POTENTIAL ENCEPHALITIS VECTORS IN HAMDEN, CONNECTICUT

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INTRODUCTION: PROCEDURE. The de- and for protection from mosquitoes fol- wing the 1959 New Jersey eastern en- phalitis (EE) epidemic has presented special problem in New England. This is been complicated by rapidly expanding burban woodland housing developments at has resulted in increased exposure to osquitoes. Where limited budgets for osquito control were available, it was cessary for town health officers to decide hether control of both pest and potential ctor mosquitoes should be attempted, or concentrate efforts only on those capable transmitting EE. For this purpose, it is necessary to evaluate the mosquito oblem in Connecticut to determine ich mosquitoes were potential vectors d to determine the period of the summer which they developed (1, 2, 3). In mden, Connecticut, the problem became gent when EE virus activity resulted in aths among pheasants during 1959. The ard of Selectmen in January, 1960, ap- inted a Citizens' Committee for Mos- ito Control. This committee recom- nded that: (1) a preliminary survey be de to locate the actual breeding areas d determine the species of mosquitoes sent; (2) consideration be given to per drainage and filling of breeding as; (3) routine inspection and spraying initiated to kill the larval or adult squitoes.

This program was continued during 61, and it is the purpose of this paper give a preliminary evaluation of the ormation obtained from sampling the eding areas during 1960 and 1961.

RESULTS. During 1960, 14 species were lected from 166 aquatic breeding places. In Table 1, the species are ranked according to the number of times each was encountered during 208 collections. Of the 14 species found in 1960, 8 were either known to be capable of transmission or species from which virus of eastern or western encephalitis has been isolated. Of these, the most frequently encountered were *Culex pipiens* (44/208), *Culex restuans* (29/208) and *Culex salinarius* (29/208). Five other species were encountered less often: *Aedes vexans* (10/208), *Culex territans* (8/208), *Aedes triseriatus* (8/208), *Aedes sollicitans* (1/208) and *Mansonia perturbans* (1/208). These species composed 62.5 percent of the collections.

During the following year, however, there was considerable change in the species profile of the larval mosquito population.

During 1961, as shown in Table 1, 267 samples of larvae were collected and identified during the summer season from 180 breeding places located throughout the town. Of 14 species represented, the 5 most frequently encountered were either known to be capable of transmitting eastern or western encephalitis virus, or species from which virus has been isolated. These five, *Culex restuans* (64/267), *C. pipiens* (55/267), *C. territans* (54/267), *C. salinarius* (44/267) and *A. vexans* (23/267) constituted 89.5 percent of the samples (267) taken. It was somewhat surprising to find *C. restuans* more commonly encountered than *C. pipiens*. Likewise, *C. territans* was almost as frequently represented as *C. pipiens* in the suburban woodland residential areas.

C. salinarius (44/267) and *A. vexans* (23/267) were the two other potential vectors frequently encountered. Though particular attention was given to scouting for *Culiseta melanura*, none were encountered.

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TABLE 1.—Species of mosquito larvae collected and the number of times each was encountered in breeding places in Hamden, Connecticut, in 1960 and 1961.

	1960		1961	
Rank	Species	No. of times larvae occurred	Species	No. of times larvae occurr
1	*Culex pipiens* **	44	*Culex restuans* *	64
2	*Aedes spp.*	34	*Culex pipiens* **	55
3	*Culex restuans* *	29	*Culex territans* *	53
4	*Culex salinarius* *	29	*Culex salinarius* *	44
5	*Aedes stimulans*	27	*Aedes vexans* *	23
6	*Aedes vexans* *	10	*Aedes stimulans*	13
7	*Culex territans* *	8	*Aedes spp.*	6
8	*Aedes triseriatus* *	8	*Aedes canadensis*	2
9	*Aedes cinereus*	4	*Uranotaenia sapphirina*	2
10	*Aedes excrucians*	3	*Aedes abserratus*	1
11	*Aedes sollicitans* *	1	*Aedes cinereus*	1
12	*Mansonia perturbans* *	1	*Aedes sollicitans* *	1
13	*Aedes abserratus*	1	*Mansonia perturbans* *	1
14	*Anopheles sp.*	1	*Anopheles punctipennis*	1
	Total	208		267

* Species known to be capable of transmitting EE virus in laboratory tests or from which the vi has been isolated from specimens collected during field studies.

** Capable of transmitting western encephalitis.

During 1961, there was not only an increase in the proportion of vectors (3/5 in 1960, to 5/5 in 1961) among the five ranking species, but there was also an increase in the percentage of vectors from 62.5 percent in 1960, to 89.5 percent in 1961. In addition, several vectors were encountered more often than expected. *C. restuans* rose from third place to the top of the list and was collected even more frequently than *C. pipiens*. *C. territans* moved from eighth place to third, and was found almost as often as *C. pipiens*. While *C. salinarius* ranked fourth during both years, more were collected in 1961 than in 1960. The species considered most likely to be involved in transmission of eastern encephalitis to man and horses (4), *A. vexans*, was collected more than twice as often during 1961 as during the previous year.

DISCUSSION. Special attention was given to the mosquito problem in Hamden, Connecticut, because a number of conditions exist which are shared with many towns in New England and must be considered in evaluation of the problem of mosquito transmission of encephalitis. While Hamden is located near the seashore, adjacent to New Haven, it is the inland side of the city where the p tential mosquito breeding sites are ac mulations of fresh water. These fr water sites, like the residential areas, located in a woodland ecology that is co mon to other towns. The rapidly expa ing suburban housing developments, p ticularly since the time of World War have resulted in a larger portion of population residing in the woodla Here people encounter species of m quitoes that were previously of little c cern to them except when picnicki or on fishing and camping trips. So of these either have been shown to capable of transmitting the eastern cephalitis virus in the laboratory, or in some way involved in the ecology arthropod-borne viruses. One of the *Culiseta melanura*, is considered import in the spread of virus among wild bir However, this mosquito does not usu bite man and is not found often in C necticut; so that here it cannot be c sidered a problem. It was not fou breeding in Hamden in either 1960 1961.

Culex restuans, however, was fou

ore often than expected within the town ring 1960 and 1961 (in the latter year, occurred surprisingly more often than *lex pipiens* which has long been con- lered the most common *Culex*). It has en shown capable of transmitting EE laboratory experiments (5) and in addi- n, virus was isolated from this species lected during the epidemic in New sey in 1959 (6, 7). Though its role in natural history of the EE virus is not npletely understood, since this mos- ito feeds preferentially on birds, it is nsidered more involved in the avian le—transmitting virus from bird to bird han to man (7).

Culex pipiens is known to be capable transmitting western encephalitis virus, l *Culex salinarius* is considered a po- tial vector of the EE virus. From both these species, unidentified etiologic nts (presumably viral), were isolated ring the 1959 epidemic in New Jersey). Unlike *C. restuans,* these two species e less specific host feeding preferences l often feed on man. While they are believed to be significant in the trans- ssion of EE to man (7, 3), until there is ter evidence for evaluation of the role y play in EE ecology, they must be nsidered potential vectors.

Though EE virus has recently been lated from *C. territans* (8), this species not known to feed on man. Its pre- red hosts are believed to be frogs and er cold-blooded vertebrates. Therefore, eems probable that this species is not ly to be important in transmission of us to man, but so little is known of its logy that it cannot be properly evalu- d at the present time.

Aedes triseriatus occurs in collections of ter in tree-holes and artificial containers ere twigs and leaves accumulate in the ter. It is an extremely pestiferous mos- to and in laboratory tests (5) has been ed as possessing an excellent capability virus transmission. However, virus not been isolated from specimens col- ed in areas of EE virus activity. There- e, it is another of the potential vectors t cannot be adequately evaluated at the present time. As shown in Table 1, *A. triseriatus* was collected eight times in Hamden during 1960, but was not en- countered during 1961.

Mansonia perturbans and *Aedes sol- licitans* are mosquitoes that are both known to have excellent capability for virus transmission (5) and EE virus has been isolated from each (9). However, neither has been considered important as EE vectors in Hamden for these reasons: *A. sollicitans* is a salt-marsh species that breeds exclusively in brackish water, found in only one place where industrial waste provided sufficient mineral in the water to create an artificial brackish con- dition; and *M. perturbans,* as shown in Table 1, develops in the spring season before EE virus activity occurs and has been encountered in only one breeding place in the town.

Another species, *Aedes vexans,* has been found naturally infected with virus during field studies in Connecticut in 1959 (4). This mosquito has been on the "suspected" list since 1939 when it transmitted virus in laboratory tests (10). During the 1938 epidemic in Massachusetts, it occurred in all areas where the disease appeared (11). *Aedes vexans* is known as a biting mos- quito that feeds not only on man, but on a wide range of hosts, including horses, cattle and birds. The fact that no cases of EE among humans in Connecticut have occurred has been the subject of much speculation. It is possible that epidemic conditions have not existed; in other words, the virus, the mosquitoes and the human hosts were not all present at the same time and place. It is also possible, however, that ditching and draining of the salt marshes have reduced the numbers of *Aedes vexans* that breed along the edge of the woodland bordering the coastal marshes to the degree that populations of this mosquito are unable to build up to dangerous concentrations.

Consideration of the evidence involving various mosquitoes as potential vectors is helpful in determining which species re- quire particular attention for control, but sampling the breeding places is necessary

to determine the best time for application of control. Sampling results in Hamden indicate that all of 38 species commonly encountered in Connecticut (3) do not occur there; of the 14 most commonly found, there is a definite seasonal succession of species (3), and it is known that the 3 most bothersome in the early spring and summertime are chiefly pest species rather than potential vectors. When particular attention is directed to those mosquitoes developing during the mid- and late summer in Hamden, it can be seen in Table 1 that 89.5 percent of them were species that are involved in the ecology of EE.

If control operations are to be limited to encephalitis vectors, then it is important to concentrate efforts on the mid- and late summer species. It is perhaps also pertinent to note the shift in frequency of occurrence of the various species from 1960 to 1961. *A. vexans,* for instance, was collected more than twice as often during 1961 as in the previous year. This coincided with virus activity appearing in Connecticut for the first time since 1959. If sufficient evidence can be accumulated correlating increases in the proportions of particular mosquitoes with the occurrence of virus activity during the year, such information can be invaluable in predicting periods of special epidemic risk requiring intensified control measures.

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