부산광역시 보건환경연구원보 제12권, 28~37(2002)
Rep. Busan Inst. Health & Environ. Vol.12, 28~37(2002)

Seasonal Prevalence of Mosquitoes Collected from Light Trap in Busan, Korea (1993~1995)

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유문등 채집에 의한 부산지역 모기의 계절적 발생소장 (1993~1995)

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Abstract

The results of adult mosquito collection at Dajeo 2-dong of Busan, located at south-east of the Korean peninsula from 1993 to 1995 are presented. A light trap was operated for adult collection from May to October each year. This surveillance was performed to determine when to recommend insecticide spraying or mosquito control in Busan. A total of 5,552, 29,878 and 21,203 adults were collected in 1993, 1994 and 1995, respectively, being comprised of 4,671(84.1%) females and 881(15.9%) males in 1993; 26,616(89.1%) females and 3,262(10.9%) males in 1994; and 19,640(92.6%) females and 1,563(7.4%) males in 1995. Among the total 3 species comprising 2 genera, *Anopheles sinensis* (46.6%) showed the highest population, followed by *Culex tritaeniorhynchus*(30.9%) and *Cx. pipiens pallens*(22.5%). A density increase of almost 44% of the *An. sinensis* proportion from 1994 to 1995 and a decrease of 66% for the *Cx. tritaeniorhynchus* proportion was observed for the same years. It was assumed that a major factor to influence reproduction of the two species of mosquitoes was temperature.

Key Words : mosquito, light trap, seasonal prevalence, trap index, Korea

INTRODUCTION

Mosquito surveillance is important to determine when to recommend insecticide spraying for mosquito control on each location. The distribution of the mosquitoes, especially vector species, is of great importance to dwellers in urban areas as well as rural areas. Both *Culex tritaeniorhynchus* Dyar and *Anopheles sinensis* Wiedemann are not only medically important vector species, the former Japanese encephalitis and the latter malaria and Brugian filariasis, but also the most dominant mosquitoes breeding in rice fields in Korea. Particulary, malaria is the most important current mosquitoborne disease in Korea[1,2]. Malaria is regarded as officially eradicated in Korea, however, sporadic cases have occurred in association with travel history to the malaria endemic area. The number of cases has increased exponentially year to year since one case of *vivax* malaria was reported in 1993 and 21 cases occurred very sporadically in 1994 in the north western area of Kyonggi-do along the boundary line of demilitarized zone[3]. The outbreaks might result from high population density of the mosquitoes, *An. sinensis*[3]. It generally breeds in rice paddies, parsley fields, irrigation ditches and various types of impounded water[4].

On the other hand, Japanese encephalitis is also very important communicable disease in Korea, Japan and many other Asian countries. When the population of the mosquitoes increased in an year, the number of the disease cases also increased in the year[5,6]. They also breed mainly in rice fields, irrigation ditches and parsley fields. *Cx. pipiens pallens* Coquillett is the most common mosquito species in human dwelling areas in Korea. The larvae occur in a wide variety of habitats such as large artificial containers or other types of stagnant water such as ditches, gutters and ground pools. They prefer polluted water containing abundant organic matter.

Prior to this study, few documentation existed as to the population density of mosquitoes in Busan area. Thus, the objective of this study described herein was to present additional scientific data that would be compared with the seasonal abundance of mosquito species captured among recent years in suburban area in Busan, Korea.

MATERIALS AND METHODS

Studies were carried out at Dajeo 2-dong of Busan, located at south-east of the Korea. A rural village was selected, where a black light trap (Nozawa type, black light FL-6w) was set up inside a cow shed. The height of the trap from the ground surface was 1.7 m. The trap was operated between the hours of dusk and dawn between 19:00 to 07:00 the following morning, twice a week from the period of the first week of May to the last week of October. The mosquitoes collected were killed by chloroform at a laboratory and identified under a stereo-microscope. Light trap indices represent the average number of female mosquitoes collected per trap night[7]. The indices were used for seasonal fluctuation analysis, and total mosquito number of the whole season (24~27 week collections) of each year were used for studying any correlations between population sized of *An. sinensis*, *Cx. tritaeniorhynchus* and *Cx. pipiens*, and various weather factors.

The meteorological factors compared with the mosquito population sizes were mean air temperatures and precipitation from January to December. The populations of each mosquito species also were compared among years. All the meteorological data were obtained from daily and weekly data in the Monthly Weather Report published by Korean Meteorological Service, Busan, Korea. The males collected were excluded for the analyses.

Table 1. The total number of mosquitoes collected in Busan with a light trap from May to October in 1993~1995

Year	Female	Male	Total	Trap Nights	TI*
1993	4,671	881	5,552	51	91.6
1994	26,616	3,262	29,878	45	591.5
1995	19,640	1,563	21,203	46	427.0

*TI(Trap Index) represents average number of female mosquitoes per trap per night.

Table 2. Total number of female mosquitoes collected in Busan with a light trap in 1993~1995 (percentage of total for each year)

Species	1993	1994	1995
An. sinensis	180 (3.9)	9,665 (36.3)	13,908 (70.8)
Cx. pipiens pallens	4,273 (91.5)	5,379 (20.2)	1,807 (9.2)
Cx. tritaeniorhynchus	218 (4.6)	11,572 (43.5)	3,925 (20.0)
Total	4,671 (100.0)	26,616 (100.0)	19,640 (100.0)

Table 3. The monthly occurrences and the average number of female mosquitoes collected with a light trap in 1993~1995 (percentage of total for each month)

Species	May	June	July	August	September	October	Total
An. sinensis	0.7 (1.5)	18.3 (1.8)	2,585.3 (49.8)	4,803.0 (54.6)	494.3 (28.0)	16.0 (13.3)	7,917.6 (46.6)
Cx. pipiens	43.3 (97.0)	1,018.3 (97.7)	1,339.0 (25.8)	828.3 (9.4)	502.0 (28.4)	88.7 (73.7)	3,819.6 (22.5)
Cx. tritaenior.	0.7 (1.5)	5.3 (0.5)	1,273.0 (24.4)	3,172.7 (36.0)	771.3 (43.6)	15.7 (13.0)	5,238.7 (30.9)
Total (Percentage)	44.7 (100.0)	1,041.9 (100.0)	5,197.3 (100.0)	8,804.0 (100.0)	1,767.6 (100.0)	120.4 (100.0)	16,975.9 (100.0)

RESULTS AND DISCUSSION

Total numbers of 5,552, 29,878 and 21,203 mosquitoes were sampled for 51, 45 and 46 nights using a black light trap in 1993, 1994 and 1995, respectively. The collection comprised 4,671 (84.1%) females and 881 (15.9%) males in 1993, 26,616 (89.1%) females and 3,262 (10.9%) males in 1994, and 19,640 (92.6%) females and 1,563 (7.4%) males in 1995 (Table 1). Three mosquito species comprising 2 genera such as *Cx. tritaeniorhynchus*, *An. sinensis*, and *Cx. pipiens pallens* were collected and identified(Table 2).

The most abundant species were different in each year. *Cx. pipiens*, *Cx. tritaeniorhynchus* and *An. sinensis* were the most abundant species composing 91.5% in 1993, 43.5% in 1994 and 70.8% in 1995 of the total mosquitoes, respectively(Table 2). *Cx. pipiens* occurred sporadically in collection samples in survey periods (Table 3). However, *An. sinensis* and *Cx. tritaeniorhynchus* were more collected in August. The

mosquitoes usually made their appearance and started to be in increasing number in Busan. *An. sinensis* was the most abundant species composing 46.6% of the mosquitoes (Table 3). This result was coincides with that of Kim et al[3,7]. The populations of this species normally peaked during July (49.8%) and August (54.6%), and declined in September when *Cx. tritaeniorhynchus* populations increased (43.6%). The population of *An. sinensis* unusually increased in August and it remained the most abundant species.

Although *An. sinensis* population decreased in September (28.0%) and October (13.3%), it still remained the second or third most abundant species in Busan area (Table 3). In 1995, however, the majority of this species (70.9%) collected were from Busan (Table 4). This mosquito was often found associated with *Cx. tritaeniorhynchus* breeding in habitats as rice fields, parsley fields, irrigation ditches and ground pools in Kimhae field located near the collection site.

Cx. tritaeniorhynchus was the most abundant species composing 43.5% in 1994 of the mosquitoes (Table 2). This species was collected in increasing numbers in July (24.4%) and trapped in large numbers during the period from August (36.0%) to September (43.6%), showing a pointed, one peaked curve (Table 3). *Cx. tritaeniorhynchus* made its first appearance in May (0.3 TI) of 1994 and June of 1993 (0.1 TI) and 1995 (0.2 TI) (Table 4). The mosquito populations of this species showed severe fluctuations according to different years like as those of *An. sinensis*. Lee and Ree[8] studied the fluctuations of mos-

Table 4. Trap Index(TI*) of the female mosquitoes trapped during 1993~1995

Species	Year	May	June	July	August	September	October	Total
	1993	0.0	0.2	3.4	11.4	5.1	0.5	20.6
An. sinensis	1994	0.3	7.0	506.5	563.6	171.0	7.0	1,255.4
	1995	0.0	0.7	525.7	1,223.4	52.6	18.0	1,820.4
	1993	4.7	226.7	198.7	58.6	23.3	3.5	515.5
Cx. pipiens	1994	7.3	122.4	212.5	177.5	199.7	21.0	740.4
	1995	3.9	26.3	132.3	59.9	15.3	10.1	247.8
	1993	0.0	0.1	5.3	11.3	8.4	0.1	25.2
Cx. tritaenior.	1994	0.3	2.0	142.6	791.5	313.0	6.4	1,255.8
	1995	0.0	0.2	68.7	384.1	46.1	0.1	499.2

*TI(Trap Index) represents average number of female mosquitoes per trap per night.

quito population densities in Chollabuk province from 1985 through 1990. In their report, also, *Cx. tritaeniorhynchus* population showed severe fluctuation according to different years. Although *Cx. pipiens pallens* was frequently collected during the study period, there has been sharp decrease from 91.5% (1993) to 20.2% (1994) and 9.2% (1995) (Table 2). This species is a typical domestic mosquito which occurs around residential areas in urban and rural areas from spring through fall. In the data from the light trap collection, *Cx. pipiens pallens* were collected in ratios of 97.0% in May, 97.7% in June, 25.8% in July, 9.4% in August, 28.4% in September and 73.7% in October (Table 3).

Cx. tritaeniorhynchus density in 1994 was over 49.8 and 2.5 times higher than those in 1993 and 1995 with same method and site, respectively, so that the density appeared to be unusually high (Table 4). Also, the percentages of collected *An. sinensis* to the total collection were more recorded 70.8% in 1995 than 36.3% in 1994 and 3.9% in 1993 (Table 2). Although the main reasons for the increase in population levels of *An. sinensis* are not apparent, it is considered to be due to the extensive use of chemical insecticides in rice fields, and change of environmental factors as high temperature and reduction of natural enemies. The extensive use of insecticides against rice pests has often produced a resurgence of mosquito populations, due to resistance to insecticides and residues of insecticides in the environment[9].

The basis for understanding the population dynamics lies in the identification of various factors of density dependent and density independent. Also it is obvious that weather factors should be most important ones. Mogi[10] proposed that major factors to influence reproduction of *Cx. tritaeniorhynchus* mosquitoes in Japan were temperature, precipitation, water management of rice fields, host availability, chemicals applied to rice fields and natural enemies, among which temperature and precipitation were responsible for the yearly change of population size. Matsuzaki[6] observed that heavy rainfall in Japan in April and May likely acted for increasing June population of *Cx. tritaeniorhynchus* and heavy rainfall in June unfavourably worked for population increase. He reported also

showed some degree of correlation between yearly population size of *Cx. tritaeniorhynchus* mosquitoes and average air temperature and total amount of precipitation during the period of May~September. Monthly observation did not show any correlation between them. Average air temperatures and precipitation in 1993, 1994 and 1995 are given in Fig. 1 and 2, respectively. Air temperatures in 1994 were much higher than those in 1993 and 1995. Ree and Lee[11] reported that average air temperature during the whole mosquito season (May~September) was also somewhat correlated with yearly population sizes of *Cx. tritaeniorhynchus* and *An. sinensis* mosquitoes. In this study, the populations of *Cx. tritaeniorhynchus* and *Cx. pipiens pallens* in 1994 was the highest among 3 years (Table 2). On the contrary, *An. sinensis* showed a highest population in 1995. *An. sinensis* might more correlate with precipitation than summer air temperature. Optimal amount of total rainfalls during May~September for *Cx. tritaeniorhynchus* population increase seemed to be more than 500mm showing in 1994 (Table 2 and Fig. 2). Ree and Lee[11] reported that winter temperature during overwintering season was the most highly correlated factor with summer population size of *Cx. tritaeniorhynchus* among many weather factors. Overwintering *Cx. tritaeniorhynchus* of 1994 might be affected by colder winter temperature(2.9℃) in January, 1995 than that (3.9℃) in January of 1994, and the population

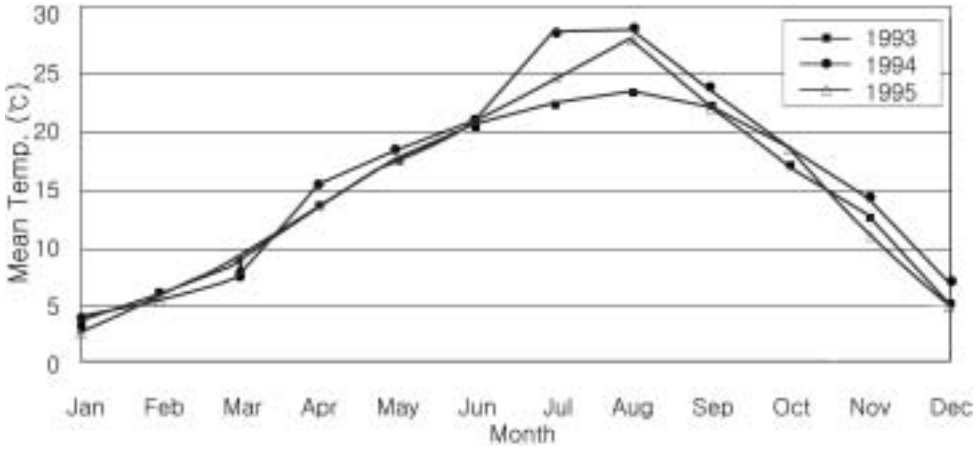

Fig. 1. Mean air temperatures in Busan area from 1993 to 1995.

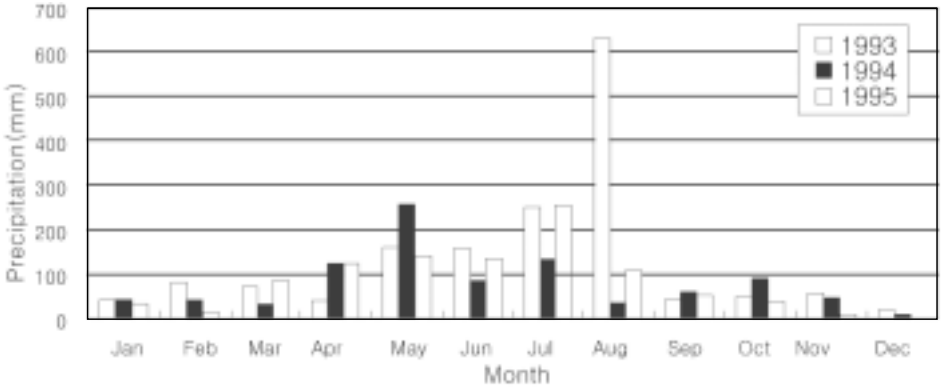

Fig. 2. Precipitation in Busan area from 1993 to 1995.

of 1995 was lower than that of 1994. However, they resulted that winter temperature did not correlate with summer population size of *An. sinensis*. It was implicated that this species has been well adapted to severe winter condition, so that cold weather can not affect the diapausing population size. This trend was similar with the report by Ree and Lee[11]. However, the population of mosquitoes in 1993 as the first year survey, was comparatively much lower than those of other two years. This phenomenon is difficult to explain clearly but it may be associated with sampling error.

요 약

1993년부터 1995년까지 모기방제 시기와 모기 발생 추이를 알아내기 위하여 김해시와 인접한 부산시 강서구 대저 2동의 한 우사에서 유문등을 지상에서 1.7m 높이에 설치하여 19:00(일몰)에서 익일 07:00(일출)까지 모기성충 채집을 실시하였으며, 유문등은 5월 첫주부터 10월 마지막 주까지 주2회 가동하였다.

채집된 모기 성충의 수는 1993년에 5,562마리, 1994년에 29,878마리, 그리고 1995년에 21,203마리였으며, 성별 채집수는 1993년에 암컷이 4,671마리(84.1%), 수컷이 881마리(15.9%), 1994년에 암컷이 26,616마리(89.1%), 수컷이 3,262마리(10.9%), 1995년에는 암컷이 19,640마리(92.6%), 수컷이 1,563마리(7.4%)였다.

조사한 3년간 채집된 모기는 2속 3종으로, 이 중 *Anopheles sinensis*(중국얼룩날개모기)가 46.6%로 가장 높은 채집율을 보였고, 다음으로 *Culex tritaeniorhynchus*(작은 빨간집 모기)가 30.9%, *Culex pipiens pallens*(빨간집모기)가 22.5%의 순이었다.

종별 채집율에서 1995년의 *Anopheles sinensis* 채집율은 전년도에 비하여 44% 증가하였으나 *Culex tritaeniorhynchus*의 채집율은 같은 기간동안 반대로 66% 감소한 것으로 나타났다. 이러한 현상은 1994년도에 나타난 높은 기온과 관계가 있는 것으로 추정하였다.

※ 본 논문은 1999년 고신대학교 보건과학연구소보(제9집)에 고신대학교 생명과학과 이동규교수와 공동으로 투고한 논문으로, 당 연구원 자료 보존을 위하여 내용을 그대로 옮겨 싣습니다. 대표 집필하신 이동규교수님께 감사드립니다.

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