

THE NATURAL ENEMIES OF SHADE TREE PEST INSECTS: A NATIONAL SURVEY¹

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A list of the natural enemies of shade tree pest insects of the United States is being developed by the Center for the Integration of the Applied Sciences of the John Muir Institute. The term "natural enemies" refers to the biotic ecosystem elements: parasites, predators and pathogens. This project arose from the need to have quick access to the existing literature which cites natural enemy information for the purpose of evaluating biological control as a management tool for shade tree pest problems throughout the continental U.S. Although the literature is scattered and sparse, information on natural enemies of insect pests is critical for developing integrated pest management (IPM) programs, identifying and evaluating existing natural enemy complexes, and initiating new natural enemy importation projects.

Purpose of the Project

Our efforts to develop IPM programs for shade trees in the San Francisco Bay area have confirmed the importance of natural enemy populations for controlling pest species (1,2,3,4,5,6). In spite of the importance of these beneficial organisms, current or existing literature on the subject is lacking in two major aspects: 1) few records of host species are available for many of the natural enemies, 2) in depth literature exists on a limited number of insect pests such as gypsy moth, Japanese beetle, San Jose scale, etc., but even most of this sadly neglects natural enemy information. One of the reasons for compiling this information has been to draw attention to a faunal group that has been thus far poorly studied.

The ultimate purpose of this project is to create a reference system that can be used by pest managers to identify and evaluate the natural enemies they encounter. For example, by knowing which pests are present in the field, the pest manager can utilize the list to find out which

natural enemies may not only be effective against these pests, but which ones are actually in the field but have gone unnoticed. In addition, the list provides references for further reading about natural enemy biology, seasonal occurrence, effectiveness, host range, etc. However, it should be kept in mind that the references are only as good as the existent literature. Hopefully, the list will encourage more studies and record-keeping on these organisms.

Investigators conducting feasibility studies for importation of natural enemies also should find the references useful as an initial source from which to evaluate existing natural enemy complexes. For example, a list of all known natural enemies of a specific pest from North America can be compared with similar lists from the presumed native areas for the pest in question. Work can then be conducted to determine the native areas in which it would be most profitable to search to find more effective natural enemies for importation. While this list cannot evaluate natural enemies, it can provide basic source information from which an evaluation can occur.

Current Status of the Survey

The original list of 654 pest species was compiled largely from the following sources:

1. USDA Cooperative Economic Insect Report (vol. 23-25)
2. USDA Cooperative Plant Pest Report (vol. 1-June, 1976)
3. A survey of all ornamental tree pests from the cooperative Extension literature for the continental United States. 1976.
4. Insects That Feed on Trees and Shrubs.

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1976. Warren T. Johnson and Howard H. Hyon.

5. Insects and Mites of Western North America. 1956. E.O. Essig.

6. Four hundred additional pest references from a large number of other sources.

Natural enemy information on these pests was then gathered through the computerized literature search service CAIN and the Agricultural Index (Agricola). Later on, the Commonwealth

Agricultural Bureau and Biological Abstracts searches were added and the remaining list of about 550 pest species was run through these searches. The literature citations received were scanned, pasted on file cards and researched. Natural enemies for each pest found from these sources were placed on file cards along with their appropriate host. Roughly 8,200 natural enemy citations, including parasites, hyperparasites (secondary parasites), pathogens and predators, are on file for these pests, with coded literature references for each natural enemy. The code is expandable so that new references may be con-

Example of a Typical Entry:

| Pest Species: <i>Schizura concinna</i> (Smith) (red-humped caterpillar) | | <i>Lepidoptera: Notodontidae</i> | |
|--|------------------------------------|----------------------------------|-----------------------------|
| Natural Enemies | Type of natural enemy ¹ | Order: Family | Reference code ² |
| <i>Actia pilipennis</i> Robineau-Desvoidy | Pr | Diptera: Tachinidae | W2 |
| <i>Apanteles</i> sp. | Pr | Hymenoptera: Braconidae | V2 |
| <i>Apanteles schizurae</i> Ashmead | Pr | Hymenoptera: Braconidae | P4 |
| <i>Apanteles nigrorufus</i> Norton | Pr | Hymenoptera: Ichneumonidae | S2 |
| <i>Bacillus thuringiensis</i> Berliner | Pt | Eubacteriales: Bacillaceae | P4 |
| <i>Campoplex guignardii</i> (Say) | Pr | Hymenoptera: Ichneumonidae | T5.1 |
| <i>Campoplex oedemasiae</i> Ashmead | Pr | Hymenoptera: Ichneumonidae | B11 |
| <i>Chrysopa carnea</i> Stephens | Pd | Neuroptera: Chrysopidae | P4 |
| <i>Compsilura concinnata</i> Meigen | Pr | Diptera: Tachinidae | W4 |
| <i>Enicospilus purgatus</i> (Say) | Pr | Hymenoptera: Ichneumonidae | T5.1 |
| <i>Enicospilus purgatus arcuatus</i> (Say) | Pr | Hymenoptera: Ichneumonidae | S2 |
| <i>Eulimnerium</i> sp. | Pr | Hymenoptera: Ichneumonidae | V2 |
| <i>Eulimnerium validum</i> Cresson | Pr | Hymenoptera: Ichneumonidae | W4 |
| <i>Exorista larvarum</i> (Linnaeus) | Pr | Diptera: Tachinidae | S2 |
| <i>Gymnophthalma</i> (<i>Actia</i>) <i>americana</i> (Townsend) | Pr | Diptera: Tachinidae | W4,S2 |
| <i>Hyposoter clisiocampe</i> Weed | Pr | Hymenoptera: Ichneumonidae | S2 |
| <i>Hyposoter fugitivus</i> (Say) | Pr | Hymenoptera: Ichneumonidae | S2,W4 |
| <i>Microgaster schizurae</i> (Muesbeck) | Pr | Hymenoptera: Braconidae | M13 |
| <i>Phorocera claripennis</i> Macquart | Pr | Diptera: Tachinidae | W4,S2 |
| <i>Phorocera erecta</i> Coquillett | Pr | Diptera: Tachinidae | W4 |
| <i>Winthemia datanae</i> (Townsend) | Pr | Diptera: Tachinidae | S2 |
| <i>Winthemia quadripustulata</i> (Fabricius) | Pr | Diptera: Tachinidae | W4 |

1. PR = parasite, Pd = predator, Pt = pathogen, and 2°Pr = secondary parasite

2: **B11** Brewer, M., K. Nauman. 1971. *On the biology of Parasierolla nigrifemur* (Bethyilidae), larval ectoparasite of *Rhyacionia buollana*. Acto. Zool.: Lilloana 26(11): 159-178.

M13 Muesbeck, C.F.W. et. al. 1951. Hymenoptera of American North of Mexico-Synoptic Catalog. USDA Monogr. 2.

P4 Pinnock, D.E., R.J. Brand, J.E. Milstead, N.F. Coe. 1974a. *Suppression of populations of Aphis gossypii and A. spiraeicola by soap sprays*. J. Econ. Ent. 67(6): 783-784.

S2 Schaffner, J.V., C.L. Griswold. 1934. Macrolepidoptera and their parasites reared from collections in the northeastern U.S. USDA Misc. Publ. 188.

T5.1 Treherne, R.C. 1915. A preliminary list of parasitic insects known to occur in Canada. 46th Ann. Rep. Ent. Soc. Ontario, Toronto. pp. 178-193.

V2 Vosler, E.J. 1913. *The red-humped caterpillar*. Monthly Bull. State Comm. Hort. Sacramento 2(9): 654-657.

W2 Walton, W.R. 1914. *Four new species of Tachinidae from North America*. Proc. Ent. Soc. Wash. 14(2): 90-95.

W4 Webber, R.T., J.V. Schaffner. 1926. Host relations of *Compsilura concinnata* Meig., an important Tachinid parasite of the gypsy moth and the brown-tailed moth. USCA Dept. Bull. 1363.

tinually added. New pest species are also being compiled but cannot be researched without further funding. The following is an example of a typical entry, the red-humped caterpillar *Schizura concinna*, a pest of many ornamental, fruit and nut trees.

Present Work and Future Plans

Presently, host plants of the 654 pests are being added to the file along with their appropriate reference sources. Ideally, pheromones and registered pesticides (from the EPA site/pest file and state files) could be combined with this list, along with geographic distribution records. These additions would improve the list as a tool for coordination of research, development and implementation of IPM programs.

In order to maximize the usefulness of this information base for the largest number of users, computerized access is desirable. At present, the information exists in the form of extensive card files. Only subsets of this information have been compiled as typed lists. The drawback of a typed list is that it needs continual revision and retyping as new information is added. Computerizing saves time and money by automatically incorporating new information and making it quickly available. In addition, if the entire system were placed on computer tapes, cross-referencing would be significantly easier. For example, natural enemies common to particular families of pests could be detected easily and targeted for research efforts, or access to the file could be expanded to include entries by host plant, natural enemy, pest species, genus, family, common name, or ecological relationship, to name a few. As it is now, file access is keyed to the scientific name of the pest only. Computerization is now in the plan-

ning stages, although the EPA funding of this project will terminate in June, 1979.

How Others Can Use This Data Base

A list of the natural enemies and their literature references can be obtained from our Center for the cost of typing, xeroxing, handling, and mailing. The cost will vary with the amount of information requested. Specify pests by their scientific and common name if possible. We are also interested in corresponding with people interested in this project. Additionally, we are interested in information about pests, their natural enemies and effective management practices throughout the United States.

Literature Cited

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