

FOREST ENTOMOLOGY - ITS RELEVANCE
AND
CONTRIBUTION TO THE URBAN COMMUNITY

FOREST ENTOMOLOGY - ITS RELEVANCE AND CONTRIBUTION TO THE URBAN COMMUNITY

ABSTRACT

It is suggested that there are a number of unfulfilled needs in the community concerning readily available, and simple information, which will allow for adequate protection of valuable Shade or Ornamental trees from insect injury or destruction. A comparison is drawn between the value of the forest crop and the Urban forest resource. The availability of information on overall value of this resource for each city is noted and it is concluded that there is a lack of reliable data since many cities have no tree inventory. The value of individual specimens is discussed with examples. The diversity of the urban forest is noted but it is suggested that this attribute is out-weighted by the stress of growing conditions in the urban community. The history of entomology in Arboriculture is reviewed, culminating in a brief assessment of current research and research expenditures. The undesirability of pesticide use in the urban setting, coupled with the development of new alternatives, integrated systems, and the introduction of the Metric system are suggested as pointers to the need to provide more complete information to sectors of the community presently served poorly with insect management information. The responsibility of the Forest Entomologist is discussed in this context. Presently available information resources are examined critically and it is determined that up-to-date, complete, or accurate advise is not generally available. Further it is found that some sources are not readily used through inadequacies in layout or indexing. Examples of various tables and catagories used by a number of authors are appended and discussed. The present use made of public advise services is recorded briefly. A simple method of information transmittal using plastic cards illustrating insect stages and damage, supported by detailed information on biology and management is presented with examples of content and format. In addition, the need for greater accessibility to information collected and analysed by Forest Entomologists is suggested with the rider that it be presented in a style readily understood by the non-technical. In conclusion, it is hypothesized that a greater awareness of the needs of the urban forest resource by Forest Entomologists might assist in enhancing the public appreciation of forest insect problems.

INTRODUCTION

At the turn of the century W. Solotanoff wrote "The most vital task, by far, in the case of trees is the extermination of the insects that threaten to destroy or injure them from time to time." (75). Though we might take exception to the intent of extermination, that early statement concerning the health and survival of our urban shade and ornamental tree resource is as valid today, 78 years later, as it was then.

Four separate experiences of this writer have served to both reinforce and broaden the scope and understanding of that concern. In 1976 a visit to the fruit growing region of the Okanagan Valley of British Columbia allowed a first hand examination of integrated pest management in fruit orchards. This program is formulated and superintended by the Canadian Department of Agriculture. In fact the growers of this region have become increasingly dependent on direct assistance from Government staff. Little attempt has been made to provide, even the most sophisticated of growers, the information and hardware which would allow for self sufficiency in terms of monitoring, identification and management of insect problems. Comprehensive bulletins have been prepared (20) (50) (52) (92) as there have been for the fruit growing areas south of the border, (21) (91) but these do not allow for concise field use, and often, (and very reasonably in a commercial operation, today), stress mainly direct controls for crop protection, rather than system management.

Two teaching experiences, one at the Van Dusen Botanical Gardens (33) in Vancouver and the other with the Vancouver School Board (32) afforded a first hand exposure to the frustrations of home gardeners and nursery tradesmen in trying to understand the complexities of insect management in the urban environment. In particular, simple aids for identification and decision making were indicated as lacking and some existing sources of information unknown. My own sympathies followed that of the students for little hand-out material of any use is available from either Federal or Provincial levels of government. This topic is discussed in greater detail in the second section of this paper which examines existing resources and their usefulness.

A more recent task, has provided a further insight into the inadequacies and supply of ready, accurate, detailed, knowledge on insect pests of the urban forest or plant resource. The Canada Department of Transport funded a study, as a component of the Government Master Specification System (97) which would allow departmental specification writers computer access to standardized base data on a variety of engineering and environmental topics. My input to the scheme has included the preparation of insect and disease management charts for 39 species of Landscape trees and 46 species of shrubs (102). In order to compile management tables a wide variety of references were consulted. An assessment of their applicability, comprehensiveness and simplicity of use is also discussed in the second section.

The value of the Forest crop and its importance to the stability of a region largely governs the expenditure for protection. In 1975 the national income for the forests of Canada amounted to approximately \$3.53 (76). At a first glance the value of urban vegetation could not remotely approach that of the forest system. This, however, is not in practice the case. It is, rather, a question of recognition - the calculation of urban tree values or in fact

an inventory of the resource base is sadly wanting (2) (79). In one study where 510 questionnaires were sent to American cities only 172 even bothered to reply (10). Of those that did, the principal concern expressed was that maintenance would be the primary street tree problem by 1978. Brown (15) writing of the City of Birmingham in the United Kingdom noted that it is a city of a million trees, and Last (47) has found that the urban tree resource in Edinburgh includes a large number of relatively undesirable species. Closer to home Pavitt in a recent article in the Vancouver Magazine (62) indicates that city plants an excess of 4,000 mature trees a year and that the city resource diversity includes 40 species and 300 varieties. Olkowski, who can be credited with reporting the first Integrated Pest Management system for street trees (61) records a program for the cities of Berkley and San Jose which included 300,000 trees of 100 species in an area of 50 square miles and one half million people. This figure does not of course include any assessment of the resource in parks or the private sector.

The only detailed study of values in the literature, Keilibaso (44) notes that for municipally owned trees alone in 17 cities in the United States the shade and ornamental tree resource could be estimated as \$186,000,000 calculated on a mean value per tree of \$198. A national accepted formula is available for Canada and the United States which allows calculation of individual tree worth in two broad categories; 0 to 12 inches D.B.H. and 13 to 40 inches D.B.H. In the latter case a first class specimen tree may be worth \$10 for each inch of cross section of girth (17).

At one time in Canada (1966) it used to be possible to assess the magnitude of increases to the urban forest resource from data published by the Dominion Bureau of Statistics (94). In 1966 for example it was possible to determine by species that some 926,000 conifers of various sizes had been shipped from Canadian nurseries, while 799,000 ornamental hardwoods had been shipped. It was possible to examine individual figures for 60 species or varieties of the former and 50 species or varieties in the latter category. By 1972 it was only possible to have figures for each province (95) but with no detail on species breakdown. However, for Canada as a whole, conifer nursery shipments amounted to 949,000 and ornamental or shade hardwood trees to 956,000. In both reports it was also possible to determine similar figures for shrubby species and low growing ornamentals.

For anyone who has the responsibility of maintaining a home garden the value of nursery stock is well illustrated by the expense incurred if a valued specimen dies and required replacement. The 1976 catalogue (98) from a well known wholesale nursery in Vancouver indicates that true cedar, Cedrus deodar for example is \$19 for a four to five foot specimen rising to \$350 for a 10' specimen or \$55 for a five foot Acer palmatum atropurpureum and \$500 for a 12 foot tree. The private citizen could however, expect to pay considerably more at the retail level. Moreover there is an obvious relationship between size, exotic nature, and cost. It is little wonder then that the average homeowner desperately wishes to protect his investment from the deprivations of insects and disease. The average simple urban garden may contain a plant resource valued in excess of \$10,000.

Forest entomologists have historically played an important part in the development of shade and ornamental tree protection programs. The First Shade Tree Conference met for two days in August of 1924. The 36 members in attendance were addressed by Dr. W. E. Britten State Entomologist of Connecticut and Chairman of the Tree Protection Examination Board. Dr. Britten concluded his remarks thus "I do not hesitate to predict that the value and beauty of trees will be more fully appreciated in future years as the country grows older, and the profession of protecting trees will become more and more important as time goes on. Let each contribute his full quota to a further knowledge of the subject". Dr. Britten was followed then by a speaker on Gypsy Moth, a speaker who discussed the factors effecting the solubility of Lead Arsenate, and Dr. E. P. Felt, editor of the Journal of Economic Entomology who, it is recorded, handled the subject of wood borers. Later W. O. Hollister, entomologist for the Davey Institute and Mayor of the City of Kent explained the type of instruction offered by that company. (90) An auspicious start one would think for Association now called the International Society of Arboriculture with over 2,000 members in 19 countries (101). Despite this growth and the awareness of shade tree problems particularly in the realm of insect injury the input of entomologists has not matched that of the founding meeting. A few papers in the Journal are now devoted to examining insect/shade tree relationships. Of the last 25 issues of the Journal each with an average of five articles per issue only six have dealt with entomology. One paramount reason for this would seem to be evident from the figures furnished by Weidhass in a 1973 review of shade tree insect research in the United States (80). It was found that there were only 62 research projects directly related to shade tree entomology and that funding amounted to only \$638,978. This was in contrast to expenditures by three American cities Lansing - Michigan, Minneapolis and Detroit who alone have spent three and one half million dollars in the last fiscal year for shade tree maintenance. In the same study it was noted that emphasis was being placed on gypsy moth, scales, Elm bark beetles, borers, tip moths and Bagworm. In a more recent and detailed paper by the same author (79) it is noted that the life history of many shade tree insects is poorly known and that emphasis must be placed in determining when and to what extent insects become pests and that economic and damaged thresholds must form the basis for insect control. It is further suggested that pheromone attractants, repellents, host selection and preference, host resistance, phenological and environmental factors that predispose trees to insect injury require more lucid determination. Discussion by other reviewers of the current status of shade tree entomology support this thesis. Wallner (78) indicates that people no longer accept the use of pesticides and that shade trees offer a great opportunity to use biological control in tandem with physical and chemical methods. Examples cited by this author include the Clearwing pheromone, gypsy moth Disparlure, the potential use of attractants for trapping, monitoring and control timing, and work on the varietal differences of some tree species to insects, as in the spruce aphid Adelges abietis, the Scots Pine saw fly Neodiprion sertifer and the plant bug Orthotylus chlorionis. Andresen also reviewing the status of research in the shade tree industry includes the need for further work on feeding deterrents, insect disease and circadian rhythmic cycle control of insect populations (1). McKenzie (55) in perhaps an apt summary, notes that the U. S. is the only country where specialists in tree protection are accorded a position in tree care comparable to the coroner in the life and death of humans. Entomologists are a profession that are consulted for a diagnosis of "What Killed It". It could be concluded that this view may marketably influence the ability of entomologists to substantiate their claim for more research funding. This view is in sad contrast to the enthusiasm of Elias writing of urban trees in Scientific American

who notes that urban trees have adapted to the stress of smog, air pollutants particulate matter, low water supply, toxic concentrations of salts and urine, soil compaction, heat and modifications of photo-period from urban lighting. (28)

Despite the relative inaction in the field of entomology to provide the basic information for detailed management plans appropriate to the urban forest or individual shade and ornamental trees there is considerable emphasis placed on the maintenance of the resource. On the one hand it is regarded as a truly commercial venture (88) as reflected in the view held by some commercial arborists in an article entitled Tree Insects-The Commercial Arborists Money Crop, or from the Legislative point of view as with the promulgation of enabling legislation Figure 1. Barker (9) reviews the increasing need for ordinance control of street trees with the preparation of master lists which prohibit the planting of various species particularly those susceptible to insect injury. It is observed that once a tree is planted the dye is cast for the character of a community landscape which may last for 50 to 100 years thus indicating that need for a choice of species resistant to the ongoing deprivations of insects and disease.

Gradual recognition of the needs in the urban forest can be seen from recent developments in organization and policy of both the British and Canadian Governments. In Canada there has been a recent creation of the Shade Tree Management Institute centered in Ottawa and in the United Kingdom the Forestry Commission responsibilities have been broadened to include amenity tree research (40). The needs in entomology however, have not been supported with the enthusiasm shown for pathology (46). Both governments do, though appear to take a more sceptical attitude to the wide use and registration status of the many pesticides used in insect control on amenity trees. It seems reasonable to expect that current reviews may substantially reduce the list of pesticides currently available. (100). In addition to the foregoing, Government commitments to introduction of metric measurement will require a major reworking of all publications and recommendations concerning urban forestry and arboriculture. (3).

The changing circumstances of the world around us, the ever increasing complexities of technology, the continuing efforts of dedicated researchers, and the gradual alienation of the individual in society coupled with apparent decreasing level of literacy and the communication problem of providing concise information when it is available, would indicate a mounting need for a reassessment of the status quo and a clear plan for future directions in the management of our urban plant resource.

INFORMATION RESOURCES

It is perhaps symptomatic of the current economic realities that those services seen by government as unessential are phased out. It seem inconceivable, however, that an arm of government which allows for better communication and access to information, especially that paid for by public money, should be disabled by closure of its offices. Information Canada Bookshops allowed the public ample opportunity for review and purchase of a wide variety of

information including publications on insect management in the non-forest setting(96). This trend towards reduced expense may eventually have severe repercussions on many professions whose employment is principally government funded, for the general public can realize no benefit from their work and presumably in future years move to further curtail their funding.

A brief survey of the book stores in downtown Vancouver, in particular Coles, Duthie Books, Murray's Books, Pauline's Books, Seymour Books, the book departments of Eatons and Simpsons and the Book Mart indicates that there are almost no books specifically concerned with insect management or entomology in general, readily available for public purchase. One exception is the Bug Book by Philbrick (65). This publication sub-titled "Harmless Insect Controls" has a number of interesting suggestions; white geraniums or bright yellow traps for Japanese beetles, cotton batting for Tussock and gypsy moths, sticky bands for canker worms, Tanglefoot for Codling moth, coriander oil for red spider mite, kerosene for tent caterpillars, kerosene for the eggs of many species and finally the wide spread use of Kieselguhr (diatomaceous Earth). Although fairly lucid this publication is typical of the natural controlled publications which seem to encourage remedies which range from turpentine to turkeys. While on this topic, though not to my knowledge available in Vancouver, a more detailed publication has been prepared in the United States by Harris (38) for the Public Citizens Health Research Group, entitled Grow It Safely - Pest Control Without Poisons.

Since public demand would not appear to warrant most book stores maintaining a stock of books concerned with entomology, a thorough examination was made of the book resources held by the Vancouver Central Library. Resources in the sections for entomology, forestry, gardening, and horticulture were examined. Books available appear to fall into two initial categories; those books which deal directly with insects or insects and diseases, and those books or other publications which contain information on insects in a summary or chapter in a book of more complete content.

The quality, quantity, relevance, and age of information was found to vary enormously. In general the most important factor would appear to be the quantity of outdated information still in evidence.

A number of publications deal specifically with the culture and maintenance of individual species of ornamental or shade trees. A publication by Beale (11) on The Evergreens though complete in other respects contains no information on insect management. In contrast a publication on Hollies (24) has detailed chapters by separate authors for holly pests in the East and Pacific Northwest of the United States. Of importance in the East it was noted that two moths, one leaf roller, one leaf miner and three scales were important pests and detailed life histories and control methods are recommended. In addition a number of references are given. In the Pacific North West one mite, seven scale, one aphid, one mealy bug, one white fly, five leaf or berry miners and four leaf eaters, one root feeder and one borer are discussed in complete detail and illustrated with black and white plates. A publication by Boer (14) on ornamental Crabapples discusses leaf hoppers, scale, borers and canker worms but concludes that there is little use to list all insects which can cause injury as many are of relatively minor importance. It is observed that many new chemicals are coming to the market place to fight insects and the suggestion is made that advice may be gained from experienced nurserymen. Specific concern is expressed about borers though none are mentioned by name;

carbon disulphide is recommended as a remedy. A number of authors seem not to have forgotten their war time experiences, Murphy in Care and Feeding of Trees indicates that insects normally attack in large numbers, that trees fight for life and that there is a constant war against the enemies of trees. DDT is recommended as an important remedy (53). Edinger in a more reasoned approach (26) noted that pest problems are normally localized, the attack short lived and often dependent on weather and season. Insects are discussed under three categories sucking, chewing, and boring although specific species are not cited. The wisdom of calling professional help is illustrated with an example of the dangers of trying to spray a 30 foot oak with a five gallon sprayer from the top of a step ladder. A well used book in the library appears to be Lavisson (48) the Home Book of Trees and Shrubs. Chapter 12 on how to control insects and disease opens with the interesting statement that all insects go through four stages of transformation during their life cycle. Nicotine sulphate is recommended for sucking insects, lime sulphur for scale and Leopard moth and Hickory bark borers, recognized as a very dangerous group of insects to trees, are not surprisingly suggested to be adversely effected by arsenate of lead a "new" insecticide, (DDT), injections of carbon disulphide as a paste or Paradichlorobenzene as an injected fumigant. Bean (12) in a 1958 re-issue of his Ornamental Trees for Amateurs wisely avoids making such hazardous recommendations. Infact Chapter V devote to the care of mature trees discusses storm damage and fungi but makes no reference whatsoever to insect control! Edlin (27) provides an interesting discussion on the recognition of insect damage while Haller (36) provides a fascinating description of a caterpillar "as a many footed restless, imprudent and very hungry crawling thing." Further the Pupa is noted as "the resting stage where, having eaten himself into a stupor, the larvae builds himself a cocoon and curls up for a long sleep." In a more serious vein the applicability of biological controls in the urban setting is questioned since the conditions which prevail there are suggested to be exceptional as the trees are growing under artificial conditions resulting in a need for more artificial controls. Perkins in Ornamental Trees for Home Grounds (64) reviews some insect pests of shade and ornamental trees only in the context of their control. Sevin or DDT is recommended for leaf insects, Lindane for leaf miners, nicotine sulphate for sap suckers, Klethane for mites, DDT for stem insects, and Chlordane for Black Vine weevil. Unfortunately no discussion is given concerning these insects life cycle nor the appropriate timing for their control. Baker (13) is one of the few authors who discusses, in the context of insect control, the need for healthy trees; adequate watering and feeding, the cleaning of debris, and the prevention of insect establishment by using simple and effective techniques such as hand removal and a dormant oil are strongly recommended. Youngmann (87) in a publication of the American Forestry Association lists seven most common questions asked of the association of which the fifth is recorded as "How can I protect against insect". A valuable suggestion is to avoid planting pest susceptible trees and shrubs. A list of 16 species particularly prone to insects pests is given and 29 species usually pest free are recommended. Only one other author Wyman (85) provides a list of susceptible and resistant plants, and this contained in a book specifically referencing choice of species.

Few authors attempt in any way to give the reader information which will specifically assist in the diagnosis of insect problems. Baumgardt (16) briefly discusses the topic, however, only one author Crockett (18) (19) provides clear concise tables as a guide to pests and diseases, examples are attached hereto as Table 7 and 8. Few authors unfortunately attempt a baseline key to assist for recognition of insect pests or their damage. Martin (51) uses four simple categories of gnawers, chewers, suckers, and stingers. To this writer's knowledge only one lay text provides good clear tables with a diagnostic breakdown (41). James in preparing the tables for this publication utilizes six categories a) foliage destroying insects b) excavating insects other than those which bore into timber c) timber borers d) bark feeders e) root feeders and f) gall makers. A major omission, however, from these tables would appear to be scales. An example of these tables and their format is given in Table 3 of this paper.

Of the texts whose prime purpose is to describe insects in relationship to plants, the reverse of the previous section, the most complete text (66) available at the Vancouver Central Library has been that of Pirone entitled Diseases and Pests of Ornamental Plants. This tome of 773 pages provides a paragraph on each pest and a reference where appropriate under a reference for all plants established for ornament in North America. If a criticism was to be made, there is on occasion an attempt to be too complete in listing specific pests while not indicating if their range included Canada. A second text by Pirone (68) specifically on tree maintenance, also contains in Chapter 9 a detailed commentary on diagnosis, control and management of the more common insect pests found on the principal shade and ornamental trees of North America. A copy of Anderson (6) may be found in the section on forestry and is well known as a good basic text on forest and shade tree entomology. Despite the comprehensive keys I would suspect that it is somewhat intimidating to any readers without a basic understanding of insect taxonomy. Two final publications of note, more for their poor qualities than virtues are authored by Peairs and by Westcott (84). The former (63) contains in Chapter 16 a review of insects injurious to various fruit and shade trees and ornamental plants. The number of insect species discussed is rather limited with two tent caterpillars, one inchworm, the Tussock and brown tailed moths, rose slug, and three borers being given as a prime concern. Since this publication is dated 1956 chemical methods of control are obviously outdated. The book contains, however, a well developed introduction on the structure and biology of insects, their classification and natural controls. The second book entitled The Gardner's Bug Book is intended specifically for the lay reader, however, the five chapters; insects in the garden, chemicals, spraying and dusting, insect names etc., and English names does little to advise the reader on specific methods for specific problems. In addition this rather expensive book is provided with rather poor colour illustrations rather than plates of important insect pests. The publication is however, recommended by a number of authors including Youngman (87).

In most cases the aforementioned publications are available for borrowing, however, this would not be the case of a more recent text (43) suggested as the more comprehensive entomology reference for trees and shrubs. The size and price (\$43.00) would preclude such an item being available for borrowing at the Public Library, severely restricting its use for home reference. It would seem that this inability to use the 212 plates of 650 pests in the field might somewhat limit the accurate diagnosis of insect pests intended by the authors. Although this book is most comprehensive and records itself as the most important in the United States and Canada, it unfortunately omits to reference the distribution of most insects in Canada. There are two authors, five collaborators and 25 acknowledgements and unfortunately none are from this country. It would seem that since 1965, when research on the publication started, some contribution could have been found from Forest Entomologists in Canada. For those requiring assistance north of the border, they do however, recommend the British Columbia Council of Forest Industries, the B. C. PFRC, the CCRI and the IPRI in Ontario. This authors harshest criticism, however, is not one regarding the origin of information but rather the inability of even the most dedicated user to find a number of the insects mentioned in the text by using the index. This index has been compiled in two parts the host English and Latin names and the pest English and Latin names. Unfortunately the compiler has omitted to include a number of insects mentioned in the body of the book either by Latin or English name thus making it extremely frustrating to use this publication as a reference. Moreover, in some cases insects or host plants are mentioned by English name but not by Latin name, or vice versa acquiring a key of the type put out by the Entomological Society of the America (5) to be used as a supplement to the book.

We turn briefly to information contained in published articles from arboricultural sources, few of significance are available since 1970. Appleby (7) in 1970 discusses the control of eastern gall aphid, leaf crumpler, Lilac borers, Birch and Hawthorn leaf miners and their chemical controls. This same author, however, in 1971 (8) gives detailed life history for Holly leaf miner, Bag worm, European Pine Shoot Moth, Leaf crumpler, and European Elm scale. Nielsen (57) reporting on research for control of borers that attack shade trees and shrubs, discusses Buprestidae, Cerambycidae and the Lepidoptera, Sesiidae. It is noted that enormous annual dollar losses can occur from 14 important species of borers and that they all have wide distribution. It is suggested that pheromone capturing should be considered for use in a borer management system. Pirone (67) in discussing advances in general tree maintenance notes that Thuricide, Imidan, Zectran and Superior Oil 60 are all important but does not discuss their use in any depth. Roscoe (69) also in a short article discusses the use of insect growth regulators and the use of BT and PHV.

In the area of government publications at the Federal level at least, only two are specifically available for the lay reader; that concerning common pests of Arbutus (39) and that by Harris on the European Pine Shoot Moth (37). A large range of material is of course available concerning forest insects and ranges from the simple folding sheet as in the case of Larch case bearer (71) through information sheets from the Great Lakes Forest Research Centre as in the case of White Pine Weevil (72) and the pest leaflet series as in the case of Spruce Gall Aphid (86) to the most impressive and relatively expensive illustrated Insect Pests of Eastern Pines (73). An important range of Federal publications which could contain appropriate information for insect management on shade or ornamental trees is that

information of the current Forest Insect and Disease Conditions (4) (30). These publications do not, however, attempt to make any reference to prevailing insect conditions or summarize insect injury to non forest trees. The combined annual reports of the Forest insect and disease survey do contain some references to pest problems encountered on ornamentals, however, since these publications (11) are normally two years behind in publication, it would seem that they serve little purpose other than historical review.

At the Provincial level certainly in B. C. the situation is little better, the most commonly available publication handed out is Pest Control for the Home Garden. This publication first appeared in 1974 (93) and has not been revised since then. Consequently it contains outdated information and is almost wholly concerned with the use of pesticides. The more comprehensive Handbook for Pesticide Applicators though complete and fairly accurate is not really appropriate for home use. In the past Gerber prepared a most complete bulletin on the recognition and life history of major insect and mite pests of ornamental shrubs and shade trees in British Columbia (35). In most instances there is a coloured picture of the insect and a review of its specific distribution, hosts, injury, description, life history and control. Control measures were given by number and contained in a supplement which allowed for on going revision. It is sad to record that this publication is now out of print and is unlikely to be reissued. A similar yet larger and more comprehensive publication by the late Ken Turner on the Common Pests of Ornamental Trees and Shrubs in Ontario (60) provides information for 38 species of plant and records defoliating, sucking, borers, gall making and root feeding insects. Detailed life histories are included with cultural or chemical controls. The publication is profusely illustrated. A United States handbook which is now out of print by MacAloney gave detailed information on the identification of Hardwood insects by type of tree injury and could serve as a model for future publications of this type.

The general lack of suitable government literature has meant that some commercial organizations have taken it upon themselves to issue information for the public, an example is given in Table 2. The calibre of this local information appears extremely poor despite its good intent and may be compared with the more detailed information being circulated by nursery organizations in the states Table 1. Finally mention should be made of the information services offered by a number of institutions in British Columbia. Most notable is perhaps that offered by the Ministry of Agriculture, in personal communication (45) it was determined that about 25 calls per week are made to this service, it is often difficult to resolve queries and manpower is noted as being inadequate. It was suggested that there is a definite need for a good illustrated handout, but that cutbacks had been already felt and that new publications in colour were extremely unlikely. The Vandusen Botanical Garden in Vancouver receives approximately one half dozen calls a day in the season concerning insect problems on ornamentals. The director, Roy Taylor indicated that they have no handouts at all and that the staff available for consultation is very limited. Moreover it was suggested that nursery and garden centres are often ill equipped and ill informed to assist the homeowner. The Department of Horticulture at

U. B. C. handled 500 calls in the last three months of which 50% are estimated to concern insect pests on ornamentals (59). A hoped for program to issue plant info-grams has not moved forward rapidly through lack of staff and funding. It was noted that outside literature was also very poor. A service offered by the Department of Plant Sciences does not record the number of calls per week, however, it is estimated that about half concern insect problems on ornamental and shade trees (74). Informal contact is also probably made with a number of other university or institutional departments but at this time the frequency of information requests has not been determined. General range and quality of information available to the non technical does not appear to have kept pace with demand, and consequently it would seem worthwhile to suggest some remedies which are both practical and inexpensive. Trade journals are also sparse information sources for the landscape manager for non technical maintenance supervisor or staff. The publication Weeds Trees & Turf has a number of articles on insect pests of turf that has not dealt directly with problems of shade or ornamental trees. Forest insect problems have been reported for Gypsy moth (106), Spruce budworm (108) and Tussock moth (107). This information is not extended to cover non-forest situations. The journal Grounds Maintenance has been more attentive to insect problems and has initiated a well illustrated and written series which has dealt so far with Crabapples (103), Oaks (104), and Maples (105). Recognition and control measures are stressed, in fact the series is entitled Detecting/Controlling Tree Diseases and Pests. This should not be seen as a criticism as it is the only attempt of its type and is obviously subject to restrictions in space for each article.

The publication of research papers by Forest Entomologists in the scholarly journals may well be a necessity of the current system for recognition and reward, but it serves the eventual user very poorly since writers of the calibre of Cummings on the life history and damage of the winter moth Operophtera brumata (20), Schreier (112) examining shoot and tip feeders in Pine, Lyons (49) review of the biology of the European Pine Sawfly, Neodiprion sentifer and the detailed examination of autocides and microorganisms as potential agents for control of Lepidoptera (77) remain obscure from all but the most avid non professional.

The only source of research summaries in Canada that enjoys wide circulation is the Bi-monthly research notes of the Forest Service of Environment Canada which, for example in a recent issue (99) discussed mating disruption of Tussock moths with a sex pheromone, Dimilin on Forest Tent Caterpillars and field calculations on application of Bacillus Thuringiensis.

Johns (42) in a recent suggestion for a remedy in the United States has suggested the use of the Arboricultural Research and Education Academy as a clearing house for information and the possible abstracting of research papers in the context of their usefulness in ornamental and shade tree management.

As with information for the general public, the grounds maintenance supervisor, the landscape supervisor, the tree company manager, the park superintendent and their respective staff again appear to suffer the same lack of access to information concerning either general principals or specific details of insect management on shade or ornamental trees.

RECOMMENDATIONS

Change in our modern world is initiated by two fundamental forces—calamity or conviction. Our inability to perceive harm before it is disastrous is not great, as evidenced by the deprivations of Dutch Elm Disease (34), despite our knowledge of this disease since the First World War (83). The onus for a change must rest then, with the professional entomologist. To learn a skill, is to accept a responsibility that should not be bounded by the dictates of a job description or administrative introspection. Rather the forest entomologist must broaden the scope and meaning of the term "forest" to include not only the production forest but the urban forest as well. Many of the principals and much of the detailed knowledge is as valid in one setting as it is in the other.

One basic concept, however, must change; management of stands must be replaced with management concepts for the single tree. The challenge is still there! Moreover many of the most recent advances, in particular pheromone traps, insect growth regulators, feeding deterrents, and disease organisms (1) (57) (69) (77) (78) are, unlike the no less valid biological control, a considerably more marketable proposition both in terms of expertise and hardware. The economic incentives that make our western world wobble round is there, not only in protecting a valuable and aesthetic resource, but in providing the public or private owner with a technology to do it.

Continuing research, basic and applied, is critical if this technology is to become established and self sustaining. The relationship between stress and susceptibility, the mechanisms of resistance, the development of resistant species and cultivars, the possible establishment of clonal source banks, the more detailed elucidation of important damaging insect life cycles and recognition of simple cueing indicators that predict insect development, (as in degree days or plant development) and the detailed assessment of vulnerability in developing insect stages, are all important goals. Moreover the economics of protection, the re-examination of registered uses of the plethora of currently available insecticides, the accurate timing of their use, specificity and rates (when use is necessary) and the subtle impact of such use in the urban environment, require more detailed documentation.

The forest entomologist has the responsibility of not only understanding pest biology and economic impact but also in considering the consequences of subsequent management methods developed to manipulate pest populations.

This responsibility, however, is not the forest entomologist; is alone. Since most entomologists are within the employ of Federal or Provincial levels of government there must be an adjustment of goals and objectives on the part of senior staff and ministerial level administrators which recognizes the management of insects in a broad yet clearly defined context. The professional expertise must emanate from a wide variety of disciplines, yet be molded together as a team approach. Geneticists, plant physiologists, horticulturalists, foresters, landscape architects, planners, chemists and professional administrators must join with the entomologist and pathologist to better co-ordinate and abstract the latest insights and development, born of research and experience.

as could reviews of the theory and practice of biological control, basic tips on good garden practice and safety precautions for pesticide use. Further it would seem worthwhile developing a series on host plants which would allow simple recognition and reinforce good cultural practice.

With a simple aid for pest recognition, understanding and management and a similar resource for plant identification and maintenance, it would seem possible to make a worthwhile contribution to the cause of informed pest management on a wider scale than heretofore.

Since these items cannot however stand alone, there is an obvious need for a more comprehensive approach by existing personnel and agencies. In particular there would seem to be merit in suggesting a broader outlook on the part of the Provincial Forest Service and the Pacific Forest Research Centre. A continuation of the detailed single page brochures may be necessary but more importantly the existing capability for survey and detection should extend to publication of a Shade and Ornamental Insect and Disease Bulletin, much in the mold of the existing Forest version (30).

More aggressive approach would be necessary to ensure availability and distribution of such information. Adequate manpower will have to be provided particularly in the lower mainland but should supplement the existing joint agriculture/horticulture system already in existence for referral, insect identification and recommendations. Applied research on a local basis is an obvious necessity, however, this must be supplemented with a detailed and applied abstracting service in order to simplify information for public consumption. Finally a forum for discussion of shade and ornamental entomology in the context of the total urban forest system is required, probably on an ongoing basis.

SUMMARY

In Western Canada there is a wealth of talent and expertise no less in the area of entomology than in any other natural science. In fact the dependence on Forestry which produced 17 million units of timber and employed 250,000 people (110) in the Province of B. C. in 1975 has meant that the forest resource is afforded considerable attention, though many would suggest it is still inadequate.

Forestry then, contributes substantially to our provincial economy and hence to our quality of life. A vital part of that quality is our urban community and its "forest" resource. We should remember that our concern for one should be no less than for the other.

It is perhaps to the partial discredit of forest entomologists generally that little is understood by the public about their responsibilities and the difficulties faced by the profession.

The necessity for defense in one situation, as with forest defoliators, should not deter leadership in another - the urban community. It could perhaps be postulated that more interest in the one may help smooth the path for the other, to the benefit of both now, and in the future.

REFERENCES

1. Andresen, J. W., 1973 status of research in the Shade Tree Industry. Proc. Int. Sd. T. Conf. 49.
2. Andreson, J. W., 1977 Urban Forestry Research Systems in Tim. Forests for Human Stn. U. of T.
3. Andresen, J. W., 1976, Canadian Shade Trees Go Metric. Contribution #2-76. Centre for Urban Forest Studies U. of Toronto.
4. Andrews, R. J., 1975, Forest Insect and Disease Conditions, Prince Rupert Forest District. B. C. Forest Service and Forest Service Environment Canada.
5. Anderson, D. M., 1975, Common Names of Insects. Entom. Soc. of Am. Special publication 75-1.
6. Anderson, R. F., 1964, Forest and Shade Tree Entomology, Wiley
7. Appleby, J. E., 1970, Control of Insects on Ornamental Plants. Arborists News 35 (5).
8. Appleby, J. E. 1971, Insects of Ornamental Plants - Life Histories and Control. Proc. 47 Int. Shade Tree Conf.
9. Barker, P. A. 1975, Ordinance Control of Street Trees. J. of Arb. 1 (11) 212 - 215.
10. Bassett, J. R., 1975 Status of Shade Tree Inventories in the United States. J. of Arb. 1 (3).
11. Beale, J. H., 1960, The Evergreens, Doubleday & Co.
12. Bean, J. W., 1925, Ornamental Trees for Amateurs Country Life.
13. Baker, J., 1973, Make Friends With Your Flowering Trees, Simon & Shuster.
14. Boer, Andre F., 1959, Ornamental Crabapples, American Assoc. of Nurserymen.
15. Brown, D., 1975, Birmingham - City of a Million Trees, Arb. J. 2 (8) 302 - 306.
16. Baumgardt, J. P., 1974, How to Care for Shade and Ornamental Trees, Intertec Publ. Corp.
17. Chadwick, L. C., 1975, Tree Valuation J. of Arb. 1 (2) 35 - 38.
18. Crockett, J. U., 1971, Evergreens, Time Life.
19. Crockett, J. U., 1972, Trees, Time Life.
20. Cummings, 1961, The Winter Moth, *Operophtera brumata*. A Review of Life History and Damage. Can. Ent. 93 135 - 142.
21. Capizzi, J., 1976, Oregon Insect Control Handbook, Extension Service Oregon State U.
22. Dawson, R., 1975, Edible Plant Cards - Temperate North America, Life Support Technology Inc.

REFERENCE (Continued)

23. Dawson, R., 1976, Wilderness Survival Cards, Life Support Technology Inc.
24. Dengler, H. W., 1957, Handbook of Hollies, the National Ort. Mag. 36.
25. Dustan, G. G., 1973, Diseases Insect and Mites of Stone Fruits, Canada Department of Agriculture.
26. Edinger, P., 1975, Garden Trees, Sunset Lane Publ.
27. Edlin, H. L., 1956, Tree Injuries, Their Cause and Prevention, Thames & Hudson.
28. Elias, T. S., 1976, Urban Trees, Scientific American 232 (10) 111 - 118.
29. Felt, E. P., 1958, Insects and Disease of Ornamental Trees and Shrubs. MacMillan Company.
30. Fiddick, R. L., 1975, Summary of Forest Pest Conditions in British Columbia and the Yukon. Pacific For Research Centre Nev. Canada. Fall and mid season summaries.
31. Gardner, M. R., 1968, Ontario hydro tree clearance chart for overhead lines, Ontario Hydro.
32. Gardner, M. R., 1976, Selection and Care of Shade and Ornamental Trees for the home garden. Lecture series, Vancouver School Board.
33. Gardner, M. R., 1976, Identification and Management of Garden Insects, Lecture series, Vandussen Botanical Gardens, Vancouver.
34. Gardiner, L. M., 1976, Recent Developments in Dutch Elm Disease Research. Forest Reserach Newsletter, Great Lakes For. Res. Centre. 5 (4) 5 - 11.
35. Gerber, H. S., 1971, The Recognition and Life History of the Major Insect and Mite Pests of Ornamental Shrubs and Shade Trees of British Columbia, B. C. Department of Agriculture.
36. Haller, J. M., 1957, Tree Care, MacMillan.
37. Harris, J. W. E., 1975, European Pine Shoot Moth, Forest pest leaflet #18. Can. For. Serv. Env. Canada.
38. Harris, S. G., 1975, Grow Them Safely - Pest Control Without Poisons, Public Citizens Health Research Group.
39. Hunt, R. S., 1976, Common Pests of Arbutus in British Columbia, Can.For. Serv. Env. Canada.
40. Insley, H., 1976, Amenity Tree Research - A new move in the forestry commission. to extent research on arboriculture. Arb. J. 3 (1) 54 - 57.

REFERENCES (Continued)

41. James, N. D., 1972, The Arboriculturist's Companion Blackwell.
42. Johns, H. R., 1976, Arboriculture Research and Education Academy as an information clearing house. J. of Arb. 2 (1) 17 - 20.
43. Johnson, W. T., 1976, Insects That Feed on Trees and Shrubs, Cornell U.
44. Keilbaro, J., 1972, Economic Value of Trees in the urban locale. S. Chapt. News. Int. Shade Tree Conf. Vol. VI.
45. Kostello, B., 1977, Calls concerning insect pest problems on ornamental and shade trees to the referral service, Ministry of Agriculture of B. C. Lower Mainland. Personal communication.
46. Last, F. T., 1974, Arboriculture; research and advisory needs, a report of the arboriculture research working group, UK Arb. Assoc.
47. Last, F. T., 1976, Inventory of Trees in Edinburgh, J. of Royal Scot. For. Soc.
48. Levison, J., 1949, The Home Book of Trees and Shrubs, Alfred A. Knopf.
49. Lyons, L. A., 1964, The European Pine Sawfly, Neodiprion sertifer, Proc. Ent. Soc. Ontario 94 5 - 37.
50. Madsen, H. F., 1971, The Recognition and Life History of the Major Orchard Insects and Mites of British Columbia, B. C. Department of Agriculture.
51. Martin, J. S., 1962, The Homeowner's Tree Book, Doubleday & Co.
52. Morgan, C. V. G., 1971, San Jose Scale & European Fruit Scale in Interior of B. C. B. C. Department of Agriculture.
53. Murphy, R. C., 1969, Care and Feeding of Trees. Crown Publ.
54. MacAloney, H. J., 1964, Identification of Hardwood Insects by Type of Tree Injury. N. Cent. Region U.S. Sor. Serv. Res. Paper. Lake States 11.
55. McKenzie, M. A., 1971, Protecting Urban and Suburban Woodlands and Trees from Insects and Disease. In trees and forest in an urbanizing environment. Co-operative extension service U. of Massachusetts.
56. Neely, D., 1973, Hints of Diagnosis of Tree Problems. Arb. News 38 (1).
57. Nielsen, D. G., 1973, Research on and Control of Borers that attack shade trees and shrubs, Arborists News 39 (2).
58. Taylor, R., 1977, Calls concerning insect pests of ornamental and shade trees to the Vandussen Botanical Gardens. Personal communication.
59. Terrant, D., 1977, Calls concerning insect pest problems of shade and ornamental trees to the U. of B. C. Horticultural Garden referral service. Personal communication.

REFERENCES (Continued)

60. Turner, K. B., 1975, Common Pests of Ornamental Trees and Shrubs. Pest control section, Forest Management Branch, Ontario Ministry of Natural Resources.
61. Olkowsky, W., 1975, Establishing an integrated pest control programme for street trees. J. of Arb. 1 (9).
62. Pavitt, B., 1975, Discover the very trees that grace our city scape, Vancouver Callendar Magazine, October issue 34 - 36.
63. Peairs, L. M., 1956, Insect Pests of Farm, Garden and Orchard, Wiley.
64. Perkins, H. O., 1965, Ornamental Trees for Home Grounds, E. P. Dutton & Company.
65. Philbrick, H. J., 1974, The Bug Book - Harmless Insect Controls. Gardenway Publ.
66. Pirone, P. P. 1960, Diseases and Pests of Ornamental Plants, Ronald Press. 773 pp.
67. Pirone, P. P. 1974, Advances in General Tree Maintenance, Arborists News 39 (3).
68. Pirone, P. P., 1972, Tree Maintenance, Oxford University Press.
69. Roscoe, R., 1977, Basic information on insecticides and their use J. of Arb. 24 - 25.
70. Rexrode, C. O., 1976, Insect Transmission of Oak Wilt, J. of Arb. 2 (4) 61 - 65.
71. Ross, D. A., 1976, Larch Casebearer Foliage Feeder. Leaflet Forest Service Environment Canada.
72. Rose, A. H., 1975, White Pine Weevil, information leaflet Great Lakes Forest Research Centre, Cn. For. Serv. Env. Canada.
73. Rose, A. H., 1973, Insects of Eastern Pine, Publ. #1313 Canadian Forest Service Environment Canada.
74. Rich, H., 1977, Calls concerning insect pest problems on ornamentals to the U. of B. C. Department of Plant Sciences Referral Services. Personal Communication.
75. Solotaroff, W., 1901, Shade Trees in Town and City, Wiley.
76. Stanton, C. R., 1976, Canadian Forestry - The View Beyond the Trees, MacMillan and Canadian Forest Service joint publ.
77. Weatherstone, J., 1975, The Potential of Autocides and Micro Organisms as ecologically acceptable agents for regulation of spruce budworm infestation J. of Env. Qual. 4 294 - 303.
78. Wallner, W. E., 1975, New directions and developments in shade tree entomology. J. of Arb. 1 (4) 61 - 67.

REFERENCES (Continued)

79. Weidhaas, 1976, Shade tree entomology in the urban sprall in Trees and Forest for human settlements. Centre for urban forestry studies U. of Toronto.
80. Weidhaas, J. A., 1973, Current status of shade tree insect research in the United States. Arb. News 38 (3).
81. Weigel, C. A., 1948, Handbook of Insect Enemies of Flowers and Shrubs. Unites States Department of Agriculture, Misc. Publication #626.
82. Weiner, M. A., 1975, Plant A Tree - A working guide to re-greening America, Collier MacMillan.
83. Wilson, C. L., 1975, The Long Battle Against Dutch Elm Disease, J. of Arb., 1 (6).
84. Westcott, C., 1973, The Gardner's Bug Book, Doubleday & Company.
85. Wyman, D., 1972, Trees for American Gardens, MacMillan.
86. Wood, C., 1977, Cooley Spruce Gall Aphid Forest Pest Leaflet #6, Canadian Forest Service Environment Canada.
87. Youngman, W. H., 1972, Growing Your Trees, American Forestry Association.

ANONYMOUS REFERENCES

88. 1972, Tree Insects - The Commercial Arborists Money Crop, Arborists News 38 (2) 49 - 52.
89. 1977, Insects and Disease Table - Booklet for the Home & Garden Show, Vancouver, B. C. Nursery Trades Association.
90. 1924, Proceedings of the first shade tree Conference (report of meeting) the Florest's Exchange and Horticultural Trade World, September.
91. 1976, Spray Guide for tree fruits in Eastern Washington, Extension Bulletin 419. Co-operative Extension Service, College of Agriculture, Washington State University.
92. 1976-77, Tree Fruit Production Guide for Interior Districts, B. C. Ministry of Agriculture.
93. 1974, Pest Control for the Home Garden, B. C. Department of Agriculture.
94. 1968, Shipments of Fruit and Ornamental Nursery Stock in 1965 and 1966 Dominion Bureau of Statistics, Catalogue #22 - 203.

REFERENCES (Continued)

95. 1974, Survey of Canadian Nursery Trades Industry in 1971-72 Statistic Canada Catalogue 22 - 203. 1975 Government Master Specification System Supply and Services Canada.
96. 1957, Culture of Ornamental Trees for Canadian Gardens Publ. 994 Can. Ag.
97. 1971 - 1972 Statistics Canada Catalogue 22 - 203.
98. 1976 Wholesale Nursery Catalogue, E. J. Murray & Sons, Blenheim Street, Vancouver, B. C.
99. 1976 Bi-monthly research notes Forest Service, Environment Canada 32 (5).
100. 1972 Pesticides listed by active ingredient registered for use in Canada Control Product Section, Plant Products Division, Canada Dept. of Agriculture.
101. 1976 Year Book and Convention Programme, International Society of Arboriculture.
102. 1977 contract for the preparation of Insect and Disease Reference Tables issued by Canada Department of Transport to Western Weed Control, Langley, B. C.
103. 1976 detecting/controlling tree diseases and pests, ornamental crabapples, Ground Maintenance June.
104. 1976 detecting/controlling tree diseases and pests, Oaks Grounds Maintenance October.
105. 1977 detecting/controlling tree diseases and pests, Maples, Grounds Maintenance January.
106. 1974 Gypsy moth, threat to the midwest, Weeds, Trees and Turf.
107. 1975 Aerial war on two fronts, Tussock moth, Weeds, Trees and Turf, March.
108. 1976 Spruce budworm, Weeds, Trees and Turf, February.
109. 1968, Ceiba Geigy Weed Tables Basel, Switzerland.
110. 1976, Forestry Statistics British Columbia PFRI Forst. Serv. Env. Can.
111. 1975, Forest Insect and Disease Report 1974, Forest Service Env. Canada.
112. 1970, Schreiner, E. J., 1970 Shoot and Tip feeder of Pine, Unasyuva 24 96-108.

TABLE 7

PEST PROFILE QWIK-FAX on reverse side of card

PEST COMMON NAME:

Local name
Latin name
Origin
Taxonomy
Range
Occurrence
Population distribution
Habitat

LIFE CYCLE:

Number of generations
Mode of reproduction
Place of reproduction
Place of oviposition
Egg description
Egg development (1) time
(2) temp
Time of emergence and cue
Stages of Development
Place and time of pupation
Place and time of over wintering
Stage over wintering

BEHAVIOUR

MODE OF LOCOMOTION

DISPERSAL

RECOGNITION:

Description of stages
Size of stages
Silhouette

Preferred hosts
Alternate hosts

DAMAGE:

When seen
Damaging stages
Type of damages
Result of damage
Evidence of insect
Other symptoms
Diagnostic aids
Predisposing factors in host

CONTROL:

Controls in nature
Cultural
Physical
Chemical (1) insecticides
(2) pheromones
(3) hormonal
(4) microbial
(5) biological
(6) regulatory

Host resistance

OTHER INFORMATION SOURCES

LISTED AS APPROPRIATE