Insect Diversity on Mount Mansfield

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OBJECTIVES

(1) Record the insect biodiversity of Mount Mansfield with respect to taxonomic composition and abundance.

(2) Establish a long-term monitoring strategy for forest insects through permanent survey sites and traps.

(3) Compare and contrast insect biodiversity in three forest habitats on Mount Mansfield.

(4) Develop a fully curated and referenced voucher collection of Mount Mansfield forest insects.

(5) Provide a taxonomic foundation for future ecological classifications of insect diversity and associations with hosts and other ecosystem components.

METHODS

Sampling sites were established at three different elevations, 400 m in a sugar maple forest at the Proctor Maple Research Center (PMRC), 600 m in a mixed hardwood forest at Underhill State Park (USP), and at 1160 m near the summit of Mt. Mansfield (1348 m) in a sub-alpine balsam fir forest (MMS).

Five circular (20 m diameter) plots were established at each site. In each of the four outlying plots a canopy malaise trap was installed 10-15 m above ground in a dominant sugar maple or 2 m above ground in a balsam fir tree (sub-alpine habitat). A water pan trap was placed 60 cm above ground in the southwest sector of each plot and six pitfall traps were installed around the plots at 60° intervals. One light trap was placed in the center plot. Two one m^2 plant survey plots were established 10 m to the east and west of plot center. Samples were collected, pressed and identified (Table 1).

Killing agents in the field include a 0.05% formalin solution in the pitfall traps, an alcohol/glycerine/acetic acid (AGA) solution in malaise traps, a water/salt/detergent solution in the waterpan traps, and a plaster-of-paris block saturated with tetrachloroethane in each of the light traps. Specimens were collected twice a week for pitfall, malaise, and water pan traps, while the light traps were operated once a week from June 1 to October 30 1991. Pitfall trap specimens were sorted at the St. Albans Correctional Facility. Insects from the light traps and waterpan traps were sorted and stored at the Entomology Research Laboratory. Coleoptera and Lepidoptera were pinned and stored in Cornell drawers while other insects and non-insect invertebrates were stored in 80% alcohol. Insects collected from the malaise traps are currently being sorted and cataloged.

RESULTS

(a) Water pan Traps

The two main orders collected were Hymenoptera and Diptera. Occasional specimens were also collected from Mecoptera, Hemiptera, Plecoptera,

Table 1. Plant species and number of individuals found in sample plots within each of the three main research sites on Mount Mansfield. MMS = Mount Mansfield Summit, USP = Underhill State Park, PMRC = Proctor Maple Research Center.

Species:	Sites/No. Individuals		
	MMS	USP	PMRC
Abies balsamea	7	1	1
Acer saccharum		3	3
A. pensylvanica		2	
A. spicatum		1	2
Anthyrium femina		1	3
Betuala cordifolia	3		
Clintonia borealis	2		
Coptis groenlandica	4		
Cornus canadensis	4	2	
C. cornuta			1
Dryopteris spinulosa	7	7	4
Graminae	1	3	
Fagus grandifolia		1	1
Impatiens capensis			5
Lycopodium lucidum	3	4	
Onoclea sensibilis			1
Osmunda cinnamomea			2
Oxalis montana	4	3	
Picea rubens	1		
Ribes glandulosum	2	3	
Rubus idaeus		1	3
Solidago rugosa		1	5
Thelpteris noveborac		1	1
Trientalis borealis	2		
Trillium grandiflorum			
Vaccinum corymbosum			
Viburnum alnifolium		3	
Viola sp.			2

Coleoptera, and Lepidoptera, but were not collated in the present study. Sample comparisons were confined to Diptera which was the only group present in large numbers. Taxa difficult to identify and not collated include the Culicidae (mosquitoes), Chironomidae (midges), and Simuliidae (blackflies).

A total of 849 specimens of Diptera were collected from 14 families (Fig. 1). The Mt. Mansfield summit site has the largest number of families (13) and individuals (725). Tachinidae (parasitoids) were most abundant at all three sites, while Muscidae (detrital feeders) were second most abundant in the MMS and PMRC. Locally abundant groups include Bibionidae (detrital feeders) in USP, Heleomyzidae (detrital feeders) in MMS, and Rhagionidae (predacious) in PMRC (Fig. 2).

(b) Pitfall traps

A range of insects and other invertebrates were collected (Table 2). The non-insect macro-invertebrates were represented by six major groups with the Areneda and Philangida comprising 88% of all individuals (Fig. 3). Insects abundance was represented by two Coleoptera families, ants (Formicidae) and one species of camel cricket (Gryllacrididae) (Fig. 4).

Table 2. Insects and other invertebrates collected from pitfall traps on Mount Mansfield.

Taxon	Abundance
Insecta	
Carabidae	1741
Staphylindae	814
Formicidae	418
Elateridae	57
Gryllacrididae	618
Areneda	2201
Phalangida	1270
Chilopoda	22
Diplopoda	375
Gastropoda	
snails	25
slugs	34

The ground beetles (Carabidae) were identified and compared at the species

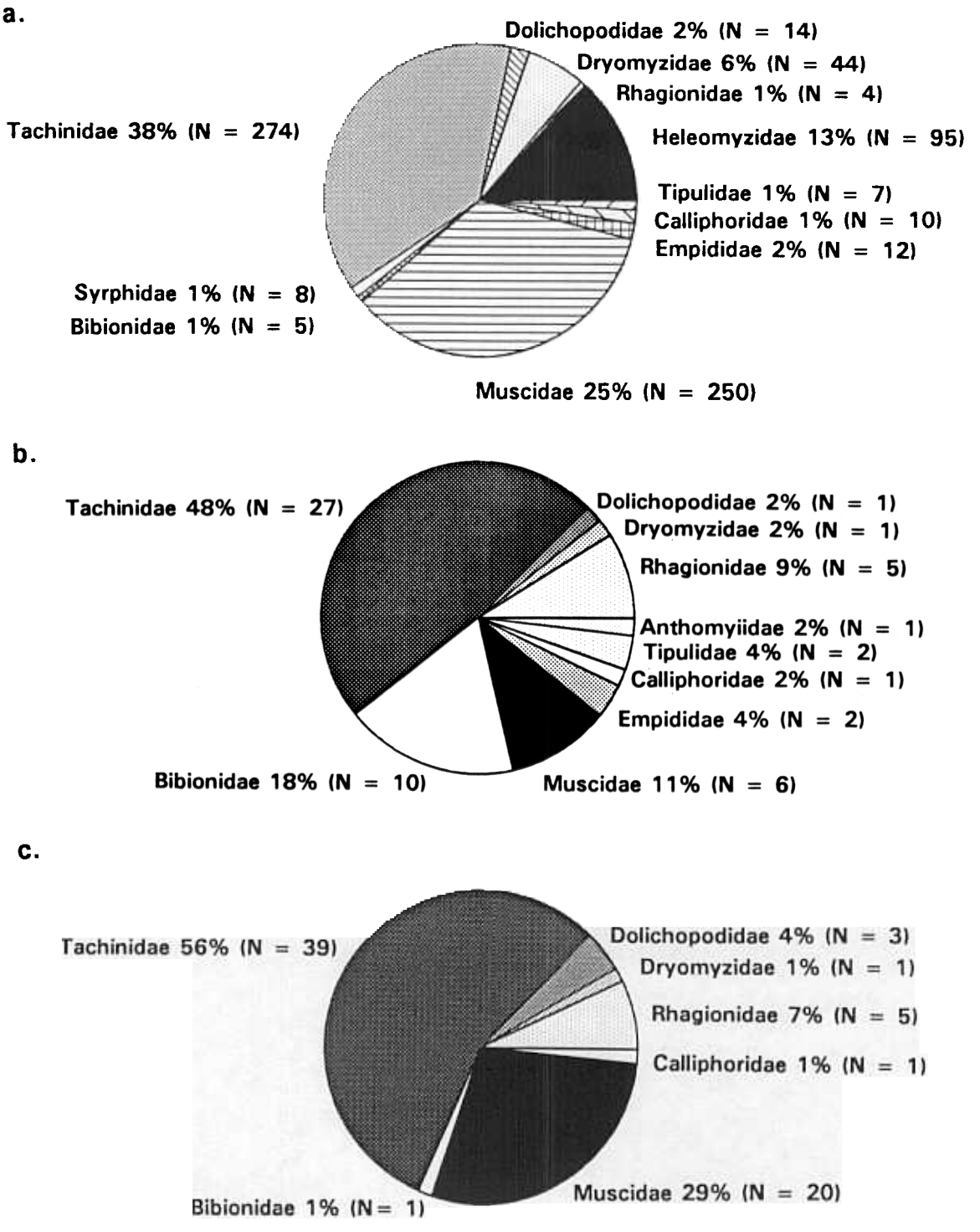


Figure 1. Abundance of Diptera families collected on Mount Mansfield in waterpan traps at: (a) the high elevation survey site (MMS) on Mount Mansfield, (b) the Underhill State Park survey site (USP) on Mount Mansfield, and (c) the Proctor Maple Research survey site (PMRS) on Mount Mansfield.

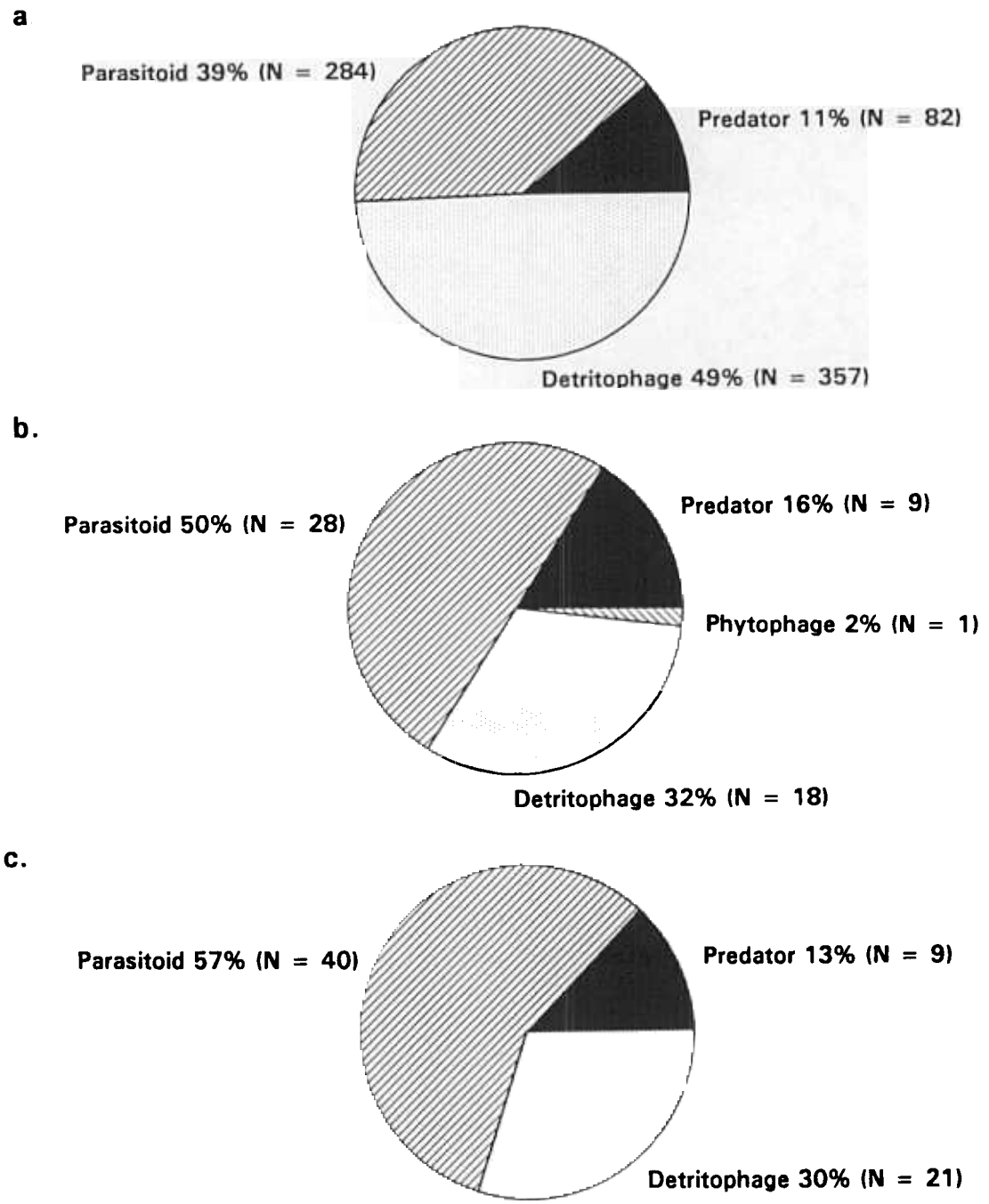


Figure 2. Abundance of Diptera feeding guilds (as represented by the larval stage) for families collected in waterpan traps on Mount Mansfield at: (a) the high elevation survey site (MMS) on Mount Mansfield, (b) the Underhill State Park survey site (USP) on Mount Mansfield, and (c) the Proctor Maple Research survey site (PMRS).

level. Out of the 32 species collected (Table 3) 12 were found at all three sites while a further 12 were each present at one site only. The four most abundant species (over 100 specimens) were present at all three sites. The total number of species in each habitat was similar (MMS 22, USP 22, and PMRC 20), but USP supported the highest total number of individuals with 1120 specimens, compared with 429 in PMRC, and 192 in MMS (Fig. 5).

Figure 3. Abundance of major non-insect macroinvertebrates (as % of total) combined for pitfall trap collections at all three survey sites on Mount Mansfield

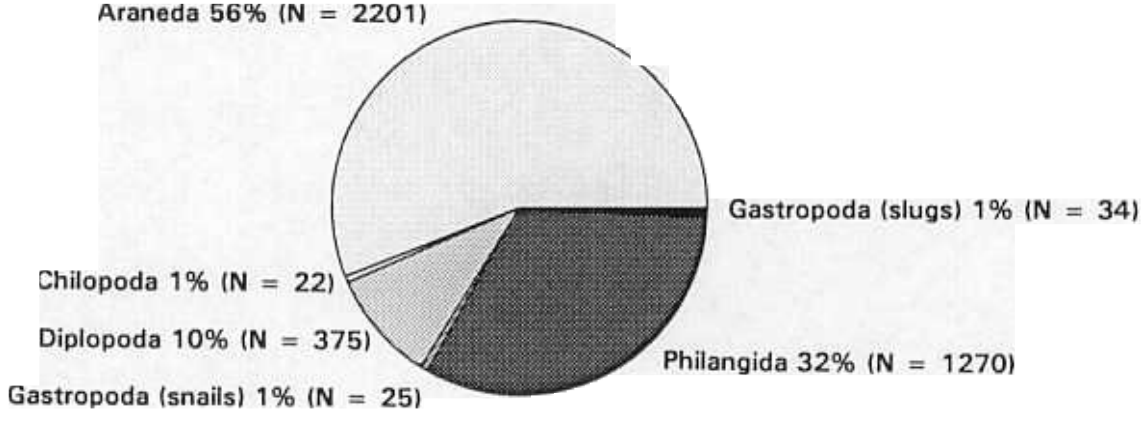
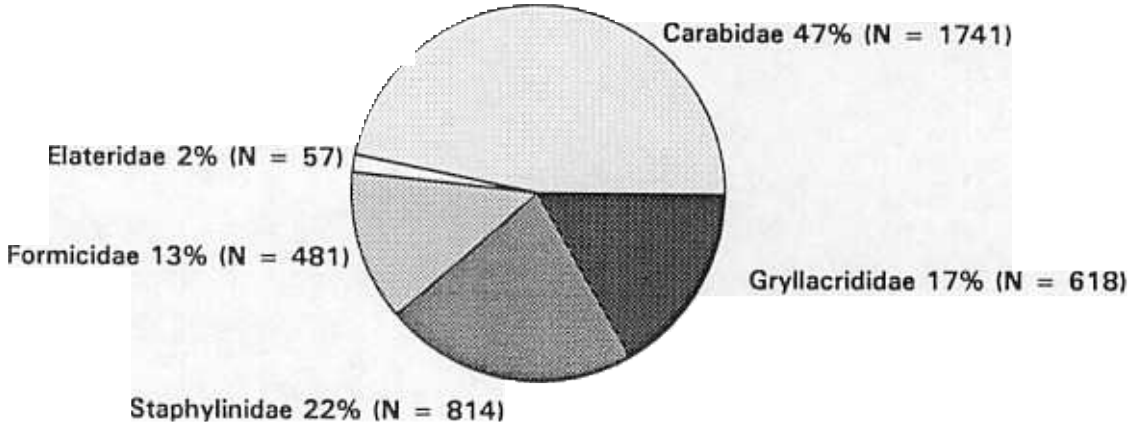


Figure 4. Abundance of the most common insect families (as as % of total) combined for pitfall trap collections at all three survey sites on Mount Mansfield.



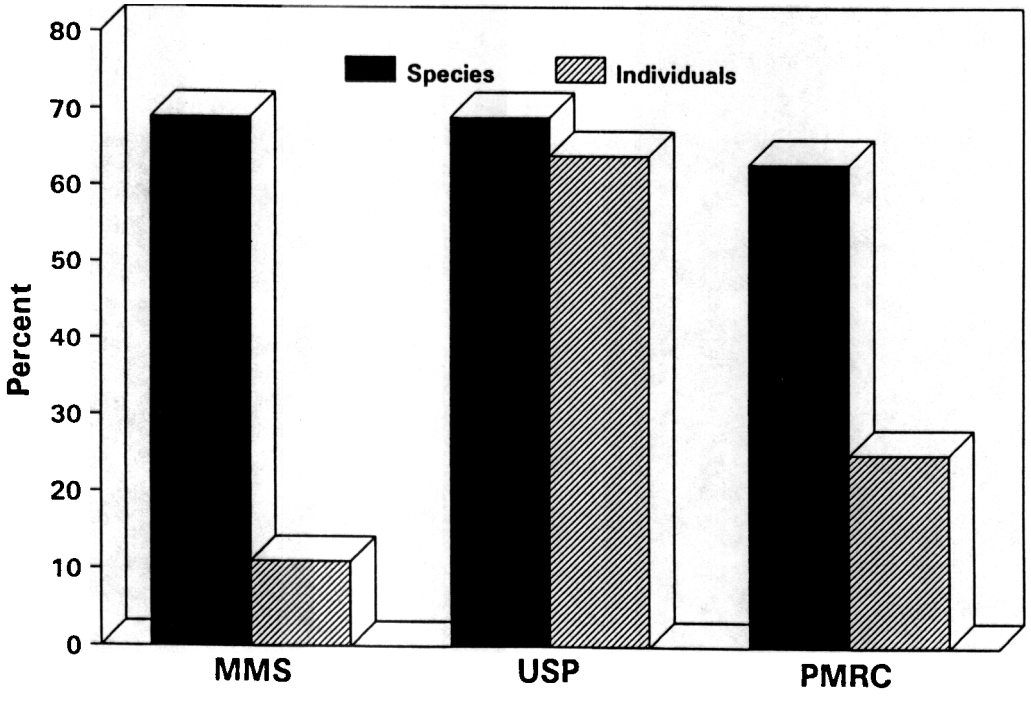


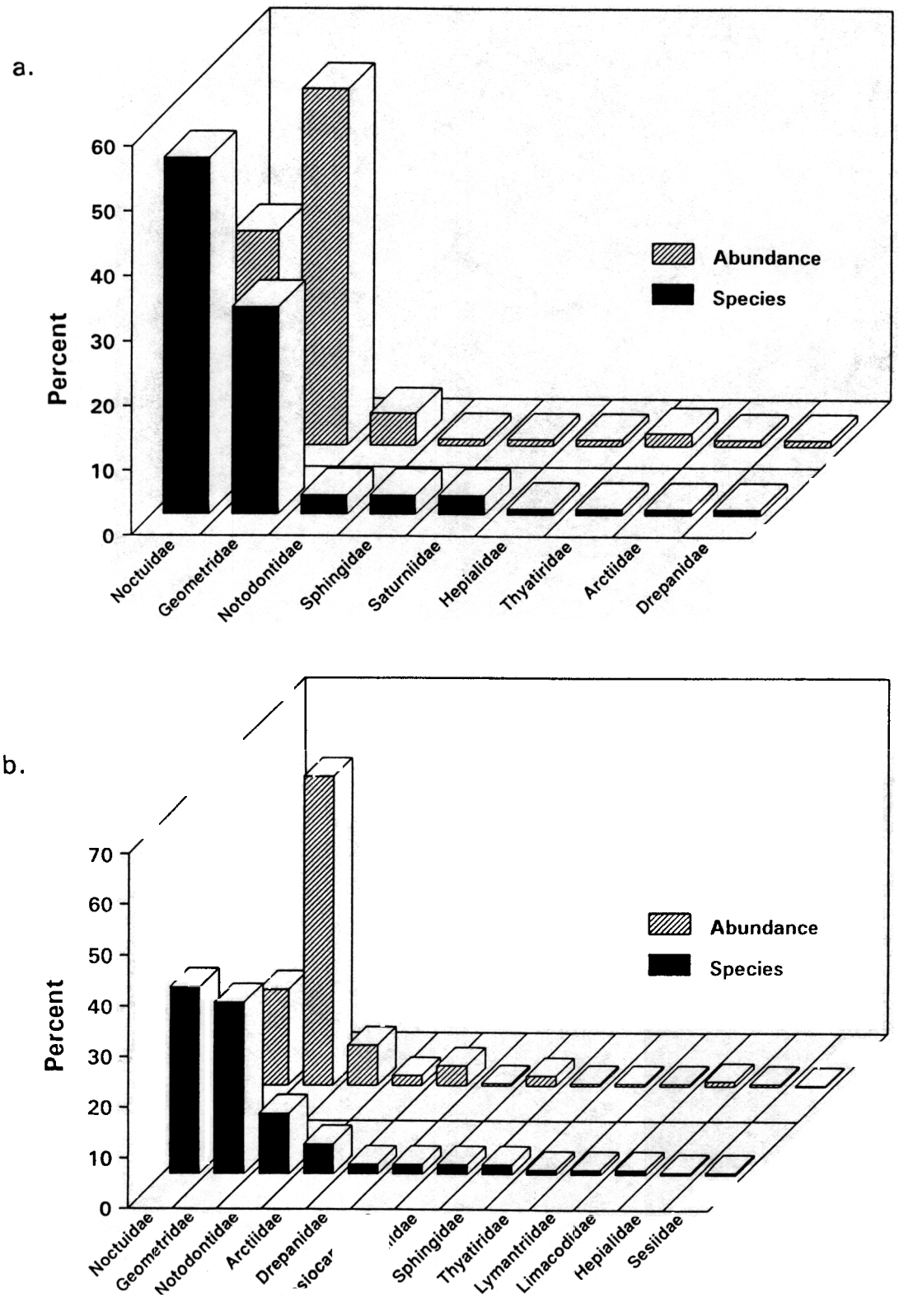
Figure 5. Percentage of species and individuals of Carabidae (Coleoptera) collected from pitfall traps for all three sites on Mount Mansfield.

(c) Light Traps

About 227 species of moths (Lepidoptera) were collected and identified. Comparisons were confined to "macrolepidoptera" which represents an artificial grouping of families with relatively large and easily identifiable species. It leaves out a considerable number of species and taxonomic groups also of interest to forest entomology, but the selection was necessary because many "microlepidoptera" are difficult to identify without appropriate reference material or specialist knowledge and methods (such as microscopic examination or genitalic dissection). The 1992 Lepidoptera survey will be expanded to include the microlepidoptera.

The results of the macrolepidoptera survey are presented as a summary of species diversity and abundance for different families (Fig. 6.). The families Noctuidae and Geometridae were dominant at all three sites in both species and numbers of individuals. The Notodontidae (closely related to Noctuidae) were the next dominant group. The remaining families were minor with respect to both species and abundance. Comparison of total species and abundance show that PMRC supported the highest numbers, while MMS supported very few (Fig. 7).

Figure 6. Species diversity and abundance of Lepidoptera families collected from Mount Mansfield light traps at: (a) the high elevation survey site (MMS), (b) the Underhill State Park survey site (USP), and (c) the Proctor Maple Research Center (PMRC).



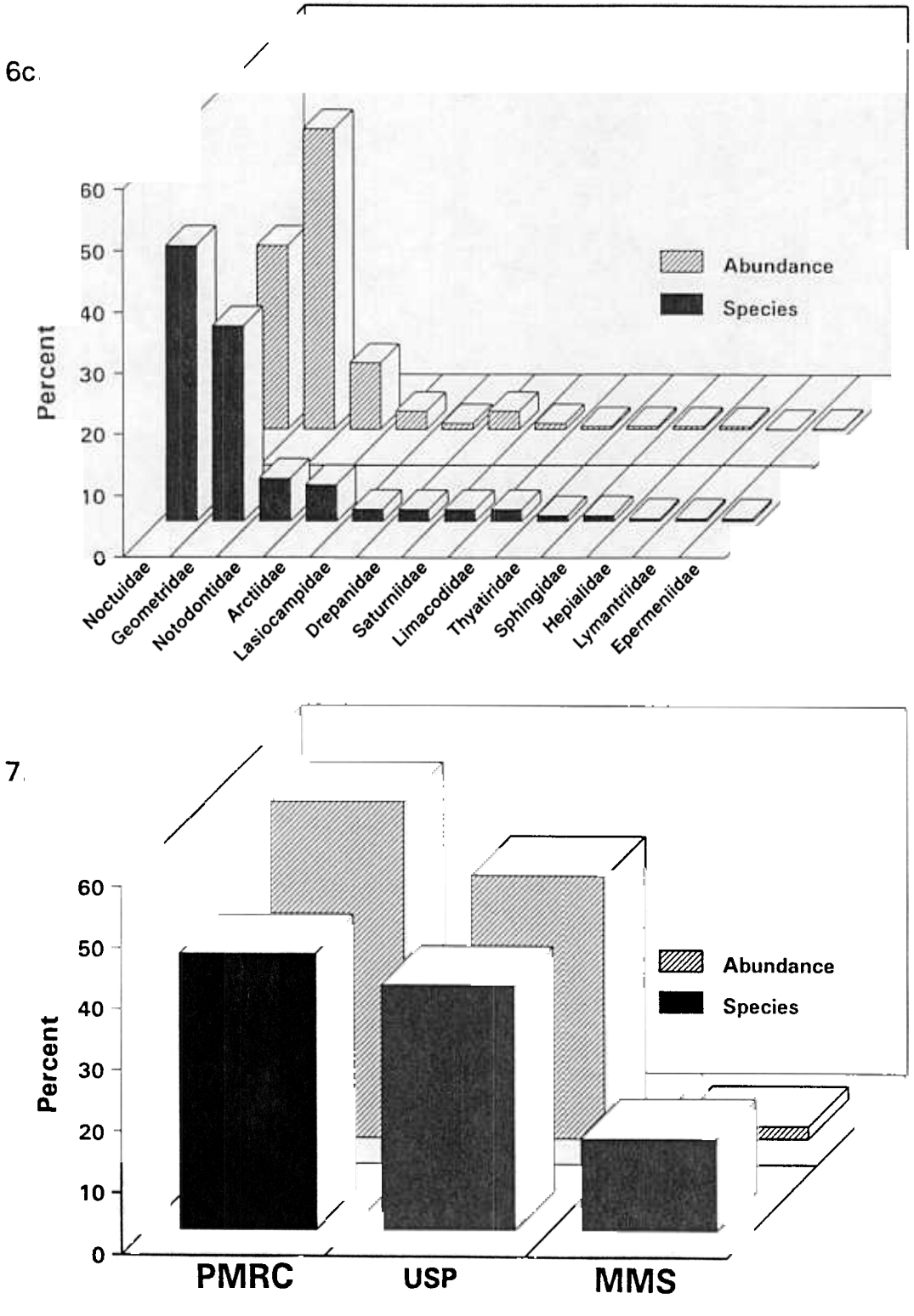


Figure 7. Percentage of species and individuals of Lepidoptera families collected from light traps for all three survey sites on Mount Mansfield.

SIGNIFICANT FINDINGS

The taxonomic focus on individual insect groups has the advantage of providing sufficient detail to recognize records of general ecological significance. In this respect several records from the 1991 season are noteworthy. Two Lepidoptera (Noctuidae) species - *Anomogyna rhaetica* Staudinger (MMS) and *Platypolia atricornis* Grote (PMRC) - qualified for inclusion in the special animal survey category in the Vermont Nongame and Natural Heritage Program (Department of Fish and Wildlife). Several species collected may represent new records for Vermont, but this designation is often uncertain because of the lack of comprehensive published records.

Four specimens of the high elevation species Sphaeroderus nitidicollis brevoorti Leconte (Carabidae) were collected from MMS. This beetle has a geographic range from Nova Scotia to the northeastern United States and New York, and west to Manitoba (Lindroth 1961). It is a "cold climate" species and may be sensitive to climate changes. It has been recorded in Vermont from Camel's Hump, but has not been sighted for several years (R. T. Bell, pers. comm.).

DISCUSSION

Mount Mansfield includes the only extensive sub-alpine/alpine habitat in Vermont. High elevation habitats have a fragile ecology susceptible to long-term environmental changes such as climate change and atmospheric pollution. The comparison of insect diversity and abundance between habitats may provide an important primary insight into long-term ecological trends affecting changes in the community structure of the forest habitat.

Taxonomy is critically important to the success of invertebrate ecosystem studies. Taxonomic detail is possible in the present study only for Carabidae and Lepidoptera. Several other groups may also be treated in similar detail within the present program, but the majority will require years of work. Available taxonomic expertise is limited and dispersed, while the published literature is often inadequate to meet the general identification requirements of a fauna survey. One partial solution is for the Vermont Monitoring Cooperative to develop its own taxonomic resource as is currently being prepared for the Carabidae, Lepidoptera, Diptera, and Hymenoptera. Even with this resource, utilization is dependant on the maintenance of staff with appropriate taxonomic skills and experience. Without this resource long-term invertebrate ecosystem studies are impossible.

CONTEXT

The Lepidoptera records are contributing to an inventory of the Vermont Lepidoptera fauna through a cooperative project between the Entomology Research Laboratory, the Extension Service, Lyndonville State College, and amateur lepidopterists. A

comprehensive list of Vermont moths and butterflies is being prepared for publication, and is based on voucher specimens maintained in Vermont, including a State reference collection at the Entomology Research Laboratory comprising over 1,000 identified species. The carabid collection will contribute to a Vermont faunal list currently being prepared by R. T. Bell, Zoology Department, UVM.

FUTURE PLANS AND POTENTIAL OPTIONS

The present survey represents only the beginning of a research program that will need to address a range of questions if the taxonomic and ecological diversity of invertebrates is to be precisely characterized. It is expected that several years of collecting will be necessary to establish an accurate inventory of the fauna. The current study concentrates only on certain groups, but future work will need to expand the coverage to include the remaining invertebrate fauna, particularly the Myriopods (centipedes and millipedes), the Arachnida (spiders), and the Mollusca (snails and slugs). Many insects collected are recognized pests of recreational and commercial forestry. The composition and relative abundance of such pests should be identified in the future. The larval stages of many species are economically and ecologically significant, but they are often not well known compared to the adult stage. The adults surveys should be complemented by establishing an inventory of larval stages.

Complementary to the taxonomic work will be a precise documentation of feeding ecology for the invertebrates. In particular, feeding associations should be investigated for the groups currently under study. The biomass representation of invertebrates should be established relative to the total ecosystem. For example, the Sphingidae and Saturniidae are low in numbers and species, but include the largest bodied insects found in the Mt. Mansfield habitats. A regional context for the insects should be established through a total geographic record of the localities. These records will provide information on the local and regional significance of the mount Mansfield fauna.

The light-trap method is constrained by recording only those species attracted, and does not, therefore, provide a complete record of all groups and species. For example, the maple leaf cutter (a significant forest pest) is abundant in the two lower sites, but its diurnal habit excludes it almost entirely from the survey. Other species may be only infrequently attracted to the trap. An ideal long-term strategy for surveying the Lepidoptera would include a variety of methods. Possibilities include the use of different light sources (incandescent, mercury vapor), and other traps (bait, sticky traps). Future traps for other insects could include ground malaise traps and tree trunk traps.

REFERENCE

Lindroth, C. H. 1969. The ground beetles of Canada and Alaska. Entomologiska Sällskapet, Lund

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