MOSQUITO LIGHT TRAP SURVEYS IN KOREA 1969-1971

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INTRODUCTION

In 1969, the Ministry of Health and Social Affairs of the Republic of Korea, in collaboration with the WHO Japanese Encephalitis Vector Research Unit (JEVRU), began mosquito light trap operations from May through September in 25 cities and towns. The surveys were primaily undertaken to monitor the density of *Culex tritaeniorhynchus*, the vector of Japanese encephalitis. Also included were other important species such as *Culex pipiens pallens*, *Anopheles sinensis* and *Aedes vexans*. The surveys provided some system of surveillance and control for the JE vector.

MATERIALS AND METHODS

Trap locations

A map in an unpublished WHO document (VBC/71.324) shows the 25 cities and towns where 25 Yoshizawa black light traps were located. They provided adequate country-wide distribution. In 1969 and 1970, each trap was situated at a health centre and operated by their personnel. These centres normally are located on paved roads near shops and sometimes multi-storied buildings.

In 1971, the traps from the health centres at Seoul, Suwon and Pusan were placed at animal shelters on the outskirts of those cities and operated by JEVRU staff. JEVRU also operated one trap in the town of Sintaein and placed it in a non-rural environment similar to those at health centres elsewhere. The specimens collected from all light traps were routinely mailed to JEVRU for identification and counts.

Traps reporting

In 1969 and 1970, all the health centres reported results, although the number of times each trap was operated each month varied greatly. Satisfactory trap operation occurred during June, July and August, covering the usual high density period.

In 1971, in addition to the four traps operated by JEVRU, eight were operated by the health centres. The 13 health centres which did not mail specimens to JEVRU are mainly located in the western provinces of Cholla Pukdo and Cholla Namdo. This is the major rice belt area and the focal point of the most recent epidemic of encephalitis which occurred in 1966. The province consistently having the best reporting has been Kyonggi Do, with trap sites at Koyang, Pyongtaek and Suwon.

Table 1 shows the number of nights the traps were operated in 1969 (635), 1970 (644)

Table 1

Comparisons of light trap use from 1969 through 1971.

Month	Number of nights the traps were operated each month		
	1969*	1970*	1971**
May	35	0	51 (70)
June	203	172	116 (78)
July	172	226	117 (61)
August	162	116	93 (57)
September	64	130	109 (56)
October	20	0	20 (80)
Total	635	644	506 (64)

* All trap operations made by personnel at health centres.

**Percentage operated by JEVRU in parenthesis.

and 1971 (506). In 1971, JEVRU accounted for 326 trap nights, being 64% of the total. The health centres operated traps for only 180 nights, which represents a substantial decrease from the previous two years. Those operating most frequently in 1971 were Koyang (58 nights), Chinju (25) and Pyongtaek (24). Each of the three JEVRU sites operated about 82 nights.

RESULTS

Dates of first appearance: In 1969, the first *Cu. tritaeniorhynchus* female was collected on 28 June at Chinju, located 95 km west of Pusan. In 1970, the first female collection occurred on 29 June at Suwon, located 35 km south of Seoul. In 1971, the earliest date was 26 May at Pusan, with the collection site being an animal shelter in the semi-rural suburb of Sasang. The first 1971 collection from a health centre occurred on 9 July at Pyongtaek, located 30 km south of Suwon.

In 1969, the health centre at Tongnae in a residential-shop district of Pusan collected its first *Cu. tritaeniorhynchus* on 5 July. Other unpublished JEVRU data indicate that *Cu. tritaeniorhynchus* usually was collected at rural animal shelters at least several weeks before those at health centres.

Total number collected : Table 2 shows that 33,123 females were collected in 1969, 32799 in 1970, and 92,572 in 1971. The 1971 total represents a marked increase despite a decrease in operating nights. About 69% of the mosquitoes collected in 1971 came from the three JEVRU animal shelter sites. Nevertheless, 28, 889 specimens were captured at the eight health centres, and the average trap night density was higher than in previous years.

Table 2

Total number of mosquitoes collected from all light traps, 1969-1971 (in parenthesis, percentage of total for each year).

Species	1969	1970	1971
An. sinensis	3,430 (10.4)	5,842 (17.8)	19,845 (21.4)
An. sineroides	110 (0.3)	3 (0.01)	767 (0.8)
An. yatsushiroensis	16 (0.05)	3 (0.01)	745 (0.8)
Cu. tritaeniorhynchus	1,356 (4.1)	346 (1.05)	38,316 (41.4)
Cu. bitaeniorhynchus	18 (0.05)	0 (0.0)	96 (0.1)
Cu. pipiens	23,313 (70.4)	22,211 (67.7)	14,271 (15.4)
Cu. orientalis	37 (0.1)	13 (0.04)	62 (0.1)
Cu. vagans	111 (0.33)	4 (0.01)	258 (0.3)
Ae. vexans	4,419 (13.3)	4,360 (13.3)	18,189 (19.6)
Ae. albopictus	17 (0.05)	0 (0.0)	1 (0.01)
Ae. flavopictus	1 (0.01)	4 (0.01)	0 (0.0)
Ae. chemulpoensis	2 (0.01)	0 (0.0)	0 (0.0)
Ae. togoi	0 (0.0)	8 (0.2)	1 (0.01)
Ae. nipponicus	0 (0.0)	0 (0.0)	3 (0.01)
Arm. subalbatus	7 (0.02)	5 (0.02)	18 (0.0)
Unidentified	286 (0.9)	0 (0.0)	0 (0.0)
Total	33,123	32,799	92,572

Species composition : In 1969, *Cu. pipiens* represented 70.4% of the captures, *Ae. vexans* 13.3% *An. sinensis* 10.4% and *Cu. tritaeniorhynchus* 4.01%. In 1970, similar results occurred. In 1971, *Cu. tritaeniorhynchus* was the most prevalent species (41.4%), followed by *An. sinensis* (21.4%), *Ae. vexans* (19.6%) and *Cu. pipiens* (15.4%). Data also are shown for 11 other lesser occurring species in Table 2.

The emergence of *Cu. tritaeniorhynchus* as the dominant species in 1971 can simply be attributed to trap operations at animal shelters and not to any unusual increase in overall density. No epidemic of encephalitis occurred during this three-year study. The densities of *Cu. tritaeniorhynchus* at animal shelters are often 100 times high than those recorded in cities or towns (unpublished JEVRU data). Ito (1964) captured only 28 *Cu. tritaeniorhynchus* in one year in the Nagasaki business centre, whereas Wada *et al.*, (1967) have collected thousands in one night in farm villages on the outskirts.

Except for *Ae. vexans*, light trap operations at the health centres and also animal shelters are not satisfactory for monitoring population trends of *Aedes* species, including *Ae. albopictus* and *Ae. togoi.*

Locations with the highest densities: In 1969, Pusan had the highest density, with an overall, average of 26 females per trap night, with the peak reaching 140 in early September. About 55% of the total 1969 *Cu. tritaeniorhynchus* captures came from Pusan. The sites with the next highest densities in 1969 were Suwon and Pyongtaek (average of seven females per trap night), followed by Ulsan (five) and Chinju (two). In 1970, all trap sites had very low densities, with Choongju and Iri, in the western rice belt, having the highest average (two females per trap night). Only 345 *Cu. tritaeniorhynchus* females were captured in 1970.

In 1971, 68% of all *Cu. tritaeniorhynchus* captures came from an animal shelter site in south-west Pusan (Sasang), with the overall average density (295) being about 10 times higher than that obtained in 1969 at the Tongnae health centre located in the northern part of that city. About 18% of the 1971 total came from the Ulsan health centre (average of 70 females per trap night) located only 55 km north of Pusan, 10% from an animal shelter site at Seoul (46) and 1.2% from an animal shelter at Suwon (2). The Chinju health centre, also near Pusan, accounted for more captures (0.5%) than those obtained within the small town of Sintaein (0.2%), located in the rice belt.

In 1971, the locations with the highest average per trap night density in August, the peak month, were Pusan (745), Ulsan (224), Seoul (108), Suwon (18) and Chinju (16). Results for 1969 and 1970 were less than 10 per trap night at all locations except Pusan In 1971, the densities at animal shelters on the outskirts of Sintaein were 80 times higher than those within the town, the peak being 724 per trap night on 24 July (unpublished JEVRU data). It should be mentioned that the western rice plain is still a potential high density area despite the great quantity of pesticide now being applied. In 1966, Ree *et al.*, (1969) capture 4,728 *Cu. tritaeniorhynchus* in one trap night near Sintaein, the highest ever recorded in Korea.

Months of high density: Table 3 compares the monthly density of the four most common species from 1969-1971. The combined 1971 results show August as the peak month for *Cu. tritaeniorhynchus.* The average density of 291.4 per trap night is rather high because 22 of the 93 nights of collections were made at Pusan. Some locations, however, had very low densities, namely Koyang (0.9 per trap night), Cheju City (0.8) and Pyongtaek (0.3).

With *Cu. pipiens*, appreciable densities occurred from June through September for

Table 3

Comparison of monthly light trap collections of the four most common mosquito species, 1969-1971.

Year	Average numbers of females per trap night				
	June	July	August	September	Overall average*
Cu. tritaeniorhynchus					
1969	0.1	1.1	2.3	12.1	3.9
1970	0.1	0.3	1.0	1.3	0.7
1971	0.4	44.9	291.4	54.3	97.8
Cu. pipiens					
1969	20.7	52.9	37.6	56.6	42.0
1970	20.9	54.2	31.7	20.7	31.9
1971	18.8	57.0	25.1	21.1	30.5
An. sinensis					
1969	3.6	8.5	6.1	3.3	5.4
1970	2.7	16.4	9.9	4.0	8.3
1971	3.2	84.4	85.0	15.2	47.0
Ae. vexans					
1969	7.9	8.9	5.1	2.9	6.2
1970	8.1	9.5	5.0	1.8	6.1
1971	47.0	76.8	36.0	0.6	40.1

* From June to September. See Table 1 for number of trap nights.

each year. With *An. sinensis*, July and August were the peak months, whereas *Ae. vexans* peaked at earlier dates.

DISCUSSION

Light traps operated at health centres can capture many mosquitoes, particularly *Cu. pipiens*, *Ae. vexans* and *An. sinensis*. Improved trap operations are probable if health centres receive continued financial support and encouragement. Health centres, lacking trained entomologists, have numerous duties not relating to vector-borne diseases. Despite the difficulties involved in coordinating a useful country-wide surveillance system, considerable success has so far been obtained.

The light trap surveys in Korea were primarily undertaken to monitor the density of *Cu. tritaeniorhynchus*, the vector of Japanese encephalitis. Clearly, many *Cu. tritaeniorhynchus* mosquitoes are not captured at health centres, despite the abundant numbers of *Cu. pipiens* specimens being forwarded to the JEVRU laboratories for identification and counts.

The total numbers of *Cu. tritaeniorhynchus* females captured at health centres in 1969 were 1356 (2.1 per trap night), 346 (0.54) in 1970 and 7664 (42.6) in 1971. The higher overall density in 1971 is due to the unusual high density at Ulsan, undoubtedly being in a favourable location. The 1969-1970 health centre total of 1802 *Cu. tritaeniorhynchus* in 1279 trap nights (average 1.3) compared to 1484 captured by one trap in one night at an animal shelter at Pusan on 26 August 1971.

The finding of exceeding low densities of *Cu. tritaeniorhynchus* at most health centres

is very valuable information, having vector control implications. These centres are normally located on paved roads within the cities or towns, although further details on Ulsan are desired. The question now arises as to whether *Cu. tritaeniorphynchus* bites humans in such areas and transmits Japanese encephalitis at such low densities.

On the other hand, pig and cow shelters located on the outskirts of cities and towns clearly can be high density sites for *Cu. tritaeniorhynchus*. Therefore, insecticide sprayed from aircraft during an epidemic might first be deposited on the outskirts before using the limited supply over urban concrete areas.

This study has also indicated that the south-east area, just above the 25th parallel, had the highest densities of *Cu. tritaeniorhynchus* in 1969 and 1971 (Fig. 1). Moreover, the 5th Preventive Medical Unit of the 8th United States Army reported that Pohang, located 98 km north of Pusan on the East Sea had the highest density (over 1,000 per trap night in August) of their 18 trap locations in 1971 (personal communication). Pusan, Ulsan and Pohang are all rapidly developing new industry and factory sites close to the ocean. The very favorable breeding sites of *Cu. tritaeniorhynchus* such as marshes and rain pools are naturally made at newly developing industrial area of these cities. Unpublished JEVRU data showed that high densities of *Cu. tritaeniorhynchus* and *Cu. pipiens* larvae were collected in marshes, the former species in less polluted and the latter one in more polluted water.

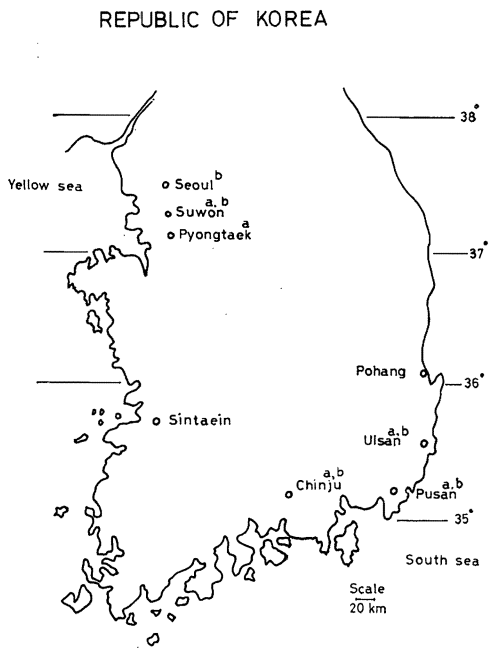

Fig. 1—Locations with the highest light trap densities of *Cu. tritaeniorhynchus* in 1969a and 1971b: Sintaein and Pohang are also shown on map (see text).

SUMMARY

Mosquito light trap surveys carried out in the vicinity of 25 cities and towns of South Korea revealed high densities of *Cu. tritaeniorhynchus*, the primary vector of Japanese encephalitis, in the south-eastern region near coastal areas. Such densities did not occur within the cities, where *Cu. pipiens* was abundant, but at the semi-rural areas on the outskirts. These surveys also revealed abundant populations of *Ae. vexans* and *An. sinensis*.

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