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SEASONAL ABUNDANCE OF ADULT AND IMMATURE *AEDES AEGYPTI* (L.) IN JAKARTA

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Dari bulan Mei 1973 sampai bulan Juni 1974 telah dilakukan pengamatan nyamuk Aedes aegypti ·tadium dewasa dan larva di keempat daerah kota yang berpenduduk padat di Jakarta Raya. ?engamatan dikerjakan 2 kali dalam satu bulan. Daya tarik nyamuk terhadap manusia rata-rata 1.2 ıntuk betina dan 1.6 untuk nyamuk jantan tiap orang tiap jam. Dalam 100 rumah diketemukan ata-rata 180 buah bejana berisi air, dimana 58 buah positif; Container index (persentasi bejana yang ositif) 32 persen. House index (persentasi rumah yang positif) adalah 47 persen dan Breteau index jumlah bejana positif dalam 100 rumah) adalah 58. Kepadatan nyamuk baik larva maupun dewasa ata-rata hampir sama sepanjang tahun. (tidak ada perbedaan pada musim hujan dan musim panas). 'emperatur dan kelembaban juga rata-rata hampir sama sepanjang tahun.
lampir semua tempat perindukan terdapat didalam rumah, hingga sedikit sekali bejana diluar rumah 'ang terisi oleh air hujan dalam musim hujan.

Since the discovery in 1901 of its role as he vector of yellow fever in the Americas and \frica, extensive research has been done on he bionomics of the mosquito *Aedes aegypti* L.) (Christophers, 1960). In Southeast Asia, /here yellow fever does not occur, another :isease, dengue haemorrhagic fever (DHF) has ecome a problem since the 1950's, first in he Phillipines (1954), then in Thailand 1958), Singapore (1960), Vietnam (1961), 1alaysia (1962), India (1963) and most reently in Indonesia (Hammon, 1973). In Jaarta cases of DHF have been reported for ach year since 1968 (Kho et al., 1969; ndonesia Directorate of Communicable)isease Control Reports). All evidence points) *Aedes aegypti* as the important vector of)HF, this mosquito being the only species apable of transmitting dengue virus occuring ı the crowded slums from whence many of the cases are reported.

Because the incidence of DHF is usually highest during the rainy season, it is important for an understanding of the epidemiology of the disease to assess any corresponding seasonal fluctuations in the mosquito population. Two previous studies of seasonal abundance of *Aedes aegypti* have been done in Jakarta. Van Peenen et al. (1972) made weekly collections of resting adult mosquitoes inside houses in four localities in Jakarta for a full year during 1970-1971. They found no seasonal pattern of abundance. The National Institute of Health Research and Development did one-larva-per-container surveys in 100 houses in each of 26 subdistricts *(kecamatan)* of Jakarta once during the rainy season of 1972-73. No significant difference was found in larval indices between the two seasons (Harijani and Immler, unpublished data). In the study reported herein, simultaneous surveys of both adult and immature populations were done in four localities in Jakarta.

STUDY AREAS

Four widely separated villages *(kelurahan)*, Tanah Tinggi, Karang Anyar, Grogol and Pasar Manggis, were chosen from among the eight

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villages reporting the highest number of cases of DHF in Jakarta (up to 16 cases per year) from 1969 until 1972. From each village a crowded section of about 200 houses was selected as a study locality. A survey of 182 houses showed that the four localities were quite similar to one another with regards to crowding and construction. The mean are per house was only 27.5 m^2 and the surrounding garden containing very little vegetation, was only 7.9 m^2. An average of 6.2 people lived in each house. The mean number of people per 100 m^2 was 17.6. One half of the people were under 16 years old. Other potential hosts for the mosquitoes, such as dogs, cats or live-stock were uncommon. Precipitin tests to determine host preference were not done. Houses were made of various combinations of cement, wood and that with tile or metal roofs and cement or earthen floors. In general the bedrooms and kitchens were very poorly illuminated.

The major mosquito breeding sources were earthenware water jars in most kitchens, and large cement water reservoirs *(bak mandi)* in many bathrooms. These containers, as well as large 200-liter metal drums were found both indoors and outdoors. Other sources indoors were glass flower vases and small plastic and metal buckets for temporary water storage. Outdoors, discarded tin cans and tires were frequent sources.

METHODS

From May 1973 until June 1974 all four licalities were surveyed twice per month. Six collectors each visited six houses for twenty minutes per house from about 08:30 until 10:30 hrs, resulting in a sample of 36 houses and 12 man-hours for each collection day. The workers sat in an undisturbed room and collected all mosquitoes landing on their bared lower legs with a sucking tube. Two other workers simultaneously examined all containers with water in 100 houses, and recorded the presence or absence of *Aedes* larvae. In the laboratory all specimens were sorted and recorded by species and sex. Physiological age-grading was not done, as insuf cient numbers of females were collected ea month to establish reliable parous rates.

During the first three months of the stuc standard NCDC oviposition traps, consisti of black glass jars (13 cm x 7.5 cm dian filled part way with water and employing pressed fibre-board paddle (2 cm x 13 cm) an oviposition surface clipped upright to t inside, were deployed every two weeks insi 18 houses in each of the four study localiti and recovered after 48 hours. In the labo tory the paddles were examined under dissecting microscope and the presence absence of eggs and the number of eggs p paddle were recorded. A sample of the eg was reared for species determination.

Daily weather data were kindly provid by the Jakarta Observatory of The Meteorol gical and Geophysical Center of the Depa ment of Communication.

Analysis of the mosquito population da was done with an Olivetti Programme 1(desk computer employing programs written t the senior author. Results for the two-wa analysis of variance, without replicates, a expressed as F (variance ratio) and p (probat lity of the difference occurring by chan alone). Results from correlation tests are e pressed as r (correlation coefficient).

RESULTS

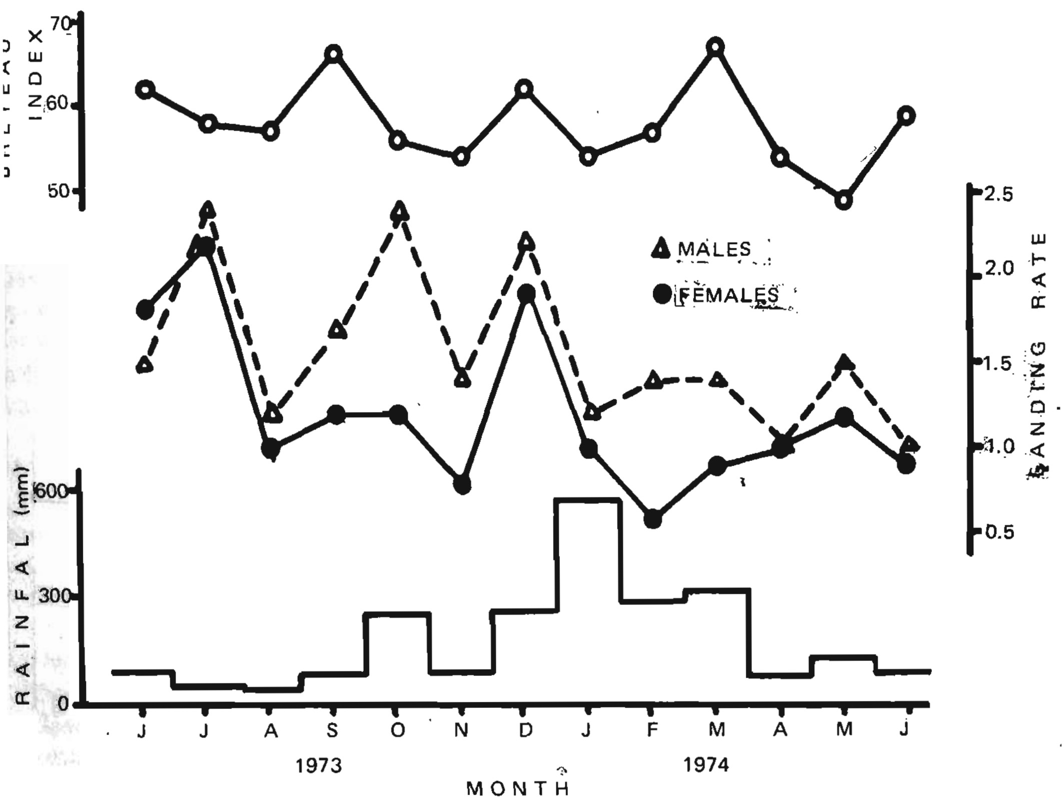
Adults

The adult data are summarized in table and the figure.

Seasonal abundance. No consistent season pattern of population density became evide in the four localities. However, density w high in three localities in July, and in thr localities (not the same three) in Decembe When the two-way analysis of variance w done with females for all localities a months, variances were found to be high significant both among months ($F = 3.560$, < 0.01) and among localities ($F = 17.148$, < 0.001). The monthly variance of males w not significant ($F = 2.017$, $p > 0.05$).

able 1 Monthly mean number per man hour of female (F) and male (M) *Aedes Aegypti* landing
ı human bait in four localities in Jakarta. Usually two samples were taken per month, each
ımple consisting of 12 man hours and 36 houses.

Month		Tanah Tinggi F	Tanah Tinggi M	Karanganyar F	Karanganyar M	Grogol F	Grogol M	Pasar Manggis F	Pasar Manggis M	All localities F	All localities M
'73	Jun	1.0	0.8	2.8	1.3	1.0	1.8	2.2	2.0	1.8	1.5
	Jul	1.0	1.0	2.6	3.1	1.6	1.4	3.8	4.0	2.2	2.4
	Aug	0.7	0.8	1.5	1.4	0.8	1.2	1.0	1.6	1.0	1.2
	Sep	0.9	1.8	1.6	1.8	0.4	0.9	2.0	2.4	1.2	1.7
	Oct	0.5	1.0	2.0	4.2	0.9	1.2	1.3	3.3	1.2	2.4
	Nov	0.4	0.6	1.0	1.6	0.8	1.1	0.8	2.3	0.8	1.4
	Dec	1.2	1.2	3.0	3.1	0.6	1.2	2.7	3.3	1.9	2.2
74	Jan	0.8	1.0	1.0	1.8	0.5	0.8	1.8	1.4	1.0	1.2
	Feb	0.8	1.6	0.2	0.9	1.0	2.1	0.6	1.0	0.6	1.4
	Mar	0.2	0.5	1.4	2.5	2.5	0.8	1.4	1.8	0.9	1.4
	Apr	0.2	0.4	1.6	1.1	0.2	0.4	2.2	2.3	1.0	1.0
	May	1.0	0.8	1.2	1.2	0.4	0.8	2.2	3.2	1.2	1.5
	Jun	0.6	0.6	0.9	0.8	0.6	1.2	1.4	1.4	0.9	1.0
months		0.7	0.9	1.6	1.9	0.7	1.1	1.8	2.3	1.2	1.6



} *Aedes aegypti* population indices in four urban localities of Jakarta and total monthly rainfall. Breteau Index = mber of containers infested with immatures per 100 houses examined. Landing Rate = number of adults per man-ɹr attracted to human bait inside houses.

The apparent peaks of female density in July and December did not correspond to any obvious climatological phenomenon (Table 2). Temperature varied little, the monthly mean ranging from 25.4°C to 27.9°C. Mean relative humidity was consistently high, ranging from 73 per cent to 85 per cent. There was, however, a distinct rainy season, as seen graphically at the bottom of figure. Th months with the most rain-fall were Decembe through March. If anything, the relationshi of rainfall and female density was inverse, bu this negative correlation was not significan either for mosquito density the same month (= - 0.276, $p > 0.05$) or one month later (r = -0.547, $p > 0.05$).

Table 2 Climatological data from Jakarta observatory from April 1973 until June 1974.

Month		Mean Temperature (°C)			Relative Humidity			Rainfall (mm)
		Max	Mean	Min	Max	Mean	Min	
1973	Apr	33.0	27.9	24.5	94	79	57	190.8
	May	32.1	27.1	24.0	95	81	58	178.8
	Jun	32.5	27.6	24.1	94	77	56	86.8
	Jul	32.6	27.4	23.5	92	75	53	48.4
	Aug	32.7	27.4	23.4	92	74	52	45.6
	Sep	32.4	27.2	23.4	92	76	53	81.5
	Oct	33.2	27.5	23.4	92	75	60	249.0
	Nov	32.6	27.6	23.8	89	73	52	86.2
	Dec	31.1	26.6	23.6	93	79	59	261.9
1974	Jan	28.8	25.4	22.8	96	85	69	573.7
	Feb	30.0	26.0	23.2	94	81	63	286.4
	Mar	30.9	26.4	23.3	95	81	62	317.7
	Apr	32.4	27.4	23.7	93	77	55	74.4
	May	32.2	27.3	23.9	94	78	57	128.1
	Jun	32.1	27.2	23.4	91	75	54	90.5
range		28.8-33.2	25.4-27.9	23.2-24.5	89-95	73-85	50-69	45.6-573.7

Locality differences: Variance among localities was highly significant. The four study areas had been chosen to be as similar as possible with regard to high density of houses and inhabitants. Only Pasar Manggis was slightly less crowded and suburban. However, both Pasar Manggis and Karanganyar consistently yielded more adults than the other two localities. Also the adult mosquito densities in these two areas were slightly correlated (r = 0.722, $p < 0.01$) despite lack of similarity in human density.

Sex ratio: Consistently more males than females were collected each month. This difference was highly significant (F = 5.123, $p < 0.01$). There was a significant month to month correlation of male vs. female density (r = 0.673, $p > 0.05$)..

Immatures. The larval indices are summarized in table 3 and figure. In preliminary surveys i the four study localities, 2289 larvae an pupae were identified from 323 positive con tainers, of which 320 (99 per cent) containe *Aedes aegypti*, 3 (1 per cent) contained *Aede albopictus* nd 2 (1 per cent) contained *Cule fatigans*. In one outdoor bak mandi all thre species occured together. For subsequen survey larvae were not identified, all positiv containers being considered to harbor *Aede aegypti*.

Seasonal abundance: Although there wer monthly fluctuations in each locality, it i seen how little variation occured over-all. Th range of mean monthly Breteau Index wa only 49-67 throughout the entire year.

Locality differences: As with adults, the va riance of Breteau Index among localities eac month was highly significant (F = 24.105, p <

Table 3 Monthly mean larval indices of *Aedes aegypti* in four localities in Jakarta. (Range in parenthesis). Usually two samples per month, 100 houses per sample.

Month		Number of containers	Container Index (%)	House Index (%)	Breteau Index
1973	Jun	194 (176-234)	33 (26-42)	50 (40-60)	62 (48-75)
	Jul	186 (164-226)	30 (28-34)	46 (32-55)	58 (42-74)
	Aug	176 (159-207)	32 (28-38)	48 (42-51)	57 (47-61)
	Sep	182 (151-215)	37 (25-48)	53 (36-68)	66 (44-88)
	Oct	181 (164-210)	31 (28-35)	46 (42-48)	56 (50-60)
	Nov	182 (158-216)	31 (24-39)	43 (37-49)	54 (44-60)
	Dec	174 (158-202)	34 (30-38)	48 (40-58)	62 (42-77)
1974	Jan	186 (158-218)	28 (24-35)	45 (37-54)	54 (40-76)
	Feb	182 (160-215)	31 (26-39)	45 (37-55)	57 (46-68)
	Mar	184 (161-218)	36 (26-44)	53 (39-64)	67 (45-84)
	Apr	176 (158-208)	30 (28-36)	46 (38-54)	54 (44-64)
	May	163 (138-197)	30 (22-39)	44 (28-53)	49 (30-61)
	Jun	172 (150-200)	35 (29-40)	50 (40-57)	59 (44-72)
All months (mean)		180 (157-220)	32 (27-39)	47 (38-56)	58 (44-71)

0.001) Grogol and Karanganyar were the highest (range 58-88 and 53-77 respectively) and Tanah Tinggi and Pasar Manggis were much lower (range 40-64 and 30-60 respectively).

There was no relationship between Breteau Index and landing rate for the four areas. For example, Pasar Manggis, with the highest landing rate, had the lowest Breteau Index. There was no significant correlation between monthly Breteau Index and landing rate of females, either for all areas combined ($r = 0.198$, $p > 0.05$) or for each area taken separately. Monthly fluctuations of Breteau Index of two localities, Tanah Tinggi and Grogol were quite similar ($r = 0.775$, $p < 0.01$). However, the landing rates of these two areas were not significantly correlated.

Oviposition: Of 496 ovipaddles deployed inside houses during the four months of June through September, 1973, only 13 (2 per cent) were positive with Aedes eggs.
On 21 of the 28 sample days not one of the 18 ovitraps was positive. The overall mean number of eggs per ovipaddle was 0.6 and the mean per positive ovipaddle was 21.7 (range 1.76). Because of the poor yield from ovitraps, their use was discontinued after September

DISCUSSION

The following discussion is restricted to the Southeast Asia region where *Aedes aegypti* is a vector of dengue haemorrhagic fever. Mention is not made of the voluminous literature from the Americas and Africa where yellow fever is the important disease carried by *Aedes aegypti*, where DHF epidemics do not occur and where the environmental conditions are considered to be not comparable to those of Southeast Asia.

Of the various techniques employed to monitor the population abundance of *Aedes aegypti* in our study, the larval surveys yielded the most reliable results. In many cases larvae could be found in sub-sections of a study area when adults were not in evidence. There was less weekly variation and subsection variation among the larval indices than among the adult indices. Larger sample size for adult collections may have eliminated part of the problem, but each landing collection already involved 12 man-hours of collecting, whereas the larval survey took only two man-hours. The poorest results came from the ovitraps. For more than two-thirds of the sampling days no eggs at all were recovered. For larval and adult surveys, on the other hand, there was never a negative day. In Bangkok (Pant et al., 1974) the relative sensitivity of these three techniques was demonstrated after a large-scale ULV fenitrothion treatment. No eggs were found in ovitraps during 8 months after treatment. However, adults were found 6 months after treatment, and the immature population, though greatly reduce, never disappeared completely. Larval indices were the most sensitive, adult indices were less sensitive, and ovitrap information was the least sensitive for the monitoring of the very low-density population.

It was appropriate to determine larval infestation rates by visual examination, only, of each container, once it had been determined by numerous larval collections that 99 per cent of all positive containers harbored *Aedes aegypti.* In areas, where another species, usually *Aedes albopictus* infects a significant percentage of the containers, the "single-larva-per-container" survey technique (Sheppard et al., 1969 a) is preferable. One larva is removed from each container and identified in the laboratory. If many containers have mixed infestation of two or more species, more than one larva per container should be identified. Some workers count and identify all the larvae in each container, there of establishing the "larval density index" (Chan et al., 1971 a). We found that time and manpower did not allow us to identify all the larvae. which sometimes numbered hundreds per container. This technique is most suitable where *Aedes aegypti* density is very low. Also, a complete harvest of larvae will decrease the mosquito population density of the area, an undesirable effect while the density is being monitored.

The relatively constant density throughout the year of *Aedes aegypti* observed in the study confirms the previous studies in Jakarta of adults (Van Peenen et al., op.cit.) and of immatures (Harijani and Immler, op.cit.). It is not surprising that no consistent differences in either larval or adult indices were found. The temperature and humidity in Jakarta varies little during the year. There was a distinct rainy season, but the number of containers with water per 100 houses was quite constant (163-1974) throughout the year. Most containers with water were indoors in the typical crowded urban study areas. Therefore, increased rainfall did not cause an increase in water-filled containers.

In other countries in Southeast Asia several studies have been directed towards relating the population density of *Aedes aegypti* to weather, season, and incidence of DHF. Scanlon (1966) found that the adult biting rate in five localities in Bangkok was highest in the wet season when the incidence of DHF was highest. Sheppard et al., (1969 b) using the mark-release-recapture technique in a small temple grounds in Bangkok, found that changes in population density "were not correlated in any simple way with temperature or rainfall and there was no striking increase in population size in the wet season". They concluded that fluctuations in movement, longevity and population size were inadequate to account for changes in the incidence of dengue haemorrhagic fever. Yasuno and Tonn (1970) found that the biting rate in Bangkok was highly correlated with the mean minimum monthly temperature, which ranged from approximately 20°C to 26°C during the year. In Jakarta we found no such correlation the minimum temperature range being only 1.3°C during the year.

Southwood et al. (1972) found that a fall in larval mortality preceded the increase in annual incidence of DHF in Bangkok. However, the larval indices fluctuated only 11-26 per cent during the year, being the highest in the wet season (Tonn et al., 1970). In Singapore during 1966-1968 the density of adult *Aedes aegypti* in indoor resting collections generally fluctuated with rainfall (Ho et al., 1971) and with DHF incidence (Chan et al., 1971 b) especially in an area where 50 per cent of the breeding habitats were outdoors.

The mean Breteau index of 58 and adult landing rate of 1.2 females per man hour in Jakarta study localities were of intermediate magnitude when compared to other areas endemic for DHF in Southeast Asia. On the WHO density scale of 1 to 9 (WHO, 1972) Jakarta is at level 6. In Bangkok, Thailand where the incidence of DHF is much higher the average Breteau Index is also higher, usually above 200 (level 9) (Tonn et al., 1967). However, there is no observed correlation from city to city between the mosquito density and the incidence of reported cases. For example, during the epidemics of DHF in Singapore during 1966-1968, the Breteau Index in most areas was between 10 and 30 (level 3-4) (Chan et al., 1971 a). In 1974 a serious epidemic of over 700 cases occurred in a population of 150,000 in Menado, North Sulawesi where the Breteau Index was only 40 and the landing rate was less than one female per man hour, (Self et al., 1975).

Apparently, there is no simple relationship between mosquito density and incidence of dengue haemorrhagic fever. Yet there is a seasonal pattern of DHF cases, usually highest during the rainy season. There may be significant changes in biting frequency, longevity, host preference or vectorial competence of the mosquitoes, changes in human behaviour thereby changing exposures to mosquito bites and changing the incidence of dengue haemorrhagic fever. Research on the variation of the competence of *Aedes aegypti* in Indonesia to develop and transmit virus is now underway at the United States Naval Medical Research Unit in Jakarta. In Bangkok, a mark-recapture-experiment revealed a change of biting frequency of *Aedes aegypti* with season (Pant and Yasuno, 1973). A similar study should be done in Jakarta. Physiological age grading and host determination of sizable samples of field collected females is also indicated.

SUMMARY

From May 1973 until June 1974 the adult and immature populations of *Aedes aegypti* (L.) were monitored twice monthly in four typical crowded urban districts of Jakarta. Attraction of adults to human bait averaged 1.2 females and 1.6 males per man hour. A mean of 180 containers with water were found per 100 houses, of which 58 were positive (Container Index = 32 per cent). The House Index was 47 per cent and the Breteau Index was 58. There was no consistent seasonal pattern of population fluctuation of either adults or immatures. Temperature and relative humidity were quite consistent throughout the year. Although there was a clear seasonal pattern of rainfall, most breeding occurred indoors, thereby minimizing the effect of increase of water-filled containers outdoors during the rainy season.

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REFERENCES

Chan, Y.C., Chan, K.L. and Ho, B.C. 1971 a. *Aedes aegypti* (L.) and *Aedes albopictus* (Skuse) in Singapore City 1. Distribution and density. Bull. Wld Hlth Org. 44 : 617-627

Chan, Y.C., Ho, B.C. and Chan, K.L. 1871 b. *Aedes aegypti* (L.) and *Aedes albopictus* (Skuse) in Singapore City 5. Observations in relation to dengue haemorrhagic fever. Bull. Wld Hlth Org. 44 : 651-656

Christophers, S.R. 1960. *Aedes aegypti* (L.). The yellow fever mosquito. Cambridge Univ. Press, Cambridge. 739

Hammon, W.McD. 1873. Dengue haemorrhagic fever - Do we know its cause? Amer. J. Trop. Med. Hygiene 22 (1) : 82-91

Ho, B.C., Chan, K.L., and Chan, Y.C. 1971. *Aedes aegypti* (L.) and *Aedes albopictus* (Skuse) in Singapore City 3. Population fluctuations. Bull. Wld Hlth Org. 44 : 635-641

Kho, L.K., Hansa Wulur, Agung Karsono and Soeprapti Thaib. 1969. Dengue haemorrhagic fever in Djakarta. J. Indonesian Med. Assoc. 19 : 417-437

Pant, C.P. and Yasuno, M. 1973. Field studies on the gonotrophic cycle of *Aedes aegypti* in Bangkok, Thailand. J. Med. Ent. 10 (2). 219-223

Scanlon, J.E. 1966. Bangkok haemorrhagic fever investigations: The 1962-63 mosquito collection. Bull. Wld Hlth Org. 35 : 82-83

Self, L.S., Nelson, M.J. Theos, B. and G. Wiseso (1975) A reduction in hospitalized cases og dengue hamorrhagic fever in Menado (Sulawesi), Indonesia after aerial. spraying with ULV malathion to control *Aedes aegypti*. Unpublished WHO document VBC/75.521

Sheppard, P.M., Mac Donald, W.W., and Tonn, R.J. 1969 a. A new method of measuring the relative prevalence of *Aedes aegypti*. Bull Wld Hlth Org. 40 : 467-469

Sheppard, P.M., Mac Donald, W.W., Tonn, R.J. and Grab, B. 1969 b. The dynamics of and adult population of *Aedes aegypti* in relation to dengue haemorrhagic fever in Bangkok. J. Anim. Ecol. 38 : 661-702

Southwood, T.R.E., Murdie, G., Yasuno, M. Tonn, R.J. and Reader, P.M. 1972. Studies on the life budget of *Aedes aegypti* in Wat Samphaya, Bangkok, Thailand. Bull. Wld Org. 46 : 211-226

Tonn, R.J., Mac Donald, W.W., Sheppard, P.M. and Sujarti Jatanasen. 1970. The magnitude of seasonal changes in larval populations of *Aedes aegypti* in Bangkok, Thailand. Bull. Wld Hlth Org. 42 : 943-958

Van Peenen, P.F.D., Soeroto Atmosoedjono, Lien, J.C. and Sulianti Saroso J. 1972. Seasonal abundance of adult *Aedes aegypti* in Djakarta, Indonesia. Mosquito News (32 (2) : 176-179

Yasuno, M. and Tonn, R.J. 1970. A study of biting habits of *Aedes aegypti* in Bangkok, Thailand. Bull. Wld Org. 43 : 319-325