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Surveillance for Dengue Fever Vectors Using Ovitraps at Kaohsiung and Tainan in Taiwan 【Research report】

以誘卵器監測高雄市及台南市的登革熱之病媒蚊【研究報告】

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Abstract

We used ovitraps, set out weekly, to monitor for Aedes aegypti and Aedes albopictus at Tainan and Kaohsiung, Taiwan, in 2002. The average proportion of ovitraps with mosquitoes – the ovitrap index (OI) was 46% in those two cities. If this value is considered as a container index, the vector density would be at level 9 in terms of Ae. aegypti density, which is much higher than that estimated by the Breteau index. The average egg number of Aedes sp. also could be estimated based on the OI with the formula developed by the general model. Our data from those areas tested revealed that the OI is a more sensitive index for detecting the presence of Aedes than the Breteau index. They also showed that Ae. aegypti was a dominant species in Tainan and Kaohsiung most of the time in 2002. Analyses revealed that weekly cases of Dengue fever (DF) and Dengue hemorrhagic fever (DHF) were correlated with the number of adult female Ae. aegypti collected from three studied sub-areas of Kaohsiung with the correlation coefficient of 0.62 in 2002. Our survey also indicated that air temperature and precipitation are not directly related to increases of mosquitoes in ovitraps. Thus, under circumstances where the Breteau index is low, the ovitrap method should be applied as an additional surveillance tool to evaluate the risk of human dengue infection, and the need for mosquito vector control.

摘要

自1987年，台灣地區監測登革熱病媒蚊的密度等級多根據布氏指數 (Breteau index)。由於衛生及環保單位的努力宣導推動清除孳生源與民眾的配合，2002年調查的布氏指數的級數並不高，但在高雄及屏東地區仍然發生登革熱的大流行。此年的四月至十二月在台南市及高雄市的三民區，前鎮區及小港區布設誘卵器，定期定點地進行病媒蚊的監測，發現所放置的誘卵器中平均有46% 有病媒蚊產卵，如將它視為容器指數，其病媒密度的級數已達九級，比同一時期的布氏指數所推估的三級為高。由於誘卵器中的病媒蚊以埃及斑蚊佔優勢，以誘卵器中得到的埃及斑蚊的數量與高雄市同一時期此三區所發生的登革熱的病例數進行相關性分析，其相關係數可達0.61，分析結果也顯示2002年的平均氣溫及降雨與病媒蚊的增減無直接的相關性。根據此一調查，可以証明當布氏指數偏低時，設置誘卵器進行常規性的監測，不但能靈敏地偵測出病媒蚊的消長情況，同時可提供評估防治成效的具體資料。

Key words: Aedes aegypti, Ae. alboptictus, ovitrap index, Breteau index, DF/DHF cases

關鍵詞: 埃及斑蚊、白線斑蚊、誘卵器、布氏指數、登革熱病例

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Surveillance for Dengue Fever Vectors Using Ovitraps at Kaohsiung and Tainan in Taiwan

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ABSTRACT

We used ovitraps, set out weekly, to monitor for *Aedes aegypt*i and *Aedes albopictus* at Tainan and Kaohsiung, Taiwan, in 2002. The average proportion of ovitraps with mosquitoes – the ovitrap index (OI) was 46% in those two cities. If this value is considered as a container index, the vector density would be at level 9 in terms of *Ae. aegypti* density, which is much higher than that estimated by the Breteau index. The average egg number of *Aedes* sp. also could be estimated based on the OI with the formula developed by the general model. Our data from those areas tested revealed that the OI is a more sensitive index for detecting the presence of *Aedes* than the Breteau index. They also showed that *Ae. aegypti* was a dominant species in Tainan and Kaohsiung most of the time in 2002. Analyses revealed that weekly cases of Dengue fever (DF) and Dengue hemorrhagic fever (DHF) were correlated with the number of adult female *Ae. aegypti* collected from three studied sub-areas of Kaohsiung with the correlation coefficient of 0.62 in 2002. Our survey also indicated that air temperature and precipitation are not directly related to increases of mosquitoes in ovitraps. Thus, under circumstances where the Breteau index is low, the ovitrap method should be applied as an additional surveillance tool to evaluate the risk of human dengue infection, and the need for mosquito vector control.

Key words: *Aedes aegypti*, *Ae. alboptictus*, ovitrap index, Breteau index, DF/DHF cases

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Introduction

Dengue fever (DF) infection has been reported throughout the nineteenth and twentieth centuries in Southeast Asia, including Taiwan (Ke, 1989; Gubler, 1998). Dengue hemorrhagic fever (DHF) has also increased steadily in this region, both incidence and distribution over the past decades (Halstead, 1988). Besides three outbreaks occurred in Taiwan from 1980 to 2002 and, on average, there are approximately 100 confirmed cases of dengue fever annually (CDC information 2002). The first DF outbreak occurred in Small Liu-Cho Village of Pingtung in 1980 where more than 16,000 of the 20,000 residents were infected (Hsien *et al*., 1982). The second outbreak was reported in Tainan, Kaohsiung, and Pingtung between 1987 and 1989 with a total of 5,700 confirmed DF cases (Huang *et al*., 1991). During a recent outbreak in 2002, a total of 5,285 and 242 cases of DF and DHF were diagnosed, respectively. Among these cases, about 89% of DF and 95% of DHF patients were residents of Kaohsiung city and surrounding areas in Kaohsiung County (CDC information, 2002).

Epidemics of DF and DHF have existed in many countries of Southeast Asia in the past decades. Millions of Taiwanese travelers and businessmen visit these dengue epidemic countries each year, and imported cases usually become the initial infective source for dengue spreading in the Taiwanese population. To prevent local infection of DF and DHF, surveillance of mosquito vectors has been routinely carried out in the past twenty years in Taiwan. Three measured indices are recommended by the WHO to estimate the vector density for dengue fever, i.e., House Index (HI), Container Index (CI) and Breteau Index (BI) (Tun-Lin *et al*., 1995; Scott and Morrison, 2003). Among these three indices, BI is considered to be the most informative because it includes the number of houses inspected and infested containers. Its main limitation is that it fails to account for adults produced from containers (Conner and Monroe, 1923; Breteau, 1954). Because of its easy application, BI has been widely used to estimate the vector density for dengue in Taiwan. In the meanwhile, clearance of natural breeding sources can be accomplished when inspection is done. In recent years, the breeding sites in the community have been effectively reduced by enthusiastic encouragement of governments. However, the number of multi-story buildings has increased rapidly in the past five years because of rapid urbanization in Taiwan. This results in numerous smaller residences, and also has affected the reliability of traditional vector surveillance that relies on skillful inspectors, density of residents, and the positive responses of the community (Focks, 2003). Setting ovitraps in public areas would serve as an alternative method of vector detection (Jacob and Bevier, 1969; Tanner, 1969; Furlow and Young, 1970; Mogi *et al*., 1990). Ovitrap data have reported to be more sensitive than the traditional *Stegomyia* indices in detecting low population (Focks, 2003). Historically, ovitraps have provided useful data on the spatial and temporal distributions of *Ae. aegypti* and other container-inhabiting mosquito species (Ritchie, 1984). Ovitrap data have also been successfully used to monitor the impact of various types of control measures involving source reduction and insecticide applications (Focks, 2003). In addition, the ovitrap method is capable of detecting mosquitoes from unexposed breeding sites and surrounding areas. Therefore, this method was selected for vector surveillance in Kaohsiung and Tainan in 2002.

During the period of the vector survey, we found that increase in mosquito populations based on the ovitraps was correlated with the incidence of dengue fever cases in Kaoshiung. Therefore, the relationships between these two factors were analyzed. The effects of air temperature and precipitation on vector mosquito density were also examined in the tested areas. This information would be valuable to workers with epidemiological concerns about DF and mosquito vectors, and for adjusting control strategies.

Materials and Methods

Location for surveillance: Ovitraps were set outdoors in 7 sub-areas in Tainan City and 3 sub-areas in Kaohsiung City according to administrative partition. A total of 42 ovitraps were set in Tainan, 6 for each sub-area; and a total of 45 ovitraps in Kaohsiung, 15 for each sub-area. These ovitraps were set 5 to 20 m apart.

Kaohsiung and Tainan are cities in southern Taiwan, located 45 m apart, that are of economic, educational and cultural importance. Tainan lies between latitude N22°58' to N22°59' and longitude E120°04' to E120°14'; Kaohsiung lies between latitude N22°30' to N22°15' and longitude E120°14' to E120°23'. The total acreage of Tainan and Koashiung is about 177.4 km^2 and 153.6 km^2, respectively. The climate is equatorial and monthly temperatures are relatively uniform throughout the year. The annual average shading temperature is about 24°C and 26°C in Tainan and Kaohsiung, respectively. Inland, day temperatures exceed 29°C and night temperatures of under 15°C are uncommon. The monthly rainfall varies from 0 to 500 mm at different periods of the year with about 90% of the annual precipitation falling between May and August. Tainan and Kaohsiung have estimated populations of about 750,000 and 1,508,000, respectively. Mass transit systems are well-established in both cities, and there are also good highway networks and air services to other cities in Taiwan.

Administratively, Tainan is divided into 7 sub-areas: Eastern, Southern, Western, Northern, Central, Anping and Annan. Except for the sub-area of Annan where many residents are fish-cultivation and vegetable farmers, the majority of the population lives in the other six sub-areas. In Kaoshiung, the two sub-areas in the southern part, Chiencheng and Shaugan, are districts of many large industries and associated business for manufacturing export goods. The third sub-area, Sanmin, is an inland area that has the highest human population in Kaohsiung. The incidence of dengue virus infection there was found to be higher than in other areas (Huang *et al.*, 1995; Chiou *et al.*, 1999).

Ovitrap setting: Black ovitraps with a cover were used in the present study. In the middle of the cover was a hole 25 mm in diameter. To avoid over-flowing of water after rainfalls and to create more favorable resting habitats for adult mosquitoes, the ovitraps were placed in shaded locations. Traps were filled with 200 ml of water and these were refilled periodically as was necessary. A piece of paper towel lining inside the trap served as an oviposition mattress; these were changed after each weekly inspection. Traps were set out over an eight-month period from April 4 through December 27 in 2002. This schedule resulted in a total of 34 surveys at each trap location.

Mosquito collection: Eggs and any larvae found in the ovitrap were brought back to the laboratory and examined microscopically. Papers with eggs not hatched were air-dried for 3 days and dipped into a solution containing diluted liver powder suspension to induce hatching. Larvae were reared to adults, identified to species, and the respective numbers for *Ae. aegypti* and *Ae. albopictus* determined.

Model test: Gerrard and Chiang (1970) proposed a general model for corn rootworm. This model describes an empirical relationship between the mean egg number (m) and the proportion of positive samples (p) without assuming any particular distribution. The equation of the model is m = a x ln [-ln $(1-p)^b$] where a and b are constants, and ln is the natural logarithm. By taking natural logarithms, the equation becomes ln m = ln a + b ln [-ln (1-p)]. In this form the mean egg number could be estimated from the regression equation. This model has also been tested for ovitrap surveillance of *Aedes* in Thailand by Mogi *et al.* (1990) and found to fit very well. Therefore, we applied this model with our ovitrap surveillance data for making predictions.

Data analyses: Data were compiled using Excel 2000 in Windows XP (2001, Microsoft Corporation, OEM, Taipei, Taiwan). Then statistical correlations and significance were done with the SPSS statistical package version 12.0 (SPSS Inc., Chicago, Illinois, USA). Comparisons were made between numbers of *Ae. aegypti* and cases of DF in the study areas. Weekly data of DF incidence were recorded according to the time of onset of symptoms as provided by the Center for Disease Control (CDC) of the Public Health Department in Taipei. These patients were confirmed to be infected with dengue virus either by a serum test or by polymerase chain reaction (PCR) assays that were conducted in the laboratory of the CDC.

Results

Mosquito estimation

The appearance of larvae in ovitraps in Tainan from April to December 2002 is shown in Fig. 1A. The lowest and highest rates of ovitraps with mosquito larvae were 19% (the 52nd week, in December) to 76% (the 25th week, in June), with an average of 46%. The average total numbers of *Ae. aegypti* and *Ae. albopictus* are also shown. Statistical analysis using Spearman's γ^s correlation revealed that the number of *Aedes* mosquitoes were positively correlated with the proportion of ovitraps with mosquitoes, with a correlation coefficient of 0.633 ($p < 0.01$). The results for Shaugan, Chiencheng and Sanmin of Kaohsiung are shown in Fig. 1B. Positive rates ranged from 16% (52th week, in December) to 75% (the 33rd week, in August) with an average of 46%. Statistical analysis indicates similar results to those in Tainan with a correlation coefficient of 0.77 ($p < 0.01$).

The applicability of the general model for our surveillance results for Tainan and Kaohsiung is shown by regression equations in Fig. 2A and 2B, respectively. Linear regression of ln mean egg number/trap using the formula ln [-ln (1-p)], where p designated the proportion of positive ovitrap, had a greater correlation at Kaohsiung (R^2 = 0.642) than at Tainan (R^2 = 0.298). The reason for the difference remains to be explored. For Tainan, based on the formula of linear regression (Fig. 2A), a = 0.86 (ln 2.373), and slope b = 0.891 (b ± 95% confidence limits = 0.891 ± 0.477, t = 3.77, df = 35, $p < 0.01$), m was estimated from p as m = 0.86 $[-\ln(1-p)]^{0.89}$. For Kaohsiung, linear regression (Fig. 2B), a = 1.14 (ln 3.128), and slope b = 1.453 (b ± 95% confidence limits = 1.453 ± 0.379, t = 7.804, df = 35, $p < 0.001$), m was estimated from p as m = 1.14 $[-\ln(1-p)]^{1.45}$.

Since both *Ae. aegypti* and *Ae. albopictus* can transmit dengue virus, a monthly comparison of the relative abundance of these two species was made for each of our collections from Tainan and Kaohsiung (Figs. 3A and 3B, respectively). These results indicated that *Ae. aegypti* was the dominant species in both cities most of the time in 2002 in Tainan, except for the period from June to September where more *Ae. albopictus* was collected.

Vector densities and confirmed incidence of the dengue fever

In Tainan, confirmed DF cases first occurred in early August (the 32nd week). Two peaks of DF infection then occurred in the 37th and 43th week (Fig. 4A). A

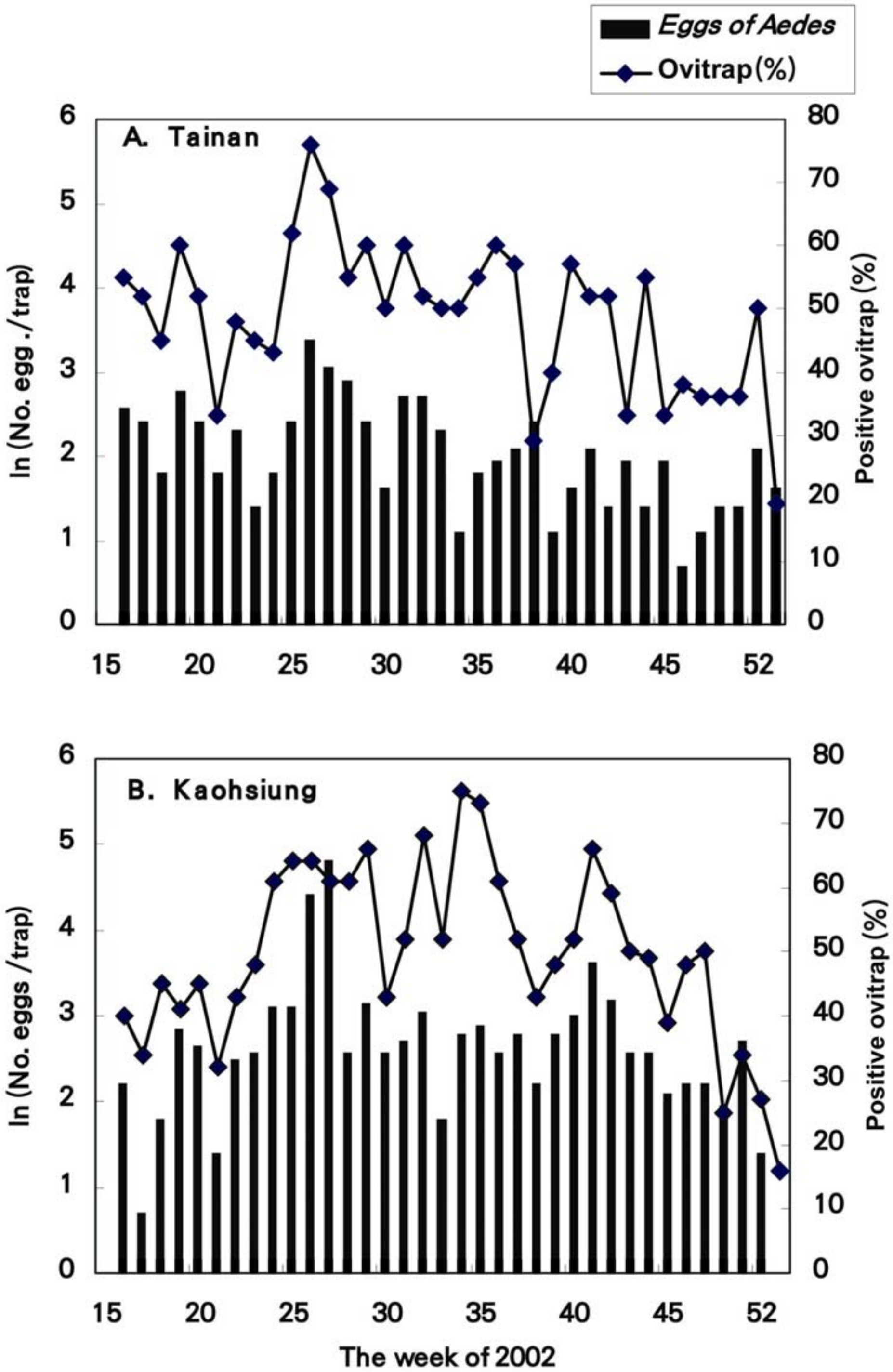
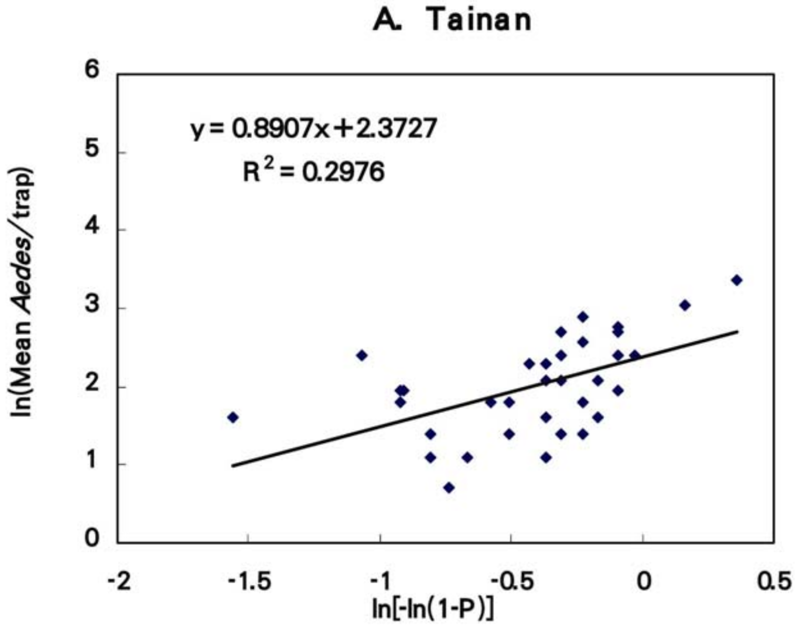


Fig. 1. *Aedes* sp. eggs collected in ovitraps at Tainan (A) and Kaohsiung (B), April-December, 2002. Bars represent the average number of *Aedes* sp. by natural log because of variation ranging from 2-126 eggs/trap among ovitraps. The line represents the positive proportion of ovitraps.



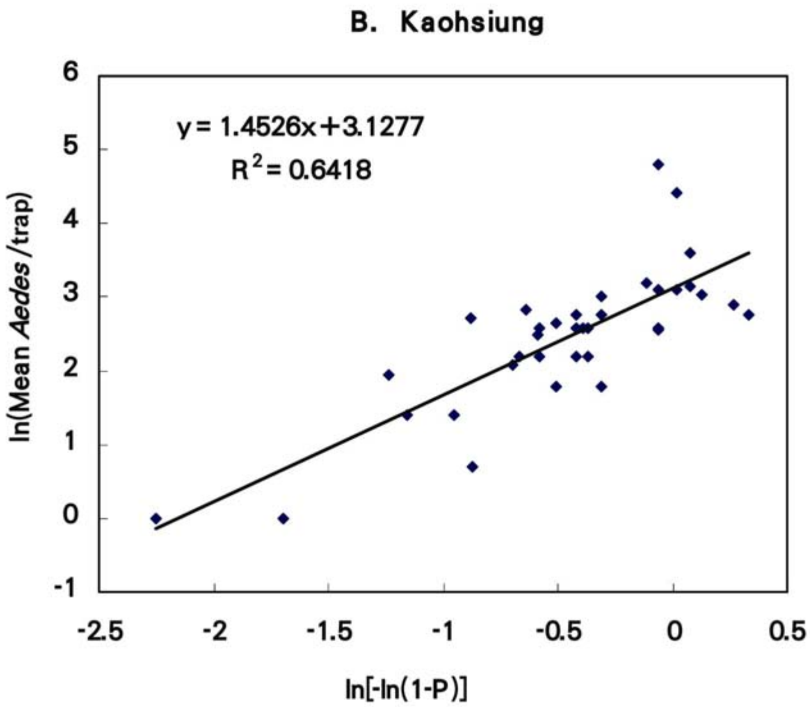


Fig. 2. Linear regression analysis for weekly-collected *Aedes* eggs (ln (mean *Aedes* per ovitrap) and the positive proportion of ovitraps [ln- (1-P)]) in Tainan (A) and Kaohsiung (B) using the general model, April-December, 2002.

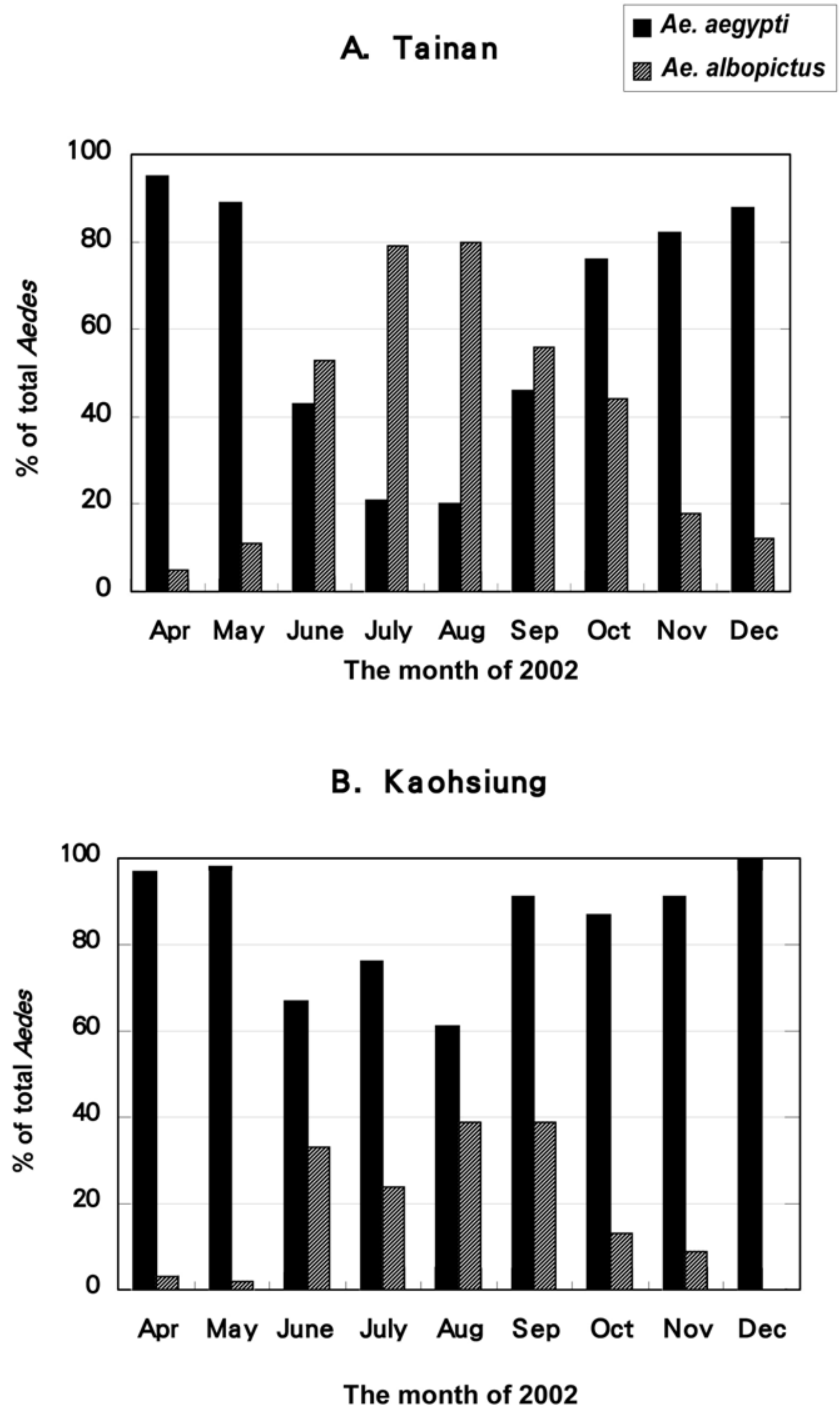


Fig. 3. Comparison between *Aedes albopictus* and *Aedes aegypti* collected from the ovitraps at Tainan (A) and Kaohsiung (B), April-December, 2002.

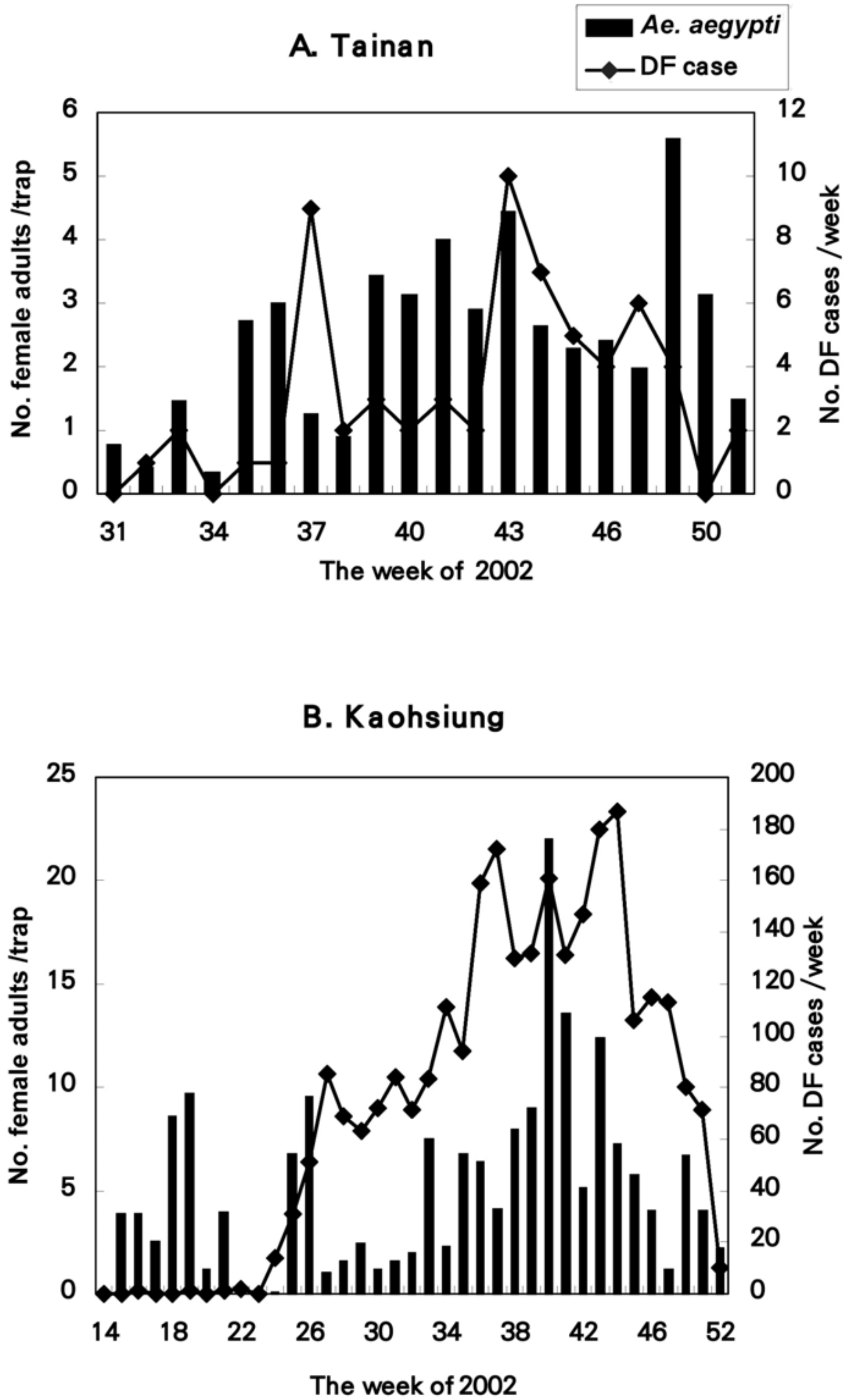


Fig. 4. The number of confirmed dengue fever (DF) patients and the number of female *Ae. aegypti* derived from eggs in ovitraps at Tainan (A), August-December, 2002; and Kaohsiung (B), May-December, 2002.

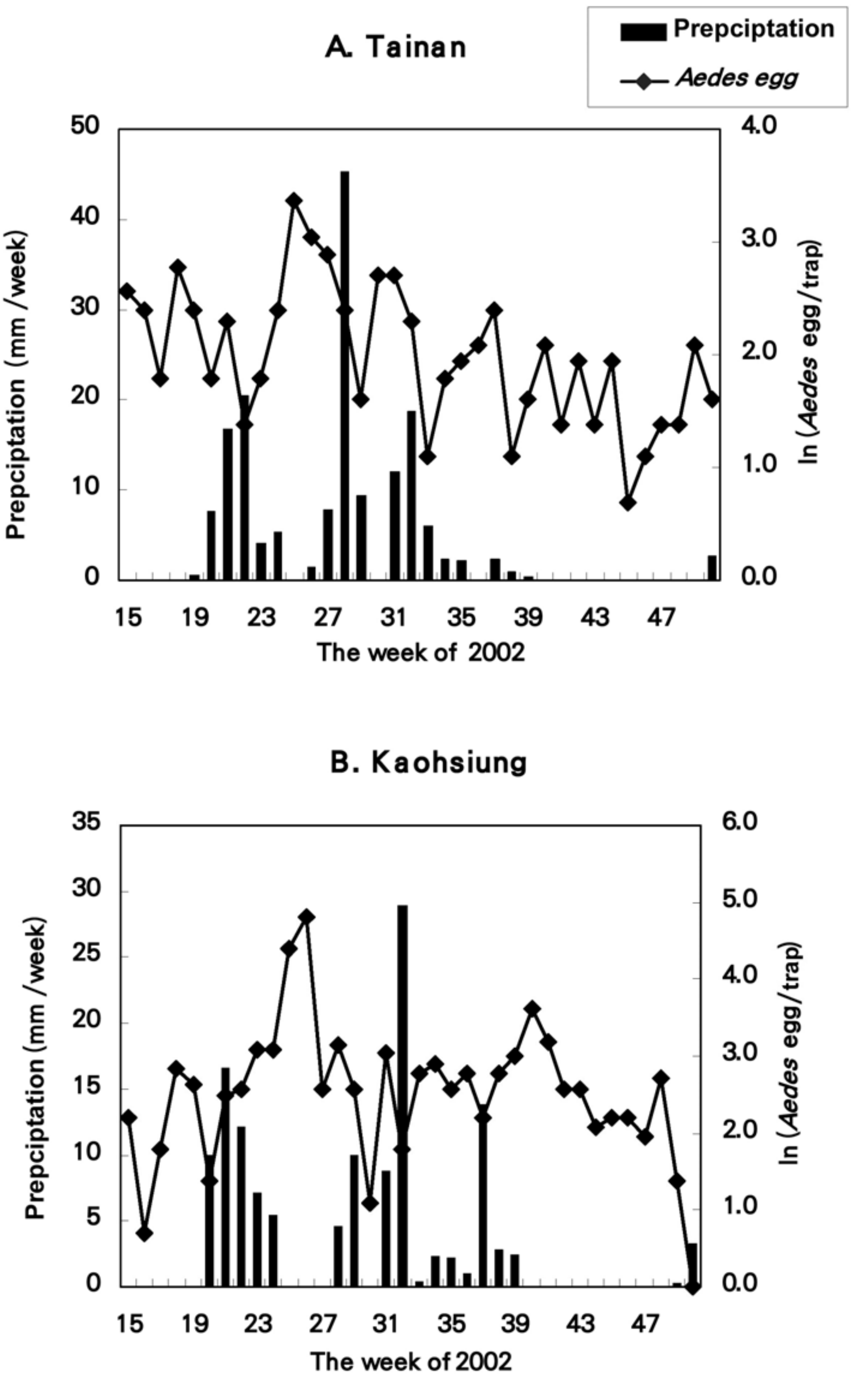


Fig. 5. Association of the mean egg number of *Aedes* sp per ovitrap with regard to mean precipitation (mm) per week at Tainan (A) and Kaohsiung, (B) during April-December, 2002.

total of 64 DF cases were confirmed in 2002. In comparison, confirmed DF virus-infected patients in Kaohsiung had been detected as early as April (the 16th week) of 2002. Thereafter, a lingering outbreak of DF occurred from June (the 24th week) through December (the 52nd week) (Fig. 4B). During that time the incidence of DF patients in Kaohsiung ranged from 10 to 187 cases each week, and a total of 2,923 cases were confirmed to be DF and/or DHF in 2002. Since our collections showed that *Ae. aegypti* was the dominant species in Tainan and Kaohsiung, correlations were also made between the numbers of DF cases and adult female *Ae. aegypti* derived from our ovitraps (Fig. 4A and Fig. 4B) for Tainan and Kaohsiung. They revealed that DF cases increased with the number of *Ae. aegypti*. Assuming the interval of extrinsic and intrinsic cycle dengue virus was 1-2 weeks (Vazeille *et al.* 2003), the Spearmans' γ^s analysis also suggested a positive correlation between the number of female adults and the incidence of DF/DHF cases in Kaohsiung with a correlation coefficient of 0.61 ($p < 0.01$). (The regression formula is the number of patients = 40.5 + 5.6 x average number of *Ae. aegypti*). However, the risk of dengue infection also varies temporally depending on other factors such as human herb immunity, density of human hosts, characteristics of mosquito-human interaction, and the virus virulence (Focks *et al.*, 1995; 2000; Scott and Morrison, 2003). Thus, vector density could only contribute partial influence on DF epidemics.

The effects of air temperature and precipitation on mosquito density

Temperature is one of the key factors affecting preadult mosquito development, the maturation of eggs in adults, and the extrinsic incubation period of dengue virus within the vector (Christopher, 1960; Thu *et al.*, 1998). The average air temperature was approximately 22-27°C in Tainan and Kaohsiung during the period of April to December in 2002. We performed a statistical analysis to examine the effect of air temperature on the number of mosquitoes found in ovitraps. Results revealed that the correlation coefficients were 0.401 and 0.416 ($p < 0.05$) in Tainan and Kaohsiung, respectively (data not shown). Because local rainfall could have had a direct impact on the humidity and activity of adult mosquitoes, we also examined the correlation of the average weekly precipitation and *Aedes* mosquto collected in ovitraps (Fig. 5A and Fig. 5B) for the two cities. The egg deposition was kept at a relatively high level in the 25th week and the 26th week, and remained to be moderate during the period of the 40th to 47th week in both cities while there was no precipitation (Fig. 5). It appeared that no direct relationship existed between egg number and precipitation. This result suggests that mosquitoes may lay eggs in any available water-filled containers, including ovitraps, if natural containers decreased or rain-filled natural oviposition sites dried up.

Discussion

Because Taiwan is located in subtropical or tropical regions that are conducive to mosquito breeding, people living in this island are at high risk for contracting DF, DHF and dengue shock syndrome (DSS). To monitor vector density as a means of preventing dengue virus transmission, the Breteau index (BI) has been the prevailing system. However, the BI is an indicator of prevalence rather than abundance (Zhen and Kay, 1993). In addition, because of environmental conditions in Taiwan, several factors may affect the accuracy of predictions based on BI. First, the original definition of BI is based on the total number of containers with the size ranging from 4 to 200 cm in diameter with the presence of *Ae. aegypti* larvae per 100 individual houses (Breteau, 1954; Service, 1976; Focks *et al.*, 1993). Because different combinations of multi-story apartments and independent houses are usually found in Taiwanese communities, it is difficult to pick comparable sets of 100 premises in different locations. Second, because *Ae. aegypti* and *Ae. albopictus* breed together in the same containers, routine surveys may not reveal real population levels of *Ae. aegypti* unless careful species identifications are made. Third, inspectors cannot always carry out the survey at fixed times of the day because the house owners may be absent. Therefore, samplings occur at times that are neither randomly nor evenly distributed in the survey areas. Fourth, accurate surveillance may also be affected by the consistency of number and training of survey personnel.

A comparison was made between the Ovitrap Index (OI) of our data and the Breteau Index provided by CDC in the sub-area of Samin, Shaugan and Chiencheng in Kaohsiung. Results are shown in Table 1. The BI values of the three sub-areas were below level 4 most of the time in 2002. However, the OI was found to be at level 4 according to the ranking grades for ovitrap index used in Hongkong (2003), which is equivalent to the highest grade of *Ae. aegypti* figures developed by Brown (1974). Table 1 also showed that when the BI was below level 3 in these sub-areas, the incidence of DF cases increased from June through November in 2002, and the proportions of mosquito-positive ovitraps remained at a high level. These findings indicated that the prevalence of vectors might be neglected by the surveillance system being used at present. Thus, OI appeared more sensitive than BI in detecting the presence of vector. It is generally accepted that the ovitrap provides a simple and convenient monitoring method since the number of eggs laid in a standard trap in a specific time period would give a relative measure of the number of mosquito in the same area (Fay and Eliason, 1966). Therefore, we suggest that setting ovitraps in public areas could result in effective monitoring for the presence of vector mosquitoes under circumstances where the BI values are low. Ovitraps do not provide estimation of *Ae. aegypti* population densities (Reiter and Gubler, 1997), but they can give insight into relative changes in the adult female populations (Anonymous, 1994). However, variable numbers of *Aedes* among sites were observed in our data (Fig. 1). This finding is likely associated with competition for natural oviposition sites (Scott and Morrison, 2003). When applying this index for surveillance, one must be aware of that an ovitrap error may come from the competitive deposition probability with other natural ovipostion sites for female mosquitoes and it varies from site to site.

We also tested the applicability of the general model (Gerrard and Chiang, 1970) that describes an empirical relationship between the mean (m) and the proportion of positive ovitraps (P) without assuming any particular distribution. Our results showed a linear regression exhibited in the survey in Kaohsiung (Fig. 2B). Thus, the density (ln m) of the *Aedes* sp. could also be approximately estimated from the linear regression formula based on the positive rate of ovitrap for each census as reported in Ching Mai, Thailand (Mogi *et al.*, 1990). In order to take advantage of this simple method and obtain more predictive data for DF epidemics, trap-setting places should include indoors at both lower- and upper-levels of a building. Appropriate partitions of the survey area are essential for the effective use of ovitrap method. A possible pitfall of using ovitraps in dengue prevention programs is that ovitraps per se may produce vectors if they hold water longer than the developmental duration of the immature mosquitoes (Mogi *et al.*, 1988). To remedy this problem, methoprene pellets can be

Table 1. Comparisons of Breteau index (BI), ovitrap index (OI) and dengue fever (DF) patients in three sub-areas in Kaohsiung from April to December, 2002

Month	Sub-area	BI[1)]		OI[2)]			No. Confirmed DF cases[3)]
		Avg. rank	n	Grade	n	Avg. Positive rate (%)	
April	Samin	1	9	4	60	71 ± 25	0
	Shaugan	1	7	3	60	30 ± 3	0
	Chiencheng	1	20	3	60	38 ± 16	0
May	Samin	1	11	4	60	51 ± 8	0
	Shaugan	2	6	2	60	20 ± 9	0
	Chiencheng	1	11	2	60	55 ± 12	3
June	Samin	1	9	4	60	75 ± 6	1
	Shaugan	2	8	4	60	40 ± 22	2
	Chiencheng	2	47	4	60	62 ± 7	95
July	Samin	0	11	4	60	48 ± 14	18
	Shaugan	3	6	4	60	43 ± 16	6
	Chiencheng	1	26	4	60	42 ± 22	240
August	Samin	1	50	4	60	72 ± 20	63
	Shaugan	1	10	4	60	52 ± 27	41
	Chiencheng	2	110	4	60	69 ± 14	133
September	Samin	1	59	4	60	60 ± 16	79
	Shaugan	1	62	3	60	35 ± 8	71
	Chiencheng	1	81	4	60	56 ± 13	167
October	Samin	1	310	4	60	68 ± 24	133
	Shaugan	1	163	3	60	38 ± 11	39
	Chiencheng	1	149	4	60	32 ± 6	178
November	Samin	1	240	4	60	42 ± 16	132
	Shaugan	1	140	2	60	28 ± 11	25
	Chiencheng	1	146	4	60	50 ± 20	127
December	Samin	1	78	2	60	27 ± 19	63
	Shaugan	1	55	3	60	33 ± 19	9
	Chiencheng	1	43	2	60	29 ± 3	21

1) Breteau index (BI) was obtained from sum of BI divided by no.of reported Lee (n). Lee is a unit of community that consists of 150-210 residences.

2) OI (ovitrap index) was expressed by the positive rate of ovitrap and grading. Grades were determined by the positive rate of the ovitrap those used in surveys of *Aedes albopictus* in Hong Kong as follows: level 1, OI < 5%; level 2, 5% < OI < 20%; level 3, 20% < OI < 40%; level 4, OI > 40%. n indicates the number of ovitraps examined in that area in a month.

3) Information of patients was provided by the Center of Disease Control of the Department of Health, ROC based on the time of onset of symptoms and confirmed by either serum tests or polymerase chain reaction in the laboratory of CDC.

added to ovitraps to prevent mosquito production (Ritchie and Long, 2003).

Failure of pesticide sprays was observed in sub-area Chiencheng of Kaohsiung in September of 2002. Laboratory tests of mosquitoes collected from ovitraps at this area showed a high level of pyrethroid resistance (Lin *et al.*, 2003). Therefore, mosquitoes collected from ovitrap samples could be used for multiple investigations such as insecticide resistance, population genetic analysis, evaluating efficacy of insecticide application and strategies of control.

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以誘卵器監測高雄市及台南市的登革熱之病媒蚊

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摘　要

自 1987 年，台灣地區監測登革熱病媒蚊的密度等級多根據布氏指數 (Breteau index)。由於衛生及環保單位的努力宣導推動清除孳生源與民眾的配合，2002 年調查的布氏指數的級數並不高，但在高雄及屏東地區仍然發生登革熱的大流行。此年的四月至十二月在台南市及高雄市的三民區，前鎮區及小港區布設誘卵器，定期定點地進行病媒蚊的監測，發現所放置的誘卵器中平均有 46% 有病媒蚊產卵，如將它視爲容器指數，其病媒密度的級數已達九級，比同一時期的布氏指數所推估的三級爲高。由於誘卵器中的病媒蚊以埃及斑蚊佔優勢，以誘卵器中得到的埃及斑蚊的數量與高雄市同一時期此三區所發生的登革熱的病例數進行相關性分析，其相關係數可達 0.61，分析結果也顯示 2002 年的平均氣溫及降雨與病媒蚊的增減無直接的相關性。根據此一調查，可以証明當布氏指數偏低時，設置誘卵器進行常規性的監測，不但能靈敏地偵測出病媒蚊的消長情況，同時可提供評估防治成效的具體資料。

關鍵詞：埃及斑蚊、白線斑蚊、誘卵器、布氏指數、登革熱病例。