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Faunal Composition, Wing Polymorphism and Seasonal Abundance of Some Flea Beetles (Coleoptera: Chrysomelidae) in Southern Quebec (Canada)

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FAUNAL COMPOSITION, WING POLYMORPHISM AND SEASONAL ABUNDANCE OF SOME FLEA BEETLES (COLEOPTERA: CHRYSOMELIDAE) IN SOUTHERN QUEBEC (CANADA)

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ABSTRACT

Chrysomelidae (51 taxa) were collected with flight intercept traps from May through October during 1987–1989, in four sites near a raspberry plantation in southern Québec. More species and individuals of phytophagous flea beetles occurred in two open sites than at a pine woods-raspberry field boundary and in a pine woods. *Longitarsus luridus* complex, an immigrant taxon in North America, represented 58% of all captures in the two open sites where both *Ranunculus acris* and *Plantago* spp. are its main host plants; this species and *Longitarsus rubiginosus* were almost exclusively represented by jumping apterous adults in pans of flight intercept traps. The seven most abundant chrysomelid species from Johnville are probably all univoltine, and they are apparently not serious raspberry pests. Three life cycle types are apparent: *L. luridus* complex oviposit in autumn and overwinter as adults. *Capraita subvittata, Chaetocnema minuta, Epitrix cucumeris, Phyllotreta striolata* and *Tricholochmaea alni* also overwinter as adults but oviposition begins in spring. *Longitarsus rubiginosus* oviposits in autumn, overwintering in the egg and/or larval stage.

The Chrysomelidae is one of the largest families of beetles well-represented in all faunal regions. Both larvae and adults of most species are plant feeders. Most crop plants are attacked by one or more species of the family. Some species are also important as vectors of plant diseases (Campbell et al. 1989).

In North America, attention has been given to the faunal composition of chrysomelids injurious to cruciferous plants (e.g. Tahvanainen 1972, Vincent and Stewart 1981, Wylie 1979), and to species found in potato (*Solanum tuberosum*) (Boiteau 1983) and sweet corn (*Zea mays*) fields (Adams and Los 1986). In addition, studies have been carried out on species associated with meadow goldenrods (*Solidago* spp.) (Messina and Root 1980), and with milkweed (*Asclepias*) species (Dailey et al. 1978, Price and Willson 1979). The faunal composition of flea beetles has been also analyzed in a Kansas native prairie (Greene 1970), in nine wetlands in Wisconsin (Lillie 1991), and in spring flood debris along the Ottawa River (Canada) (LeSage et al. 1994). Nevertheless, the composition of chrysomelid fauna in several North American ecosystems remains unknown, particularly in small fruit crops.

We found many individuals of this family in flight intercept traps, during a study of beetles in a raspberry (*Rubus idaeus*) plantation and adjacent sites

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in southern Québec. Since chrysomelid species may be pests in raspberry plantations (Campbell et al. 1989), we present results on the faunal composition of flea beetles in four sites adjacent to a raspberry plantation in southern Québec, and also the seasonal activity of some abundant species, over a three-year period (1987–1989).

MATERIALS AND METHODS

The beetles were collected from early May through late October during a three-year period, on a monocultural raspberry farm at Johnville (45°26'N, 71°41'W, about 240 m a.s.l.), near Sherbrooke, in southern Québec, Canada. Levesque and Levesque (1992) presented detailed information about the study sites, including a map and description of plant communities.

We studied beetles flying close to the ground with flight intercept traps at four sites: (A) an open site near the center of the plantation, about 20 m from old raspberry plants; (B) an open site near a pond, about 5 m from young raspberry plants; (C) a pine woods-raspberry field boundary; and (D) a pine woods dominated by eastern white pine, *Pinus strobus*. These traps were not located between rows of raspberry plants because of grower's activities and public access during harvest. Flight intercept traps were modified from the large-area "window" trap design (Peck and Davies 1980). Each consisted of a gray 1.5 mm mesh window screen (1.22 m height, 1.52 m width, about 1.85 m^2 of surface) fastened to a wooden frame. The frame itself was suspended by two lateral triangular wooden supports (1.83 m at the base, 1.25 m height), 2–4 cm over a set of two galvanized metal pans (25 by 61 cm at the top, 7.5 cm deep, white painted) which were placed directly on the ground. The insects were caught in pans partially filled with 2% formalin solution into which a few drops of detergent were added. We installed one flight intercept trap in each site; the pine woods trap (D) was only operated in 1988 and 1989. Samples were collected twice a week and were pooled weekly.

In all traps, formalin was used as a killing and preserving agent as well as to prevent escape and predation, in spite of its potential selective effect as repellent or attractant to some beetle species (Adis 1979). Adults paler than usual and with soft integument were classified as tenerals. We use the terminology "*Longitarsus luridus* complex" because the exact species identification of the specimens cannot be obtained without a revision of this group (LeSage pers. comm.).

RESULTS AND DISCUSSION

Faunal composition of chrysomelid catches. We collected 1049 adults belonging to 51 taxa, almost exclusively in the three flight intercept traps (A, B, C) near raspberry plants (Table 1). Only 12 beetles of 9 species were captured in the pine woods trap (D) (Table 1). The number of species was of 38 in the open site A, 35 in the open site B and 21 at the boundary. The catch number was similar in the two open sites, 489 in the site A and 444 in the site B, whereas 104 adults were captured in the site C (Table 1). The vegetation was richest in the three sites near raspberry plants than in the pine woods (Levesque and Levesque 1992).

In Poland and Switzerland chrysomelid associations, meadow faunae principally differ from forest faunae by the greater number of species and individuals (Krause 1981, Wasowska 1989a, b). Except for open habitats with a large admixture of willows and deciduous shrubs, the majority of forest com-

Table 1. Total catches of Chrysomelidae species in flight traps at Johnville, Québec (1987–1989).

Species	Open site near center (A)	Open site near pond (B)	Boundary (C)	Pine woods[a] (D)	Total	Wings[b]	Biogeography[c]
Altica corni Woods	5	5	9	0	19	M	
Altica ulmi Woods	4	3	9	0	16	M	
Altica sp.1	1	0	0	0	1	M	
Altica sp.2	3	0	0	0	3	M	
Calligrapha multipunctata bigsbyana (Kirby)	0	2	0	0	2	M	
Capraita subvittata(Horn)	1	2	26	3	32	M	
Cassida rubiginosa O. F. Müller	1	0	0	0	1	M	I
Chaetocnema concinna (Marsh.)	3	0	1	0	4	M	I
Chaetocnema cribrifrons LeC.	1	0	0	0	1	M	
Chaetocnema minuta Melsh.	15	25	1	0	41	M	
Crepidodera sp.	1	4	0	0	5	M	
Diabrotica barberi Smith & Lawrence	0	0	1	0	1	M	
Dibolia borealis Chev.	2	8	1	0	11	M	
Dibolia chelones Parry	4	0	1	0	5	M	
Distigmoptera borealis Blake	0	0	1	1	2	M	
Epitrix cucumeris (Harris)	20	3	7	1	31	M	
Exema canadensis Pierce	0	3	0	0	3	M	
Gastrophysa polygoni (L.)	1	0	0	0	1	M	H
Glyphuroplata pluto (Newm.)	1	0	0	0	1	M	
Glyptina prob. *atriventris* Horn	2	3	0	0	5	A(60%)	
Hippuriphila canadensis W. J. Brown	0	1	0	0	1	M	
Hydrothassa vittata (Oliv.)	1	0	0	0	1	?	H
Longitarsus luridus complex	328	217	8	1	554	A(86%)	I
Longitarsus pratensis (Panzer)	5	16	2	0	23	M	I
Longitarsus prob. *melanurus* (Melsh.)	1	1	0	0	2	M	
Longitarsus prob. *testaceus* (Melsh.)	3	2	2	0	7	M(71%)	
Longitarsus rubiginosus (Foudras)	24	31	4	2	61	A(97%)	I
Longitarsus sp.1	3	1	0	0	4	M	
Longitarsus sp.2	2	0	0	0	2	A	
Longitarsus sp.3	3	6	0	0	9	A(62%)	
Mantura chrysanthemi (Koch)	9	10	0	0	19	M	I
Ophraella conferta (LeC.)	0	6	1	0	7	M	
Oulema melanopus (L.)	0	1	0	0	1	M	I
Pachybrachis sp.	0	0	0	1	1	M	
Paria fragariae Wilcox	2	2	4	0	8	M	
Phratora purpurea purpurea W. J. Brown	0	0	5	0	5	M	
Phyllotreta cruciferae (Goeze)	3	1	0	0	4	M	I
Phyllotreta striolata (Fab.)	22	22	13	1	58	M	I
Plagiodera versicolora (Laich.)	1	1	0	0	2	M	I
Plateumaris emarginata (Kirby)	1	0	0	0	1	M	
Plateumaris rufa (Say)	1	2	0	0	3	?	

(Continued)

Table 1. (*Continued*).

Species	Open site near center (A)	Open site near pond (B)	Boundary (C)	Pine woods[a] (D)	Total	Wings[b]	Biogeography[c]
Psylliodes napi (Fab.)	1	1	0	1	3	M	I
Psylliodes picina (Marsh.)	4	6	6	0	16	M	I
Psylliodes punctulata Melsh.	3	3	1	0	7	M	
Strabala rufa (Ill.)	0	0	1	0	1	M	
Sumitrosis inaequalis (Weber)	0	2	0	0	2	M	
Tricholochmaea alni (Fall)	4	25	0	1	30	M	
Tricholochmaea cavicollis (LeC.)	1	1	0	0	2	M	
Tricholochmaea decora decora (Say)	0	2	0	0	2	M	
Tricholochmaea spiraeae (Fall)	2	22	0	0	24	M	
Trirhabda borealis Blake	0	4	0	0	4	M	
Total	489	444	104	12	1049		
Number of taxa	38	35	21	9	51		

[a] Not sampled in 1987.
[b] A = apterous individuals, M = macropterous individuals, ? = undetermined; the % is indicated in brackets only if it is less than 100%.
[c] H = Holarctic species, I = Immigrant species in North America.

munities have a poor chrysomelid faunae (Wasowska 1989a). In addition, both species richness and abundance of chrysomelids declined with increasing levels of shade in British conifer plantation woodland rides (Greatorex-Davies et al. 1994), supporting our observations at Johnville.

Most Abundant Chrysomelids In Flight Traps. The dominant flea beetles in the two open sites (40 individuals or more) were *Longitarsus luridus* complex, *L. rubiginosus* (Foudras), *Phyllotreta striolata* (Fab.) and *Chaetocnema minuta* Melsh.; several adults (20 to 39 individuals) of *Tricholochmaea alni* (Fall), *T. spiraeae* (Fall), *Epitrix cucumeris* (Harris) and *L. pratensis* (Panzer) were also captured in sites A and B (Table 1). *Capraita subvittata* (Horn) was the most abundant species in the flight trap at the boundary (Table 1). All these taxa (except the genus *Tricholochmaea* Laboissière) are Alticinae.

Hill (1952) recorded only six chrysomelid species (all Alticinae) on cultivated raspberry in Scotland: *Phyllotreta undulata* (Kutsch.), *Chaetocnema concinna* (Marsh.), *Longitarsus membranaceus* (Foudras), *L. ganglbaueri* Heik, *L. suturalis* (Marsh.) and *L. luridus* (Scopoli). At Johnville, only three *C. concinna* adults were collected, but *L. luridus* complex represented 58% of all catches by two flight traps in open sites (Table 1). In Poland, *L. luridus* occurred in pine forests only sporadically (Wasowska 1994). The dominance of Alticinae was also observed in European cultivated meadows and pastures (Wasowska 1989b).

Variations Of Chrysomelid Assemblages In Flight Traps. The annual taxa number in flight traps varied between 12 and 26 in site A, between 20 and 26 in site B, and between 8 and 14 at the boundary. The number of taxa collected each year of the study was six in site A, 10 in site B, and four at the boundary. Any chrysomelid species was constant in the four traps. Only *L. luridus* complex and *P. striolata* were constant in the three traps (A, B, C) near raspberry plants. Four constant Alticinae (*C. minuta, L. luridus*

complex, *L .pratensis* and *P. striolata*) were collected in both open sites; they are eurytopic (Biondi 1996, Blades and Marshall 1994).

Holarctic Or Immigrant Chrysomelids In North America. Among the 51 taxa monitored by flight traps at Johnville, two Holarctic Chrysomelinae species, *Gastrophysa polygoni* (L.) and *Hydrothassa vittata* (Oliv.), were captured in open site A only accidentally (Table 1). At least 12 immigrant flea beetles in North America (or 24% of caught taxa) were collected by flight traps during our study (Table 1) (LeSage 1991); they were represented by 11 taxa in site A, 10 in site B, six at the boundary and four in the pine woods. These immigrant chrysomelids, mainly Alticinae, represented 82% of adults captured in site A, 69% in site B, but only 33% of catches at the boundary.

Additional Chrysomelids In Pitfall Traps. During the three-year study of beetles at Johnville, we also operated pitfall traps in raspberry plantations, at the woods-field boundary and in the pine woods. Levesque and Levesque (1992) presented detailed information about this method. Pitfall trapping resulted in the catch of only 37 flea beetles representing 11 species. *Calligrapha pruni* W.J. Brown and *Charidotella sexpunctata bicolor* (Fab.) were the two additional species captured by pitfall traps during this study. Eleven *Paria fragariae* Wilcox were collected in raspberry rows, and 11 *Phratora purpurea purpurea* W.J. Brown at the boundary. According to Campbell et al. (1989), *P. fragariae* may cause considerable damage to raspberry leaves.

Wing Polymorphism. We observed apterous adults in the pans of flight intercept traps. Apterous adults were represented in six Alticinae taxa: *Glyptina* prob. *atriventris* Horn (3/5 examined adults), *L. luridus* complex (434/507), *L.* prob. *testaceus* (Melsh.) (2/7), *L. rubiginosus* (57/59), *L.* sp. 2 (2/2) and *L.* sp. 3 (5/8) (Table 1). Alticinae are known for their ability to jump. Although we did not investigate the flight muscle condition of macropterous chrysomelids from Johnville, most dispersal movements seemed particularly associated with jumping in *L. luridus* complex (86% of wingless individuals in catch) and *L. rubiginosus* (97% apterous).

The phenomenon of intraspecific wing polymorphism is unusually prevalent in *Longitarsus* (the largest genus of Alticinae) (Furth 1979). In Israel, 48% of the 42 species are known to have wing polymorphism (Furth 1979). The incidence of wing polymorphism was also investigated in 37 of the 41 species of *Longitarsus* currently on the British list and 25 species are shown to exhibit variation in wing development (Shute 1980). The most common situation observed in the United Kingdom is vestigial wings for *L. luridus*, reduced wings for *L. pratensis* and vestigial wings for *L. rubiginosus* (Shute 1980). According to Krause (1981), adults of *L. luridus* are mainly apterous, and those of *L. pratensis* are chiefly macropterous.

Studies on the habits and biology of various *Longitarsus* species in the field showed little tendency for the beetles to disperse by flight even when the food plant was heavily infested (Shute 1980). The Coleoptera also took flight when disturbed, whereas *Longitarsus* observed by Shute (1980) fell to the ground or escaped by jumping when disturbed.

Seasonal Activity Of Abundant Chrysomelids. We collected adults of *Capraita subvittata* during two activity periods, the first in June, probably associated with overwintered adults, and the second in September-October with the emergence of new generation adults (Fig. 1). In central New York, adults of this species were active at least from early May to mid-August; *Aster divaricatus* is the main host plant for adults, but *C. subvittata* feeds on other asters, on Scrophulariaceae and perhaps on Rosaceae (*Amelanchier* flowers) (Sholes 1987). In this study, the boundary vegetation was character-

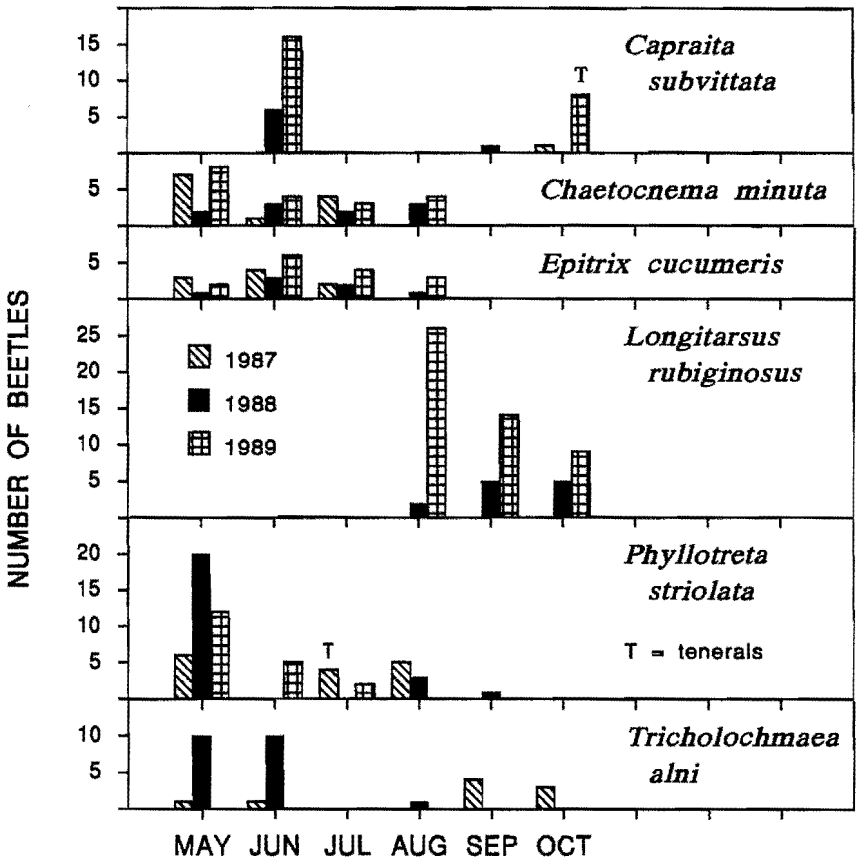

Figure 1. Seasonal abundance of *Capraita subvittata, Chaetocnema minuta, Epitrix cucumeris, Longitarsus rubiginosus, Phyllotreta striolata* and *Tricholochmaea alni* in flight traps at Johnville, Québec (1987–1989).

ized by numerous Rosaceae such as *Rubus idaeus, Fragaria virginiana, Prunus virginiana* and *Spiraea latifolia*.

Adults of *Chaetocnema minuta* from Johnville were active from May to August (Fig. 1). We suggest that this species overwinters as adults. Other species of the genus (*C. concinna* and *C. pulicaria* Melsh.) overwinter also in the adult stage (Campbell et al. 1989, Roth 1985). *Chaetocnema minuta* has already been collected on corn, *Dirca palustris, Solidago* spp., *Aesculus octandra*, also at base of clipped golf green bent grass, and by sweeping Bermuda grass pastures (White 1996). At Johnville, Gramineae and *Solidago* were abundant in and around the raspberry plantation (Levesque and Levesque 1992).

The potato flea beetle, *Epitrix cucumeris*, was active from May to August

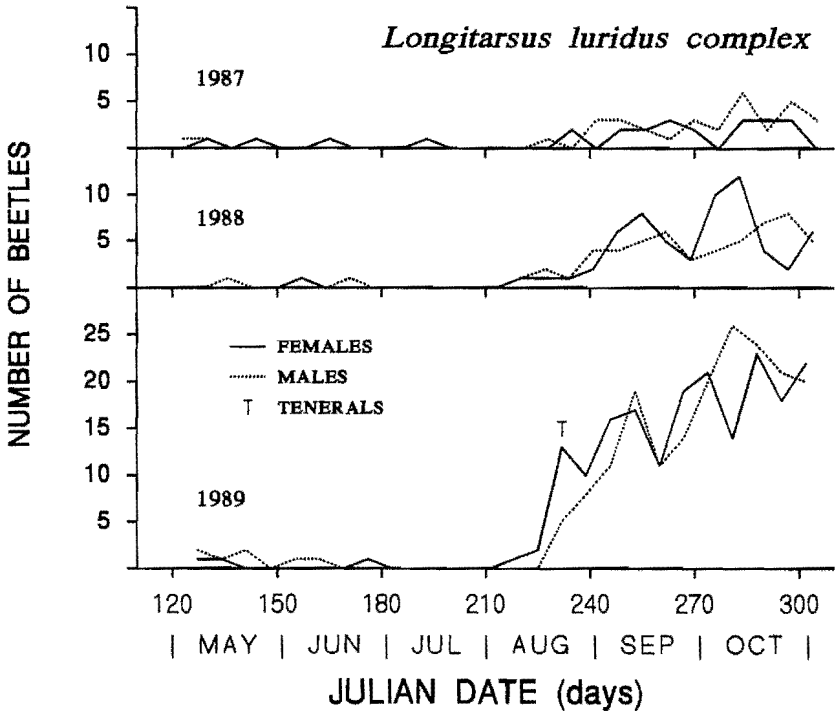

Figure 2. Seasonal abundance of *Longitarsus luridus* complex in flight traps at Johnville, Québec (1987–1989).

at Johnville (Fig. 1). Only one generation a year is produced in Canada; adults overwinter in the soil or under plant debris along fence rows or margins of fields and woods, and oviposition occurs in early summer (Campbell et al. 1989). Our data are consistent with published accounts of the life cycle. This species feeds sometimes on raspberry and plantain (*Plantago*) (Campbell et al. 1989).

We collected adults of *Longitarsus luridus* complex from May through October during the three-year study (1987–1989) (Fig. 2). Only a few overwintered adults were captured from May until July. Thereafter, the activity of the new generation adults began in August and peaked in September–October. We observed the activity of a few tenerals in August. The sex ratio of adults was generally close to one; the activity of females and males was similar (Fig. 2). The total number of catches from Johnville was increased by a factor of 6.5 between 1987 and 1989; this difference, mainly associated with the new generation adult activity, may not be explained with the available data. We suggest that overwintered adults were principally found on host plants in spring and early summer, whereas the colonization chiefly by jumping in new breeding sites seems dependent on the new generation adult ac-

tivity. Oviposition probably began in autumn. According to Krause (1981), *L. luridus* in Switzerland is univoltine with hibernating adults. *L. luridus* may feed on many host plants in Europe, but particularly on *Ranunculus* and *Plantago* (Biondi 1996, Furth 1979, Krause 1981, LeSage 1988). In addition, many adults of *L. luridus* have been found on *Fragaria vesca* in Canada (LeSage 1988). During this study, *Ranunculus acris* and *Plantago* spp. were among the most abundant plants in uncultivated areas (Levesque and Levesque 1992); we believe that these plants were the main hosts for *L. luridus* complex at Johnville.

We observed the August–October *Longitarsus rubiginosus* activity only in 1988 and 1989 (Fig. 1). The sex ratio of captured adults was of 1.0♀:2.4♂. We believe that *L. rubiginosus* overwintered as eggs and/or larvae and was collected particularly during its breeding period. According to LeSage (1988), *L. rubiginosus* adults feed on *Convolvulus* spp., but these plants were not observed on the study area at Johnville.

Adults of *Phyllotreta striolata* were active from May until September, but mainly in May (Fig. 1). One teneral adult was captured in July 1987. The sex ratio was generally close to one at Johnville, whereas it was of 1.6♀:1.0♂. when adults were trapped in yellow water traps in southern Québec (Vincent and Stewart 1981). *Phyllotreta striolata* is univoltine in Canada, and oviposition occurs in spring (Campbell et al. 1989). This flea beetle showed a peak of flight activity at the time of spring emergence from overwintering sites, but no late summer peak in flight activity corresponding to a migration to overwintering sites, probably because most dispersal movements of new generation adults would be associated with jumping (Lamb 1983, Vincent and Stewart 1983). Our data agreed generally with previous reports. However, *P. striolata* feeds mainly on cruciferous plants (Campbell et al. 1989), but these plants were scarce on the study area at Johnville. In Saskatchewan, the population of *P. striolata* in the boreal forest is substantial, although cruciferous plants growing in the forest do not appear abundant enough to constitute an adequate food supply (Burgess 1982). The identity of the major host plants of this species at Johnville is unknown.

We observed two activity periods in *Tricholochmaea alni*, the first in May–June (mainly in 1988) and the second one in August–October (Fig. 1). We suggest that this species, like *T. decora* (Say) in the Canadian prairie provinces (Ives and Wong 1988), overwinters as a sexually immature adult and has one generation per year.

In conclusion, the seven most abundant chrysomelid species captured in flight intercept traps at Johnville were probably all univoltine, and they were apparently not serious raspberry pests. Three life cycle types may be distinguishable: *L. luridus* complex oviposit in autumn and overwinter as adults. *Capraita subvittata, Chaetocnema minuta, Epitrix cucumeris, Phyllotreta striolata* and *Tricholochmaea alni* overwinter also as adults but oviposition begins in spring. *Longitarsus rubiginosus* oviposits in autumn, overwintering in the egg and/or larval stage. These three life cycle types have already been observed by Perner (1996) in selected Alticinae from Central European xerothermic grasslands.

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