INFORMATION TECHNOLOGY IN MEDICAL ENTOMOLOGY

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Abstract - The paper deals with the application of user-friendly programs in mosquito control. Identification of Indian anopheline mosquitoes in malaria control operations is a paramount importance. The WHO monograph which describes the taxonomic data in the form of a pictorial key is generally difficult to understand by a non-taxonomist. Expert system is a new dimension of Information Technology concerned with knowledge-based computer program, which can be used, in taxonomic studies. Utilizing the principles of ID3 algorithm, a novel rule-based system for the fast identification of 54 species of anopheline mosquitoes is developed and termed as ANOMOS. In order to understand the flight adaptation of different mosquitoes AEROD is developed for the rapid estimation of aerodynamic parameters. This program has several ideal features like calculation of wing beat frequency (both practical and theoretical), and rapid estimation of biophysical characters. The output of the program will help in studying the vectorial capacity and migratory behavior of the mosquitoes. The utility of probit analysis in the fields of entomology toxicology and biology is emphasized. PROBIT is user-friendly, menu-driven computer program developed for bioassay studies of mosquitoes. The data generated from the program will give an idea to estimate the lethal dose of a compound to be evaluated in the field conditions for the control of mosquitoes.
Key words - Mosquitoes, malaria, expert system, migratory behavior, control

INTRODUCTION

Information technology is playing a major role in various entomological studies (Murty *et al.*, 1994; Reddy *et al.*, 1992; Murty *et al.*, 1996) in the recent times. Mosquitoes are the vectors for many diseases like malaria, filaria, dengue fever, yellow fever and Japanese encephalitis. Most of the diseases are originated from rural areas due to several reasons like lack of proper drainage system, community participation. Keeping the importance of the vector role in the rural health care system, an attempt has been made to develop three software packages in various aspects of mosquitoes: 1) Probit analysis, 2) Aerodynamics, and 3) Rule-Based system for the identification of 54 species of Indian anopheline mosquitoes.

SOFTWARE PACKAGES

Probit analysis

The utility of probit analysis need not be overemphasized in entomological and toxicological evaluation. Its application embraces various fields of biology such as entomology and toxicology (Mather, 1966). An automatic computer program that performs the various calculations involved in probit analysis is highly desirable. Generally larvicidal and adulticidal activity of a compound either from natural or synthetic sources can be determined by standard procedures (WHO, 1975). The mortality may be determined by counting at the end of a standard exposure period (24 hr) and the control mortality adjusted by using Abbot's formula (WHO, 1975). The data obtained from bioassay may be analyzed using probit analysis from which an estimate of the LC_{50} together with confidence limits can be obtained. Finney (1952) and Busvine (1971) have discussed probit analysis of quantal response data. Finney recommended a computational procedure for critical analysis, especially when there is a considerable heterogenecity of response.

In order to calculate statistically valid lethal doses such as LD_{50}, LD_{90} for a given number of experiments, the input data required for each experiments is concentration, number of insects treated, and percentage of mortality. The program is partly menu-driven and the user is expected to key in the following values: CONST: A suitable integer (1 or 2) to be added to make a log (dose plus CONST) as non-

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negative; H: a convergence parameter (0.5, 0.1, 0.2) for terminating the iteractive procedure; LD: this is the value to express the lethal dose of the toxicant. User is given option to calculate any two LD values (LD_{50} or LD_{90}).

The output file PROBIT.OUT provides the following information: 1) Log dose plus CONST and H, LD table values selected; 2) C1, n1, p1; 3) Expected probits, working probits, improved expected probits and final values of log doses plus constant; 4) Log LD_{50}, LD_{90}, variance, standard error, upper and lower 95% confidence limits for dose plus constant; 5) X, Y, X regression coefficients, expected probit.

Aerodynamics of mosquitoes

When an insect is in hovering state, it is said to be in dynamic equilibrium which is achieved by the insect generating the air induced downwards due to its wing beat. This develops a reacting force to balance its body weight. The insect and induced air together is considered as the system. This in hovering flight the system constitutes an "action-reaction pair" which helps in the insect to be air borne (Hasan *et al.*, 1984). Consequently, we studied the static and dynamic parameters of the system (flier plus air) and aerodynamic parameters of *Culex quinquefasciatus* (Murty *et al.*, 1993). Since it was difficult to calculate the entire biophysical character manually, we developed a software in FORTRAN 77 on personal computers with facilities like quick calculations, and utmost accuracy All the parameters were calculated using the Appendix I of Murty *et al.* (1993).

The input parameters of the program to be fed in the order and their corresponding units of measurement are shown in Table 1. The program also provides an option to calculate wing beat frequency theoretically for which the practical or actual values need not be given. The calculated values of wing beat frequency are based on mass flow theory, which is closer to the practical values.

Table 1. Order of the input parameters and the corresponding unit of measurement.

Sl No	Input parameters	Unit of measurement
1	Mass of flier	mg
2	Length of wing	cms
3	Area of wing	cms
4	Length of flier	cms
5	Mass of wing	mg
6	Wing beat frequency	Hz

The program supports ten sets of male and female data. The format of the input file is shown in Table 2. These sets of data are to be fed into an input file (AEROD.DAT) in the order: Line1: No of sets; Line 2: Name of the species; Line 3: First set of male data; Line 4: Second set of male data; Line N+2: Nth set of male data; Line N+3: First set of female data; Line 2*N+3: Nth set of female data.

Table 2. Data format for each set.

Line number	Columns	Variable
1	1-3	No of sets
2	1-40	Name of species
3	1-10	Mass of flier
4	11-20	Length of wing
5	21-30	Area of wing
6	31-40	Length of flier
7	41-50	Mass of wing
8	51-60	Wing beat frequency

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A sample input data of *Culex quinquefasciatus* is given in Table 3.

Table 3. Sample input data.

010						
CULEX QUINQUEFASCIATUS						
0.0008	0.2666	0.0090	0.4000	0.1571	0.0080	580.0
0.0011	0.2666	0.0121	0.4147	0.1571	0.0080	600.0
0.0006	0.2500	0.0080	0.3857	0.1571	0.0090	550.0
0.0006	0.2222	0.0080	0.3857	0.1714	0.0090	600.0
0.0011	0.2333	0.0105	0.3857	0.1429	0.0100	780.0
0.0008	0.2333	0.0100	0.4000	0.1571	0.0083	600.0
0.0010	0.2611	0.0080	0.4286	0.1571	0.0083	750.0
0.0011	0.2555	0.0111	0.3571	0.1571	0.0083	650.0
0.0009	0.2333	0.0105	0.4000	0.1286	0.0090	650.0
0.0009	0.2333	0.0111	0.4286	0.1571	0.0083	600.0
0.0013	0.2944	0.0193	0.4000	0.0857	0.0100	480.0
0.0026	0.3500	0.0233	0.5000	0.1429	0.0090	550.0
0.0018	0.3277	0.0166	0.4714	0.1429	0.0100	640.0
0.0022	0.3500	0.0233	0.5000	0.1286	0.0083	580.0
0.0017	0.3166	0.0188	0.4714	0.1286	0.0083	550.0
0.0026	0.3144	0.0234	0.5000	0.1433	0.0083	540.0
0.0030	0.3500	0.0214	0.4857	0.1429	0.0090	560.0
0.0022	0.2944	0.0214	0.4429	0.1429	0.0090	610.0
0.0025	0.3611	0.0215	0.4571	0.0857	0.0090	550.0
0.0024	0.3333	0.0190	0.4851	0.1429	0.0090	610.0

After feeding the input data, type AEROD at the DOS prompt to execute the program. The program asks for the input and output filenames after which the program asks for the option to calculate the wing beat frequency. Answer Y to calculate or N to get the practical values. This option facilitates calculating the wing beat frequency theoretically whose values cannot be measured practically. It takes 5 seconds for execution of the program after which the results are stored in the corresponding output file.

The data of the calculated and practical values can be seen in M1.OUT and M2.OUT files respectively. The values obtained from the M1.OUT file i.e., static, dynamic parameters of the mosquito, dynamic parameters of air induced by the mosquito and aerodynamic parameters (wing beat frequency calculated) values are given in table form.

Body mass, wing length, wing span, wing area, effective wing breadth, length of the flier, breadth of the flier, wing mass, disc area, wing swept area, wing swept volume, fineness ratio, arc length and total wing area forms the static parameters. Moment of inertia, angular velocity, angular acceleration, angular momentum and kinetic energy forms the dynamic parameters of the mosquito. Dynamic parameters of the air induced by the flier constitutes rate of mass flow, mass of the induced air, acceleration of the induced air, velocity of the induced air, kinetic energy of induced air and moment of induced air. Other parameters like aspect ratio, wing loading, disc loading, wing mass/ mass of flier and wing beat frequency forms aerodynamic parameters.

This software is a powerful tool to estimate the aerodynamic parameters of mosquitoes and other active fliers. The data obtained from this program will give an idea of the flight adaptation of the mosquito, which is very important in vector control programs.

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RULE BASED SYSTEM FOR THE IDENTIFICATION OF 54 INDIAN ANOPHELINE MOSQUITOES

Anopheline mosquitoes are the vectors for malarial disease and over the last 10 years the number of malarial cases has been increasing in many areas of the world. More than 2000 million people in some 100 countries now live in areas where there is a definite risk of malaria. (Benzerragh, 1991). In 1988 the number of malarial cases was 18,54,830 and there has been a steady increase every since reaching a staggering 20,99,154 cases in 1992 (NMEP Directorate, 1993). In India and other developing countries, the problem has become all the more demand with frequent outbreaks of malaria and other vector borne diseases in most of the rural endemic areas.

Classification and identification of the species of anopheline mosquitoes is of paramount importance for the planners and administration involved in mosquito control operations. To understand the responsible vector for the outbreak of an epidemic, it is essential to carry out systematic and need-based control operations. For this purposes normally an experienced taxonomist is required, who would go systematically through the taxonomic characteristics of the unknown species and try to identify it. In this regard the pictorial key on the taxonomic data for the identification of an unknown species of anopheline mosquito published by Das *et al.* (1990) is quite useful. However these monographs which describe in detail the identification of anopheline species are quite difficult and time-consuming for a non-taxonomist to follow, hence it is desirable to have a computerized system that could be utilized for the accurate identification of an unknown species. The rule-based so developed is easy to handle even by a novice for the purpose of identification of an unknown species at various levels of control operations. These methodologies can easily be extended to other insect species and also to similar taxonomic problems. This rule-based system is expected to be highly useful in mosquito control operations.

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