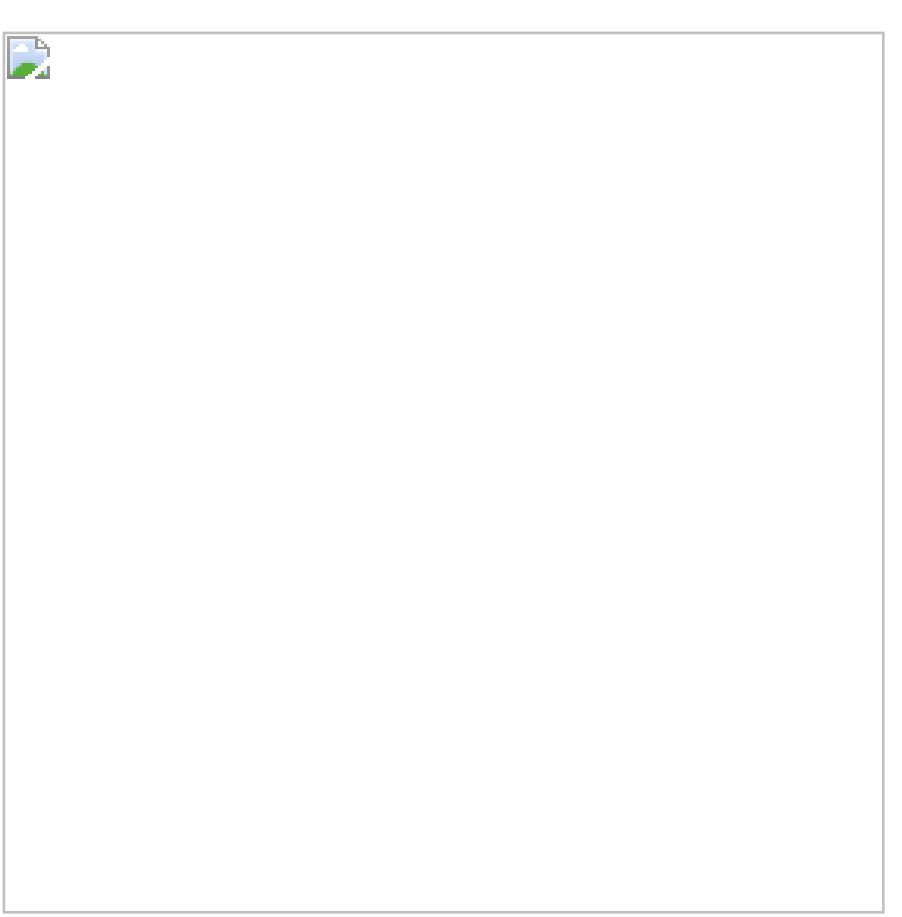

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Habitat Associations and Phenology of Sand Dune Hister Beetles in the Grasslands of Western Canada (Coleoptera: Histeridae)

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Abstract

Histerid beetle (Histeridae) phenology and habitat associations were inferred from specimens collected in pitfall traps on a grassland dune field near Empress, Alberta, Canada, during 3 May to 27 August 1984. Four vegetation associations were identified by cluster analysis (Scurf Pea, Open Sand, Stabilized Dune, and Sand Flat) and 516 histerid beetles, representing 11 species, were collected in these zones, with an additional three species collected without microhabitat data. Beetles were most strongly associated with the Scurf Pea vegetation type, and less than 50% ground cover. The two most abundant species, *Hypocaccus iris* (Fall) and *Hypocaccus seminitens* (J. L. LeConte), were most active during June and early July, consistent with the proposition that all species in this assemblage overwinter as long-lived adults.

Key Words: *Hypocaccus*, *Saprinus*, *Xerosaprinus*, *Spilodiscus*, *Hister*, ecology, by-catch

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Introduction

Despite a recent review of the histerid beetle fauna of Canada (Bousquet and Laplante 2006), not much is known about the phenology or habitat associations of most Canadian species. However, it is clear that histerids are especially abundant on sandy soils, including both stabilized and actively blowing dune fields. Open sand is being overgrown by vegetation on most western Canadian dune fields, with conservation implications for psammophilic species in this biodiverse habitat type (Acorn 2011; Glasier *et al.* 2019). A sample of 516 histerids, representing 14 species, was collected on the Empress dune field during the summer of 1984, as by-catch during a study of tiger beetles (Carabidae: *Cicindela* Linnaeus spp.) (Acorn 1988, 1991), and since most of these specimens were collected in pitfall traps for which habitat characteristics had been recorded, we were curious if they could be used to characterize the habitat associations and phenology of the histerid beetles collected during this study.

Methods

The Empress dune field is located approximately 11 km south of Empress, Alberta (50.9567°N, 110.0080°W), on a bend in the South Saskatchewan River, along the Alberta-Saskatchewan border. Surrounded by mixed-grass prairie and extensive cropland, the dune field is vegetated primarily by grasses and herbaceous plants, with only scattered trees and shrubs (*Populus* L., *Acer* L., *Rosa* L., and *Prunus* L.). During 1984, some of the dunes were open and unvegetated, with active aeolian sand movement, whereas most were stabilized by plants, to various degrees. Today, very few open dunes remain (2019 personal observation). The Empress dune field is well known among Alberta entomologists (*e.g.*, Acorn 1991; Hilchie 1982) but it has never been an easy site to access, requiring approximately 15 km of rough off-road travel through fire-prone grasslands, and increasingly complicated landowner permissions. Thus, we have limited our study to the historical dataset from some 36 years ago.

White plastic pitfall traps (11 cm in diameter, 13 cm in depth), intended to collect tiger beetles, were buried with their tops flush with the ground surface and filled with 5 cm of propylene glycol as a preservative. Traps were harvested after one week, on 3 May 1984, and then once per week every week from 2 June through 27 August. Only the data from June onward were used to assess phenology, since the 3 May samples contained few hister beetles, and there was a month-long gap between the first two trapping periods. Some traps filled up with sand and other insects between collection dates, but remained functional so long as there was some preservative above the level of the sand-insect mixture. Traps were arranged in five 50-m transects of 10 evenly spaced traps each, and oriented parallel to the west-to-east prevailing winds (and therefore dune movements). Trap contents were sieved, with added water, through a kitchen strainer with 2-mm mesh, to separate specimens from the preservative and sand. All non-*Cicindela* beetles were retained as by-catch.

The five transects represented a succession of dune stabilization by plants. Two transects were placed on the upwind side of actively moving dunes, vegetated primarily by scurf pea (*Psoralea lanceolata* Pursh). One was placed on a recently stabilized dune, with more extensive vegetation including sand grass (*Calamovilfa longifolia* (Hook.) Scribn.), and only a small (*ca.* 3 m^2) open area on the dune crest. One was placed on a heavily vegetated dune, with numerous rose and cherry shrubs (*Rosa* sp. and *Prunus virginiana* L.) on its crest. Finally, one transect was placed on a heavily vegetated, relatively flat area between two dunes.

During 4 June 1984, a 0.25-m^2 quadrat immediately to the northwest of each pitfall trap was photographed, all plant species were identified within this quadrat, and each photograph was scored by computer for percent open sand area. A cluster analysis was then performed using Jaccard's coefficient of similarity for presence/absence of plant species using an average distance algorithm (Acorn 1988, 1991). The intent of this analysis was to determine whether the *a priori* transects represented ecologically relevant habitat types, or whether another arrangement might show better objective support.

Four vegetation clusters were identified (Acorn 1988, 1991), and characterized as Open Sand (OS), Scurf Pea (SP), Stabilized Dune (SD) and Sand Flat (SF) (Fig. 1). This simplified the *a priori* habitat classification implied by the five transects, and made intuitive sense as well. In the Scurf Pea zone, trap sites were located on the upwind side of active dunes, where the vegetation consisted primarily of

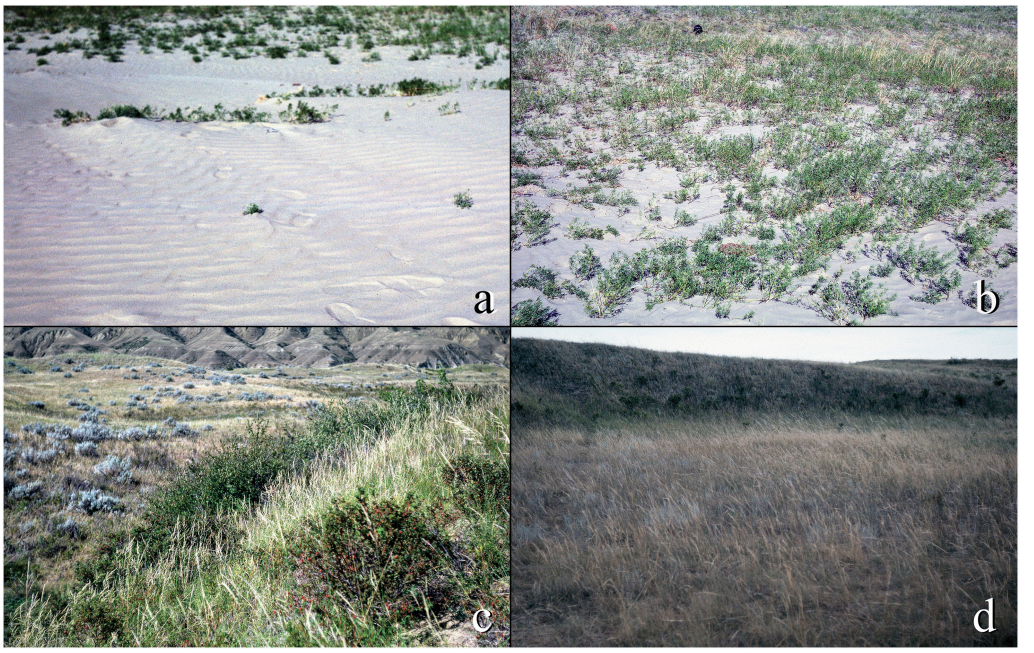

Fig. 1. Vegetation/habitat zones on the Empress dune field: a) Open Sand, b) Scurf Pea, c) Stabilized Dune, d) Sand Flat. The order represents habitat reducing in sandiness. Photos scanned from 35-mm slides taken during the 1984 field season.

well-spaced *P. lanceolata* with open sand visible between the plants. In the Open Sand zone, generally downwind of the Scurf Pea zone, trap sites had little to no vegetation. In the Stable Dune zone, trap sites were vegetated primarily by dense *P. lanceolata* plus various other plant taxa, especially *Koeleria macrantha* (Ledeb.) Schult and *C. longifolia*, with no apparent actively moving sand on the ground surface. In the Sand Flat zone, trap sites were vegetated densely by *Artemisia frigida* Willd., *Stipa comata* Trin. and Rupr., and *K. macrantha*. Here, the overlying loose sand had apparently been removed by wind erosion in the distant past, revealing a more or less horizontal, relatively erosion-resistant stratum below, on which a distinct organic A horizon had formed in the sandy soil.

Results and Discussion

A total of 516 histerid beetles were collected, representing 14 species: 12 *Saprinus oregonensis* J. E. LeConte; one *Euspilotus cribrum* (Casey); three *Euspilotus insertus* (J. L. LeConte); two *Xerosaprinus acilinea* (Marseul); one *Hypocaccus patruelis* (J. E. LeConte); one *Hypocaccus fraternus* (Say); two *Hypocaccus acorni* Bousquet and Laplante; 382 *Hypocaccus seminitens* (J. L. LeConte); two *Hypocaccus omissus* (Casey); 62 *Hypocaccus iris* (Fall); one *Margarinotus harrisii* (Kirby); eight *Hister furtivus* J. E. LeConte; five *Hister abbreviatus* Fabricius; and 23 *Spilodiscus instratus* (J. L. LeConte). Of these 14 species, three (*E. insertus*, *H. fraternus*, and *M. harrisii*) were hand collected on the dunefield, without microhabitat information, but were not captured in the pitfall traps. No myrmecophilous (ant-associated) histerids were collected during the sampling. Two myrmecophilous histerid species are known from Alberta, *Haeterius tristriatus* Horn and *Psiloscelis subopaca* (J. L. LeConte), associated with the genus *Formica* Linnaeus (Bousquet and Laplante 2006). As *Formica* are common on the Empress Dunes (Glasier and Acorn 2014) it is likely these myrmecophilous histerids are also found at ground level on the dunes, but were not sampled because of their inquiline lifestyle. We therefore focus on the 11 species collected in the pitfalls.

Phenology. The two most abundant species, *H. iris* and *H. seminitens* (~86% of total catch), showed similar patterns of adult activity during the pitfall-trapping period, as did the pooled pattern for all species (Fig. 2). Results from the week ending on 14 June were removed from the dataset due to high winds and cool weather, during which sand drifted into most pitfall traps, creating an artificial impression of a population decline. Beetle activity was greatest during June and early July, consistent with long-lived adults that overwinter (Bousquet and

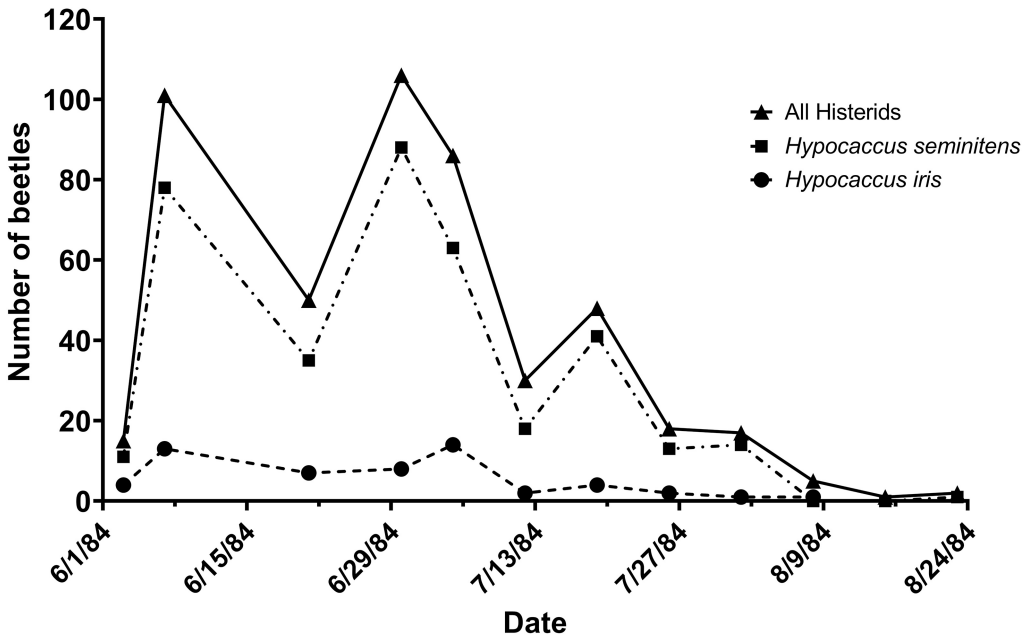

Fig. 2. Phenology of *Hypocaccus iris*, *H. seminitens*, and all histerids collected in pitfall traps on the Empress dune field. Dates are expressed as month/day/year.

Laplante 2006), with greatest adult activity at ground level during early summer.

An important early spring period of histerid activity may have been missed by the Empress Dune study. Recently, we received a report from a citizen scientist (J. Stevenson, *in litt.*) of a mass spring flight of histerids, suggesting dispersal by flight upon emergence from hibernation. The observation was made during 26 April 2018, at about 4:00pm, near the town of Michichi, some 195 km WNW of the Empress Dunes and also within the grassland region of southern Alberta. Stevenson wrote, "We had thousands of them just fly in pretty quickly yesterday and they were gone just as fast. They came from a coulee area with water and a dam close by. They moved off fairly fast. But there were literally thousands flying around." A photo, sent with this report, clearly showed a histerid beetle, possibly a *Hypocaccus*, but not identifiable from the image.

Habitat Associations. With respect to percent ground cover, trap sites were grouped into two categories (below and above 50% ground cover), in order to obtain adequate sample sizes for analysis. In the pooled sample, 441 beetles were collected in areas of 0–50% ground cover, and only 62 in areas of 51–100% ground cover. All species showed a strong association with low percent cover (G-test, $p < 0.05$ for the combined totals, as well as for *H. iris* and *H. seminitens*). This may indicate preferred habitats (in our opinion, the most parsimonious interpretation), but it may also indicate, at least in part, increased activity at ground level in less vegetated areas, leading to increased probability of capture.

In general, the Scurf Pea Zone yielded the most beetle captures, followed by Open Sand, Stable Dune, and Sand Flat. For *H. iris*, but not *H. seminitens* the association was statistically significant (G-test, $p < 0.05$), but for the other species the sample size was inadequate for statistical analysis. Some habitat information exists for the species we studied, as summarized by Bousquet and Laplante (2006). Species previously known to be sand-associated (psammophilic) include *M. harrisi*, *S. instratus*, and all species in the genus *Hypocaccus*. Some have been recorded previously from sand deposits near water, but the Empress Dunes lie well above the elevation of the South Saskatchewan River, and are best characterized as upland dunes, as seen in the carabid (and in particular the *Cicindela*)

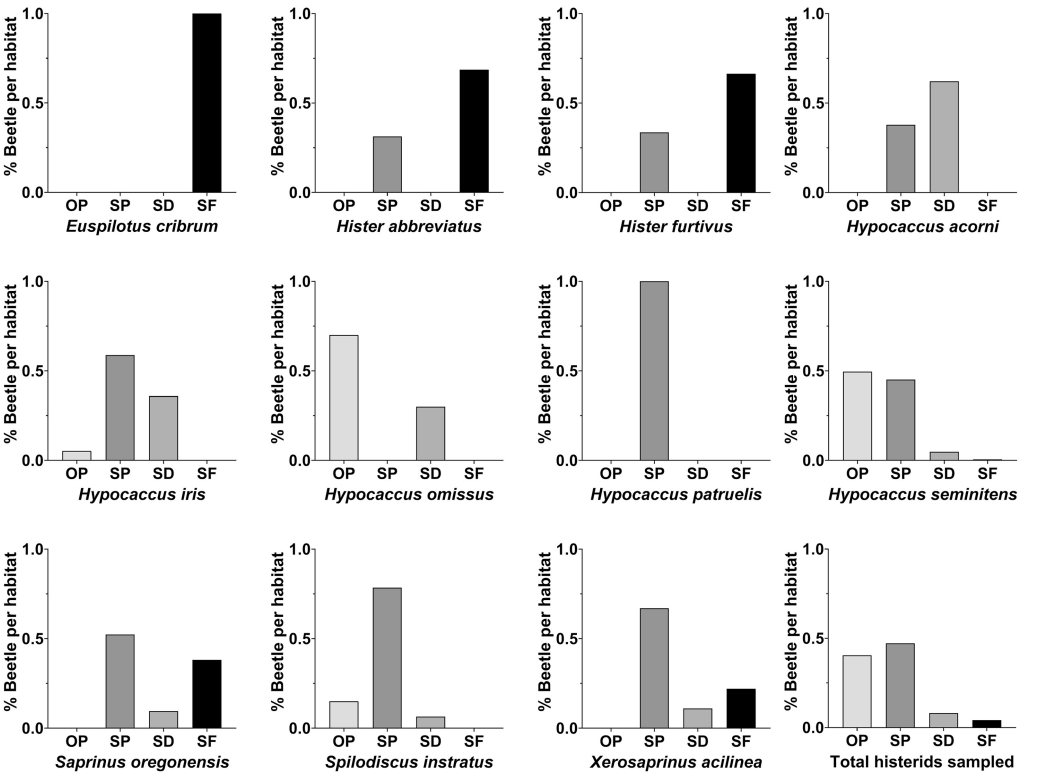

Fig. 3. Habitat associations of Histeridae on the Empress dune field. Note: Y-axis reports percentage, not number of specimens.

fauna of the dunes, which is clearly an upland fauna (Acorn 1988, 1991).

Psammophily. Our results (Fig. 3) suggest that all of the species we encountered were strongly associated with open sand, with the possible exception of *E. cribrum*, which was found only once, in the most heavily vegetated area surveyed. In hindsight, it is unfortunate that the pitfall trap transects were not also laid out on non-sandy grasslands, and other nearby environments. For this reason, we can only use the data to infer habitat associations within the dune field, and not to conclude that the species encountered are restricted to sand dunes. However, the fact that many of the species collected on the Empress dunes are also considered psammophilic by Bousquet and Laplante (2006) does indeed suggest a strong association.

Those species that were not considered psammophilic by Bousquet and Laplante (2006) were considered saprophilic instead, associated with carrion, dung, or decaying vegetation. In this study, we think it likely that these species could be both psammophilic and saprophilic. As well, it is possible that beetles were attracted to the pitfalls by both the trapping fluid (in an arid landscape) and the numerous accumulations of semi-decomposed, large-bodied acridid orthopterans in some pitfalls. Many *Nicrophorus* Fabricius adults (Silphidae) were also collected in the pitfalls, and these beetles were also attracted to the outdoor work area during sorting and pinning of specimens (although no histerids were observed or collected at that time).

Although an incremental step toward better characterization of histerid beetle habitat associations, we believe that the information presented here does have potential value, both for elucidation of the basic biology of the species involved, and for conservation status assessments, should such ever come to pass. The fact that most species were clearly associated with the sparsely vegetated Scurf Pea and Open Sand zones bodes poorly for these beetles on dune fields where vegetation is rapidly overgrowing and stabilizing the sand. In general, and despite climatic warming, the dunes are becoming more heavily vegetated, not more open and active (Acorn 2011). Dune sand movement is the result of cumulative moisture stress, and counter-intuitively, this seems not to have been the case on the Empress Dunes, nor the nearby Great Sand Hills of Saskatchewan, in recent decades, nor indeed since the cold-drought conditions of the late eighteenth century (Wolfe *et al.* 2001). As with many other sand-associated species, aeolian sand movement may improve the quality of habitat for particular species, and quantifying this relationship should be a priority for future work on the conservation of psammophilic insects.

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