

Effect of photoperiod on blood feeding activity of female hybrids between *Culex pipiens pipiens* and *Culex pipiens quinquefasciatus* (Diptera: Culicidae)

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Abstract Blood feeding activity was examined in females of hybrids (F_1) between *Culex pipiens pipiens* and *Culex pipiens quinquefasciatus* in long and short photoperiods at 21°C to examine the effect of photoperiod on blood feeding rate. Blood feeding rates (F_1) were lower in short photoperiods than in long photoperiods. From this, it seems that the hybrids show diapause.

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Key Words : *Culex pipiens pipiens*, *Culex pipiens quinquefasciatus*, hybrids, diapause, short photoperiod

INTRODUCTION

In Japan, the mosquito of the *Culex pipiens* complex is the main vector of Bancroftian filariae and dog filariae (*Dirofilaria immitis*). The *Culex pipiens* complex consists of three taxa: *Culex pipiens quinquefasciatus* Say, *Culex pipiens pallens* Coquillett, and *Culex pipiens molestus* Forskal. *Culex pipiens quinquefasciatus* is distributed throughout the Ryukyu and Ogasawara Islands. *Culex p. pallens* and *Cx. p. molestus* are found north of Kagoshima (31°34'N), throughout the main Kyushu Islands and northward, but not in more southern parts such as Okinawa. Although these three mosquito taxa are morphologically similar, except for some minor details such as the structure of the male genitalia, they show marked differences in physiological and behavioral characteristics (Sasa et al. 1966; Tanaka et al. 1979). In *Cx. p. molestus*, the females exhibit autogeny and lack a diapause. Females of *Cx. p. quinquefasciatus* also lack diapause, but *Culex*

p. pallens females exhibit imaginal diapause induced by short photoperiods (Oda et al. 1992).

Previously we reported the insemination rates of female Japanese *Cx. p. pallens* and Japanese *Cx. p. quinquefasciatus* at 25°C and 30°C. The rate was high for *Cx. p. pallens* at 25°C, but very low at 30°C. In *Cx. p. quinquefasciatus*, the rates were very high at both 25°C and 30°C (Oda et al. 2002). Moreover, the insemination rate was also high in hybrids (F_1) between *Cx. p. pipiens* and *Cx. p. quinquefasciatus* (Kurokawa et al. 2004). From this, high temperatures may be a limiting factor for the spread of this species to the southern part of Japan (Oda et al. 2002). In the present report, in order to confirm the effect of photoperiod on blood feeding activity of female hybrids of *Cx. p. pipiens* and *Cx. p. quinquefasciatus*, we examined blood feeding rates by hybrids during long and short photoperiods.

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MATERIALS AND METHODS

An Indonesian strain of *Cx. p. quinquefasciatus* and a German strain of *Cx. p. pipiens* were used in this study. The strain (Ja) of *Culex p. quinquefasciatus* from Jakarta was collected in Jakarta City (06° 11'S), Indonesia in July 1982, and maintained for 55 to 57 generations. Hibernating females representing *Cx. p. pipiens* were collected in the cellar of a house in Hamburg (53° 33'N), Germany in February 1989. All colonies were maintained in insectaries at 25°C and relative humidity of 70-80% under a 16-hr lighting schedule (L:D=16:8), using 2000 LUX fluorescent lighting. These mosquitoes were fed on mice at night.

One hundred first instar larvae were placed in an enamel tray (22×28×4 cm) with Ca 1,500 ml water. Equal amounts of brewer's yeast and finely ground mouse-food pellet powder were mixed and given as larval food (Mori et al. 1988). A water suspension of 0.2 g of this mixture was added to each tray every day. About 700 larvae were reared to pupae at 25°C. Thereafter, the pupae of each strain were put individually into 2 ml of water in glass tubes (5 cm in height and 2 cm in diameter) plugged with cotton wool and kept at 25°C until adult emergence. Newly emerged adults of each sex were isolated from each other for a further two days and maintained in a netted cage (20×20×30 cm) and provided a constant source of 2% sugar solution. When two days old, 100

male *Cx. p. pipiens* were released into a cage containing 100 females of *Cx. p. quinquefasciatus*.

Following procedures described above hybrid strains between *Cx. p. pipiens* and *Cx. p. quinquefasciatus* or *Cx. p. pallens* was established and allowed to interbreed. The first instar larvae were bred to adults in long photoperiod (L:D=16:8) and a short photoperiod (L:D=10:14) at 21°C. The mosquitoes were fed on mice at night 8 days after emergence, and the next morning, the number of fed females was counted.

RESULTS AND DISCUSSION

The blood feeding rates were high in *Culex p. quinquefasciatus* in long and short photoperiod and in *Cx. p. pipiens*, the rate was very low in the short photoperiod, but high in the long photoperiod (Table 1).

This means that *Cx. p. quinquefasciatus* does not show a diapause state in a short photoperiod and females of *Cx. p. pipiens* indicate the diapause state, which is induced by short photoperiod.

The blood feeding rate in hybrid females was lower during the short photoperiod in F₁ and F₃ than during the long photoperiod, but in F₂, the rates were high in long and short photoperiod. It seems that the hybrid also has the physiological character of the diapause state (Table 2).

In the present study, it seems that the female hy-

Table 1. Blood feeding rates in *Culex pipiens quinquefasciatus* and *Culex pipiens pipiens* females bred in long and short photoperiods at 21°C

Strain	Photoperiod (L:D)	<i>Cx. p. quinquefasciatus</i>			<i>Cx. p. pipiens</i>		
		Feeding rate			Feeding rate		
		No. unfed	No. fed	%	No. unfed	No. fed	%
	16:08	100	71	71.0*	100	46*	46.0*
	10:14	100	65	65.0*	100	3*	3.0*

* N.S. between long and short photoperiod in *Cx p. quinquefasciatus* : P<0.05

* Significant difference between long and short photoperiod in *Cx. p. pipiens* : P<0.01

Table 2. Blood feeding rates in female hybrids between *Culex pipiens quinquefasciatus* and *Culex pipiens pipiens* bred in long and short photoperiods at 21°C

Strain	Generation Photoperiod (L:D)	F ₁			F ₂			F ₃		
		Feeding rate			Feeding rate			Feeding rate		
		No. unfed	No. fed	%	No. unfed	No. fed	%	No. unfed	No. fed	%
L	16:08	100	32	32.0*	100	67	67.0*	100	63	63.0*
S	10:14	100	9	9.0*	100	64	64.0*	100	28	28.0*

* N.S. between long and short photoperiod in F₂: P<0.05

* Significant difference between long and short photoperiod in F₁ and F₃: P<0.001

brids also demonstrate the physiological character of the diapause state. This strain was maintained for 44 generations under a short photoperiod and during this term, the feeding rate changed from about 30% to 70%. Therefore, the depth of diapause appears to be shallow. It is necessary to examine the critical day length and the depth of diapause in hybrids between *Cx. p. pipiens* and *Cx. p. quinquefasciatus* in order to obtain a better understanding of the relationship between *Cx. p. pallens* and hybrid offspring.

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