution in Canada
Superfamily Notonectoidea			
35. Notonectidae	12	0	Trans., S
36. Pleidae	2	0	E (Man., Ont., Que.)
Superfamily Corixoidea			
37. Corixidae	72	1	Trans., S (11 spp. in low arctic)
Suborder Homoptera			
Superfamily Cicadoidea			
38. Cicadidae	9	3	Trans., S (1–2 spp. to tree line)
39. Cercopidae	33	5	Trans., S (1 sp. to subarctic)
Superfamily Membracoidea			
40. Membracidae	69	10	Trans., S
41. Aetalionidae	1	0	S. Ont.
42. Cicadellidae	800	400	Trans., S (1–2 spp. to arctic)
Superfamily Fulgoroidea			
43. Delphacidae	81	40	Trans., S
44. Derbidae	14	0	Mainly E, 1 sp. in W
45. Cixiidae	25	0	Trans., S
46. Fulgoridae	4	0	Trans., S
47. Achilidae	17	0	Trans., S
48. Flatidae	1	0	S. Ont., S. Que.
49. Issidae	3	0	E (Ont.)
50. Caliscelidae	7	0	Trans., S
Superfamily Psylloidea			
51. Liviidae	4	1?	Trans., to tree line
52. Aphalaridae	50	10	Trans., to tree line
53. Psyllidae	35	5	Trans., to tree line
54. Triozidae	18	7	Trans., to tree line
Superfamily Aleyrodoidea			
55. Aleyrodidae	3	0	Trans., S
Superfamily Aphidoidea			
56. Aphididae	650	50	Trans., incl. high arctic
57. Adelgidae	22	1	Trans., to tree line
58. Phylloxeridae	6	0	SW
Superfamily Coccoidea			
59. Margarodidae	4	2	Trans., S
60. Arthezidae	3	0	Trans., S (1 sp. to arctic)
61. Diaspidae	16	0	Trans., S
62. Coccidae	15	0	Trans., incl. high arctic
63. Asterolecaniidae	1	0	S. Ont., S. Br. Columbia
64. Pseudococcidae	13	2	Trans., incl. high arctic
65. Eriococcidae	3	0	Trans., S
66. Dactylopidae	1?	0	Southernmost, W
TOTAL	3079	1147	

ABBREVIATIONS: Trans., transcontinental; undescr., undescribed.

Many aphids exhibit interesting alternation between asexual generations on summer hosts and sexual forms on winter hosts. Further, while a small number of species are polyphagous, most are host specific, have many types of polymorphism (Hille Ris Lambers 1966), and develop biotypes (Eastop 1973). Additional modifications of life cycles and form are found among the aphids in the arctic (Downes 1965).

The Aphididae, Aleyrodidae, and Coccoidea in Canada contain a wealth of information for geneticists, developmental biologists, and evolutionists. The above life cycle strategies, plus the observation that host plant specificity has formed the basis of much aphid speciation (Eastop 1972), makes these Homoptera of special interest to entomologists.

Hemipterans typically feed on a liquid diet. All homopterans and most heteropterans are herbivorous, and some of them are of economic importance in Canada. Beirne (1972) lists 112 hemipteran species that have harmed annual crop plants in this country. They may reduce plant vigour by their feeding, may cause deformation of plants during the early growing period, and often serve as vectors of plant diseases. Their feeding often results in the formation of honeydew, a phenomenon most frequently observed in aphids and coccids. The honeydew is not only a nuisance itself, but it frequently grows a "sooty mould" that inhibits photosynthesis.

The main hemipterous economic pests in Canada are plant bugs (Miridae), aphids (Aphidoidea), leafhoppers (Cicadellidae), psyllids (Psyllidae), and scale insects (Coccoidea). The actual economic damage by such bugs in Canada has not been accurately assessed, and their importance as virus vectors has not been fully investigated: they do transmit a great number of our plant diseases.

A number of pentatomids, anthocorids, nabids, and mirids are useful natural predators. They are effective antagonists of codling moths in the integrated control attempts (MacLellan 1961) for which Canada has gained an international reputation. However, full use of hemipterans for biological control of pests and weeds in Canada has not been adequately explored.

Beardsley, J.W. and R.H. Gonzales. 1975. The biology and ecology of armoured scales. *A. Rev. Ent.* 20: 47–73.

Beirne, B.P. 1972. Pest insects of annual crops in Canada. IV. Hemiptera-Homoptera, V. Orthoptera, VI. Other groups. *Mem. ent. Soc.Can.* 85. 73 pp.

Blatchley, W.S. 1926. Heteroptera or true bugs of Eastern North America with especial reference to the faunas of Indiana and Florida. Nature, Indianapolis. 1116 pp.

Britton, W.E. 1923. Guide to the Insects of Connecticut. Part IV. The Hemiptera or Sucking Insects of Connecticut. *Bull. Conn. St. Geol. nat. Hist. Surv.* 34. 807 pp.

Brown, S.W. 1969. Developmental control of heterochromatization in Coccids. *Genetics* **61** *Suppl.* 1: 191–198.

Cobben, R.H. 1968. Evolutionary trends in Heteroptera. Part I. Eggs, architecture of the shell, gross embryology and eclosion. *Agric. Res. Rep.* (Wageningen) 707. 475 pp.

_____ 1978. Evolutionary trends in Heteroptera. Part II. Mouthpart-structures and feeding strategies. *Meded. LandbHoogesch. Wageningen* 78–5. 407 pp.

Downes, J.A. 1965. Adaptations of insects in the arctic. *A. Rev. Ent.* **10**: 257–274.

Downes, W. 1927. A preliminary list of the Heteroptera and Homoptera of British Columbia. *Proc. ent. Soc. Br. Columb.* **23**: 1–22.

_____ 1934. Additions to the list of B.C. Hemiptera. *Proc. ent. Soc. Br. Columb.* **31**: 46–48.

Eastop, V.F. 1972. The evolution of the insect plant relationship: deductions from the present day host plants of aphids and related insects. *Symp. R. ent. Soc. Lond.* **6**: 153–174.

_____ 1973. Biotypes of aphids *in* A.D. Lowe (Ed.), Perspectives in Aphid Biology. *Bull. ent. Soc. New Zealand* **2**: 40–51.

Evans, J.W. 1963. The phylogeny of the Homoptera. *A. Rev. Ent.* **8**: 77–94.

Hille Ris Lambers, D. 1966. Polymorphism in Aphididae. *A. Rev. Ent.* **11**: 47–78.

Kennedy, J.S. and H.L.G. Stroyan. 1959. Biology of aphids. *A. Rev. Ent.* **4**: 139–160.

Lindberg, H. 1958. Hemiptera Heteroptera from Newfoundland, collected by the Swedish-Finnish Expedition of 1949 and 1951. *Acta zool. fenn.* 96: 1–25.

MacLellan, C.R. 1961. Predator populations and predation on the codling moth in an integrated control orchard — 1961. *Mem. ent. Soc. Can.* 32. pp. 41–54.

Moore, G.A. 1950. Check-list of Hemiptera of the Province of Quebec. *Contr. Inst. Biol. Univ. Montreal* 26. 49 pp.

Nur, U. 1971. Parthenogenesis in coccids (Homoptera). *Am. Zool.* **11**: 301–308.

Parshley, H.M. 1923. Records of Nova Scotian Hemiptera-Heteroptera. *Proc. Acadian ent. Soc.* 1922: 102–108.

Slater, J.A. and R.M. Baranowski. 1978. How to know the true bugs (Hemiptera-Heteroptera). Brown, Dubuque, Iowa.

Strickland, E.H. 1953. An annotated list of the Hemiptera (s.l.) of Alberta. *Can. Ent.* 85: 193–214.

Pentatomoidea

The shield or stink bugs are among the largest and most noticeable Heteroptera, but they have not been studied intensively in Canada: the last list of species was published by Walley (1929). It is likely that some of the named species in Canada, especially in the genera *Chlorochroa* and *Euschistus*, are incorrectly identified.

There is no key to the species of Canadian Pentatomoidea, but the publications by Parshley (1915, 1923), Hart (1919), and Froeschner (1941) can be used for the fauna of eastern Canada. There are no good keys to the species in the west. However, the general revision of the Cydnidae by Froeschner (1960) can be used for this family. Generic revisions relevant to the Canadian fauna are listed below.

A number of pentatomoids have been recorded as pests of annual crops (Beirne 1972, see Introduction). While *Brochymena affinis* V-D. can be a nuisance when it overwinters in houses (Scudder unpubl.), the most destructive pentatomid is the Say stink bug, *Chlorochroa sayi* Stål. This has been a pest of wheat and potato in Saskatchewan and Alberta, and has harmed flax, oats, barley, various non-crop plants (Beirne 1972), as well as sugar beet seed crops, alfalfa, beans, peas, sunflowers, grasses, and garden crops (Anon. 1945). Although infestations of wheat fields are usually confined to the margins, yields can be reduced by more than 75% when feeding occurs just before or within 5 days after the heads emerge (Jacobson 1965).

Some predaceous pentatomids are beneficial, especially in forests: Kelton (1972) has recently reported a European species in Quebec, feeding on an introduced sawfly. *Podisus maculiventris* (Say) is one of the most important forest predators, feeds on pests of alfalfa (Wheeler 1977), and is a common predator in apple orchards in Nova Scotia (MacLellan 1977): its feeding habits have been studied in the laboratory. *Perillus bioculatus* (Fab.), which is reported to feed on the Colorado potato beetle, exhibits interesting colour variation (Knight 1923).

Anon. 1945. Field crop insects in the Prairie Provinces. *Bull. Line Elevators Farm Service* (Winnipeg) 5. 62 pp.

Brown, A.W.A. 1941. Foliage insects of spruce in Canada. *Can. Dep. agric. Tech. Bull.* 31. 29 pp.

Froeschner, R.C. 1941. Contribution to a synopsis of the Hemiptera of Missouri, Pt. I. Scutelleridae, Podopidae, Pentatomidae, Cydnidae, Thyreocoridae. *Am. Midl. Nat.* 26: 122–146.

_____ 1960. Cydnidae of the Western Hemisphere. *Proc. U.S. natn. Mus.* **111**: 337–680.

Gallopin, G.C. and R.L. Kitching. 1972. Studies on the process of ingestion in the predatory bug *Podisus maculiventris* (Hemiptera: Pentatomidae). *Can. Ent.* **104**: 231–237.

Hart, C.A. 1919. The Pentatomoidea of Illinois with keys to the Nearctic genera. *Bull. Illinois nat. Hist. Surv.* **13**: 157–223.

Jacobson, L.A. 1965. Damage to wheat by Say Stink Bug, *Chlorochroa sayi*. *Can. J. Plant Sci.* 45: 413–417.

Kelton, L.A. 1972. *Picromerus bidens* in Canada. *Can. Ent.* **104**: 1743–1744.

Knight, H.H. 1923. Studies on the life history and biology of *Perillus bioculatus* Fabricius, including observations on the nature of the colour pattern. *19th Rep. St. Entomologist, Minnesota* Dec. 1922: 50–96.

MacLellan, C.R. 1977. Populations of some major pests and their natural enemies on young and semi-dwarf apple trees in Nova Scotia. *Can. Ent.* **109**: 797–806.
McDonald, F.J.D. 1976. Revision of the genus *Trichopepla* (Hemiptera: Pentatomidae) in N. America. *Jl N.Y. ent. Soc.* **84**: 9–22.
Morris, R.F. 1963. The effects of predator age and prey defence on the functional response of *Podisus maculiventris* Say to the density of *Hyphantria cunea* Drury. *Can. Ent.* **95**: 1009–1020.
Mukerji, M.K. and E.J. LeRoux. 1969a. The effect of predator age on the functional response of *Podisus maculiventris* to the prey size of *Galleria mellonella*. *Can. Ent.* **101**: 314–327.
_____ 1969b. A quantitative study of food consumption and growth of *Podisus maculiventris* (Hemiptera: Pentatomidae). *Can. Ent.* **101**: 387–403.
Parshley, H.M. 1915. Systematic papers on New England Hemiptera. II. Synopsis of the Pentatomidae. *Psyche, Camb.* **22**: 170–177.
_____ 1923. Key to heteropterous families: and the Termatophylidae, Anthocoridae, Cimicidae, Nabidae, Phymatidae, Enicocephalidae, Piesmidae, Tingidae, Neididae, Coreidae, Alydidae, Corizidae, Pentatomidae, Cydnidae, and Scutelleridae. *Bull. Conn. St. geol. nat. Hist. Surv.* **34**: 383–385, 665–674, 692–707, 737–783.
Rolston, L.H. 1972. The small *Thyanta* species of North America (Hemiptera: Pentatomidae). *J. Georgia ent. Soc.* **7**: 278–285.
Ruckes, H. 1947. Notes and keys to the genus *Brochymena* (Pentatomidae, Heteroptera). *Entomologica am.* **26** (n.s.): 143–238.
_____ 1957. The taxonomic status and distribution of *Thyanta custator* (Fabricius) and *Thyanta pallido-virens* (Stål) (Heteroptera, Pentatomidae). *Am. Mus. Novit.* 1824. 23 pp.
Thomas, D.B. 1974. The genus *Codophila* Mulsant in North America (Hemiptera: Pentatomidae). *Pan-Pacif. Ent.* **50**: 441–442.
Walley, G.S. 1929. Hemiptera. *Ann. Rep. ent. Soc. Ont.* **59**: 120–123.
Wheeler, A.G. 1977. Studies on the arthropod fauna of alfalfa. VIII. Predaceous insects. *Can. Ent.* **109**: 423–427.

Coreoidea

This superfamily includes the familiar boxelder bugs, the squash bugs, and the leaf-footed bugs. A list of the Canadian species was given by Brown (1929), but there has been considerable change of names since. Several keys for species identification exist (see below).

The boxelder bugs (*Leptocoris* spp.) and squash bugs (*Anasa* spp.) are widespread pests in southern Canada (Beirne 1972, see Introduction). The eastern *L. trivittatus* (Say) has been reported as a minor pest of some fruit crops, and may also be a pest when it overwinters in homes near to where its host plant, the boxelder, *Acer negundo* Linn., is grown as an ornamental (Schaefer 1975). In the west, *L. rubrolineatus* Barber has likewise been a pest in winter in homes in the interior of British Columbia (Scudder unpubl.).

The western leaf-footed bug, *Leptoglossus occidentalis* Heid., has been reported as crowding into houses for hibernation (Spencer 1945), and is an important coniferous seed pest (Koerber 1963).

Allen, R.C. 1969. A revision of the genus *Leptoglossus* Guerin (Hemiptera: Coreidae). *Entomologica am.* **45**: 35–140.
Brown, W.J. 1929. The Entomological Record, 1929. *A. Rep. ent. Soc. Ont.* **60**: 146–157.
Bueno, J.R. de la Torre-. 1941. Help notes toward a revision of the genus *Harmostes* Burm. 1835. *Bull. Brooklyn ent. Soc.* **36**: 82–92.
Chopra, N.P. 1967. The higher classification of the family Rhopalidae (Hemiptera). *Trans. R. ent. Soc. Lond.* **119**: 363–399.
_____ 1968. A revision of the genus *Arhyssus* Stål. *Ann. ent. Soc. Am.* **61**: 629–655.
Dolling, W.R. and T.R. Yonke. 1976. The genus *Coriomeris* in North America. *Ann. ent. Soc. Am.* **69**: 1147–1152.
Fracker, S.B. 1918. Alydidae of the United States. *Ann. ent. Soc. Am.* **11**: 255–282.
Froeschner, R.C. 1942. Contributions to a synopsis of the Hemiptera of Missouri, Pt. II. Coreidae, Aradidae, Neididae. *Am. Midl. Nat.* **27**: 591–609.
_____ 1963. The genus *Ceraleptus* Costa in the Western Hemisphere (Hemiptera: Coreidae). *J. Kans. ent. Soc.* **36**: 109–113.

Gibson, E.H. 1917. The genus *Harmostes* Burm. (Coreidae, Heterop.). *Ent. News* **28**: 439–450.
_____ 1919. Notes on the North American species of *Corizus* (Coreidae, Heteroptera). *Can. Ent.* **51**: 89–92.
Harris, H.M. 1943. Concerning the Rhopalidae (Hemiptera). *Iowa St. Coll. J. Sci.* **17**: 192–204.
Koerber, T.W. 1963. *Leptoglossus occidentalis* (Hemiptera, Coreidae), a newly discovered pest of coniferous seed. *Ann. ent. Soc. Am.* **56**: 229–234.
Parshley, H.M. 1923. Key to heteropterous families: and the Termatophylidae, Anthocoridae, Cimicidae, Nabidae, Phymatidae, Enicocephalidae, Piesmidae, Tingidae, Neididae, Coreidae, Alydidae, Corizidae, Pentatomidae, Cydnidae, and Scutelleridae. *Bull. Conn. St. geol. nat. Hist. Surv.* **34**: 383–385, 665–674, 692–707, 737–783.
Schaefer, C.W. 1975. A re-assessment of North American *Leptocoris* (Hemiptera-Heteroptera: Rhopalidae). *Ann. ent. Soc. Am.* **68**: 537–541.
Spencer, G.J. 1945. On the incidence, density and decline of certain insects in British Columbia. *Proc. ent. Soc. Br. Columb.* **42**: 19–23.

Lygaeoidea

The seedbugs (Lygacidae) of Canada are being revised by Scudder. The last list of species for Canada was published by Brown (1934), although Beique and Robert (1963, 1964) have studied the species in Quebec. The keys by Bueno (1946) are useful, although many genera have since been revised (see below). Biological features of the Cyminae have been described by Slater (1952), and those of the Rhyparochrominae by Sweet (1964*a*, *b*).

The most obvious lygaeid species in Canada are the red and black *Oncopeltus fasciatus* (Dallas) and *Lygaeus kalmii* Stål, which occur on milkweeds (*Asclepias* spp.) and sequester cardenolides, presumably for defence (Duffey and Scudder 1972, 1974; Isman *et al.* 1977*a*, *b*). While *L. kalmii* overwinters in Canada, *O. fasciatus* does not, and invades this country from the south each year (Caldwell 1974; Dingle 1972).

The chinch bugs (*Blissus* spp.) are pests in both the east and the west. While the eastern species is reported as *Blissus leucopterus* (Say), Leonard (1966, 1970) has stated that the nominate subspecies does not occur in Canada: the common eastern form is the hairy chinchbug, *Blissus leucopterus hirtus* Mont. While *Blissus occiduus* Barb. occurs on the Prairies, the identity of the species in British Columbia has not been clarified. The false chinchbug, *Nysius niger* Baker (= *N. ericae* Amer. auct. nec Schill.), is also a common pest of a wide variety of cultivated plants.

There are only two Nearctic berytinids, *Jalysus spinosus* (Say) and *Neides muticus* (Say) in Canada (McAtee 1919), plus *Berytinus minor* H-S. which was introduced from Europe (Wheeler 1971). *Jalysus spinosus* has been reported as an egg predator of the tomato hornworm, *Manduca sexta* (Elsey 1972). *Neides muticus* is predaceous on aphids, thrips, and other small insects in orchards (Madsen and Morgan 1975).

Ashlock, P.D. 1958. A revision of the genus *Malezonotus* (Hemiptera-Heteroptera: Lygaeidae). *Ann. ent. Soc. Am.* **51**: 199–208.
_____ 1961. A review of the genus *Arphnus* Stål with a new species from Mexico (Hemiptera: Lygaeidae). *Pan-Pacif. Ent.* **37**: 17–22.
Barber, H.G. 1947. Revision of the genus *Nysius* in the United States and Canada (Hemiptera: Heteroptera: Lygaeidae). *J. Wash. Acad. Sci.* **37**: 354–366.
_____ 1952. The genus *Pachybrachius* in the United States and Canada with the description of two new species (Hemiptera: Lygaeidae). *Jl N.Y. ent. Soc.* **60**: 211–220.
_____ 1953. A revision of the genus *Kleidocerys* Stephens in the United States (Hemiptera: Lygaeidae). *Proc. ent. Soc. Wash.* **55**: 273–283.
Beique, R. and A. Robert. 1963. Les Lygéides de la Province de Québec (Hétéroptères). *Annls Soc. ent. Québ.* **8**: 70–96.
_____ 1964. Les Lygéides de la Province de Québec (Hétéroptères) (2 parti). *Annls Soc. ent. Québ.* **9**: 72–104.
Brown, W.J. 1934. The Entomological Record 1931, 1932, 1933. *A. Rep. Queb. Soc. Prot. Plants* **25–26**: 140–162.

Bueno, J.R. de la Torre-. 1946. A synopsis of the Hemiptera-Heteroptera of America north of Mexico. Part III. Family XI Lygaeidae. *Entomologica am.* **26**: 1–141.
Burgess, L. 1977. *Geocoris bullatus*, an occasional predator on flea beetles (Hemiptera: Lygaeidae). *Can. Ent.* **109**: 1519–1520.
Caldwell, R.L. 1974. A comparison of the migratory strategies of two milkweed bugs. pp. 304–316 *in* L. Barton Browne (Ed.), Experimental Analysis of Insect Behaviour. Springer, New York. 366 pp.
Dingle, H. 1972. Migration strategies of insects. *Science, N.Y.* **175**: 1327–1335.
Drake, C.J. and N.T. Davis. 1958. The morphology and systematics of the Piesmatidae (Hemiptera), with keys to world genera and American species. *Ann. ent. Soc. Am.* **51**: 567–581.
Duffey, S.S. and G.G.E. Scudder. 1972. Cardiac glycosides in North American Asclepiadaceae, a basis for unpalatability in brightly coloured Hemiptera and Coleoptera. *J. Insect Physiol.* **18**: 63–78.
_____ 1974. Cardiac glycosides in *Oncopeltus fasciatus* (Dallas) (Hemiptera: Lygaeidae). I. The uptake and distribution of natural cardenolides in the body. *Can. J. Zool.* **52**: 283–290.
Elsey, K.D. 1972. Defenses of eggs of *Manduca sexta* against predation by *Jalysus spinosus*. *Ann. ent. Soc. Am.* **65**: 896–897.
Isman, M.B., S.S. Duffey, and G.G.E. Scudder. 1977*a*. Cardenolide content of some leaf- and stem-feeding insects on temperate North American milkweeds (*Asclepias* spp.). *Can. J. Zool.* **55**: 1024–1028.
_____ 1977*b*. Variation in cardenolide content of the lygaeid bugs, *Oncopeltus fasciatus* and *Lygaeus kalmii kalmii* and of their milkweed hosts (*Asclepias* spp.) in central California. *J. Chem. Ecol.* **3**: 613–624.
Leonard, D.E. 1966. Biosystematics of the "*leucopterus* complex" of the genus *Blissus* (Heteroptera: Lygaeidae). *Bull. Conn. agric. Exp. Stn.* 677. 47 pp.
_____ 1968. A revision of the genus *Blissus* (Heteroptera: Lygaeidae) in eastern North America. *Ann. ent. Soc. Am.* **61**: 239–250.
_____ 1970. A new North American species of *Blissus* (Heteroptera: Lygaeidae). *Can. Ent.* **102**: 1531–1533.
Madsen, B.J. and C.V.G. Morgan. 1975. Mites and insects collected from vineyards in the Okanagan and Similkameen Valleys, British Columbia. *J. ent. Soc. Br. Columb.* **72**: 9–14.
McAtee, W.L. 1919. Key to the Nearctic genera and species of Berytidae (Heteroptera). *Jl N.Y. ent. Soc.* **27**: 79–92.
Scudder, G.G.E. 1965. *Neacoryphus* Scudder, a new genus of Lygaeinae (Hemiptera: Lygacidae). *Proc. ent. Soc. Br. Columb.* **62**: 34–37.
Slater, J.A. 1952. A contribution to the biology of the subfamily Cyminae (Heteroptera: Lygaeidae). *Ann. ent. Soc. Am.* **45**: 315–325.
Slater, J.A. and P.D. Ashlock. 1966. *Atrazonotus*, a new genus of Gonianotini from North America (Hemiptera: Lygaeidae). *Proc. ent. Soc. Wash.* **68**: 152–156.
Sweet, M.H. 1964*a*. The biology and ecology of the Rhyparochrominae of New England (Heteroptera: Lygaeidae). Part I. *Entomologica am.* **43**: 1–124.
_____ 1964*b*. The biology and ecology of the Rhyparochrominae of New England (Heteroptera: Lygaeidae). Part II. *Entomologica am.* **44**: 1–201.
Wheeler, A.G. 1971. An additional note on *Berytinus minor* (Hemiptera: Berytidae) in North America. *Can. Ent.* **103**: 497.

Aradoidea, Tingoidea, and Dipsocoroidea

The bark bugs (Aradidae) of Canada have been monographed by Matsuda (1977), and the lacebugs (Tingidae) of Canada are being revised by the same author. The genus *Aneurus* in North America was recently reviewed by Picchi (1977), while the Aradidae of the world were considered by Usinger and Matsuda (1959).

Corythuca lacebugs have been found on beans in British Columbia and Alberta (Beirne 1972, see Introduction), but for the most part the Tingoidea and Aradoidea are of little economic interest. However, the introduced *Tingis ampliata* (H-S.) is a candidate for the biological control of the Canada thistle, *Cirsium arvense* (Peschken 1977).

Ceratocombus vagrans McA. and Mall. is recorded from Ontario and Quebec, and is the only dipsocorid known from Canada. Dipsocorids live in ground litter among stones and are presumed to be predaceous (Slater and Baranowski 1978).

Froeschner, R.C. 1944. Contributions to a synopsis of the Hemiptera of Missouri, Part III. Lygaeidae, Pyrrhocoridae, Piesmidae, Tingidae, Enicocephalidae, Phymatidae, Ploiariidae, Reduviidae, Nabidae. *Am. Midl. Nat.* **31**: 638–683.
Matsuda, R. 1977. The Aradidae of Canada (Hemiptera: Aradidae). The Insects and Arachnids of Canada, Part 3. *Can. Dep. Agric. Publ.* 1634. 116 pp.
Peschken, D.P. 1977. Host specificity of *Tingis ampliata* (Tingidae: Heteroptera): a candidate for the biological control of Canada Thistle (*Cirsium arvense*). *Can. Ent.* **109**: 669–674.
Picchi, V.D. 1977. A systematic review of the genus *Aneurus* of North and Middle America and the West Indies (Hemiptera: Aradidae). *Quaest. ent.* **13**: 255–308.
Slater, J.A. and R.M. Baranowski. 1978. How to know the true bugs (Hemiptera-Heteroptera). Brown, Dubuque, Iowa.
Usinger, R.L. and R. Matsuda. 1959. Classification of the Aradidae (Hemiptera-Heteroptera). British Museum (Nat. Hist.), London.

Reduvioidea

The ambush bugs (Phymatidae), assassin bugs (Reduviidae), and thread-legged bugs (Ploiariidae) of Canada need revision. The Phymatidae of the world were revised by Kormilev (1962), but the identity of the Canadian forms is not clear. The review of the Reduviidae by Fracker (1913) is useful, while keys to eastern species are contained in Froeschner (1944).

The predatory nature of reduviids is well known, but their life cycle and habits in Canada are not well studied. *Reduvius personatus* (Linn.) has been found to be abundant in dockside warehouses in Vancouver (Scudder 1961).

The Ploiariidae are infrequent and little is known about them. The only enicocephalid reported in Canada is *Systelloderus biceps* (Say) from Quebec.

Fracker, S.B. 1913. A systematic outline of the Reduviidae of North America. *Proc. Iowa Acad. Sci.* **19**: 217–252.
Froeschner, R.C. 1944. Contributions to a synopsis of the Hemiptera of Missouri. Part III. Lygaeidae, Pyrrhocoridae, Piesmidae, Tingidae, Enicocephalidae, Phymatidae, Ploiariidae, Reduviidae, Nabidae. *Am. Midl. Nat.* **31**: 638–683.
Kormilev, N.A. 1962. Revision of Phymatinae (Hemiptera, Phymatidae). *Philip. J. Sci.* **89**: 287–486.
Scudder, G.G.E. 1961. Some Heteroptera new to British Columbia. *Proc. ent. Soc. Br. Columb.* 58: 26–29.

Cimicoidea

The Nabidae or Damsel bugs are well known predators, although they have been recorded as plant feeders as well (Stoner 1972). There is no recent review of the Canadian species. Harris (1928) monographed the species in North America, and Froeschner (1944) considered the eastern species, but the genera have now been revised (Kerzhner 1968).

Nabids are common in alfalfa fields (Stoner *et al.* 1975; Wheeler 1977), have been recorded as predators of the mirid *Lygus hesperus* Knight (Perkins and Watson 1972) and the potato psyllid (Knowlton 1933), and are predaceous on aphids, thrips, and other small insects in British Columbia orchards (Madsen and Morgan 1975). They have been recorded as predaceous on the pea aphid, the potato leafhopper, the tarnished plant bug (*Lygus lineolaris* P. de B.), and the alfalfa bug (*Adelphocoris lineolatus* (Goeze)) (Wheeler 1977).

The flower bugs, minute pirate bugs, or Anthocoridae are perhaps the most familiar as useful predators. The Canadian fauna has been monographed by Kelton (1978).

Anthocorids are important predators of the pear psylla in British Columbia (Madsen 1961; Fields and Beirne 1973), and have been recorded as predaceous on the green peach aphid on sugar beets and broccoli (Tamaki and Weeks 1968). They are common predators in apple orchards in Nova Scotia (MacLellan 1977), and are

reported to prey upon flower thrips, *Frankliniella tritici* (Fitch), *Thrips tabaci* Lind., the potato leafhopper (*Empoasca fabae* (Harr.)), and the pea aphid (*Acyrthosiphon pisum* (Harn.)) (Wheeler 1977). *Orius tristicolor* (White) is predaceous on aphids, thrips, and other small insects in orchards in British Columbia (Madsen and Morgan 1975), while *O. minutus* (Linn.) similarly feeds on similar insects on brambles on the coast (Tonks 1953). The European *Anthocoris nemoralis* (Fab.) has been introduced into the Okanagan Valley of British Columbia in a biological control attempt against the pear psylla (McMullen 1971).

There are four species of bedbug (Cimicidae) in Canada. Three of these were considered by Spencer (1935), while the fourth, *Hesperocimex coloradensis* List, was added to the Canadian list by Scudder (1961). This latter bedbug is an ectoparasite of woodpeckers and purple martins nesting in cavities in trees, and has $X_1\ X_2\ X_3\ Y$ sex chromosomes in males, and $2X_1\ 2X_2\ 2X_3$ in females (Ryckman and Ueshima 1964). The common bedbug, *Cimex lectularius* Linn., is not uncommon in human habitats. The family has been well monographed by Usinger (1966).

Only one species of Isometopidae or jumping tree bugs, *Myiomma cixiiformis* (Uhler), has been recorded in Canada to date. It is known only from Quebec.

The Miridae, or plant bugs, are one of the largest families in Canada, and are being studied intensively by Kelton: a monograph on the Miridae of the Prairies is nearing completion. However, a number of revisions of genera have already been published, and the important pest genera *Lygus* and *Lygocoris* have been considered in detail (Kelton; Kelton and Knight). There is, however, no complete key to the species of mirids in Canada: the keys in Knight (1921, 1922, 1941, 1968), Froeschner (1949, 1963), and Van Duzee (1916, 1921) can be used as a supplement to those in Kelton.

A number of mirids are of economic importance, although they may be rather local. They have been recorded damaging apple fruit at harvest in Nova Scotia (Pickett 1939; MacPhee 1976; MacLellan 1977), and are recorded on a number of annual crops (Beirne 1972, see Introduction). By far the most serious pests are those occurring on alfalfa in the Prairies, British Columbia, and the Yukon. Included here are species of *Adelphocoris, Chlamydatus, Labops, Lopidea, Lygus,* and *Plagiognathus* (Beirne 1972; Wheeler 1974).

Some mirids are useful predators. McMullen and Jong (1967) record them as predators of the pear psylla in British Columbia, while MacLellan (1977) regards them as beneficial in orchards in Nova Scotia.

Fields, G.J. and B.P. Beirne. 1973. Ecology of Anthocorid (Hemipt: Anthocoridae) predators of the Pear Psylla (Homopt.: Psyllidae) in the Okanagan Valley, British Columbia. *J. ent. Soc. Br. Columb.* **70**: 18–19.

Froeschner, R.C. 1944. Contributions to a synopsis of the Hemiptera of Missouri, Part III. Lygaeidae, Pyrrhocoridae, Piesmidae, Tingidae, Enicocephalidae, Phymatidae, Ploiariidae, Reduviidae, Nabidae. *Am. Midl. Nat.* **31**: 638–683.

_____ 1949. Contributions to a synopsis of the Hemiptera of Missouri, Part IV. Hebridae, Mesoveliidae, Cimicidae, Anthocoridae, Cryptostemmatidae, Isometopidae, Miridae. *Am. Midl. Nat.* **42**: 123–188.

_____ 1963. Review of the genus *Atractotomus* Fieber in North America with notes, key, and description of one new species (Hemiptera; Miridae). *Bull. Brooklyn ent. Soc.* **58**: 1–5.

Harris, H.M. 1928. A monographic study of the hemipterous family Nabidae as it occurs in North America. *Entomologica am.* **9**: 1 1–97.

Kelton, L.A. 1955*a*. Genera and subgenera of the *Lygus* complex (Hemiptera: Miridae). *Can. Ent.* **98**: 277–301.

_____ 1955*b*. Species of *Lygus, Liocoris,* and their allies in the Prairie Provinces of Canada (Hemiptera: Miridae). *Can. Ent.* **87**: 531–556.

_____ 1961. Synopsis of the Nearctic species of *Stenodema* Laporte, and description of a new species from Western Canada (Hemiptera: Miridae). *Can. Ent.* **93**: 450–455.

_____ 1965*a*. *Diaphnidia* Uhler and *Diaphnocoris* Kelton in North America (Hemiptera: Miridae). *Can. Ent.* **97**: 1025–1030.

_____ 1965*b*. *Chlamydatus* Curtis in North America. *Can. Ent.* **97**: 1131–1144.

_____ 1966. Review of the species of *Teratocoris* Fieber, with description of a new species from the Nearctic region (Hemiptera: Miridae). *Can. Ent.* **98**: 1265–1271.

_____ 1968. Revision of the North American species of *Slaterocoris* (Heteroptera: Miridae). *Can. Ent.* **100**: 1121–1137.

_____ 1971*a*. Revision of the species of *Trigonotylus* in North America (Heteroptera: Miridae). *Can. Ent.* **103**: 685–705.

_____ 1971*b*. Review of *Lygocoris* species found in Canada and Alaska (Heteroptera: Miridae). *Mem. ent. Soc. Can.* 83. 87 pp.

_____ 1972*a*. Four new species of *Bolteria*, with a key to North American species and a note on the species found in Canada (Heteroptera: Miridae). *Can. Ent.* **104**: 627–640.

_____ 1972*b*. Species of *Dichrooscytus* found in Canada, with descriptions of four new species (Heteroptera: Miridae). *Can. Ent.* **104**: 1033–1049.

_____ 1973. A new species of *Semium* (Heteroptera: Miridae) from Mexico, with new records of distribution for two other species. *Can. Ent.* **105**: 1583–1584.

_____ 1975. The *Lygus* bugs (genus *Lygus* Hahn) of North America (Heteroptera: Miridae). *Mem. ent. Soc. Can.* 95. 101 pp.

_____ 1977. Species of the genus *Pinalitus* Kelton found in North America (Heteroptera: Miridae). *Can. Ent.* **109**: 1549–1554.

_____ 1978. The Anthocoridae of Canada and Alaska (Heteroptera: Anthocoridae). The Insects and Arachnids of Canada, Part 4. *Can. Dep. Agric. Publ.* 1639. 101 pp.

Kelton, L.A. and H.H. Knight. 1959. A new species of *Paradacerla* from Mexico, and synopsis of the genus in North America (Hemiptera: Miridae). *Can. Ent.* **91**: 122–126.

_____ 1962. *Mecomma* Fieber in North America (Hemiptera: Miridae). *Can. Ent.* **94**: 1296–1302.

_____ 1970. Revision of the genus *Platylygus*, with descriptions of 26 new species (Hemiptera: Miridae). *Can. Ent.* **102**: 1429–1460.

Kerzhner, I.M. 1968. New and little known Palearctic bugs of the family Nabidae (Heteroptera). *Rev. Ent. URSS* **47**: 848–863.

Knight, H.H. 1921. Monograph of the North American species of *Deraeocoris* – Heteroptera Miridae. *Tech. Bull. Univ. Minn. Agric. Exp. Stn.* 1. 210 pp.

_____ 1922. The North American species of *Labops* (Heteroptera, Miridae). *Can. Ent.* **54**: 258–261.

_____ 1941. The Plant Bugs, or Miridae, of Illinois. *Bull. Illinois nat. Hist. Surv.* **22**: 1–234.

_____ 1968. Taxonomic review: Miridae of the Nevada test site and the Western United States. *Brigham Young Univ. Sci. Bull.* (Biol. Ser.) 9(3): 1–282.

Knowlton, G.F. 1933. Notes on injurious Utah insects: Potato Psyllid. *Utah Acad. Sci.* **10**: 153.

MacLellan, C.R. 1977. Populations of some major pests and their natural enemies on young and semi-dwarf apple trees in Nova Scotia. *Can. Ent.* **109**: 797–806.

Madsen, B.J. and C.V.G. Morgan. 1975. Mites and insects collected from vineyards in the Okanagan and Similkaneen Valleys, British Columbia. *J. ent. Soc. Br. Columb.* **72**: 9–14.

Madsen, H.F. 1961. Notes on *Anthocoris melanocerus* Reuter (Hemiptera: Anthocoridae) as a predator of the pear psylla in British Columbia. *Can. Ent.* **93**: 660–662.

McMullen, R.D. 1971. *Psylla pyriocola* Forster, pear psylla (Hemiptera: Psyllidae) *in* Biological Control Programmes against Insects and Weeds in Canada 1959–1968. *Commonw. Inst. biol. Contr. Tech. Comm.* **4**: 33–38.

McMullen, R.D. and C. Jong. 1967. New records and discussion of predators of the Pear Psylla, *Psylla pyricola* Forster in British Columbia. *J. ent. Soc. Br. Columb.* **64**: 35–40.

MacPhee, A.W. 1976. Predictions of destructive levels of the apple-stinging bugs *Atractotomus mali* and *Campylomma verbasci* (Hemiptera: Miridae). *Can. Ent.* **108**: 423–426.

Perkins, P.V. and T.F. Watson. 1972. *Nabis alternatus* as a predator of *Lygus hesperus*. *Ann. ent. Soc. Am.* **65**: 625–629.

Pickett, A.D. 1939. The mullein Leaf bug, *Campylomma verbasci* Meyer, as a pest of apple in Nova Scotia. *A. Rep. ent. Soc. Ont.* **69**: 105–106.

Ryckman, R.E, and N. Ueshima. 1964. Biosystematics of the *Hesperocimex* complex (Hemiptera: Cimicidae) and Avian hosts (Piciformes: Picidae; Passeriformes: Hirudinidae). *Ann. ent. Soc. Am.* **57**: 624–638.

Scudder, G.G.E. 1961. Some Heteroptera new to British Columbia. *Proc. ent. Soc. Br. Columb.* **58**: 26–29.

Spencer, G.J. 1935. The bedbugs of British Columbia. *Proc. ent. Soc. Br. Columb.* **31**: 43–45.

Stoner, A. 1972. Plant feeding by *Nabis*, a predaceous genus. *Environ. Ent.* **1**: 557–558.
Stoner, A., A.M. Metcalfe, and R.E. Weeks. 1975. Seasonal distribution, reproductive diapuse, and parasitization of three *Nabis* spp. in Southern Arizona. *Environ. Ent.* **4**: 211–214.
Tamaki, G. and R.E. Weeks. 1968. *Anthocoris melanocerus* as a predator of the green peach aphid on sugar beets and broccoli. *Ann. ent. Soc. Am.* **61**: 579–584.
Tonks, N.V. 1953. Annotated list of insects and mites collected on brambles in the lower Fraser Valley, British Columbia, 1951. *Proc. ent. Soc. Br. Columb.* **49**: 27–29.
Usinger, R.L. 1966. Monograph of Cimicidae (Hemiptera-Heteroptera). *Thomas Say Foundation* 7. 585 pp.
Van Duzee, E.P. 1916. Monograph of the North American species of *Orthotylus* (Hemiptera). *Proc. Calif. Acad. Sci.* (4)6: 87–128.
_____ 1921. A study of the North American grass-bugs of the genus *Irbisia*. *Proc. Calif. Acad. Sci.* (4)**11**: 145–152.
Wheeler, A.G. 1974. Studies on the arthropod fauna of alfalfa. VI. Plant bugs (Miridae). *Can. Ent.* **106**: 1267–1275.
_____ 1977. Studies on the arthropod fauna of alfalfa. VII. Predaceous insects. *Can. Ent.* **109**: 423–427.

Saldoidea, Gelastocoroidea, and Gerroidea

The shore bugs (Saldoidea) and toad bugs (Gelastocoridae) are not well known in Canada, although the Saldidae of the Great Lakes region have been described by Schuh (1967), and the Gelastocoridae have been considered by Todd (1955). However, the surface water bugs (Gerroidea) have been studied rather extensively. While the way of life of one or two gerroids has been studied in the east (Cheng and Fernando 1971; Galbraith and Fernando 1977) and Alaska (Kaufmann 1971), that of the western Gerridae is now under intensive study (Jamieson 1973; Jamieson and Scudder 1977, 1979; Spence 1978). Wing polymorphism in gerrids has attracted a great deal of attention elsewhere in the world (e.g. Vepsäläinen 1974; Järvinen and Vepsäläinen 1976, and many other papers), but it has not been studied extensively in Canada.

Brooks, A.R. and L.A. Kelton. 1967. Aquatic and semiaquatic Heteroptera of Alberta, Saskatchewan, and Manitoba (Hemiptera). *Mem. ent. Soc. Can.* 51. 92 pp.
Bueno, J.R. de la Torre-. 1924. A preliminary survey of the species of *Microvelia* Westwood (Veliidae, Heteroptera) of the western world, with description of a new species from the southern United States. *Bull. Brooklyn ent. Soc.* **19**: 186–194.
Chagnon, G. and O. Fournier. 1948. Contribution à l'étude des Hémiptères aquatiques du Québec. *Contr. Inst. Biol. Univ. Montreal* 21. 66 pp.
Cheng, L. and C.H. Fernando. 1970. The water-striders of Ontario (Heteroptera: Gerridae). *Life Sci. misc. Publ. R. Ont. Mus.* 1970: 1–23.
_____ 1971. Life history and biology of the riffle bug *Rhagovelia obesa* Uhler (Heteroptera: Veliidae) in Southern Ontario. *Can. J. Zool.* **49**: 435–442.
Drake, C.J. and H.M. Harris. 1934. The Gerrinae of the Western Hemisphere (Hemiptera). *Ann. Carnegie Mus.* **23**: 179–240.
Drake, C.J. and D.R. Lauck. 1959. Descriptions, synonymy, and checklist of American Hydrometridae (Hemiptera: Heteroptera). *Great Basin Nat.* **19**: 43–52.
Froeschner, R.C. 1962. Contributions to a synopsis of the Hemiptera of Missouri, Part V. Hydrometridae, Gerridae, Veliidae, Saldidae, Ochteridae, Gelastocoridae, Naucoridae, Belostomatidae, Nepidae, Notonectidae, Pleidae, Corixidae. *Am. Midl. Nat.* **67**: 208–240.
Galbraith, D.F. and C.H. Fernando. 1977. The life history of *Gerris remigis* (Heteroptera: Gerridae) in a small stream in southern Ontario. *Can. Ent.* **109**: 221–228.
Jamieson, G.S. 1973. Coexistence in the Gerridae. Ph.D. Thesis, Univ. British Columbia, Vancouver.
Jamieson, G.S. and G.G.E. Scudder. 1977. Food consumption in *Gerris* (Hemiptera). *Oecologia (Berl.)* **30**: 23–41.
_____ 1979. Predation in *Gerris* (Hemiptera): reactive distance and locomotion rates (in press).
Järvinen, O. and K. Vepsäläinen. 1976. Wing dimorphism as an adaptive strategy in water-striders (*Gerris*). *Hereditas* **84**: 61–68.
Kaufmann, T. 1971. Ecology, biology and gonad morphology of *Gerris rufoscutellatus* (Hemiptera: Gerridae) in Fairbanks, Alaska. *Am. Midl. Nat.* **86**: 407–416.

Schuh, T. 1967. The shore bugs (Hemiptera: Saldidae) of the Great Lakes region. *Contr. Am. ent. Inst.* 2(2): 1–35.
Scudder, G.G.E. 1971. The Gerridae (Hemiptera) of British Columbia. *J. ent. Soc. Br. Columb.* **68**: 3–10.
_____ 1977. An annotated checklist of the aquatic and semi-aquatic Hemiptera (Insecta) of British Columbia. *Syesis* **10**: 31–38.
Scudder, G.G.E. and G.S. Jamieson. 1972. The immature stages of *Gerris* (Hemiptera) in British Columbia. *J. ent. Soc. Br. Columb.* **69**: 72–79.
Spence, J.R. 1978. Microhabitat selection and regional coexistence in waterstriders (Hemiptera: Gerridae). Ph.D. Thesis, Univ. British Columbia, Vancouver.
Todd, E.L. 1955. A taxonomic revision of the family Gelastocoridae (Hemiptera). *Univ. Kans. Sci. Bull.* **37**: 277–475.
Vepsäläinen, K. 1974. The life cycles and wing lengths of Finnish *Gerris* Fabr. species (Heteroptera, Gerridae). *Acta. zool. fenn.* **141**: 1–73.

Nepoidea, Notonectoidea, and Corixoidea

The aquatic bugs show various stages of adaptation to lotic and lentic environments, and the Corixidae have even adapted to life in the sea and saline lakes (Scudder 1976). The general biology of these aquatic insects has been described by Hungerford (1919), but the Corixidae are now known to be predaceous (Jansson and Scudder 1972; Reynolds 1975; Reynolds and Scudder 1979*a*, *b*).

The Nepidae have been considered by Hungerford (1923), while the Belostomatidae have been reviewed by Cummings (1933), Menke (1963), and Lauck (1962–1964). The papers by Hungerford (1933) and Truxal (1953) have considered the two genera of Notonectidae, *Notonecta* and *Buenoa*, respectively. The life history of *Notonecta* has been investigated by Clark (1928) and Taylor (1968), and Scudder (1967) has pointed out that *Notonecta borealis* Bueno and Hussey is mostly a flightless species, with an apparent change of habitat from lakes to streams as one proceeds north into northern Alberta and the Northwest Territories.

The Pleidae have been considered by Drake and Chapman (1953). Two species of *Plea* are known in Canada east of the Rockies, but this family has not been detected yet in British Columbia, although it occurs just to the south in the State of Washington.

The Corixidae were reviewed by Hungerford (1948), and the Canadian fauna has been considered by Brooks and Kelton (1967), Lansbury (1955, 1960), and Scudder (1977). Jansson (1972*a*) revised the genus *Cenocorixa*, and this has been studied extensively by Scudder and his students. The genus *Trichocorixa* has also been studied on the prairies (Tones and Hammer 1975; Tones 1977).

Brooks, A.R. and L.A. Kelton. 1967. Aquatic and semiaquatic Heteroptera of Alberta, Saskatchewan and Manitoba (Hemiptera). *Mem. ent. Soc. Can.* 51. 92 pp.
Cannings, S.G. 1977. The influence of temperature and salinity on the cuticular permeability of some Corixidae, M.Sc. Thesis, Univ. British Columbia, Vancouver.
Clark, L.B. 1928. Seasonal distribution and life history of *Notonecta undulata* in the Winnipeg Region, Canada. *Ecology* **9**: 383–403.
Cummings, C. 1933. The Giant Waterbugs (Belostomatidae-Hemiptera). *Univ. Kans. Sci. Bull.* **21**: 197–219.
Drake, C.J. and H.C. Chapman. 1953. Preliminary report on the Pleidae (Hemiptera) of the Americas. *Proc. Biol. Soc. Wash.* **66**: 53–59.
Froeschner, R.C. 1962. Contributions to a synopsis of the Hemiptera of Missouri, Part V. Hydrometridae, Gerridae, Veliidae, Saldidae, Ochteridae, Gelastocoridae, Naucoridae, Belostomatidae, Nepidae, Notonectidae, Pleidae, Corixidae. *Am. Midl. Nat.* **67**: 208–240.
Hungerford, H.B. 1919. The biology and ecology of aquatic and semi-aquatic Hemiptera. *Univ. Kans. Sci. Bull.* 11. 328 pp.
_____ 1923. The Nepidae in North America north of Mexico. *Kans. Univ. Sci. Bull.* **14**. 425–469.
_____ 1933. The genus *Notonecta* of the World. *Univ. Kans. Sci. Bull.* 21. 195 pp.

_____ 1948. The Corixidae of the Western Hemisphere (Hemiptera). *Univ. Kans. Sci. Bull.* 32. 827 pp.

Jansson, A. 1972*a*. Systematic notes and new synonymy in the genus *Cenocorixa* (Hemiptera: Corixidae). *Can. Ent.* **104**: 449–459.

_____ 1972*b*. Mechanisms of sound production and morphology of the stridulatory apparatus in the genus *Cenocorixa* (Hemiptera, Corixidae). *Ann. zool. fenn.* **9**: 120–129.

_____ 1973*a*. Stridulation and its significance in the genus *Cenocorixa* (Hemiptera, Corixidae). *Behaviour* **46**: 1–36.

_____ 1973*b*. Diel periodicity of stridulatory activity in the genus *Cenocorixa* (Hemiptera, Corixidae). *Ann. zool. fenn.* **10**: 378–383.

_____ 1974*a*. Annual periodicity of male stridulation in the genus *Cenocorixa* (Hemiptera, Corixidae). *Freshwat. Biol.* **4**: 93–98.

_____ 1974*b*. Effects of temperature on stridulatory signals of *Cenocorixa* (Hemiptera, Corixidae). *Ann. zool. fenn.* **11**: 288–296.

Jansson, A. and G.G.E. Scudder. 1972. Corixidae (Hemiptera) as predators: rearing on frozen brine shrimp. *J. ent. Soc. Br. Columb.* **69**: 44–45.

_____ 1974. The life cycle and sexual development of *Cenocorixa* species (Hemiptera, Corixidae) in the Pacific Northwest of North America. *Freshwat. Biol.* **4**: 73–92.

Jarial, M.S. and G.G.E. Scudder. 1970. The morphology and ultrastructure of the Malpighian tubules and hindgut in *Cenocorixa bifida* (Hung.) (Hemiptera, Corixidae). *Z. Morph. Tiere* **68**: 269–299.

_____ 1971. Neurosecretion and water balance in *Cenocorixa bifida* (Hung.) (Hemiptera, Corixidae). *Can. J. Zool.* **49**: 1369–1375.

Lansbury, I. 1955. Distributional records of North American Corixidae (Hemiptera: Heteroptera). *Can. Ent.* **87**: 474–481.

_____ 1960. The Corixidae (Hemiptera-Heteroptera) of British Columbia. *Proc. ent. Soc. Br. Columb.* **57**: 34–43.

Lauck, D.R. 1962–1964. A monograph of the genus *Belostoma*, Part I-III. *Bull. Chicago Acad. Sci.* **11**: 34-154.

Menke, A.S. 1963. A review of the genus *Lethocerus* in North and Central America, including the West Indies (Hemiptera: Belostomatidae). *Ann. ent. Soc. Am.* **56**: 261–267.

Oloffs, P.C. and G.G.E. Scudder. 1966. The transition phenomenon in relation to the penetration of water through the cuticle of an insect, *Cenocorixa expleta* (Uhler). *Can. J. Zool.* **44**: 621–630.

Reynolds, J.D. 1974. Aspects of the ecology of two species of *Cenocorixa* (Corixidae. Hemiptera) in allopatry and sympatry. Ph.D. Thesis, Univ. British Columbia, Vancouver.

_____ 1975. Feeding in corixids (Heteroptera) of small alkaline lakes in central B.C. *Verh. int. Verein theor. angew. Limnol.* **19**: 3073–3078.

Reynolds, J.D. and G.G.E. Scudder. 1979*a*. Experimental evidence of fundamental feeding niche in *Cenocorixa* (Hemiptera: Corixidae). (in press).

_____ 1979*b*. Serological study of feeding in *Cenocorixa* species (Hemiptera). (in press).

Scudder, G.G.E. 1967. *Notonecta borealis* Bueno and Hussey (Hem., Notonectidae): a flightless species? *Entomologists mon. Mag.* **102**. 258–259.

_____1969.The distribution of two species of *Cenocorixa* in inland saline lakes of British Columbia. *J. ent. Soc. Br. Columb.* **66**: 32–41.

_____ 1971. The postembryonic development of the indirect flight muscles in *Cenocorixa bifida* (Hung.) (Hemiptera: Corixidae). *Can. J. Zool.* **49**: 1387–1398.

_____ 1975. Field studies on the flight muscle polymorphism in *Cenocorixa* (Hemiptera: Corixidae). *Verh. int. Verein. theor. angew. Limnol.* **19**: 3064–3072.

_____ 1976. Water-boatmen of saline waters (Hemiptera: Corixidae). pp. 263–289 *in* L. Cheng (Ed.), Marine Insects. North Holland, Amsterdam.

_____ 1977. An annotated checklist of the aquatic and semi-aquatic Hemiptera (Insecta) of British Columbia. *Syesis* **10**: 31–38.

Scudder, G.G.E., M.S. Jarial, and S.K. Choy. 1972. Osmotic and ionic balance in two species of *Cenocorixa* (Hemiptera). *J. Insect Physiol.* **18**: 883–895.

Taylor, O.R. 1968. Coexistence and competitive interactions in fall and winter populations of six sympatric *Notonecta* (Hemiptera, Notonectidae) in New England. *Univ. Conn. Occ. Pap.* (Biol. Ser.) **1**: 109–139.

Tones, P.I. 1977. The life cycle of *Trichocorixa verticalis interiores* Sailer (Hemiptera, Corixidae) with special reference to diapause. *Freshwat. Biol.* **7**: 31-36.

Tones, P.I. and U.T. Hammer. 1975. Osmoregulation in *Trichocorixa verticalis interiores* Sailer — an inhabitant of Saskatchewan saline lakes, Canada. *Can. J. Zool.* **53**: 1207–1212.

Truxal, F.S, 1953. A revision of the genus *Buenoa* (Hemiptera, Notonectidae). *Univ. Kans. Sci. Bull.* **35**: 1351–1523.

Cicadoidea

The Cicadidae of Canada have been considered by Beirne (1959). However, further study is required.

The spittle bugs, or Cercopidae, are conspicuous and occur on all kinds of plants. The Canadian fauna is now being revised by Hamilton. The best known cercopid is the polymorphic meadow spittlebug, *Philaenus spumarius* (Linn.), which has been investigated by Weaver and King (1954) and Farish and Scudder (1967). This species is an important pest of alfalfa (Beirne 1972, see Introduction) and is common in Canada. The colour polymorphism in this species has been studied extensively elsewhere, and would be a topic worthy of further study in Canada, especially on the coastal islands of British Columbia.

The spittlebug *Philaenus lineatus* (Linn.) has been found on forage crops in Prince Edward Island and Quebec, while *Philaenarcys bilineata* (Say) has damaged merion blue grass in central and northern British Columbia (Arnott and Bergis 1967). Spittlebugs have also attacked alfalfa, corn, and strawberries in Ontario and British Columbia (Beirne 1972). Various species of *Aphrophora* have been reported to attack conifers (Brown 1941; Anderson 1947; Kelson 1964).

Anderson, R.F. 1947. Saratoga spittlebug unjury to pine. *J. econ. Ent.* 40: 26–33.

Arnott, D.A. and I. Bergis. 1967. Note on damage to grasses in the Peace River region by the spittlebug, *Philaronia bilineata* Say (Cercopidae: Hemiptera). *J. ent. Soc. Br. Columb.* 64: 8–9.

Beirne, B.P. 1959. The Cicadas (Homoptera: Cicadidae) and Treehoppers (Homoptera: Membracidae) of Canada. Can. Dep. Agric., Scient. Info. Section.

Brown, A.W.A. 1941. Foliage insects of spruce in Canada. *Can. Dep.Agric. Tech. Bull.*31. 29. pp.

Farish, D.J. 1972. Balanced polymorphism in North American populations of the Meadow Spittlebug, *Philaenus spumarius* (Homoptera: Cercopidae). I. North American morphs. *Ann. ent. Soc. Am.* 65. 710–719.

Farish, D.J. and G.G.E. Scudder. 1967. The polymorphism in *Philaenus spumarius* (Linn.) (Hemiptera: Cercopidae) in British Columbia. *J. ent. Soc. Br. Columb.* 64: 45–51.

Halkka, O. 1964. Geographical, spatial and temporal variability in the balanced polymorphism of *Philaenus spumarius*. *Heredity* **19**: 383–401.

Halkka, O. and R. Lallukka. 1969. The origin of balanced polymorphism in the spittlebugs (*Philaenus*, Homoptera). *Ann. zool. fenn.* 6: 431–434.

Halkka, O. and E. Mikkola. 1965. Characterization of clines and isolates in a case of balanced polymorphism. *Hereditas* **54**: 140–148.

Halkka, O., M. Raatikainen, A. Vasarainen, and L. Heinonen. 1967. Ecology and ecological genetics of *Philaenus spumarius* (L.) (Homoptera). *Ann. zool. fenn.* 4: 1–18.

Kelson, W.E. 1964. The biology of *Aphrophora permutata* and some observations on *Aphrophora canadensis* attacking Monterey Pine in California (Homoptera: Cercopidae). *Pan-Pacif. Ent.* 40: 135–146.

Thompson, V. 1973. Spittlebug polymorphism for warning coloration. *Nature, Lond.* 242: 126–128.

Thompson, V. and O. Halkka. 1973. Color polymorphism in some North America *Philaenus spumarius* (Homoptera: Aphrophoridae) populations. *Am. Midl. Nat.* 89: 348–359.

Weaver, C.R. and D.R. King. 1954. Meadow Spittlebug. *Bull. Ohio agric. Exp. Stn.* 741. 99 pp.

Membracoidea

The Canadian Membracidae were considered by Beirne (1959). The buffalo treehopper, *Stictocephalus bisonia* Knopp and Yonke, has been found on alfalfa across Canada, but the extent of the damage is not known (Beirne 1972, see Introduction).

Hamilton (1971) has described the Aetalionidae, with a single species *Microcentrus caryae* (Fitch) in Canada from Ontario.

The leafhoppers, or Cicadellidae, are major economic pests in Canada, and are second in importance only to aphids in the transmission of plant viruses (Smith and Brierley 1956). The Canadian leafhoppers were reviewed by Beirne (1956), but significant revisions have been published by Hamilton, Hamilton and Ross, and Ross and Hamilton.

Several cicadellid species have been found on and damaging alfalfa, and the potato leafhopper, *Empoasca fabae* (Harris), is a common pest of field beans and potato, especially in eastern Canada. It has been reported to cause "hopperburn" on potato, white, soy, lima and string beans, tobacco, alfalfa, clover, cucumber, and corn (Beirne 1972).

Leafhoppers cause leaf and fruit injury in vineyards in British Columbia, and require control measures (Madsen and Morgan 1975). They are also a nuisance in sweet cherry orchards in British Columbia (Wilde 1962). Further, they are vectors of wheat striate mosaic disease in Manitoba and Saskatchewan, and can transmit a celery-infesting strain of aster yellows virus (Beirne 1972).

The best known cicadellid in Canada is the six-spotted or aster leafhopper, *Macrosteles fascifrons* (Stål), which occurs in all life zones from Alaska to Mexico and Puerto Rico (DeLong 1971). It causes major losses in a wide variety of crops, including barley, flax, rape, carrots, lettuce, etc. (Beirne 1972), and is the vector of the mycoplasma-like organism causing aster yellows (Raine *et al.* 1976). *M. fascifrons* passes the winter as an adult, but does not normally overwinter in Canada. Like some other leafhoppers (e.g. *Empoasca fabae*), the large milkweed bug (*Oncopeltus fasciatus*) and some aphids, *M. fascifrons* is carried to Canada each spring by the prevailing winds from the south (Medler 1962; Westdahl *et al.* 1961).

Beirne, B.P. 1956. Leafhoppers (Homoptera: Cicadellidae) of Canada and Alaska. *Can. Ent.* **88** *Suppl.* 2. 180 pp.

_____ 1959. The cicadas (Homoptera: Cicadidae) and Treehoppers (Homoptera: Membracidae) of Canada. Can. Dep. Agric., Sci. Info. Section.

DeLong, D.M. 1971. The bionomics of leafhoppers. *A. Rev. Ent.* **16**: 179–210.

Hamilton, K.G.A. 1970. The genus *Cuerna* (Homoptera: Cicadellidae) in Canada. *Can. Ent.* **102**: 425–441.

_____ 1971. Placement of the genus *Microcentrus* in the Aetalionidae (Homoptera: Cicadellidae), with a redefinition of the family. *J. Georgia ent. Soc.* **6**: 229–236.

_____ 1972*a*. The Manitoban fauna of leafhoppers (Homoptera: Cicadellidae). I. Descriptions of new species and colour forms. *Can. Ent.* **104**: 825–832.

_____ 1972*b*. The Manitoban fauna of leafhoppers (Homoptera: Cicadellidae). II. The fauna of macro-leafhoppers. *Can. Ent.* **104**: 1137–1148.

_____ 1975*a*. Review of the tribal classification of the leafhopper family Aphrodinae (Deltocephalinae of authors) of the Holarctic Region (Rhynchota: Homoptera: Cicadellidae). *Can. Ent.* **107**: 477–498.

_____ 1975*b*. A review of the Northern Hemisphere Aphrodina (Rhynchota: Homoptera: Cicadellidae), with special reference to the Nearctic fauna. *Can. Ent.* **107**: 1009–1027.

_____ 1975*c*. Revision of the genera *Paraphlepsius* Baker and *Pendarus* Ball (Rhynchota: Homoptera: Cicadellidae). *Mem. ent. Soc. Can.* 46. 129 pp.

Hamilton, K.G.A. and H.H. Ross. 1975. New species of grass-feeding Deltocephaline leafhoppers with keys to the Nearctic species of *Palus* and *Rosenus* (Rhynchota: Homoptera: Cicadellidae). *Can. Ent.* **107**: 601–611.

Madsen, B.J. and C.V.G. Morgan. 1975. Mites and insects collected from vineyards in the Okanagan and Similkameen Valleys, British Columbia. *J. ent. Soc. Br. Columb.* **72**: 9–14.

Medler, J.T. 1962. Long range displacement of Homoptera in the central United States. *Proc. XI int. Congr. Ent.* **3**: 30–35.

Raine, J., A.R. Forbes, and F.E. Skelton. 1976. Mycoplasma-like bodies, Rickettsia-like bodies, and salivary bodies in the salivary glands and saliva of the leafhopper *Macrosteles fascifrons* (Homoptera: Cicadellidae). *Can. Ent.* **108**: 1009–1019.

Ross, H.H. and K.G.A. Hamilton. 1972. A review of the North American leafhopper genus *Laevicephalus* (Hemiptera: Cicadellidae). *Ann. ent. Soc. Am.* **65**: 929–942.

Smith, F.F. and P. Brierley. 1956. Insect transmission of plant viruses. *A. Rev. Ent.* **1**: 299–322.

Westdahl, P.H., C.F. Barrett, and H.P. Richardson. 1961. The six-spotted leafhopper, *Macrosteles fascifrons* (Stål) and aster yellows in Manitoba. *Can. J. Plant Sci.* **41**: 320–331.

Wilde, W.H.A. 1962. Incidence of leafhoppers inhabiting sweet cherry orchards in the Kootenay Valley of British Columbia. *Proc. ent. Soc. Br. Columb.* **59**: 15–17.

Fulgoroidea

The eight families of Fulgoroidea in Canada have not been monographed to date, although a review of some of the taxa has been started by Scudder, and Hamilton is revising the higher classification. Metcalf (1923) has treated the majority of the fulgorid families and genera in eastern North America, and Osborn (1938) monographed the fauna of Ohio.

The Canadian Cixiidae were reviewed by Beirne (1950*a*) and the achilid tribe Plectoderini in North America was revised by O'Brien (1971): the Canadian species of the achilid genus *Epiptera* were considered by Beirne (1950*b*).

The North American Issinae have been monographed by Doering. The major available working papers on the Delphacidae are by Crawford (1914) and Muir (1915). While a number of the delphacid genera have since been revised, the genus *Delphacodes* has not been monographed and species identification is very difficult.

Very few fulgorids are known economic pests, although some delphacids are potentially so. The moth-bug, *Metcalfa pruinosa* (Say), has been found on alfalfa and raspberry in Ontario, while the fulgorid *Scolops grossus* Uhler has been found on sweet clover in Alberta (Beirne 1972, see Introduction). Achilids and the cixiid *Cixius basalis* V-D. are reported to attack shoots of spruce trees (Brown 1941).

Beamer, R.H. 1946. The genus *Stenocranus* in America north of Mexico (Homoptera-Fulgoridae-Delphacinae). *J. Kans. ent. Soc.* **19**: 1–11.

_____ 1951. A review of the genus *Kelisia* in America north of Mexico with four new species (Homoptera-Fulgoridae-Delphacinae). *J. Kans. ent. Soc.* **24**: 117–121.

_____ 1952. The genus *Eurysa* in America north of Mexico (Homoptera: Fulgoridae, Delphacinae). *Pan-Pacif. Ent.* **28**: 51–55.

_____ 1954. A revision of the genus *Achrotile* in America north of Mexico (Homoptera: Fulgoridae, Delphacinae). *J. Kans. ent. Soc.* **27**: 143–147.

_____ 1955. A revision of the genus *Megamelus* in America north of Mexico (Homoptera, Fulgoridae, Delphacinae). *J. Kans. ent. Soc.* **28**: 29–46.

Beirne, B.P. 1950*a*. The Canadian Cixiidae (Homoptera: Fulgoroidea). *Can. Ent.* **82**: 93–101.

_____ 1950*b*. The Canadian species of *Epiptera* (Homoptera: Achilidae). *Can. Ent.* **82**: 186–190.

Brown, A.W.A. 1941. Foliage insects of spruce in Canada. *Can. Dept. Agric. Tech. Bull.* 31. 29 pp.

Crawford, D.L. 1914. A contribution toward a monograph of the homopterous insects of the family Delphacidae of North and South America. *Proc. U.S. natn. Mus.* 46: 557–640.

Doering, K.C. 1936. A contribution to the taxonomy of the subfamily Issinae in America north of Mexico (Fulgoridae, Homoptera). Part I. *Univ. Kans. Sci. Bull.* **24**: 421–467.

_____ 1938. A contribution to the taxonomy of the subfamily Issinae in America north of Mexico (Fulgoridae, Homoptera). Part II. *Univ. Kans. Sci. Bull.* **25**. 447–575.

_____ 1940. A contribution to the taxonomy of the subfamily Issinae in America north of Mexico (Fulgoridae, Homoptera). Part III. *Univ. Kans. Sci. Bull.* **26**: 83–167.

_____ 1941. A contribution to the taxonomy of the subfamily Issinae in America north of Mexico (Fulgoridae, Homoptera). Part IV. *Univ. Kans. Sci. Bull.* **27**: 186–233.

Kramer, J.P. 1973. Revision of the American planthoppers of the genus *Stobaera* (Homoptera: Delphacidae) with new distributional data and host plant records. *Proc. ent. Soc. Wash.* **75**: 379–402.

Metcalfe, Z.P. 1923. A key to the Fulgoridae of eastern North America with descriptions of new species. *J. Elisha Mitchell scient. Soc.* **38**: 139–230.

Morgan, L.W. and R.H. Beamer. 1949. A revision of three genera of Delphacine Fulgorids from America north of Mexico (Homoptera-Fulgoridae-Delphacinae). *J. Kans. ent. Soc.* **22**: 97–142.

Muir, F. 1915. A contribution towards the taxonomy of the Delphacidae. *Can. Ent.* 47: 208–212, 261–270, 296–302.

O'Brien, L.B. 1971. The systematics of the tribe Plectoderini in America north of Mexico (Homoptera: Fulgoridea, Achilidae). *Univ. Calif. Publs Ent.* **64**: 1–79.

Osborne, H. 1938. The Fulgoridae of Ohio. *Bull. Ohio Biol. Surv.* **35**: 283–357.

Penner, L.R. 1945. The genus *Laccocera* Van Duzee (Homoptera:Delphacidae). *J. Kans. ent. Soc.* **18**: 30–47.

_____ 1947. Some notes on the genus *Pentagramma* and four new species (Homoptera-Delphacidae-Asiracinae). *J. Kans. ent. Soc.* **20**. 30–39.

Scudder, G.G.E. 1963. Studies on the Canadian and Alaskan Fulgoromorpha (Hemiptera). I. The genera *Achrotile* Fieber and *Laccocera* Van Duzee (Delphacidae). *Can. Ent.* **95**: 167–177.

_____ 1964. Studies on the Canadian and Alaskan Fulgormorpha (Hemiptera). II. The genus *Megamelus* Fieber (Delphacidae). *Can. Ent.* **96**: 813–820.

Psylloidea and Aleyrodoidea

The Psyllidae of North America were considered by Tuthill (1943). Journet and Vickery (1978) have revised the taxonomic relationships within the superfamily. The Alberta fauna was treated by Strickland (1938, 1939), while Kitching (1971) and Hodkinson (1973, 1978) considered the species in British Columbia and Alaska.

The pear psylla, *Psylla pyricola* Foerster, is a key pest in some fruit growing areas, not only because of the direct injury to pear trees, but because it is the vector of pear decline virus and leaf curl (Chang and Philogène 1975). Wilde *et al.* (1971) have also reported that it is the vector of fireblight. Chang and Philogène (1976) have studied its development on different pear rootstocks and cultivars. The potato or tomato psyllid, *Paratrioza cockerelli* (Sulc), is known as a pest of potatoes and tomatoes in Alberta, British Columbia, Quebec, and Saskatchewan, where it causes leaf curl and psyllid yellows (Beirne 1972, see Introduction).

The white flies, or Aleyrodidae, are occasionally of economic importance in Canada. The iris whitefly, *Aleyrodes spiraeoides* Quaint., has been reported on potato in British Columbia and the Atlantic Provinces. The greenhouse whitefly, *Trialeurodes vaporariorum* (Westw.), occurs on many crops, attacking especially tomato, cucumber, and lettuce (Beirne 1972). Occasionally the whitefly on rhododendron also requires control (Olds 1936).

Chang, J.F. and B.J.R. Philogène. 1975. A bibliography on the Pear Psylla, *Psylla pyricola* (Homoptera: Psyllidae). *Bull. ent. Soc. Am.* **21**: 247–249.

_____ 1976. The development and behaviour of the Pear Psylla, *Psylla pyricola* (Homoptera: Psyllidae) on different pear rootstocks and cultivars. *Phytoprotection* **57**: 137–149.

Hodkinson, I.D. 1973. A note on the taxonomy of the Psyllidae of British Columbia. *J. ent. Soc. Br. Columb.* **70**: 68–69.

_____ 1978. The psyllids (Homoptera: Psylloidea) of Alaska. *Syst. Ent.* **3**: 333–360.

Journet, A.R.P. and V.R. Vickery. 1978. Studies on Nearctic *Craspedolepta* Enderlein, 1921 (Homoptera: Psylloidea): taxonomic relationships within the superfamily. *Can. Ent.* **110**: 1–12.

Kitching, R.L. 1971. The Psyllidae of British Columbia with a key to species. *J. ent. Soc. Br. Columb.* **68**: 36–43.

Olds, H.F. 1936. The distribution of the Rhododendron white fly in British Columbia. Notes on its life history and control measures. *Proc. ent. Soc. Br. Columb.* **32**: 23–25.

Strickland, E.H. 1938. The Chermidae (Homoptera) of Alberta. *Can. Ent.* **70**: 200–206.

_____ 1939. Further notes on Psyllidae taken in Alberta. (Homoptera). *Can. Ent.* **71**: 212–215.

Tuthill, L.D. 1943. The psyllids of America north of Mexico (Psyllidae: Homoptera). *Iowa St. Coll. J. Sci.* **17**: 443–460.

Wilde, W.H.A., J. Carpenter, J. Liberty, and J. Tunnicliffe. 1971. *Psylla pyricola* (Hemiptera: Psyllidae) vector relationships with *Erwinia amylorora*. *Can. Ent.* **103**: 1175–1178.

Aphidoidea

In the Adelgidae, the balsam woolly aphid, *Adelges piceae* (Ratz.), is one of the most important coniferous forest pests in the Maritime Provinces and British Columbia. Various species of *Adelges* also induce galls on spruce (Brown 1941).

In the Phylloxeridae, the grape phylloxera, *Phylloxera vitifoliae* (Fitch), is of particular importance (Morgan *et al.* 1973). Aphids are ubiquitous on crops of the temperate regions (Watson and Plumb 1972). More plant viruses are transmitted by aphids than by any other group of insects (Smith and Brierley 1956; Harris and Maramorosch 1977), and non-persistent viruses are normally only transmitted by these insects (Watson and Plumb 1972).

While no doubt many aphids have yet to be reported, the Canadian fauna has received a good deal of attention. Not only have some of the major taxa been revised by Richards, but the Maritime species have been listed (Burnham 1938; MacGillivray 1952, 1953), the Manitoba species are under investigation (Robinson and Bradley 1968; Rojanavongse and Robinson 1977), and the British Columbia species are reasonably well known (Forbes and others).

Aphids are pests of forest trees (Brown 1941), and Beirne (1972, see Introduction) lists 34 species as pests of annual crop plants in Canada. The most prominent of these are the pea aphid (*Acyrthosiphon pisum* (Harris)), the black bean aphid (*Aphis fabae* Scop.), the cabbage aphid (*Brevicoryne brassicae* (Linn.)), the potato aphid (*Macrosiphum euphorbiae* (Thom.)), and the corn leaf aphid (*Rhopalosiphum maidis* (Fitch)). The latter aphid is an annual pest, reducing yields of corn in southwest Ontario (Foott and Timmins 1973) and remote sensing has shown that levels of infestation of corn aphid in 1974 varied from 35.6% to 67.1% (Wallen *et al.* 1976).

However, the green peach aphid, *Myzus persicae* (Sulz.), is by far the most important aphid pest across Canada. It has been recorded from over 150 hosts altogether, and is able to transmit over 100 virus diseases of plants of about 34 different families, including such major crops as beans, sugar beet, brassicas, potatoes, citrus, etc. (Van Emden *et al.* 1969). It transmits almost all of the mosaics that occur on vegetables. In fact, *M. persicae* is one of the most efficient vectors known (Smith and Brierley 1956), and is the most important single vector of plant viruses (Ossiannilsson 1966).

Brown, A.W.A. 1941. Foliage insects of spruce in Canada. *Can. Dep. Agric. Tech. Bull.* 31. 29 pp.

Bryant, D.G. 1976. Distribution, abundance, and survival of the balsam woolly aphid, *Adelges piceae* (Homoptera. Phylloxeridae), on branches of balsam fir, *Abies balsamea*. *Can. Ent.* **108**: 1097–1111.

Burnham, J.C. 1938. A contribution to a list of the Aphididae of the Maritime Provinces of Canada. *Can. Ent.* **70**: 180–183.

Foott, W.H. and P.R. Timmins. 1973. Effects of infestations by the corn leaf aphid, *Rhopalosiphum maidis* (Homoptera: Aphididae), on field corn in southwestern Ontario. *Can. Ent.* **105**: 449–458.

Forbes, A.R. and C-K. Chan. 1976. The aphids (Homoptera:Aphididae) of British Columbia. 4. Further additions and corrections. *J. ent. Soc. Br. Columb.* **73**: 57–63.

Forbes, A.R. and B.D. Frazer. 1973. The aphids (Homoptera:Aphididae) of British Columbia. 2. A host plant catalogue. *J. ent. Soc. Br. Columb.* **70**: 58–68.

Forbes, A.R., B.D. Frazer, and C-K. Chan. 1974. The aphids (Homoptera:Aphididae) of British Columbia. 3. Additions and corrections. *J. ent. Soc. Br. Columb.* **71**: 43–49.

Forbes, A.R., B.D. Frazer, and H.R. MacCarthy. 1973. The aphids (Homoptera:Aphididae) of British Columbia. 1. A basic taxonomic list. *J. ent. Soc. Br. Columb.* **70**: 43–57.

Greenbank, D.O. 1970. Climate and the ecology of the balsam woolly aphid. *Can. Ent.* **102**: 546–578.

Harris, K.F. and K. Maramorosch (Eds.). 1977. Aphids as virus vectors. Academic Press, New York.

MacGillivray, M.E. 1952. Some aphids of the genus *Aphis* from the Maritime Provinces of Canada. *Can. Ent.* **84**: 74–76.

_____ 1955. Further aphids of the Maritime Provinces (Homoptera: Aphididae). *Can. Ent.* **87**: 331–337.

McMullen, L.H. and J.P. Skovsgaard. 1972. Seasonal history of the balsam woolly aphid in coastal British Columbia. *J. ent. Soc. Br. Columb.* **69**: 33–40.

Morgan, C.V.G., P.J. Proctor, and J. Vielvoye. 1973. Occurrence of and attempts to eradicate grape phylloxera (Homoptera:Phylloxeridae) in British Columbia. *J. ent. Soc. Br. Columb.* **70**: 11–12.

Ossiannilsson, F. 1966. Insects in the epidemiology of plant viruses. *A. Rev. Ent.* **11**: 213–232.

Richards, W.R. 1960. A synopsis of the genus *Rhopalosiphum* in Canada (Homoptera: Aphididae). *Can. Ent.* **92** *Suppl.* 13. 51 pp.

_____ 1963. The Aphididae of the Canadian arctic (Homoptera). *Can. Ent.* **95**: 449–464.

_____ 1965. The Calliphidini of Canada (Hom.: Aphididae). *Mem. ent. Soc. Can.* 44. 149 pp.

_____ 1968. A synopsis of the world fauna of *Myzocallis* (Homoptera: Aphididae). *Mem. ent. Soc. Can.* 57. 76 pp.

———— 1971. A synopsis of the world fauna of the Saltusaphidinae, or sedge aphids (Homoptera: Aphididae). *Mem. ent. Soc. Can.* 80. 97 pp.
———— 1972. The Chaitophorinae of Canada (Homoptera: Aphididae). *Mem. ent. Soc. Can.* 87. 109 pp.
———— 1976. A host index for species of Aphidoidea described during 1935 to 1969. *Can. Ent.* **108**: 499–500.
Robinson, A.G. and G.A. Bradley. 1968. A revised list of aphids of Manitoba. *Man. Ent.* **2**: 60–65.
Rojanavongse, V. and A.G. Robinson. 1977. Species of *Aphis* (Homoptera: Aphididae) in Manitoba, with a key, and description of new species. *Can. Ent.* **109**: 649–661.
Smith, F.F. and P. Brierley. 1956. Insect transmission of plant viruses. *A. Rev. Ent.* **1**: 299–322.
Tamaki, G. 1972. The biology of *Geocoris bullatus* inhabiting orchard floors and its impact on *Myzus persicae* on peaches. *Environ. Ent.* **1**: 559–565.
Tamaki, G. and D. Olsen. 1977. Feeding potential of predators of *Myzus persicae*. *J. ent. Soc. Br. Columb.* **74**: 23–26.
Van Emden, H.F., V.F. Eastop, R.D. Hughes, and M.J. Way. 1969. The ecology of *Myzus persicae*. *A. Rev. Ent.* **14**: 197–270.
Wallen, V.R., H.R. Jackson, and S.W. MacDiarmid. 1976. Remote sensing of corn aphid infestation, 1974 (Hemiptera: Aphididae). *Can. Ent.* **108**: 751–754.
Watson, M.A. and R.T. Plumb. 1972. Transmission of plant-pathogenic viruses by aphids. *A. Rev. Ent.* **17**: 425–452.
Wood, R.O. 1968. First occurrence of Balsam Woolly Aphid in the interior of British Columbia. *J. ent. Soc. Br. Columb.* 65: 13–15.

Coccoidea

The scale insects of North America were considered by Ferris (1937–1955), and Morrison and Renk (1957) have provided a selected bibliography for this superfamily. The scale insects of British Columbia were listed by Venables (1939).

The San Jose scale, *Quadraspidiotus perniciosus* (Comstock), is a major orchard pest in the southern part of the Okanagan Valley and in the Similkameen Valley of British Columbia. Growers lost over 50% of the crop in 1975 and according to packing house officials, an average of 15% of the apple crop in the southern Okanagan Valley was culled because of this scale (Downing and Logan 1977). The San Jose scale is known to infest representatives of 34 different families of plants (Beardsley and Gonzales 1975).

The European fruit scale, *Q. ostraeiformis* (Curtis), also occurs on apples and pears, while the soft scales (*Lecanium* spp., *Pulvinaria* spp.) on peach and apricots are of note (Proverbs 1957). The Comstock mealybug, *Pseudococcus comstocki* Kuw., is a pest of peach in Ontario (Phillips 1961).

Beardsley, J.W. and R.H. Gonzales. 1975. The biology and ecology of armoured scales. *A. Rev. Ent.* **20**: 47–73.
Downing, R.S. and D.M. Logan. 1977. A new approach to San Jose Scale control (Hemiptera: Diaspididae). *Can. Ent.* **109**: 1249–1252.
Ferris, G.F. 1937–1955. Atlas of the Scale Insects of North America. 7 Vols. Stanford Univ. Press.
Morrison, H. and A.V. Renk. 1957. A selected bibliography of the Coccoidea. *Misc. Publ. U.S. Dep. Agric. Res. Serv.* 734. 222 pp.
Phillips, J.H.H. 1961. An infestation of Comstock mealybug, *Pseudococcus comstocki* (Kuw.) (Homoptera: Coccoidea) on peach in Ontario. *Proc. ent. Soc. Ont.* **91**: 268–270.
Proverbs, M.D. 1957. Control of soft scales (Homoptera: Coccidae) in British Columbia, peach and apricot orchards. *Proc. ent. Soc. Br. Columb.* **54**: 3–8.
Venables, E.P. 1939. The scale insects of British Columbia. *Proc. ent. Soc. Br. Columb.* **35**: 23–24.

The preparation of this section was supported by a grant from the National Research Council of Canada. I am indebted to the following for their assistance: Drs. A.R. Forbes, B.D. Frazer, K.G.A. Hamilton, L.A. Kelton, and W.R. Richards.

36. THYSANOPTERA

B.S. HEMING

Thysanoptera (thrips) are among the smallest of insects, adults of most species rarely exceeding 2 mm in length. They appear to have evolved from litter-dwelling psocopteroid ancestors some time in the upper Carboniferous and to constitute the sister group of the Hemiptera. The order is primarily tropical in distribution and about 4500 species in 537 genera and 6 families have been described. Recent work on tropical faunas, however, suggests that the order actually comprises about 10,000 species (Mound 1977).

One hundred and two species in 41 genera and three families are so far recorded from Canada (Table 36), probably less than half the actual fauna and only about one-ninth of that recorded for North America (980 species in 149 genera and 5 families: Jacot-Guillarmod 1970–1975; Stannard 1957). As understood at present, the Canadian fauna is represented by Holarctic (27 species), Cordilleran (18), southeastern U.S. (13), introduced (10), southwestern U.S. (7), and great plains (4) forms. The centre of origin of other species remains undetermined. Higher latitudes are progressively depauperate and only three species are recorded from Canada's arctic archipelago (Lake Hazen, Ellesmere Island, 81°41′ N: Downes 1964).

Thrips are characterized by their asymmetric, "punch and suck" mouth parts (only the left mandibular stylet is present), with which they feed on a variety of substrates. Mycophagous, phytophagous, carnivorous, and pollen-feeding species are known. Although they can occur in particular areas in very high numbers, for example on flowers, their ecological significance is obscure (Lewis 1973). Larvae and adults of investigated Aeolothripidae either feed on pollen or leaves or are facultative predators on other small arthropods. Most thripids are phytophagous or

Table 36. Census of Canadian Thysanoptera

	No. spp. known from Canada	Est. no. Canadian spp. undescr. or unrecorded	Approx. no. Canadian spp. with larvae (II) described	Distribution in Canada
Suborder Terebrantia				
1. Aeolothripidae	13	10	3	Trans., S with spp. falling out at higher latitudes
2. Heterothripidae	0	5	0	Probably in S. Ont.
3. Thripidae	59	45	23	Trans., S with spp. falling out at higher latitudes
4. Merothripidae	0	1	0	Probably in S. Ont.
Suborder Tubulifera				
5. Phlaeothripidae	30	83	7	Trans., S with spp. falling out at higher latitudes
TOTAL	102	144	33	

ABBREVIATIONS: Trans., transcontinental; undescr., undescribed.