RES. BULL. PL. PROT. JAPAN No. 29: 19~25 (1993)

Habitat and Reproduction in a Winter Population of the Melon Fly, *Dacus cucurbitae* COQUILLETT (Diptera: Tephritidae) in the Southern Part of Okinawa Island

Ren IWAIZUMI

Research Division of
Yokohama Plant Protection Station

Abstract: Habitat and reproduction of the melon fly (MF), *Dacus cucurbitae* COQUILLETT were investigated in the southern part of Okinawa Island in winter season. Adult MF was observed on the canopy of the broad-leaved forest and cucurbitaceous plant, *Melothria liukiuensis* NAKAI. Comparisons on sex ratio and ovarian maturation of the fly collected from these two kinds of habitat suggested that the former site was an overwintering refuge and the latter one was a breeding site. The survey on the infestation of MF larvae to host fruit indicated that MF maintained it's reproductive potential under the winter climatic conditions in Okinawa Island.
Key words: *Dacus cucurbitae*, reproduction, life history

INTRODUCTION

The melon fly (MF), *Dacus cucurbitae* COQUILLETT, as well as the oriental fruit fly, *D. dorsalis* HENDEL, is one of the most important horticultural pests in tropical and subtropical Asia. These species are characterized by multivoltine and have no apparent diapause, although some observations which imply the reproductive diapause of Dacini fruit flies were reported (BATEMANN, 1972; FLETCHER, 1989).

Okinawa Islands are located near the northern limit of the range for the MF distribution. It is thought that the climate in the winter season would become a limiting factor of the reproduction of MF there, because the mean temperatures in the winter season (January and February) almost coincide with the threshold temperature for the mating and oviposition of MF (KOIDZUMI and SHIBATA, 1964; OKUMURA et al., 1981).

Estimation of the reproductive potential of MF in the low temperature season is important for the consideration on the threat of it's invasion into the temperate mainland of Japan, as well as on the control strategies using sterile insect technique (SIT), male annihilation etc. Therefore, it has been studied in the laboratory or field cages (OKUMURA et al., 1981; ISHIZUKA et al., 1983). However, there are few reports on the reproduction and biology of MF in the field during the winter season (KAWAI, 1981; KOYAMA et al., 1981; OKAMOTO et al., 1982).

The author reports the observations of the reproduction of MF under the field conditions in the southern part of Okinawa Island during the winter season.

MATERIALS AND METHODS

1. Study area

The study was conducted in the southern part of Okinawa Island, Itoman City in 1986, 1987 and 1988. Various cucurbit crops, e.g. bitter gourd and sponge gourd, are cultivated there and the population density of MF was maintained at a high level compared with other areas of the island. Broad-leaved forests, bushes of *Leucaena leucocephala*, sugarcane fields and cucurbit fields coexist there.

2. Collection of adult flies and dissection of gonads

The adult flies were caught by a sweeping net from their habitats.

Collected flies were counted with distinction of collecting site and sex, and abdomens of females were dissected under binoculars within a day. According to HAYASHI and KOYAMA (1981), maturation of the ovary was graded to eight stages. A pair of spermathecae was examined under a microscope to check the mating status of individuals.

At the time of the examination in 1987, the eradication program of MF with SIT had been conducted since November, 1986. Therefore, the detection of fluorescent dye in heads of the adult flies were needed as the sterile flies which had been marked with a dye, Blaze Orange® were collected with wild flies in the area. After the discrimination between marked sterile flies and non-marked wild ones, further examinations mentioned above were conducted for only latter ones.

3. Examination on the infestation of MF larvae to host plants

The host fruits of MF were collected from the study area to investigate the infestation of MF. This survey had been conducted monthly through the year from January, 1987 to February, 1988, to clarify the seasonal fluctuation of the infestation and host plants in the area. Collected fruits were kept on sand in plastic containers until adult flies emerged under the laboratory conditions. Of the host plants collected, some bitter gourds were cut at the time of collection or several days after collection in order to check the infestation of larvae immediately and to avoid the water leaks from rotten fruits.

RESULTS

1. Habitats where the adult flies were observed in the winter season

The adult flies were observed in four collecting sites in the winter season. Two of them were edges of broad-leaved forests, and other two sites were colonies of wild cucurbitaceous plant, *Melothria liukiuensis* NAKAI which grows in the bush of *Leucaena leucocephala* de WIT.

The former sites consist of *Mellotus philipiensis*, *Bischotia japanica*, *Ficus superva*, *Ficus virgata*, *Pongamia pinnata*, *Macaranga tanarius*, etc. The adult flies were observed on the surface of sunshiny canopies of the trees. However, they could not always be observed in such places, rather, they were distributed highly-contagiously. At one of the

sites, Dacini species other than MF were observed simultaneously (Table 1).

Table 1-a. Tephritid flies collected from broad-leaved forests in the southern part of Okinawa Island in winter season

Species	No. collected		Date	Site
	Male	Female		
Dacus cucurbitae	15	9	Jan. 11, 1986	B1
	18	16	Jan. 12, 1986	B2
	12	8	Jan. 19, 1986	B2
	30	18	Feb. 1, 1987	B1
	18	11	Feb. 1, 1987	B2
	10	6	Feb. 8, 1987	B2
D. scutellatus	1	0	Jan. 12, 1986	B2
	0	1	Feb. 8, 1987	B2
D. hyalinus	2	3	Jan. 12, 1986	B2
	0	1	Jan. 19, 1986	B2
D. expandens	0	2	Jan. 12, 1986	B2
	1	1	Jan. 19, 1986	B2
Myoleja superflucta	1	1	Jan. 19, 1986	B2

Table 1-b. Tephritid flies collected from wild cucurbitaceous plants in the southern part of Okinawa Island in winter season

Species	No. collected		Date	Site
	Male	Female		
Dacus cucurbitae	0	10	Feb. 7, 1987	C1
	1	1	Feb. 8, 1987	C1
	0	21	Feb. 11, 1987	C2
D. scutellatus	0	1	Feb. 11, 1987	C2

The adult flies were also observed contagiously in certain colonies of *Melothria liukiuensis* NAKAI. But the extent of the contagiousness seemed not so high as compared to the broad-leaved forests.

2. Comparison of sex ratio, ovarian maturation and mating rate of females between the samples from the two habitats

Sex ratio and percentage of mated females were compared between the different winter habitats (Table 2). In the edge of broad-leaved forests, sex ratioes were distorted slightly to males and the mean percentage of mated females was approximately fourty percent. On the contrary, in the colony of wild cucurbitaceous plant, most of the collected flies were females (approximately ninety percent) and the percentage of mated females was above ninety.

Table 2. Sex ratio and percentage of mated females of the melon fly, *D. cucurbitae*, collected from winter habitats in the southern part of Okinawa Island

Vegetation	Site	No. males	No. females	%females	%mating*	Date
Broad-leaved forest	B1	15	9	37.5	33.3	Jan., 1986
	B2	30	24	44.4	45.8	Jan., 1986
	Total	45	33	42.3	42.4	
	B1	30	18	37.5	27.8	Feb., 1987
	B2	28	17	37.8	52.9	Feb., 1987
	Total	58	35	37.6	40.0	
	General T.	103	68	39.8	41.1	
Cucurbitaceous plant	C1	1	11	91.7	90.9	Feb., 1987
	C2	0	21	100	95.2	Feb., 1987
	Total	1	32	97.0	93.8	

* Percentage of females having sperm in their spermathecae

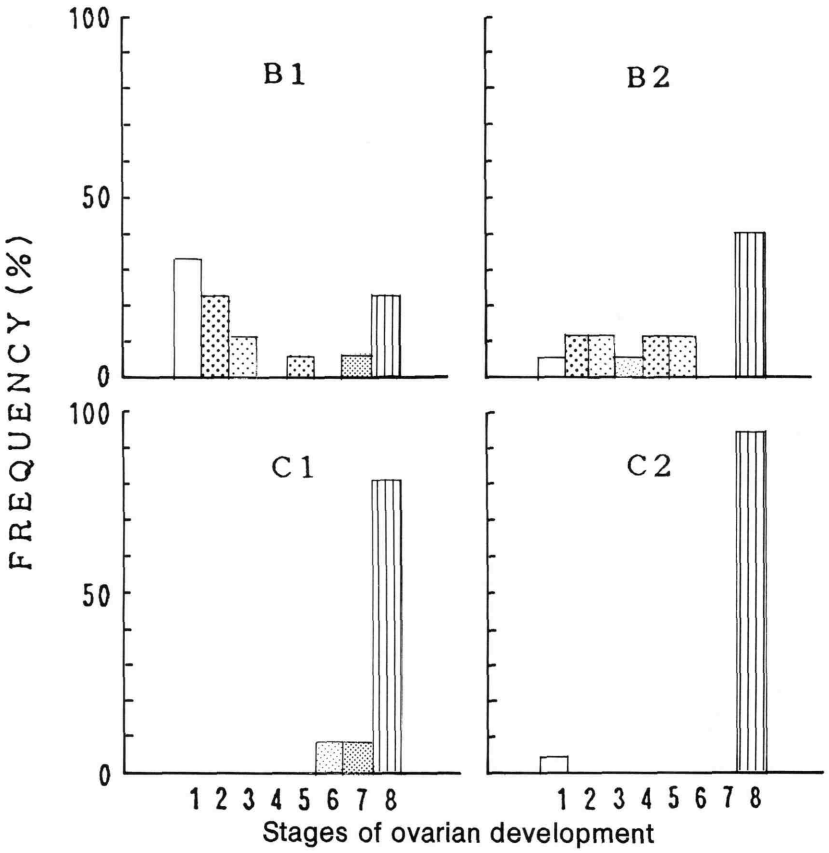

Fig. 1 Stages of ovarian development of the female melon fly, *D. cucurbitae* collected from different habitats in winter season, 1987.

B1, B2: Broad-leaved forest C1, C2: Wild cucurbitaceous plant These data correspond to Tables 1 and 2. Stages of ovarian development are classified into eight stages, from 1 (immature) to 8 (mature), according to HAYASHI and KOYAMA (1981).

Frequency distributions of the stages of ovarian development were also compared between the two habitats (Fig.1). In the edge of broad-leaved forests, various stages of ovarian development were observed and the frequencies of the each stage were relatively equal. On the contrary, in the colony of wild cucurbitaceous plants, most females had ovaries of stage eight.

3. Seasonal change in occurrence of host plants and the infestation of MF in the area

Table 3 shows the kinds and numbers of examined host fruits of MF and the infestation of it throughout one year. Three kinds of host plants, i.e. *Melothria liukiuensis* (ML), *Diplocyclos palmatus* (DP) and *Momordica charantia* (MC) were dominantly distributed in the area.

Table 3. Seasonal fluctuation of the host fruits and infestation of the melon fly, *D. cucurbitae* in the southern part of Okinawa Island

Host plant	No. of fruits examined monthly (Jan., 1987 - Feb., 1988)													
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Melothria liukiuensis	329	664	-	922	654	0	0	0	0	0	238	328	2,197	1,700
	(61.1)	(40.1)		(2.6)	(4.1)						(0)	(0)	(0.2)	(0.1)
Diplocyclos palmatus	0	0	-	0	606	274	492	0	0	0	0	18	315	250
					(6.9)	(17.2)	(2.2)					(0)	(0)	(0)
Momordica charantia	0	0	-	0	320	450	120	620	580	590	610	42	0	0
					(3.4)	(4.9)	(20.0)	(8.9)	(1.0)	(0.3)	(0.8)	(0)		
Total	329	664	-	922	1,580	724	612	620	580	590	848	388	2,512	1,950
	(61.1)	(40.1)		(2.6)	(5.1)	(9.5)	(5.7)	(8.9)	(1.0)	(0.3)	(0.6)	(0)	(0.2)	(0.1)

Numerals within parenthses indicate the percentage of infested fruits

Fruiting periods of each of the three host plants were different. ML was dominant from winter to spring and the colony was withered in summer while MC was cultivated on the bare ground in summer. In case of DP, it fruited in winter (from December to February) and early summer (from May to July).

Monthly percentages of MF infested fruits fluctuated from 0% to 61.1% in the experimental period.

DISCUSSION

It has been reported that some species of Dacini which are native in the tropical or subtropical region aggregate in a patch of evergreen trees in low-temperature season (BATEMANN, 1972; FLETCHER, 1989). KAWAI (1981) reported that MF was observed at a defined patch of broad-leaved forests in Kikai Island in the winter season and could not be observed in other seasons. The similar phenomenon was observed in this study. Moreover, at one of the sites, other Dacini species also observed on a same canopy of trees. This implies the similar behavioral habit of Dacini species distributed in the area.

Meanwhile, the adult flies were also observed in the colony of wild cucurbitaceous plants in the area during the winter season. Apparent differences in sex ratio, ovarian

maturation and percentage of mated females between samples collected from these two types of collection sites suggests the different functions of these habitats for the winter population of the fly. It seems that the broad-leaved forests are utilized as a refuge which provides foraging sites for the adult flies while the wild host plants are oviposition sites for matured females.

NAKAMORI and SOEMORI (1985) studied temporal changes of the number of adult MF caught by traps baited with slices of pumpkin in bitter gourd fields and adjacent forests in autumn and reported that more female flies were caught in the bitter gourd fields than in the adjacent forests. The tendency that the rate of females caught in the host plants is higher than that one in the non-host plants, may not be limited to the winter season. However, it could be said that the functions of the sites as habitats of MF are divided more apparently in winter.

Seasonal fluctuations of the numbers of collected fruit indicate that each kind of host plant shows seasonality in fruiting periods and the reproduction of MF depends on available host fruits annually. In the winter season, the wild cucurbitaceous plant, especially ML is thought to be the most important resource for the reproduction of MF in the study area.

Rather high levels of infestation of MF larvae were maintained even in winter season in the area in 1987. On the contrary, the infestation rates were very low in the same season in 1988. Apparently, that was because the effective control using SIT had been conducted since November, 1986. In general, infestation rates of MF in winter season were very low (IWAHASHI, 1979; KOYAMA et al., 1981; OKAMOTO et al., 1982), contrary to the results obtained by this study in 1987. It seemed that the relatively rich and continuous host resources in the study area allowed the high levels of the population density there, as compared to other areas.

KOIDZUMI and SHIBATA (1964) reported that the threshold temperature for the reproduction of adult MF was 14-16℃, by an experiment in a laboratory. The mean temperatures of January and February at Naha, Okinawa Is. is 16.0℃ and 16.4℃ respectively, close to the threshold. Therefore, the climate in winter in the area is supposed to be hard for the reproduction of MF. However, no evidence to prove the reproductive suppression of adult MF was obtained by this study, although the daily behavior such as foraging and oviposition might be affected by the fluctuating micro-climatic conditions in winter. It is concluded that MF maintained it's reproductive potential under the field conditions in the winter season in Okinawa Island.

ACKNOWLEDGMENTS

The author thanks Dr. M. SHIGA and Dr. H. NAKAMORI, National Institute of Agro-Environmental Science, for their critical readings of the manuscript.

REFERENCES

BATEMANN, M. A.(1972) The Ecology of Fruit Flies. Ann. Rev. Ent. 17 : 493-518

FLETCHER, B. S.(1989) Life History Strategies of Tephritid Fruit Flies. In *Fruit Flies, Their Biology, Natural Enemies and Control* 3B (A. S. ROBINSON and G. HOOPER Eds.), Elsevier, Amsterdam, p. 195-208

HAYASHI, K. and J. KOYAMA (1981) Effects of Gamma Irradiation on External and Internal Morphological Characters of the Adult Melon Fly, *Dacus cucurbitae* COQUILLETT (Diptera: Tephritidae). Jpn. J. Appl. Ent. Zool. 25 : 141-149

ISHIZUKA, Y., T. YOSHIDA, T. Ide and M. OKUMURA (1983) Studies on the Development of the Melon Fly, *Dacus cucurbitae* COQUILLETT, in Amami Island, Kagoshima Prefecture. Res. Bull. Pl. Prot. Japan 19 : 7-11

KAWAI, A. (1981) Overwintering Adults of the Melon Fly. Kyushu Nogyo Kenkyu 43 : 102

KOIDZUMI, S. and K. SHIBATA (1964) Possible Distribution and Establishment of Two Species of Tropical Fruit Flies, Melon Fly and Oriental Fruit Fly, in Japan and Its Adjacent Temperate Countries 1.Effective, Favorable and the Lowest Temperatures for the Development and Reproduction of Both Flies and Their Relations to the Distribution and Abundance in the World and Especially in Japan and the Other Oriental Countries. Jpn. J. Appl. Ent. Zool. 8 : 11-20

KOYAMA, J., O. IWAHASHI and Y. CHIGIRA (1981) Seasonal Change in the Population of the Melon Fly, *Dacus cucurbitae* COQUILLETT, Investigated from Infested Fruit. Bull. Okinawa Agricultural Experiment Station 6 : 35-45

NAKAMORI, H. and H. SOEMORI (1985) Diurnal Changes in the Attraction of the Melon Fly, *Dacus cucurbitae* COQUILLETT (Diptera : Tephritidae), in Different Habitats. Jpn. J. Appl. Ent. Zool. 29 : 216-222

OKAMOTO, T., M. OKUMURA, T. IDE and Y. ISHIZUKA (1982) To What an Extent Fruits of a Wild Cucurbit Are Infested with the Melon Fly Larvae on Kikai Island? Res. Bull. Pl. Prot. Japan 18: 57-59

OKUMURA, M., S. TAKAGI and T. IDE (1981) Studies on the Effect of Temperature on the Development of the Melon Fly, *Dacus cucurbitae* COQUILLETT. Res. Bull. Pl. Prot. Japan 17 : 51-56

和 文 摘 要

沖縄本島南部におけるウリミバエ冬期個体群の生息場所及び繁殖

岩 泉 連

横浜植物防疫所調査研究部

沖縄本島南部における冬期のウリミバエの生態と繁殖について，成虫の生息場所並びに雌の交尾率と卵巣の発育状況を調査するとともに，寄主植物に対する幼虫の寄生率の年間変動を調査した。

1) 成虫は冬期，陽当りの良い広葉樹林の林縁部と野生ウリ科植物群落で観察された。

2) 林縁部で採集された成虫の性比は雄がやや多く(60.2%)，雌の齢構成は多様であった。一方，野生ウリ科植物群落では雌が多く(97.0%)，その殆どが既交尾で成熟卵を有する個体であった。

3) 寄主植物の着果状況と幼虫の寄生率から，夏期にはニガウリ，冬期にはクロミノオキナワスズメウリが主要な寄主植物となっていることが示唆された。

以上の結果から，ウリミバエは沖縄本島南部の冬期野外条件下でも繁殖可能な状態を維持しているものと考えられた。