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COMPUTERS IN THE ALAMEDA COUNTY (CALIFORNIA) MOSQUITO ABATEMENT DISTRICT—A CASE HISTORY

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ABSTRACT. The Alameda County Mosquito Abatement District currently uses microcomputers to process operational data, to transmit data by telephone and to do word processing. The computer hardware consists of a Model I (48K RAM) and two Model II (64K RAM) Radio Shack microcomputers. An 8 megabyte hard disk system provides the primary on-line storage. The programs have been written in BASIC programming language by district employees. Each workday the district processes operational data to update various direct access files. The files, in turn are accessed to create inspection and treatment schedules and to generate a variety of reports. The automated system has proven to be relatively inexpensive, processing greater quantities of data more rapidly than the manual system that it replaced.

The operation of an effective mosquito control program in Alameda County, California depends heavily upon an effective information processing system. The system must provide accurate, appropriate and timely information for the various decision makers in the organization. Decisions to treat mosquito sources, to purchase equipment, to hire employees or to build support facilities all require reliable information.

In the past two decades, forces have acted upon the District to require increasing efficiency and effectiveness in the information processing system. Regulatory agencies have placed increasing demands to maintain records and report pesticide applications. More recently, regulatory agencies concerned with the environmental changes affecting the San Francisco Bay have required reports of physical control activities. Financial considerations have also forced the District to look to methods for increasing the volume of information that can be processed while reducing costs.

The District began the search for a cost/effective automated data processing system in 1976 when a manual punch card system was used for processing operational data. A computer based system was desired to reduce the man-hours required to process the operational data and to increase the amount of data that could be stored. After a number of consultants had been contacted, it was apparent that the cost of the required systems analysis, computer hardware and software development would be prohibitive.

Research and purchasing of hardware. In 1978 the author purchased a TRS-80 Model I microcomputer made by Radio Shack. By the latter months of 1979, programs were developed by the author that stored the District's daily operational data on floppy diskettes and generated the monthly operational report and inspection reports. Although early attempts to efficiently store and process the data on tape cassettes were frustrating, once disk drives were purchased and placed in operation, the system was reliable and the manual punch card system was phased out. Comparison of the two systems indicated that the computer would free the secretary and field supervisors of 308 hours per year of punch card processing.

In 1980 the District acted to implement a more comprehensive data processing system by purchasing computer hardware and communications software. The new system was designed to provide additional storage capacity, to provide more memory (RAM) for more complex programming, and to enable the District to transmit data between substations. The selection of the hardware was based upon projected requirements for on-line storage, memory capacity (RAM) and availability of compatible accessories (line printers, telephone modems, additional disk drives, etc.). Availability of communication programs was also considered vital in the search for hardware. A formal bid process was used resulting in the selection of a Model I and a Model II Radio Shack microcomputer, two line printers, two telephone modems and communications software. In November 1980, the District added a disk expansion system (one additional drive) to the Model II system to double the existing on-line storage. The District purchased a daisy wheel line printer for word processing in April 1982 and in August 1982 the District purchased another Model II computer and an 8 megabyte hard disk system to increase the on-line data storage by eight-fold.

HARDWARE PROBLEMS AND THEIR RESOLUTION. The only significant hardware problem that was encountered occurred with the floppy disk expansion system of the Model II computer. The system could not operate error free. The problem was temporarily resolved by switching disks in and out of the main disk drive (drive 0). The problem has since been solved by the replacement of the disk expansion system with an 8 megabyte hard disk system.

ALLOCATION OF STAFF. Since all of the employees were to be affected by the implementation of the computer system, general meetings were held with the employees to inform them of proposed changes and to obtain their opinions. For the most part the manager and the entomologist decided on the applications of the system, although all of the employees and some trustees made suggestions that have been implemented in the system. The manager conducted the systems analysis in close coordination with the entomologist and source reduction supervisor. Programming and documentation were accomplished by the manager and three mosquito control technicians. Technicians familiar with typing enter the daily operational data at the operational facility and the secretary/bookkeeper, who is located at the administrative offices, generates the reports as needed and enters the daily operational data of employees located at that facility.

DEVELOPMENT OF PROGRAMS—TIME REQUIRED AND MEETING DEADLINES. The amount of time required to develop programs was invariably underestimated. The additional time required in programming can most probably be attributed to the inexperience of the programmers at the beginning of the project. Fortunately, the finished product, after appropriate modifications and debugging, invariably operated as expected. The investment of time has been considered worthwhile since the computers now handle tasks more quickly than processing the data by hand, and automation has made it feasible to process much more data than was possible by hand.

APPLICATIONS. The District's computer system is now utilized to accomplish the following:

1. Store all operational data including activities on mosquito sources, service request information and light trap data.
2. Store weather and tidal data for use in generating inspection and treatment schedules.
3. Update direct access files each day with the operational data. The files include the inventory of mosquito sources, service requests, inspection and treatment schedules, and the history of employee insecticide exposure.
4. Generate inspection and treatment schedules to provide field personnel with current information about mosquito sources that require their attention. The schedules are developed by the operation of an environmental simulation program that accesses weather data, tidal information, time of year, and the biological information at each inventoried source.
5. Predict maximum levels of adult mosquitoes of the species *Culex pipiens* to compare to established thresholds. The prediction is made through a program which operates an equation using the current level of the mosquito population to project future levels (Roberts and Conner 1979).

6. Generate reports on the monthly operations, employee work distribution, weekly larval sampling and light trap data, the kind and amount of control effort on particular species of mosquitoes, cost data on sources, and employee insecticide exposure. A general search program is also used to produce special reports.
7. Provide immediate access to the information on inventoried mosquito sources including the address data, description of the source, biological records (mosquitoes, vegetation, non-target organisms, endangered species, and natural control organisms), and yearly costs of monitoring and control of the source.
8. Simulation of a freshwater marsh system to assist in marsh management decisions. The District is cooperating with researchers in the development of a computer model to simulate Coyote Hills Marsh (Schooley et al. 1982). The computer model is expected to increase the sophistication of critical management decisions that bear on both mosquito control and wildlife management of the marsh.
9. Transmit data over the telephone line from one facility to another. Daily operational data is transferred from the operational facility in Union City to the administrative facility in Oakland. Inspection and treatment schedules are sent in the opposite direction.
10. Word processing.

SOFTWARE PROBLEMS AND THEIR RESOLUTION. We feel that software problems were minimized because the programs were written by employees of the District. Four employees worked as a programming team, writing the programs in BASIC programming language. Since the programmers were "in house," correction of software problems could be made immediately minimizing interruptions in the operation of the system. However, some difficulty was experienced in setting up the packaged communications programs that were to be used to transmit data by telephone. The programming team was unfamiliar with data transmission, but through a process of consulting experts, reading manuals, and trial and error, the team was able to establish the appropriate procedures to operate the communications programs. The complex procedures were then simplified by placing many of the steps under software control to operate automatically.

FUTURE PLANS. The District is now in the process of consolidating the operational and administrative facilities in a central location. A TRS-XYNEX multi-user operating system will be installed at that time which will utilize an enhanced Model 11 TRS-80 and terminals. A Model II will be upgraded to 384 RAM to act as a "main frame." The terminals will be placed in the laboratory and offices where the need to input or access data is high. An additional 8 megabyte hard disk system will be added to increase the on-line storage to 16 megabytes. The District's existing software will be used in the new system.

WHAT WE WOULD DO DIFFERENTLY. A number of lessons have been learned during the design and implementation of the system:

1. More time should be allocated to the development of computer programs since the amount of time required has consistently been underestimated. The additional time required has been almost 50% of the total time anticipated.
2. The amount of on-line storage purchased should exceed that which seems to be necessary at the moment. When our system performed effectively in the planned applications, it only increased our desire to add other applications requiring more on-line storage.
3. We should not be hesitant to spend additional money on hardware if it provides obvious benefits. We have made the mistake of purchasing line printers that were relatively inexpensive but were relatively slow and would not produce letter quality output.

COSTS AND BENEFITS OF THE COMPUTER SYSTEM. The District to date has expended $21,276 in the purchase of three computers, three line printers, and on-line storage. Programming costs can be approximated at 80% of one man-year or approximately $20,000. The District saves approximately $2,400 per year in labor and paper costs when comparing the old punch card system with the computer system. Amortizing the software and hardware over 10 years, and subtracting the savings, suggests a yearly cost of about $1708 to operate the present system.

The benefits provided by the automated data processing system are well worth the relatively low yearly cost. There is no doubt that the computer system has increased efficiency by processing more data per unit effort than was possible with the manual system. It also processes a greater quantity of information more rapidly. The result has been that the computer system places more information in the hands of decision makers when it is needed. It is believed that the overall efficiency and effectiveness of the

District's mosquito control efforts have increased as a result.

An indirect benefit derived by the District has occurred as a by-product of the system analysis that was required to implement the computer system. The kinds of data required and the logic used in decision making were reviewed, re-evaluated and modified as required. The result has been a clarification of information flow and decision making procedures.

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GONOTROPHIC STATE AND PARITY OF NECTAR-FEEDING MOSQUITOES

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ABSTRACT. Mosquitoes were collected on autumn evenings in Ohio while they were feeding on snakeroot and goldenrod flower nectar. Females of *Aedes vexans* and *Culex restuans* were sufficiently numerous to indicate when, in the gonotrophic cycle and in the adult life span, they typically took nectar. Dissections of 444 females indicated that both species seldom fed on nectar while digesting a blood meal (3–4% were blooded). The great majority of *Ae. vexans* took nectar while empty (79%) (neither blooded nor gravid), whereas *Cx. restuans* took nectar as commonly when gravid (49%) as when empty (48%). Parous nectar feeders were common among both species. A comparison of the parous/nulliparous ratio of nectar-feeding and blood-seeking collections of *Ae. vexans* indicated that nectar feeding was most frequent among nulliparous females but continued throughout adulthood.

INTRODUCTION

Many observations have been recorded of female mosquitoes feeding on plant nectars (Hocking 1953), and the utilization of nectar sugars for dispersal, reproduction, and survival has been demonstrated (Nayar and Sauerman 1971, 1975a, 1975b, 1975c; Nayar and Van Handel 1971). Sugar feeding appears to inhibit blood-feeding behavior temporarily in *Aedes aegypti* (Linn.) (Jones and Madhukar 1976) and to delay oviposition in several species (see Shroyer and Sanders 1977). Since both longevity and biting frequency are important to a mosquito's ability to transmit pathogens, knowledge of the details of the timing of nectar feeding may prove useful in epidemiological studies. In the present study we examined the gonotrophic state and reproductive age (parity) of mosquitoes in central Ohio in order to determine when, in the gonotrophic cycle, nectar feeding is most likely to occur, and whether it is a repetitive event.

Most reports of female nectar feeding have not noted whether any of the mosquitoes were digesting blood or were gravid at the time. Philip (1943), de Meillon et al. (1967) and Brantjes and Leemans (1976) indicated that nectar-feeding mosquitoes frequently contain blood meals or mature eggs, but the data of McCrae et al. (1976) and Magnarelli (1977, 1978) suggest that mosquitoes are usually empty of both blood and eggs when they take nectar. Magnarelli (1978, 1980) has provided indirect evidence that mosquitoes take nectar repeatedly throughout adulthood; resting and blood-seeking females contained fructose about as frequently when they were parous as when they were nulliparous. Direct comparisons of the parous/nulliparous ratios of nectar-feeding mosquitoes and the mosquito population at large apparently have not been published.

MATERIALS AND METHODS

Collections were made in a narrow wooded area between Union Cemetery and the Olentangy River in Columbus, Ohio, on 13 days from September 16 to October 19, 1979. Sampling began 0.5 hr after sunset and continued for approximately 2 hr or until mosquito ac-