INSECT DIVERSITY IN ALVARS OF SOUTHERN ONTARIO

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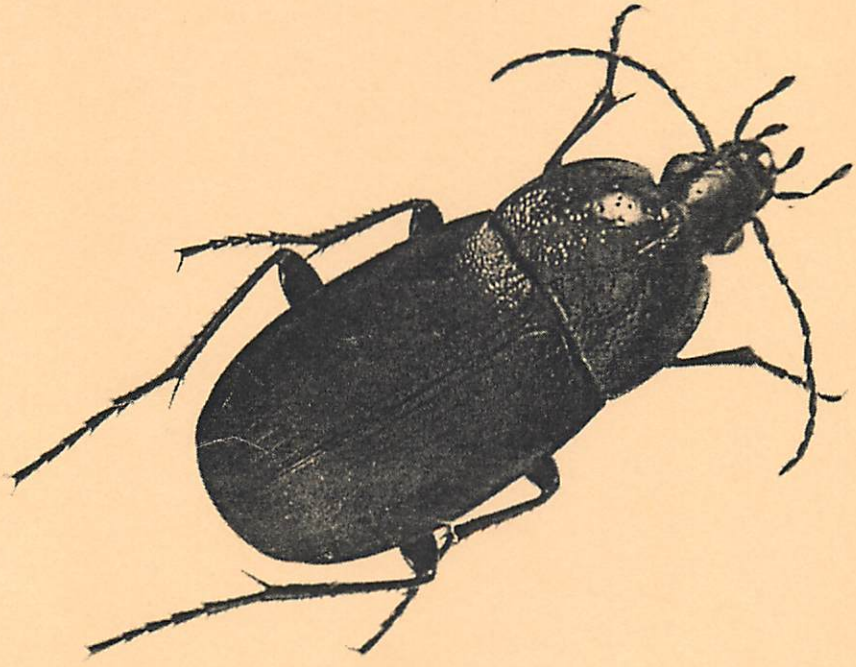

Chlaenius p. purpuricollis Randall

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ABSTRACT

Alvars are naturally open habitats which are found in the Great Lakes region in North America and in Scandinavia. The insect fauna of six sites representing four alvar types (grassland, grassland savanna, shrubland and pavement) were sampled in the summer of 1997 in southern Ontario. Over 15000 specimens from five target insect groups (Coleoptera: Carabidae, Homoptera: Auchenorrhyncha, Lepidoptera: Papilionoidea and Heperioidea, Hymenoptera: Symphyta and Orthopteroid orders) were identified. This report includes data on the seasonal occurrence and abundance of the 500 species identified from these groups in 1997, as well as summarizing the distribution of these and additional species known to occur in alvar sites around the Great Lakes. Of the species of insects reported in the present study, 54 are thought to be of biological significance which can potentially be used in the future in both global and regional management efforts. Although comprehensive information on alvar insects is available for only a small number of sites and for a small number of taxa, the information summarized in this report should be used to illustrate the richness of biologically significant insect species present in alvars and to supplement the large amount of data known on vascular plants in future conservation decisions.

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INTRODUCTION

Alvars are naturally open areas of thin soil lying over flat bedrock, mostly limestone (Catling, 1995). The vegetation is generally sparse and is usually dominated by shrubs, grasses and sedges. Trees seldom grow in these habitats because of the restricted soil available and drought conditions during the growing season, but when present, they can be found in the deeper and wider cracks in the bedrock where soil has accumulated over time (Catling and Brownell, 1995).

Alvar communities can be found in the Baltic Sea region on islands in southwestern Sweden, in Estonia and in small areas in western Russia (Rosén, 1995); and around the Great Lakes in North America (Catling and Brownell, 1995). Similar habitats can also be found in the southeastern United States where they are called cedar glades due to their association with red cedar (*Juniperus virginiana* L.: Cupressaceae). Well-developed cedar glades occur in Kentucky, Tennessee, Alabama and Georgia with the most numerous, extensive and floristically rich sites occurring in the Central Basin of Tennessee (Baskin and Baskin, 1985).

In the Great Lakes region, the sedimentary bedrock on which most of the alvars can be found was deposited by ancient seas about 450 million years ago and overlies the granite and quartzite of the Precambrian shield. This limestone was scraped by glaciers, which covered the area until about 12000 years ago (Morton and Venn, 1984). The alvars around the Great Lakes are isolated remnants of a "prairie-like" community which covered a wide area in North America during the Hypsithermal period (a time of warmer and drier climate, approximately 8000 - 4000 years before present) (Morton and Venn, 1984). Since then, the boreal and deciduous forests have taken over most of the area (Scudder, 1979), leaving open only a few patches unsuitable for tree growth. These patches, or alvars, have been maintained as natural openings until now, by a variety of environmental factors including the lack of soil, fires, grazing by large herbivores and a pattern of flood-drought-flood experienced during different seasons (spring-summer-fall).

The number of alvar sites known in the Great Lakes region is estimated to be between 250 and 300 covering an estimated 1100 km^2 (Catling and Brownell, 1995). Most of these sites are in southern Ontario, but others can be found in the states of New York, Michigan, Vermont and Ohio (Catling & Brownell, 1995). Small and isolated sites are also known from the province of Quebec (Huggett, 1993) and from Vermont (Catling and Brownell, 1995). Six different types of alvars have been recognized (Catling and Brownell, 1995; Nature Conservancy, unpublished data) based on the percentage of herb and shrub cover, the percentage of exposed bedrock and the percentage of tree cover (table 1). Two types (grassland and pavement alvars) have been

classified as globally imperiled and imperiled in Ontario by the Nature Conservancy and most savanna alvars in Ontario have been classified as critically imperiled globally by the same organization (Catling and Brownell, 1995).

The first comprehensive account of the flora of alvars in the Great Lakes region was by Catling et al. (1975) when the authors provided a list of vascular plants found in seven sites in southern Ontario. This list has grown extensively since then and the number of native vascular plant species has reached 347, of which 28% are considered characteristic of alvars (Catling and Brownell, 1995). The lack of introduced European flora in alvars is very noticeable characteristic of alvars to a knowledgeable observer although many invading species, such as the Tartarian honeysuckle (*Lonicera tatarica* L.: Caprifoliaceae) and lilac (*Syringa vulgaris* L.: Olaceae), have colonized the Great Lakes alvars recently because of artificial stresses. A number of endemic plant species are now restricted to alvars; one of these, the lakeside daisy (*Hymenoxys herbacea* (Greene): Compositae), can be found only in small areas in Ohio, the Bruce Peninsula and on Manitoulin Island.

Around the Great Lakes, eight "alvar regions" can be distinguished based on their geographical distribution and floristic affinities (adapted from Catling and Brownell, 1995). The region with the largest amount of original alvar habitat is consist of Manitoulin and surrounding Island (400 km^2) followed by the Napanee Plains (300 km^2) and the Carden Plains (220km^2) (Catling and Brownell, 1995). The other regions are the Bruce Peninsula, northern Michigan, Western Lake Erie, northwestern New York and the Smith Fall's Plains.

Most of the information on alvar arthropods has been obtained through intensive research which started about six decades ago in Sweden mainly on two islands, Öland and Gotland (Ander, 1931; Ardo, 1948; Bruce, 1964; Coulianos, 1973, and many more). The largest and most comprehensive study on alvar arthropods was carried out between 1977 and 1979 on the Great Alvar of Öland Island. The study was done to increase the available knowledge of the fauna of alvars as a base for future management and conservation strategies (Sylvén, 1983). The spiders (Araneae) and several insect groups (Psocoptera, Heteroptera, Coleoptera, Lepidoptera, Diptera (Cecidomyiidae and Brachycera) and Hymenoptera (Chalcidoidea and Aculeata)) were used as environmental indicators (results summarized in Entomologisk Tidskrift, vol. 104, 1983). The Öland alvars were shown to support a number of biogeographically important species of insects (species with restricted or disjunct distributions, rare species in other habitats but common in alvars, new species, species found nowhere else in northern Europe, etc.) and it was concluded that the conservation of the natural vegetation against non-natural stresses was

essential to preserve the great biodiversity of arthropods (Coulianos, 1983).

The study of alvar arthropods in the Great Lakes region has been patchy with no major comprehensive surveys. Brunton (1986) provided a useful analysis of moths and butterflies of the Burnt Lands alvar (near Ottawa) which included several rare, restricted or disjunct species including one new species of Owlet Moth (Noctuidae). The garita skipper (*Oarisma garita* (Reakirt): Hesperiidae) which occurs on the La Cloche Island alvar is a disjunct from a population that occurs 1040 km west where it has a fairly continuous range throughout the prairies and the Rockies (Catling, 1977). The Napanee Plain alvar in Ontario has the majority of the population of the olive hairstreak (*Mitoura gryneus* (Hubner): Lycaenidae), a very localized butterfly in Ontario, and two other butterflies with restricted occurrence in Ontario are associated with alvars: the hoary elfin (*Incizalia polios* Cook and Watson: Lycaenidae) and the mottled duskywing (*Erynnis martialis* (Scudder): Hesperiidae) (Catling and Brownell, 1995). One species of ground beetle, *Chlaenius p. purpuricollis* Randall (Coleoptera: Carabidae) is very rare and restricted in eastern Canada but was found in the Burnt Lands alvar where it is a disjunct of southwestern populations (H. Goulet, pers. comm.). The sawflies *Blennogeris spissipes* (Cresson) and *Zachizonyx montana* (Cresson) (Hymenoptera: Tenthredinidae) are other western disjuncts that can be found in the Ottawa valley alvar but nowhere else in Ontario (H. Goulet, pers. comm.). The Great Lakes alvars also have a number of disjunct and rare species of leafhoppers (Homoptera: Cicadellidae) that are normally associated with western and southern prairie communities (Hamilton, 1990, 1994, 1995). These documented examples are probably only a fraction of the rare, restricted, disjunct and undescribed species associated with alvars (Catling and Brownell, 1995). The present study started in 1996 as part of the International Alvar Conservation Initiative, the goal of which is to characterize the biodiversity and ecology of alvar habitats to help in future management and conservation decisions.

The choice of indicator taxa in a study is critical for getting the largest amount of information about an ecosystem by looking only at a few groups. Pearson (1994) identified the basic characteristics of good indicator taxa. The group should be taxonomically well-known and stable so that populations can be reliably defined. The biology and the general life history of the species within the group should be well understood: we should have a good indication on the limiting resources, enemies, physical tolerances, and the different stages for most of the species. The group should be readily collectable by non-experts so a great amount of information can be gathered quickly by professionals and non-professionals. The group should occur over a broad geographical range and types of habitats at higher taxonomic levels (i.e. order, family, tribe,

genus). The members of the group should show a great deal of specialization within a narrow type of habitat at lower taxonomic levels (i.e. species, subspecies). Another important aspect is that there should be some evidence that the taxa chosen shows similar patterns of diversity to other groups.

Insects have been used extensively in the past as indicators because of their great abundance in all terrestrial habitats. The taxa selected for this study, based on the requirements listed above, included the ground beetles (Coleoptera: Carabidae), the leafhoppers and allies (Homoptera: Auchenorrhyncha), the sawflies (Hymenoptera: Symphyta), the butterflies and skippers (Lepidoptera: Papilionoidea and Hesperioidea) and the orthopteroid insects (Orders Cheleutoptera, Dictuoptera, Grylloptera and Orthoptera).

The specific objectives of this study were to:

1- conduct a preliminary assessment of the species diversity in southern Ontario alvar habitats for the different target groups (this study is the first full season duration, multitaxon investigation of arthropods in North American alvars),

2- compile data on the status and distribution of the species collected (i.e. rare species, species restricted to alvars, species with disjunct distributions or at the extreme limit of their range, new species, etc.),

3- determine any differences in the diversity or abundance of species in the various alvars types found in southern Ontario,

4- compare the insect fauna of the various alvar regions in southern Ontario,

5- assess the importance of alvars for Canadian and North American biodiversity for future conservation purposes.

MATERIAL AND METHODS

Sampling

Six alvar sites in southern Ontario were sampled in 1997 (table 2, figure 1). All of the sites were chosen because of their high conservation potential within each of the regions based on vascular plant data. Because this project is a multitaxon biodiversity assessment, several standard collecting techniques were required to maximize the number of specimens and diversity of arthropods sampled (Marshall et al., 1994; Danks, 1996). On each of the six sites 16 pitfall traps consisting of white plastic beer cups (top diameter of 9 cm), 16 pan traps (yellow 12 Oz. "Party Bowls") and two flight intercepts (80 X 80 cm squares of commercial polystyrene black window screen supported by two wooden sticks and twine with a yellow painted wallpaper tray as collecting bowl) were used. The pitfall, pan and flight intercept traps were placed randomly throughout each site in areas where soil was deep enough. These traps were filled approximately half way with commercial plumbing antifreeze (propylene glycol), as a preserving fluid, and a few drops of detergent were used as wetting agent. One Malaise trap was also used on each of the sites (preserving agent : ethylene glycol). For comparison purposes, the collecting techniques used in 1997 were the same as those used in Manitoulin Island alvars in 1996 (Bouchard, 1997). The traps were emptied twice a month (every two weeks) and specimens were preserved in 70% ethanol until their preparation for identification. All of the traps (except for the shrubland alvar of the Carden Plains) were in place by mid-May (the first traps were set on May 18th) and were functional until mid-September (the last traps were pulled out on September 12th). The pitfall and pan traps in the shrubland alvar of the Carden Plains were continuously destroyed by (I suspect) small mammals between each visits from mid-May to mid-July, in such a way that no arthropod samples were obtainable. Therefore, these traps were removed from the site completely in mid-July, leaving only the Malaise and the flight intercept traps present for the last two months of sampling. Sweeping with a butterfly net was also performed on each for one to two hours for each visit to a site in order to maximize the number of Auchenorrhyncha collected and to sample the butterfly and skipper fauna. All of the specimens listed in this report (unless stated otherwise) are stored either in the Lyman Entomological Museum and Research Laboratory (Ste-Anne-de-Bellevue, Quebec) or at the Canadian National Collection of Insects (Ottawa, Ontario). Scientific names and authorities for the species of plants were based mostly on Gleason and Cronquist (1991).

Reference material used and confirmation of identifications by specialists.

1- Specimens of the family Carabidae (Coleoptera) were partially identified by the author and their distribution and status determined using Lindroth (1961, 1963, 1966, 1968, 1969a, 1969b) and Bousquet & Larochelle (1993). All of the identifications were confirmed by both Dr. H. Goulet and Dr. Y. Bousquet (Agriculture and Agri-Food Canada, Ottawa).

2- Specimens of the suborder Auchenorrhyncha (Homoptera) were partially identified by the author and all of the identifications were confirmed by Dr. K. G. A. Hamilton (Agriculture and Agri-Food Canada, Ottawa). Details on the distribution and status of the various species were also obtained from Hamilton (1982, 1990, 1994, 1995), Panzer et al. (1995) and unpublished data from Dr. Hamilton.

3- Specimens from the suborder Symphyta (Hymenoptera) were identified by Dr. H. Goulet and data on the status and distribution of the species was obtained from Gibson (1980), Goulet (1986; 1992), Krombein et al. (1979), Ross (1938, 1943), Smith (1969a, 1969b, 1969c, 1971, 1989), Townes (1951) and unpublished data from Dr. Goulet.

4- Specimens of the superfamilies Papilionoidea and Hesperioidea (Lepidoptera) were identified by the author using mostly Laplante (1985). The information on the status and distribution of the species was obtained from Holmes et al. (1991), the Audubon Society Field Guide to North American Butterflies (Pyle, 1990) and the Toronto Entomological Association yearly butterfly sighting lists (Hanks, 1996; 1997).

5- Specimens of the orders Cheleutoptera, Dictuoptera, Grylloptera and Orthoptera were identified by Dr. V.R. Vickery (Lyman Entomological Museum and Research Laboratory, Ste-Anne-de-Bellevue). The information on the status and distribution of the species was obtained from Vickery and Kevan (1986) and Panzer et al. (1995).

Quantitative analysis

Sorensen's Quantitative Index of Similarity (Magurran, 1988), which considers both the number of species and the number of specimens shared between sites, was used to quantify the similarity between the faunas of each alvar type for the family Carabidae (Coleoptera). This family was the only one collected in large numbers and in which the specimens were obtained mostly from trap samples (the family Cicadellidae was also abundant but was not used for this analysis because a large portion of the specimens were collected using sweep netting which

could not be quantified accurately from visit to visit and from site to site therefore). The dendrogram based on this similarity index was constructed following Spellerberg (1991).

RESULTS AND DISCUSSION

Ground beetles (Order Coleoptera: family Carabidae)

Diversity and distribution in the Great Lakes alvars:

A total of 5109 specimens of ground beetles representing 118 species were collected in southern Ontario alvars in 1997 (table 3). The total number of specimens collected in 1996 and 1997 is 8647 representing 143 species (table 4). This number represents about 28% of the fauna in the province of Ontario (Bousquet and Larochelle, 1993) which is rather large when compared to the Great Alvar of Öland Island in Sweden, which is known to support 95 ground beetle species (Lundberg, 1983).

Ground beetles seemed to occur in largest numbers in the grassland alvars of the Ramsay township (2188 specimens), Camden East (1841 specimens) and Manitoulin Island (1156 specimens) as well as in the grassland savanna alvar of Manitoulin Island (1201 specimens) (table 4). Although the grassland alvars of the Carden Plains and the Bruce Peninsula support the same general vegetational structure as the other grassland alvars in the province, they did not support large populations of ground beetles in the summer of 1997 (CRG = 324 and BPG = 372 specimens, table 3). In general, the pavement and shrubland alvars do not support large numbers of ground beetles when compared to sites with denser vegetation.

Sites with large numbers of specimens collected in them will often have a larger number of species. This is the case for the grassland alvars of Manitoulin Island (52 spp.), Camden East (68 spp.) and the Ramsay township (57 spp.). However, this is not always the case. The number of specimens collected in the grassland savanna alvar (MIGS) was high but the number of species is in middle range (44 species). On the opposite, the grassland alvar of the Carden Plains did not support high numbers of ground beetles but the number of species was high (56 spp.). The pavement alvars seem to support rather high numbers of species for their small numbers of specimens. The shrubland alvars seem less diverse than other alvar types.

The large number of specimens and species collected in 1996 and 1997 enabled the used of Sorensen's Quantitative Index of Similarity to compare the ground beetle fauna of nine alvar sites (figure 2) (the shrubland alvar in the Carden Plains was not included because the sampling effort was not identical to the other sites investigated - see Materials and Methods section. The results showed that all of the sites with a dense vegetation (herb cover > 50%, i.e. alvar grassland and savanna grassland) form a single cluster and the sites with sparse vegetation (herb cover < 50%, i.e. alvar pavement and shrubland) form another well defined group. More sampling with the same intensity is necessary to see if these clusters represent distinct groupings of alvars

habitats or if structurally similar habitats such as disturbed meadows would also show high similarity within the dense vegetation group.

The two species *Agonum cupripenne* and *Poecilus l. lucublandus* are found in dominant numbers (table 4) only in sites with dense vegetation cover which shows the close relationship of the ground beetle fauna of those sites over the entire geographical area covered by this study. Additional species such as *Agonum nutans* and *Harpalus faunus* also demonstrate a clear preference for the sites with dense vegetation. On the other hand, the species *Carabus serratus* was found in dominant numbers only in the two pavement alvars and *Harpalus plenalis* also demonstrate a preference for sites with sparse vegetation. Species such as *Calathus gregarius* and *Pterostichus novus* seem to be "alvar generalists" as they have been found in dominant numbers in both densely vegetated and sparsely vegetated alvar types.

Significant fauna:

Among the 143 species of ground beetles recorded in southern Ontario alvars in 1996 and 1997, four species (*Agonum nutans*, *Chlaenius p. purpuricollis*, *Pterostichus novus* and *Amara pennsylvanica*) are very rarely collected in Ontario but occur in dominant numbers in one or more alvar sites. These species are probably the most significant ground beetles for alvar conservation. Ten other species are very rarely collected and found in small numbers in alvars or are at or near the extreme limit of their range in Ontario alvars (*Carabus sylvosus*, *Cicindela denikei, Cicindela p. purpurea*, *Cymindis americanus*, *Selenophorus gagatinus*, *Selenophorus opalinus*, *Harpalus indigens*, *Cyclotrachelus s. sodalis*, *Anisodactylus carbonarius* and *Agonum crenistriatum*). Three other species are uncommonly collected in Ontario (*Bembidion rapidum*, *Harpalus faunus* and *H. fallax*) but frequent in certain alvars (Bouchard, 1997, table 3).

1- Agonum nutans: This eastern North American species occurs from Ontario south to Florida. According to Lindroth (1966) the true habitat of *Agonum nutans* was still unknown. Most of the specimens collected before the present study were from drift material on the shore of lake Erie according to Lindroth (1966). This species seems to be almost entirely restricted to grassland alvars in southern Ontario (table 4). It was collected in varying numbers in all grassland alvars and seemed to be doing especially well on the site west of Gore Bay (Manitoulin Island) where most of the specimens from 1996 and 1997 were collected (N=370) (Bouchard, 1997). *Agonum nutans* appears to be an autumn breeder which are usually characterized by overwintering larvae undergoing diapause and, usually, overwintering adults, completion of larval development the following spring and summer,

and emergence of adults and reproduction later in the summer (Larsson, 1939; Thiele, 1977). In autumn breeders, the peak of adult activity and of teneral (recently emerged) adults occurs in late summer and there is often another peak of adult activity early in the season as overwintering adults emerge from hibernation. The 1996 data showed a peak of abundance of adults in mid August (figure 3a) and the presence of teneral adults from mid July until mid September (unpublished data). There was an additional peak of adult activity in early summer, possibly due to the emergence from hibernation of overwintering adults (figure 3a). Blatchley (1910) reported that adults of *A. nutans* hibernate in Indiana; the 1996 results were consistent with Blatchley's observations. My1997 data did not show the same trend (figure 3b); the peak of abundance in early June was present as expected, but the second peak of adult abundance in late summer was much smaller than in 1996, as was the total number of specimens collected. No explanation can be put forth at this point to justify these differences. Additional study of this species in several alvar sites in subsequent years might resolve this anomaly. The numerous specimens collected clearly indicate that I collected the largest number of specimens of this species in any collection in the world. One specimen of this species was identified (by the author and confirmed by H. Goulet) from material collected by pitfall traps in a lakeplain prairie within Algonac State Park (Michigan) in 1995 by D. Cuthrell. Although this site was not an alvar, it seems to confirm an association of *A. nutans* with native prairie remnants at least in Michigan and Ontario.

2- Chlaenius p. purpuricollis: This widespread North American species has been described as rare and very local (Lindroth, 1969). Blatchley (1910) reported *C. p. purpuricollis.* as a rare species occurring along the shores of Lake Michigan. The ecology of *Chlaenius p. purpuricollis* is not known (Lindroth, 1969). This species was collected in all of the alvar sites except for the two shrubland sites and the two Bruce Peninsula sites (table 4). It was found in dominant numbers in the grassland savanna alvar of Manitoulin Island and the grassland alvar of Ramsay Twp. Once again, this is the largest collection of this species in the world. Fourteen specimens of this species were identified (by the author and confirmed by H. Goulet) from material collected by pitfall traps in the Maxton Plains alvars (Michigan) in 1994 and 1995 by D. Cuthrell. *Chlaenius p. purpuricollis* is a spring breeder. Spring breeders are characterized by overwintering adults, spring and early summer reproduction and uninterrupted larval development through the summer to produce the next generation of adults by late summer (Larsson, 1939; Thiele, 1977). Spring breeders may be recognized by a peak of adult activity in late spring and early summer and the presence of teneral adults late

in the summer. Adult abundance peaked in early June in both 1996 and 1997 (figures 4a, 4b) as overwintering adults emerged from hibernation. The few teneral adults collected were taken between mid July and early September, indicating that the next generation of adults were emerging (unpublished data). Lindroth (1969) assumed that adult hibernation occurs in all species of *Chlaenius* occurring in Canada and the seasonal abundance of *C. p. purpuricollis* is consistent with that assumption. This species has never been collected outside of alvars in Ontario and I suspect it is restricted to this type of habitat around the Great Lakes.

3- Pterostichus novus: The global distribution in North America is incompletely known (Lindroth, 1966) although all evidence seems to point towards a eastern central representation (Bousquet and Larochelle, 1993). *Pterostichus novus* appears to be associated with all types of alvars (one of only two ground beetle species that have been found in all of the alvar sites investigated), but was most abundant in alvars of the Bruce peninsula and Manitoulin Island (table 4). Lindroth (1966) reported collecting four specimens of *P. novus* in a "moist hardwood forest among dead leaves near a small brook" at Aweme, Manitoba. Recent reports of this species include Pelee Island (Will et al., 1995), deciduous forests of Dickinson county (Michigan) (Snider and Snider, 1986) as well as several habitat types in east-central Minnesota (Epstein and Kulman, 1984; 1990). Sixty seven specimens of this species were identified (by the author and confirmed by H. Goulet) from material collected by pitfall traps in the Maxton Plains alvars (Michigan) in 1994 and 1995 by D. Cuthrell. Fifteen specimens of *P. novus* were collected by H. Goulet in a Quebec alvar the summer of 1997. This is the first population of *P. novus* ever known from this province. Only one other specimen was recorded in Quebec and it was near Montreal at the turn of the Century. This species is closely related to another species present on the sites investigated *P. coracinus*. Because only a few specimens of *P. novus* were known, the morphological characters used to distinguish it from *P. coracinus* were unclear. An article describing easy to use characters to differentiate the two species is almost completed and ready fore publication. *Pterostichus novus* is an autumn breeder. Both adult abundance and the number of teneral adults peaked in mid August in both sampling years (figures 5a, 5b). There was no appreciable peak of adult activity early in the season, suggesting that adults may not overwinter, or that they do so in relatively low numbers. The seasonal abundance of *P. novus* collected in this study corresponded closely to patterns reported by Epstein and Kulman (1984, 1990) although peak of adult abundance seems to occur a little later in the summer in southern Ontario alvars.

4- *Amara pennsylvanica*: This widespread North American species is rare in Ontario (only 5 specimens in the Canadian National Collection of Insects). It was found only in the two eastern Ontario sites (table 4) of Camden East and Ramsay Twp. It was found in dominant numbers in the grassland alvar in the Ramsay Twp. In 1997 this species showed a seasonal abundance typical of autumn breeders (figure 6) as most of the specimens were collected towards the end of the summer (N= 319 specimens in the first two weeks of September). No specimens were recorded in the Maxton Plains alvars of Michigan nor in the Quebec alvar.

5- *Carabus sylvosus*: This species is one of few which seems to reach its northern limits in Ontario alvars. It is mostly found in eastern United States south to Florida (Bousquet and Larochelle, 1993). The presence of this insect in alvar habitats is highly unusual as it is usually restricted to undisturbed, pristine forests in southern Ontario (mostly Belville). Ten specimens were collected in the Misery Bay pavement alvar in 1996 (Bouchard, 1997) and three were found in the grassland alvar of the Carden Plains in 1997 (table 3). Additional records of this species in the Great Lakes region include: oak forests in Michigan (Liebherr and Mahar, 1979), deciduous forests in Dickinson county (Michigan) (Snider and Snider, 1986) and the first record of this species in Ohio (Purrington and Stanton, 1996). More research is needed to understand the habitat requirements of this species. No specimens were recorded in the Maxton Plains nor in the Quebec alvars.

6- *Cicindela p. purpurea*: This insect is a difficult to find throughout its fairly wide North American range (alvars seem to be a preferred habitat type for this species). It is more common in the western part of its range. In a recent account of the tiger beetles encountered in Ontario by an avid amateur entomologist during his life, only one specimen of this species was listed (caught on dirt road at Westport, 1978; Gunderman, 1997). This species is at its northern limit on Manitoulin Island alvars in Ontario but it is also found in alvars of the Carden Plains as well as the grassland alvar of the Ramsay Twp (table 4). Its habitat has been described as fields with clay or hard-packed soil adjacent to a field habitat. No specimens were recorded in the Maxton Plains alvars.

7- *Cicindela denikei*: This species is truly one of the best carabid finds for the summer 1996. It is really similar to a closely related species (which is more widespread) called *Cicindela sexguttata*. Due to the close resemblance all of the specimens were sent to Dr. Richard Freitag (Lakehead University, Thunder Bay, Ont.) who revised this genus before and designated *C. denikei* as a true species instead of a subspecies of *C. sexguttata* like it was

once thought to be (Kaulbars and Freitag, 1993). The genitalia of the female, the size and the coloration all point towards *C. denikei* which is only known from northwestern Ontario and southeastern Manitoba, on each side of the border between the two provinces, making this a very important range extension. This tiger beetle is currently on the list of rare species tracked by the Ontario NHIC (Holder and Sutherland, 1998). It usually lives on the Canadian shield and the larvae seem to have an interesting ecological feature. Instead of making vertical burrows like all of the other tiger beetles in Ontario, it makes a more or less horizontal burrow underneath rocks or stones. Specimens were collected from the grassland savanna and shrubland alvars of Manitoulin Island in 1996 (Bouchard, 1997; table 4). Many more adult specimens were sighted on the bare limestone especially during warm sunny days (they were most active during June and July). Specimens typical of *C. sexguttata* have been collected in Gore Bay (Mike Kaulbars, pers. comm.) so Manitoulin Island would probably be the first area where both species can be found that close from each other. In a visit to Manitoulin Island in the summer of 1997, Dr. H. Goulet collected an additional 20 specimens on the shrubland alvar site. No specimens were recorded in the Maxton Plains alvars.

8- *Cymindis americanus*: Only one specimen of this species was collected on the pavement alvar of Manitoulin Island in 1996. This eastern North American species is very rare in Ontario as well as Canada and its habitat has been described as an open well drained area with a sand base (Lindroth, 1969). Three specimens were also collected from the alvar in the province of Quebec in 1997 by H. Goulet. Manitoulin Island is at or near the northern limit of its North American range. A total of 21 specimens from Ontario are in the Canadian National Collection. No specimens were recorded in the Maxton Plains alvars.

9- *Selenophorus gagatinus*: This eastern North American species has been collected mostly in Quebec and New Brunswick in Canada (Canadian National Collection). Only 6 Ontario specimens are in the CNC making it a rare species. *Selenophorus gagatinus* is known as a high, dry hill species and was found in relatively large numbers on the Rigaud mountain (Quebec). Twenty eight specimens were collected in 1997 in three alvar sites (grasslands of Carden Plains, Camden East and Ramsay Twp.). Five specimens of this species were collected by H. Goulet in 1997 in the Quebec alvar. No specimens were recorded in the Maxton Plains alvars.

10- *Selenophorus opalinus*: This is an eastern North American species which occurs as far south as Florida (Lindroth, 1968). This species is very rare in Canada and the only large series of specimens were collected from Mont Rigaud in the province of Quebec (H. Goulet,

pers. comm.). Most of the other Canadian specimens were collected on the Toronto Peninsula. Other records include 5 specimens from the Quebec alvar (H. Goulet, pers. comm.) and specimens from western Lake Erie (Will et al., 1995). One specimen was collected by the author on the pavement alvar of the Bruce Peninsula in 1997 (table 4). No specimens were recorded in the Maxton Plains alvars.

11- *Harpalus indigens*: This species is restricted to the north east corner on the continent and is thought to be rare (Lindroth, 1968). The ecology of *Harpalus indigens* has never been recorded. One specimen was collected in the grassland alvar of Ramsay Twp. None were collected in the Quebec alvar in 1997 nor in the Maxton Plains alvars.

12- *Cyclotrachelus s. sodalis*: The distribution of this species is incompletely known (Lindroth, 1966; Bousquet and Larochelle, 1993) and no records were ever made on its habitat preferences and ecology. It is only known from Ontario in Canada and most likely reaches its northern Canadian limit in the grassland alvar of the Carden Plains (table 3) where 12 specimens were collected by the author in 1997. Only six specimens from Ontario are housed in the Canadian National Collection of Insects in Ottawa. Interestingly, this species is one of the dominant carabids which were collected in a small alvar site near Ancaster (Ontario) in 1997 (H. Goulet, pers. comm.). This species was also reported from western Lake Erie (Will et al., 1995) and northeastern Ohio (Purrington et al., 1989). Six specimens were recorded in the Maxton Plains alvars in Michigan but none were found in the Quebec alvar in 1997.

13- *Anisodactylus carbonarius*: This eastern North American species has only been collected in Ontario and Quebec in Canada (the Quebec record has not been confirmed; Lindroth, 1968). The ecology of this species has not been recorded and Lindroth (1968) mentioned that it could be occurring in Canada only as a straggler. Several specimens of *Anisodactylus carbonarius* were collected by the author in the two eastern Ontario alvars (Camden East and Ramsay Twp.: table 3) and more research is needed to see if it reproduces on these sites or not. No specimens were recorded in the Maxton Plains alvars nor in the Quebec alvar. A total number of 11 specimens from the province of Ontario can be found in the Canadian National Collection.

14- *Agonum crenistriatum*: This is another eastern North American species and it occurs only in Quebec and Ontario in Canada. It is known to occur on the seashores in New York and New Jersey although it has been found in open country independently of the presence of water (Lindroth, 1966). The total number of specimens found in the Canadian

National Collection is 17. *Agonum crenistriatum* was collected in three grassland alvars in 1997 (Bruce Peninsula, Camden East and Ramsay Twp.). No specimens were recorded in the Maxton Plains alvars nor in the Quebec site.

Global distribution and origin of fauna:

Excluding introduced species, the majority of the carabid beetles found in Ontario alvars are either widespread in North America (50%) or restricted to the eastern half of the continent (36%) (table 4). A smaller percentage of species are boreal (10%) or southern (1%). One species (*Bembidion praticola*) can be found on each sides of the continent with a gap in the middle and two other species have incomplete distributions (*Cyclotrachelus s. sodalis* and *Pterostichus novus*). Because ground beetles are microhabitat specialists (as opposed to host plant specialists such as Auchenorrhyncha) they are not expected to have a close relationship with specific plant species or assemblages. In the 143 species of carabids collected in 1996 and 1997, nine were introduced from Europe in the past (6.3%) (*Agonum muelleri*, *Amara familiaris*, *A. lunicollis*, *Carabus nemoralis*, *Clivina fossor*, *Harpalus affinis*, *H. puncticeps*, *Pterostichus melanarius* and *Trechus quadristriatus*). The sites with the largest number of specimens of introduced species are: the savanna grassland of Manitoulin Island (5 species, 55 specimens), the grassland alvars of Manitoulin Island (4 species, 142 specimens) and Camden East (5 species, 138 specimens). The two sites on Manitoulin Island have been used in the past (more than 7 years ago) as pasture fields which could explain the presence of larger populations of some of these opportunistic species (i.e. *Pterostichus melanarius* is one of few ground beetles which is associated with humans and their activities both in Europe and North America (Spence, 1990)).

Leafhoppers and relatives (Order Homoptera: suborder Auchenorrhyncha)

Diversity and distribution in the Great Lakes alvars:

In 1997, a total of 7735 specimens on Auchenorrhyncha were collected in southern Ontario alvars representing 178 species (table 5). The family Cicadellidae was by far the most speciose with 140 species, followed by Delphacidae (13), Cercopidae (9), Membracidae and Caliscelidae (4), Cixiidae (3) and the five remaining families (Cicadidae, Achilidae, Flatidae, Derbidae and Dictyopharidae) had one species in each. The combined number of specimens of Auchenorrhyncha collected by the author in 1996 and 1997 in the 10 alvar sites sampled is 13509 which represent 230 species (table 6). Data from six additional sites investigated by the author are included in table 6 (BBP, BBG, QBG, GLCI, CRPD and DNDG) as well as data from alvars of five counties in Michigan (MNC, MND, MNK, MNM, MIMC; unpublished data obtained from D. Cuthrell). It should be noted that the Auchenorrhyncha fauna of the Great Lakes alvars has also been collected extensively in the last ten years by K.G.A. Hamilton (Agriculture and Agri-Food Canada) and additional information can be found in Hamilton 1990, 1994, 1995.

Alvar sites with dense vegetation such as the alvar grasslands and savanna grasslands in general support larger numbers of Auchenorrhyncha specimens than pavement or shrubland alvars (table 6). This pattern is true for the grassland savanna site of Manitoulin Island (2978 specimens) and the grassland sites of Camden East (1895), Carden township (1728) and Manitoulin Island (1716). However, a few exceptions were noticed, for example the rather low number of specimens of the grassland alvars of the Bruce Peninsula (590 specimens; this was also noticed in the family Carabidae) and Ramsay township (866), as well as the rather high abundance of specimens of the pavement alvar on the Bruce Peninsula (2171).

As for the number of species present in each site, the grassland alvars of Camden East and the Carden township (84 and 93 species respectively) and the pavement alvar of the Bruce Peninsula (85 species) were among the most species-rich. One striking observation was that although the sites MIGS and MIG support large number of specimens, the total number of species found within them is rather low (51 and 49 respectively). The last two sites are populated by very large numbers of a relatively low number of dominant species (Bouchard, 1997). The site with the second lowest number of species, the grassland alvar of Ramsay township, is dominated by one main species (*Memnonia sp.n.*) which represents almost 50% of the total number of specimens collected on that site. The shrubland alvar of Manitoulin Island has the

lowest number of specimens and species (33) however a large number of species (67) were recorded on the other shrubland alvar, (CRS: table 6).

Among the species of Cicadellidae which occur in dominant numbers both in densely and sparsely vegetated alvar sites are *Empoasca sp.*, *Latalus personatus*, *Macrosteles quadrilineatus* and *Xestocephalus superbus* (table 6). Species such as *Aceratagallia n.subsp.*, *Agalliopsis peneoculata*, *Auridius sp.n.*, *Erythoneura sp.*, *Extrusanus extrusus*, *Graphocephala teleformis*, *Latalus sp.*, *Limotettix arctostaphili*, *Mocuellus americanus*, *Neokolla* hieroglypha, *Paraphlepsius fulvidorsum* and *Psammotettix lividellus* seem to prefer the sparsely vegetated sites like pavement and shrubland alvars. Others such as *Diplocolenus abdominalis*, *Limotettix urnura* and *Memnonia sp.n.* can be found in dominant numbers only in grassland or grassland savanna alvars (table 6).

Significant fauna:

Among the 230 Auchenorrhyncha species reported in the Great Lakes alvars in table 6, thirteen species (12 in the family Cicadellidae: *Aflexia rubranura*, *Auridius sp.n.*, *Flexamia delongi*, *Flexamia inflata*, *Graminella mohri*, *Limotettix urnura*, *Memnonia sp.n.*, *Mocuellus americanus*, *Paraphlepsius lobatus*, *Pendarus punctiscriptus*, *Texananus marmor* and *Xerophloea major*, and 1 species in the family Delphacidae: *Delphacodes nigriscutellata*) are thought to be North American prairie endemics which are very restricted in distribution in the Great Lakes region. Two additional species (*Idiocerus productus* and *Clastoptera arborina*) are at the extreme limits of their ranges in Ontario alvars.

1- *Aflexia rubranura*: This species is restricted to the tallgrass prairie occurring from southern Manitoba south to Illinois (Hamilton, 1995). It feeds exclusively on *Sporobolus heterolepis* (Gray) (Poaceae) and is known only from alvars of Manitoulin and surrounding Islands in Ontario. The presence of the host plant per se does not assure the presence of these leafhoppers since they are not always found where the host is (i.e. the foodplant is known to occur in all of the alvars regions in around the Great Lakes except for western Lake Erie (Catling and Brownell, 1995)). Specimens were collected by the author in three sites on Manitoulin Island in 1996 (pavement, savanna grassland and grassland alvars) (table 6). Individuals with long wings were known to occur in Chicago where the species has two distinct generations. Most of the long-winged *A. rubranura* occur in the first generation in the United States where about 10% of the population consists of long-winged specimens. I found the first long-winged individuals of this species ever found in Canada (and North of

Chicago): one in the pavement and seven in the grassland alvars of Manitoulin Island. No explanation has been put forward for the presence of long-winged specimens in Ontario since only one generation occurs.

2- *Auridius sp.n.*: This species is restricted to a few sites in Alberta, southern Manitoba and northern Minnesota in North America and almost entirely restricted to alvar habitats in northern Michigan and Ontario in the east. Outside of alvars, it is only known from the sandhill system near Madawaska (Ontario) (Hamilton, 1994). I collected a total of 53 specimens from the pavement alvar of Manitoulin Island (1996) and the grassland alvar on the Bruce Peninsula (1997) (table 6). The host for this leafhopper is in the genus *Poa* (bluegrasses: Poaceae).

3- *Flexamia delongi*: This species is common in north eastern North America where its host plant occur (*Andropogon scoparius* Michx. (Poaceae). It is known from Manitoba south to Illinois and several prairie remnants in Michigan and Ontario. I collected specimens in four alvars in southern Ontario (the pavement and grassland alvars of Manitoulin Island and the Bruce Peninsula) (table 6). Specimens were also collected during visits to the pavement alvar at Belanger Bay (Manitoulin Island) and one alvar on the Great LaCloche Island (Bouchard, 1997). Unpublished data from D. Cuthrell (Michigan) showed that this species has also been collected in alvars of the Maxton Plains and North Helen's Lake in the county of Chippewa (table 6).

4- *Flexamia inflata*: This species is widespread in North American prairie communities occurring from the north western bunchgrass steppes of British Columbia south to the shortgrass prairie in Texas across to the eastern Coastal Plains. In Ontario it reaches its northern limit on the Camden East grassland alvar (36 specimens collected in 1997: table 5) but it is also known from a few other alvar sites in the Napanee Plains (Canadian National Collection, Ottawa). This species is known to feed on *Muhlenbergia asperifolia* Nees and Meyen (Gramineae) (KGA Hamilton, pers. Comm.).

5- *Graminella mohri*: This species is distributed from Texas to Georgia in the south, north to Wisconsin, Michigan and Ontario. In Ontario, it is only found on alvars of the Bruce Peninsula and prairies in Blenheim and Windsor. I collected 13 specimens in 1997 in one site only (grassland alvar of the Bruce Peninsula) (table 5). This species is known to feed on *Panicum virgatum* L. (Gramineae).

6- *Limotettix urnura*: This species is distributed from Saskatchewan to Ontario in Canada and reaches its southern extent in Kansas. It is known to occur in northern Michigan

alvars and reaches its northern limit in Ontario on Manitoulin and surrounding Islands alvars. I have collected specimens in three alvar sites on Manitoulin Island as well as in the grassland alvar of the Bruce Peninsula (table 5, table 6). *Limotettix urnura* feeds on *Eleocharis elliptica* Kunth (Cyperaceae). This species can occur in large populations on alvars as I collected a total of 412 specimens in 1996. David Cuthrell also reported it from the Maxton Plains alvar (unpublished data).

7- *Memnonia sp.n.*: Along with *Aflexia rubranura*, this species is typical of tallgrass prairie ranging in distribution from southern Manitoba to Illinois and found only in alvars in Ontario (Hamilton, 1995). This species is restricted to the Bruce Peninsula, one site in Eastern Ontario (Almonte alvar), Great LaCloche and Manitoulin Islands. *Memnonia sp.n.* was collected by the author in the pavement alvar of Manitoulin Island and in large numbers in the grassland alvars of Manitoulin Island and Ramsay Twp (table 6). Two specimens were also collected in the shrubland alvar of the Carden Plains (table 5) which was unexpected there because the only patch of *Sporobolus heterolepis* in the area was swept repeatedly by the author during the summer of 1997 without yielding any specimens. More research is needed to confirm the status of this species in the Carden alvars. This species is often found along with *Aflexia rubranura* and also feeds on *Sporobolus heterolepis*.

8- *Mocuellus americanus*: This species is restricted to the northern mixed-grass prairies and occurs from Alberta and Montana in the west east to southern Manitoba and Wisconsin. It is only found in alvars of Manitoulin and surrounding Islands in eastern North America. I found 71 specimens in the pavement alvar of Misery Bay in 1996 (Bouchard, 1997). The host plant for this species is *Agropyron trachycaulum* (Link) (Gramineae) (KGA Hamilton, pers. comm.).

9- *Paraphlepsius lobatus*: This species can be found in Alberta, Manitoba and Ontario in Canada and in the east central United States, south to Oklahoma. It has been collected almost entirely in alvars in Ontario and Michigan although it has also been found in deep soil prairie remnants (i.e. Ipperwash P.P. and Pinery P.P.). A total of 21 specimens were collected from Manitoulin Island alvars in 1996 (12 from Misery Bay and 9 from the grassland alvar) (Bouchard, 1997) and nine specimens were collected on the grassland alvar on the Bruce Peninsula in 1997 (table 5). Even with the collecting of K.G.A. Hamilton on Manitoulin Island before, specimens were never found there. These leafhoppers feed on *Andropogon scoparius* Michx. (Poaceae).

10- *Pendarus punctiscriptus*: This species is widespread east of the Rockies. In eastern North America, it is known from alvars of northern Michigan, Manitoulin Island and the Bruce Peninsula as well as a few other remnant sites in Michigan and Ontario. I have collected *Pendarus punctiscriptus* on the pavement and grassland alvars of Manitoulin Island in 1996 and on the grassland alvar of the Bruce Peninsula in 1997 (table 6). The host plant is unknown.

11- *Texananus marmor*: This species is only known from the northern mixed-grass prairies of Alberta, Saskatchewan, Manitoba and Montana; in the east, it occurs only in alvars on Manitoulin and surrounding Islands as well as on the Bruce Peninsula. *Texananus marmor* was collected by the author on the pavement alvars of the Bruce Peninsula and Manitoulin Island and the grassland alvar of Manitoulin Island (table 6). It was also sighted on the Cabot Head site (grassland alvar) although no specimen were collected. This species had never been collected on Manitoulin Island prior to this study. It feeds uniquely on the creeping juniper (*Juniperus horizontalis* Moench: Cupressaceae).

12- *Delphacodes nigriscutellata*: Canadian records include one specimen from Manitoba and three from Alberta. This very rare prairie endemic species is known in the United States from Wisconsin, Iowa, South Dakota and Minnesota. East of Manitoba it is known only from alvar habitats in Ontario (sites in the Smith Falls Plains, Bruce Peninsula and Manitoulin Island alvar regions). I found six specimens in 1996, all from a new site at the grassland alvar (four males and two females). I also collected specimens in the grassland and the pavement alvars of the Bruce Peninsula (new sites for Ontario) and in the grassland alvar of Ramsay Twp in 1997 (table 5). The number of specimens collected is very low confirming the need for intensive, all-season collecting to find this species which is usually found in low abundance. The probable hosts for this species in Ontario are *Eleocharis compressa* Sull. (Cyperaceae) and *E. elliptica*.

13- *Idiocerus productus*: This is the first arctic-alpine species of Cicadellidae ever recorded in the Great Lakes alvars. It is known from Alaska, Yukon Territory, North West Territories, Labrador and northern parts of Saskatchewan, Alberta and British Columbia. This species is also known from several high altitude localities (British Columbia, Alberta, Colorado, Idaho, Montana and Wyoming). *Idiocerus productus* has never been collected in Ontario prior to this study. I collected two specimens in the grassland alvar of the Carden township in 1997 (table 5) which represents the southernmost collection site for this species, at least in eastern North America. It has been collected on several willows species

(Salicaceae) in the past including *Salix commutata*, *S. sitchensis* and *S. wolfii*. The only reported species of *Salix* found in the Carden alvars is *S. petiolaris* (R. Reid and J. Grand, pers. comm.).

14- *Clastoptera arborina*: This species is restricted to southern Ontario in Canada. Three specimens were collected in 1997 in the grassland alvar of Camden East which is at or near the northern limit of its Canadian range. It feeds on red cedar (*Juniperus virginiana*).

Global distribution and origin of fauna:

The majority of species listed in table 6 have rather widespread distributions in North America although some exceptions can be observed. The species *Idiocerus productus* is the only one restricted to boreal regions, the species *Clastoptera arborina* is southern whereas some of the prairie endemics listed in the significant species section have restricted global ranges. Of the species recorded, eleven are of European origin: four in the family Cercopidae (*Aphrophora alni*, *Leypironia coleoptrata*, *Neophilaenus lineatus* and *Philaenus spumarius*) and seven in the family Cicadellidae (*Anoscopus flavostriatus*, *Anoscopus serratulae*, *Aphrodes sp.*, *Athysanus argentarius*, *Deltocephalus pulicaris* (eastern population: Hamilton, 1997), *Doratura stylata* and *Elymana sulphurella*).

Butterflies and Skippers (Order Lepidoptera: superfamilies Papilionoidea and Hesperioidea)

Diversity and distribution in the Great Lakes alvars:

A total of 44 species of butterflies and skippers were collected or sighted in Ontario alvars in 1997 by the author (table 7). The highest number of species recorded in one site was at the grassland alvar of the Carden plains with the grassland alvar of Camden East coming after with 24 species. The grassland alvar on the Bruce Peninsula had the smallest number of species recorded on it with only 11. This number was surprisingly low but the number of butterflies specimens sighted on that site was always very low even on warm sunny days. A similarly low number of Auchenorrhyncha specimens was also observed on that site although no explanation as to why this may be can be put forth. In 1996 a total of 40 species of butterflies and skippers were recorded on Manitoulin Island alvars. Table 8 lists the species collected by the author in 1996 and 1997 as well as the main records on butterflies and skippers compiled in the last 15 years in the Great Lakes alvars including data from the Burnt Lands alvars (BLALL) (Brunton, 1986), the Carden Plains alvars (CRALL) (B. Bowles, unpublished list of species), the Maxton Plains alvars (MXPL) (S. Stephenson, unpublished list of species) and the New York state alvars (NYALL) (Stanton, 1997).

Significant fauna:

Seven species of butterflies and skippers collected by the author in Ontario alvars in 1996 and 1997 are worthy of mention based on their provincial or regional status. Three species (*Euchloe olympia*, *E. ausonides* and *Phyciodes batesii*) are currently being tracked by the Ontario Natural Heritage Information Center (Holder and Sutherland, 1998) based on their rarity at a provincial level. The four other species (*Erynnis lucilius*, *Hesperia comma*, *Incisalia polia* and *Oneis chryxus*) were also included in the list of significant taxa based on their status at a regional scale. Additional butterflies and skippers of interest which were not collected in this study (such as the garita skipper (*Oarisma garita*), the olive hairstreak (*Mitoura gryneus*) as well as the mottled duskywing (*Erynnis martialis*)) were reported in Catling and Brownell (1995).

1- *Erynnis lucilius*: This species which feeds on wild columbine (*Aquilegia canadensis* (L.): Ranunculaceae) is considered as stable in Ontario (S5 in Holmes et al., 1991) and is at or close to the northern limit of its range in Ontario alvars. It was recorded from the pavement and shrubland alvars of Manitoulin Island, in the two sites in the Carden

Plains and in the grassland alvar of the Ramsay township. It has also been collected in the alvars of New York state and the Maxton Plains alvars (table 8).

2- *Hesperia comma*: Only three specimens of this species were listed in the records of Lepidoptera by the Toronto Entomologist Association (Hanks, 1996) and a relatively small number was recorded in 1996 (Hanks, 1997). This species is listed as non-threatened by Holmes et al. (1991). It was collected on the grassland and pavement alvars of Manitoulin Island in 1996 and it is also known from the Burnt Lands alvars (Brunton, 1986) and in the Maxton Plains alvars (S. Stephenson, unpublished data) (table 8). It is at or near the southern limit of its range in Ontario in alvar habitats.

3- *Incisalia polia*: The Hoary elfin, which feeds on bearberry (*Arctostaphylos uva-ursi* (L.): Ericaceae), has been identified as a subarctic species in Brunton (1986) which would be close to the southern limit of its range in Ontario alvars. It is of restricted occurrence in Ontario (Catling & Brownell, 1995) although it is not under any threat according to Holmes et al. (1991). This species was collected in the pavement and shrubland alvars of Manitoulin Island in 1996 as well as in the grassland alvars of the Bruce Peninsula and the Ramsay Township in 1997. It has also been collected in the Maxton Plains alvars (table 8).

4- *Phyciodes batesii*: The tawny crescent is listed as S4 in Holmes et al. (1991) but it is considered as rare by the Ontario NHIC and is one of the insect species tracked by them (Holder and Sutherland, 1998). In 1996, this species was collected in the pavement and grassland alvars of Manitoulin Island (table 8) and in 1997, it was recorded from the two alvar sites investigated in the Carden Plains (table 7). This species is thought to be associated with several *Aster spp.* (Compositae) in Ontario (Holmes et al., 1991).

5- *Euchloe ausonides*: The large marblewing is a rare butterfly which is at the southern limit of its range on Manitoulin Island. This species is currently in the list of tracked insects in Ontario (Holder and Sutherland, 1998). In 1995, only 2 specimens were recorded (Hanks, 1996) and both individuals had been collected flying across Little Lake Huron road inside the Misery Bay Park which is also where I collected my only specimen. No records of this butterfly was listed in the 1996 summary of the Toronto Entomologist Association (Hanks, 1996) and it has not been recorded in other alvar regions (table 8). The adults can be found in the spring during a very short period. The food plant for this insect is the rock cress (*Arabis spp.*: Cruciferae).

6- *Euchloe olympia*: The Olympia marblewing is at the northern limit of its range on Manitoulin Island. It is also tracked by the NHIC as a rare species (Holder and Sutherland, 1998). Holmes et al. (1991) listed this species as S4 (apparently secure) and mentioned that it is associated with dry limestone or sandy areas between Lake Huron and Eastern Ontario. The immature stages feed on rock cress and other plants of the mustard family (Cruciferae). Only one adult was found in the grassland savanna alvar in 1996 and a few specimens were also collected in the grassland alvar near Camden East and in the shrubland alvar of the Carden Plains in 1997 (table 7). This species has been recorded in alvars of New York state and the Maxton Plains alvars (table 8).

7- *Oneis chryxus*: This subarctic species is at or near the southern limit of its range in Ontario alvars. It was recorded on the Burnt Lands alvars by Brunton in 1986. In 1996 it was collected from the pavement alvar of Manitoulin Island and in 1997 it was found in the shrubland alvar of the Carden Plains and in the grassland alvar in the Ramsay Twp (table 8). The poverty grass (*Danthonia spicata* (L.): Poaceae) is one of the favorite host plants of the larvae. Holmes et al. listed it as S4 (1991) and in 1995 it was only found in one locality (Matachewan, Ont.) in jack pine barrens (Hanks, 1996). In 1996 it was only recorded from Misery Bay on Manitoulin Island and in the county of Peterborough (Hanks, 1997).

Global distribution and origin of fauna:

The majority of species listed in table 8 have a widespread distribution in North America (88%) with smaller components being restricted to the east (4%), to the north (5%) and to the south (3%) of the continent. None of the species listed in the table are restricted to western North America although one such example (*Oarisma garita*) was discovered by Catling (1977) on limestone barrens (pavement alvar) of Great LaCloche Island. Three species (*Thymelicus lineola*, *Pieris rapae* and *Nymphalis antiopa*) are European species which have been introduced in North America in the past.

Sawflies (Order Hymenoptera: suborder Symphyta)

Diversity and distribution in the Great Lakes alvars:

A total of 460 specimens representing 119 species of sawflies were collected by the author in southern Ontario alvars in 1997 (table 9). The total number of sawflies collected in Ontario alvars in 1996 and 1997 by the author is 722 specimens representing 144 species (table 10). The number of specimens and species found within each of the ten sites (table 10) varied greatly between alvar regions and within alvar types so that no significant patterns in abundance and species representation was observed.

Significant fauna:

The reason that the sawflies were selected as a target group for this study was because of the presence of two prairie sawflies which had been found in Almonte alvars near Ottawa and Quyon (near Aylmer, Quebec) by Dr. H. Goulet. These species (*Blennogeneris spissipes* (Cresson) and *Zachizonyx montana* (Cresson)) are known to feed on plants of the genus *Symphoricarpos* (Caprifoliaceae). Of the 144 species of sawflies collected in 1996 and 1997, one first mention for Canada (*Pseudodineura rileda*), several rarely collected species (*Sterictiphora serotina*, *Periclista albicollis*, *P. diluta*, *Tenthredo spp.*), one western species (*Zachizonyx montana*), two species at or near the extreme limit of their range (*Empria candidata* and *Eutomostethus luteiventris*) as well as one species new to science (*Rhadinoceraea sp.n.*), were recorded (table 10).

1- *Pseudodineura rileda*: This species is only known from Illinois and southern Michigan. One specimen of this species was collected in 1997 in the shrubland alvar in the Carden Plains making it the first record for Canada (table 9). The host plant for this species is not known.

2- *Sterictiphora serotina*: This eastern North American species species, which is rarely found in Canada feeds on black cherry trees (*Prunus serotina* Ehrh.: Rosaceae). It was found only on the grassland savanna alvar of Manitoulin Island in 1996 (table 10) even though the host plant has not been recorded from the site. This sawfly is not expected to be closely associated with the Great Lakes alvars since the host plant has not been recorded in any alvar region (Catling and Brownell, 1995).

3- *Periclista albicollis* and *P. diluta*: Members of this genus are very rarely collected both in Ontario and Quebec (H. Goulet, pers. comm.). Both species feed on oaks (*Quercus sp.* (Fagaceae)) but the previously known host plant for *P. diluta* was the white oak

(*Quercus alba* L.) which is not found on Manitoulin Island (Morton and Venn, 1984) nor in any other alvar regions (Catling and Brownell, 1995). Three specimens of *P. diluta* were collected on the grassland savanna of Manitoulin Island (Bouchard, 1997). *Periclista albicollis* (host plant = *Quercus macrocarpa* Michx.) was collected only on the grassland savanna alvar of Manitoulin Island where it was expected. The host plant for *P. albicollis* is found in all alvar regions except for the Bruce Peninsula (Catling and Brownell, 1995).

4- Genus *Tenthredo spp.* (Tenthredinidae): This genus contains more than 50 species in southern Ontario and Quebec and has been very uncommon in trap catches since the early 1980's (H. Goulet, pers. comm.). In the Ottawa and Montreal region, members of this genus usually represent less than 1% of the total number of sawflies collected. Surprisingly, 98 of the 262 specimens collected in 1996 were from the genus *Tenthredo*. The number of specimens collected in southern Ontario alvars in 1997 (44 specimens out of 460; table 9) was significantly lower than on Manitoulin Island. The individuals in this genus feed mainly on herbaceous vegetation and are usually quite specific as to their host plants. Adults feed on other insects and the extensive usage of herbicides and insecticides in agricultural regions such as Ottawa and Montreal is believed to have had a detrimental effect on the populations of *Tenthredo* (H. Goulet and L. Masner, pers. comm.). Manitoulin Island supports agricultural practices also but the pristine nature of alvars might help to preserve refuge populations of this genus.

5- *Zachizonyx montana*: This species is frequently collected in the western prairies and extends as far east as the alvar regions of Ontario and Quebec. This species was collected by H. Goulet in alvars of the Ottawa region and in 1997 he collected several specimens in an alvar near Quyon (Quebec). Only one specimen of this species was collected by the author and it was in the shrubland alvar of the Carden Plains (table 9). A potential host plant for this species , *Symphoricarpos albus*, has been recorded in all alvar regions around the Great Lakes (Catling and brownell, 1995).

6- *Empria candidata*: This rarely collected boreal species is thought to be at the southern limit of its range in Manitoulin Island alvars (Bouchard, 1997) and feeds on *Betula sp.* (birches: Betulaceae). One specimen was collected in the pavement alvar site but it is thought to be an accidental occurrence there. *Betula papyrifera*, a potential host for this species, has been recorded in alvars of western Lake Erie, Manitoulin Island, Bruce Peninsula and the Carden Plains (Catling, and Brownell, 1995).

7- *Eutomostethus luteiventris*: This European species (host plant = *Juncus sp.* (rushes: Juncaceae)) is at the northwestern limit of its range on Manitoulin Island (Bouchard, 1997). Samples from the grassland savanna alvar contained one specimen of this species. The specimen collected on the grassland alvar of Manitoulin Island is thought to be an accident (H. Goulet, pers. comm.).

8- *Rhadinoceraea sp.n.*: Members of the subgenus *Veratra* within the genus *Rhadinocerea* contains species feeding mostly on two genera of plants (*Veratrum* and *Zygadenus* (Liliaceae)). Only the later genus can be found in Ontario and the two adult specimens collected on the Bruce Peninsula in 1997 are thought to be of a new species to science which probably feeds on *Zygadenus elegans* var. *glaucus* (Nutt.) Preece, a restricted species found in all Ontario alvar regions except for the Smith Falls Plains (Catling and Brownell, 1995).

Global distribution and origin of fauna:

Of the 144 species of sawflies collected, there are distribution data available on 93 of them (see list of references in Materials and Methods section). Of these, 45 species (48% of the fauna) are widespread in North America (table 10), 43 are found east of the Rocky mountains (46%) and only one species (*Empria candidata*) has a boreal distribution. Four European species (*Allantus cinctus*, *Dolerus nitens*, *Monophadnus pallescens* and *Strongylogaster macula*) can be found both in eastern and western North America with no occurrence in the central part of the continent. There were no species that exhibited a strictly western or southern distribution.

Eleven of the sawfly species collected (8 %) were accidentally introduced from Europe: *Diprion similis*, *Acantholyda erythrocephala*, *Allantus cinctus*, *Ametastegia glabrata*, *Dolerus nitens*, *Endelomyia aethiops*, *Eutomostethus luteiventris*, *Kaliofenusa ulmi*, *Monophadnus pallescens*, *Pristiphora pallipes* and *Strongylogaster macula*. The proportion of European species a little lower than the southern Ontario average (11%) (Goulet, 1996).

Orthopteroid insects (Orders Cheleutoptera, Dictuoptera, Grylloptera and Orthoptera).

Diversity and distribution in the Great Lakes alvars:

A total of 1740 specimens, representing 11 families and 49 species were collected in southern Ontario alvars in 1997 (table 11). The sites which have the largest orthopteroid diversity according to the sampling of 1996 and 1997 (table 12) are the grassland alvars of Camden East (29 spp.), Ramsay township (30 spp.) and Carden township (28 spp.). The sites with the lowest diversity include the grassland alvars of Cabot Head (12 spp.) and Manitoulin Island (15 spp.) as well as the shrubland alvar of Manitoulin Island (16 spp.). The four other sites have a middle range diversity. The total number of orthopteroid species known from southern Ontario and northern Michigan alvars now reaches 54 (table 12). Species collected by the author in opportunistic visits to six additional alvar sites are included in table 12 as well as unpublished orthopteroid records from alvars found in four townships in Michigan (see legend for abbreviations).

Significant fauna:

Among the orthopteroid species collected by the author in southern Ontario alvars in 1996 and 1997 (table 12), eight species are rare in Ontario and tracked by the NHIC (*Melanoplus mancus*, *M. p. punctulatus*, *M. huroni*, *Orphulella p. pelidna*, *Scudderia septentrionalis*, *Ceuthophilus meridionalis*, *Conocephalus saltans* and *C. strictus*) (Holder and Sutherland, 1998) and two other species (*Melanoplus dawsoni* and *Scudderia pistillata*) have been listed as highly dependant on native prairie remnants by Panzer et al. (1995). It should be noted that *Stethophyma gracila*, a grasshopper which was found in alvars of the Maxton Plains (Chippewa county, Michigan) (table 12) is a rare species tracked by the Ontario NHIC but it was not recorded in southern Ontario alvars by the author.

1- *Melanoplus mancus*: This eastern North American species is rare throughout its range which extends from Ontario, Quebec and Maine in the north, south to Virginia. It has been found in association with blueberries (*Vaccinium spp.*) and is known to occur on exposed, rocky mountain slopes as far as 1000 meters in altitude. *Melanoplus mancus* was collected only once in the shrubland alvar of the Carden Plains (table 11) where *Vaccinium angustifolium* Ait. (Ericaceae) is known to occur (Catling and Brownell, 1995). This species of plant can also be found in the alvars of Manitoulin and surrounding islands (Morton and Venn, 1984) as well as in western New York (Catling and Brownell, 1995) although no specimens of *Melanoplus mancus* have been collected there.

2- *Melanoplus p. punctulatus*: This is an eastern North American species with a range extending from Michigan to Quebec in the north and reaches its southern extent in Georgia. This uncommonly collected species is known to occur mostly in forested areas dominated with conifers. Small numbers of *Melanoplus p. punctulatus* were collected in 1997 in the two eastern Ontario alvar sites investigated (grassland alvars of Camden East and Ramsay township) (table 11).

3- *Melanoplus huroni*: This insect is present in Canada from British Columbia east to the province of Quebec and extends southward to the states of Nebraska and Michigan. It is rarely collected in Ontario (Holder and Sutherland, 1998). It is typically found in open forests. This species was only recorded in the shrubland alvar of Manitoulin Island (table 12).

4- *Orphulella p. pelidna*: This grass feeding species ranges from Alberta to Ontario in Canada and south to New England and Mexico. This insect is usually restricted to the southern most part of Ontario where it is rarely collected. It was found in the two eastern Ontario sites investigated by the author in 1997 (grassland alvars of Camden East and Ramsay township) (table 12) and it was the single most dominant species of orthopteroid insects in the Ramsay township site (table 11) where it is most likely at the northern limit of its range in eastern North America.

5- *Scudderia septentrionalis*: This rarely collected species can be found in eastern North America from Minnesota to Quebec, south to Tennessee and South Carolina. It has been found in largest numbers in shady woodlands with oaks (*Quercus sp.*). *Scudderia septentrionalis* was collected in the alvar savanna grassland of Manitoulin Island (table 12) where bur-oak trees (*Quercus macrocarpa*) are present.

6- *Ceuthophilus meridionalis*: This species seems to be restricted to the Great Lakes region as it is found from Michigan and Ontario south to Pennsylvania. It is one of the species tracked by the Ontario NHIC (Holder and Sutherland, 1998). It was found in all of the sites sampled in 1997 except the grassland alvar of Camden East (table 11). It was also found in the pavement and shrubland alvars of Manitoulin Island in 1996 (table 12). This camel cricket is at or close to the northern North American limit of its range in Ontario alvars. It occurs in greatest numbers in pavement and shrubland alvars where specimens stay in cracks during the day (where moisture is higher) and come out to feed during the night.

7- *Conocephalus saltans*: This species is widely distributed in North America, from Alberta to southern Ontario in the north, south the New Mexico and Florida. It is commonly

collected in prairies of western Canada. In the Chicago region, this species is highly restricted to xeric prairie remnants (Panzer et al., 1995). *Conocephalus saltans* has been collected in numerous alvar sites in southern Ontario (grassland alvar of the Carden Plains, grassland alvar of the Smith Fall's Plains, the grassland alvars of Manitoulin and Great LaCloche Islands, the savanna grassland alvar of Manitoulin Island) and in northern Michigan (Chippewa County) (table 12). This species reaches its northern limit in Ontario in alvar sites.

8- *Conocephalus strictus*: This species ranges from Montana to southern Ontario in the North and extends south as far as Arizona and Georgia. It is known to occur in sandy and grassy areas. Only one specimen of this species was collected by the author in 1997 (table 11) at the grassland alvar near Camden East where it is at or near its northern limit. It is not known from any other alvar sites (table 12).

9- *Melanoplus dawsoni*: This is a widespread species which occupies most of central North America (from British Columbia to Quebec, south to Utah and Pennsylvania). This species prefers grassy pastures where short shrubs are growing in western Canada but it was found to be highly dependant on native prairie remnants in the Chicago region (Panzer et al., 1995) mostly associated with sand prairies. *Melanoplus dawsoni* was collected in the grassland alvar of the Carden Plains in 1997 and the pavement and savanna grassland alvars of Manitoulin Island in 1996.

10- *Scudderia pistillata*: This widespread species has been collected from British Columbia to Nova Scotia south to Indiana and New York. It is usually found sitting on bushes in damp localities. Panzer et al. (1995) described this species as highly dependant of native prairie remnants in the Chicago region. *Scudderia pistillata* has been collected from two alvar sites on Manitoulin island (grassland savanna and grassland alvars) (table 12).

Global distribution and origin of fauna:

Most of the orthopteroid insects are generalist herbivores that are adapted to a wide variety of habitats. The majority of species listed in table 11 are therefore widely distributed in North America (75%). A smaller percentage is restricted to the eastern half of the continent (17%), whereas two species are restricted to the Great Lakes region (*Ceuthophilus meridionalis* and *Melanoplus islandicus*), one is a predominantly southern species (*Conocephalus strictus*) and one species can be found in both western and eastern North America with a gap in between

(the introduced species *Mantis r. religiosa*). Only two species listed in table 12 have been introduced from Europe (*Mantis religiosa* and *Metrioptera roselii*).

Diversity and significance of the insect fauna of the Great lakes alvars

A total of over 15000 insect specimens (from the following target taxa: ground beetles, leafhoppers and allies, butterflies and skippers, sawflies and orthopteroid insects), were collected and identified from the six alvar sites collected in southern Ontario in 1997. More than 500 species were represented. When put together with the 1996 data, these totals reach over 25000 specimens and 600 species for the groups mentioned above. Of the species of insects reported in the present study, 54 are thought to be biologically significant species which can potentially be used in the future in both global and regional management efforts (table 13, species which were found in only one alvar site investigated by the author are highlighted in gray). These biologically significant species include species rarely collected outside of alvars but common within them, species rarely collected which have been found in small numbers in alvars, species which are at or near the limit of their geographical range in alvars, species new to science and species which can be found nowhere else in the Great Lakes region. The status and abundance of the species listed in table 13 were all discussed in more details in the text. It is important to remember that some of these species were present in very large numbers compared to others and some species were thought to occur accidentally on certain alvar sites. Although comprehensive information on alvar insects is available for only a small number of sites and for a small number of taxa, the information summarized in this report should be used to demonstrate the richness of biologically significant insect species present in alvars and to supplement the large amount of data known on vascular plants in future conservation decisions.

Alvar conservation based on insect fauna

Many factors have to be taken into consideration when assessing the quality of a particular site for conservation and management purposes (Margules and Usher, 1981). The most important factors include the diversity and rarity of the organisms present within the site and its "naturalness". It has been suggested that diversity is a measure of habitat complexity and that more diverse areas are also more stable (i.e. Steiner, 1994; McCreary-Waters, 1994). Tilman and Downing (1994) have presented evidence that a higher plant biodiversity in grasslands will increase the stability of a particular site after a major drought. The argument behind this assumption is that more diverse ecosystems are more likely to contain some species that can thrive during an environmental perturbation, whereas in the species-poor sites, the loss of species due to the perturbation will have a progressively greater impact on ecosystem stability. However, the particular species present within the site will greatly influence its future stability. For

example, a stand containing a more natural (or native) vegetation will probably have a better resiliency after a severe drought (as observed by Tilman and Downing, 1994) than a more diverse site which supports a lot of introduced species.

It should be made clear though that the greatest possible diversity should not be the optimal criteria when selecting a particular site for conservation purposes. Coulianos and Sylvén (1983) mentioned that the insect diversity was highest in alvars with rich vegetation but the most unique arthropod species are often found in sites with poor, low-growing vegetation. The present study clearly shows that alvars support a relatively high number of rare insect species and species which are restricted to this type of habitat. But unfortunately, the mere presence of such species on a site does not mean that it reproduces or it will sustain its populations if the site is preserved. In fact, for many populations, a large number of individuals regularly occurs in what are called "sink habitats" where within-habitat reproduction is insufficient to account for local mortality (Pulliam, 1988). In order to confirm that a rare species of insect will have sustainable populations within a site for many years to come, we could look for certain clues. For example, the sites which have dominant populations of significant species should be prioritized because population density is one of the most readily observed indicators of population viability (Winston and Angermeier, 1995). The rarest species of the log normal distribution are usually more likely to have insufficient abundance of critical resources if the habitat is disturbed (Rosenzweig and Abramsky, 1993). Another way of finding out if particular species reproduce on the sites where recorded, we could also look for evidence of emergence (i.e. teneral specimens in ground beetles) and the presence of immatures (i.e. nymphs of Auchenorrhynca, sawfly larvae, caterpilars) to conclude that the entire life cycle of the insect occurs on the site. The presence of significant species in small numbers does not necessarily exclude the possibility that the species reproduces and has a sustainable density on that site, but instead, it might reveal limitations in the collecting methods used. One of the best examples can be found in the species *Caenodelphax nigriscutellata* (Auchenorrhynca: Delphacidae), a prairie endemic which has been collected occasionally in Ontario alvars. This species is never collected in large numbers. It is tiny and probably feeds close to the roots of its host plant which makes it extremely hard to collect by sweeping with a net (K.G.A. Hamilton, pers. comm.). Perhaps a better evaluation of population sizes could be done using a vacuum suction sampler (Marshall et al., 1994) which are commonly used for studies on Auchenorrhynca (e.g. Waloff and Solomon, 1973).

Alvars (and especially dry grassland alvars) are thought to be among the most species rich communities in the world in the small scale (10 to 100 cm2) and are of extraordinary

protection value (Rosén, 1995). Catling and Brownell (1995) suggested that, within each of the alvar regions around the Great Lakes, it would be necessary to protect two or three sites within each in order to achieve adequate representation of the association types. Alvars are constantly exposed to harsh climatic conditions such as periodic droughts (Stephenson and Herendeen, 1986; Rosén, 1995), flooding and scraping of flora by ice slabs in the winter (especially on lake shores, see Morton and Venn (1984)) which makes them very dynamic communities that change over time.

Being distributed in isolated patches, all the alvar sites within a region should be viewed as sets of spatially separated subpopulations that may be connected by immigration and emigration of insect specimens (Wiens, 1997). As consequences of natural stresses, local subpopulations may suffer local extinction, but under proper management practices, colonization from other subpopulations will reestablish populations in those patches.

According to metapopulation modeling, no local population is so large that its expected lifetime is longer in relation to that of a metapopulation as a whole (Wiens, 1997). What this means is that conservation decisions should include questions which will help understand the population dynamics of the significant taxa. How much exchange between patches is there at the regional level? How much exchange is there between the different alvar regions? What are the dispersal potentials of the various significant species that we are trying to protect? How many sites of a certain alvar type are necessary to protect in order to preserve sustainable populations of target species? How many community types are necessary to protect within a region in order to preserve the highest genetic diversity of the species? The time and human resources needed to assess all of the variables listed above before taking conservation decisions might be too great when considering the potential threats that some of the sites are under (for details see Belcher and Keddy, 1992; Catling and Brownell, 1995; Reid, 1996). Therefore, the balance between ideal management considerations (i.e. protect representative examples of all native ecosystems across their natural range of variation (Finnamore, 1996)) and the time left before certain high quality sites are destroyed or degraded further should be carefully evaluated at a regional basis.

Future work and recommendations

One of the most stimulating aspect of this project is that it showed the great potential for future work. Inventory and monitoring are two essential activities necessary for sound conservation planning (Kremen et al., 1993). Inventory programs help in documenting the distribution of biologically significant species which, in turn, help in the selection and design of

reserves. Such programs should therefore be emphasized in the next few years in all of the different alvar regions. On the other hand, monitoring programs are useful to assess the changes in ecosystem structure, composition and function in response to natural factors, human disturbances or management activities over time (Kremen et al., 1993). There exist a small number of protected alvar sites in the province of Ontario (Belcher and Keddy, 1992) which offer great potential for the long-term monitoring of natural fluctuations of the habitat in response to natural stresses. The ecological requirements of a number of rare insect species found in alvars are completely unknown; therefore, by putting more effort into leaning about the needs of these species (probably easier with species with high densities), it will be easier to make informed and relevant conservation decisions. An example of future investigation of habitat requirements using ground beetles could be done by performing mark - recapture experiments. The dispersal potentials of significant insect species could be investigated using suction or rotary traps (Marshall et al., 1994) (for an example using Auchenorrhynca, see Waloff, 1973). Measurements of gene flow or connectivity between patches (or subpopulations) could be assessed using mitochondrial genetic variations (Roderick, 1996). Knowing that important changes in the insect fauna of moderately to heavily grazed alvars in Sweden have been observed (Coulianos, 1983; Bornfeldt, 1995), it would be interesting to find out if these effects are present in North American alvars as well and to what extent. The presence of rare and significant species of insects presented in this study should be seen as tools to understand the origin and present "health" or quality of the Great Lakes alvars. Even more crucial would be to combine these data with observations on other groups such as vascular plants, birds and other invertebrates as well as including knowledge about the topography, geology, hydrology, soil characteristics, geochemistry of the various sites in order to make the best possible management decisions (Scott et al., 1987; Roberts, 1988; Meyer, 1997).

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LIST OF ABBREVIATIONS USED IN THE TABLES AND FIGURES

1) Sites:

CEG: Camden East - grassland alvar
BPP: Bruce Peninsula - pavement alvar
BPG: Bruce Peninsula - grassland alvar
CRG: Carden township - grassland alvar
CRS: Carden township - shrubland alvar
RAG: Ramsay township - grassland alvar
MIP: Manitoulin Island - pavement alvar
MIS: Manitoulin Island - shrubland alvar
MIGS: Manitoulin Island - grassland savanna alvar
MIG: Manitoulin Island - pavement alvar
BBP: Belanger Bay - pavement alvar (Manitoulin Island)
BBG: Belanger Bay - grassland alvar (Manitoulin Island)
QBG: Quarry Bay - grassland alvar (Manitoulin Island)
GLCI: Great LaCloche Island - grassland alvar
CRPD: Carden township - Prarie dropseed (*Sporobolus heterolepis*) patch
DNDG: Department of National Defense property - grassland (Ramsay township)
MNC: Michigan - Chippewa County
MND: Michigan - Delta County
MNK: Michigan - Keweenaw County
MNM: Michigan - Marquette County
MIMC: Michigan - Mackinac county
MXPL: Michigan - Maxton Plains
CRALL: Carden township - all alvar sites combined
BLALL: Burnt Lands - all alvar sites combined
NYALL: New York State - all alvar sites combined

2) Global distribution of species (DIST):

N: northern, W: western, E: eastern, S: southern, Ws: widespread, INC: incompletely known, G-Lakes: around the Great Lakes only.

3) DATE/...: collecting dates between which the species were recorded

4) Others:
X: species present on the site
D: species present in dominant numbers on the site

Table 1- Alvar community types in the Great Lakes region. Numbers refer to the percentage of ground cover.

	open : <10% trees	savanna : 10-50% trees
>50% exposed bedrock <50% herbs <50% shrubs	pavement alvar	pavement savanna alvar
<50% exposed bedrock >50% herbs usually <25% shrubs	grassland alvar	grassland savanna alvar
<50% exposed bedrock <50% herbs >25% shrubs	shrubland alvar	shrubland savanna alvar

Table 2 - Location of sample sites and alvar types in 1996-1997.

Site	Location (Lat.; Long.)	Alvar type	Year sampled
MIP	Misery Bay Prov. Nat. Res., Manitoulin Is. (45°47'26"N; 82°45'00"W)	pavement	1996
MIS	10 km W Evansville, Manitoulin Is. (45°49'18"N; 82°41'04"W)	shrubland	1996
MIGS	10 km SW Gore Bay, Manitoulin Is. (45°52'12"N; 82°31'48"W)	grassland savanna	1996
MIG	10 km W Gore Bay, Manitoulin Is. (45°53'45"N; 82°34'41"W)	grassland	1996
CEG	5 km E Camden East (44°20'19"N; 76°47'49"W)	grassland	1997
BPP	3 km N Miller Lake, Bruce Peninsula (45°07'46"N; 81°26'44"W)	pavement	1997
BPG	Cabot Head, Bruce Peninsula (45°14'44"N; 81°18'28"W)	grassland	1997
CRG	1.5 km NE Dalrymple (44°41'02"N; 79°05'31"W)	grassland	1997
CRS	7.5 km E Seabright (44°38'27"N; 79°03'59"W)	shrubland	1997
RAG	Ramsay Township, 5 km N Almonte (45°16'14"N; 76°10'58"W)	grassland	1997

Table 3 - GROUND BEETLES (COLEOPTERA: CARABIDAE) COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

	GENUS	SPECIES	CEG	DATE/CEG	BPP	DATE/BPP	BPG	DATE/BPG	GRG	DATE/GRG	CRS	DATE/CRS	RAG	DATE/RAG	TOT
1	Acupalpus	canadensis	0		0		0		1	18-VI	0		0		1
2	Acupalpus	nanellus	2	01-VI:30-VI	0		0		0		0		0		2
3	Acupalpus	partiarius	0		0		0		1	18-VI	2	03-VI	0		3
4	Agonum	crenistriatum	13	01-VI:09-IX	0		15	02-VI:10-IX	0		0		85	17-VII:12-IX	113
5	Agonum	cupripenne	202	18-V:09-IX	8	19-V:28-VII	92	02-VI:15-VII	32	22-V:16-VII	0		74	23-V:12-IX	408
6	Agonum	gratiosum	0		0		1	17-VI	1	04-VI	0		0		2
7	Agonum	harisii	1	01-VI	0		0		1	04-VI	0		0		2
8	Agonum	lutulentum	1	01-VI	0		1	17-VI	0		0		0		2
9	Agonum	nutans	45	01-VI:28-VIII	0		2	02-VI:17-VI	2	04-VI	0		26	23-V:12-IX	75
10	Agonum	placidum	1	01-VI	1	01-VII	1	28-VII	1	02-VII	0		1	17-VII	5
11	Agonum	rufipes	39	01-VI:16-VI	0		22	02-VI:17-VI	0		0		1	19-VI	62
12	Agonum	trigeminum	19	01-VI:25-VIII	1	02-VI	0		12	18-VI:27-VIII	0		3	23-V:03-VII	35
13	Amara	angustata	0		0		0		1	29-VII	0		0		1
14	Amara	cupreolata	8	01-VI	2	02-VI	4	02-VI:17-VI	1	04-VI	2	18-VI	10	05-VI:03-VII	27
15	Amara	familiaris	2	01-VI	0		0		0		0		1	05-VI	3
16	Amara	impuncticollis	8	01-VI:14-VII	10	02-VI:26-VIII	11	02-VI:26-VIII	1	04-VI	0		5	05-VI:30-VII	35
17	Amara	laevipennis	2	16-VI:30-VI	0		0		2	02-VII:16-VII	0		0		4
18	Amara	lunicollis	0		0		0		5	29-VII:13-VIII	0		0		5
19	Amara	obesa	0		0		0		0		0		11	28-VIII:12-IX	11
20	Amara	pallipes	2	16-VI:27-VII	0		0		23	04-VI:11-IX	0		0		25
21	Amara	pensylvanica	57	16-VI:09-IX	0		0		0		0		367	05-VI:12-IX	424
22	Anisodactylus	carbonarius	41	18-V:25-VIII	0		0		0		0		13	23-V:12-IX	54
23	Anisodactylus	harrisi	0		28	20-V:15-VII	8	17-VI:15-VII	14	04-VI:29-VII	0		36	05-VI:12-IX	86
24	Anisodactylus	nigerrimus	49	01-VI:25-VIII	2	28-VII	13	02-VI:12-VIII	9	04-VI:13-VIII	0		152	05-VI:17-VII	225
25	Anisodactylus	rusticus	19	01-VI:09-IX	0		0		2	04-VI:02-VII	0		9	05-VI:17-VII	30
26	Anisodactylus	sanctaecrucis	1	16-VI	0		0		0		0		1	03-VII	2
27	Badister	neopulchellus	0		0		0		0		1	02-VII	0		1
28	Badister	notatus	1	27-VII	3	17-VI:01-VII	7	17-VI:28-VII	5	02-VII:13-VIII	0		29	05-VI:28-VIII	45
29	Bembidion	castor	0		1	28-VII	0		0		0		0		1
30	Bembidion	concretum	1	01-VI	0		0		0		0		0		1
31	Bembidion	mimus	3	01-VI:16-VI	39	20-V:10-IX	1	01-VII	3	18-VI:29-VII	1	11-IX	10	05-VI:12-IX	57
32	Bembidion	mutatum	0		0		0		1	16-VII	0		0		1
33	Bembidion	patruele	0		3	02-VI:15-VII	1	28-VII	0		0		3	05-VI:03-VII	7
34	Bembidion	praticola	0		0		0		1	04-VI	0		0		1
35	Bembidion	rapidum	1	14-VII	12	15-VII:26-VIII	0		0		0		0		13
36	Brachinus	cyanochroaticus	0		0		1	01-VII	0		0		1	19-VI	2
37	Brachinus	tenuicollis	2	01-VI:16-VI	0		0		0		0		0		2
38	Bradycellus	neglectus	0		0		0		2	18-VI	0		1	05-VI	3
39	Bradycellus	nigriceps	3	01-VI	2	02-VI	0		1	04-VI	0		3	05-VI	9
40	Bradycellus	nigrinus	0		0		0		1	04-VI	0		0		1
41	Calathus	gregarius	1	08-VIII	0		19	02-VI:10-IX	4	29-VII:27-VIII	0		6	03-VII12-IX	30

Table 3 - GROUND BEETLES (COLEOPTERA: CARABIDAE) COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

	GENUS	SPECIES	CEG	DATE/CEG	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	TOT
42	Calathus	opaculus	1	09-IX	0		0		0		0		4	12-IX	5
43	Calosoma	calidum	6	01-VI:16-VI	0		1	01-VII	2	02-VII	0		36	05-VI:12-IX	45
44	Carabus	meander	58	01-VI:25-VIII	0		17	02-VI:01-VII	39	04-VI:11-IX	0		2	05-VI:17-VII	116
45	Carabus	nemoralis	127	01-VI:09-IX	0		0		0		0		2	19-VI	129
46	Carabus	serratus	0		24	02-VI:12-VIII	8	02-VI:17-VI	0		0		5	19-VI:28-VIII	37
47	Carabus	sylvosus	0		0		0		3	29-VII:13-VIII	0		0		3
48	Chlaenius	emarginatus	0		0		0		1	16-VII	5	02-VII:16-VII	1	14-VIII	7
49	Chlaenius	p. pensylvanicus	1	09-IX	0		1	01-VII	1	18-VI	0		0		3
50	Chlaenius	p. purpuricollis	8	01-VI:08-VIII	0		0		7	04-VI:27-VIII	0		125	23-V:12-IX	140
51	Chlaenius	s. sericeus	2	16-VI:27-VII	1	02-VI	0		0		0		0		3
52	Chlaenius	t. tomentosus	0		0		0		0		0		7	19-VI:28-VIII	7
53	Chlaenius	t. tricolor	1	16-VI	0		0		0		0		0		1
54	Cicindela	limbalis	0		0		0		0		1	02-VII	69	05-VI:12-IX	70
55	Cicindela	p. purpurea	0		0		0		2	22-V	7	18-VI:11-IX	3	05-VI:17-VII	12
56	Cicindela	punctulata	0		0		0		0		4	29-VII:27-VIII	2	28-VIII	6
57	Cicindela	sexguttata	1	16-VI	0		0		1	21-V	2	03-VI:18-VI	0		4
58	Clivina	fossor	5	01-VI:16-VI	15	02-VI:28-VII	3	02-17-VI	2	18-VI	1	18-VI	32	05-VI:14-VIII	58
59	Cyclotrachelus	s. soladis	0		0		0		12	18-VI:27-VIII	0		0		12
60	Cymindis	cribricollis	0		1	28-VII	0		0		0		0		1
61	Cymindis	neglectus	4	01-VI:25-VIII	0		1	28-VII	0		1	29-VII	0		6
62	Cymindis	pilosa	2	25-VIII:09-IX	0		0		0		0		0		2
63	Dicaelus	teter	0		0		0		0		1	18-VI	0		1
64	Diplocheila	obtusa	13	16-VI:09-IX	6	01-VII:15-VII	0		3	18-VI:16-VII	0		28	05-VI:30-VII	50
65	Dromius	piceus	1	01-VI	1	17-VI	0		0		1	03-VI	0		3
66	Dyschirius	globulosus	4	01-VI:27-VII	22	02-VI:12-VII	6	02-VI:17-VI	3	04-VI:02-VII	1	21-V	15	05-VI:28-VIII	51
67	Elaphropus	anceps	1	01-VI	2	17-VI	1	02-VI	3	18-VI	0		11	05-VI:03-VII	18
68	Elaphropus	granarius	8	01-VI:27-VII	0		0		2	04-VI:02-VII	0		7	05-VI:03-VII	17
69	Elaphropus	incurvus	0		0		1	28-VII	0		0		2	30-VII	3
70	Elaphrus	clairvillei	0		0		0		1	04-VI	0		0		1
71	Elaphrus	fuliginosus	0		0		0		1	04-VI	0		0		1
72	Galerita	janus	8	01-VI:09-IX	1	28-VII	0		0		0		0		9
73	Harpalus	affinis	3	16-VI:14-VII	1	17-VI	0		0		0		0		4
74	Harpalus	erythropus	4	25-VIII:09-IX	0		0		2	27-VIII	0		109	03-VII:12-IX	115
75	Harpalus	fallax	18	30-VI:25-VIII	3	17-VI:28-VII	20	17-VI26-VIII	11	02-VII:11-IX	1	16-VII	31	16-VI:12-IX	84
76	Harpalus	faunus	486	16-VI:09-IX	0		0		0		0		341	05-VI:12-IX	827
77	Harpalus	herbivagus	18	01-VI:09-IX	1	02-VI	0		1	04-VI	0		7	05-VI:30-VII	27
78	Harpalus	indigens	0		0		0		0		0		1	30-VII	1
79	Harpalus	opacipennis	0		1	26-VIII	0		0		0		0		1
80	Harpalus	pensylvanicus	45	27-VII:09-IX	4	28-VI:12-VIII	1	10-IX	5	13-VIII:11-IX	0		45	17-VII:12-IX	100
81	Harpalus	plenalis	1	25-VIII	12	02-VI:26-VIII	1	28-VII	0		3	03-VI	0		17
82	Harpalus	puncticeps	0		2	12-VIII:26-VII	1	10-IX	0		0		0		3

Table 3 - GROUND BEETLES (COLEOPTERA: CARABIDAE) COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

	GENUS	SPECIES	CEG	DATE/CEG	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	TOT
83	Harpalus	viduus	2	30-VI:14-VII	0		0		0		0		0		2
84	Lebia	atriventris	0		0		0		1	02-VII	0		0		1
85	Lebia	fuscata	1	01-VI	0		0		0		0		0		1
86	Lebia	moesta	1	16-VI	0		0		0		0		0		1
87	Lebia	pumila	0		11	02-VI:26-VIII	0		0		2	03-VI	0		13
88	Lebia	viridis	0		0		0		1	02-VII	0		0		1
89	Microlestes	linearis	1	01-VI	0		0		0		0		0		1
90	Notiophilus	aquaticus	0		4	20-V:17-VI	0		0		0		0		4
91	Oodes	fluvialis	0		0		1	17-VI	0		0		0		1
92	Patrobus	longicornis	1	27-VII	0		0		0		0		0		1
93	Platynus	decentis	0		1	02-VI	0		0		0		0		1
94	Poecilus	chalcites	1	30-VI	1	28-VII	0		0		0		1	28-VIII	3
95	Poecilus	l. lucublandus	416	18-V:09-IX	1	17-VI	31	02-VI:12-VIII	25	22-V:27-VIII	1	03-VI	235	23-V:12-IX	709
96	Pterostichus	commutabilis	22	18-V:09-IX	2	01-VII	17	02-VI:10-IX	21	04-VI:11-IX	0		74	23-V:12-IX	136
97	Pterostichus	coracinus	0		5	02-VI10-IX	11	01-VII:12-VIII	0		1	21-V	0		17
98	Pterostichus	corvinus	2	16-VI:30-VI	0		0		0		0		0		2
99	Pterostichus	femoralis	0		0		0		22	04-VI:13-VIII	0		0		22
100	Pterostichus	lachrymosus	0		2	01-VII	0		0		0		0		2
101	Pterostichus	luctuosus	4	01-VI:25-VIII	0		2	02-VI	1	04-VI	0		3	05-VI:03-VII	10
102	Pterostichus	melanarius	1	14-VII	3	17-VI:26-VIII	0		0		0		2	28-VIII:12-IX	6
103	Pterostichus	novus	22	30-VI:09-IX	86	17-VI:10-IX	35	17-VI:10-IX	16	22-V:27-VIII	2	02-VII	107	03-VII:12-IX	268
104	Pterostichus	patruelis	0		0		0		3	04-VI:13-VIII	0		0		3
105	Pterostichus	pensylvanicus	2	16-VI	0		1	02-VI	0		0		0		3
106	Pterostichus	tenuis	1	16-VI	0		7	02-VI:01-VII	0		0		1	05-VI	9
107	Pterostichus	tristis	0		1	15-VII	0		0		0		0		1
108	Selenophorus	gagatinus	2	14-VII:27-VII	0		0		2	16-VII	0		24	05-VI:30-VII	28
109	Selenophorus	opalinus	0		1	01-VII	0		0		0		0		1
110	Sphaeroderus	canadensis	0		0		0		0		3	21-V:18-VI	0		3
111	Sphaeroderus	stenostomus lecontei	0		3	02-VI:17-VI	3	02-VI	0		0		1	05-VI	7
112	Stenolophus	conjunctus	10	01-VI:14-VII	0		0		2	04-VI:18-VI	2	03-VI	6	05-VI:19-VI	20
113	Stenolophus	fuliginosus	2	06-VI:30-VI	1	17-VI	0		0		0		1	05-VI	4
114	Stenolophus	ochropezus	0		1	15-VII	0		0		0		0		1
115	Syntomus	americanus	0		2	01-VII	0		0		1	02-VII	0		3
116	Synuchus	impunctatus	0		0		0		1	11-IX	0		0		1
117	Trechus	apicalis	0		3	02-VI:17-VI	0		0		0		0		3
118	Trechus	quadristriatus	0		1	26-VIII	3	17-VI:10-IX	0		0		0		4
	# SPECIMENS / SITE		1841		338		372		324		46		2188		5109
	# SPECIES / SITE		68		47		39		56		23		57		

Table 4 - GROUND BEETLES (COLEOPTERA: CARABIDAE) COLLECTED IN ONTARIO ALVARS IN 1996 AND 1997

	GENUS	SPECIES	AUTHOR	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	DIST
1	Acupalpus	canadensis	Casey				X							NE
2	Acupalpus	nanellus	Casey	X										NE
3	Acupalpus	partiarius	(Say)				X	X					X	E
4	Agonum	crenistriatum	(LeConte)	X		X			X					E
5	Agonum	cupreum	Dejean									X	X	N
6	Agonum	cupripenne	(Say)	D	X	D	D		X	X		D	D	W
7	Agonum	gratiosum	(Mannerheim)			X	X							W
8	Agonum	harisii	LeConte	X			X						X	W
9	Agonum	lutulentum	(LeConte)	X		X								N
10	Agonum	melanarium	Dejean									X	X	W
11	Agonum	metallescens	(LeConte)									X		W
12	Agonum	muelleri	Herbst									X		W
13	Agonum	nutans	(Say)	X		X	X		X				D	E
14	Agonum	placidum	(Say)	X	X	X	X		X	X			X	W
15	Agonum	rufipes	Dejean	X		D			X					E
16	Agonum	trigeminum	Lindroth	X	X		X		X				X	E
17	Amara	aeneopolita	Casey							X				N
18	Amara	angustata	Say				X							E
19	Amara	cupreolata	Putzeys	X	X	X	X	X	X	X		X	X	W
20	Amara	familiaris	Dultschmid	X					X					E & O
21	Amara	impuncticollis	(Say)	X	X	X	X		X			X	X	E
22	Amara	laevipennis	Kirby	X			X							N
23	Amara	latior	Kirby							X				W
24	Amara	lunicollis	Schiodte				X							N
25	Amara	obesa	Say						X	X				W
26	Amara	pallipes	Kirby	X			D						X	W
27	Amara	pensylvanica	Hayward	X					D					W
28	Anisodactylus	carbonarius	(Say)	X					X					E
29	Anisodactylus	harrisi	LeConte		D	X	X		X			X		W
30	Anisodactylus	nigerrimus	(Dejean)	X	X	X	X		D					E
31	Anisodactylus	rusticus	(Say)	X			X		X					E
32	Anisodactylus	sanctaecrucis	(Fabricius)	X					X					W
33	Badister	neopulchellus	Lindroth					X				X	X	W
34	Badister	notatus	Haldeman	X	X	X	X		X	X			X	E
35	Bembidion	castor	Lindroth		X									W
36	Bembidion	concretum	Casey	X										N
37	Bembidion	mimus	Hayward	X	X	X	X	X	X				X	E
38	Bembidion	mutatum	Gem. & Harold				X					X		N

Table 4 - GROUND BEETLES (COLEOPTERA: CARABIDAE) COLLECTED IN ONTARIO ALVARS IN 1996 AND 1997

	GENUS	SPECIES	AUTHOR	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	DIST
39	Bembidion	nitidum	(Kirby)									X		N
40	Bembidion	patruele	Dejean		X	X			X					W
41	Bembidion	praticola	Lindroth				X							E & O
42	Bembidion	rapidum	LeConte	X	X					X				S
43	Bembidion	versicolor	(LeConte)									X	X	N
44	Brachinus	cyanochroaticus	Erwin			X			X				X	W
45	Brachinus	tenuicollis	LeConte	X										W
46	Bradycellus	lecontei	Csiki										X	N
47	Bradycellus	neglectus	(LeConte)				X		X					W
48	Bradycellus	nigriceps	LeConte	X	X		X		X					E
49	Bradycellus	nigrinus	(Dejean)				X							W
50	Calathus	gregarius	(Say)	X		D	X		X	D	D	D	X	E
51	Calathus	opaculus	LeConte	X					X					W
52	Calosoma	calidum	(Fabricius)	X		X	X		X	X		X	X	NE
53	Carabus	meander	F. von Wal.	X		X	D		X		X		X	N
54	Carabus	nemoralis	O.F. Mueller	D					X			X		O & E
55	Carabus	serratus	Say		D	X			X	D	X	X	X	W
56	Carabus	sylvosus	Say				X			X				SE
57	Chlaenius	emarginatus	Say				X	X	X					W
58	Chlaenius	impunctifrons	Say										X	E
59	Chlaenius	l. lithophilus	Say										X	W
60	Chlaenius	p. pensylvanicus	Say	X		X	X						X	W
61	Chlaenius	p. purpuricollis	Randall	X			X		D	X		D	X	?
62	Chlaenius	s. sericeus	(Forster)	X	X							X	X	W
63	Chlaenius	t. tomentosus	(Say)						X			X		W
64	Chlaenius	t. tricolor	Dejean	X						X			X	W
65	Cicindela	denikei	Fabricius								X	X		N
66	Cicindela	l. longilabris	Say								X	X		W
67	Cicindela	limbalis	Klug					X	X		X			E
68	Cicindela	p. purpurea	Olivier				X	X	X	X		X		E
69	Cicindela	punctulata	Olivier					X	X					W
70	Cicindela	sexguttata	Fabricius	X			X	X						W
71	Clivina	fossor	Linne	X	X	X	X	X	X				X	W
72	Cyclotrachelus	s. sodalis	(LeConte)				X							INC
73	Cymindis	americanus	Dejean							X				E
74	Cymindis	cribricollis	Dejean		X					X				W
75	Cymindis	neglectus	Haldeman	X		X		X		X		X		E
76	Cymindis	pilosa	Say	X										E

Table 4 - GROUND BEETLES (COLEOPTERA: CARABIDAE) COLLECTED IN ONTARIO ALVARS IN 1996 AND 1997

	GENUS	SPECIES	AUTHOR	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	DIST
77	Dicaelus	teter	Bonelli					X						E
78	Diplocheila	obtusa	(LeConte)	X	X		X		X	X		X	X	W
79	Diplocheila	striatopunctata	(LeConte)								X		X	W
80	Dromius	piceus	Dejean	X	X			X		X				W
81	Dyschirius	globulosus	(Say)	X	D	X	X	X	X	X		X	X	W
82	Elaphropus	anceps	LeConte	X	X	X	X		X					W
83	Elaphropus	granarius	(Dejean)	X			X		X			X		E
84	Elaphropus	incurvus	(Say)			X			X				X	W
85	Elaphrus	clairvillei	Kirby				X							W
86	Elaphrus	fuliginosus	Say				X							W
87	Galerita	janus	Fabricius	X	X									W
88	Harpalus	affinis	(Shrank)	X	X									E &O
89	Harpalus	bicolor	Fabricius							X		X	X	E
90	Harpalus	caliginosus	Fabricius								X			S
91	Harpalus	erythropus	Dejean	X			X		X					E
92	Harpalus	fallax	Leconte	X	X	D	X	X	X	X		X	X	E
93	Harpalus	faunus	Say	D					D	X		X	X	E
94	Harpalus	herbivagus	Say	X	X		X		X	X				W
95	Harpalus	indigens	Casey						X					NE
96	Harpalus	opacipennis	(Haldeman)		X					X	X	X		W
97	Harpalus	pensylvanicus	DeGeer	X	X	X	X		X	X	X	X		W
98	Harpalus	plenalis	Casey	X	X	X		X			X			W
99	Harpalus	puncticeps	Stephens		X	X				X		X	X	E
100	Harpalus	viduus	Casey	X										E
101	Lebia	atriventris	Say				X							?
102	Lebia	fuscata	Dejean	X							X			W
103	Lebia	moesta	LeConte	X										NE
104	Lebia	pumila	Dejean		X			X			X			W
105	Lebia	viridis	Say				X							W
106	Lophoglossus	scrutator	(LeConte)										X	E
107	Microlestes	linearis	LeConte	X										W
108	Myas	cyanescens	Dejean							X				E
109	Notiophilus	aeneus	(Herbst)									X		E
110	Notiophilus	aquaticus	Linne		X									N
111	Notiophilus	semistriatus	Say							X	X			W
112	Oodes	fluvialis	LeConte			X								E
113	Patrobus	longicornis	Say	X							X			W
114	Platynus	decentis	Say		X									W

Table 4 - GROUND BEETLES (COLEOPTERA: CARABIDAE) COLLECTED IN ONTARIO ALVARS IN 1996 AND 1997

	GENUS	SPECIES	AUTHOR	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	DIST
115	Poecilus	chalcites	Say	X	X				X					E
116	Poecilus	l. lucublandus	(Say)	D	X	D	D	X	D	X	X	D	D	W
117	Pterostichus	caudicalis	(Say)										X	W
118	Pterostichus	commutabilis	(Motschulsky)	X	X	X	D		X			X	X	W
119	Pterostichus	coracinus	(Newman)		X	X		X		D	D		X	E
120	Pterostichus	corvinus	(Dejean)	X									X	W
121	Pterostichus	femoralis	(Kirby)				D					X	X	W
122	Pterostichus	lachrymosus	Newman		X									E
123	Pterostichus	luctuosus	(Dejean)	X		X	X		X				X	W
124	Pterostichus	melanarius	(Illiger)	X	X				X	X	D	X	D	W
125	Pterostichus	mutus	(Say)									X		E
126	Pterostichus	novus	Straneo	X	D	D	X	X	X	D	D	D	X	INC
127	Pterostichus	patruelis	Dejean				X							W
128	Pterostichus	pensylvanicus	LeConte	X		X							X	W
129	Pterostichus	tenuis	Casey	X		X			X					E
130	Pterostichus	tristis	(Dejean)		X						X			E
131	Selenophorus	gagatinus	Dejean	X			X		X					E
132	Selenophorus	opalinus	(LeConte)		X									E
133	Sphaeroderus	canadensis	Chaudoir					X						E
134	Sphaeroderus	nitidicollis brevoorti	Guerin-Men.							X				NE
135	Sphaeroderus	stenostomus lecontei	Dejean		X	X			X	X			X	E
136	Stenolophus	comma	(Fabricius)							X				W
137	Stenolophus	conjunctus	(Say)	X			X	X	X			X	X	W
138	Stenolophus	fuliginosus	Dejean	X	X				X			X	X	W
139	Stenolophus	ochropezus	Say		X					X				E
140	Syntomus	americanus	(Dejean)		X			X		X		X	X	W
141	Synuchus	impunctatus	(Say)				X			D	X	X		W
142	Trechus	apicalis	Motschulsky		X									W
143	Trechus	quadristriatus	Schrank		X	X				X		X	X	E
	# SPECIMENS / SITE			1841	338	372	324	46	2188	703	478	1201	1156	8647
	# SPECIES / SITE			68	47	39	56	23	57	41	21	44	52	

X = PRESENT ON THE SITE
D = DOMINANT ON THE SITE

Table 5 - AUCHENORRHYNCHA COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

No	GENUS	SPECIES	AUTHOR	CEG	DATE/CEG	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	TOT
	CICADELLIDAE															
1	Aceratagallia	humilis n.subsp.	Oman	10	14-VII:09-IX	175	20-V:10-IX	1	15-VII	11	02-VI:13-VIII	1	18-VI	5	05-VI:17-VII	203
2	Aceratagallia	sanguinolenta	(Provancher)	0		0		0		0		2	03-VI	0		2
3	Aceratagallia	sp.		8	01-VI:30-VI	0		0		6	04-VI:02-VII	1	02-VII	2	30-VII	17
4	Agallia	constricta	(VanDuzee)	0		1	17-VI	0		0		0		0		1
5	Agallia	quadripunctata	(Provancher)	2	16-VI	5	17-VI:15-VII	0		8	04-VI:18-VI	5	18-VI	0		20
6	Agallia	sp.		0		1	12-VIII	0		0		0		0		1
7	Agalliopsis	peneoculata	(Oman)	0		0		0		0		41	03-VI	0		41
8	Agalliopsis	sp.		0		0		1	28-VII	0		0		0		1
9	Amplicephalus	(Endria) inimicus	(Say)	85	30-VI:09-IX	18	01-VII:10-IX	2	28-VII:12-VIII	10	02-VII:11-IX	3	16-VII:11-IX	4	12-IX	122
10	Anoscopus	albifrons	(Linnaeus)	71	27-VII:25-VIII	0		0		0		0		0		71
11	Anoscopus	flavostriatus	(Donovan)	5	08-VIII:25-VIII	4	12-VIII:26-VIII	2	12-VIII	43	29-VII:27-VIII	1	11-IX	0		55
12	Anoscopus	serratulae	(Fabricius)	2	08-VIII	0		0		0		0		0		2
13	Anoscopus	spp.		28	30-VI:09-IX	1	01-VII	0		2	02-VII:16-VII	0		0		31
14	Aphrodes	sp.		27	30-VI:09-IX	8	01-VII:10-IX	2	10-IX	5	02-VII:11-IX	0		0		42
15	Arboridia	sp.		1	01-VI	6	02-VI:10-IX	1	26-VIII	40	04-VI:27-VIII	10	03-VI:18-VI	0		58
16	Athysanella	longicauda	Beirne	67	01-VI:25-VIII	0		1	12-VIII	0		0		66	05-VI:28-VIII	134
17	Athysanella	spp.		1	16-VI	0		0		0		0		0		1
18	Athysanus	argentarius	Metcalf	33	16-VI:25-VIII	1	12-VIII:26-VIII	3	01-VII:26-VIII	52	18-VI:11-IX	0		3	03-VII:30-VII	92
19	Auridius	sp.n.		0		0		10	01-VII:26-VIII	0		0		0		10
20	Balcanocerus	provencheri	(Van Duzee)	0		0		0		0		2	29-VII:13-VIII	0		2
21	Balclutha	impicta	(VanDuzee)	2	30-VI:14-VII	13	01-VII:15-VII	2	01-VII:15-VII	5	02-VII:16-VII	0		0		22
22	Balclutha	sp.		3	16-VI:25-VIII	28	20-V:10-IX	5	17-VI:10-IX	18	16-VII:27-VIII	1	13-VIII	0		55
23	Chlorotettix	unicolor	(Fitch)	42	30-VI:09-IX	4	12-VIII:10-IX	13	01-VII:26-VIII	51	02-VII:11-IX	0		23	03-VII:28-VIII	133
24	Cicadula	smithi	(VanDuzee)	1	14-VII	2	10-IX	2	15-VII:26-VIII	40	02-VII:11-IX	0		0		45
25	Cicadula	sp.		0		0		0		1	02-VII	0		0		1
26	Cicadula	straminea	(Sand. & DeL.)	0		1	12-VIII	0		0		0		0		1
27	Cicadula	subcupreae	(Provancher)	0		0		0		31	27-VIII:11-IX	0		0		31
28	Colladonus	clitellarius	(Say)	1	14-VII	0		0		0		1	16-VII	0		2
29	Colladonus	youngi	Nielson	0		2	02-VI:17-VI	1	17-VI	0		3	03-VI	0		6
30	Comellus	cedilla	Hamilton	3	30-VI:27-VII	0		0		0		0		0		3
31	Cosmotettix	bilineatus	(Gill. & Baker)	0		0		0		2	29-VII	0		0		2
32	Cuerna	strita	(Walker)	0		22	02-VI:01-VII	0		0		0		0		22
33	Deltocephalus	pulicaris	(Fallen)	1	14-VII	1	01-VII	0		1	16-VII	0		1	03-VII	4
34	Dikraneura	mali	(Provancher)	0		0		0		0		1	03-VI	0		1
35	Dikrella	cruentata	(Gillette)	0		0		0		0		2	03-VI	0		2
36	Diplocolenus	(D.) configuratus	(Uhler)	104	16-VI:25-VIII	0		0		11	02-VII:16-VII	4	18-VI:02-VII	0		119
37	Diplocolenus	(Verdanus) abdominalis	(Fallen)	101	16-VI:08-VIII	2	01-VII	3	01-VII:15-VII	95	18-VI:29-VII	0		5	19-VI:03-VII	206

Table 5 - AUCHENORRHYNCHA COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

No	GENUS	SPECIES	AUTHOR	CEG	DATE/CEG	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	TOT
38	Diplocolenus	(Verdanus) spp.		0		0		0		0		0		2	03-VII	2
39	Doratura	stylata	(Boheman)	42	16-VI:25-VIII	46	01-VII:10-IX	1	28-VII:12-VIII	18	16-VII:11-IX	1	02-VII	1	30-VII	109
40	Draeculacephala	antica	(Walker)	2	25-VIII	0		0		1	11-IX	0		0		3
41	Draeculacephala	noveboracensis	(Fitch)	0		2	12-VIII:26-VIII	0		4	29-VII:13-VIII	0		0		6
42	Draeculacephala	spp.		5	30-VI:14-VII	3	15-VII	0		0		1	16-VII	1	03-VII	10
43	Draeculacephala	zeae	Hamilton	0		3	28-VII:12-VIII	1	28-VII	1	29-VII	0		0		5
44	Elymana	inornata	(Van Duzee)	0		1	26-VIII	0		1	29-VII	0		0		2
45	Elymana	spp.		1	14-VII	0		2	15-VII:12-VIII	1	16-VII	0		0		4
46	Elymana	sulphurella	(Zetterstedt)	10	27-VII:25-VIII	0		0		0		0		0		10
47	Empoasca	sp.		68	16-VI:09-IX	157	17-VI:26-VIII	38	01-VII:10-IX	82	04-VI:11-IX	89	03-VI:11-IX	27	19-VI:12-IX	461
48	Erythroneura	nigra	(Gillette)	0		0		0		0		2	03-VI	0		2
49	Erythroneura	spp.		4	01-VI:27-VII	6	02-VI:17-VI	1	17-VI	23	04-VI:13-VIII	106	03-VI:18-VI	1	19-VI	141
50	Erythroneura	tricincta	Fitch	0		0		0		0		1	03-VI	0		1
51	Erythroneura	vitis	(Harris)	3	01-VI	0		0		1	04-VI	0		0		4
52	Eupteryx?	spp.		0		1	01-VII	0		0		0		0		1
53	Euscelis	spp.		1	14-VII	0		0		3	16-VII	0		0		4
54	Extrusanus	extrusus	(VanDuzee)	1	16-VI	0		0		0		9	03-VI:29-VII	1	03-VII	11
55	Flexamia	delongi	Ross & Cooley	0		1	12-VIII	35	15-VII:10-IX	0		0		0		36
56	Flexamia	inflata	(Osborn & Ball)	36	14-VII:09-IX	0		0		0		0		0		36
57	Forcipata	loca	Caldwell	31	16-VI:25-VIII	29	01-VII:10-IX	0		17	18-VI:11-IX	11	02-VII:11-IX	1	28-VIII	89
58	Forcipata	sp.		5	30-VI:14-VII	17	01-VII:15-VII	11	01-VII	44	02-VII:11-IX	1	16-VII	7	19-VI:12-IX	85
59	Forcipatra	triquetra	Caldwell	0		3	01-VII:15-VII	8	28-VII:10-IX	22	02-VII:11-IX	1	16-VII	2	12-IX	36
60	Graminella	mohri	DeLong	0		0		13	28-VII:26-VIII	0		0		0		13
61	Graminella	sp.		0		2	12-VIII	0		0		1	13-VIII	0		3
62	Graphocephala	sp.		6	27-VII:25-VIII	4	26-VIII:10-IX	0		0		14	29-VII:13-VIII	0		24
63	Gyponana	salsa	DeLong	0		0		1	10-IX	0		1	11-IX	0		2
64	Gyponana	serpenta	DeLong	0		0		0		6	13-VIII:11-IX	0		0		6
65	Gyponana	sp.		2	25-VIII	0		0		0		0		0		2
66	Hecalus	montanus	(Ball)	0		0		0		1	04-VI	0		0		1
67	Helochara	communis	Fitch	1	18-V	0		0		0		0		0		1
68	Idiocerus	formosus	Ball	1	25-VIII	0		1	12-VIII	0		0		0		2
69	Idiocerus	pallipus	Fitch	0		6	28-VII:10-IX	0		1	29-VII	0		0		7
70	Idiocerus	productus	Gill. & Baker	0		0		0		2	27-VIII:11-IX	0		0		2
71	Idiocerus	spp.		0		1	17-VI	5	02-VI	2	04-VI	0		0		8
72	Idiodonus	aurantiacus	(Provancher)	0		1	26-VIII	0		0		0		0		1
73	Idiodonus	kennecottii	(Uhler)	5	27-VII:25-VIII	2	28-VII:12-VIII	0		0		0		0		7
74	Idiodonus	morsei	(Osborn)	4	30-VI:27-VII	11	01-VII:28-VII	0		1	13-VIII	0		0		16
75	Jikradia	olitoria	(Say)	0		0		0		0		0		1	12-IX	1

Table 5 - AUCHENORRHYNCHA COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

No	GENUS	SPECIES	AUTHOR	CEG	DATE/CEG	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	TOT
76	Laevicephalus	acus	Delong)	8	30-VI:25-VIII	212	15-VII:10-IX	32	01-VII:26-VIII	423	02-VII:11-IX	0		12	03-VII:28-VIII	687
77	Laevicephalus	melsheimerii	(Fitch)	2	08-VIII	1	28-VIII	0		0		0		0		3
78	Laevicephalus	sp.		1	08-VIII	0		0		0		1	27-VIII	0		2
79	Latalus	ocellaris	(Fallen)	2	30-VI	1	15-VII	1	01-VII	2	16-VII	0		1	17-VII	7
80	Latalus	personatus	Beirne	326	30-VI:09-IX	281	15-VII:10-IX	13	28-VII:10-IX	17	02-VII:11-IX	3	13-VIII:11-IX	3	17-VII:12-IX	643
81	Latalus	sp.		0		1	28-VII	0		0		0		0		1
82	Limotettix	(Neodrylix) parallelus	(Van Duzee)	0		0		0		4	16-VII	0		0		4
83	Limotettix	(Neodrylix) urnura	Hamilton	0		0		25	15-VII:26-VIII	0		0		0		25
84	Limotettix	sp.		0		0		13	01-VII:15-VII	1	16-VII	1	11-IX	1	28-VIII	16
85	Limotettix	ferganensis	Dubovsky	0		4	01-VII:15-VII	0		3	02-VII:29-VII	2	02-VII:16-VII	0		9
86	Limotettix	instabilis	(Ball)	0		1	12-VIII	0		0		0				1
87	Limotettix	osborni	(Ball)	0		12	01-VII:10-IX	0		1	29-VII	0		9	03-VII:12-IX	22
88	Limotettix	vaccinii	(VanDuzee)	0		0		1	26-VIII	0		0		0		1
89	Macropsis	sordida	(Van Duzee)	0		0		0		1	29-VII	0		0		1
90	Macropsis	spp.		1	14-VII	0		0		6	02-VII:16-VII	0		0		7
91	Macropsis	tunicata	Hamilton	0		0		0		1	29-VII	0		0		1
92	Macropsis	viridis	(Fitch)	0		0		0		2	29-VII	0		0		2
93	Macrosteles	quadrilineatus	(Forbes)	31	16-VI:09-IX	219	17-VI:10-IX	26	17-VI:10-IX	114	02-VII:27-VIII	14	02-VII:11-IX	12	14-VIII:12-IX	416
94	Macrosteles	spp.		1	25-VIII	2	28-VII	0		1	02-VII	1	02-VII	0		5
95	Memnonia	sp.n.		0		0		0		0		2	27-VIII	409	05-VI:28-VIII	411
96	Menosoma	cincta	(Osborn & Ball)	0		6	10-IX	0		1	27-VIII	0		0		7
97	Neocoelidia	tumidifrons	Gillette & Baker	0		0		0		0		5	18-VI:16-VII	6	19-VI:17-VII	11
98	Neokolla	hieroglyphica	(Say)	0		1	17-VI	0		2	04-VI	25	03-VI:02-VII	0		28
99	Norvellina	seminuda	(Say)	0		0		0		1	16-VII	0		0		1
100	Oncopsis	cinctifrons	(Provancher)	0		1	28-VII	0		0		0		0		1
101	Oncopsis	sobria	(Walker)	0		1	12-VIII	0		0		0		0		1
102	Oncopsis	sp.		0		5	01-VII:15-VII	0		0		0		0		5
103	Osbornellus	consors	(Uhler)	5	25-VIII:09-IX	1	10-IX	0		6	13-VIII:27-VIII	21	13-VIII:11-IX	6	28-VIII:12-IX	39
104	Osbornellus	sp.		0		0		0		0		4	13-VIII:11-IX	0		4
105	Ossiannilssonola	volans	(McAtee)	0		0		0		0		1	16-VII	0		1
106	Paraphlepsius	fulvidorsum	(Fitch)	3	14-VII:09-IX	4	12-VIII:10-IX	0		0		0		0		7
107	Paraphlepsius	irroratus	(Say)	5	30-VI:25-VIII	3	15-VII	0		0		0		0		8
108	Paraphlepsius	lobatus	(Osborn)	0		0		9	26-VIII:10-IX	0		0		0		9
109	Paraphlepsius	luxuria	Hamilton	0		0		0		0		1	11-IX	0		1
110	Paraphlepsius	spp.		3	30-VI:14-VII	0		0		0		0		2	03-VII	5
111	Paraphlepsius	truncatus	(Van Duzee)	61	30-VI:09-IX	1	28-VII	0		0		1	29-VII	170	30-VII:12-IX	233
112	Pendarus	punctiscriptus	(VanDuzee)	0		0		8	12-VIII:10-IX	0		0		0		8
113	Platymetopius	spp.		0		0		0		1	16-VII	0		0		1

Table 5 - AUCHENORRHYNCHA COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

No	GENUS	SPECIES	AUTHOR	CEG	DATE/CEG	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	TOT
114	Platymetopius	vitellinus	(Fitch)	0		0		0		2	29-VII	1	11-IX	1	30-VII	4
115	Polyamia	apicata	(Osborn)	3	14-VII:08-VIII	3	12-VIII	1	26-VIII	18	29-VII:27-VIII	0		3	30-VII:12-IX	28
116	Polyamia	compacta	(Osborn & Ball)	0		4	12-VIII:10-IX	0		0		0		0		4
117	Ponana	pectoralis	(Spangberg)	0		0		0		3	02-VII	16	18-VI:16-VII	0		19
118	Ponana	rubida	DeLong	2	30-VI:14-VII	0		0		3	02-VII:29-VII	9	02-VII:29-VII	0		14
119	Prescottia	lobata	(Van Duzee)	0		0		0		0		1	11-IX	0		1
120	Psammotettix	lividellus	(Zetterstedt)	4	16-VI:30-VI	110	01-VII:10-IX	1	01-VII	1	18-VI	0		0		116
121	Psammotettix	sp.		0		0		0		1	27-VIII	0		0		1
122	Ribautiana	spp.		0		0		0		0		2	16-VII:11-IX	0		2
123	Scaphoideus	sp.		3	25-VIII	4	12-VIII:10-IX	0		8	29-VII:11-IX	1	29-VII	0		16
124	Scaphytopius	acutus	(Say)	19	30-VI:14-VII	2	01-VII	0		10	02-VII:16-VII	0		3	03-VII	34
125	Scaphytopius	sp.		69	27-VII:09-IX	26	28-VII:10-IX	8	12-VIII:26-VIII	12	29-VII:11-IX	15	18-VI:11-IX	6	30-VII:12-IX	136
126	Sorhoanus	(Arthaldeus) pascuellus	(Fallen)	1	30-VI	0		0		2	02-VII	0		0		3
127	Sorhoanus	(Lebradea) flavovirens	(Gilette & Baker)	0		0		0		1	16-VII	0		0		1
128	Sorhoanus	(Lemellus) bimaculatus	(Gilette & Baker)	0		0		0		3	02-VII:29-VII	0		0		3
129	Stroggylocephalus	mixtus	(Say)	0		0		0		10	04-VI:16-VII	0		0		10
130	Stroggylocephalus	placidus	(Provancher)	0		0		0		1	16-VII	0		0		1
131	Texananus	arctostaphylae	(Ball)	0		0		0		0		1	13-VIII	0		1
132	Texananus	marmor	(Sand. & DeLong)	0		10	12-VIII:10-IX	0		0		0		0		10
133	Tylozygus	bifidus	(Say)	0		0		0		0		2	13-VIII:27-VIII	0		2
134	Typhlocyba	albicans	(Walsh)	0		0		0		0		1	29-VII	0		1
135	Typhlocyba	scripta	McAtee	1	14-VII	0		0		0		0		0		1
136	Typhlocyba	sp.		2	30-VI:14-VII	6	01-VII:26-VIII	6	28-VII:12-VIII	2	16-VII	2	16-VII:11-IX	0		18
137	Typhlocyba	venusta	McAtee	0		12	28-VII:26-VIII	7	28-VII:10-IX	1	29-VII	8	29-VII:11-IX	0		28
138	Xerophloea	major	Baker	3	01-VI:30-VI	0		0		0		0		0		3
139	Xestocephalus	fulvidorsum	Van Duzee	0		0		0		11	13-VIII:11-IX	0		0		11
140	Xestocephalus	superbus	(Provancher)	12	09-IX	91	12-VIII:10-IX	11	26-VIII:10-IX	3	27-VIII:11-IX	6	13-VIII:11-IX	46	28-VIII:12-IX	169
	CALISCELIDAE															
141	Bruchomorpha	oculata	Newman	15	27-VII:09-IX	26	12-VIII:10-IX	0		6	13-VIII:11-IX	0		1	28-VIII	48
142	Cedusa	spp.		2	14-VII:08-VIII	5	26-VIII:10-IX	0		9	16-VII:11-IX	2	29-VII	1	14-VIII	19
143	Peltonellus	spp.		0		0		1	01-VII	1	02-VII	0		0		2
144	Peltonotellus	histrionicus	Stal	0		0		2	28-VII:12-VIII	17	29-VII:11-IX	0		0		19
	CERCOPIDAE															
145	Aphrophora	alni	(Fallen)	0		12	28-VII:26-VIII	0		0		0		0		12
146	Aphrophora	cribrata	(Walker)	4	08-VIII:25-VIII	1	12-VIII:10-IX	7	28-VII:10-IX	0		3	29-VII:13-VIII	0		15
147	Aphrophora	saratogensis	(Fitch)	0		0		0		0		1	29-VII	0		1
148	Clastoptera	arborina	Ball	3	08-VIII:09-IX	0		0		0		0		0		3
149	Clastoptera	proteus	Fitch	0		20	28-VII:10-IX	0		11	16-VII:13-VIII	1	29-VII	0		32
150	Lepyronia	quadrangularis	(Say)	3	16-VI:25-VIII	0		0		0		1	13-VIII	0		4

Table 5 - AUCHENORRHYNCHA COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

No	GENUS	SPECIES	AUTHOR	CEG	DATE/CEG	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	TOT
151	Neophilaenus	lineatus	(Linnaeus)	0		105	15-VII:26-VIII	14	28-VII:26-VIII	16	16-VII:27-VIII	0		0		135
152	Philaenarcys	bilineata	(Say)	0		0		0		1	16-VII	0		0		1
153	Philaenus	spumarius	(Linnaeus)	84	30-VI:09-IX	67	01-VII:10-IX	159	01-VII:10-IX	127	02-VII:11-IX	5	16-VII:13-VIII	3	14-VIII:28-VIII	445
	CICADIDAE															
154	Okanagana	canadensis		0		0		0		0		0		1	17-VII	1
	CIXIIDAE															
155	Cixius	basalis	Van Duzee	0		4	28-VII	1	28-VII	0		0		0		5
156	Cixius	missellus	Van Duzee	0		0		0		0		2	13-VIII:11-IX	0		2
157	Oliarus	quinquemaculatus	(Say)	0		0		0		0		2	29-VII	0		2
	ACHILIDAE															
158	Epiptera	variegata	(Van Duzee)	0		0		0		0		0		2	30-VII:28-VIII	2
	FLATIDAE															
159	Metcalfa	pruinosa	(Say)	36	08-VIII:09-IX	0		0		0		0		0		36
	DELPHACIDAE															
160	Delphacodes	nigriscutellata	(Beamer)	0		1	10-IX	11	01-VII:10-IX	0		0		5	03-VII:12-IX	17
161	Delphacodes	parvula	Ball	0		0		17	17-VI:01-VII	0		0		0		17
162	Kelisia	axialis	VanDuzee	1	01-VI	0		0		0		0		0		1
163	Liburnia	campestris	VanDuzee	195	18-V:09-IX	276	20-V:10-IX	10	15-VII	145	04-VI:11-IX	0		0		626
164	Liburnia	lutulenta	VanDuzee	121	18-V:25-VIII	3	01-VII:12-VIII	3	15-VII:12-VIII	4	16-VII:29-VII	0		0		131
165	Liburnia	parvula	(Ball)	0		0		16	28-VII:10-IX	0		0		0		16
166	Liburnia	sp.		0		0		1	01-VII	2	18-VI	1	18-VI	1	19-VI	5
167	Liburniella	ornata	(Stal)	1	08-VIII	18	15-VII:26-VIII	16	12-VIII:10-IX	0		0		1	12-IX	36
168	Megamelus	sp.		0		1	12-VIII	0		1	13-VIII	0		0		2
169	Pissonotus	flabellatus	(Ball)	1	08-VIII	0		0		0		0		0		1
170	Pissonotus	marginatus	Van Duzee	1	14-VII	4	12-VIII:26-VIII	0		0		0		0		5
171	Pissonotus	sp.		0		0		0		1	16-VII	0		0		1
172	Stenocranus	spp.		2	18-V	3	01-VII:10-IX	0		4	13-VIII:11-IX	0		0		9
	DERBIDAE															
173	Cedusa	sp.		2	14-VII:08-VIII	5	26-VIII:10-IX	0		9	16-VII:11-IX	2	29-VII	1	14-VIII	19
	DICTYOPHARIDAE															
174	Scolops	sulcipes	(Say)	1	27-VII	0		0		1	27-VIII	1	29-VII	2	30-VII:28-VIII	5
	MEMBRACIDAE															
175	Campylenchia	latipes	(Say)	1	27-VII	1	26-VIII	3	26-VIII	22	29-VII:27-VIII	0		5	30-VII:28-VIII	32
176	Ceresa	basalis	(Walsker)	1	25-VIII	3	26-VIII	0		2	27-VIII	0		0		6
177	Ceresa	diceros	(Say)	0		0		1	12-VIII:10-IX	0		0		0		1
178	Ceresa	lutea	(Walker)	27	01-VI:08-VIII	0		0		7	18-VI:27-VIII	1	18-VI	0		35
	TOTAL NUMBER OF SPECIMENS			1895		2171		590		1728		485		866		7735
	TOTAL NUMBER OF SPECIES			84		85		57		93		67		45		178

Table 6 - AUCHENORRHYNCHA COLLECTED IN THE GREAT LAKES ALVARS

No	GENUS	SPECIES	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	BBP	BBG	QBG	GLCI	CRPD	DNDG	MNC	MND	MNK	MNM	MIMC
	CICADELLIDAE																						
1	Aceratagallia	humilis n.subsp.	X	D	X	X	X	X			X	X											
2	Aceratagallia	sanguinolenta					X																
3	Aceratagallia	sp.	X			X	X	X				X				X	X		X	X	X		
4	Aflexia	rubranura							X		X	D				X							
5	Agallia	constricta		X																			
6	Agallia	quadripunctata	X	X		X	X					X											
7	Agallia	sp.		X																			
8	Agalliopsis	peneoculata					D																
9	Agalliopsis	sp.			X																		
10	Amplicephalus	(Endria) inimicus	D	X	X	X	X	X	X		X			X			X		X				
11	Anoscopus	albifrons	D																				
12	Anoscopus	flavostriatus	X	X	X	X	X				D	X											
13	Anoscopus	serratulae	X								X												
14	Anoscopus	spp.	X	X		X																	
15	Aphrodes	sp.	X	X	X	X			X	X	D	X							X	X			
16	Arboridia	sp.	X	X	X	X	X			X													
17	Athysanella	longicauda	X		X			D															
18	Athysanella	spp.	X															X					
19	Athysanus	argentarius	X	X	X	X		X	X	X	X	X			X	X	X	X	X	X	X	X	
20	Auridius	sp.n.			X				D														
21	Balcanocerus	provencheri					X												X				
22	Balclutha	impicta	X	X	X	X																	
23	Balclutha	sp.	X	X	X	X	X		X	X	X	X					X		X		X		
24	Chlorotettix	sp.							X														X
25	Chlorotettix	unicolor	X	X	X	X		X	X			X		X		X	X	X	X				
26	Cicadula	melanogaster							X														
27	Cicadula	smithi	X	X	X	X													X				
28	Cicadula	sp.				X																	
29	Cicadula	straminea		X																			
30	Cicadula	subcupreae				X													X				
31	Cloanthanus	sp.																					X
32	Colladonus	clitellarius	X				X																
33	Colladonus	eburatus																	X				
34	Colladonus	youngi		X	X		X		X	X													
35	Comellus	cedilla	X																				
36	Cosmotettix	bilineatus				X																	
37	Cuerna	strita		X																	X		
38	Deltocephalus	balli									X												
39	Deltocephalus	pulicaris	X	X		X		X															
40	Dikraneura	mali					X				X												

Table 6 - AUCHENORRHYNCHA COLLECTED IN THE GREAT LAKES ALVARS

No	GENUS	SPECIES	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	BBP	BBG	QBG	GLCI	CRPD	DNDG	MNC	MND	MNK	MNM	MIMC
41	Dikrella	cruentata					X																
42	Diplocolenus	configuratus	D			X	X										X		X				
43	Diplocolenus	abdominalis	D	X	X	D		X	X		D	X											
44	Diplocolenus	spp.						X										X					
45	Doratura	stylata	X	X	X	X	X	X			X	X						X	X		X		
46	Draeculacephala	angulifera							X														
47	Draeculacephala	antica	X			X																	
48	Draeculacephala	noveboracensis		X		X																	
49	Draeculacephala	spp.	X	X			X	X											X	X			
50	Draeculacephala	zeae		X	X	X											X						
51	Elymana	inornata		X		X																	
52	Elymana	spp.	X		X	X																	
53	Elymana	sulphurella	X								X												
54	Empoa	latifasciata																	X				
55	Empoasca	sp.	X	D	D	D	D	X	X	X		X						X					
56	Erythroneura	nigra					X																
57	Erythroneura	spp.	X	X	X	X	D	X													X		
58	Erythroneura	tricincta					X																
59	Erythroneura	vitis	X			X																	
60	Eupteryx?	spp.		X																			
61	Euscelis	spp.	X			X																	
62	Evacanthus	orbitalis							X														
63	Extrusanus	extrusus	X				X	X		D													
64	Fitchana	vitellina																	X				
65	Flexamia	delongi		X	D				X			D	X			X			X				
66	Flexamia	inflata	X																				
67	Forcipata	loca	X	X		X	X	X	X									X					
68	Forcipata	sp.	X	X	X	X	X	X	X								X	X					
69	Forcipatra	triquetra		X	X	X	X	X			X	X		X				X					
70	Graminella	fitchi																	X				
71	Graminella	mohri			X																		
72	Graminella	sp.		X			X												X				
73	Graphocephala	coccinea																			X		
74	Graphocephala	sp.	X	X			X																
75	Graphocephala	teleformis							X	D													
76	Gyponana	salsa			X		X		X		X												
77	Gyponana	serpenta				X																	
78	Gyponana	sp.	X						X														
79	Hecalus	major									X	X											
80	Hecalus	montanus				X																	
81	Helochara	communis	X																X				X

Table 6 - AUCHENORRHYNCHA COLLECTED IN THE GREAT LAKES ALVARS

No	GENUS	SPECIES	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	BBP	BBG	QBG	GLCI	CRPD	DNDG	MNC	MND	MNK	MNM	MIMC
82	Idiocerus	formosus	X		X																		
83	Idiocerus	pallipus		X		X			X		X												
84	Idiocerus	productus				X																	
85	Idiocerus	spp.		X	X	X					X								X				
86	Idiocerus	venosus									X	X											
87	Idiodonus	aurantiacus		X																			
88	Idiodonus	kennecottii	X	X					X			X											
89	Idiodonus	morsei	X	X		X			X			X		X	X				X				
90	Jikradia	olitoria						X															
91	Kyboasea	sp.																	X	X			
92	Laevicephalus	acus	X	D	D	D		X				X		X			X	X	X				
93	Laevicephalus	melsheimerii	X	X					X			X											
94	Laevicephalus	sp.	X				X					X							X	X	X		
95	Laevicephalus	unicoloratus										X				X							X
96	Latalus	ocellaris	X	X	X	X		X				X											
97	Latalus	personatus	D	D	X	X	X	X	D		X	X	X		X		X	X					
98	Latalus	sayii																					X
99	Latalus	sp.		X					D		X	X				X			X	X	X		
100	Limotettix	arctostaphyli							D	D													
101	Limotettix	balli																	X				
102	Limotettix	ferganensis		X		X	X		X														
103	Limotettix	instabilis		X																			
104	Limotettix	osborni		X		X		X			X							X					
105	Limotettix	parallelus				X																	
106	Limotettix	pseudosphagneticus																	X				
107	Limotettix	sp.			X	X	X	X	X	X									X				
108	Limotettix	urnura			D				X		D	D							X				
109	Limotettix	vaccinii			X							X											
110	Macropsis	sauroni							X														
111	Macropsis	sordida				X																	
112	Macropsis	spp.	X			X																	
113	Macropsis	tunicata				X																	
114	Macropsis	viridis				X					X												
115	Macrosteles	borealis										X											
116	Macrosteles	quadrilineatus	X	D	D	D	X	X	X		X	X	X	X		X	X	X					
117	Macrosteles	spp.	X	X		X	X												X	X	X		
118	Memnonia	sp.n.					X	D	X			D				X							
119	Menosoma	cincta		X		X																	
120	Mocuellus	americanus							D														
121	Neocoelidia	tumidifrons					X	X	X			X											
122	Neokolla	hieroglyphica		X		X	D			D									X	X		X	

Table 6 - AUCHENORRHYNCHA COLLECTED IN THE GREAT LAKES ALVARS

No.	GENUS	SPECIES	CEG	BPP	BPGI	CRG	CRS	RAG	MIP	MIS	MIGS	MIC	BBP	BBG	QBG	GLC	CRPD	DNDG	MNC	MND	MNK	MNM	MIMC
123	Neokolla	sp.								X													
124	Norvellina	novica							X														
125	Norvellina	seminuda				X			X														
126	Oncopsis	cinctifrons		X					X	D													
127	Oncopsis	citra							X	X													
128	Oncopsis	dorsalis									X												
129	Oncopsis	sobria		X																			
130	Oncopsis	sp.		X																			
131	Oncopsis	variabilis								X													
132	Osbornellus	auronitens								X													
133	Osbornellus	consors	X	X		X	X	X															
134	Osbornellus	sp.					X																
135	Ossiannilssonola	volans					X																
136	Paluda	gladiola							X														
137	Paraphlepsius	fulvidorsum	X	X					D	X	X	X			X								
138	Paraphlepsius	irroratus	X	X																			
139	Paraphlepsius	lobatus			X				X			X											
140	Paraphlepsius	luxuria					X																
141	Paraphlepsius	spp.	X					X											X				
142	Paraphlepsius	truncatus	X	X			X	D			X	X											
143	Pendarus	punctiscriptus			X				X			X											
144	Platymetopius	spp.				X																	
145	Platymetopius	twingi								X													
146	Platymetopius	vitellinus				X	X	X	X		X												
147	Polyamia	apicata	X	X	X	X		X								X	X		X				
148	Polyamia	compacta		X																			
149	Ponana	pectoralis				X	X				X	X											
150	Ponana	rubida	X			X	X																
151	Prescottia	lobata					X																
152	Psammotettix	lividellus	X	D	X	X			X		X	X							X				
153	Psammotettix	sp.				X									X								
154	Ribautiana	spp.					X																
155	Scaphoideus	sp.	X	X		X	X			X													
156	Scaphytopius	acutus	X	X		X		X	X	X				X									
157	Scaphytopius	latus							X	X	X	X											
158	Scaphytopius	magdalensis							X														
159	Scaphytopius	sp.	X	X	X	X	X	X									X	X	X		X		X
160	Sorhoanus	bimaculatus				X																	
161	Sorhoanus	flavovirens				X																	
162	Sorhoanus	pascuellus	X			X																	
163	Stroggylocephalus	mixtus				X										X							

Table 6 - AUCHENORRHYNCHA COLLECTED IN THE GREAT LAKES ALVARS

No	GENUS	SPECIES	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	BBP	BBG	QBG	GLCI	CRPD	DNDG	MNC	MND	MNK	MNM	MIMC
164	Stroggylocephalus	placidus				X																	
165	Texananus	arctostaphylae					X		X	X	X												
166	Texananus	marmor		X					X			X											
167	Tylozygus	bifidus					X																
168	Typhlocyba	albicans					X																
169	Typhlocyba	giletta								X													
170	Typhlocyba	scripta	X																				
171	Typhlocyba	sp.	X	X	X	X	X																
172	Typhlocyba	venusta		X	X	X	X																
173	Xerophloea	major	X																				
174	Xestocephalus	fulvidorsum				X																	
175	Xestocephalus	nigrifrons								X													
176	Xestocephalus	superbus	X	D	X	X	X	D	X		X	D											
	CALISCELIDAE																						
177	Bruchomorpha	oculata	X	X		X		X									X	X					
178	Bruchomorpha	tristis									X												
179	Cedusa	spp.	X	X		X	X	X															
180	Peltonellus	spp.			X	X																	
181	Peltonotellus	histrionicus			X	X						X				X	X	X					
	CERCOPIDAE																						
182	Aphrophora	alni		X																			
183	Aphrophora	cribrata	X	X	X		X		X	X	X							X			X		
184	Aphrophora	paralella										X											
185	Aphrophora	saratogensis					X																
186	Clastoptera	arborina	X																				
187	Clastoptera	obtusa																	X				X
188	Clastoptera	proteus		X		X	X		X		X												
189	Clastoptera	saintcyri																	X				
190	Lepyronia	coleoptrata																X			X		
191	Lepyronia	quadrangularis	X				X													X		X	
192	Neophilaenus	lineatus		X	X	X			X		X	X	X	X	X	X	X		X	X			X
193	Philaenarcys	bilineata				X											X		X				
194	Philaenus	spumarius	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		
	CICADIDAE																						
195	Okanagana	canadensis						X	X	X													
196	Tibicen	canicularis								X	X	X											
	CIXIIDAE																						
197	Cixius	basalis		X	X																		
198	Cixius	sp.								X													
199	Oliarus	quinquemaculatus					X		X	X													

Table 6 - AUCHENORRHYNCHA COLLECTED IN THE GREAT LAKES ALVARS

No	GENUS	SPECIES	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	BBP	BBG	QBG	GLCI	CRPD	DNDG	MNC	MND	MNK	MNM	MIMC
	ACHILIDAE																						
200	Epiptera	variegata						X									X						
	FLATIDAE																						
201	Metcalfa	pruinosa	X																				
	DELPHACIDAE																						
202	Bakerella	muscotana														X							
203	Delphacodes	nigriscutellata		X	X			X				X						X					
204	Delphacodes	parvula			X																		
205	Kelisia	axialis	X																				
206	Laccocera	vittipennis							X		X												
207	Liburnia	campestris	X	X	X	X					X	X				X	X						
208	Liburnia	lutulenta	X	X	X	X												X					
209	Liburnia	parvula			X				X			X											
210	Liburnia	sp.			X	X	X	X	X														
211	Liburniella	ornata	X	X	X			X	X		X	X	X	X									
212	Megamelus	sp.		X		X			X		X												
213	Pissonotus	flabellatus	X																				
214	Pissonotus	marginatus	X	X																			
215	Pissonotus	sp.				X				X													
216	Stenocranus	spp.	X	X		X																	
	DERBIDAE																						
217	Cedusa	sp.	X	X		X	X	X		X													
218	Cedusa	vulgaris								X													
	DICTYOPHARIDAE																						
219	Scolops	sulcipes	X			X	X	X			X							X					
	MEMBRACIDAE																						
220	Campylenchia	latipes	X	X	X	X		X									X	X	X				
221	Carynota	stupida									X												
222	Ceresa	basalis	X	X		X											X	X					
223	Ceresa	diceros			X																		
224	Ceresa	lutea	X			X	X																
225	Cyrtolobus	sp.									X												
226	Ophiderma	sp.							X										-				
227	Telamona	monticola									X												
228	Telamona	spereta									X												
229	Telamona	univittata									X												
230	Telamona	westcotti									X												
	TOTAL # OF SPECIMENS		1895	2171	590	1728	485	866	905	175	2978	1716											
	TOTAL # OF SPECIES		84	85	57	93	67	45	63	33	51	49											

Table 7 - BUTTERFLIES AND SKIPPERS COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

No	GENUS	SPECIES	AUTHOR	CEG	DATE\CEG	BPP	DATE\BPP	BPG	DATE\BPG	CRG	DATE\CRG	CRS	DATE\CRS	RAG	DATE\RAG
	DANAIDAE														
1	Danaus	plexippus	(Linnaeus)	[4]	30-VI:14-VII	[7]	01-VII:15-VII	4 [25]	01-VII:15-VII	1 [1]	02-VII:29-VII			[10]	19-VI:12-IX
	HESPERIIDAE														
2	Carterocephalus	palaemon	(Pallas)	1	16-VI										
3	Erynnis	icelus	(Scud. & Burg.)	2	01-VI:16-VI					4	04-VI:16-VII	3	18-VI:02-VII	1	23-V
4	Erynnis	juvenalis	(Fabricius)	1	01-VI							1	18-VI		
5	Erynnis	lucilius	Burgess)							6	04-VI:29-VII	17	03-VI:29-VII	3	23-V:17-VII
6	Euphyes	vestris	(Boisduval)	3	14-VII:27-VII							1	16-VII		
7	Hesperia	saussacus	Harris	2	16-VI:30-VI	1	01-VII					6	18-VI:02-VII	16	19-VI:03-VII
8	Polites	peckius	(W. Kirby)									1	16-VII		
9	Polites	mystic	(Edwards)	4	30-VI					1	16-VII				
10	Polites	origenes	(Fabricius)	4	16-VI:30-VI							2	29-VII	3	30-VII
11	Polites	themistocles	(Latreille)	16	16-VI:30-VI	1	26-VIII	1	15-VII	2	18-VI:02-VII			1	03-VII
12	Thorybes	pylades	(Scudder)							1	02-VII				
13	Thymelicus	lineola	(Ochsen.)	16	30-VI:14-VII	[1]	15-VII	1	15-VII	16	02-VII:16-VII	20	02-VII:16-VII	6	03-VII
	LYCAENIDAE														
14	Celastrina	ladon	(Cramer)	4 [5]	18-V:14-VII	[1]	02-VI			3 [2]	22-V:04-VI			[1]	05-VI
15	Epidemia	dorcas	(Kirby)			6	28-VII:26-VIII	16	06-VII:12-VIII						
16	Everes	comyntas	(Godart)	2	14-VII:25-VIII										
17	Glauchopsyche	lygdamus	(Doubleday)	2	01-VI									2	05-VI
18	Harkenclenus	titus	(Fabricius)			1	26-VIII					5	02-VII:29-VII		
19	Hyllolycaena	hyllus	(Cramer)							1	16-VII				
20	Incisalia	niphon	(Hubner)			1	02-VI								
21	Incisalia	polia	Watson					1	02-VI					2	23-V:05-VI
22	Satyrium	acadicum	Edwards)							2	16-VII:29-VII				
	NYMPHALIDAE														
23	Basilarchia	archippus	(Cramer)	[1]	30-VI					3 [1]	02-VII:16-VII			1 [1]	19-VI:30-VII
24	Basilarchia	arthemis	(Drury)			[5]	15-VII:27-VII	[7]	01-VII:28-VII	1 [4]	02-VII	1 [8]	02-VII:16-VII		
25	Clossiana	bellona	(Fabricius)							23	04-VI:27-VIII				
26	Clossiana	selene	(Den. & Sch.)			1	01-VII			2	02-VII			5	05-VI:17-VII
27	Nymphalis	antiopa	(Linnaeus)	1 [1]	18-VI:01-VI	1	01-VII	[3]	02-VI	[3]	04-VI:29-VII				
28	Phyciodes	batesii	(Reakirt)							3	18-VI:02-VII	6	18-VI:02-VII		
29	Phyciodes	tharos	(Drury)	5	30-VI:27-VII	19	01-VII:26-VIII	4	15-VII:28-VII	12	18-VI:29-VII	9	18-VI:16-VII	9	19-VI:30-VII
30	Polygonia	progne	(Cramer)											1	17-VII
31	Speyeria	aphrodite	(Fabricius)							11	16-VII:27-VIII	1	29-VII		
32	Vanessa	virginiensis	(Drury)			1	17-VI								
	PAPILIONIDAE														
33	Papilio	glaucus	(Linnaeus)	[2]	16-VI	[1]	17-VI			1 [3]	03-VI:02-VII	[3]	02-VII	[2]	05-VI:19-VI
34	Papilio	polyxenes	Fabricius	1 [1]	30-VI:08-VIII										
	PIERIDAE														
35	Colias	philodice	Godart	10	01-VI:25-VIII	1	26-VIII			5	04-VI:16-VII			5	05-VI:30-VII

Table 7 - BUTTERFLIES AND SKIPPERS COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

No	GENUS	SPECIES	AUTHOR	CEG	DATE\CEG	BPP	DATE\BPP	BPG	DATE\BPG	CRG	DATE\CRG	CRS	DATE\CRS	RAG	DATE\RAG
36	Euchloe	olympia	(Edwards)	3	01-VI							3	03-VI		
37	Pieris	napi	(Linnaeus)			1	28-VII			2	04-VI	1	02-VII		
38	Pieris	rapae	(Linnaeus)	4	14-VII:25-VIII			4	15-VII:26-VIII					2	17-VII
	SATYRIDAE														
39	Cercyonis	pegala	(Fabricius)	6	14-VII:25-VIII			4	06-VII:28-VII	3	16-VII:29-VII			7	17-VII:14-VIII
40	Coenonympha	inornata	Edwards	13[100]	16-VI:25-VIII			2	01-VII:15-VII	1 [15]	18-VI	2 [5]	18-VI:02-VII	6 [30]	19-VI:12-IX
41	Enodia	anthedon	A.H. Clarck			1	28-VII								
42	Megisto	cymela	(Cramer)	2	16-VI:30-VI	5	01-VII:28-VII			3	18-VI:02-VII	6	18-VI:02-VII		
43	Oneis	chryxus	(Dou. & Hew.)									2	03-VI	10	23-V:05-VI
TOTAL # SPECIES / SITE				24		18		11		24		19		20	

Table 8 - BUTTERFLIES AND SKIPPERS KNOWN FROM THE GREAT LAKES ALVARS

No.	GENUS	SPECIES	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	CRALL	BLALL	NYALL	MXPL	DIST
	DANAIDAE																
1	Danaus	plexippus	X	X	X	X		X	X		X	X	X	X	X	X	Ws
	HESPERIIDAE																
2	Amblicirtes	vialis							X	X			X	X		X	Ws
3	Ancyloxypha	numitor											X			X	E
4	Atrytone	delaware														X	Ws
5	Carterocephalus	palaemon	X										X			X	N
6	Erynnis	icelus	X			X	X	X	X	X			X	X		X	Ws
7	Erynnis	juvenalis	X				X			X	X		X		X	X	Ws
8	Erynnis	lucilius				X	X	X	X	X			X	X	X	X	Ws
9	Erynnis	martialis												X			Ws
10	Euphyes	bimacula											X				E
11	Euphyes	vestris	X				X		X				X	X	X	X	Ws
12	Hesperia	comma							X			X		X		X	N
13	Hesperia	laurentina														X	
14	Hesperia	saussacus	X	X			X	X	X				X		X		Ws
15	Poanes	hobomok							X	X	X		X		X	X	Ws
16	Poanes	viator												X			Ws
17	Polites	peckius					X						X	X		X	Ws
18	Polites	mystic	X			X						X	X	X	X	X	Ws
19	Polites	origenes	X				X	X					X	X	X		Ws
20	Polites	themistocles	X	X	X	X		X			X		X	X		X	Ws
21	Thorybes	pylades				X					X		X	X		X	Ws
22	Thymelicus	lineola	X	X	X	X	X	X	X	X	X	X	X	X	X	X	Ws
23	Wallengrenia	egeremet												X	X		Ws
	LYCAENIDAE																
24	Celastrina	ladon	X	X		X		X	X	X			X		X	X	Ws
25	Epidemia	dorcas		X	X				X		X	X				X	Ws
26	Epidemia	helloides														X	Ws
27	Everes	comyntas	X														Ws
28	Glauchopsyche	lygdamus	X					X		X				X		X	Ws
29	Harkenclenus	titus		X			X		X				X	X		X	Ws
30	Hyllolycaena	hyllus				X							X	X		X	Ws
31	Incisalia	augustinus							X	X	X			X		X	Ws
32	Incisalia	niphon		X									X				Ws
33	Incisalia	polia			X			X	X	X				X		X	Ws
34	Lycaena	phlaeas											X		X		Ws
35	Plebejus	saepiolus														X	Ws
36	Satyrium	acadicum				X							X	X		X	Ws

Table 8 - BUTTERFLIES AND SKIPPERS KNOWN FROM THE GREAT LAKES ALVARS

No.	GENUS	SPECIES	CEG	BPR	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	CRALL	BLALL	NYALL	MXPL	DIST
37	Satyrium	calanus												X			Ws
38	Satyrium	liparops												X			Ws
	NYMPHALIDAE																
39	Aglais	milberti														X	Ws
40	Basilarchia	archippus	X			X		X				X	X	X	X	X	Ws
41	Basilarchia	arthemis		X	X	X	X		X	X	X		X	X	X	X	Ws
42	Charidryias	harisii							X				X			X	Ws
43	Charidryias	nycteis													X		Ws
44	Clossiana	bellona				X							X	X			Ws
45	Clossiana	selene		X		X		X	X		X	X	X	X	X	X	Ws
46	Junonia	evarete														X	S
47	Nymphalis	antiopa	X	X	X	X			X	X	X		X	X	X	X	Ws
48	Nymphalis	vau-album											X			X	Ws
49	Phyciodes	batesii				X	X		X			X				X	Ws
50	Phyciodes	tharos	X	X	X	X	X	X	X	X		X		X	X	X	Ws
51	Phyciodes	pascoensis														X	
52	Polygonia	comma											X				Ws
53	Polygonia	interrogationis											X			X	Ws
54	Polygonia	progne						X					X	X		X	Ws
55	Speyeria	aphrodite				X	X		X		X		X	X	X	X	Ws
56	Speyeria	atlantis							X				X	X	X	X	Ws
57	Speyeria	cybele							X				X	X	X	X	Ws
58	Vanessa	atalanta											X			X	Ws
59	Vanessa	cardui											X	X		X	Ws
60	Vanessa	virginiensis		X												X	Ws
	PAPILIONIDAE																
61	Papilio	glaucus	X	X		X	X	X	X	X			X	X	X	X	Ws
62	Papilio	polyxenes	X										X		X		Ws
	PIERIDAE																
63	Colias	eurytheme											X		X	X	Ws
64	Colias	interior							X				X		X		Ws
65	Colias	philodice	X	X		X		X					X	X		X	Ws
66	Euchloe	ausonides							X								N
67	Euchloe	olympia	X				X				X				X	X	S
68	Pieris	napi		X		X	X		X		X		X	X		X	Ws
69	Pieris	rapae	X		X			X	X				X		X	X	Ws
	SATYRIDAE																
70	Cercyonis	pegala	X		X	X		X			X	X	X	X	X	X	Ws
71	Coenonympha	inornata	X		X	X	X	X			X	X	X	X	X	X	Ws

Table 8 - BUTTERFLIES AND SKIPPERS KNOWN FROM THE GREAT LAKES ALVARS

No	GENUS	SPECIES	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	CRALL	BLALL	NYALL	MXPL	DIST
72	Enodia	anthedon		X					X				X		X	X	Ws
73	Megisto	cymela	X	X		X	X				X		X		X	X	Ws
74	Oneis	chryxus					X	X	X				X	X			N
75	Satyrodes	eurydice											X	X		X	Ws
	TOTAL # SPECIES / SITE		24	18	11	24	19	20	30	14	17	11					

Table 9 - SAWFLIES (HYMENOPTERA: SYMPHYTA) COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

No	GENUS	SPECIES	AUTHOR	CEG	DATE/CEG	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	TOT
	ARGIDAE															
1	Arge	cerulea	(Norton)			4	02-VI:12-VIII	1	17-VI							5
2	Arge	cyra	(Kirby)			1	28-VII			1	18-VI					2
3	Arge	macleayi	(Leach)	1	16-VI					5	04-VI:18-VI					6
4	Arge	onerosa	MacGillivray			1	12-VIII			1	13-VIII					2
5	Strictiphora	sericea	(Norton)	1	16-VI							3	03-VI			4
	CIMBICIDAE															
6	Trichosoma	triangulum	Kirby							1	04-VI					1
7	Zaeraea	inflata	Norton			1	02-VI					3	03-VI	1	05-VI	5
	DIPRIONIDAE															
8	Diprion	similis	(Hartig)									1	02-VII			1
9	Monoctenus	fulvus	(Norton)	3	01-VI:16-VI	3	02-VI	1	17-VI	1	04-VI	8	03-VI			16
	PAMPHILIDAE															
10	Acantholyda	erythocephala	(Linne)											1	03-VI	1
11	Onycholyda	multisignatus	(Norton)							1	18-VI					1
12	Pamphilus	ochreipes	(Cresson)											2	05-VI	2
	PERGIDAE															
13	Acordulacera	sp.										1	03-VI			1
	SIRICIDAE															
14	Urocerus	albicornis	(Fabricius)									1	11-IX			1
	TENTHREDINIDAE															
15	Allantus	cinctus	(Linne)	2	01-VI:16-VI											2
16	Allantus	mellipes	(Norton)	1	16-VI					22	04-VI:11-IX					23
17	Amauronematus	sp. 1				3	02-VI			1	04-VI					4
18	Amauronematus	sp. 2				2	02-VI:17-VI			1	04-VI					3
19	Amauronematus	sp. 3								1	04-VI	1	03-VI			2
20	Amauronematus	sp. 4				4	02-VI:17-VI			1	04-VI					5
21	Amauronematus	sp. 5								1	04-VI					1
22	Amauronematus	sp. 6								1	04-VI	2	03-VI:21-VI			3
23	Amauronematus	sp. 7								1	04-VI	2	03-VI			3
24	Ametastegia	aperta	(Norton)							1	13-VIII					1
25	Ametastegia	glabrata	(Fallen)							1	27-VIII					1
26	Ametastegia	rocia	Smith							2	18-VI					2
27	Ametastegia	sp.								1	04-VI					1
28	Aphillodyctium	fidum	Cresson	3	16-VI	1	02-VI					2	03-VI	2	05-VI:19-VI	8
29	Caliroa	fasciata	(Norton)									1	13-VIII			1
30	Caliroa	petiolata	Smith									1	13-VIII			1
31	Dolerus	apricus	(Norton)							1	04-VI					1
32	Dolerus	aprilis	(Norton)							4	04-VI:13-VIII					4
33	Dolerus	bicolor	(Beauvois)					1	02-VI							1
34	Dolerus	e. elderi	Kincaid							4	02-VII:29-VII	1	29-VII			5

Table 9 - SAWFLIES (HYMENOPTERA: SYMPHYTA) COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

No.	GENUS	SPECIES	AUTHOR	CEG	DATE/CEG	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	TOT
35	Dolerus	maculicollis or abstrusus								2	04-VI					2
36	Dolerus	mimus	Goulet	1	01-VI:16-VI											1
37	Dolerus	nitens	Zaddach											1	19-VI	1
38	Dolerus	rossi	Goulet							1	04-VI					1
39	Dolerus	sp.								2	18-VI:16-VII					2
40	Empria	ignota	(Norton)					1	02-VI	2	04-VI	1	03-VI			4
41	Empria	improba	(Cresson)							1	04-VI					1
42	Empria	maculata	(Norton)							1	02-VII	2	03-VI			3
43	Empria	multiciolor	(Norton)							1	18-VI:16-VII					1
44	Empria	obscurata	(Cresson)	1	01-VI:16-VI	4	20-V:17-VI	1	17-VI	21	04-VI:18-VI	6	03-VI	4	05-VI	37
45	Endelomyia	aethiops	(Fabricius)			1	02-VI									1
46	Eupontania	sp.				1	17-VI			2	04-VI					3
47	Haplocampa	halcyon	(Norton)									4	03-VI			4
48	Haplocampa	sialica	Ross			1	02-VI									1
49	Hemichroa	militaris	(Cresson)			2	02-VI					1	03-VI			3
50	Kaliofenusa	ulmi	(Sundeval)			1	02-VI					1	03-VI	2	05-VI:19-VI	4
51	Macremphytus	testaceus	(Norton)							7	18-VI:13-VIII					7
52	Macrophya	flicta	MacGillivray	1	19-VII	2	02-VI			2	18-VI:02-VII					5
53	Macrophya	fuliginea	Norton									1	16-VII			1
54	Macrophya	intermedia	(Norton)							4	18-VI:02-VII					4
55	Macrophya	mixta	MacGillivray							1	18-VI					1
56	Macrophya	succincta	Cresson	7	16-VI											7
57	Macrophya	trisyllaba	(Norton)			1	02-VI			1	02-VII	1	02-VII			3
58	Messa	leucostoma	(Rohwer)									1	03-VI			1
59	Messa	populifolia	(Townsend)	1	01-VI:16-VI											1
60	Messa	wuestneii	(Konow)			2	02-VI									2
61	Monophadnoides	conspiculatus	MacGillivray	1	16-VI											1
62	Monophadnus	pallescens	(Gmelin)			1	17-VI									1
63	Nematinus	unicolor	(Dyar)									1	02-VII			1
64	Nematus	sp. 1				2	02-VI:17-VI			9	04-VI:11-IX	4	02-VII:11-IX			15
65	Nematus	sp. 2								2	11-IX	1	29-VII			3
66	Nematus	sp. 3				1	26-VIII									1
67	Pachynematus	sp. 1		1	16-VI					1	11-IX	1	11-IX	1	03-VII	4
68	Pachynematus	sp. 2		1	01-VI	1	26-VIII			1	11-IX					3
69	Pachynematus	sp. 3		2	16-VI			1	02-VI	1	11-IX					4
70	Pachynematus	sp. 4								1	27-VIII	3	03-VI	1	12-IX	5
71	Pachynematus	sp. 5								1	27-VIII					1
72	Phrontosoma	belfragei	(Cresson)							2	18-VI					2
73	Phyllocolpa	sp. 1				2	02-VI:17-VI			7	04-VI	3	03-VI			12
74	Phyllocolpa	sp. 2		1	01-VI	1	17-VI									2
75	Phyllocolpa	sp. 3								1	18-VI					1

Table 9 - SAWFLIES (HYMENOPTERA: SYMPHYTA) COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

No	GENUS	SPECIES	AUTHOR	CEG	DATE/CEG	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	TOT
76	Phyllocolpa	sp. 4		1	01-VI											1
77	Phyllocolpa	sp. 5								1	04-VI					1
78	Phyllocolpa	sp. 6				1	17-VI			5	04-VI:02-VII					6
79	Phyllocolpa	sp. 7				1	02-VI			8	04-VI:18-VI	1	03-VI			10
80	Phymatocera	rusculla	(MacGillivray)											10	23-V:19-VI	10
81	Priophorus	infuscatus or pallipes								1	11-IX	1	03-VI			2
82	Pristiphora	sp. 1		5	01-VI:16-VI					2	04-VI:13-VIII	1	03-VI	3	05-VI	11
83	Pristiphora	sp. 2				1	02-VI									1
84	Pristiphora	sp. 3				1	02-VI			7	04-VI:11-IX	1	03-VI			9
85	Pristiphora	sp. 4								4	04-VI:27-VIII	1	29-VII			5
86	Pristiphora	sp. 5								4	04-VI:02-VII	1	03-VI			5
87	Pristiphora	sp. 6										1	03-VI			1
88	Pristiphora	sp. 7								1	29-VII					1
89	Pristiphora	sp. 8				2	02-VI					5	03-VI:11-IX			7
90	Pristiphora	sp. 9										1	03-VI			1
91	Pristiphora	sp. 10										1	03-VI			1
92	Profenusa	canadensis	(Marlatt)											1	05-VI	1
93	Pseudodineura	rileda	Smith									1	03-VI			1
94	Pontania	sp. 1				8	02-VI:17-VI									8
95	Pontania	sp. 2								1	13-VIII					1
96	Pontania	sp. 3				1	17-VI			1	04-VI					2
97	Pontania	sp. 4				3	02-VI:17-VI	1	17-VI	6	04-VI			1	05-VI	11
98	Pontania	sp. 5				1	02-VI									1
99	Pontania	sp. 6		1	01-VI	4	02-VI:17-VI			3	04-VI	9	03-VI	1	05-VI	18
100	Rhadinoceraea	sp.n.				2	15-VII:28-VII									2
101	Rhogogaster	californica	(Norton)							2	02-VII					2
102	Strongylogaster	impressata	Provancher					1	17-VI							1
103	Strongylogaster	macula	(Klug)									1	03-VI			1
104	Strongylogaster	multicincta	Norton							1	18-VI					1
105	Strongylogaster	soriculatipes	Cresson			1	02-VI									1
106	Taxonus	borealis	MacGillivray	2	01-VI:16-VI	1	02-VI			2	02-VII:27-VIII	1	18-VI			6
107	Taxonus	proximus	(Provancher)											1	28-VIII	1
108	Taxonus	rufocinctus	(Norton)							1	13-VIII	1	02-VII			2
109	Taxonus	terminalis	(Say)							1	16-VII					1
110	Tenthredo	basilaris	Say							1	13-VIII	1	13-VIII			2
111	Tenthredo	castanaea	Kirby			1	02-VI			14	18-VI:16-VII	6	02-VII:16-VII	1	03-VII	22
112	Tenthredo	formosa	Norton	1	30-VI											1
113	Tenthredo	leucostoma	Kirby							2	02-VII:16-VII					2
114	Tenthredo	nr. leucostoma				1	02-VI					1	02-VII			2
115	Tenthredo	rufipes	Say			1	02-VI			4	18-VI:02-VII	6	02-VII:29-VII			11
116	Tenthredo	rusticana	MacGillivray							2	16-VII:29-VII					2

Table 9 - SAWFLIES (HYMENOPTERA: SYMPHYTA) COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

No	GENUS	SPECIES	AUTHOR	CEG	DATE/CEG	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	TOT
117	Tenthredo	nr. secunda										2	02-VII:29-VII			2
118	Zaschizonyx	montana	(Cresson)									1	03-VI			1
	XYELIDAE															
119	Xylea	obscura	(Strobl)			5	02-VI									5
TOTAL # OF SPECIMENS				38		78		8		201		102		33		460
TOTAL # OF SPECIES				21		41		8		68		49		16		119

Table 10 - SAWFLIES (HYMENOPTERA: SYMPHYTA) COLLECTED IN ONTARIO ALVARS IN 1996 AND 1997

No	GENUS	SPECIES	AUTHOR	CEC	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	DIST
	ARGIDAE													
1	Arge	cerulea	(Norton)		X	X					X	X		E
2	Arge	cyra	(Kirby)		X		X			X				Ws
3	Arge	macleayi	(Leach)	X			X							Ws
4	Arge	onerosa	MacGillivray		X		X							Ws
5	Arge	pectoralis	(Leach)							X	X	X		Ws
6	Strictiphora	sericea	(Norton)	X				X						E
7	Strictiphora	serotina	Smith									X		E
	CIMBICIDAE													
8	Cimbex	americana	Leach								X			Ws
9	Trichosoma	triangulum	Kirby				X							Ws
10	Zaeraea	inflata	Norton		X			X	X	X				Ws
	DIPRIONIDAE													
11	Diprion	similis	(Hartig)					X						E
12	Monoctenus	fulvus	(Norton)	X	X	X	X	X		X				E
13	Monoctenus	suffusus	(Cresson)							X	X	X	X	E
14	Neoprion	sp.								X				INC
	PAMPHILIDAE													
15	Acantholyda	erythocephala	(Linne)						X					E
16	Onycholyda	multisignatus	(Norton)				X							Ws
17	Pamphilus	ochreipes	(Cresson)						X					Ws
	PERGIDAE													
18	Acordulacera	sp.						X						INC
	SIRICIDAE													
19	Urocerus	albicornis	(Fabricius)					X						Ws
	TENTHREDINIDAE													
20	Allantus	cinctus	(Linne)	X										E&W
21	Allantus	mellipes	(Norton)	X			X					X		Ws
22	Amauronematus	sp. 1			X		X			X	X			INC
23	Amauronematus	sp. 2			X		X					X	X	INC
24	Amauronematus	sp. 3					X	X						INC
25	Amauronematus	sp. 4			X		X					X	X	INC
26	Amauronematus	sp. 5					X							INC
27	Amauronematus	sp. 6					X	X				X		INC
28	Amauronematus	sp. 7					X	X						INC
29	Ametastegia	aperta	(Norton)				X							E
30	Ametastegia	glabrata	(Fallen)				X							Ws
31	Ametastegia	rocia	Smith				X							Ws
32	Ametastegia	sp.					X							INC
33	Aneugmenus	flavipes	(Norton)									X		E
34	Aphillodyctium	fidum	Cresson	X	X			X	X	X			X	Ws

Table 10 - SAWFLIES (HYMENOPTERA: SYMPHYTA) COLLECTED IN ONTARIO ALVARS IN 1996 AND 1997

No.	GENUS	SPECIES	AUTHOR	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	DIST
35	Caliroa	fasciata	(Norton)					X						E
36	Caliroa	nr. obsoleta										X		INC
37	Caliroa	obsoleta	(Norton)									X		E
38	Caliroa	petiolata	Smith					X						E
39	Dimorphopteryx	abnormis	Rohwer							X	X			E
40	Dolerus	apricus	(Norton)				X					X		Ws
41	Dolerus	aprilis	(Norton)				X							Ws
42	Dolerus	bicolor	(Beauvois)			X								E
43	Dolerus	e. elderi	Kincaid				X	X						Ws
44	Dolerus	maculicollis or abstrusus					X							INC
45	Dolerus	mimus	Goulet	X										E
46	Dolerus	nitens	Zaddach						X					E&W
47	Dolerus	rossi	Goulet				X							E
48	Dolerus	tibialis conjugatus	MacGillivray									X		Ws
49	Dolerus	sp.					X							INC
50	Empria	candidata	(Fallen)							X				N
51	Empria	ignota	(Norton)			X	X	X				X		Ws
52	Empria	improba	(Cresson)				X							Ws
53	Empria	maculata	(Norton)				X	X				X		Ws
54	Empria	multiciolor	(Norton)				X			X				Ws
55	Empria	obscurata	(Cresson)	X	X	X	X	X	X	X		X		Ws
56	Endelomyia	aethiops	(Fabricius)		X									Ws
57	Eupontania	sp.			X		X							INC
58	Eutomostethus	luteiventris	(Klug)									X	X	Ws
59	Hoplocampa	halcyon	(Norton)					X				X		Ws
60	Hoplocampa	montanicola	Rohwer									X		E
61	Hoplocampa	sialica	Ross		X									E
62	Hemichroa	militaris	(Cresson)		X			X						Ws
63	Kaliofenusa	ulmi	(Sundeval)		X			X	X					E
64	Macremphytus	tarsatus	(Say)										X	E
65	Macremphytus	testaceus	(Norton)				X							E
66	Macrophya	cassandra	Kirby									X		E
67	Macrophya	flicta	MacGillivray	X	X		X							E
68	Macrophya	fuliginea	Norton					X		X	X	X	X	E
69	Macrophya	intermedia	(Norton)				X			X		X		E
70	Macrophya	mixta	MacGillivray				X							E
71	Macrophya	succincta	Cresson	X								X	X	Ws
72	Macrophya	trisyllaba	(Norton)		X		X	X			X			Ws
73	Messa	leucostoma	(Rohwer)					X						Ws
74	Messa	populifolia	(Townsend)	X										Ws
75	Messa	wuestneii	(Konow)		X									Ws

Table 10 - SAWFLIES (HYMENOPTERA: SYMPHYTA) COLLECTED IN ONTARIO ALVARS IN 1996 AND 1997

No.	GENUS	SPECIES	AUTHOR	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	DIST
76	Monophadnoides	conspiculatus	MacGillivray	X										E
77	Monophadnus	pallescens	(Gmelin)		X									E&W
78	Nematinus	unicolor	(Dyar)					X						Ws
79	Nematus	sp. 1			X		X	X						INC
80	Nematus	sp. 2					X	X						INC
81	Nematus	sp. 3			X									INC
82	Nematus	sp. 4								X				INC
83	Pachynematus	sp. 1		X			X	X	X					INC
84	Pachynematus	sp. 2		X	X		X							INC
85	Pachynematus	sp. 3		X		X	X							INC
86	Pachynematus	sp. 4					X	X	X			X	X	INC
87	Pachynematus	sp. 5					X							INC
88	Periclista	albicollis	(Norton)									X		E
89	Periclista	diluta	(Cresson)									X		E
90	Phrontosoma	belfragei	(Cresson)				X							Ws
91	Phyllocolpa	sp. 1			X		X	X						INC
92	Phyllocolpa	sp. 2		X	X									INC
93	Phyllocolpa	sp. 3					X							INC
94	Phyllocolpa	sp. 4		X										INC
95	Phyllocolpa	sp. 5					X							INC
96	Phyllocolpa	sp. 6			X		X							INC
97	Phyllocolpa	sp. 7			X		X	X						INC
98	Phymatocera	rusculla	(MacGillivray)						X					Ws
99	Pikonema	alaskensis	(Rohwer)							X			X	Ws
100	Priophorus	infuscatus or pallipes					X	X						INC
101	Pristiphora	sp. 1		X			X	X	X					INC
102	Pristiphora	sp. 2			X									INC
103	Pristiphora	sp. 3			X		X	X					X	INC
104	Pristiphora	sp. 4					X	X						INC
105	Pristiphora	sp. 5					X	X						INC
106	Pristiphora	sp. 6						X						INC
107	Pristiphora	sp. 7					X							INC
108	Pristiphora	sp. 8			X			X				X		INC
109	Pristiphora	sp. 9						X						INC
110	Pristiphora	sp. 10						X						INC
111	Pristiphora	sp. 11											X	INC
112	Pristiphora	pallipes	Lepeletier										X	Ws
113	Profenusa	canadensis	(Marlatt)						X					E
114	Pseudodineura	rileda	Smith					X						E
115	Pontania	sp. 1			X									INC
116	Pontania	sp. 2					X							INC

Table 10 - SAWFLIES (HYMENOPTERA: SYMPHYTA) COLLECTED IN ONTARIO ALVARS IN 1996 AND 1997

No.	GENUS	SPECIES	AUTHOR	GEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIC	DIST
117	Pontania	sp. 3			X		X							INC
118	Pontania	sp. 4			X	X	X		X					INC
119	Pontania	sp. 5			X									INC
120	Pontania	sp. 6		X	X		X	X	X					INC
121	Rhadinoceraea	sp.n.			X									INC
122	Rhogogaster	californica	(Norton)				X							Ws
123	Strongylogaster	impressata	Provancher			X								Ws
124	Strongylogaster	macula	(Klug)					X						E&W
125	Strongylogaster	multicincta	Norton				X							E
126	Strongylogaster	soriculatipes	Cresson		X									E
127	Taxonus	borealis	MacGillivray	X	X		X	X				X		E
128	Taxonus	proximus	(Provancher)						X			X		E
129	Taxonus	rufocinctus	(Norton)				X	X						E
130	Taxonus	terminalis	(Say)				X							E
131	Tenthredo	basilaris	Say				X	X				X	X	Ws
132	Tenthredo	castanaea	Kirby		X		X	X	X	X	X	X		Ws
133	Tenthredo	formosa	Norton	X										INC
134	Tenthredo	leucostoma	Kirby				X							Ws
135	Tenthredo	nr. leucostoma			X			X		X				INC
136	Tenthredo	piceocincta	(Norton)								X	X		Ws
137	Tenthredo	ruficolor	(Norton)							X	X	X		E
138	Tenthredo	rufipes	Say		X		X	X		X	X	X		E
139	Tenthredo	rusticana	MacGillivray				X					X		E
140	Tenthredo	nr. secunda						X						E
141	Tenthredo	varipicta	Norton									X		E
142	Tenthredo	verticalis	Say							X		X		E
143	Zaschizonyx	montana	(Cresson)					X						Ws
	XYELIDAE													
144	Xylea	obscura	(Strobl)		X									Ws
	TOTAL # OF SPECIMENS			38	78	8	201	102	33	140	32	81	37	
	TOTAL # OF SPECIES			21	41	8	68	49	16	21	12	37	14	

Table 11 - ORTHOPTEROID INSECTS COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

	GENUS	SPECIES	CEG	DATE/CE	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	# COLL	DIST
	ACRIDIDAE															
1	Camnula	pellucida	8	01-VI-27-VII	16	15-VII:26-VIII	1	12-VIII	6	04-VI:18-VII	1	03-VI	34	05-VI:14-VIII	66	Ws
2	Chloealtis	abdominalis			1	26-VIII									1	Ws
3	Chloealtis	conspersa	1	08-VIII	1	26-VIII									2	Ws
4	Chorthippus	c. curtipennis	1	08-VIII	13	15-VII:10-IX	11	15-VII:10-IX	32	29-VII:11-IX	1	13-VIII	22	17-VII:12-IX	80	Ws
5	Chortophaga	viridifasciata	17	01-VI:27-VII					20	04-VI:16-VII			83	23-V:17-VII	120	Ws
6	Dissosteira	carolina	5	27-VII:09-IX					1	27-VIII			2	14-VIII:28-VII	8	Ws
7	Melanoplus	b. borealis	13	30-VI:09-IX	3	01-VII:26-VIII	4	28-VII:12-VIII	49	02-VII:11-IX	6	09-VII:11-IX	55	03-VII:12-IX	130	Ws
8	Melanoplus	bivittatus	25	14-VII:25-VIII	1	26-VIII	13	28-VII:10-IX	32	02-VII:11-IX	4	29-VII:27-VIII	140	17-VII:12-IX	215	Ws
9	Melanoplus	confusus											1	17-VII	1	Ws
10	Melanoplus	dawsoni							1	13-VIII					1	Ws
11	Melanoplus	f. femurrubrum	3	08-VIII:09-IX	13	12-VIII:10-IX	1	10-IX	29	18-VI:11-IX	1	16-VII	19	28-VIII:12-IX	66	Ws
12	Melanoplus	fasciatus	1	08-VIII			10	15-VII:12-VIII	6	16-VII:11-IX	13	16-VII:13-VIII	1	12-IX	31	Ws
13	Melanoplus	islandicus					1	26-VII							1	G-Lakes
14	Melanoplus	keeleri luridus			1	10-IX					1	27-VIII	32	28-VIII:12-IX	34	Ws
15	Melanoplus	mancus									1	29-VII			1	E
16	Melanoplus	p. punctulatus	7	08-VIII:09-IX									5	14-VIII:12-IX	12	E
17	Melanoplus	s. sanguinipes	1	08-VIII	29	28-VII:10-IX					5	29-VII:11-IX	7	19-VI:28-VIII	42	Ws
18	Orphulella	p. pelidna	1	08-VIII									267	14-VIII:12-IX	268	Ws
19	Orphulella	speciosa	1	25-VIII	1	15-VII			1	29-VII			9	17-VII:30-VII	12	Ws
20	Spharagemon	b. bolli	24	27-VII:25-VIII					3	29-VII:27-VIII	12	29-VII:11-IX	31	30-VII:12-IX	70	E
21	Trimerotropis	verruculata	1	27-VII	13	28-VII:10-IX			3	04-VII:27-VIII	6	16-VII:27-VIII	2	17-VII:12-IX	25	Ws
	BLATELLIDAE															
22	Parcoblatta	pennsylvanica									10	18-VI:02-VII			10	Ws
23	Parcoblatta	sp. (immatures)									9	21-V:11-IX			9	
24	Parcoblatta	virginica									2	18-VI:02-VII			2	E
	GRYLLIDAE															
25	Allonemobius	allardi?	5	25-VIII:09-IX	6	26-VIII:10-IX	6	26-VIII:10-IX	8	27-VIII:11-IX			10	28-VIII:12-IX	35	Ws
26	Allonemobius	fasciatus	6	25-VIII:09-IX	4	26-VIII:10-IX			5	27-VIII:11-IX			7	28-VIII:12-IX	22	Ws
27	Allonemobius	g. griseus			5	26-VIII:10-IX			3	27-VIII:11-IX					8	Ws
28	Gryllus	pennsylvanicus	2	27-VII	1	10-IX			6	13-VIII:11-IX			8	30-VII:12-IX	17	Ws
29	Gryllus	veletis	16	18-V:14-VII					11	21-V:16-VII	3	21-V:02-VII	13	05-17-VII	43	Ws
	OECANTHIDAE															
30	Oecanthus	quadripunctatus	2	09-IX					4	27-VIII:11-IX			22	28-VIII:12-IX	28	Ws
	HETERONEMIIDAE															
31	Diapheromera	femorata									1	27-VIII			1	Ws

Table 11 - ORTHOPTEROID INSECTS COLLECTED IN SOUTHERN ONTARIO ALVARS IN 1997

	GENUS	SPECIES	CEG	DATE/CE	BPP	DATE/BPP	BPG	DATE/BPG	CRG	DATE/CRG	CRS	DATE/CRS	RAG	DATE/RAG	# COLL	DIST
	MANTIDAE															
32	Mantis	r. religiosa	23	25-VIII:09-IX					2	11-IX					25	E&W
	RAPHIDOPHORIDAE															
33	Ceuthophilus	brevipes?											1	12-IX	1	E
34	Ceuthophilus	meridionalis			3	17-VI:10-IX	1	10-IX	1	27-VIII	4	13-VIII	1	19-VI	10	G-Lakes
	TETRIGIDAE															
35	Nomotettix	c. cristatus	9	01-VI:14-VII			1	15-VII					5	05-VI:14-VIII	15	E
36	Tetrix	o. ornata	11	01-VI:25-VIII	44	02-VI:26-VIII	11	02-VI:10-IX	5	04-VI:29-VII	34	03-VI:29-VII	51	05-VI:12-IX	156	Ws
37	Tetrix	subulata	1	18-VI	8	02-VI:01-VII			3	22-V:18-VI					12	Ws
38	Tettigidea	lateralis	28	18-V:08-VIII	1	02-VI			73	04-VI:29-VII	1	02-VII	26	23-V:12-IX	129	Ws
	CONOCEPHALIDAE															
39	Conocephalus	attenuatus											1	14-VIII	1	E
40	Conocephalus	brevipennis							1	27-VIII			1	28-VIII	2	Ws
41	Conocephalus	fasciatus			1	12-VIII	2	26-VIII	6	13-VIII:27-VIII					9	Ws
42	Conocephalus	saltans							2	27-VIII			3	28-VIII:12-IX	5	Ws
43	Conocephalus	strictus	1	08-VIII											1	S
44	Neoconocephalus	ensiger							3	29-VII:11-IX					3	Ws
45	Orchelimum	sp.							1	27-VIII					1	
	TETTIGONIIDAE															
46	Metrioptera	roselii	5	16-VI:27-VII											5	E
	PHANEROPTERIDAE															
47	Scudderia	curvicauda									2	27-VIII			2	Ws
48	Scudderia	f. furcata	1	25-VIII							6	27-VIII:11-IX			7	Ws
49	Scudderia	sp.	2	14-VII:27-VII							2	16-VII:29-VII	1	17-VII	5	
	# SPECIMENS / SITE		221		165		62		317		125		860		1750	
	# SPECIES / SITE		29		20		12		28		22		30			

Table 12 - ORTHOPTEROID INSECTS COLLECTED IN THE GREAT LAKES ALVARS

	GENUS	SPECIES	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	BBP	BBG	QBG	GLCI	CRPD	DNDG	MNC	MND	MNK	MNM
	ACRIDIDAE																					
1	Camnula	pellucida	X	X	X	X	X	X	X					X								
2	Chloealtis	abdominalis		X										X								
3	Chloealtis	conspersa	X	X					X	X	X	X										
4	Chorthippus	c. curtipennis	X	X	X	X	X	X	X		X	X					X	X	X	X		
5	Chortophaga	viridifasciata	X			X		X														
6	Dissosteira	carolina	X			X		X	X		X							X				
7	Melanoplus	b. borealis	X	X	X	X	X	X	X	X	X	X						X				
8	Melanoplus	bivittatus	X	X	X	X	X	X	X	X	X	X			X			X				
9	Melanoplus	confusus						X														
10	Melanoplus	dawsoni				X			X		X											
11	Melanoplus	f. femurrubrum	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X		
12	Melanoplus	fasciatus	X		X	X	X	X	X	X											X	
13	Melanoplus	huroni								X												
14	Melanoplus	islandicus			X														X			
15	Melanoplus	keeleri luridus		X			X	X	X	X					X			X	X			
16	Melanoplus	mancus					X															
17	Melanoplus	p. punctulatus	X					X														
18	Melanoplus	s. sanguinipes	X	X			X	X	X	X	X	X			X			X		X		
19	Orphulella	p. pelidna	X					X														
20	Orphulella	speciosa	X	X		X		X														
21	Spharagemon	b. bolli	X			X	X	X														
22	Stethophyma	gracila																	X			
23	Trimerotropis	verruculata	X	X		X	X	X	X	X	X								X		X	
	BLATELLIDAE																					
24	Parcoblatta	pennsylvanica					X		X	X												
25	Parcoblatta	sp. (immatures)					X			X												
26	Parcoblatta	virginica					X			X												
	GRYLLIDAE																					
27	Allonemobius	allardi	X	X	X	X		X											X			
28	Allonemobius	fasciatus	X	X		X		X											X			
29	Allonemobius	g. griseus		X		X				X	X		X		X				X			
30	Gryllus	pennsylvanicus	X	X		X		X	X	X	X	X										
31	Gryllus	veletis	X			X	X	X	X		X											
	OECANTHIDAE																					
32	Oecanthus	quadripunctatus	X			X		X			X	X						X				
	HETERONEMIIDAE																					
33	Diapheromera	femorata					X											X				
	MANTIDAE																					
34	Mantis	r. religiosa	X			X																

Table 12 - ORTHOPTEROID INSECTS COLLECTED IN THE GREAT LAKES ALVARS

	GENUS	SPECIES	CEG	BPP	BPG	CRG	CRS	RAG	MIP	MIS	MIGS	MIG	BBP	BBG	QBG	GLCI	CRPD	DNDG	MNC	MND	MNK	MNM
	RAPHIDOPHORIDAE																					
35	Ceuthophilus	brevipes?						X														
36	Ceuthophilus	meridionalis		X	X	X	X	X	X	X												
	TETRIGIDAE																					
37	Nomotettix	c. cristatus	X		X			X			X								X			
38	Tetrix	o. ornata	X	X	X	X	X	X	X	X	X	X		X								
39	Tetrix	subulata	X	X		X																
40	Tettigidea	lateralis	X	X		X	X	X				X							X			
	CONOCEPHALIDAE																					
41	Conocephalus	attenuatus						X														
42	Conocephalus	brevipennis				X		X											X			
43	Conocephalus	fasciatus		X	X	X			X		X	X	X		X	X	X		X	X		X
44	Conocephalus	saltans				X		X			X	X				X			X			
45	Conocephalus	strictus	X																			
46	Neoconocephalus	ensiger				X											X		X			
47	Orchelimum	gladiator																	X			
48	Orchelimum	sp.				X																
	TETTIGONIIDAE																					
49	Metrioptera	roselii	X								X	X										
	PHANEROPTERIDAE																					
50	Scudderia	curvicauda					X		X		X	X							X			
51	Scudderia	f. furcata	X				X										X					
52	Scudderia	pistillata									X	X										
53	Scudderia	septentrionalis									X											
54	Scudderia	sp.	X				X	X	X													
	# SPECIES / SITE		29	20	12	28	22	30	20	16	21	15										

Table 13 - SIGNIFICANT INSECT SPECIES COLLECTED IN TEN SOUTHERN ONTARIO ALVAR SITES IN 1996 AND 1997

No	GENUS	SPECIES	AUTHOR	CEC	BPP	BPC	CRC	CRS	RAG	MIP	MIS	MIGS	MIG
	COLEOPTERA: CARABIDAE												
1	Agonum	crenistriatum	(LeConte)	X		X			X				
2	Agonum	nutans	(Say)	X		X	X		X				D
3	Amara	pennsylvanica	Hayward	X					D				
4	Anisodactylus	carbonarius	(Say)	X					X				
5	Carabus	sylvosus	Say				X			X			
6	Chlaenius	p. purpuricollis	Randall	X			X		D	X		D	X
7	Cicindela	denikei	Fabricius								X	X	
8	Cicindela	p. purpurea	Olivier				X	X	X	X		X	
9	Cyclotrachelus	s. sodalis	(LeConte)				X						
10	Cymindis	americanus	Dejean							X			
11	Harpalus	indigens	Casey						X				
12	Pterostichus	novus	Straneo	X	D	D	X	X	X	D	D	D	X
13	Selenophorus	gagatinus	Dejean	X			X		X				
14	Selenophorus	opalinus	(LeConte)		X								
	HOMOPTERA: CICADELLIDAE												
15	Aflexia	rubranura	(DeLong)							X		X	D
16	Auridius	sp.n.				X				X			
17	Flexamia	delongi	Cooley		X	D				X			D
18	Flexamia	inflata	(Osb. & Ball)	X									
19	Graminella	mohri	DeLong			X							
20	Idiocerus	productus	Gill. & Baker				X						
21	Limotettix	urnura	Hamilton			D				X		D	D
22	Memnonia	sp.n.						X	D	X			D
23	Mocuellus	americanus	Emeljanov							D			
24	Paraphlepsius	lobatus	(Osborn)			X				X			X
25	Pendarus	punctiscriptus	(VanDuzee)			X				X			X
26	Texananus	marmor	(DeLong)		X					X			X
27	Xerophloea	major	Baker	X									
	HOMOPTERA: DELPHACIDAE												
28	Caenodelphax	nigriscutellata	(Beamer)		X	X			X				X
	HOMOPTERA: CERCOPIDAE												
29	Clastoptera	arborina	Ball	X									
	LEPIDOPTERA: HESPERIIDAE												
30	Erynnis	lucilius	(Scud. & Burg.)				X	X	X	X	X		
31	Hesperia	comma	(Linnaeus)							X			X
	LEPIDOPTERA: LYCAENIDAE												
32	Incisalia	polios	Cook & Wats.			X			X	X	X		
	LEPIDOPTERA: NYMPHALIDAE												
33	Phyciodes	batesii	(Reakirt)				X	X		X			X

Table 13 - SIGNIFICANT INSECT SPECIES COLLECTED IN TEN SOUTHERN ONTARIO ALVAR SITES IN 1996 AND 1997

No	GENUS	SPECIES	AUTHOR	CEG	BPP	BPG	ORG	CRS	RAG	MIP	MIS	MIGS	MIG
	LEPIDOPTERA: PIERIDAE												
34	Euchloe	ausonides	Lucas							X			
35	Euchloe	olympia	(Edwards)	X				X				X	
	LEPIDOPTERA: SATYRIDAE												
36	Oneis	chryxus	(Dou. & Hew.)					X	X	X			
	HYMENOPTERA: SYMPHYTA												
37	Empria	candidata	(Fallen)							X			
38	Eutomostethus	luteiventris	(Klug)									X	X
39	Periclista	albicollis	(Norton)									X	
40	Periclista	diluta	(Cresson)									X	
41	Pseudodineura	rileda	Smith					X					
42	Rhadinocera	sp.n.			X								
43	Sterictiphora	serotina	Smith									X	
44	Zachizonyx	montana	(Cresson)					X					
	ORTHOPTERA: ACRIDIDAE												
45	Melanoplus	dawsoni	(Scudder)				X			X			
46	Melanoplus	huroni	Blatchley								X		
47	Melanoplus	mancus	(Smith)					X					
48	Melanoplus	p. punctulatus	(Scudder)	X					X				
49	Orphulella	p. pelidna	(Burmeister)	X					X				
	GRYLLOPTERA: RAPHIDOPHORIDAE												
50	Ceuthophilus	meridionalis	Scudder		X	X	X	X	X	X	X		
	GRYLLOPTERA: CONOCEPHALIDAE												
51	Conocephalus	saltans	(Scudder)				X		X			X	X
52	Conocephalus	strictus	(Scudder)	X									
	GRYLLOPTERA: PHANEROPTERIDAE												
53	Scudderia	pistillata	Brunner von W.									X	X
54	Scudderia	septentrionalis	(Aud.-Ser.)									X	
	# SIGNIFICANT SPECIES / SITE			14	7	12	13	11	18	23	6	14	16

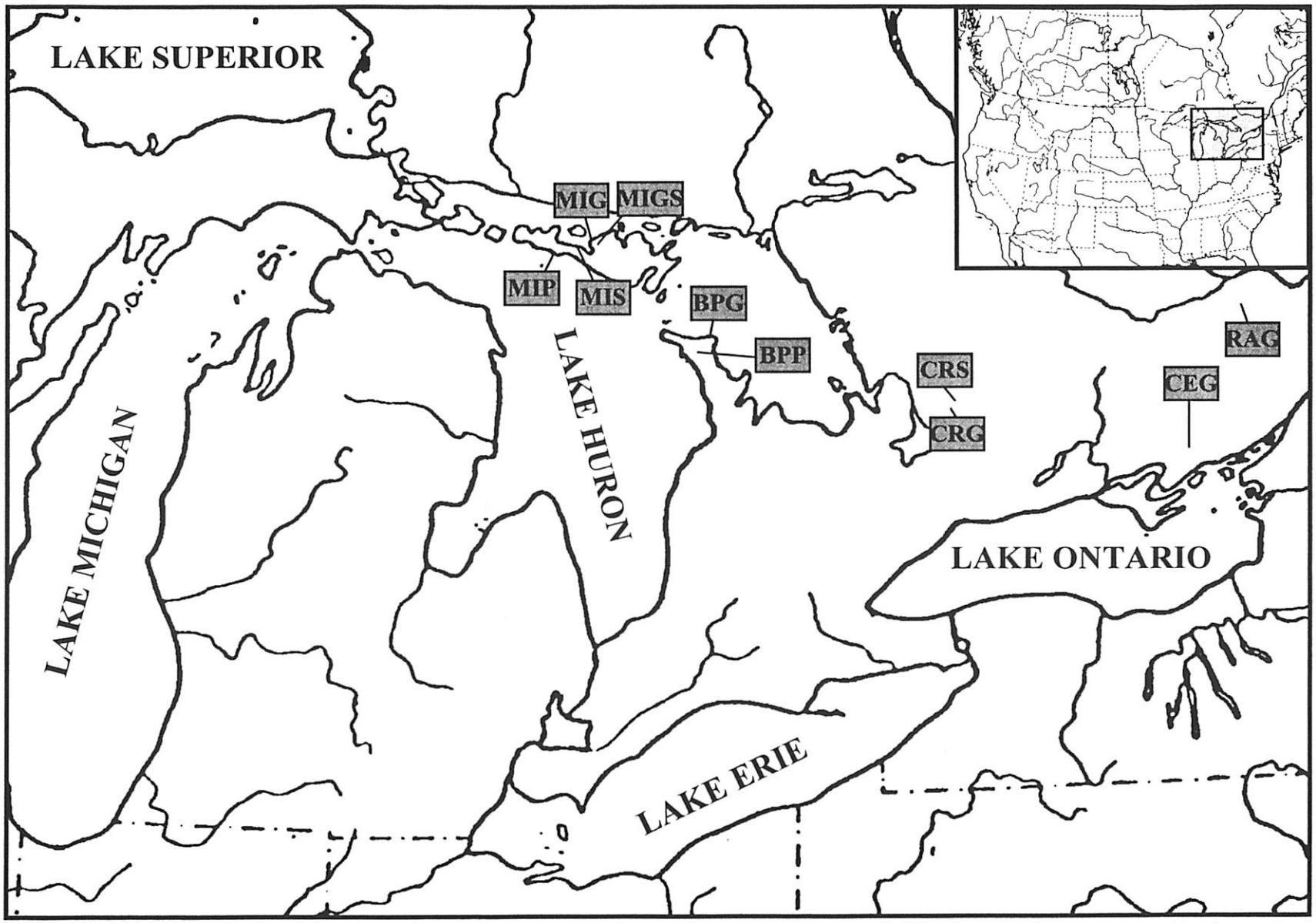


Figure 1 - Alvar sites sampled by the author on Manitoulin Island in 1996 (MIP=pavement, MIS=shrubland, MIGS=grassland savanna and MIG=grassland alvars) and in southern Ontario in 1997 (BPP= Bruce Peninsula: pavement alvar, BPG=Bruce Peninsula: grassland alvar, CRS=Carden Plains: shrubland alvar, CRG= Carden Plains: grassland alvar, RAG= Ramsay Twp.: grassland alvar and CEG= Camden East: grassland alvar).

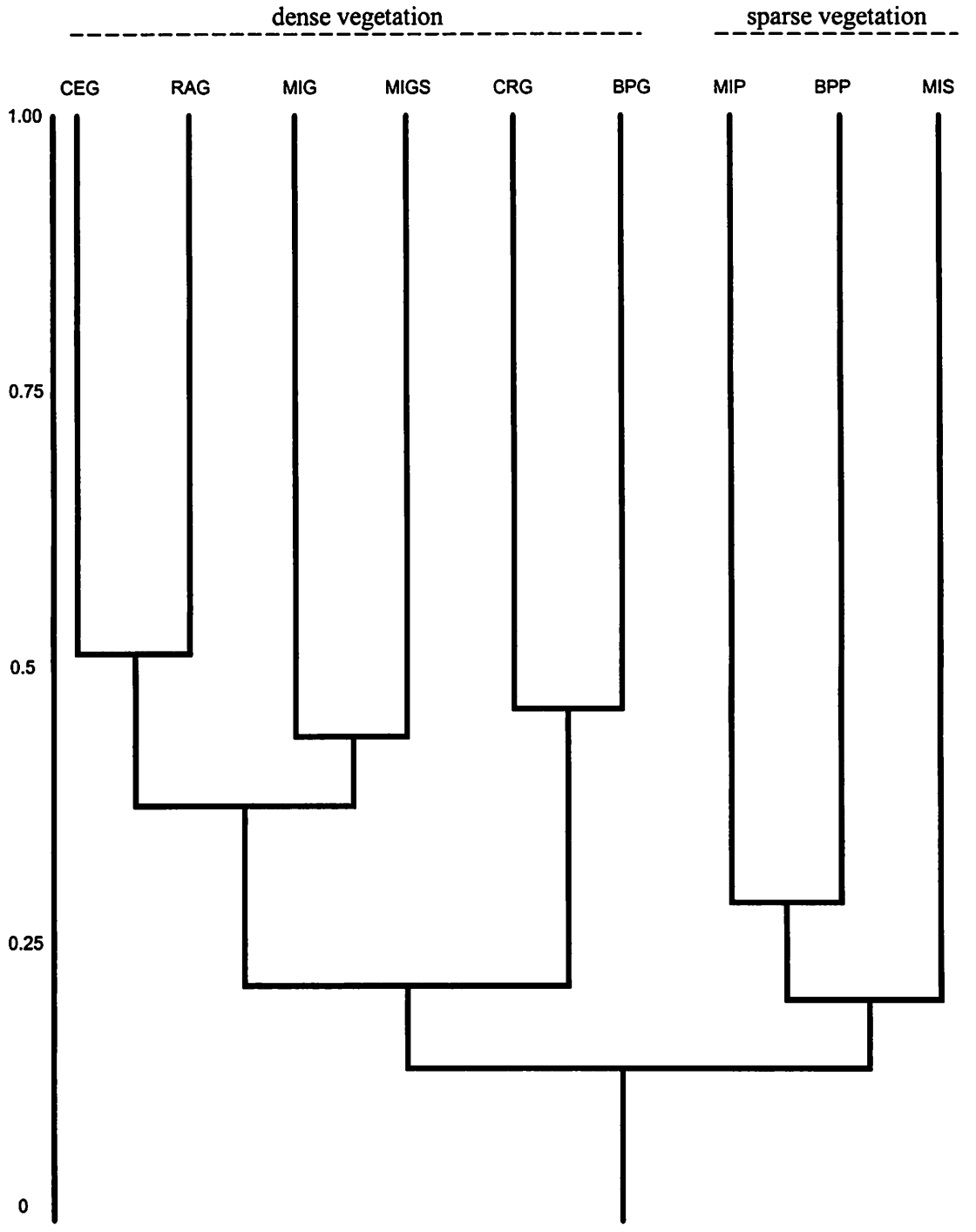
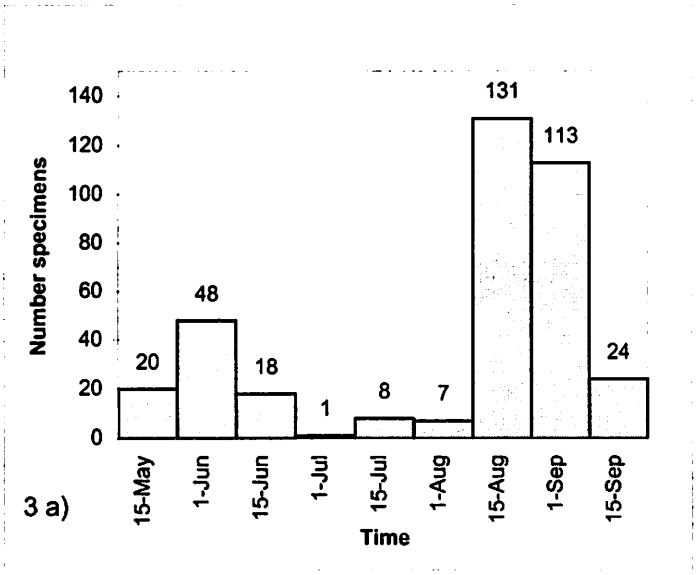


Figure 2 - Dendogram using Sorensen's Quantitative Index of Similarity showing percentage of similarity of the ground beetle fauna (Coleoptera: Carabidae) in nine alvar sites sampled in Ontario in 1996 and 1997.



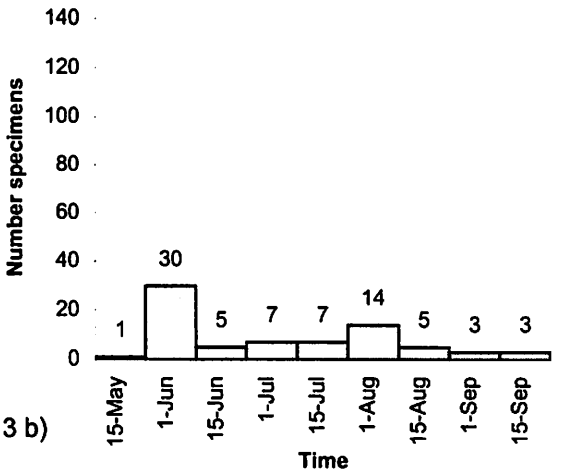
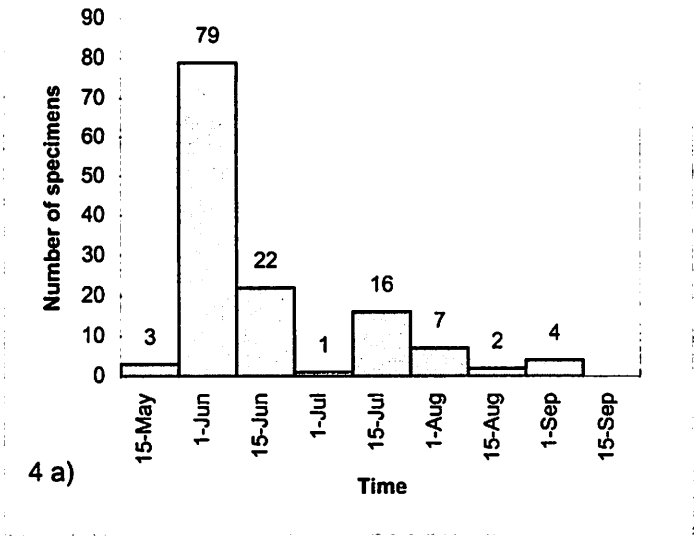


Figure 3 - Seasonal abundance of *Agonum nutans* (Say): a) 1996, b) 1997.



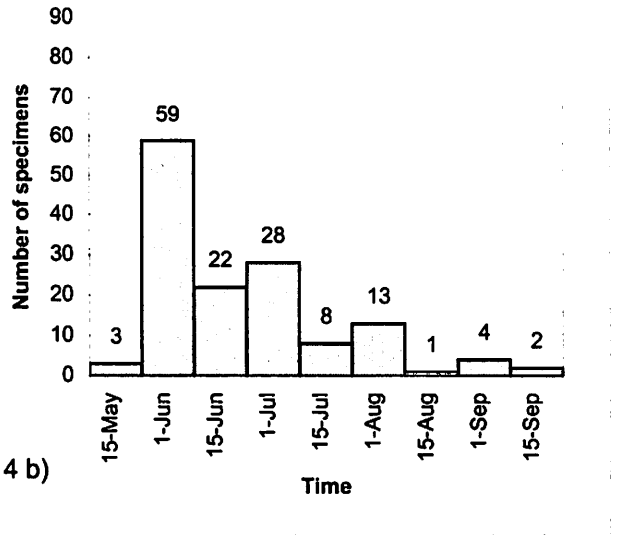


Figure 4 - Seasonal abundance of *Chlaenius p. purpuricollis* Randall: a) 1996, b) 1997.

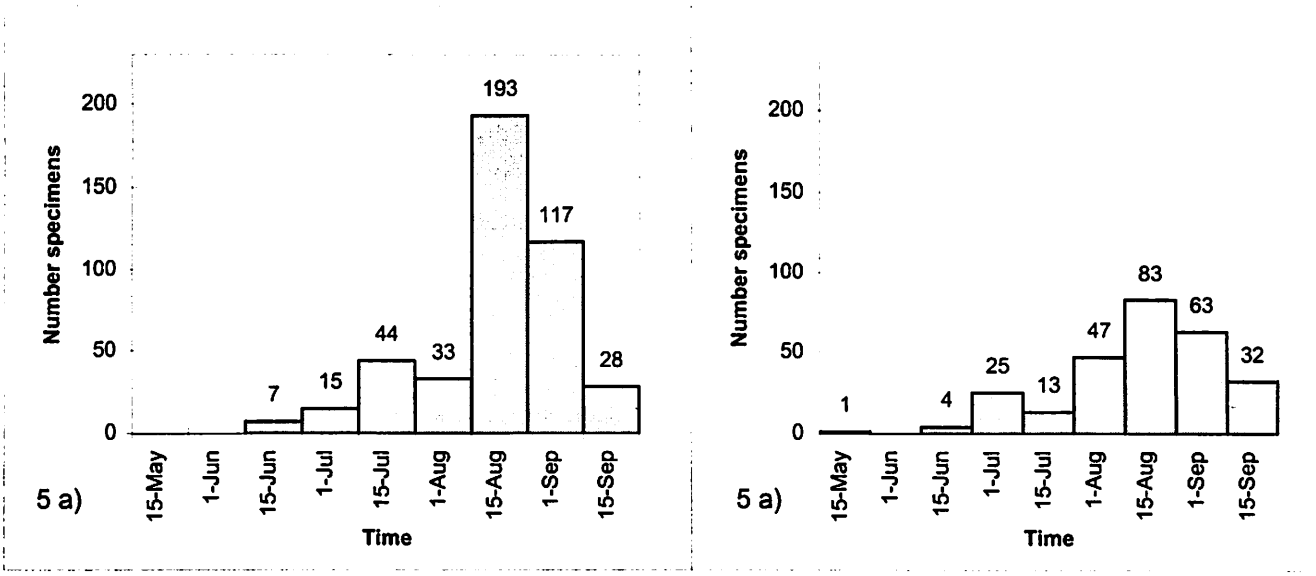


Figure 5 - Seasonal abundance of *Pterostichus novus* Straneo: a) 1996, b) 1997.

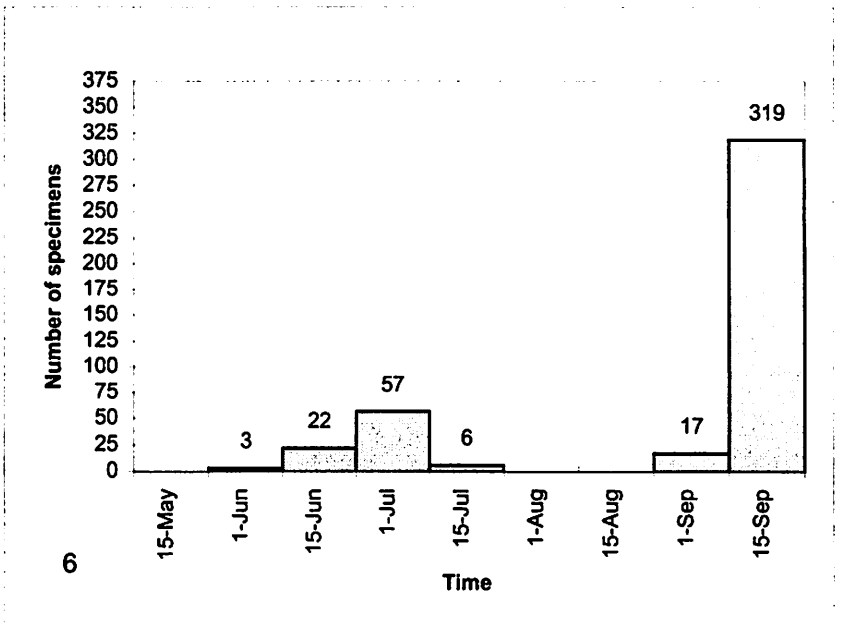


Figure 6 - Seasonal abundance of *Amara pennsylvanica* Hayward in 1997.