CULEX RESTUANS: AN EXPERIMENTAL VECTOR FOR WILD TURKEY MALARIA, *PLASMODIUM HERMANI*

JAI K. NAYAR,[1] MARTIN D. YOUNG[2] AND DONALD J. FORRESTER[2]

ABSTRACT. *Culex (Culex) restuans, Culex (Melanoconion) opisthopus* and *Culex (Melanoconion) erraticus* were tested for susceptibility to *Plasmodium hermani,* a malaria parasite of wild turkeys *(Meleagris gallopavo)* in Florida. The sporogonous cycle was completed in *Cx. (Cux.) restuans* and mosquitoes with infected salivary glands transmitted the infection to domestic turkey poults by bites. Transmission was achieved also by intraperitoneal, intravenous and intra-muscular injections of whole body slurry. This is the third mosquito, belonging to the subgenus *Culex,* found to be suspectible to wild turkey malaria. *Culex (Mel.) opisthopus* and *Cx. (Mel.) erraticus* did not become infected.

INTRODUCTION

Recently, 3 mosquito species have been shown to be susceptible to infection by wild turkey *(Meleagris gallopavo* Linnaeus) malaria, *Plasmodium hermani* (Telford and Forrester). These are *Culex (Culex) nigripalpus* Theobald, both as an experimental and natural vector (Young et al. 1977, Forrester et al. 1980), *Cx. (Cux.) salinarius* Coquillett, as an experimental vector (Nayar et al. 1981), and *Wyeomyia vanduzeei* Dyar and Knab in which the parasite completed the sporogonous cycle and the sporozoites produced infections in domestic turkey poults when inoculated parenterally but not by the bites of the infected mosquitoes (Nayar et al. 1980).

Other common Florida *Culex* species found in Lykes Fisheating Creek Wildlife Management Area, Glades County, where wild turkey malaria is prevalent are *Cx. (Cux.) restuans* Theob., *Cx. (Melanoconion) erraticus* Dyar and Knab and *Cx. (Melanoconion) opisthopus* Komp (Edman 1979, Forrester et al. 1980, Provost 1969). Two of these, *Cx. (Cux.) restuans* and *Cx. (Mel.) erraticus,* feed mainly on avian hosts (Edman 1979, Murphey et al. 1967, Mitchell et al. 1980) whereas *Cx. (Mel.) opisthopus* feeds mainly on rodents and other mammals (Edman 1979). *Culex (Cux.) restuans* reaches the southern limits of its continental distribution in south Florida where its population peaks from late fall to early winter (Provost 1969), and the other 2 *Cx. (Mel.)* species are found in summer months in Florida (Edman 1979, Forrester et al. 1980). Susceptibility of these 3 species of mosquitoes to wild turkey malaria and transmission attempts are reported here.

MATERIALS AND METHODS

The methods used for infecting and transmitting the infections are given in detail in previous reports (Young et al. 1977, Nayar et al., 1980, 1981). Two experiments were conducted in trials reported herein. In Expt. 1, 2 of the 3 species of mosquitoes used *(Cx. (Cux.) restuans,* and *Cx. (Mel.) opisthopus)* were from recently established self-mating colonies; similarly in Expt. 2, 2 of the 3 species of mosquitoes *(Cx. (Cux.) salinarius* and *Cx. (Mel.) erraticus),* were from F_1 and a self-mating recently established colony, respectively. The third species, *Cx. (Cux.) nigripalpus* was used as controls for both experiments and was from an older established colony. In both experiments,

[1] Florida Medical Entomology Laboratory, IFAS—University of Florida, P.O. Box 520, Vero Beach, FL 32960.

[2] Department of Preventive Medicine, College of Veterinary Medicine, University of Florida, Gainesville, FL 32610.

the experimental and control mosquitoes were fed simultaneously on infected domestic turkey poults.

Four to 7-day old adult mosquitoes of all species were fed daily upon 4–6 wk old domestic turkey poults (broad-breasted white Nicholas strain) infected with Strain P-41 of *Plasmodium hermani* during the peak parasitemias. This strain had been isolated from a wild turkey from south Florida in 1979. After an infective blood meal all mosquitoes were incubated at 27°C and a relative humidity of 75–80%. Midguts and salivary glands were dissected on days 11–13 post-infective blood meal for oocysts and on days 14–16 for sporozoites, respectively. Sixteen to 18 days post-infective blood meal, the mosquitoes with sporozoites in the salivary glands were allowed to feed on uninfected 2-wk old domestic turkey poults. Transmission was attempted also by intraperitoneal, intra-muscular and intravenous injections of a slurry of comminuted mosquitoes, as described earlier (Young et al. 1977, Nayar et al. 1980, 1981).

RESULTS AND DISCUSSION

Both *Cx. (Cux.) restuans* and *Cx. (Cux.) nigripalpus* in Expt. 1 were very susceptible as shown by the percentage of midguts infected (Table 1). Both of these species had sporozoites in the salivary glands 14–15 days after the infective blood meal.

All of the 17 turkey poults challenged with sporozoites, either by bites (6 poults bitten by a mean of 18.5, range of 7–35, *Cx. (Cux.) restuans* and 2 poults bitten by a mean of 60, range 54–60, *Cx. (Cux.) nigripalpus)* or by intraperitoneal, intravenous and intramuscular injections (3 poults per treatment injected with a slurry of 25 *Cx. (Cx.) restuans* in Hank's solution per poult) became positive. The prepatent periods of the resultant parasitemias were 10 to 13 days with one exception; in one poult bitten by only 7 mosquitoes, the prepatent period was 19 days.

In comparison with other susceptible *Culex* species, *Cx. (Cux.) restuans* was similar in susceptibility to *Cx. (Cux.) salinarius* as regards the number of oocysts on the midgut (Table 1) while it differed from *Cx. (Cux.) nigripalpus* by having more than twice the mean number of oocysts per midgut. This could be due to the larger size of *Cx. (Cux.) restuans* and its ability to ingest twice the amount of blood per meal as *Cx. (Cux.) nigripalpus* (Nayar, unpublished data). Transmission success and the prepatent periods were similar for all 3 species (Nayar et al. 1981).

Table 1. Comparative susceptibility of different species of mosquitoes fed simultaneously on turkey poults infected with *Plasmodium hermani.*

	No. dissected	No. of daily feedings	% infected midguts within daily feedings		Oocysts per infected midgut[a]	
			Mean	Range	Mean ± S.E.	Range
Expt. 1						
Culex (Cux.) restuans	66	7	90.0	70–100	23.7 ± 2.8*	1–62
Culex (Cux.) nigripalpus	66	7	78.8	20–100	9.0 ± 1.1*	1–62
Culex (Mel.) opisthopus	28	2	0.0	0–0	0.0	0
Expt. 2						
*Culex (Cux.) salinarius***	203	11	57.6	11–90	21.2 ± 2.5	1–75
*Culex (Cux.) nigripalpus***	184	11	62.6	26–90	10.2 ± 0.9	1–69
Culex (Mel.) erraticus	30	3	0.0	0.0	0.0	0

Note: Approximately 10 mosquitoes were dissected from each lot.

[a] Females were dissected and examined 11–13 days post-infective blood meal.

* $P < 0.05$.

** Details of these infections are from Nayer et al. (1981).

Culex (Mel.) opisthopus a companion mosquito in Expt. 1, did not become infected. Another *Melanoconion* species, *Cx. (Mel.) erraticus,* had been tried previously when *Cx. (Cux.) salinarius* was tested as in Expt. 2 (Nayar et al. 1981). *Culex (Mel.) erraticus* did not become infected although *Cx. (Cux.) salinarius* had an infection rate of 57.6% and the companion *Cx. (Cux.) nigripalpus* 62.6% (Table 1).

These studies showed that *Cx. (Cux.) restuans* is a good experimental vector of *P. hermani.* The significance of this finding will not be known until field studies are conducted and its role as a natural vector is understood. If it is functioning as a natural vector it may do so during a time of year when other *Culex* mosquito populations are low since its population peak is during late fall to early spring.

ACKNOWLEDGMENTS

We thank Mr. J. S. Haeger and Mrs. J. W. Knight for their assistance in collecting *Cx. (Cux.) restuans, Cx. (Cux.) salinarius, Cx. (Mel.) erraticus* and *Cx. (Mel.) opisthopus* egg-rafts, identifying the first instar larvae and newly emerged adults, and finally in colonizing these species. We also thank Dr. D. M. Sauerman, Jr. for his assistance in various phases of this study. Supported in part by Research Grant No. 1270-G from the Florida Game and Freshwater Fish Commission's Federal Aid to Wildlife Restoration Program, Florida Pittman-Robertson Project W-41. Florida Agricultural Experimental Stations Journal Series No. 3088.

References Cited

Edman, J. D. 1979. Host-feeding patterns in Florida mosquitoes (Diptera: Culicidae). VI. *Culex (Melanoconion).* J. Med. Entomol. 15:521–525.

Forrester, D. J., J. K. Nayar and G. W. Foster. 1980. *Culex nigripalpus:* A natural vector of wild turkey malaria *(Plasmodium hermani)* in Florida. J. Wildl. Dis. 16:391–394.

Mitchell, C. J., D. B. Francy and T. P. Monath. 1980. Arthropod vectors. Chapter 7, pp. 313–370. In St. Louis Encephalitis. Editor, T. P. Monath. Am. Public Hlth Assoc., Washington, D.C.

Murphey, F. J., P. O. Burbutis and D. F. Bray. 1967. Bionomics of *Culex salinarius* Coquillett. II. Host acceptance and feeding by adult females of *Culex salinarius* and other mosquito species. Mosq. News 27:366–374.

Nayar, J. K., M. D. Young and D. J. Forrester. 1980. *Wyeomyia vanduzeei,* an experimental host for wild turkey malaria, *Plasmodium hermani.* J. Parasitol. 66:166–167.

Nayar, J. K., M. D. Young and D. J. Forrester. 1981. *Plasmodium hermani:* Experimental transmission by *Culex salinarius* and comparison with other susceptible Florida mosquitoes. Expt. Parasitol. 51:431–437.

Provost, M. W. 1969. The natural history of *Culex nigripalpus.* Fla. State Bd. Hlth. Monogr. No. 12, pp. 46–62.

Young, M. D., J. K. Nayar and D. J. Forrester. 1977. Mosquito transmission of wild turkey malaria, *Plasmodium hermani.* J. Wildl. Dis. 13:168–169.