M-1960 applied at a rate of 0.5 g per g provided 213 days protection but was ineffective after exposure to only 0.3 inch of rain; also, it was effective for only 29 days when it was applied at a rate of 0.25 g per g.

Further studies of biological effectiveness and toxicology are needed.

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FEEDING PATTERNS OF SIX SPECIES OF MOSQUITOES IN ARID SOUTHEASTERN CALIFORNIA [1]

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ABSTRACT. Positive precipitin tests with host antisera were obtained for the blood of 875 engorged mosquitoes. *Culex tarsalis* had fed on a variety of mammals and birds, in an annual ratio of almost 1:1; as elsewhere the dietary ratio shifted with the season. *Aedes dorsalis, Aedes vexans, Psorophora confinnis* and *Culiseta inornata,* which were collected mainly in agricultural areas, had fed predominantly on large domestic mammals. *Culex erythrothorax* collected at a seepage area isolated in the desert had fed primarily on cricetid rodents and herons. This mammal-bird feeding pattern could allow this species to be a vector of arboviruses.

Knowledge of the host-feeding patterns of mosquito species is useful in assessing their potential to serve as vectors. Such information from a wide range of geographical areas aids in explaining regional differences in disease infection rates and the basic ecology of the species.

The present study gives information on the feeding habits of six species of mosquitoes in southeastern Riverside County and Imperial County, California. Engorged females were collected by New Jersey light traps and Malaise traps from January 1969 through July 1970 at sites described in Chew and Gunstream (1970). The host sources of the blood in over 900 females were analyzed by precipitin tests in the laboratory of C. H. Tempelis by methods described in Tempelis and Lofy (1963). The results are summarized in Table 1.

The data for *Culex erythrothorax* are of special interest because of the limited information on this species. All the specimens reported in Table 1 were taken at an isolated natural seepage area in open desert about 2 miles northeast of the Salton Sea (site 84, Chew and Gunstream, 1970). No livestock was within 10–20 miles of this site, except for animals that may have been present temporarily in trucks parked at a gas station-cafe about 1 mile away. Adult *C. erythrothorax* were present from February through July; most of the engorged females were captured in March and April. Of the total feedings, 42 per-

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TABLE 1.—Host-feeding patterns for six species of mosquitoes in southeastern California.

Host taxon	Percentage of precipitin tests positive for a given host taxon with each species of mosquito					
	Aedes dorsalis	*Aedes vexans*	*Psorophora confinnis*	*Culex erythrothorax*	*Culex tarsalis*	*Culiseta inornata*
Feedings on mammals						
Dog	16.0	10.2	8.9	0	9.3	6.2
Horse	28.7	25.4	32.2	0	10.9	25.0
Cattle	46.8	40.7	49.2	1.5	18.2	56.2
Rabbit	1.1	6.8	0.3	1.5	2.4	4.2
Human	3.2	10.2	0.3	0	2.0	0
Cricetid rodents	0	0	0	34.3	0	0
Cat	1.1	0	1.1	0	0.4	0
Pig	1.1	0	2.8	0	0.8	2.1
Unknown	1.1	1.7	5.0	4.5	4.0	2.1
Mammal subtotal	99.1	95.0	99.8	41.8	48.0	95.8
Feedings on birds						
Chicken	1.1	3.4	0.3	3.0	14.6	4.2
Quail	0	0	0	0	1.2	0
Columbiformes	0	0	0	13.4	3.2	0
Passeriformes	0	1.7	0	10.4	15.8	0
Ciconiiformes	0	0	0	22.4	0.4	0
Gruiformes	0	0	0	1.5	2.4	0
Anseriformes	0	0	0	1.5	1.6	0
Unknown	0	0	0	6.0	10.9	0
Bird subtotal	1.1	5.1	0.3	58.2	50.1	4.2
Feedings on reptiles and amphibians						
Snake	0	0	0	0	1.2	0
Frog	0	0	0	0	0.4	0
Total number of positive tests	94	59	360	67	247	48

cent were on mammals and 58 percent on birds. Of the mammal feedings, 82 percent were on cricetid rodents, which is an unusually high incidence of rodent feedings; one blood meal was positive for rabbit antiserum and one for cattle antiserum. Of the bird feedings, 39 percent were on ciconiiformes (herons). Since *C. erythrothorax* will feed on domestic mammals (Tempelis, 1970), the low incidence of such feedings in our sample probably is a result of the very low availability of such hosts, rather than a matter of preference of the mosquitoes. In the absence of domestic mammals, the mosquitoes may have shifted their feeding to native rodents. The almost equal feedings on mammals and birds contrasts with the findings of Tempelis (1970) that *C. erythrothorax* in Kern County, California fed almost exclusively on domestic mammals and that those in the area of Salt Lake, Utah fed almost entirely on birds. The mammal-bird feeding pattern suggests that *C. erythrothorax* could be a vector of arboviruses. The species will feed on humans (Rees, 1943). The period of presence of adult *C. erythrothorax* at our study site coincides with the time of maximum human activity in the area at nearby mineral spa trailer camps. California encephalitis virus has recently been isolated from *C. erythrothorax* from Utah (Crane *et al.*, 1970).

The variety of hosts used by *Culex tarsalis* is yet another indicator of the broad adaptation of this species, which is ubiquitous in our study region. The nearly 1:1 mammal-to-bird feeding ratio is like that found for the species in the

Sacramento Valley, California (Tempelis and Washino, 1967). The seasonal ratios of mammal:bird feedings were: fall and winter, 11:43; spring, 68:63; and summer, 40:14. This pattern is consistent with the seasonal shifts of diet found in other areas (Tempelis, 1970). It is probable that this dietary shift is related to seasonal changes in host availabilities. The three feedings of *C. tarsalis* on snakes is of interest because of the potential overwintering of viruses in reptiles. Henderson and Senior (1961) found that *C. tarsalis* are attracted to a variety of lizards and snakes, and feed upon them, although they are much more atracted to birds and mammals.

Aedes dorsalis, Aedes vexans, Psorophora confinnis and *Culiseta inornata* were collected primarily in agricultural areas. Their predominance of feeding on large domestic mammals agrees with the results of earlier studies (Edman and Downe, 1964; Tempelis, 1970).

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The annual meeting of the Ohio Mosquito Control Association will be held on September 8 and 9, 1971, in Willoughby, Ohio. The Secretary-Treasurer is now Mr. Boyd Marsh, Cleveland City Health Department, Cleveland City Hall, Cleveland, Ohio