

**DIVERSITY AND CONSERVATION STATUS OF PRAIRIE ENDEMIC
AUCHENORRHYNCHA (HOMOPTERA) IN ALVAR
OF THE GREAT LAKES REGION**

P. BOUCHARD¹, K.G.A. HAMILTON² and T.A. WHEELER³

Abstract

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Eighteen species of prairie endemic Auchenorrhyncha (Homoptera) representing three families: Cicadellidae (16 species); Caliscelidae (1); and Delphacidae (1), were recorded from alvar habitats in the Great Lakes region. The three alvar regions with the highest number of prairie endemic species were Northern Michigan (USA), Bruce Peninsula (Ontario) and Manitoulin and surrounding islands (Ontario). Numbers of species of prairie endemic Auchenorrhyncha varied from one alvar region to another and between sites within each region. Five species: *Aflexia rubranura* (DeLong); *Memnonia panzeri* Hamilton; *Mocuellus americanus* Emeljanov; *Texananus marmor* (Sanders and DeLong); and *Caenodelphax nigriscutellata* (Beamer) **comb. n.**, were restricted to alvar habitats in the study area. Our data indicate that Auchenorrhyncha species are useful as indicators of alvar quality for conservation and management purposes.

Introduction

Alvars are prairie-like communities that occur on flat limestone bedrock primarily in the Great Lakes region of North America and the Baltic Sea region of Europe (Catling and Brownell 1995; Rosén 1995). Most North American alvars are in southern Ontario with others in Quebec, Michigan, New York, Ohio, Vermont and Wisconsin (Catling and Brownell 1995; Bouchard 1997) and exist currently as isolated, open "islands" surrounded by forested areas. Alvars are characterized by a thin layer of soil and annual extremes in moisture and temperature and are dominated by grasses, sedges and shrubs (Catling and Brownell 1995). Many factors including periodic summer droughts, seasonal flooding in spring and fall, frost upheaval, lack of soil and grazing by large mammals are thought to have played a major role in restricting the growth of woody vegetation in alvars (Pettersen 1965; Stephenson and Herendeen 1986; Rosén 1995). Trees, when present, are often confined to deeper and wider cracks in the bedrock where soil has accumulated.

The presence of rare, endemic and restricted plant species in Great Lakes alvars has been well documented and the need to protect this habitat has received much attention recently (e.g., Belcher and Keddy 1992; Catling and Brownell 1995; Reschke et al. 1999; Brownell and Riley 2000). Several alvars have already been damaged or destroyed by limestone quarrying, housing development, coal dumping, heavy grazing and other factors (Hamilton 1990; Catling and Brownell

¹ Department of Zoology and Entomology, University of Queensland, Brisbane, Qld 4072, Australia

² ECORC, Agriculture and Agri-Food Canada, K.W. Neatby Building, Ottawa, ON Canada K1A 0C6

³ To whom correspondence should be addressed: Department of Natural Resource Sciences, McGill University, Macdonald Campus, Ste-Anne-de-Bellevue, QC Canada H9X 3V9; email

tbouchar@mcgill.ca

1995). The extensive data on vascular plants have been useful in identifying high quality alvar sites for conservation and management; comparable data on animal taxa are scarce.

Leafhoppers and allies (Homoptera: Auchenorrhyncha) are one of the most abundant and characteristic animal groups in open, grassy areas of temperate regions (Morris 1971; Waloff and Solomon 1973). Several species of Auchenorrhyncha occur on a single host plant or a few closely related species in a genus and, therefore, have been considered useful indicators of grassland quality for conservation purposes (Whitcomb 1987; Whitcomb et al. 1994; Hamilton 1995). Recent collections of Auchenorrhyncha in Great Lakes alvars have revealed a large number of species that are associated only with grasslands outside the study area. The objectives of this paper are to summarize data on the diversity and distribution of prairie endemic Auchenorrhyncha in Great Lakes alvars, and to comment on the use of Auchenorrhyncha in establishing conservation priorities within and among alvar regions.

Materials and Methods

Auchenorrhyncha were collected in 51 alvar sites around the Great Lakes between 1988 and 1997 (Fig. 1, Table I). The geographic division of major alvar regions used in Table I follows Catling and Brownell (1995). Ten sites (Table I) were sampled by PB using traps (pitfall, yellow pan, Malaise, flight intercept) and sweeping. Sampling at each of these sites was carried out from mid-May to mid-September of 1996 (sites 36, 37, 39, 40) and 1997 (sites 6, 12, 14, 15, 18, 21). Forty-one other alvar sites (Table I) were sampled using a sweep net from 30–90 minutes per site per visit by KGAH between 1988 and 1996 (Site 42 was sampled in the same way by PB). Most sites were visited at least once in June and in August. When both seasons could not be sampled independently, samples taken in July were presumed to represent the faunas of both seasons. Complete lists of Auchenorrhyncha collected are in Hamilton (1990, 1994a, 1995) and Bouchard (1997, 1998). Specimens are deposited in the Canadian National Collection of Insects (Ottawa, Ontario) and the Lyman Entomological Museum, McGill University (Ste-Anne-de-Bellevue, Quebec).

Species distributions were compiled from taxonomic publications, published surveys of north-eastern native prairie relict sites and specimens housed in the Canadian National Collection of Insects. Vegetation types used in the distribution sections were taken from Risser et al. (1981). The taxonomy of vascular plants follows Gleason and Cronquist (1991).

Results

Eighteen species of prairie endemic Auchenorrhyncha in three families were recorded in Great Lakes alvars. In the following annotated checklist, the North American distribution of each species is given, followed by a list of alvar sites in which the species was collected and information on host plants.

Family Cicadellidae

1. *Aflexia rubranura* (DeLong)

Distribution: This flightless species is found in tallgrass prairies from southern Manitoba to South Dakota and east to Wisconsin and Illinois (DeLong 1935, 1948; Panzer et al. 1995). Outside of tallgrass prairies, it is only found in Ontario alvars and dolomite ridges, which are similar to alvars but do not experience seasonal flooding (Hamilton 1994a, 1995; Bouchard 1997).

Alvar records: Sites 31–38, 40 (Fig. 2).

Host plant: Prairie dropseed, *Sporobolus heterolepis* Gray (Poaceae).

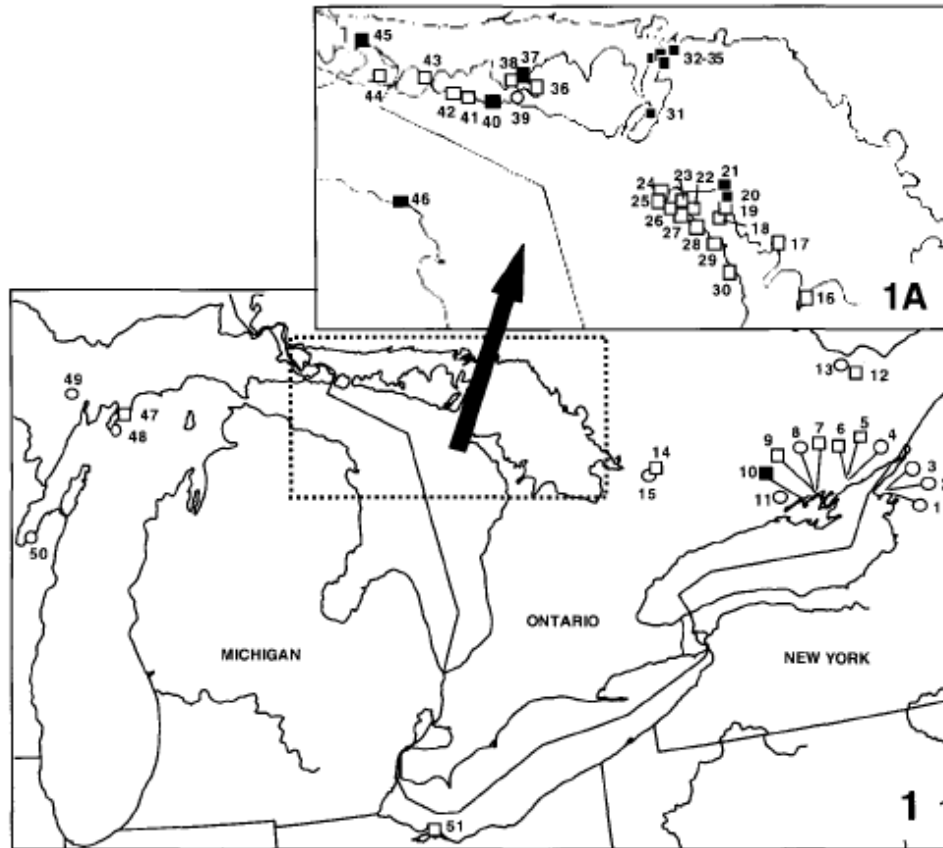


FIGURE 1. Alvar sites sampled in the Great Lakes region; rectangle shows area magnified in Figure 1A. Numbers correspond to site numbers in Table I. Symbols show number of prairie Auchenorrhyncha species at each site (circles: none; white squares: 1–3 species; black squares: 4–8 species).

2. *Athysanella longicauda* Beirne

Distribution: This species is found only in the northeastern United States and adjacent areas of Canada, from Wisconsin to southern Quebec. It occurs primarily in limestone areas, but not necessarily alvars. However, it is also known from igneous intrusions such as Mont Royal and Mont St-Hilaire, Quebec and a sand-based prairie relict at Brantford, Ontario. Its distribution in Canada corresponds closely to that of its only recorded host plant (Dore and McNeill 1976), suggesting that it is monophagous.

Alvar records: Sites 5, 7, 10, 12 (Fig. 3).

Host plant: Ensheathed dropseed, *Sporobolus vaginiflorus* (Torr.) Wood (Poaceae).

3. *Auridius sandaraca* Hamilton

Distribution: This species is known from five prairie localities in Alberta, Manitoba and Minnesota. It is also known from alvars in northern Michigan and Ontario and sand-based prairie relicts at Madawaska, Ontario and Epoufette Bay, Michigan (Hamilton 1999).

TABLE I. Alvar sites sampled between 1988 and 1997. Major alvar regions are in bold type. Site numbers correspond to those in Figure 1. Sites numbered in bold were sampled using pitfall, pan, flight intercept and Malaise traps and sweeping; all others were sampled by sweeping only. Numbers in right column refer to Auchenorrhyncha species numbers in annotated checklist.

Site	Locality	Prairie species present
Western New York		
1	Chaumont Barrens (44°05'N; 76°05'W)	-
2	Lucky Star (44°07'N; 76°07'W)	-
3	Three Mile Creek (44°08'N; 76°09'W)	-
Napanee Plain (Ontario)		
4	3 km S Yarker (44°22'N; 76°47'W)	-
5	5 km E Camden East, SE model aircraft club (44°20'N; 76°46'W)	2
6	5 km E Camden East, model aircraft club (44°20'N; 76°47'W)	16
7	3 km W Deseronto (44°12'N; 77°05'W)	2, 7, 11
8	2 km S Lonsdale (44°15'N; 77°07'W)	-
9	5 km S Marysville (44°10'N; 77°06'W)	11
10	Pointe Anne alvar (44°09'N; 77°18'W)	2, 6, 7, 11
11	7 km S Stirling (44°13'N; 77°33'W)	-
Smith Falls Plain (Ontario)		
12	5 km N Almonte (45°16'N; 76°10'W)	2, 12, 18
13	7 km SW Arnprior (45°20'N; 76°24'W)	-
Carden Plain (Ontario)		
14	7.5 km E Seabright (44°38'N; 79°03'W)	12
15	1.5 km NE Dalrymple (44°41'N; 79°05'W)	-
Bruce Peninsula (Ontario)		
16	Squaw Point, 4 km SW Leith (44°37'N; 80°54'W)	4, 11
17	Prairie Point, 3 km S Cape Crocker (44°55'N; 81°03'W)	4, 11
18	3 km N Miller Lake (45°07'N; 81°26'W)	15, 18
19	7 km NE Miller Lake (45°09'N; 81°23'W)	15
20	10 km E Dyer's Bay (45°13'N; 81°17'W)	3, 6, 8, 11, 18
21	Cabot Head (45°14'N; 81°18'W)	3, 5, 6, 11, 12, 14, 15, 18
22	14 km SE Tobermory (45°11'N; 81°31'W)	15
23	Borden Road, 15 km SE Tobermory (45°09'N; 81°34'W)	5, 14
24	Cape Hurd, 6 km SW Tobermory (45°13'N; 81°43'W)	5
25	1 km N Baptiste Harbour, 5 km S Tobermory (45°13'N; 81°41'W)	15
26	Dorcas Bay Cons. Area, 8 km SE Tobermory (45°11'N; 81°36'W)	5, 14, 15
27	Johnston Harbour, 17 km SE Tobermory (45°07'N; 81°33'W)	5, 15
28	1 km E Pine Tree Harbour (45°05'N; 81°29'W)	5
29	Stokes Bay (45°00'N; 81°22'W)	5, 14
30	St-Jean Point, 1 km N Howdenvale (44°50'N; 81°19'W)	5, 15
Manitoulin and surrounding islands (Ontario)		
31	South Bay, 19 km SW Wikwemikong (45°50'N; 81°47'W)	1, 5, 11, 18
32	Little LaCloche Is. (45°59'N; 81°44'W)	1, 5, 8, 11, 12, 13, 15, 17
33	Great LaCloche Is., 13 km E Little Current (46°00'N; 81°46'W)	1, 5, 11, 12, 13
34	Great LaCloche Is., 5 km E Little Current (46°00'N; 81°51'W)	1, 3, 5, 11, 12, 13
35	Goat Island (45°59'N; 81°54'W)	1, 5, 9, 11, 12, 13, 14
36	10 km SW Gore Bay (45°52'N; 82°31'W)	1, 11, 15
37	10 km W Gore Bay (45°53'N; 82°34'W)	1, 5, 8, 11, 12, 14, 15, 18

TABLE I. Continued.

Site	Locality	Prairie species present
38	W extremity Barrie Island (45°55'N; 82°42'W)	1, 5, 12
39	10 km W Evansville (45°49'N; 82°41'W)	-
40	Misery Bay (45°47'N; 82°45'W)	1, 3, 5, 11, 12, 13, 14, 15
41	Burnt Island, 9 km SW Silver Water (45°50'N; 82°57'W)	5, 14
42	Belanger Bay (45°51'N; 83°01'W)	5
43	12 km W Meldrum Bay (45°54'N; 83°14'W)	6
Northern Michigan		
44	7 km ESE Johnswood (45°55'N; 83°32'W)	3
45	Maxton Plains alvar (46°04'N; 83°39'W)	3, 5, 8, 11, 14
46	North Point alvar, 11 km W Presqu'île (45°18'N; 83°47'W)	4, 5, 10, 11, 14
47	6 km S Garden (45°41'N; 86°31'W)	3, 9
48	3 km ENE Fairport (45°37'N; 86°35'W)	-
49	Cornell (45°53'N; 87°14'W)	-
Wisconsin		
50	4 km SW Dyckesville (44°37'N; 87°48'W)	-
Western Lake Erie (Ohio)		
51	Marblehead Peninsula (41°31'N; 82°43'W)	11

Alvar records: Sites 20, 21, 34, 40, 44, 45, 47 (Fig. 4).

Host plant: Kentucky bluegrass, *Poa pratensis* L. (Poaceae).

4. *Dorydiella kansana* Beamer

Distribution: This species is found in prairies of Kansas, Iowa and Illinois and in remnants of native prairie vegetation in Pennsylvania, Ohio, Michigan and Ontario (Beamer 1945; DeLong 1948; Hamilton 1994a, 1995).

Alvar records: Sites 16, 17, 46 (Fig. 5).

Host plants: *Eleocharis elliptica* Kunth (Cyperaceae). It has also been recorded from *Scleria* spp. (Cyperaceae) in Pennsylvania (as *Dorydiella floridana*) by DeLong (1923).

5. *Flexamia delongi* Ross and Cooley

Distribution: This species is found in tallgrass prairies from southern Manitoba to Illinois and it is abundant almost anywhere its host plant occurs in Ontario, Michigan and Ohio (Whitcomb and Hicks 1988; Hamilton 1994a, 1995; Panzer et al. 1995; Bouchard 1997, 1998).

Alvar records: Sites 21, 23, 24, 26–35, 37, 38, 40–42, 45, 46 (Fig. 6).

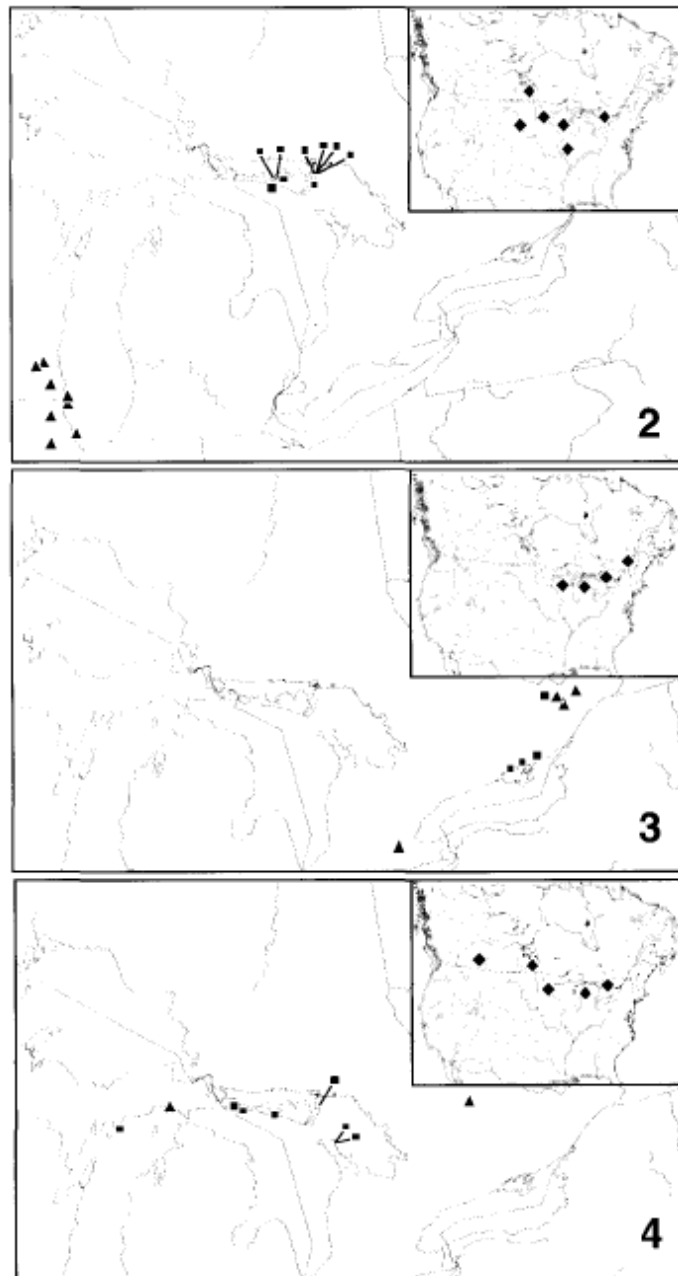
Host plant: Little bluestem, *Schizachyrium scoparium* (Michx.) Nash. (Poaceae).

6. *Graminella mohri* DeLong

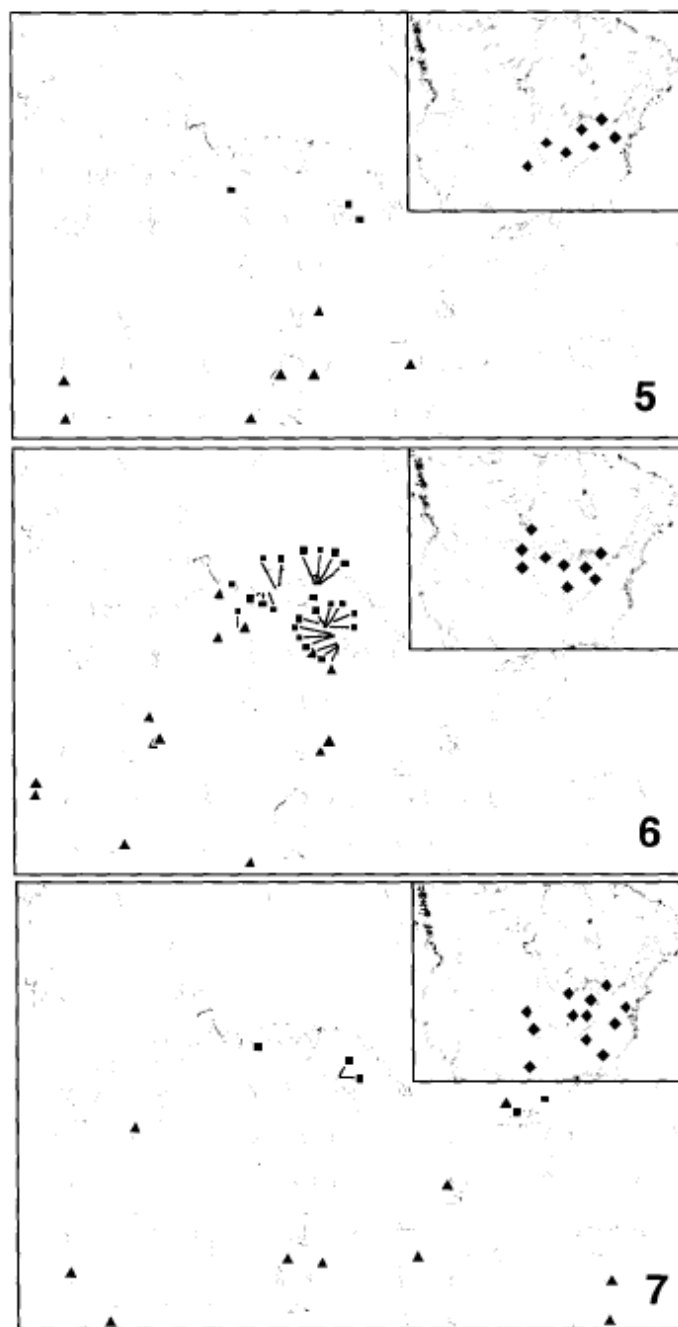
Distribution: This species is known from the shortgrass prairie of Texas, Kansas and Nebraska, east to Georgia and Tennessee and north to the tallgrass prairies of Wisconsin and Illinois (Kramer 1967; Panzer et al. 1995). It has also been found in prairie remnants in Ontario and Michigan (Hamilton 1994a, 1995; Bouchard 1998).

Alvar records: Sites 10, 20, 21, 43 (Fig. 7).

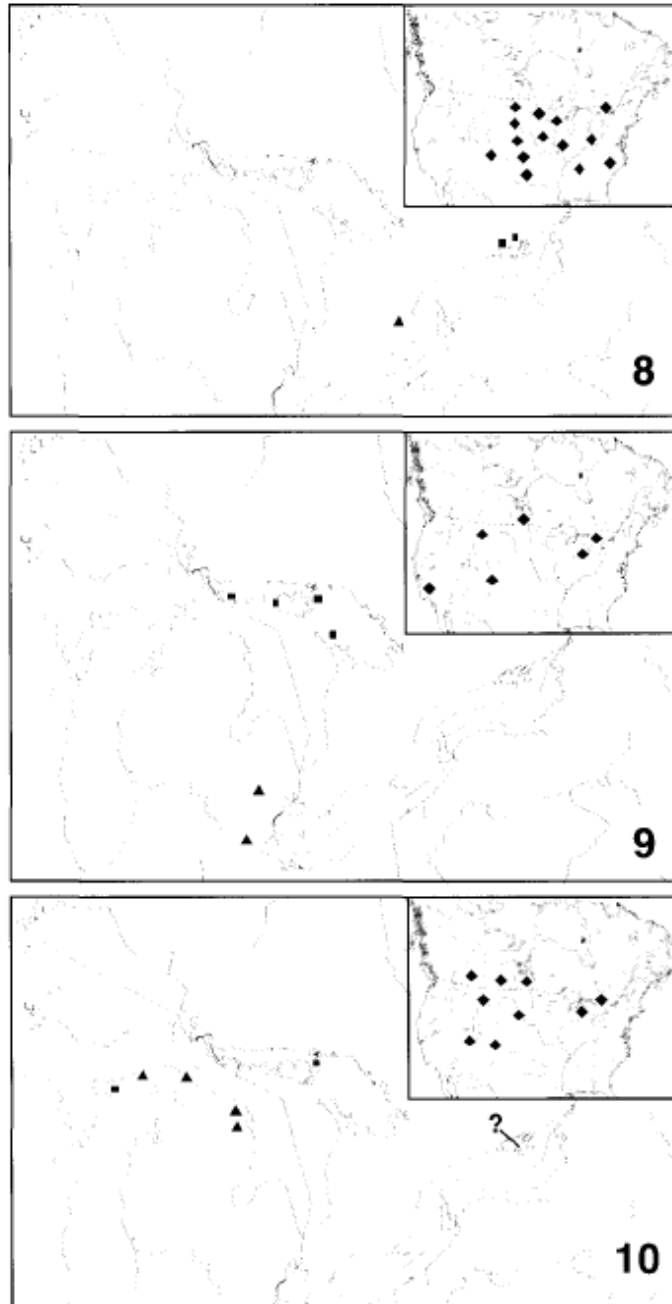
Host plant: Switchgrass, *Panicum virgatum* L. (Poaceae).



FIGURES 2–4. Distribution of *Aflexia rubranura* (2), *Athysanella longicauda* (3) and *Auridius sandaraca* (4) in the study area. Squares: occurrence in alvar sites; triangles: occurrence in non-alvar sites. Inset map shows North American distribution by state and province.



FIGURES 5–7. Distribution of *Dorydiella kansana* (5), *Flexamia delongi* (6) and *Graminella mohri* (7) in the study area. Legend as in Figures 2–4.



FIGURES 8–10. Distribution of *Laevicephalus minimus* (8), *Limotettix balli* (9) and *Limotettix bisoni* (10) in the study area. Legend as in Figures 2–4.

7. *Laevicephalus minimus* (Osborn and Ball)

Distribution: This species is widespread on the prairies as far north as Wisconsin and Illinois (Ross and Hamilton 1972), entering southern Ontario in Napanee Plain alvars and a single prairie relict near Brantford (Hamilton 1995). The species may be a good disperser, but its occurrence in two eastern relict populations of the host plant, separated by at least 200 km from each other and the prairie populations (Dore and McNeill 1976), probably reflects a reduction in the abundance and range of the host plant since the end of the Hypsithermal warming interval (5000 bp).

Alvar records: Sites 7, 10 (Fig. 8).

Host plant: Side-oats grama, *Bouteloua curtipendula* (Michx.) Torr. (Poaceae).

8. *Limotettix balli* (Medler)

Distribution: This species is known from California grasslands and the bunchgrass steppes of Montana and Colorado, in prairies of southern Manitoba and east to relicts of native vegetation in Michigan and Ontario (Medler 1958; Hamilton 1995).

Alvar records: Sites 20, 32, 37, 45 (Fig. 9).

Host plant: The host plant of this species is unknown, but is probably a species of Ericaceae.

9. *Limotettix bisoni* Knull

Distribution: This species is found in the northern mixed-grass prairies of Manitoba, Saskatchewan, Alberta, Montana and South Dakota, in bunchgrass steppes of Colorado and Utah (Knull 1952; Panzer et al. 1995) and in native vegetation remnants in Michigan and Ontario.

Alvar records: Sites 35, 47 (Fig. 10).

Host plant: Spikerush, *Eleocharis* spp. (Cyperaceae).

10. *Limotettix elegans* Hamilton

Distribution: This species has a bicentric distribution. It is known in the south in prairies of Texas, Missouri and Oklahoma and in the north in very few prairie remnants of Ontario, Michigan and Ohio (Hamilton 1994b, 1995).

Alvar records: Site 46 (Fig. 11).

Host plant: Low spikerushes, *Eleocharis elliptica* and *E. compressa* Sulliv. (Cyperaceae).

11. *Limotettix urnura* Hamilton

Distribution: This species is common in northern mixed-grass and tallgrass prairies from Saskatchewan east to Ontario, south to Kansas, Colorado and Utah (Hamilton 1994b; Panzer et al. 1995). It is found in Great Lakes alvars where the host plant occurs (Hamilton 1995; Bouchard 1997, 1998).

Alvar records: Sites 7, 9, 10, 16, 17, 20, 21, 31–37, 40, 45, 46, 51 (Fig. 12).

Host plant: *Eleocharis elliptica*.

12. *Memnonia panzeri* Hamilton (= *Parabolocratus grandis* sensu DeLong, 1948 nec Shaw)

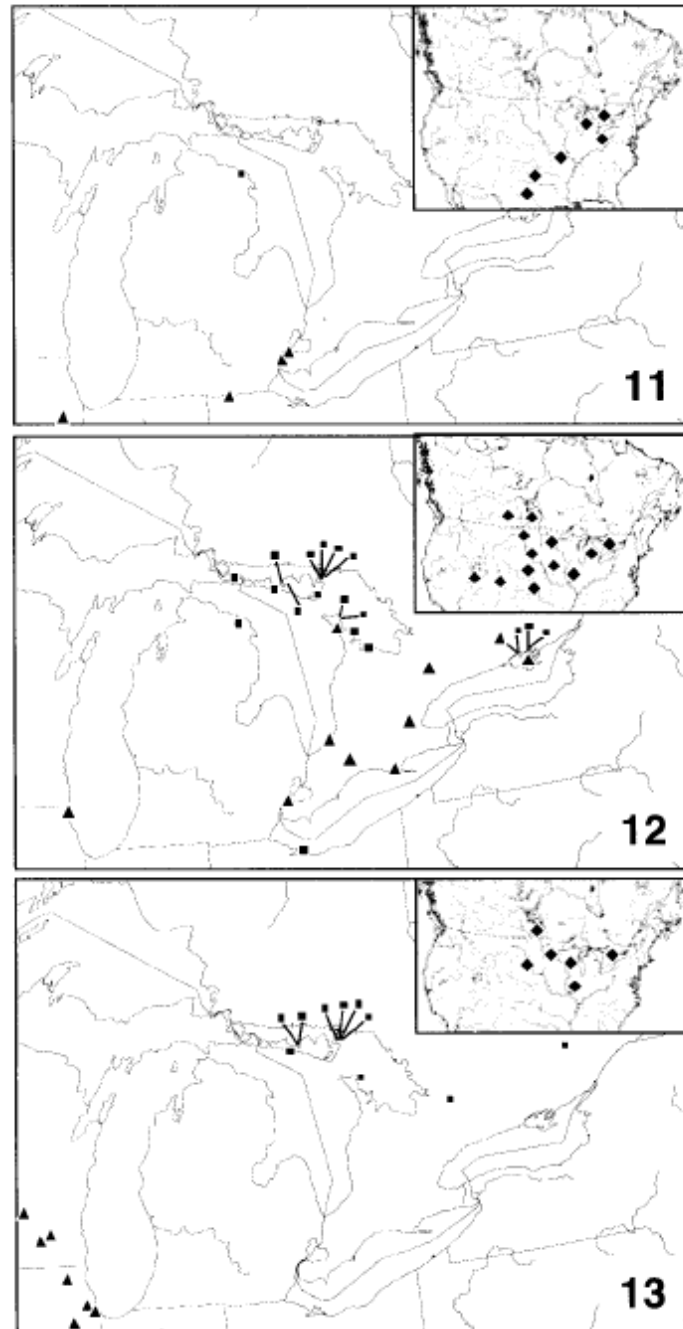
Distribution: This flightless species is found in tallgrass prairies of Manitoba, South Dakota, Minnesota, Wisconsin and Illinois and in Ontario alvars (Bouchard 1997, 1998 (as *Memnonia n. sp.*); Hamilton 2000).

Alvar records: Sites 12, 14, 21, 32–35, 37, 38, 40 (Fig. 13).

Host plant: Prairie dropseed, *Sporobolus heterolepis*.

13. *Mocuellus americanus* Emeljanov

Distribution: This species is found in the northern mixed-grass prairies of Saskatchewan, Alberta and Montana, in tallgrass prairies of Manitoba, North Dakota and Minnesota and reaches



FIGURES 11–13. Distribution of *Limotettix elegans* (11), *Limotettix urnura* (12) and *Memnonia panzeri* (13) in the study area. Legend as in Figures 2–4.

its eastern limit in alvars of Manitoulin and surrounding islands (Hamilton 1994a, 1995; Bouchard 1997).

Alvar records: Sites 32–35, 40 (Fig. 14).

Host plant: Slender wheatgrass, *Elymus trachycaulus* (Link) Gould (Poaceae).

14. *Paraphlepsius lobatus* (Osborn)

Distribution: This species is characteristic of the central Great Plains. It is found from Manitoba south to Kansas and Oklahoma (Hamilton 1975a; Panzer et al. 1995) and west to Alberta. In the east it is present mostly in alvar habitats in Ontario and Michigan (Hamilton 1994a, 1995; Bouchard 1997, 1998).

Alvar records: Sites 21, 23, 26, 29, 35, 37, 40, 41, 45, 46 (Fig. 15).

Host plant: Little bluestem, *Schizachyrium scoparium*.

15. *Texananus marmor* (Sanders and DeLong)

Distribution: This species is found in the northern mixed-grass prairies of Alberta, Saskatchewan, Manitoba and Montana and reaches its eastern limit in southern Ontario where it occurs exclusively in alvars (Hamilton 1972, 1994a, 1995; Bouchard 1997, 1998). It is particularly abundant on the Bruce Peninsula.

Alvar records: Sites 18, 19, 21, 22, 25–27, 30, 32, 36, 37, 40 (Fig. 16).

Host plant: Creeping juniper, *Juniperus horizontalis* Moench (Cupressaceae).

16. *Xerophloea major* Baker

Distribution: This southeastern species has been collected in small numbers from Kansas and Oklahoma east to North Carolina and Virginia and north to the tallgrass prairies of Illinois and Wisconsin and prairie remnants of Ontario and New York (Nielson 1962; Hamilton 1975b, 1995; Panzer et al. 1995; Bouchard 1998).

Alvar records: Site 6 (Fig. 17).

Host plants: Bee-balm, *Monarda* spp. (Labiaceae) and other forbs.

Family Caliscelidae

17. *Bruchomorpha dorsata* Fitch

Distribution: This species is found from the northern mixed-grass prairies of Saskatchewan, east through the tallgrass prairies of Manitoba, Minnesota, Wisconsin and Illinois, and south to Colorado, Texas and North Carolina (Dozier 1926; Ball 1935). It is also found in a small number of native prairie remnants in Michigan, New York, Ohio and Ontario (Hamilton 1995).

Alvar records: Site 32 (Fig. 18).

Host plant: Not known, but probably bluestem grasses (*Andropogon* and *Schizachyrium* spp.)

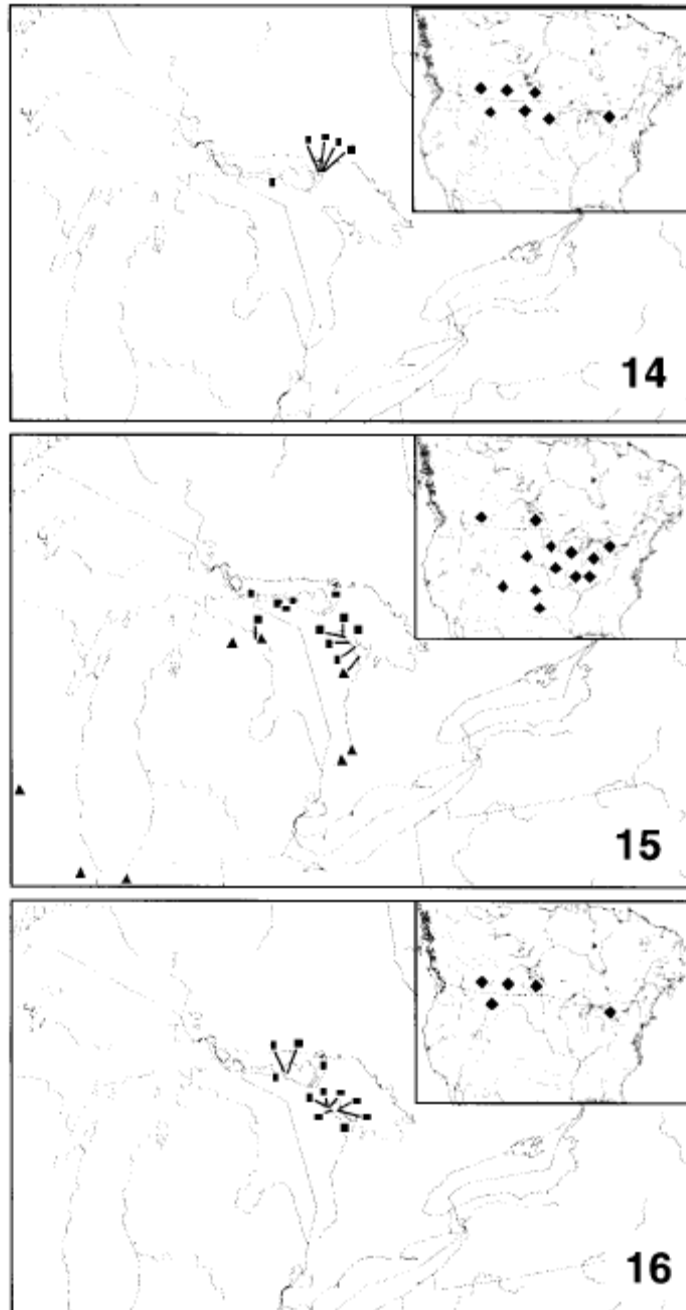
Family Delphacidae

18. *Caenodelphax nigriscutellata* (Beamer) n. comb.

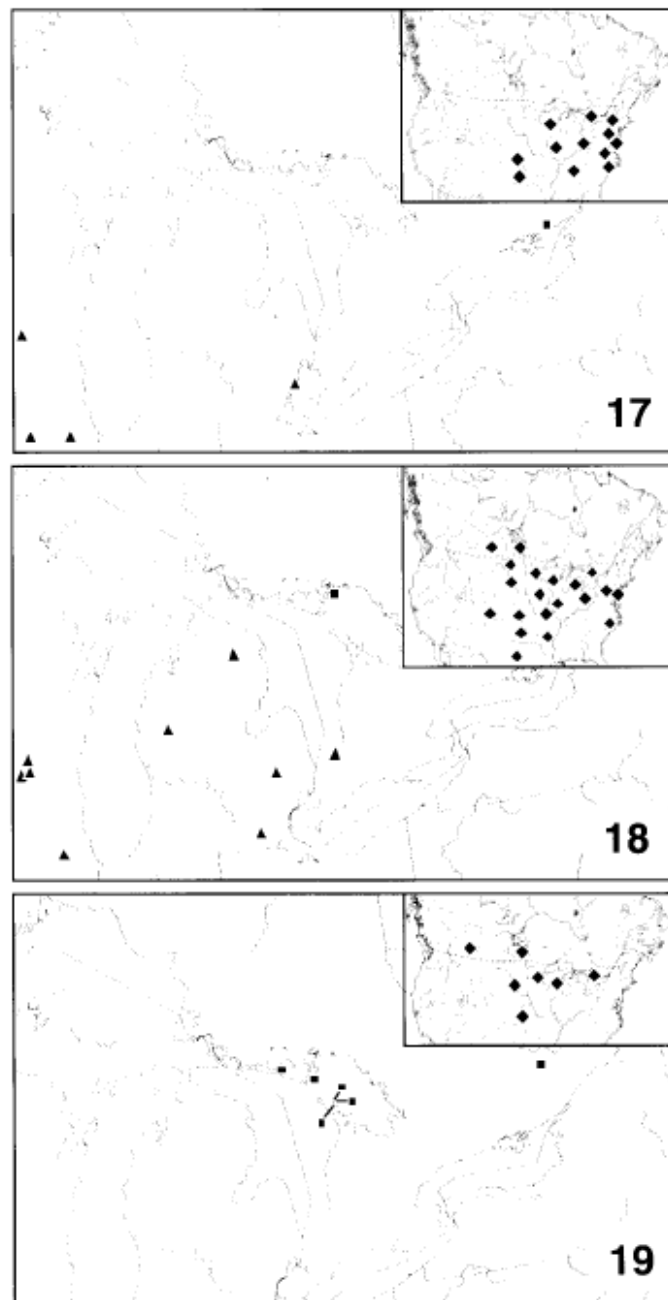
Distribution: This species is found in the northern mixed-grass and tallgrass prairies from Alberta to Manitoba in the north, south to prairies of South Dakota and Kansas (Beamer 1947). It is also found in alvar habitats in the Great Lakes region where it reaches its eastern limit near Ottawa (Bouchard 1997, 1998). *Caenodelphax nigriscutellata* is a new combination, transferred from the genus *Delphacodes* Fieber on the basis of its polished face and contrasting white antennae.

Alvar records: Sites 12, 18, 20, 21, 31, 37 (Fig. 19).

Host plants: *Eleocharis compressa* and *E. elliptica*.



FIGURES 14–16. Distribution of *Mocuellus americanus* (14), *Paraphlepsius lobatus* (15) and *Texanamus marmora* (16) in the study area. Legend as in Figures 2–4.



FIGURES 17–19. Distribution of *Xerophloea major* (17), *Bruchomorpha dorsata* (18) and *Caenodelphax nigriscutellata* (19) in the study area. Legend as in Figures 2–4.

Discussion

Origin and distribution of prairie endemic Auchenorrhyncha in Great Lakes alvars

Two historical events have had a major influence on the present biotic composition of Great Lakes alvars: the Wisconsin glacialiation (23,000–10,000 bp) and the Hypsithermal warming interval (8,000–5,000 bp) (Matthews 1979). The Great Lakes region was glaciated until about 12,000 bp and the limestone bedrock underlying most of the alvar sites was scoured by retreating glaciers (Morton and Venn 1984). Most of the cold-adapted species that were associated with tundra habitats south of the ice sheets during the Wisconsin glacialiation moved northward during deglaciation and the subsequent advance of the boreal forest (Scudder 1979). Such species are currently distributed in arctic and boreal regions of Canada although some northern plants (e.g. *Allium schoenoprasum* L. (Liliaceae), *Poa alpina* L. (Poaceae), *Carex scirpoidea* Michx. (Cyperaceae)) are believed to have persisted postglacially in Great Lakes alvars as disjuncts near the southern limit of their range (Catling and Brownell 1995).

The herbaceous vegetation of most Great Lakes alvars is dominated by native prairie-associated grasses and sedges which probably reached the area from the west and south during the Hypsithermal. Species such as *Sporobolus heterolepis*, *Carex crawei* Dewey (Cyperaceae), *Geum triflorum* Pursh (Rosaceae) and *Orobancha fasciculata* Nutt. (Orobanchaceae) are widespread in western North America and extend narrowly eastward into the Great Lakes alvars (Catling and Brownell 1995). These and several other plants may have dispersed eastward during the Hypsithermal, bringing with them a characteristic community of plant feeding invertebrates such as the skipper *Oarisma garita* (Reakirt) (Lepidoptera: Hesperidae) and the flightless Auchenorrhyncha species *Aflexia rubranura* and *Memnonia panzeri*. Southern plant species such as *Carex juniperorum* Catling, Reznicek and Crins (Cyperaceae) and *Hypoxis hirsuta* (L.) Cov. (Liliaceae) reach their northern limits in alvars (Catling and Brownell 1995).

The North American distribution of the Auchenorrhyncha species discussed in this paper suggests that alvar habitats share components of the Auchenorrhyncha fauna with all of the major types of native prairies. Alvars of northern Michigan, Manitoulin and surrounding islands and the Bruce Peninsula share the greatest number of prairie Auchenorrhyncha species (Table I) which suggests a similar postglacial history. The alvar communities of the Smith Falls Plain, northern Michigan, Manitoulin and surrounding islands and the Bruce Peninsula were formed just preceding or during the Hypsithermal as lower water levels enabled western prairie-associated plants and animals to disperse eastward on dry land connections across Lake Huron (Hamilton 1994a). This hypothesis is supported by the presence of two prairie Auchenorrhyncha species: *Caenodelphax nigriscutellata* (Fig. 19); and *Memnonia panzeri* (Fig. 13) in alvars of the Smith Falls Plain, Manitoulin and surrounding islands and the Bruce Peninsula. The prairie Auchenorrhyncha found in the above alvar regions are mostly characteristic of northern mixed-grass and tallgrass prairies.

In contrast, the alvar communities of western Lake Erie, the Napanee Plain and western New York were probably formed in the late Hypsithermal when southern prairie communities reached their northern limits during postglacial temperature maxima (Hamilton 1994a). *Xerophloea major* (Fig. 17), collected to date only in the Napanee Plain alvar region (although it is a rarely collected species that occurs in low numbers in other sites), is an example of a species associated with southern prairies.

Diversity and conservation of prairie endemic Auchenorrhyncha in Great Lakes alvars

Hamilton (1995) developed a ranking system to assess the quality of northeastern prairie remnants based on the number of prairie endemic Auchenorrhyncha found within them. According to that ranking system, most alvar sites sampled in this study were of depauperate or poor quality (i.e. supporting 0–3 prairie Auchenorrhyncha species). These included all sites in the western

New York, Smith Falls Plain, Carden Plain, Wisconsin and Western Lake Erie regions, and most Napanee Plain alvars. However, 12 sites (10, 20, 21, 31–35, 37, 40, 45, 46) were of fair to good quality (4–8 prairie species) compared to tallgrass prairies of Wisconsin, Minnesota and Manitoba (Hamilton 1995). No sites were of very good quality (nine or more prairie endemic species), although sites 21, 37 and 40 had eight species. The fair to good quality sites, mostly restricted to the Bruce Peninsula, Manitoulin and surrounding islands and Northern Michigan alvar regions (Figure 1, Table I) had more species of prairie endemic Auchenorrhyncha than any native vegetation remnants in Ontario and Michigan, except for the Newago Plain (Michigan), Ipperwash Beach and Windsor prairies (Ontario) (Hamilton 1995).

The number of prairie endemic Auchenorrhyncha species varied greatly from one alvar region to another and also from site to site within a given region. This was expected because of variation in vascular plant species composition between and within alvar regions (Belcher and Keddy 1992). Three species of Auchenorrhyncha (*Mocuellus americanus*, *Texananus marmor*, *Caenodelphax nigriscutellata*) are restricted to alvars in the Great Lakes region and two others (*Aflexia rubranura*, *Memnonia panzeri*) are restricted to alvars in the study area as well as some prairie remnants in Wisconsin and Illinois. These five species deserve prime attention from a conservation point of view. Six species have been collected in only one alvar region, which means that one or more sites in which they occur should also be included in conservation efforts. These species include *Laevicephalus minimus* and *Xerophloea major* (Napanee Plain), *Aflexia rubranura*, *Mocuellus americanus* and *Bruchomorpha dorsata* (Manitoulin and surrounding islands) and *Limotettix elegans* (Northern Michigan).

The three alvar regions which supported the highest numbers of prairie endemic Auchenorrhyncha were the Bruce Peninsula, Manitoulin and surrounding islands and Northern Michigan. These regions should, therefore, receive the most attention from a conservation perspective. However, we also agree with Catling and Brownell (1995) who suggested that within each of the alvar regions around the Great Lakes, it would be necessary to protect two or three high quality sites in order to achieve adequate representation of the various association types. From this point of view, the data on prairie endemic Auchenorrhyncha could help to choose between a number of sites with equal conservation value based on vascular plant data. For example, in the event that all the Napanee Plain alvar sites investigated in this study (sites 4–11, Table I) had equal weight based on vascular plant data, information on Auchenorrhyncha would make a strong case for the protection of sites 6 and 10. Indeed, the protection of these two sites would enhance the chances of preserving representative populations of all five prairie Auchenorrhyncha species present in that alvar region. In the Smith Falls Plain, the only prairie endemic species were found in site 12, which should also receive higher conservation priority.

Because of the overall rarity of alvars worldwide and their vulnerability to increasing anthropogenic pressures, the need to protect an adequate number of representative alvar communities has received much attention in recent years (Belcher and Keddy 1992; Catling and Brownell 1995; Reschke et al. 1999). Thus far, the evaluation of the habitat health and quality of North American alvars has been based almost entirely on the vascular plants. It is our opinion that data from additional groups such as the Auchenorrhyncha should be incorporated into future conservation decisions to complement vascular plant data and provide more comprehensive information on these biologically significant areas for the use of land owners and policy makers.

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