WIREWORMS OF CULTIVATED LAND IN BRITISH COLUMBIA[1]

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The first published record of wireworm damage in British Columbia appears to be that of Anderson (1892) who reported great damage during 1891 at Salmon Arm and South Saanich by a "hard yellow worm, the larva of the skip jack beetle". Many reports of damage followed but identifications were largely by inference based on adults collected in the general area where wireworm damage occurred. The first authentic identification of pest species appears to be that of Glen *et al.* (1943). They listed *Limonius canus* LeC., *Ludius (=Ctenicera) aeripennis* Kby., *L. (=C.) glauca* Germ., and *L. (=C.) pruinina* Horn. as pests in the Okanagan Valley and *L. (=C.) aeripennis* and *L. canus* as pests of truck crops on the Pacific Coast. In the Peace River area they found *L. (=C.) a. destructor (=destructor)* Brown and *Cryptohypnus (=Hypolithus) nocturnus (=bicolor)* Esch. attacking grain and truck crops. From 1946 to 1958 annual surveys were made of many agricultural areas to identify the species found and to determine their importance as pests. The purpose of this paper is to bring together the information obtained in the surveys (Table 1), and to provide a workable key to the known local species.

Methods

The surveys were carried out mainly during the spring when the larvae could be found near the surface actively feeding on seeds or seedlings. Large numbers were collected wherever possible; some were preserved and some reared to obtain adults for positive identification. In some areas damage was assessed at harvest. Grower's inquiries on wireworms were followed up and assistance was obtained from Provincial District Agriculturists and Horticulturists in locating areas where wireworms were troublesome. Adults were collected by sweeping the grass and beating shrubs and trees around the fields. This was done to help determine the larvae found in the fields.

The illustrations were made with the aid of a squared reticule, but are not drawn to the same scale throughout. The adults were identified by E. C. Becker, Taxonomy Section, Entomology Research Institute, Ottawa, and by M. C. Lane[2], U.S.D.A., Walla Walla, Washington. Determinations of larvae were made or checked by M. C. Lane.

The key to the species was made using largely the methods and terminology of Glen *et al.* (1943) and Glen (1950). The lengths given for larvae are those of the last instar at full growth.

Results and Discussion

Twenty-seven species of wireworms in 9 genera have been identified from cultivated land. Other *Dalopius* species were found and are listed here but are not separable to species in the larval stage. It has not been pos-

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sible to determine their separate importance as pests. The larvae of 9 species in other genera have been recognized only recently and described in this paper for the first time. Little is known about their habits or status, but none of these new species is thought to have caused appreciable damage in the past.

Genus AGRIOTES Eschscholtz

This is one of the most important genera. Six species are found in agricultural land: *Agriotes criddlei* Van D., *A. ferrugineipennis* (LeC.), *A. opaculus* (LeC.), and *A. sparsus* LeC. are native, but *A. lineatus* (L.) and *A. obscurus* (L.) were introduced from Europe around 1900. The 9th abdominal segments (Fig. 2, 36, 37, 39, 40) of *Agriotes* and *Dalopius* are conical and pointed, which separates them from the 7 other genera mentioned in this paper. In *Agriotes* the 9th abdominal segment lacks the two central dorsal setae (Fig. 37) which are present in the closely related *Dalopius* (Fig. 36). Becker (1956) included 10 species of *Agriotes* in his key to the larvae of nearctic species. The larva of *A. opaculus* was not included in Becker's key since it was recognized only in 1956.

Agriotes criddlei Van Dyke. The larva is small, about 10 mm. long. Like *Dalopius* it has a ring of setiferous tubercles (Fig. 36) on the apical third of the 9th abdominal segment which separates it from other *Agriotes* but has the blunt point typical of *Agriotes*. Glen (1944) described the larva in detail.

It has been found in three locations in upper parkland loam where wheat was grown. Once only was it found feeding on the seedlings. The damage caused was considered negligible.

Agriotes ferrugineipennis (LeConte). This larva is large, about 21 mm. long. It is readily distinguished from other *Agriotes* by the nipple-like, blunt tip of the 9th segment (Fig. 39) and a small, well defined eye spot at the base of each antenna.

Glen (1944) described this larva as *Agriotes* sp. It is found across southern British Columbia and is especially abundant in the lower Fraser Valley. It seems to have no preference for any particular type of soil but is usually found in wet areas and irrigated land. Often it is found in gardens where the soil is kept wet by sprinkling. It has not been found in large numbers nor has it been reported damaging crops.

Agriotes opaculus (LeConte). This larva is about 15 mm. long, and is generally lighter yellow than any other species. The setae are fine, light colored and very difficult to see, which gives the larva a naked look. There is no eye spot at the base of the antenna (Fig. 38).

Only one infestation has been found. *A. opaculus* and *C. aeripennis* were found together feeding on potato seed pieces near Quesnel. The land was silty-loam and had been in sod for the previous 4 years.

Agriotes sparsus LeConte. About 17 mm. long. It has two clear muscular impressions (Fig. 37) similar to those of *lineatus* and *obscurus* but is somewhat smaller and lacks eye spots (Fig. 38) at the base of the antenna. Becker (1956) has described this larva more fully.

The larvae of *sparsus* are found mostly in low, moist, silty-loam soils in the delta of the Fraser River. They have been found causing damage as far east as Cloverdale. This is one of the main pests attacking potatoes in the area. In one field near Ladner in 1955 where a population of nine *A. sparsus* larvae per sq. ft. was found, 65 per cent of the potatoes were graded as unmarketable for table

use because of wireworm damage and the average damage in nine fields was 20 per cent. Damage usually occurs when potatoes are planted following sod and is more severe in the second year. Most of the damage is caused late in the season so that early potatoes are seldom damaged. There is one record of their attacking gladiolus corms on Lulu Island. *Ctenicera lobata* (Esch.) is often found in the same fields as *sparsus*.

Agriotes lineatus (Linnaeus) and *Agriotes obscurus* (Linnaeus). The larvae of these Old World species are extremely difficult to separate. They are discussed here together. Full grown larvae are 18-22 mm. long. Both have muscular impressions on the 9th abdominal segment (Fig. 37), and eye spots (Fig. 38) at the base of the antenna. Both have been described by Beling (1883), Eidt (1954), and Becker (1956). *A. lineatus* has also been described by Roberts (1928, p. 90) and *A. obscurus* by Ford (1917).

The distribution in British Columbia is limited to two areas each of about 1000 acres near the coast. The rate of spread is slow. Both species are found near Cobble Hill on southern Vancouver Island but *A. lineatus* is dominant (King, 1950). *A. obscurus* alone occurs near Agassiz in the lower Fraser valley (King, *et al.*, 1952). Potatoes, corn and rye planted following pasture have been very severely damaged (Wilkinson, 1957). Populations of more than 20 wireworms per square foot have been found in pastures, but less than half this number have caused severe reduction in stands of corn.

The soil at Agassiz is silty-loam and at Cobble Hill it is clay, but both species may occur in light sandy, gravelly and muck soils so long as the moisture remains high all year.

Genus CTENICERA Latreille

Eight species of this important genus have been found. They are, *Ctenicera aeripennis* (Kby.), *C. funerea* (Brown), *C. glauca* (Germ.), *C. morula* (LeC.) *C. pruinina* (Horn), and *C. semimetallica* (Walk.) in one group and *C. lobata* (Esch.) and *C. resplendens* (Esch.) in another. The first group has a large caudal notch (Fig. 1, 22, 25, 26, 28, 29, 30), and the presternum of the prothorax is divided into four sclerites (Fig. 16). The second group has a small caudal notch (Fig. 7, 8) and the presternum of the prothorax is undivided (Fig. 15). The larvae of *lobata* and *resplendens* resemble closely those of the genus *Limonius* included in this paper. The larvae of *funerea, semimetallica, morula, lobata,* and *resplendens* are described here for the first time.

Ctenicera aeripennis (Kirby) and *Ctenicera destructor* (Brown). Glen (1950) described *destructor* in detail and found it indistinguishable from *aeripennis* except by size. The larva of *aeripennis* attains 28 mm. but *destructor* rarely exceeds 22 mm. The most important character separating the *aeripennis-destructor* complex from other *Ctenicera* having a large caudal notch, is the lack of setae on the central dorsal area of the 9th abdominal segment (Fig. 29). *C. glauca* is also without setae in this area (Fig. 26) but can be recognized by the sharp horny protuberances on the lateral margins of the 9th segment (Fig. 26), and by relatively slender urogomphi (Fig. 27). In *aeripennis* and *destructor*, the protuberances are rounded and the urogomphi are short and thick (Fig. 29, 31).

C. aeripennis is by far the most widespread pest species in the province. Larvae have been found in all agricultural areas. It is found in light sandy loams in the valleys but is

much more abundant in high parkland soils. It is not found in large numbers in irrigated land. Glen (1950) records both *aeripennis* and *destructor* in the Peace River area with *destructor* predominating in open grassland. Because they are indistinguishable and both occur in the same general area of the Peace River Block, the localities are listed in Table I for the *aeripennis-destructor* complex. The two species are not known to occur together elsewhere.

Ctenicera glauca (Germar). The largest specimen collected measured 17 mm. The species falls in with the *aeripennis* group but can easily be separated by projections on the lateral margins and the urogomphi (Fig. 26). Glen (1950) described this species in detail.

It has been found in three areas attacking wheat in parkland soil. It was found with *aeripennis* but was never numerous enough to cause serious damage. It was also found in muck soil in the Okanagan Valley near Vernon damaging cabbage transplants.

Ctenicera morula (LeConte). Length about 23 mm. *C. morula* resembles *aeripennis* in appearance and is found with *aeripennis* in the same habitat. It can be separated by the presence of 4 setae on the central dorsal area of the 9th abdominal segment (Fig. 30) which are lacking on *aeripennis* (Fig. 29). In lateral view the urogomphal prongs on *morula* and *funerea* are like grappling hooks (Fig. 32). These two species can be separated by the inner prongs; on *morula* the inner prongs angle inward from the base (Fig. 30), while on *funerea* they curve strongly inward (Fig. 25).

There is no record of crop damage by this species. It is usually found with *aeripennis* in well-drained light soils but is never the predominant species nor does it occur in numbers that would cause serious damage.

Ctenicera funerea (Brown). Length about 15 mm. *C. funerea* has a large caudal notch and urogomphal prongs like grappling hooks (Fig. 32). It can be further identified by the presence of several small setae in addition to the 4 larger setae in the central dorsal area of the 9th abdominal segment (Fig. 25).

There is no record of damage by this species. It has been found only twice: in well-drained, light, sandy-loam soil planted in wheat, and in an irrigated orchard.

Ctenicera pruinina (Horn). Length about 22 mm. It can be separated from other species in the group by having a large caudal notch, 4 or more setae on the central dorsal area and outer urogomphal prongs which are straight or bent slightly caudad at the tip (Fig. 33). The outer prongs of *funerea, morula, aeripennis* and *glauca* all have outer prongs that curve sharply caudad (Fig. 31, 32). Glen (1950) described this larva more fully.

This is a serious pest of grain crops in dry-farming areas of Washington, Idaho and Oregon (Lane, 1925, 1935) but there is no record of it as a pest in British Columbia. It has been found only in newly broken sagebrush land in the southern Okanagan Valley.

Ctenicera semimetallica (Walker). The largest specimen measured 23 mm. It is similar to *aeripennis* and *morula* but can be separated by the two setae on the central dorsal area of the 9th abdominal segment (Fig. 22).

Several specimens are usually found in large collections of *aeripennis* from parkland soils. There is no

record of it causing damage.

Ctenicera lobata (Eschscholtz). Length about 15 mm. This species differs from previously mentioned *Ctenicera* in having a small caudal notch (Fig. 8) and an undivided presternum of the prothorax (Fig. 15). The color varies from light yellow to brown depending upon the soil in which it is found. In peat soil it is whitish yellow, but in silt loam it is much darker. It is very similar to several *Limonius* larvae described here but can readily be separated and recognized by the dark transverse striations on the dorsum of abdominal segments 1-8 (Fig. 9).

Agriotes sparsus is found with *C. lobata* in heavy silt loams but not in peat soil. It is mainly a pest of late potatoes in the Lower Fraser Valley but has attacked other vegetable crops and gladiolus corms. Damage is usually heaviest when potatoes are grown in the second year after sod.

Ctenicera resplendens (Eschscholtz). The largest larva measured 27 mm. Like *lobata* this species has a small caudal notch (Fig. 7) and an undivided presternum of the prothorax (Fig. 15). It can be separated from *lobata* by the blunt setiferous protuberances on the lateral margins of the 9th abdominal segment; these are more rounded and less prominent on *Limonius* larvae (Fig. 19) and *lobata* (Fig. 8). It has been found in land planted to wheat where *aeripennis* was causing damage. It is not considered a pest.

Genus LIMONIUS Eschscholtz

Five species of the genus *Limonius* were found in agricultural land: the Pacific Coast wireworm, *L. canus* LeC., the most important pest species; the western field wireworm, *L. infuscatus* Mots.; the sugar-beet wireworm, *L. californicus* Mann.; the Columbia Basin wireworm, *L. subauratus* LeC.; and *L. pectoralis* LeC.

Larvae of this group are recognized by the small caudal notch and small posterior aperture (Fig. 14, 19, 21) and by the undivided presternum of the prothorax (Fig. 15). Other genera having these characteristics can be separated from *Limonius* by transverse striations on the dorsum of the abdominal segments 1-8 (Fig. 9) *(Athous pallidipennis* and *C. lobata)* or by prominent blunt setiferous protuberances on the lateral margins of the 9th abdominal segment *(C. resplendens)* (Fig. 7). *L. canus, infuscatus, californicus* and *subauratus* were included in a key by Lanchester (1946) to six *Limonius* species. Lanchester's method of separation was followed closely.

Limonius canus LeConte. Length 18 mm. The anterolateral grooves of the 2nd, 3rd, and 4th abdominal tergites (Fig. 18) fade as they approach the median suture on *canus* and *subauratus* but remain strong (Fig. 17) on *infuscatus* and *californicus. Canus* can be separated from *subauratus* by the tergal plate which is longer than wide with angulate anterior corners in *canus* (Fig. 19) and as wide as long with rounded anterior corners in *subauratus,* (Fig. 21). Lanchester (1939) described the species in detail.

This wireworm has been a major pest of vegetables for many years. It is generally found in light, moist, sandy loam, and loam soils throughout southern B.C. and Vancouver Island and has become adapted to conditions in irrigated areas. Seedlings are severely damaged in the spring when the larvae feed near the surface after overwintering at depths of 2 or more feet. Root crops are damaged in late summer and fall.

Limonius infuscatus Motschulsky. This wireworm is similar to *canus* in

size, color and habits but can readily be separated from the other 4 *Limonius* species by the outer urogomphi which curve anteriorly to form hooks (Fig. 13).

It is generally found with *canus* and is often the predominant species causing damage. It has not been found so far north as *canus*.

Limonius californicus (Mannerheim). In size and color the larvae are similar to those of *canus* and *infuscatus*. The anterolateral grooves remain strong as they approach the median suture as in *infuscatus* (Fig. 17) but the outer urogomphal prongs stand erect (Fig. 20).

This species was found in economic numbers only in the Kootenay Valley near the Montana border, where it was damaging potatoes. It has been found as far north as Kelowna in the Okanagan Valley but the infestations were light.

Limonius subauratus LeConte. The larvae are similar to other *Limonius* species in size and color. Like *canus* the anterolateral grooves fade out as they approach the median suture on abdominal segments 1-8 (Fig. 18), but unlike *canus* the tergal plate on the 9th abdominal segment is wider than long and the anterior corners are rounded (Fig. 21).

According to Lane *(in litt.)* and Lanchester (1946) this species is a pest and may often be found with other species of *Limonius* in the Pacific Northwest, but we have found a single specimen in 70 collections of *Limonius* larvae. The adults of this species have been collected in fields bordering sandy moist river banks but larvae have never been collected in cultivated land.

Limonius pectoralis LeConte. Length about 14 mm., colored light yellow. The larvae of *pectoralis* differ from other elaterid larvae in having two prominent conical protuberances on the dorsum of the 9th abdominal segment (Fig. 14). The outer prongs of the urogomphi are reduced to small pointed tubercles (Fig. 14). Previous descriptions were made by Glen *et al.* (1943) and Glen (1950). It was found once in wheat growing in loam near Prince George. The field was also heavily infested with *Ctenicera aeripennis* and *Dalopius* sp.

Genus HYPOLITHUS Eschscholtz

Only two species of this genus have been found in cultivated soil in the Province. They can be recognized by the presence of small, dorsoposteroepicranial setae and medial anterotergal setae on the anterior part of each body segment (Fig. 3) and by four setae on the central dorsal area of the 9th abdominal segment (Fig. 4). The larva of *Hypolithus impressicollis* (Mann.) is described here for the first time.

Hypolithus bicolor Eschscholtz. Length 11 mm. It is separated from *H. impressicollis* by the urogomphal prongs: the inner prongs on *bicolor* are larger than the outer prongs (Fig. 5) while on *impressicollis* the prongs are subequal in length (Fig. 6). Glen *et al.* (1943) described this larva more fully.

This species appears to have a wide range. It was found in well separated localities (Table 1), generally in loam soils. The population was usually low but on occasion moderate damage was caused.

Hypolithus impressicollis (Mannerheim). Length 12 mm. This species is readily separated from *bicolor* by the urogomphal prongs.

It has been found only in the delta of the Fraser River in low, poorly drained fields. Damage observed has been that caused to potato seed pieces in spring but not to the mature crop.

Genus MELANOTUS Eschscholtz

Melanotus oregonensis (LeConte). This species is the only representative of the genus found so far in the Province. The larva is described here for the first time. The largest larva collected was 23 mm. and was considerably darker than most wireworms. It is readily recognized by the 9th abdominal segment which is flattened and scalloped at the tip (Fig. 34, 35) and by striate impressions on the anterior dorsum of each abdominal segment (Fig. 35).

It is not considered a serious pest. It was found only once, when it was damaging newly-planted grape cuttings in light sandy soil in the Okanagan Valley.

Genus HEMICREPIDIUS Germar

Hemicrepidius oregonus (LeConte). Only one species of this genus has been found in cultivated land. The largest larva collected measured 21 mm. This wireworm has not been described previously. It has transverse striations on the dorsum of abdominal segments 1-8 (Fig. 9) and an undivided presternum of the prothorax like that of *C. lobata* (Fig. 15) but with a large caudal notch. It is also similar to *Athous* species but can be recognized by the absence of eye spots at the base of the antennae. It has been found only in the lower Fraser Valley in muck and peat soils. It has no record of damaging crops in this area.

Genus ATHOUS Eschscholtz

Athous pallidipennis Mannerheim. Length 21 mm. The caudal notch is small (Fig. 11) and the outer prongs are long, slender and curved anteriorly (Fig. 12). It has transverse striations (Fig. 9) like *C. lobata* and *H. oregonus* but can be separated by the sharp horny protuberances on the lateral margins (Fig. 11). Eyes are present. Glen (1950) described this larva more fully. It has been found twice in cultivated fields of muck soil but is not considered of economic importance.

Genus AEOLUS Eschscholtz

Aeolus mellillus (Say). The largest larva collected measured 14 mm. This small flat larva is easily recognized by the v-shaped caudal notch (Fig. 24) and the anal armature on the 10th abdominal segment (Fig. 23). A more detailed description is given by Comstock and Slingerland (1891). It was found once in light sandy soil planted to potatoes. It is not considered to be a pest species.

Genus DALOPIUS Eschscholtz

The genera *Dalopius* and *Agriotes* are closely related and in many ways are similar in habits and appearance. *Dalopius* larvae are separated from *Agriotes* by having central dorsal tergal setae on the 9th abdominal segment (Fig. 36). The 9th segment of *Dalopius* is pointed and bears three whorls of pre-apical setiferous tubercles (Fig. 36). The larvae are relatively slender and the largest measured 19 mm. The following 10 species, known to occur in British Columbia, cannot be recognized or separated in the larval stage: *D. asellus* Brown, *D. corvinus* Brown, *D. fucatus* Brown, *D. gartrelli* Brown, *D. insolens* Brown, *D. insulanus* Brown, *D. maritimus* Brown, *D. spretus* Brown, *D. suspectus* Brown and *D. tristis* Brown.

Dalopius larvae have been found in nearly every area but usually in such small numbers that they are not considered to be pests. Populations build up in sod but seldom seem to survive even light cultivation. *D. asellus* Brown, which was identified by rearing larvae to adults, damaged potato seed pieces in the Cariboo. *Dalopius* larvae also caused considerable damage to a strawberry planting in the Kootenay Valley.

Key to wireworms of cultivated land in British Columbia

1. Ninth abdominal segment with median caudal notch (Fig. 1, 4) 2
   Ninth abdominal segment without median caudal notch (Fig. 2) 19
2. Head bearing dorsal posteroepicranial setae; thoracic segments and first 8 abdominal segments bearing medial anterotergal setae (Fig. 3) 3
   Without dorsal posteroepicranial setae and medial anterotergal setae 4
3. Inner prongs of urogomphi longer than outer prongs ..... **Hypolithus bicolor**
   Urogomphal prongs subequal in length (Fig. 6) ..... **Hypolithus impressicollis**
4. Caudal notch small with narrow posterior aperture (Fig. 7, 8, 11, 14, 19, 21) 5
   Caudal notch large with wide posterior aperture (Fig. 1, 22, 24, 25, 26, 28, 29, 30) 12
5. Dorsum of abdominal segments 1-8 with transverse striations (Fig. 9) 6
   Dorsum of abdominal segments without transverse striations (Fig. 17, 18) 7
6. Outer prongs of urogomphi, long, slender and curved anteriorly; ninth abdominal segment with sharp horny protuberances on lateral margins (Fig. 11, 12) ..... **Athous pallidipennis**
   Outer prongs of urogomphi short and erect; ninth abdominal segment with small rounded protuberances (Fig. 8, 10) **Ctenicera lobata**
7. Dorsum of ninth abdominal segment with prominent, blunt setiferous protuberances on lateral margins (Fig. 7) ..... **Ctenicera resplendens**
   Dorsum of ninth abdominal segment with rounded less prominent protuberances on lateral margins (Fig. 14, 19, 21) 8
8. Ninth abdominal segment with two conical protuberances on the central dorsal area (Fig. 14) **Limonius pectoralis**
   Ninth abdominal segment without protuberances on the central dorsal area 9
9. Inner ends of anterolateral grooves of second, third and fourth abdominal tergites remain strong as they approach the median suture (Fig. 17) 10
   Inner ends of anterolateral grooves of second, third and fourth abdominal tergites fade and end before reaching the median suture (Fig. 18) 11
10. Outer prongs of urogomphi curved anteriorly to form hooks (Fig. 13) ..... **Limonius infuscatus**
    Outer prongs of urogomphi erect or inclined posteriorly (Fig. 20) ..... **Limonius californicus**
11. Tergal plate of ninth abdominal segment elongate, with sides straight distinctly angulate (Fig. 19) ..... **Limonius canus**
    Tergal plate of ninth abdominal segment round or oval with anterior angles rounded (Fig. 21) ..... **Limonius subauratus**
12. Tenth abdominal segment with anal armature (Fig. 23); caudal notch V-shaped (Fig. 24) ..... **Aeolus mellillus**
    Tenth abdominal segment without anal armature; caudal notch rounded (Fig. 22, 25, 26, 28, 29, 30) 13
13. Presternum of prothorax divided into 4 sclerites (Fig. 16) 14
    Presternum of prothorax undivided (Fig. 15) ..... **Hemicrepidius oregonus**
14. Ninth abdominal segment with setae on the central dorsal area (Fig. 22, 25, 28, 30) 15
    Ninth abdominal segment without setae on the central dorsal area (Fig. 26, 29) 18
15. Ninth abdominal segment with 2 setae on the central dorsal area; caudal notch U-shaped (Fig. 22) ..... **Ctenicera semimetallica**
    Ninth abdominal segment with 4 or more setae on the central dorsal area; caudal notch not U-shaped, inner prongs curved or angled inward (Fig. 25, 28, 30) 16
16. Outer prongs of urogomphi curved strongly caudad (Fig. 32) 17
    Outer prongs of urogomphi straight or bent slightly caudad at the tip (Fig. 33) ..... **Ctenicera pruinina**
17. Inner prongs of urogomphi curved strongly inward; protuberances on lateral margins of ninth abdominal segments small (Fig. 25) ..... **Ctenicera funerea**
    Inner prongs of urogomphi angled inward from base; lateral margins of 9th abdominal segment with prominent protuberances (Fig. 30) ..... **Ctenicera morula**
18. Ninth abdominal segment with rounded protuberances on lateral margins (Fig. 29); urogomphi short and thick (Fig. 31) ..... **Ctenicera aeripennis**
    Ctenicera destructor
    Ninth abdominal segment with sharp horny protuberances on lateral margins (Fig 26), urogomphi relatively slender (Fig. 27) ..... **Ctenicera glauca**
19. Posterior of ninth abdominal segment flattened and scalloped (Fig. 34, 35) **Melanotus oregonensis**
    Posterior of ninth abdominal segment subconical (Fig. 2, 36, 37, 39, 40) 20
20. Central dorsotergal setae on ninth abdominal segment as figured (Fig. 36) ..... **Dalopius** spp.
    Central dorsotergal setae not present (Fig. 37, 39, 40) 21

21. Ninth abdominal segment with two conspicuous muscular impressions (Fig. 37) 22
Ninth abdominal segment without muscular impressions (Fig. 39, 40) 23

22. Head with definite eye spot behind base of antenna (Fig. 38) .....
Agriotes obscurus
Agriotes lineatus
Head without eye spot behind base of antenna ..... **Agriotes sparsus**

23. Ninth abdominal segment with setiferous tubercles (Fig. 36) .....
Agriotes criddlei
Ninth abdominal segment without setiferous tubercles (Fig. 39) 24

24. Ninth abdominal segment nipple-like (Fig. 39) ..... **Agriotes ferrugineipennis**
Ninth abdominal segment tapering gradually towards a blunt tip (Fig. 40) ..... **Agriotes opaculus**

TABLE 1—Species of wireworms found in cultivated land with localities in British Columbia.

Species	Localities
Agriotes criddlei Van D.	Kettle Valley, Brigade Lake, Wycliffe.
A. ferrugineipennis LeC.	Creston, Grand Forks, Keremeos, Chilliwack, Coquitlam, Vancouver, Armstrong, Kelowna, Cloverdale.
A. lineatus (L.)	Cobble Hill.
A. obscurus (L.)	Cobble Hill, Agassiz.
A. opaculus (LeC.)	Quesnel.
A. sparsus LeC.	Ladner, Lulu Island, Cloverdale.
Athous pallidipennis Mann.	Cordova Bay, Lulu Island.
Ctenicera aeripennis (Kby.)—**C. destructor** (Brown)	Prince George, Vanderhoof, Wycliffe, Montney, Grand Haven, Bessborough, Smithers, Quesnel, Cranbrook, Creston, Brigade Lake, Cowichan, Courtenay, Burnaby, Cloverdale, Ladysmith, White Rock, Cordova Bay, Coquitlam, Victoria, Salmon Arm, Gundy, Dawson Creek.
C. funerea (Brown)	Wycliffe, Oliver.
C. glauca (Germ.)	Wycliffe, Quesnel, Kettle Valley, Vernon, Grand Forks.
C. lobata (Esch.)	Ladner, Lulu Island, Cobble Hill, Chilliwack.
C. morula (LeC.)	Prince George, Montney, Smithers, Terrace, Kettle Valley, Creston, Tete Jaune, Brigade Lake, Salmon Arm, Procter.
C. pruinina (Horn.)	Keremeos, Oliver.
C. resplendens (Esch.)	Boundary Creek, Prince George.
C. semimetallica (Walk.)	Quesnel, Kamloops, Kettle Valley.
Dalopius asellus Brown	Prince George.
Dalopius spp.	Smithers, Tete Jaune, Cobble Hill, Grand Forks, Lulu Island, Chilliwack, Metchosin, Vancouver, Oliver, Cowichan, Glen Lake, Prince George, Quesnel, Agassiz, Ladner, Armstrong, Echo Lake, Cranbrook, Balfour, Salmon Arm, Procter.
Aeolus mellillus (Say)	Grand Forks.
Hemicrepidius oregonus (LeC.)	Lulu Island, Cloverdale, Ladner.
Hypolithus bicolor Esch.	Quesnel, Smithers, Prince George, Agassiz, Armstrong, Salmon Arm, Kelowna, Brigade Lake.
H. impressicollis (Mann.)	Lulu Island, Cloverdale, Ladner.
Limonius californicus (Mann.)	Wycliffe, Newgate, Kelowna.
L. canus LeC.	Wycliffe, Duncan, Vernon, Kelowna, Grand Forks, Agassiz, Vedder Crossing, Abbotsford, Kamloops, Shoreacres Nelson, Cranbrook, China Creek, Langley, Summerland, Saanich, Oliver, Penticton, Armstrong, Salmon Arm, Lillooet.
L. infuscatus Mots.	Victoria, Vernon, Duncan, Kelowna, Grand Forks, Alberni, Keating, Cobble Hill, Oliver, Armstrong, Lavington.
L. pectoralis LeC.	Prince George.
L. subauratus LeC.	Cranbrook.
Melanotus oregonensis (LeC.)	Kelowna.

Conclusions

Since Lane (1952) has listed 150 elaterids from the Province, it is likely that species not listed here will turn up in cultivated land; it is less likely that they will be in economic numbers. The most serious pests in the southern Interior were *L. canus* and *L. infuscatus* in irrigated land, *C. aeripennis* in dry land, and *L. californicus* in both. In the southern coastal area the most serious pests were *C. lobata* and *A. sparsus*, with the two European wireworms posing a continuing threat. In the Peace River area *C. aeripennis* and *C. destructor* predominated, but in the Cariboo area *C. aeripennis* only.

There is evidence that in cultivated land the wireworm population is being depleted. Each year losses from wireworm damage are becoming less and enquiries on control fewer. Other workers have noticed the same trend (Lafrance, 1963). This may result from the extensive use of soil treatments not only against wireworms but also against other soil insects. The combination of the long life cycle and the wide use and persistence of modern insecticides in the soil has reduced wireworms from major to minor pests in British Columbia.

Summary

Spring surveys of the various agricultural areas in British Columbia produced 27 species in cultivated land. These are listed by localities, annotated, and distinguished briefly. An illustrated key is provided. The major damaging species were: *Ctenicera aeripennis* (Kby.), *C. lobata* (Esch.), *Limonius canus* (LeC.), *L. infuscatus* Mots., and *Agriotes sparsus* LeC. An assessment is made of the relative importance of each species.

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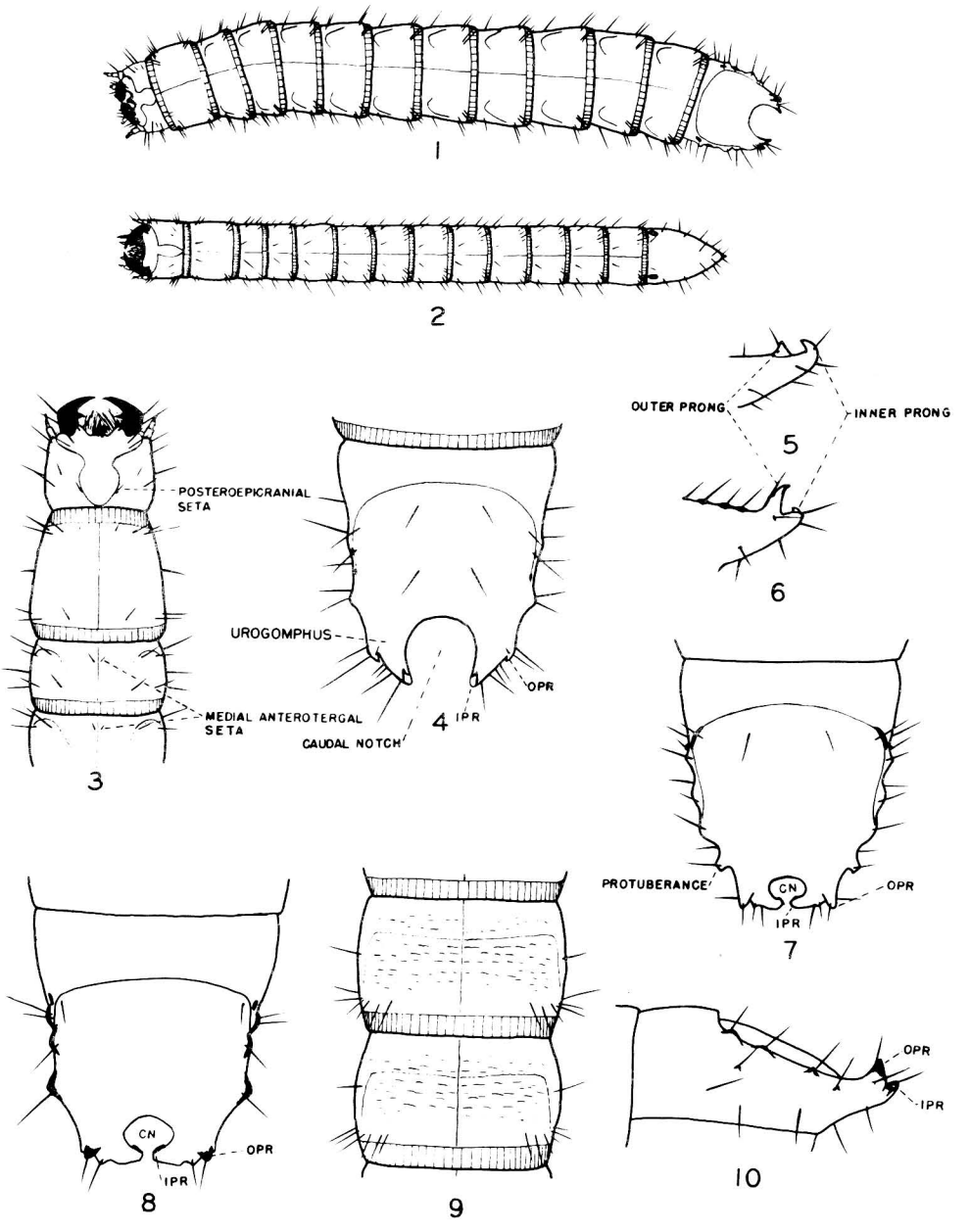
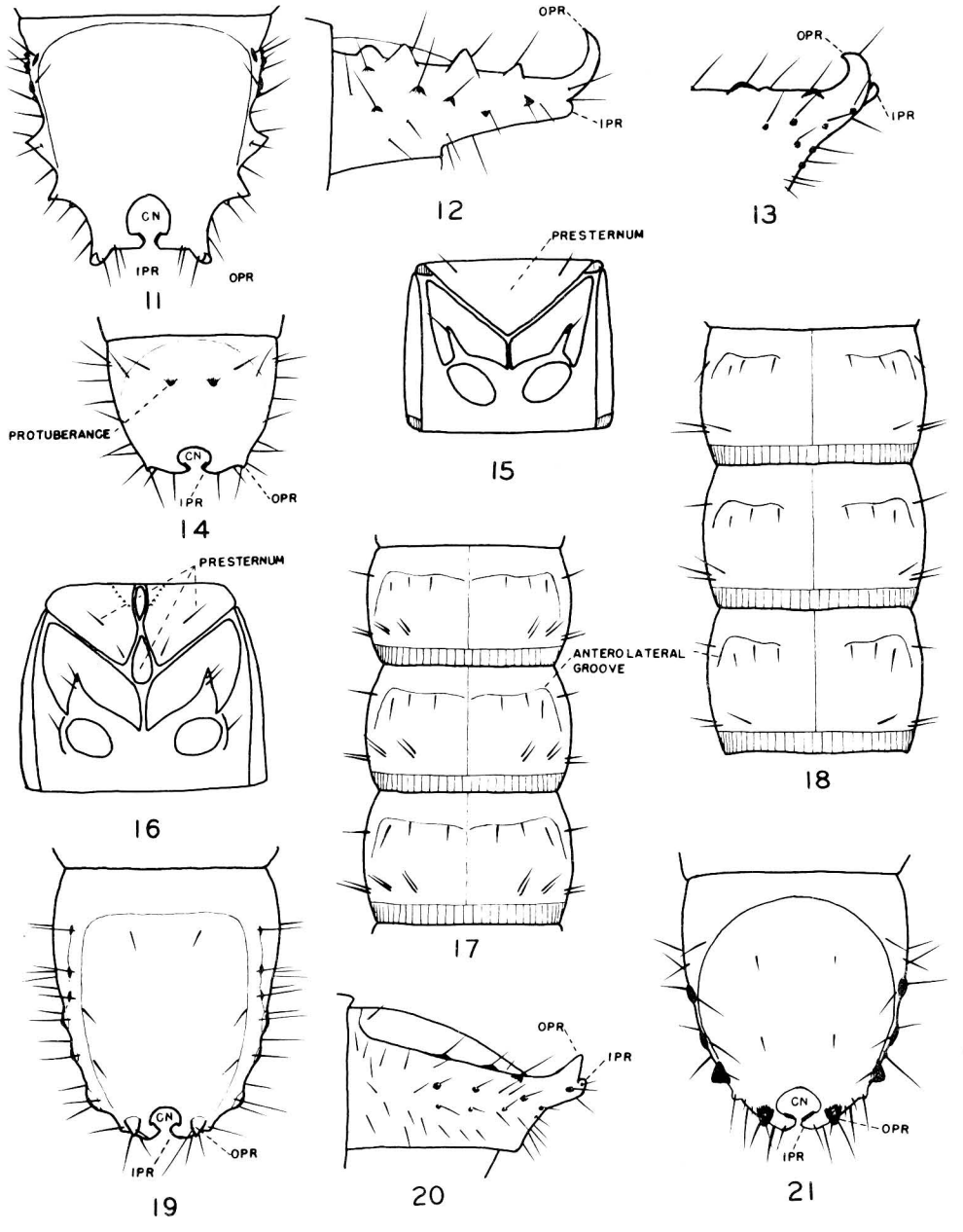
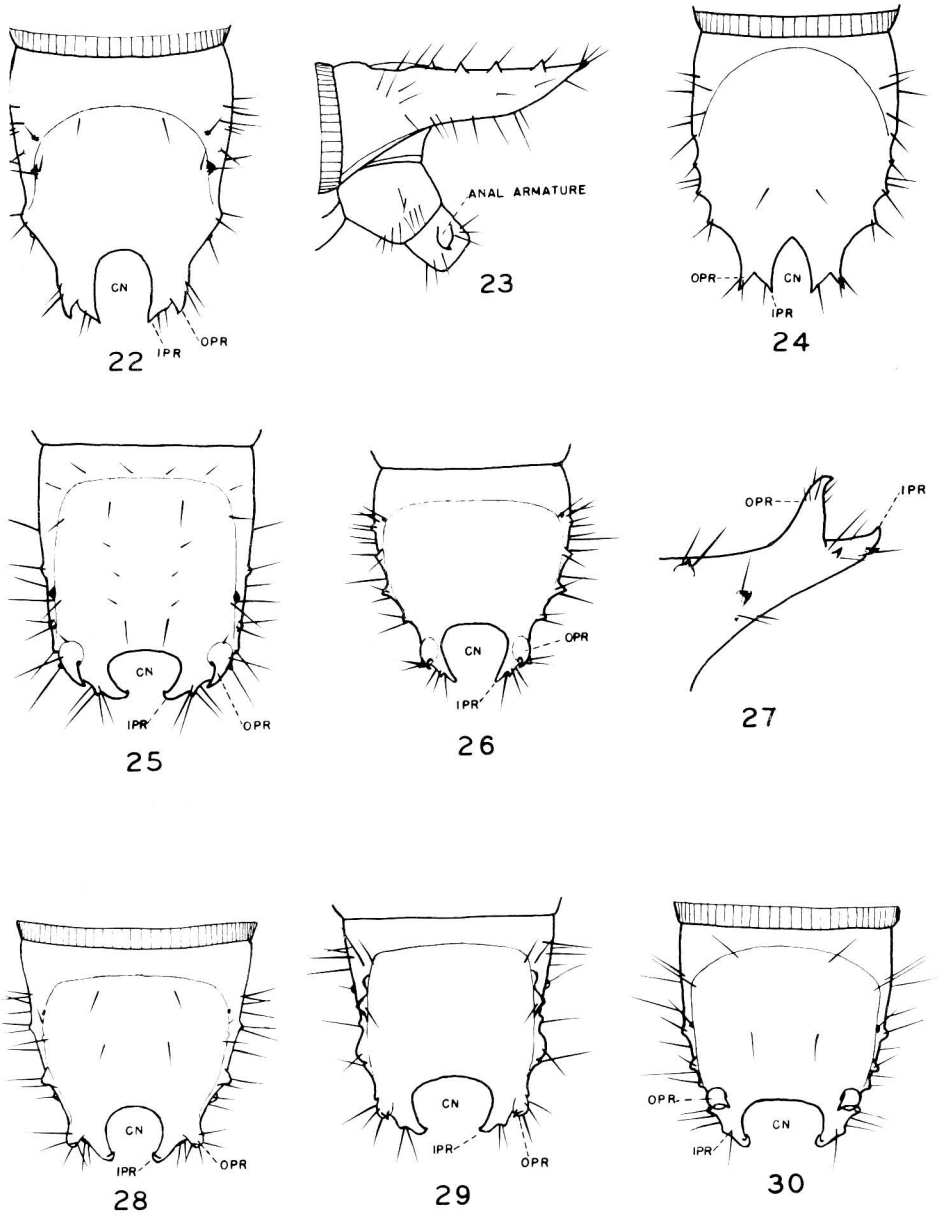


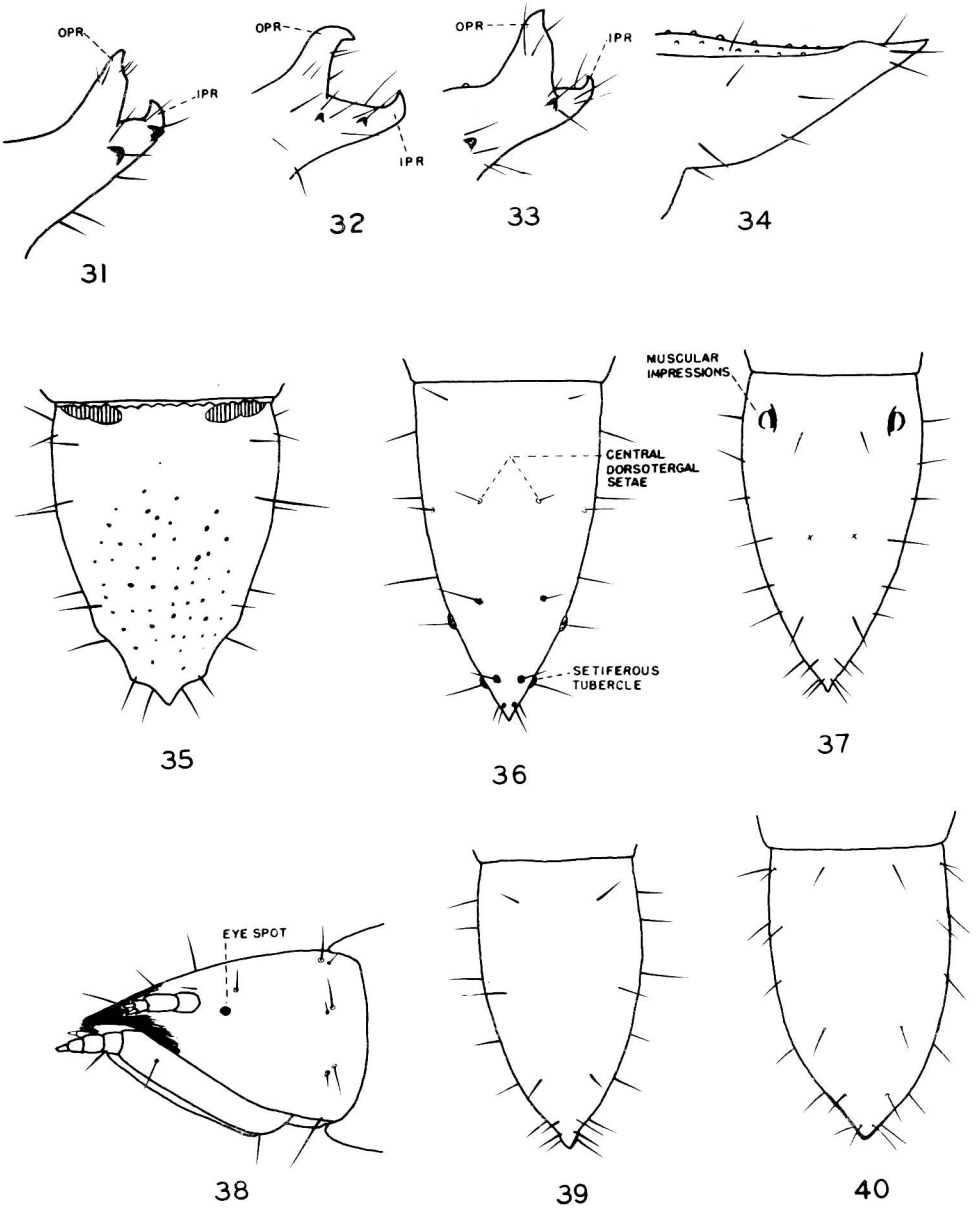
Figs. 1-10—**Ctenicera, Agriotes** and **Hypolithus:** 1. **C. aeripennis,** dorsal; 2. **A. sparsus,** dorsal; 3. **H. impressicollis,** head and thoracic segments, dorsal; 4. **H. bicolor,** ninth abdominal segment, dorsal; 5. **H. bicolor,** left urogomphus, lateral; 6. **H. impressicollis,** left urogomphus, lateral; 7. **C. resplendens,** ninth abdominal segment, dorsal; 8. **C. lobata,** ninth abdominal segment, dorsal; 9. **C. lobata,** abdominal segments, dorsal; 10. **C. lobata,** ninth abdominal segment, lateral.



Figs. 11-21—**Athous, Limonius, Hemicrepidius, Ctenicera:** 11. **A. pallidipennis,** ninth abdominal segment, dorsal; 12. **A. pallidipennis,** ninth abdominal segment, lateral; 13. **L. infuscatus,** left urogomphus, lateral; 14. **L. pectoralis,** ninth abdominal segment, dorsal; 15. **H. oregonus,** presternum of the prothorax; 16. **C. aeripennis,** presternum of the prothorax; 17. **L. infuscatus,** second, third and fourth abdominal segments, dorsal; 18. **L. canus,** second, third and fourth abdominal segments, dorsal; 19. **L. canus,** ninth abdominal segment, dorsal; 20. **L. californicus,** ninth abdominal segment, lateral; 21. **L. subauratus,** ninth abdominal segment dorsal.



Figs. 22-30—**Ctenicera, Aeolus:** 22. **C. semimetallica,** ninth abdominal segments, dorsal; 23. **Aeolus mellillus,** ninth and tenth abdominal segments, lateral; 24. **A. mellillus,** ninth abdominal segment, dorsal; 25. **C. funerea,** ninth abdominal segment, dorsal; 26. **C. glauca, ninth** abdominal segment, dorsal; 27. **C. glauca,** ninth abdominal segment, lateral; 28. **C. pruinina,** ninth abdominal segment dorsal; 29. **C. aeripennis,** ninth abdominal segment, dorsal; 30. **C. morula,** ninth abdominal segment, dorsal.



Figs. 31-40—**Ctenicera, Melanotus, Dalopius, Agriotes:** 31. **C. aeripennis,** left urogomphus, lateral; 32. **C. morula,** left urogomphus, lateral; 33. **C. pruinina,** left urogomphus, lateral; 34. **M. oregonensis,** ninth abdominal segment, lateral; 35. **M. oregonensis,** ninth abdominal segment, dorsal; 36. **D. asellus,** ninth abdominal segment, dorsal; 37. **A. sparsus,** ninth abdominal segment, dorsal; 38. **A. obscurus,** head, lateral; 39. **A. ferrugineipennis,** ninth abdominal segment, dorsal; 40. **A. opaculus,** ninth abdominal segment, dorsal.

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ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA
PART XI *Papilio* spp. (PAPILIONIDAE)[1]

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Six species of the genus *Papilio* commonly occur in British Columbia. The larvae of four species feed on the foliage of broad-leaved trees and shrubs but are not sufficiently numerous to be of economic importance.

Full-grown forest *Papilio* larvae are velvet green, about 1½ to 2 inches long, widest at the metathoracic segment and tapering gradually to the last abdominal segment. The head is tan to reddish brown. A dorsal Y-shaped, orange-coloured, eversible gland is present near the anterior margin of the prothorax; two "eye spots" appear on the dorsum of the third thoracic segment, and a transverse yellow band bordered posteriorly by a velvet black band occurs on the dorsum along the anterior margin of the first abdominal segment. *Papilio* spp. overwinter in sheltered sites as chrysalids usually supported in an upright position by a silken "harness". Hybrids may occur where the ranges of some species overlap.

P. glaucus canadensis R. & J. — *Populus tremuloides* Michx., *Alnus* sp. (3 records), *Betula* sp. (3), *Populus trichocarpa* Torr. & Gray (1), *Salix* sp. (1). Throughout the interior of British Columbia, commonest in the central and northern Interior. LARVA: easily separated from other forest *Papilio* because each "eye spot" is composed of only one element. The "eye spot" is yellow, outlined in black and bisected by a black line; the blue centre spot is enclosed by a black line. The black transverse band, narrower than the anterior yellow band, does not extend to the spiracular line.

P. rutulus Luc.—*Populus* spp., *Salix* spp., *Betula* sp. (2), *Alnus* sp. (2). Central to southern Interior, southern coastal regions and Vancouver Island; common. LARVA: each "eye spot" composed of two elements, yellow, enclosed by a black line. The larger element, bisected by a black line, has a bluish centre spot; the line about the blue spot is wider than the line containing the element. The black transverse band, twice as wide as the anterior yellowish band, does not extend to the spiracular line.

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