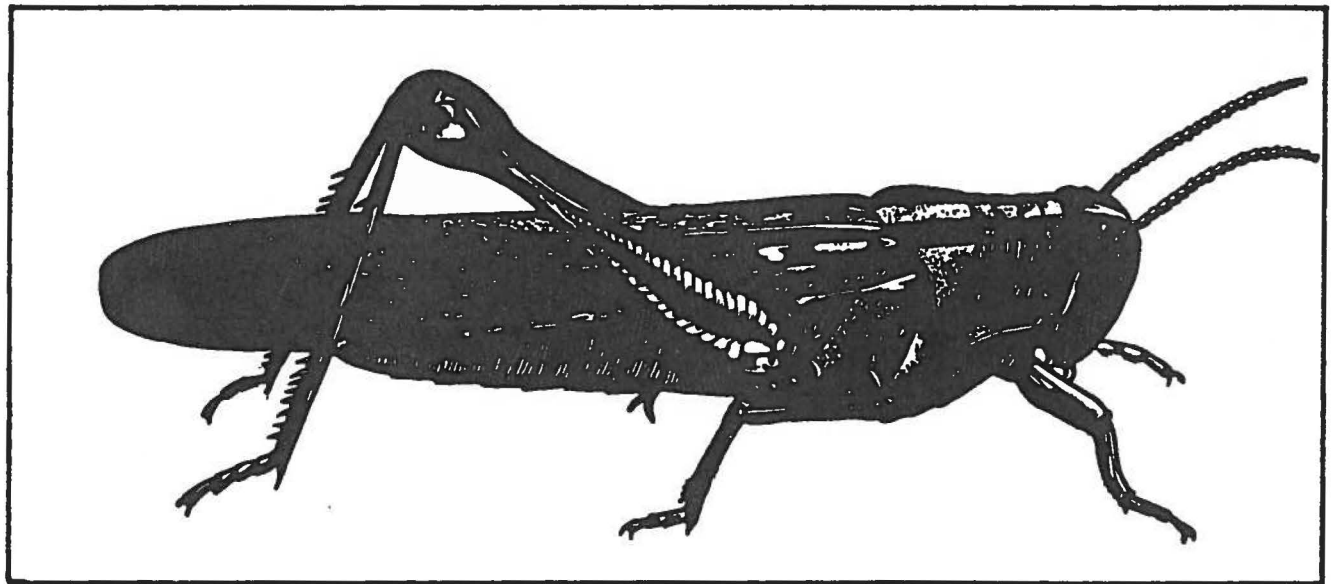


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## CURRENT NOTIONS ABOUT SYSTEMATICS AND CLASSIFICATION OF INSECTS\*

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Following is a statement of a personal (though not original) conception of the nature of systematics, based on consideration of recent literature about this field. It is a point of view rather than an evaluation of all of the possible approaches to systematics that have been advocated. Classification of insects is used to exemplify some principles and methods. Additionally, reference is made to identification of insects as a major immediately practical aspect of the work of insect systematists.

### GENERAL ASPECTS

Systematics is the study of diversity, or of relationships among organisms at the population level, or above. This field includes the following components (Figure 1): 1. biosystematics (study of origin and differentiation of living systems), with two subsections – speciation (study of origin and evolution of species), and phylogeny (study of relationships among species); and 2. taxonomy (study and application of the principles of classification to organisms, and naming of the recognized taxa) (Ross 1974). Thus, all taxonomists are by definition (or inclusion relations) systematists, but not all systematists are taxonomists (that is, a systematist can concentrate on biosystematic aspects, without regard for the taxonomic consequences of these studies).

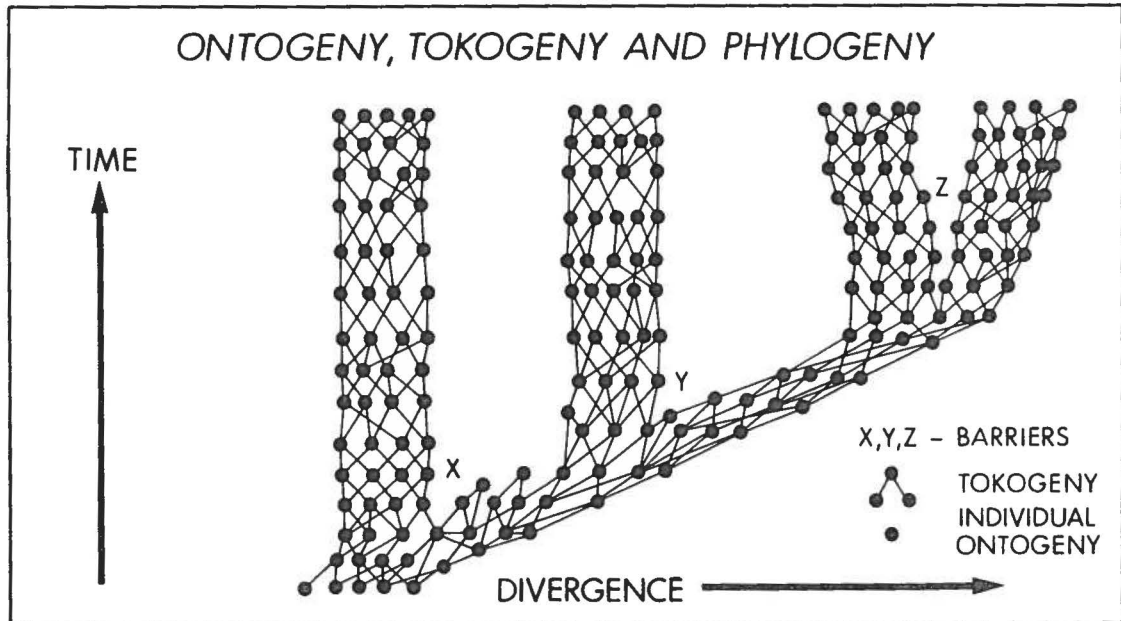
Evidence about biological relationships is obtained from similarity (that is, shared character states, from which past genetic contiguity is inferred), or from inference of contiguity, directly. Relations of contiguity include ontogeny (development of individuals), tokogeny (events related to birth, including those involved with fertilization of ova), and phylogeny (development of lineages, which achieve their independence from other lineages when toko-genetic relations among related groups are no longer possible – that is, when reproductive isolation has been attained) (Hennig 1966). Ontogeny, tokogeny, and phylogeny are the inter-locking elements of the great current of life that flows through time and space on this planet, and includes ultimately all beings now living, or that have lived in the past (Figure 2). "Current" in the title of this paper refers not only to contemporary events, but also to the relations that link all organisms.

FIG.1

COMPONENTS OF SYSTEMATICS AND TYPES OF SYSTEMATISTS	
SYSTEMATICS	SYSTEMATIST
BIOSYSTEMATICS	
SPECIATION	SPECIATIONIST
PHYLOGENY	PHYLOGENIST
TAXONOMY	TAXONOMIST
CLASSIFICATION	
NOMENCLATURE	

\*This is an abstract of the text for an address presented on November 13, 1980, at the Annual Meeting of the Entomological Society of Manitoba, Winnipeg, Manitoba.

FIG. 2



Because of links of contiguity, living organisms are part of a natural system (Griffiths 1974), and their relationships should be reflected in their formal classification – as Darwin advocated, more than a century ago. Phylogenetic systematics is based on this line of reasoning. A recent formulation of principles (Platnick 1979) is the following:

1. Nature is ordered in a single specifiable pattern, which can be represented by a branching diagram, or hierarchical classification.
2. The pattern can be estimated by sampling characters and providing replicable, internested sets of derived character states.
3. Knowledge of evolutionary history, like classifications, is derived from the hierarchical pattern thus hypothesized.

Evidence for past contiguity is derived from relations of similarity, of which there are four sources (Figure 3): holomorphy (the holomorph is an individual from birth to death, including its structure, functions, life stages, and relations with the environment); chorology (distribution in space); palaeontology (distribution in time of living and extinct taxa, as well as study of extinct taxa, themselves); and parasitology (host animal relationships and host plant relationships). Characters derived from these sources are not only evidence of relationships, but also information for recognition of taxa and their members.

Progress in understanding taxa is made by successive studies of aspects of holomorphy (Figure 4). Structural features of adults were the first to be used, and are universally employed in study of most animal groups, including insects. Characters of immature forms have been investigated in many taxa, and in some (such as nematoceran Diptera), such studies are routine. Developmental features (that is, metamorphosis) have been employed for several hundred years. Ethological, physiological, cytological, genetic, and biochemical characters are receiving attention, for use in those groups where they can be most effectively applied. In fact, it would be impossible to understand interrelations of some taxa unless such characters were studied.

Figure 5 illustrates in a very general way historical aspects of use of different character systems in classification of insects. The vertical axis represents time, from Aristotle (third century, B.C.) to the present. Above the thick diagonal line (labelled NATURAL HISTORY), the horizontal axis is divided into segments representing character systems used. Below the diagonal line are recorded in the time of their discovery events of importance: some in development of biological theory in general, others in development of classification.

FIG. 3

# SYSTEMATICS AND ITS SOURCES OF EVIDENCE OF RELATIONSHIPS

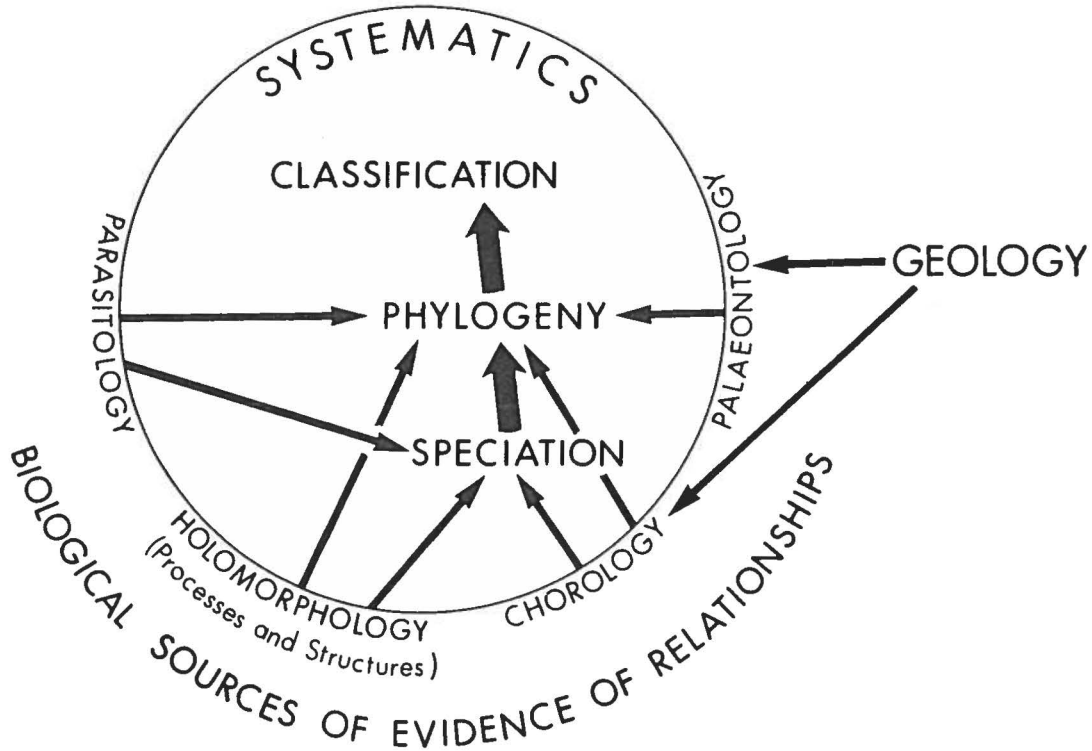
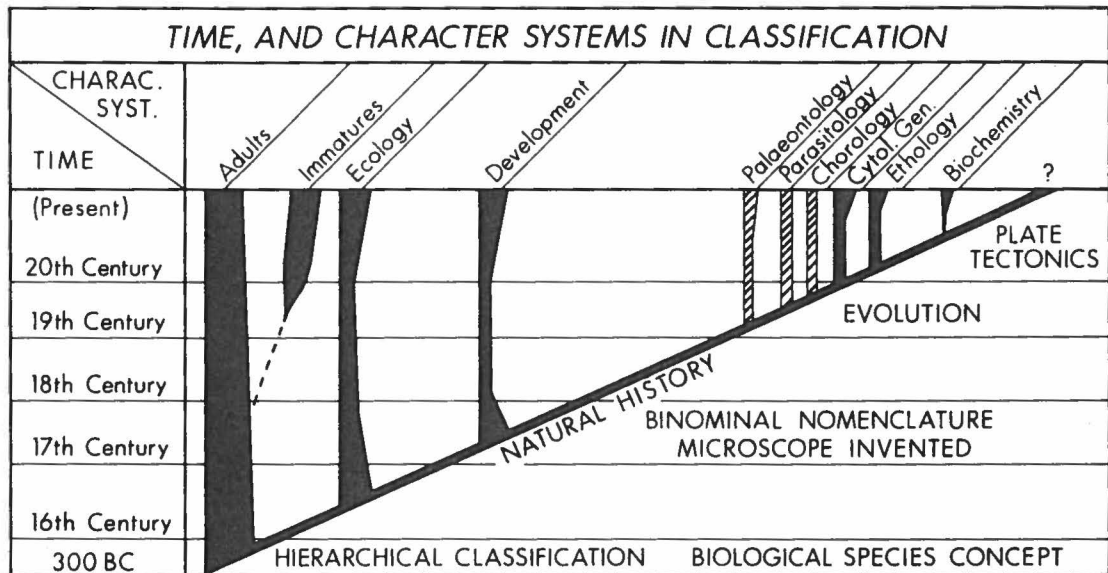


FIG. 4

CHARACTERS FOR RECOGNITION OF SPECIES AND HIGHER TAXA	
HOLOMORPHOLOGICAL	
STRUCTURAL FEATURES Adults Immatures	CYTOLOGICAL FEATURES Chromosome Banding Chromosome Form Chromosome Number
ETHOLOGICAL FEATURES Sounds Activity Patterns	BIOCHEMICAL FEATURES Proteins Enzymes Pheromones
ECOLOGICAL FEATURES Habitat Seasonal Occurrence	
CHOROLOGICAL Distribution in Space	PALAEONTOLOGICAL Distribution in Time
PARASITOLOGICAL Host Plant Relationships Host Animal Relationships	

Natural history, or study of organisms in the field under natural conditions, is perceived as the well-spring which has motivated and links together studies of particular aspects of organisms (Darlington 1980: viii). Vertical columns are of two types: black and striped. Black columns represent holomorphological features – those that are intrinsic properties of organisms. Diagonally striped columns represent extrinsic properties of organisms that are useful in classification. Thickness of columns represents in a very rough, relative way extent of use of each character system in classification. Length of column is in proportion to the time each character system has been used in classification of insects. In essence, Figure 5 is a phylogenetic diagram of development of the basis of insect classification. Other aspects are discussed below. Such a diagram could be developed for other taxonomic groups, as well.

FIG. 5



One of the important aspects to note is that use of character systems has been accumulative. That is, those studied earlier are not discarded as the result of later developments. Thus, study of adult structure is still an important component of taxonomic work today, even though many other systems are studied as well. To resolve the correlations that result from use of many characters, complex mathematical formulations can be employed, with iterative operations carried out by computers (Sneath and Sokal 1973).

A second important aspect is that the biological species concept is very old, and has been a basic (though unspecified) tenet of biological classification for a very long time (Berlin 1973).

A third aspect involves the role of Linnaeus (1707 to 1778). He is generally credited with originating a hierarchical system of classification in biology, and binominal nomenclature. The diagram shows, however, that both of these developments preceded the 18th Century, that is, the time of Linnaeus. A superb field naturalist, with an extensive knowledge of the western European fauna and flora, Linnaeus provided through the *Systema Naturae* (see, for example, 1758, Vol. 1, Ed. X.), a general taxonomic treatment of the known biota of the world. His published works were models of simplicity, clarity, consistency, and precision. For the insects, he developed the "alary" system, which was based on general features of wings (including their absence from adults of some groups).

He preferred a binary system of nomenclature for species (generic name plus a descriptive phrase that was the specific name), but he provided a single work (*nomen triviale*) as a handy reference for each species – just as some of his predecessors had done. Eventually, subsequent workers realized that only two words were required to designate a



species (the generic name and specific epithet), and the binary system was mostly abandoned before the end of the 18th Century and later was declared to be unacceptable.

Linnaeus also wrote extensively about principles of classification and nomenclature, and these writings plus his preeminently useful publications made him the outstanding systematist of his time. Because of his abilities as a classifier, his extensive treatments of the fauna and flora, and his personality, he held a special place in the hearts and minds of his contemporaries. His accomplishments were appreciated in his own time, and those who came later had impressed upon them by their teachers the importance of Linnaeus. It is not surprising, therefore, that Linnaeus is still regarded as a man in a class of his own, though in fact he was but one in a panoply of savants who provided both the theoretical and physical bases for our present system of classification.

## SPECIATION

Although a biological species concept has been used from time immemorial for at least some groups of animals and plants, only within the past hundred years or so has this concept been generally and consciously applied. On the basis of this concept, species are defined as groups of natural, interbreeding populations that are reproductively isolated from other such groups (Rothschild and Jordan 1906; Mayr 1963); or more generally, a lineage (ancestor-descendant sequence of populations) evolving separately from others, and with its own evolutionary role and tendencies (Simpson 1961; Wiley 1978).

Ease of recognition of species depends upon clear-cut readily-observable differences. However, many species are cryptic, and these are discovered by study of character systems whose states are not easily observed. These involve physiological, ethological, ecological, cytological, genetic, and biochemical attributes.

Prior to present understanding of the complex structure of species, the more widely accepted mechanism for divergence and development of isolating mechanisms (that is rupture of tokogenetic links) was geographical isolation (Mayr 1963). It was thought that selection was not sufficiently strong to permit divergence to the species level, unless tokogenetic links between related populations were first broken by external circumstances. However, recent studies have shown that isolating mechanisms can develop in sympatry, leading to rapid divergence and reproductive isolation within an initially freely interbreeding population (White 1978). This understanding provides not only more accurate expressions of reality, for traditional systematists, but also establishes more clearly the role to be played in systematics by biochemists, ecologists, ethologists, physiologists, and geneticists.

Figure 6 illustrates the relationships between changes in character systems associated with speciation, and mode of speciation as determined by geographical distribution of the groups undergoing change. There are three modes of speciation: allopatric, parapatric, and sympatric, with stasipatric being a special type of parapatric speciation. Conspecific groups that are allopatric (geographical isolation complete) or parapatric (geographical isolation nearly complete, but peripheral contact maintained) can become reproductively isolated by genetic changes that affect any or all of the systems listed under "NATURE OF DIFFERENTIATION", provided that the differences developed influence ability to interbreed. If such differentiation takes place, and if the geographical barriers disappear, the descendant stocks can subsequently come to overlap extensively or totally, and the differences will be maintained because of lack of interbreeding.

A single population can diverge into two or more that become reproductively isolated by genetic changes in part of the population involving ecological, or physiological systems, by development of parthenogenesis (thelytoky), or by development of polyploidy. (See Templeton (1980) for an excellent synopsis of modes of speciation).

Stasipatric speciation, as explained by White (1978: 177), "envisages a widespread species generating within its range daughter species characterized by chromosomal rearrangements that play a primary role in speciation because of the diminished fecundity or viability of the heterozygotes. The daughter species are assumed to gradually extend

FIG. 6

GEOGRAPHICAL AND ORGANISMIC ASPECTS OF DIFFERENTIATION OF POPULATIONS AND SPECIATION				
DIFFERENTIATION CAUSE	NATURE	CHOROLOGICAL RELATIONS		
		ALLOPATRY	PARAPATRY	SYMPATRY
Genetic	Structural	●	●	
	Developmental	●	●	
	Biochemical	●	●	
	Ecological	●	●	●
	Ethological	●	●	●
	Physiological	●	●	●
	Thelytoky	●	●	●
Cytological	Chromosome:			
	Rearr.	●	Stasipatric Speciation	
	Number	●	●	●

their ranges at the expense of the parental species, maintaining a narrow parapatric zone of overlap at the periphery of their distribution within which hybridization leads to production of genetically inferior individuals (usually inferior because of irregularities at meiosis)".

### PHYLOGENY

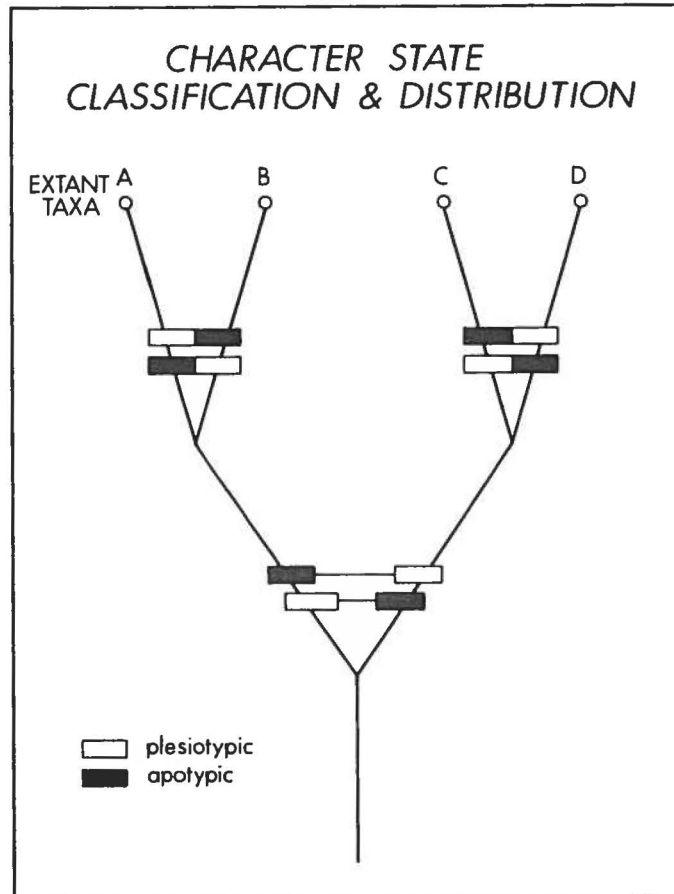
Phylogenies of taxa are inferred, using comparisons of character states, interpreted in terms of the principles of homology, parsimony, and various special rules (such as Dollo's law, which states that a complex character, once lost, is unlikely to be regained in its original form). Groupings are made on the basis of shared character states that are inferred to be derived, that is, apotypic, or apomorphic, in the formal language of phylogenetic systematics. The antonym of apotypic is plesiotypic, meaning a character state hypothesized to be ancestral. Among mammals, for example, for the character "mode of birth", oviparity is plesiotypic, and viviparity is apotypic.

Figure 7 illustrates a reconstructed phylogeny of four extant species, A, B, C, and D, each represented by a circle. The lines connecting them represent lineages of extinct populations. Angles represent divergence in holomorphological features.

These features are represented by rectangles, each opposing pair of which represents an apotypic (black) or plesiotypic (white) state. Positions of the rectangles indicate relative times when the apotypic states were inferred to have been developed.

Each living taxon has a relatively recently-derived apotypic state. Additionally, as indicated, A and B share an apotypic state that was derived at an earlier time not shared by C and D, and *vice versa*. Because of the distribution of apotypic states, A and B are

FIG. 7



inferred to have had a common ancestry that was not shared by C and D.

The value of palaeontological material in reconstructing phylogenies is limited because many fossils provide evidence about structural features, only. Further, characters of fossils have to be interpreted according to the same rules that apply to interpretation of shared similarities of living taxa. Fossils do provide evidence of minimal ages of taxa, and evidence of lineages that are now extinct. They can be enormously important in inference of past climates and distribution patterns, and provide evidence about temporal changes in these features. (See, for example, Coope (1979) and Matthews (1979) for analyses of Quaternary and late Tertiary assemblages of insect fossils). They also provide material for testing phylogenetic hypotheses, based on living taxa, only. Although the importance of the fossil record is appreciable, fossil material is not necessary to develop good reconstructed phylogenies (Hennig 1966).

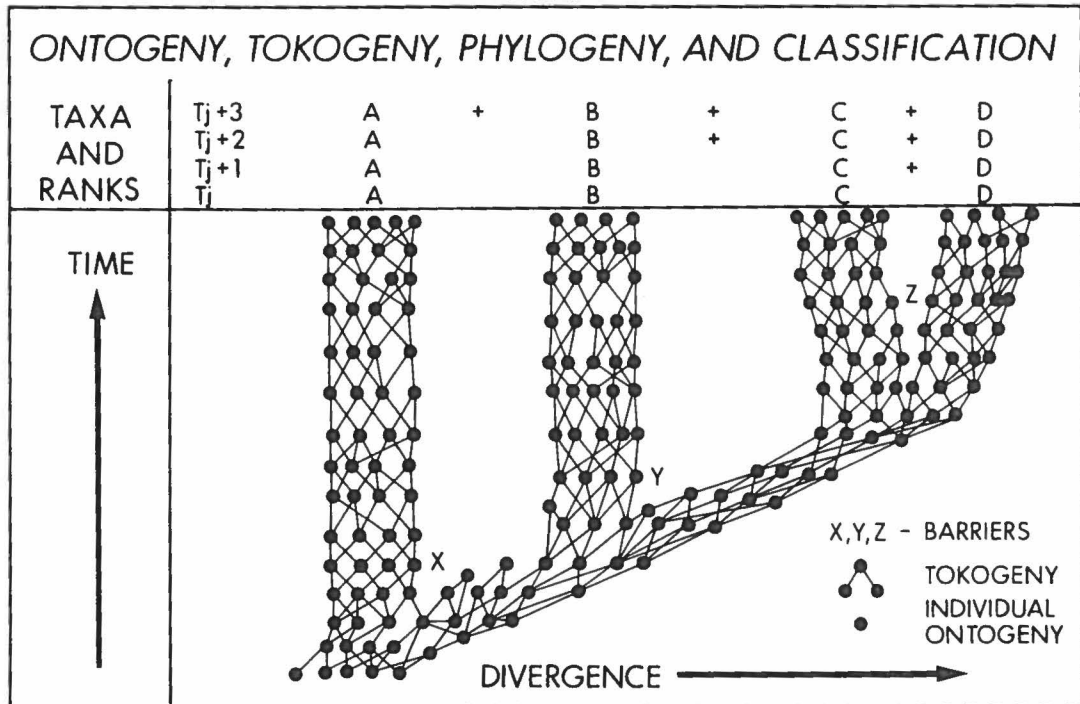
### CLASSIFICATION

The three principal rules for phylogenetic classification (Simpson 1961) are:

1. All taxa must be monophyletic (that is, each taxon must include only its ancestral stock and all its descendants);
2. Sister groups (the two or more descendant taxa at each branching point in the phylogeny) must receive the same rank, regardless of subsequent diversity of each lineage.
3. Taxa are ranked according to propinquity of descent, or relative recency of common ancestry: that is, within a given high ranking taxon, most genera are younger than the families within which they are included, and most families are younger than the orders in which they are included. Some lower ranking taxa are as old as the higher taxa in which they are included, but not older.

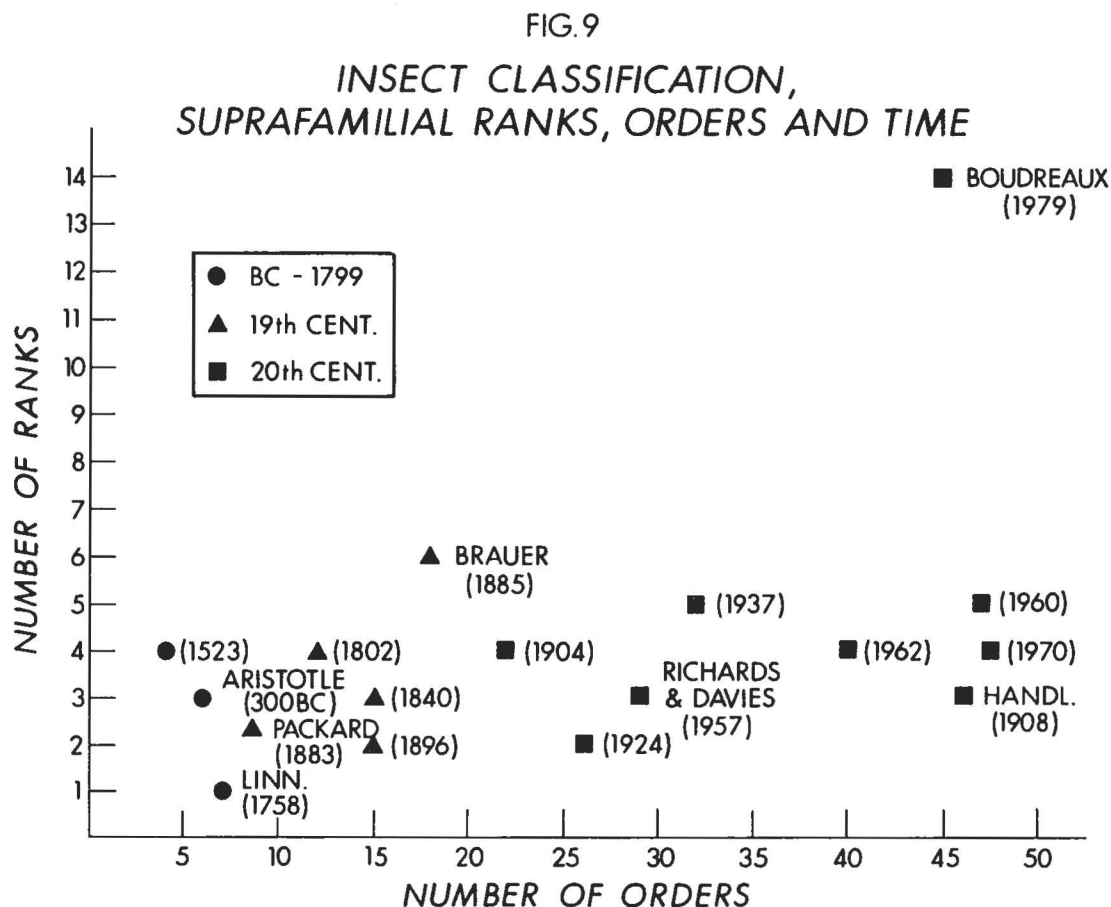
Figure 8 illustrates how a reconstructed phylogeny is used as the basis for a formal classification. Four extant taxa are related as indicated. Taxa C and D share the most recent common ancestry. In turn, their ancestor shares a common ancestry with taxon B. And taxon A shares a still earlier ancestry with the common ancestor of B + C + D. Put in another way, A is the sister group of B + C + D; and B is the sister group of C + D. These are the phylogenetic relationships. This diagram also indicates phenetic similarity, with taxon B being closer to A than it is to C + D, shown by greater proximity of B to the A stem, than to the C + D stem.

FIG 8



For formal classification, the taxa are grouped in a hierarchic fashion, with each level being a category, increasing in rank from "j" to "j + 3". If  $T_j + 3$  is of family rank,  $T_j + 2$  would be subfamilial,  $T_j + 1$  generic, and  $T_j$  specific. According to sister group relations, there would be two subfamilies (one including A; the other, B + C + D); three genera (one including A; one including B; and one including C + D); and four species (A, B, C, and D). Note that Subfamily A, and Genera A and B are monobasic, each including at the lowest level a single species. Note also that phenetic similarity is not taken into account, for B is placed with its closest relatives (C + D), and not with the species that it most closely resembles in holomorphological features (A). This simple example is the general model for phylogenetic classification.

Implications of use of phylogenetic classification is illustrated in terms of classification of insects at the ordinal level. As the number of lower-level taxa (species and genera) has increased (from a few thousand in the time of Linnaeus to about a million currently) so has the number of Orders increased (from seven Linnean orders to 40 or more, today; Figure 9). Until recently, the number of ranks between Order and Class (referred to here as supraordinal) was about four (having varied between one and six, from Aristotle's time on). In one classification by Boudreaux (1979), the number increased to 14, with a striking increase in number of supraordinal taxa (53, altogether).



Boudreaux' system of classification (Figure 10) provides a direct reflection of the reconstructed phylogeny, with clear indication (by ranking) of inferred relative ages of taxa, and of inferred sister group relations. This information is thus directly and simply recoverable from the form of the classification. Additionally, Boudreaux provides a fully developed hypothesis of relationships that can be tested in terms of new data, or by re-evaluation of the data on which he based his system. These are good points.

To counter the good points, is the large number of supraordinal taxa required (Figure 11), each with a name that must be remembered, and the large number of oligobasic high-ranking taxa (that is, supraordinal taxa that include few orders). For example, the Order Collembola is the only Order included in the Subterclass Oligoentomata, one of two included in the Infraclass Ellipurata, and one of three Orders included in the Subclass Entognathata.

On the other hand, some high-ranking taxa contain numerous groups. For example, the Subclass Ectognathata contains the 38 orders not contained in the Subclass Entognathata. This striking asymmetry (38 Orders as opposed to three) is characteristic of phylogenetic classifications, generally.

A simple solution would be to employ a system of classification that would require fewer categories (and associated taxa), with the orders arranged in phylogenetic sequence (Wiley 1979). Accompanying the formal classification would be the phylogenetic diagram, showing details of relationships. Of course, some of the taxa would be paraphyletic (by exclusion of some descendant groups), but this might be a small price to pay for having a greatly simplified system – one that is more traditional.

Classifications are used as storage and retrieval for information about taxa. One of the uses of such information is in making identifications.

FIG. 10

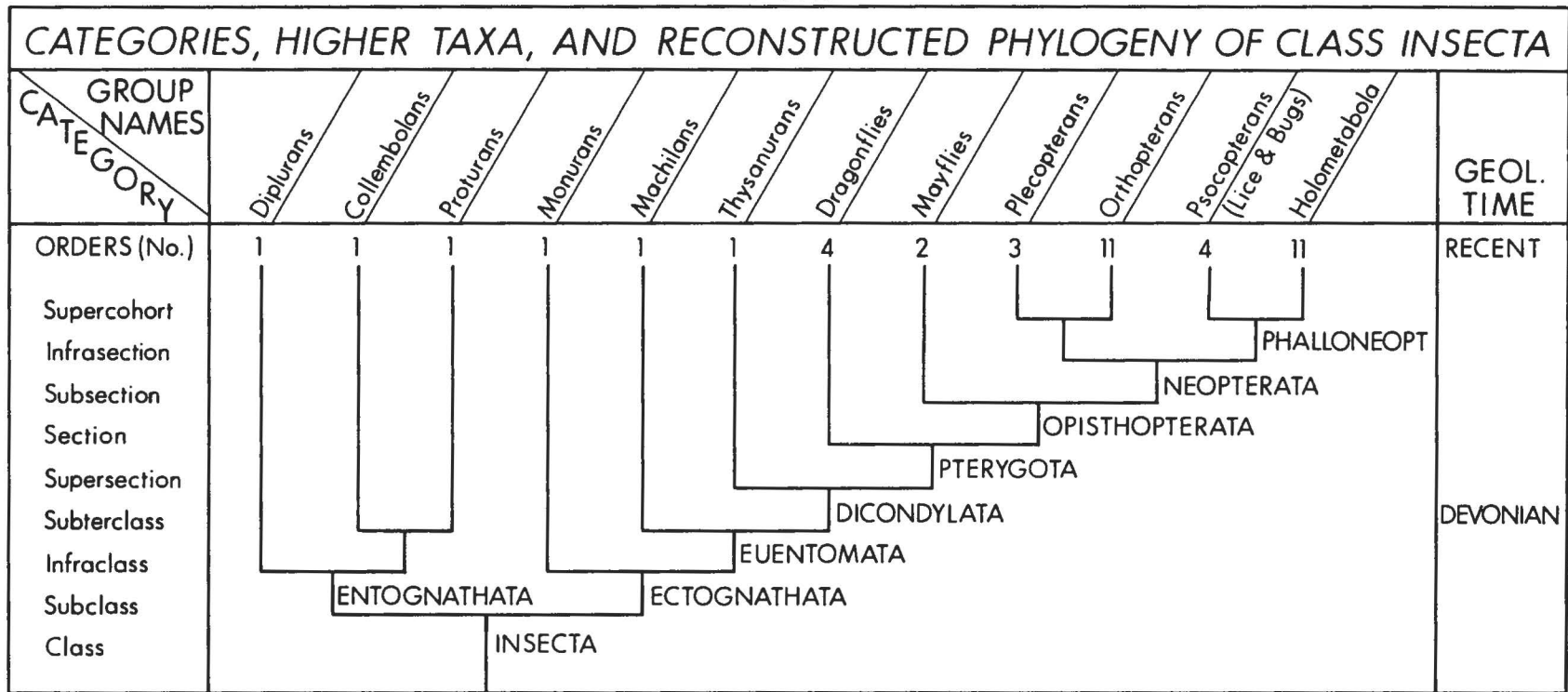


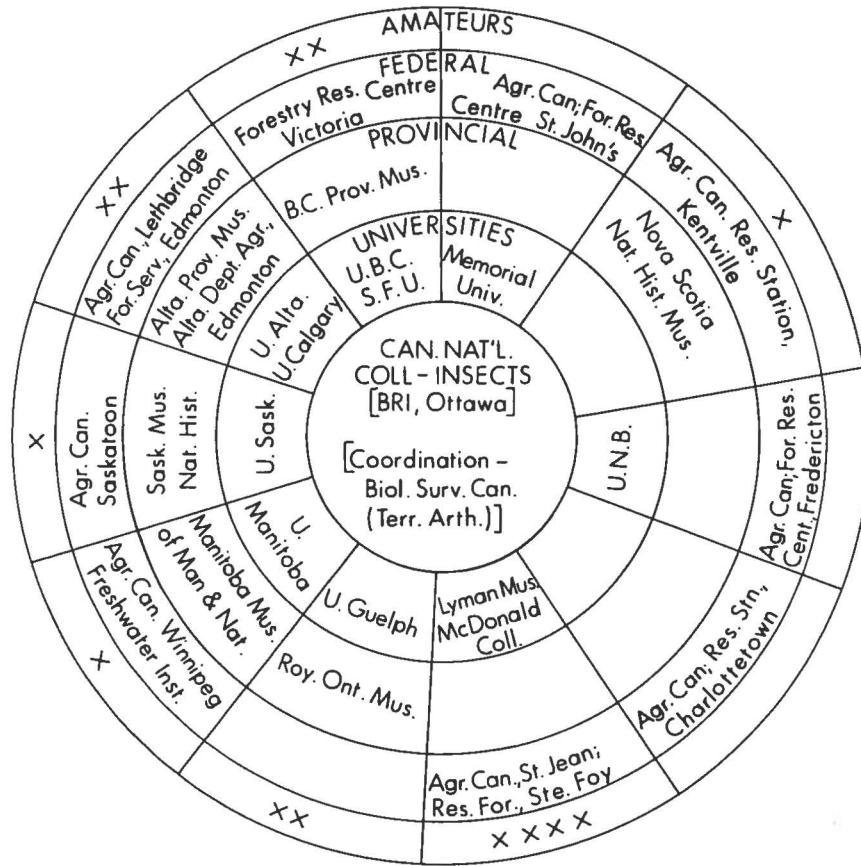
FIG. 11

HIERARCHICAL CATEGORIES AND NUMBER OF ORDERS INCLUDED IN EACH, IN BOUDREAUX'S (1979) CLASSIFICATION OF INSECTS								
CATEGORY	NUMBER OF INCLUDED ORDERS						N	NUMBER of ORDERS
	1	2-3	4-5	6-10	11-29	30-39		
Subclass		1				1	2	41
Infraclass	2	1				1	4	41
Subterclass	3					1	4	40
Supersection	1					1	2	36
Section		1				1	2	35
Subsection		3			1		4	35
Infrasection					2		2	29
Supercohort		1	1		2		4	29
Cohort	1	4	1	2			8	29
Subcohort	5	4	1				10	26
Infracohort	1	3	1				5	12
Subtercohort	2	2					4	7
Superorder	1	1					2	3
TOTAL S.O. TAXA	16	21	4	2	5	5	53	
							TOTAL ORDERS	41
							TOTAL S.F. TAXA	94

### IDENTIFICATION OF INSECT TAXA

At a practical level, insect taxonomists in Canada serve the general community by providing identifications, which are based on comparisons with previously identified specimens, and on published descriptions. The system of workers and collections of identified material is like a web (Figure 12), with the Biosystematics Research Institute of Agriculture Canada at the middle, and with universities, provincial and other federal institutions, and amateurs more peripheral, their distance from the center being determined by the extent of their contributions to making identifications. The strands of the web that informally connect these individuals and institutions comprise a free exchange of information and specimens, and to a more limited extent exchange of persons. The Biological Survey (Terrestrial Arthropods) of the National Museums of Canada, organized a few years ago by the Entomological Society of Canada with funding received through a contract issued by the Department of Supply and Services, is in position to play an important role in coordinating the efforts of the institutions and individuals, concerned with insect identification. The Biological Survey is also in position to organize and integrate other activities by the community of Canadian systematists that will lead to improved understanding of the insect fauna of the northern part of the Nearctic Region. Establishment of the Biological Survey is probably the most important event of this decade for development of insect systematics in Canada.

FIG. 12  
ENTOMOLOGICAL COLLECTIONS IN CANADA



The Pilot Study of the Biological Survey produced a basic publication about the insect fauna of Canada notable for extent of coverage, that offers an excellent starting point for more restricted and intensive analyses (Danks 1979). Soon to be published under the aegis of the Survey is a general treatment of arctic arthropods, with emphasis on the Nearctic species, and a bibliography of arctic arthropods.

The Biosystematics Research Institute has undertaken production of a series of Handbooks, each handbook dealing with a particular taxonomic group. These volumes are guides for identification of species occurring in Canada. The text is clearly written, and each volume is profusely illustrated. This series should be of substantial importance in expanding knowledge of the insects of Canada.

### CONCLUDING OBSERVATIONS

Systematics occupies a central position in biology, because it organizes and synthesizes so much information. It is an old field, but it remains fresh, for it seizes new techniques to examine new character systems; at the same time, it does not reject its past.

It is interesting that chemistry is built on the ashes of alchemy, and astronomy on the shards of astrology, but the present system of biological classification is based on the edifice provided by Aristotle, as it has been modified by addition of knowledge, including evolutionary theory. So, present and past merge, and give a trajectory for the future.

Another feature of biological systematics is that amateurs can still make valuable contributions. In the prairies, insect systematics by Canadians got its start in Manitoba,



with the Criddles of Aweme, who, early on, were joined by J. B. Wallis, and then by Ralph Bird, of Brandon, who, in due course, became a professional entomologist. Others followed, and their places were taken by such men as Charles Bird, Ralph's son, and now a farmer near Calgary; by the Rev. R. R. Hooper, in Fort Qu'Appelle, by Walter Krivda, in The Pas; and so on. On the other hand, it is a very long time since there have been amateur physicists or chemists who have done work of professional caliber.

It is well that amateurs can play a significant role in the continued development of insect systematics, for there is far more to be done than the small band of professionals working during any time period can achieve. A significant increase in professional workers cannot be expected, for the work that they do is funded by the public, and the limit that society has set for financing such activities is short of what is required to attain the goals desired by systematists. So, it is essential that amateurs and professionals work together, and that their efforts be made more effective through coordination and extension by organizations such as the Biological Survey.

Approaching systematics from an evolutionary perspective not only leads to development of a classification that is in harmony with natural history, but it also serves as a reminder to mankind of his own position in the scheme of things – one species among many, with clearly inferable sister group relations with the genus *Pan*. This knowledge in the future might induce man to deal in a more considerate manner with the other inhabitants of the planet Earth than he has up to the present time. Such a development, if it came to pass, would be the greatest practical contribution that systematics could make.

#### ACKNOWLEDGEMENTS

I am grateful to the members of the audience who listened attentively to the oral version of this paper, and especially to those who participated in the subsequent discussion.

A preliminary draft of the typescript of this paper was reviewed by my colleague Bruce S. Heming, and I appreciate the advice for improvement that he offered. I also acknowledge advice received from the Editor, and from an unknown reviewer, who discovered in a previous draft some additional important defects in presentation.

I appreciate the skill and patience of my Department secretary, Iris E. Bergum, who typed the various drafts of this presentation. I am also pleased to acknowledge the assistance of John S. Scott, who drafted the illustrations.

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While this paper was in press, the following major works that are relevant to the text either were published or came to my attention. Danks' contributions are referred to on page 16, above.

- Danks, H. V. 1981a. Arctic arthropods. A review of systematics and ecology with particular reference to the North American fauna. Entomological Society of Canada, Ottawa. Preface, Contents + 608 pp.
- 1981b. Bibliography of the arctic arthropods of the Nearctic Region. *IBID.* Preface + 125 pp.
- Eldredge, N., and J. Cracraft. 1980. *Phylogenetic patterns and the evolutionary process. Method and theory in comparative biology.* Columbia University Press, New York. viii + 349 pp.
- Nelson, G., and N. Platnick. 1981. *Systematics and Biogeography: cladistics and vicariance.* *IBID.* xi + 567 pp.
- Wiley, E. O. 1981. *Phylogenetics: the theory and practice of phylogenetic systematics.* John Wiley and Sons, New York . . . Toronto. Frontispiece, XV + 439 pp.

## POTENTIAL OF AZAMETHIPHOS FOR CONTROL OF SPRUCE BUDWORM

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One of several compounds successfully screened in recent laboratory toxicological studies (P. C. Nigam, FPMI, personal communication) for control of the spruce budworm, *Choristoneura fumiferana* (Clem.), was azamethiphos (=Alfacron®, CGA-18809), a proprietary organophosphorus insecticide of CIBA-Geigy Canada Ltd. Azamethiphos was included in a series of aerial spray experiments during 1979 to obtain preliminary information on its efficacy for control of third (L3)- to fifth (L5)-instar larvae of the spruce budworm. This note summarizes these results.

Three azamethiphos spray mixtures were selected as treatments for emission at 1.8 l/ha/application at active ingredient (AI) dosages of 18 g/ha, 35 g/H and 70 g/ha (11.25%, 22.5% and 45% by volume, respectively). Other components of the mixtures include Cellosolve® as diluent and Automate Red B liquid dye. Treatments were applied by a Micronair®-equipped Piper Pawnee to mixed forest stands within Canadian Forces Base Gagetown, New Brunswick. The rectangular spray blocks each measured ca 23 ha in area. The experimental design included 2 replicates of each spray treatment and 5 untreated spray blocks. Each spray block was treated twice at 4 or 5 day intervals during the peak occurrence of L4 larvae (2-7 June). Spray deposit estimates were based on stain samples from Kromekote® cards placed 30 cm above ground level in clearings near branch sample trees (Prebble 1975). Sampling for efficacy was restricted to *Abies balsamea* (L.) Mill because of sparse and uneven distribution of *Picea*. Estimates of larval population density were based on 40 mid-crown branch samples per replicate, collected once prior to spray application and 4 times afterwards. An additional branch sample collection was made at the completion of the larval feeding period for estimating defoliation of current year foliage. First sprays on 2 June occurred when larval stadia mix was 40% L3, 40% L4, 15% L5, and 5% L6; the composition during the second applications on 6 and 7 June was 25% L3, 35% L4, 30% L5, and 10% L6. Overall weather conditions during applications were considered average.

Table 1. Results of experimental aerial applications of Azamethiphos for control of Spruce Budworm.

Treatment (Azamethiphos g AI/ha/ application)	Average number of live larvae/45 cm branch <sup>1</sup>					Population reduction (%) <sup>2</sup>	Defoliation (%) <sup>3</sup>
	Prespray	1st Postspray	2nd Postspray	3rd Postspray	4th Postspray		
18	24	12	6	4	3	72	21
35	23	9	8	6	4	66	22
70	29	9	4	5	4	72	19
Untreated	26	23	19	17	13	—	63

<sup>1</sup> Prespray samples collected 1-2 days before first spray applications. First postspray samples collected 1-2 days after first sprays. Second to fourth postspray samples collected 4-5, 10-12 and 20-22 days, respectively, after second sprays.

<sup>2</sup> Corrected by Abbott's Formula (1925).

<sup>3</sup> Fettes Method (1951).

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The results of the experimental sprays indicated that 2 applications of azamethiphos at dosages as low as 18 g AI/ha/application significantly reduced population densities of spruce budworm larvae while providing worthwhile levels of foliage protection (Table 1). Uniformly-fine droplet deposits of ca 85  $\mu$  volume median diameter and averaging from 6 to 26/cm<sup>2</sup> were considered representative of such ultra-low volume aerial applications. Between treatment comparisons of the results did not indicate any obvious relationships among dosages, spray deposits, larval mortality, and defoliation of host trees.

Research and development work on azamethiphos is being concentrated in the public health area, mainly for control of biting flies (G. E. Barnsley<sup>2</sup>, personal communication). Should research efforts in forestry be renewed, completion of this field study on the control of spruce budworm would be very appropriate.

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AGGREGATIONS OF LADY BEETLES (*COLEOPTERA: COCCINELLIDAE*)  
ON THE SHORES OF LAKE MANITOBA<sup>1</sup>

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Lady beetles are commonly found during autumn and spring in aggregations on the shores of lakes in northcentral North America. Lee (1980) reviews published reports on these aggregations and provides detailed information on several aggregations in Minnesota. This note describes the species composition and mortality in aggregations on the beaches of Lake Manitoba.

Large numbers of lady beetles were seen on the beach at Lily Bay, Manitoba (50°45'N, 98°19'W), at about 1400 h on 2 November 1978. They were congregated on the organic debris and rocks on the sandy beach and, in smaller numbers, on moss and other low vegetation where the lakeshore was swampy. The day was calm and sunny with a reported maximum of 16.5°C at Lundar, the nearest meteorological station (Monthly Record 1978). The lady beetles were exposed to full sunlight and, when disturbed, moved rapidly but did not fly. In 15 minutes, 3454 beetles were collected from the debris on the beach. No dead beetles were seen.

The following spring, on 22 April 1979, an attempt was made to revisit Lily Bay to determine the survival of lady beetles on the beach. However, the spring was late and melting snow made the roads to the beach impassable. Therefore, we examined a similar beach located 8 miles southeast of Lily Bay and 7 miles west of Lundar. Samples of beach debris, leaf litter and low vegetation were taken from the following sites: terminology of beach topography follows King (1966).

1. Beach debris. A 0.4 m<sup>2</sup> sample was removed from the line of organic debris on the foreshore. Patches of snow covered the debris.
2. Foreshore top. A 1 m<sup>2</sup> sample consisting of litter, mostly aspen leaves, was collected just below the upper limit of the foreshore. The sampling site was covered with 0.25 m of snow.
3. Backshore. A 1 m<sup>2</sup> sample was taken 1 m above the foreshore in an area with sparse grassy vegetation under about 0.5 m of snow. A second 1 m<sup>2</sup> sample was taken 4 m above the foreshore in a small grove of aspens about 4 m in height. Snow depth was 1 m.

The lady beetles were removed from each sample and the numbers of living and dead beetles of each species were recorded. Six species were found in the autumn and spring collections (Table 1). *Hippodamia convergens* was the most abundant species in the autumn collection and in the spring collections from the beach debris and the top of the foreshore. *Coccinella transversoguttata* slightly outnumbered *H. convergens* in the spring samples from the backshore. In the spring, most of the beetles were found on the beach debris, with the numbers decreasing rapidly with distance from the shore. No beetles were found in the sample taken 4 m above the foreshore.

In the autumn, no dead beetles were found in the aggregation, but in the spring only 10% were living (Table 1). In the spring, the highest percentage of living beetles was found in the sample from the top of the foreshore and the lowest from the beach debris.

The lady beetles collected in the spring must have aggregated on the lake shore in the autumn, because the spring weather up to the date of collection had been too cold for

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Table 1. Numbers of lady beetles by species collected from sites on the shore of Lake Manitoba in autumn, 1978, and spring, 1979.

Species	Autumn collection	Spring collection <sup>a</sup>				Living (%)
	Beach debris	Beach debris	Top of foreshore	Backshore <sup>b</sup>	Total	
<i>Hippodamia convergens</i> Guer.	3,316	347 (0)	46 (23)	11 (1)	404 (24)	6
<i>H. tredecimpunctata tibialis</i> (Say)	69	24 (3)	0	1 (1)	25 (4)	16
<i>H. parenthesis</i> (Say)	34	13 (1)	2 (0)	1 (0)	16 (1)	6
<i>H. quinquesignata</i> (Kby.)	1	0	0	1 (0)	1 (0)	0
<i>Coccinella trifasciata perplexa</i> Muls.	3	3 (0)	0	1 (1)	4 (1)	25
<i>C. transversoguttata richardsoni</i> Brown	31	14 (3)	26 (16)	13 (2)	53 (21)	40
TOTAL	3,454	401 (7)	74 (39)	28 (5)	503 (51)	—
Living (%)	100	2	53	18	—	10

<sup>a</sup>Number of living beetles in parentheses.

<sup>b</sup>Sample taken 1 m above foreshore. No beetles were found in the sample taken 4 m above the foreshore.

insect activity. If these beetles were living and active in early November, as were the beetles collected on 2 November at Lily Bay, the high level of mortality observed was caused by exposure to unsuitable winter conditions. Weather records for Lundar show that maximum air temperatures fell below 0°C on 10 November and remained below 0°C for the rest of the month and that snow fell on 11 November and on 9 more days in the month (Monthly Record 1978).

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ANNOTATED LIST OF APHIDS (*HOMOPTERA: APHIDIDAE*)  
OF NORTHWEST CANADA, YUKON AND ALASKA

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**ABSTRACT:** An annotated list of aphids from Northwest Canada, Yukon and Alaska has been compiled from several sources. The list gives names of 124 species, subspecies, or species complexes, and host plants where known.

INTRODUCTION

Smith and Parron (1978) (S and P) list 25 species of aphids from Alaska, including 4 species listed by Pergande (1900) from the Harriman Alaska expedition, and 2 from the Yukon Territory. The author has collected aphids in both areas, and the following annotated list is a compilation from these collections and from other collectors as designated. F. C. Hottes (FCH) collected aphids in Alaska from 21 July 1961 to 26 July 1961 and this material is in the United States National Museum. There are other slides in the USNM from Alaska submitted by the United States Forest Service (USNM). H. G. Walker (HGW) collected in the Yukon Territory and Alaska from 9 June 1975 to 21 June 1975. On several occasions R. H. Washburn (RHW) sent to the author aphids collected at the Experiment Station at Palmer, Alaska. The author (AGR) collected at Yellowknife, Northwest Territories, from 7 August 1978 to 14 August 1978, and with B. A. Batulla (BAB) at Whitehorse, Yukon, from 15 August 1979 to 21 August 1979 and at Anchorage and Fairbanks, Alaska, from 9 July 1980 to 14 July 1980. Other aphid material seen by the author was from Kluane National Park from R. D. Wickstrom (RDW), and from the Northwest Territories submitted by D. M. Rosenberg (DMR).

Aphid names are those from Smith and Parron (1978), except for numbers 3, 26 and 79 in Robinson (1979), number 83 in Robinson (1980), and numbers 87, 88, 89 and 90 in Heie (1979). Host plant names are listed when known.

ANNOTATED LIST

1. *Acyrtosiphon assiniboinensis* Robinson  
Yellowknife (AGR) and Whitehorse (AGR) on *Potentilla fruticosa* (L.); Kluane National Park (RDW); Paxton, Alaska (FCH); Anchorage (BAB).
2. *Acyrtosiphon caraganae* (Cholodkovsky)  
Whitehorse (AGR); USNM; Palmer (RHW) on 4 August 1971; all on *Caragana arborescens* Lam.
3. *Acyrtosiphon churchillense* Robinson  
Yellowknife (AGR) on *Oxytropis deflexa* (Pall.) DC var. *sericea* T. and G.; Whitehorse (AGR) on *Melilotus alba* Desr.
4. *Acyrtosiphon (Metopolophium) caudatum* (Pergande)  
Juneau, Alaska (S and P).
5. *Amphorophora agathonica* Hottes  
Yellowknife (AGR); Whitehorse (AGR); Anchorage (AGR); Fairbanks (BAB); Sakona and Juneau, Alaska (FCH); all on *Rubus idaeus* L. var. *strigosus* (Michx.) Maxim.
6. *Aphis astragalina* Hille Ris Lambers  
Fairbanks (AGR) on *Hedysarum alpinum* L.
7. *Aphis farinosa* Gmelin  
Yellowknife (AGR); Dawson City, Yukon (HGW); Anchorage (AGR, FCH); Sakona (FCH); all on *Salix* spp.
8. *Aphis helianthi* Monell

- Fairbanks (BAB, HGW) on *Epilobium angustifolium* L.; Palmer (RHW) on 18 July 1967 and 16 June 1970 on *Cornus stolonifera* Michx.
9. *Aphis heraclella* Davis  
Fairbanks (AGR) on *Cicuta maculata* L.
  10. *Aphis maculatae* Oestlund  
Yellowknife (AGR) on *Populus tremuloides* Michx.
  11. *Aphis masoni* Richards  
Yellowknife (AGR) on unidentified legume.
  12. *Aphis nasturtii* Kaltentbach  
Mackenzie River, N.W.T. (DMR) from yellow pan traps.
  13. *Aphis neogillettei* Palmer  
Fairbanks (BAB) on *Epilobium angustifolium*.
  14. *Aphis nivalis* Hille Ris Lambers  
Yellowknife (AGR); Nanyuk Lake, N.W.T. (DMR) on *Epilobium angustifolium*.
  15. *Aphis ribiensis* Gillette and Palmer  
Whitehorse (AGR) on *Ribes* sp. (wild gooseberry).
  16. *Aphis rubicola* Oestlund  
Whitehorse (AGR); Anchorage (FCH); Homer, Alaska (FCH); all on *Rubus spectabilis* Pursh.
  17. *Aphis rumicis* Linnaeus  
Yellowknife (AGR) sweeping vegetation.
  18. *Aphis salicariae* Koch  
Yellowknife (AGR); Fairbanks (BAB) on *Epilobium angustifolium*.
  19. *Aphis varians* Patch  
Yellowknife (AGR) on *Epilobium angustifolium* and *Ribes oxycanthoides* L.; Whitehorse (AGR) on *Ribes* sp. (gooseberry) and *E. angustifolium*; Dawson City (HGW) on *Ribes* sp.; Anchorage, Toke, and Salkova, Alaska (FCH) on *Ribes* sp. and *E. angustifolium*; Palmer (RHW) on *E. angustifolium* on 18 July 1967.
  20. *Aulacorthum solani* (Kaltentbach)  
Yellowknife (AGR) in yellow pan trap; Texana, Alaska (HGW) on *Rosa acicularis* Lindl.
  21. *Betulaphis quadrituberculata* (Kaltentbach)  
Yellowknife (AGR); Whitehorse (AGR); Anchorage (AGR); all on *Betula papyrifera* Marsh.
  22. *Boernerina variabilis* Richards  
Yellowknife (AGR) on *Alnus rugosa* (Du Roi) Spreng.; Fairbanks (AGR) on *Alnus* sp.; Palmer (RHW) on 18 July 1967 on *A. crispa* (Ait.) Pursh.
  23. *Boernerina variabilis* subsp. *alaskensis* Hille Ris Lambers and Hottes  
Anchorage (S and P) on *Alnus* sp.
  24. *Boernerina (Boernerinella) occidentalis* Hille Ris Lambers and Hottes  
Anchorage (AGR) on *Alnus* sp.; (S and P) on *A. crispa* subsp. *sinuata* (Reg.) Nutt.; Mt. McKinley Park (HGW); Aleyska, Alaska (HGW).
  25. *Capitophorus elaeagni* (Del Guercio)  
Mackenzie River from yellow pan traps (DMR); Alaska (S and P).
  26. *Capitophorus hudsonicus* Robinson  
Fairbanks (BAB) on *Shepherdia canadensis* (L.) Nutt.
  27. *Cavariella aegopodii* (Scopoli)  
Yellowknife (AGR) on *Salix* sp.; Willow Lake, N.W.T. (DMR) from yellow pan trap; Anchorage (FCH) on *S. bebbiana* Sarg.; Anchorage (AGR) on *Cicuta maculata*.
  28. *Cavariella konoii* Takahashi  
Yellowknife (AGR) on *Cicuta bulbifera* L.; Anchorage (AGR) on *Salix* sp.; Anchorage (AGR) on *C. maculata*; Anchorage (FCH) on *S. bebbiana*; Juneau (FCH); Aleyska (HGW) on *Salix* sp.



29. *Cavariella pastinacae* (Linnaeus)  
Alaska (USNM) on *Salix* sp.; Anchorage (BAB) on *Heracleum lanatum* Michx.
30. *Cavariella (Cavariellia) aquatica* (Gillette and Bragg)  
Sakona, Alaska (FCH) sweeping.
31. *Cepigillettea betulaeifoliae* Granovsky  
Fairbanks (AGR) on *Betula glandulifera* (Regel) Gl.
32. *Ceruraphis viburnicola* (Gillette)  
Mackenzie River from yellow pan traps (DMR).
33. *Chaetosiphon (Pentatrichopus) fragaefolii* (Cockerell)  
Yellowknife (AGR) on *Rosa* sp.; Whitehorse (AGR) on *Rosa* sp.; Haines (FCH) on *Rosa* sp.; Anchorage (BAB) on *Rosa* sp.; Anchorage (BAB) on *Fragaria* sp.; Fairbanks (AGR) on *Rosa* sp.
34. *Chaetosiphon (Pentatrichopus) minor* (Forbes)  
Alaska (S and P).
35. *Chaitophorus essigi* Gillette and Palmer  
Yellowknife (AGR) on *Populus balsamifera* L.; Whitehorse (BAB) on *P. balsamifera*; Whitehorse (AGR) on *P. tremuloides*; Dawson City (HGW) on *P. trichocarpa* Torr. and Gray.; Anchorage (FCH) and Juneau (FCH) on *P. tremuloides*; Fairbanks (AGR) on *P. tremuloides* and *P. balsamifera*.
36. *Chaitophorus nigrae* Oestlund  
Yellowknife (AGR) on *Salix* sp.; Fairbanks (AGR) collected in flight.
37. *Chaitophorus populicola* Thomas  
Yellowknife (AGR) on *Populus tremuloides*; Whitehorse (AGR) on *P. balsamifera* and *P. tremuloides*; Fairbanks (HGW) on *P. trichocarpa*; Fairbanks (AGR) on *P. balsamifera*.
38. *Chaitophorus pusillus* Hottes and Frison  
Yellowknife (AGR) on *Salix* sp.
39. *Cinara alaskana* Hottes  
Fairbanks (S and P).
40. *Cinara bonica* Hottes  
Gulkana River, Alaska (S and P).
41. *Cinara bonita* Hottes  
Gulkana River, Alaska (S and P).
42. *Cinara braggii* (Gillette)  
Fairbanks (AGR) on *Picea glauca* (Moench) Voss.
43. *Cinara coloradensis* (Gillette)  
Whitehorse (BAB) on *Picea glauca*; Alaska (S and P).
44. *Cinara fornacula* Hottes  
Whitehorse (AGR) on *Picea glauca*; Fairbanks (AGR) on *P. glauca*; Alaska (S and P).
45. *Cinara glacialis* Hottes  
Juneau (S and P) on *Picea sitchensis* (Bong.) Carriere.
46. *Cinara laricifex* (Fitch)  
Yellowknife (AGR) on *Larix laricina* (Du Roi) K. Koch; Fairbanks (AGR) on *L. laricina*.
47. *Cinara nimbata* Hottes  
Alaska (S and P).
48. *Cinara obscura* Bradley  
Yellowknife (AGR) on *Picea glauca*.
49. *Cinara pergandei* (Wilson)  
Yellowknife (AGR) on *Pinus banksiana* Lamb.
50. *Cinara rara* Bradley  
Alaska (S and P).

51. *Cinara spiculosa* Bradley  
Yellowknife (AGR) on *Larix laricina*.
52. *Cinara vandykei* (Wilson)  
Alaska (S and P).
53. *Cinara yukona* Hottes  
Gulkona, Alaska (S and P) from *Picea glauca*.
54. *Euceraphis betulae* (Koch)  
Whitehorse (AGR) on *Betula glandulifera* and *B. papyrifera*; Anchorage (AGR) on *B. glandulifera* and *B. papyrifera*; Fairbanks (AGR) on *B. glandulifera*. This species comes close to *E. betulae* as defined by Blackman (1977).
55. *Euceraphis gillettei* Davidson  
Whitehorse (AGR) on *Alnus rugosa*; Anchorage (AGR) on *Alnus* sp.; Fairbanks (AGR) on *Alnus* sp. This species come close to *E. gillettei* as defined by Blackman (1977).
56. *Fimbriaphis fimbriata* Richards  
Whitehorse (AGR) from wild rose.
57. *Fullawaya flocculosa* (Weed)  
Yellowknife (AGR) on *Salix* sp.
58. *Fullawaya martini* (Richards)  
Alaska (S and P).
59. *Hayhurstia atriplicis* (Linnaeus)  
Yellowknife (AGR) on *Chenopodium album* L.; Whitehorse (AGR) on *C. album*; Anchorage (AGR) on *C. album*; Palmer (RHW) on 29 July 1971 from yellow pan trap.
60. *Hyperomyzus (Neonasonovia) nabali* (Oestlund)  
Yellowknife (AGR) on *Ribes glandulosum* Grauer and *R. hudsonianum* Richards.; Whitehorse (AGR) on *R. glandulosum* and yellow pan trap; Anchorage (USNM).
61. *Hyperomyzus (Neonasonovia) nabali* subsp. *fronki* (Knowlton)  
Yellowknife (AGR) sweeping; Whitehorse (AGR) on *Ribes glandulosum*.
62. *Illinoia alni* (Mason)  
Yellowknife (AGR) on *Alnus* sp.
63. *Illinoia azaleae* (Mason)  
Yellowknife (AGR) on *Myrica gale* L. and sweeping.
64. *Illinoia canadensis* (MacGillivray)  
Yellowknife (AGR) on *Myrica gale*.
65. *Illinoia goldamaryae* (Knowlton)  
Yellowknife (AGR) sweeping; Mackenzie River (DMR) from yellow pan traps; Whitehorse (AGR) from a blue *Aster* sp.; Alaska (USNM) from *Solidago* sp.
66. *Illinoia (Masonaphis) paquetai* (MacGillivray)  
Yellowknife (AGR); Anchorage and Fairbanks (AGR); all from sweeping vegetation.
67. *Illinoia (Oestlundia) davidsoni* (Mason)  
Sakona, Alaska (FCH) on red raspberry.
68. *Illinoia (Oestlundia) rubicola* (Oestlund)  
Whitehorse (AGR); Anchorage (AGR, BAB, FCH); Homer (FCH); all from wild red raspberry.
69. *Iziphya umbella* Richards  
Yellowknife (AGR) sweeping roadside vegetation; Mackenzie River (DMR) from yellow pan traps.
70. *Lipaphis erysimi* (Kaltenbach)  
Anchorage (AGR) on *Erysimum cheiranthoides* L.
71. *Macrosiphoniella frigidicola* Gillette and Palmer  
Whitehorse (AGR) sweeping *Artemisia* sp.

72. *Macrosiphoniella tapuskae* (Hottes and Frison)  
Whitehorse (AGR); Haines (FCH); Paxton, Alaska (FCH); all from *Achillea* sp.
73. *Macrosiphum albifrons* Essig  
Anchorage (AGR) on *Lupinus polyphyllus* Lindl.
74. *Macrosiphum californicum* (Clarke)  
Yellowknife (AGR); Anchorage (FCH); all on *Salix* sp.
75. *Macrosiphum constrictum* Patch  
Alaska (S and P).
76. *Macrosiphum euphorbiae* complex  
Collections of *M. euphorbiae* (Thomas) or closely related species were made on many different species of plants at Yellowknife, Whitehorse and in several places in Alaska. RHW reported economic infestations (pers. comm.) on apples at Palmer on 18 July 1967 and on lettuce in the Matanuska Valley, Alaska, on 15 July 1970. It is not possible at present to separate the species or subspecies in this complex.
77. *Macrosiphum pseudorosae* Patch  
Whitehorse (AGR) on wild rose and *Chenopodium album*.
78. *Macrosiphum stanleyi* Wilson  
Anchorage (AGR) on *Sambucus racemosa* L.; Juneau (FCH) on *S. pubens* Michx.
79. *Macrosiphum subarcticum* Robinson  
Yellowknife (AGR); Whitehorse (AGR); Anchorage (BAB, FCH); all on *Epilobium angustifolium*.
80. *Macrosiphum (Sitobion) avenae* (Fabricius)  
Whitehorse (AGR) sweeping grass; Mackenzie River (DMR) from yellow pan traps; Anchorage (AGR) on grass.
81. *Macrosiphum (Sitobion) insularis* (Pergande)  
Alaska (S and P).
82. *Macrosiphum (Sitobion) manitobensis* Robinson  
Mackenzie River (DMR) from yellow pan traps.
83. *Macrosiphum (Sitobion) woodsiae* Robinson  
Yellowknife (AGR) on *Woodsia ilvensis* (L.) R. Br.
84. *Mindarus ?abietinus* Koch  
Anchorage (AGR) on *Picea glauca*.
85. *Myzaphis rosarum* (Kaltenbach)  
Yellowknife (AGR) sweeping; Anchorage (BAB) on *Potentilla fruticosa*.
86. *Myzus (Nectarosiphon) persicae* (Sulzer)  
Palmer (RHW) on broccoli in greenhouse.
87. *Nasonovia (Eokakimia) wahinkae robinsoni* Richards  
Whitehorse (AGR); Palmer (RHW) on 18 July 1967; Sakona (FCH); Fairbanks (HGW); all on cultivated delphinium; Fairbanks (AGR, BAB) on *Aconitum delphinifolium* D.C.
88. *Nasonovia (Kakimia) aquilegiae* (Essig)  
Alaska (USNM) from *Aquilegia* sp.
89. *Nasonovia (Kakimia) castelleiae* (Sampson)  
Yellowknife (AGR) sweeping; Anchorage (AGR) on *Castilleja unalaschcensis* (C and S.) Malte.
90. *Nasonovia (Kakimia) cynosbati* (Oestlund)  
Yellowknife (AGR) on *Ribes glandulosum* and *R. oxyacanthoides*; Whitehorse (AGR) on *Ribes* sp. (gooseberry) and yellow pan trap; Anchorage (BAB) on *R. triste* Pall. and *R. alpinum* L.; Anchorage (AGR) on *R. glandulosum*; Juneau (FCH) on *Ribes* sp.
91. *Nearctaphis bakeri* (Cowen)  
Palmer (RHW) on 16 June 1970 on *Malus baccata* (L.) Borkh.

92. *Nearctaphis yohoensis* Bradley  
Palmer (RHW) on 18 July 1967 on *Sorbus* sp. and 7 July 1971 on *S. aucuparia* L.
93. *Oestlundiella flava* (Davidson)  
Whitehorse (AGR) on *Alnus crispa*.
94. *Pachypappa sacculi* (Gillette)  
Anchorage (BAB) on *Populus tremuloides*.
95. *Pemphigus betae* Doane  
Whitehorse (AGR, BAB) on *Populus balsamifera*.
96. *Pemphigus populiglobuli* Fitch  
Fairbanks (BAB) taken in flight.
97. *Periphyllus testudinacea* (Ferne)  
Alaska (S and P).
98. *Placoaphis siphunculata* Richards  
Anchorage (AGR, BAB) on wild rose.
99. *Pleotrichophorus knowltoni* Corpuz-Raros and Cook  
Alaska (S and P).
100. *Pleotrichophorus patonkusellus* Corpuz-Raros and Cook  
Whitehorse (AGR) sweeping *Achillea* sp.
101. *Pleotrichophorus pseudopatonkus* Corpuz-Raros and Cook  
Yellowknife (AGR) sweeping vegetation.
102. *Pseudocercidis rosae* Richards  
Yellowknife (AGR); Fairbanks (AGR); all on wild rose.
103. *Pterocomma beulahensis* (Cockerell)  
Alaska (S and P).
104. *Pterocomma bicolor* (Oestlund)  
Yellowknife (AGR) on *Populus balsamifera*, *P. tremuloides* and *Salix* sp.; Whitehorse (AGR) on *P. balsamifera* and *Salix* sp.; South Nahanni River, Yukon (RDW) on 7 July 1976 on *Populus* sp.; Dawson City (HGW) on *Salix* sp.; Anchorage (AGR, BAB) on *P. balsamifera* and *Salix* sp.; Anchorage (FCH) on *S. bebbinana*; Fairbanks (AGR) on *P. tremuloides*.
105. *Pterocomma populeum* (Kaltenbach)  
Alaska (S and P).
106. *Pterocomma populifoliae* (Fitch)  
Alaska (S and P).
107. *Pterocomma salicis* (Linnaeus)  
Yellowknife (AGR); Whitehorse (AGR); Dawson City (HGW); all on *Salix* sp.
108. *Pterocomma smithiae* (Monell)  
Yellowknife (AGR) on *Salix* sp.
109. *Rhopalosiphoninus (Myzosiphon) staphyleae tulipaella* (Theobald)  
Mackenzie River (DMR) in yellow pan trap.
110. *Rhopalosiphum insertum* (Walker)  
Alaska (USNM) from *Crataegus* sp.
111. *Rhopalosiphum maidis* (Fitch)  
Mackenzie River (DMR) from yellow pan trap.
112. *Rhopalosiphum padi* (Linnaeus)  
Palmer (RHW) on 16 June 1970 and 2 July 1971 on *Prunus padus* L.; Fairbanks (HGW) on *P. pensylvanica* L.
113. *Rhopalosiphum padiformis* Richards  
Fairbanks (AGR) on grasses.
114. *Schizaphis graminum* (Rondani)  
Mackenzie River (DMR) from yellow pan trap.

115. *Tamalia coweni* (Cockerell)  
Whitehorse (AGR) on *Arctostaphylos uva-ursi* L. (Spreng.).
116. *Thecabius affinis* (Kaltenbach)  
Yellowknife (AGR); Whitehorse (AGR) on *Populus balsamifera*; Fairbanks (AGR) on *P. balsamifera*.
117. *Thecabius (Parathecabius) populimonilis* (Riley)  
Yellowknife (AGR) in yellow pan trap; Whitehorse (AGR) on *Populus balsamifera*.
118. *Thripsaphis (Trichocallis) cyperi* (Walker)  
Yellowknife (AGR) sweeping vegetation; Mackenzie River (DMR) from yellow pan trap; Kluane National Park (RDW); Anchorage (AGR); Juneau (FCH).
119. *Thripsaphis (Trichocallis) verrucosa* Gillette  
Alaska (S and P).
120. *Thripsaphis (Trichocallis) verrucosa* subsp. *nodulosa* Hille Ris Lambers  
Alaska (S and P).
121. *Uroleucon* spp.  
Samples were taken from several plants in many places, but it is not yet possible to determine the species.
122. *Uroleucon epilobii* (Pergande)  
Alaska (S and P).
123. *Uroleucon (Uromelan) taraxaci* (Kaltenbach)  
Whitehorse (AGR, BAB) on *Taraxacum officinale* Weber.
124. *Wahlgreniella nervata* (Gillette)  
Whitehorse (AGR) on wild rose.

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Erratum: Turnock, W. J., and H. G. Philip. The outbreak of bertha armyworm, *Mamestra configurata* (Noctuidae: Lepidoptera) in Alberta, 1971-1975. Manitoba Ent. 11(1977)

p. 19, paragraph 4, lines 5-6 should read:

$$DI = \left[ \left( \frac{M + 1 - S_i}{M} \right) \right] \frac{100}{F}$$

where M = the maximum duration of sampling effort in the  $i^{\text{th}}$  field (10 minutes in 1973, 6 sample units in 1974);

p. 19, paragraph 5, delete line 6 and insert:

used was  $FI \geq 50$  (Table 5). Municipal District 48, where  $FI = 43$  and 11,862 acres were treated, was incorrectly classified. For 1973 and 1974, the usefulness of both FI and DI was tested. For municipalities in which insecticidal treatment was used, the best prediction included municipalities where  $FI \geq 67$  or  $DI \geq 50$  (Table 5). In each of 1973 and 1974, the need for treatment

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