Survey of the medically important insects carried by the international aircrafts to Tokyo International Airport¹⁾

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Abstract: In order to clarify the actual situation of insects of medical importance carried into Japan by aircrafts, the survey was conducted by checking the inside of the international aircrafts just after arriving at Tokyo International Airport, during the period from July 1972 to August 1973.

Of 42 aircrafts surveyed, 10 species of the pest insects, excluding several unidentified species, were captured in 24 aircrafts. *Musca domestica* Linné and *Culex fatigans* Wiedemann were collected most abundantly, 59 and 24, respectively. Of 10 species identified, 5 species were exotic ones and the other 3 were either the exceptional or rare ones around Tokyo. It is worth to note that an engorged female of *Aedes aegypti* (Linné), an important vector of yellow fever, and *Anopheles subpictus* Grassi, a malaria vector, were caught.

It must be emphasized that important mosquito species were carried mainly by the flights *via* Bangkok, Hongkong or Manila, whilst the house flies were abundantly carried by Seoul and Khavarovsk lines. In order to know the possible place where the mosquitoes embarked on the aircrafts, a discussion was made considering the actual time schedules of the flights. As for the house flies the levels of the insecticide susceptibility between the captured insects and Japanese colonies were compared.

With vast increase and speedy movement in international travel and exchange of goods in trade, the chance of invasion of diseases and their vectors from one country to another is presumed to remarkably be increasing. There have been a number of reports regarding the insects carried by aircrafts (Whitfield, 1939; Laird, 1952). In Japan, several records have been made about

rodents and their parasitic fleas principally by the quarantine workers (Ikeda and Abe, 1967; Ohtomo, 1968). Nevertheless there was no report about the other insects, excepting a single paper of the cockroaches taken from overseas vessels (Hitomi, 1957). Even the quarantine has made no investigation on the situation of pest insects carried by international air transport. Therefore, through a period from July 1972 to August 1973, we conducted surveys to examine inside of the international aircrafts just after arriving at Tokyo International Airport.

METHOD AND PROCEDURE

1. Selection of aircrafts surveyed. On

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Table 1 International aircrafts surveyed for insect pest at Tokyo International Airport, 1972-1973

No.	date	Time surveyed	Equipment	Origin & Transit
	1972			
1	27 July	13 : 40	DC 8	NYC ANC (Cargo)
2		14 : 20	DC 8	in hanger
3		15 : 00	Antonov 12	KHV (Cargo)
4	18 Aug.	19 : 50	DC 8	MEX YVR
5		21 : 00	B 747	NYC LON IST KHI DEL BKK HKG
6		02 : 00	B 747	AMS ATH BEY DEL BKK MNL
7	28 Aug.	14 : 05	B 707	CAI BOM BKK MNL
8	13 Sep.	14 : 10	B 747	CAI BOM BKK HKG
9		14 : 15	B 747	SAO RIO LIM LAX
10		14 : 05	DC 8	MNL
11	26 Sep.	16 : 20	DC 8	SEL
12	2 Oct.	14 : 40	B 707	CAI BOM BKK MNL
13	18 Oct.	13 : 20	B 707	SAO RIO LIM LAX
14		13 : 40	DC 8	MNL
15		13 : 50	B 707	CAI BMB BKK HKG
16	4 Dec.	13 : 30	B 707	CAI BOM BKK MNL
17		14 : 17	SVC 10	LON EBB SEZ CMB HKG
18		16 : 40	DC 8	TPE
	1973			
19	23 Feb.	16 : 00	B 707	GUM OSK
20		13 : 40	DC 8	SYD MNL HKG
21		15 : 10	B 707	SAO RIO LIM LAX
22		15 : 30	B 707	LON FRA DXB CCU HKG (Cargo)
23	31 May	18 : 50	B 707	BKK HKG
24		19 : 55	B 727	SGN HKG TPE OSK
25		21 : 00	DC 8	GVA ZRH ATH BOM BKK MNL
26		21 : 20	DC 8	BKK HKG TPE
27		21 : 35	B 707	BRU ATH BOM BKK MNL
28		21 : 50	B 747	NYC LON IST BEY DEL BKK HKG
29	25 June	14 : 00	VC 10	JNB SEZ CMB HKG
30		14 : 10	B 707	CAI BOM BKK MNL
31		16 : 10	DC 8	SEL
32		16 : 50	DC 8	TPE
33	9 Aug.	20 : 30	DC 8	TPE OSK (Cargo)
34		20 : 45	B 707	BRU ATH ROM BKK MNL
35		21 : 15	DC 8	BKK HKG TPE
36		21 : 40	DC 8	JKT SIN HKG
37		22 : 10	DC 8	SEL (Cargo)
38		22 : 15	DC 8	ROM THR BOM BKK HKG
39		22 : 30	B 707	PAR ATH BEY KHI BKK MNL OSK
40		22 : 50	B 747	FRA ATH DEL BKK HKG
41	10 Aug.	06 : 15	DC 8	SFO SEA ANC (Cargo)
42		06 : 20	DC 8	BKK HKG TPE (Cargo)

the selection of aircrafts surveyed, special attention was paid to the aircrafts coming through the Southeast Asia, South America and Africa, where the insect-borne diseases are endemic. Though the intention was to include both passenger and cargo aircrafts equally, it resulted in that the majority of the surveyed aircrafts were the passenger ones due to the arrival schedules.

2. *Aircrafts surveyed.* The aircrafts investigated belonged to 18 airlines such as Air France, Aeroflot Soviet Air Lines, Air Siam, Alitalia Airlines, BOAC British Airways, Egyptair, Flying Tiger, Japan Airlines, Korean Air Lines, KLM Royal Dutch Airlines, Lufthansa German Airlines, Pan American World Airways, Philippines Air Lines, Sabena Belgian World Airlines, Swissair, Thai Airways International, Varig Brazilian Airlines and Air Vietnam. The equipments, ports of origin and transit, and dates of aircrafts surveyed are shown in Table 1. Forty-two aircrafts, including 7 cargoes were checked during the period from July 1972 to August 1973.

3. *Search and capture of insects.* Effort was made to enter the aircrafts as soon as possible after they arrived, and actually we

entered the aircrafts as the passengers and the crews disembarked. Flying, crawling or resting insects were hunted using flash lights, nets, forceps and the other tools, all the places such as passenger cabins, baggage and cargo compartments, cockpits, toilets, galleys and the others.

RESULTS

The species and number of insects captured during the survey are shown in Tables 2 and 3. Of 42 aircrafts surveyed, 10 species of the pest insects, excepting several unidentified species, were captured in 24 aircrafts. House flies, *Musca domestica* Linné, followed in abundance by the common mosquitoes, *Culex fatigans* Wiedemann, were collected most abundantly, 59 and 24, respectively.

Of 10 species identified, 5 were the exotic ones and 3 do not occur, or very rare in Tokyo and its vicinities, though they occur in the other areas of Japan. As the remaining unidentified species seem also to be exotic, all captured pests, excluding house flies and German cockroaches, are presumably aliens in Tokyo. It is worth to mention that an engorged female of *Aedes aegypti*

Table 2 Insect pests of medical importance captured in the international aircrafts at Tokyo International Airport, 1972-1973

species	male	female	larva	egg capsule	total
<i>Musca domestica</i>	27	32			59
<i>Culex fatigans</i> **	9	15			24
<i>Culex gelidus</i> *	0	2			2
<i>Culex pseudovishnui</i> **	0	1			1
<i>Culex sitiens</i> group*	0	1			1
<i>Culex</i> spp.*	—	—			3
<i>Aedes aegypti</i> *	0	1			1
<i>Mansonia uniformis</i> **	0	1			1
<i>Anopheles subpictus</i> *	0	1			1
<i>Supella longipalpa</i> *	1	0	1	1	3
<i>Blattella germanica</i>	0	(3)	1		1
<i>Blatta</i> spp.*	0	—	3		3
Unknown flies*	—	—			2
total					102

* Species not occurring in Japan

** Species not occurring in Tokyo area

() Number of dead collected

Table 3 Insect pests captured in the international aircrafts just after landing at Tokyo International Airport, 1972-1973

No.	<i>Musca domestica</i>		<i>Culex fatigans</i>		Other mosquitoes	Cockroaches	Other flies
	male	female	male	female			
3	10	9					
5		2					
6	1		1				
7			2	2	<i>Ae. aegypti</i> female 1	<i>S. longipalpa</i> larva 1 <i>Blatta</i> sp. larva 1	<i>Sepsidae</i> sp. male 1
8		1	1	6			
9		3	1				
10						<i>S. longipalpa</i> egg cap. 1 <i>Blatta</i> sp. larva 1	unknown 1
11	2	4					
12					<i>C. gelidus</i> female 1		
13	2					<i>S. longipalpa</i> male 1	
14	1	1			<i>C. gelidus</i> female 1		
15	1	1		2	<i>C. pseudo-vishnui</i> female 1		
16		3	2		<i>C. sitiens</i> group	<i>Blatta</i> sp. larva 1	
19		1			female 1		
22	1	1		1	<i>Culex</i> spp. 3		
23	2			3	<i>An. subpictus</i> female 1 <i>M. uniformis</i> female 1		
24	3						
25	1						
28	1					<i>B. germanica</i> larva 1	
30		3	2	1			
31	1	1					
36	1						
38		1					
39		1					

No pest was obtained on the following eighteen flights ;

No. 1, 2, 4, 17, 18, 20, 21, 26, 27, 29, 32, 33, 34, 35, 37, 40, 41 and 42.

Linné, an important vector of yellow fever, and *Anopheles subpictus* Grassi, a malaria vector, were caught.

Table 4 shows the results of the capture of insects according to the different original or final transit ports of the flights. Five hundred and twelve regular passenger flights arrived at Tokyo International Airport weekly in July 1973. Half of them belonged to the flights from Manila, Hongkong, Taipei and Bangkok (50.9 %), a quarter from Seoul and Moscow (21.0 %). Of 41 aircrafts surveyed (excluding No. 2 in the hanger), 24 (58.4 %) lodged the pests. As shown in Tables 1 and 3, the considerable number of mosquitoes were found in the flights flown

through either Cairo, Bombay, Bangkok, Hongkong or Manila. On the other hand, numerous flying house flies were captured in the cabins of the aircrafts from Seoul and Khabarovsk.

It seems rather difficult to decide the place where the mosquitoes entered the aircrafts. In order to reason that place to some degree, the actual time of the flights in which important vectors were collected are shown in Table 5. No. 7 flight, in which 4 *fatigans* and 1 *aegypti* were collected, landed in Manila and Cairo in the morning, and in Bombay and Bangkok at night. It seems very likely that *Ae. aegypti* entered the stationary aircraft in Manila because of

Table 4 Original or final transit ports of the passenger aircrafts surveyed at Tokyo International Airport, 1972-1973

Ports	No. of arrival per week**	No. of surveyed flights	No. of flights pests were found
1. MNL HKG TPE BKK	261	23	13
2. MOW SEL	108	4	3
3. ANC FAI SEA	64	3	0
4. HNL	58	0	—
5. Latin America*	10	3	2
6. Africa*	8	8	6
7. SYD	3	0	—
total	512	41	24

* indicates the original ports, the others show the final transit ports to Japan

** in July, 1973

Table 5 The time schedule of the flights carried the important pests

No. Flights	Scheduled time (local time)					
	CAI	BOM	BKK	HKG	MNL	TKO
No. 7	arr.	19 : 35	02 : 15		07 : 50	13 : 35
	dep.	11 : 45	20 : 50	03 : 00	08 : 45	(14 : 35)*
No. 15	arr.	19 : 35	02 : 15	09 : 00		13 : 25
	dep.	11 : 45	20 : 50	03 : 00	09 : 45	(13 : 40)*
No. 23	arr.		14 : 55	12 : 40		18 : 10
	dep.		09 : 00	13 : 30		(18 : 45)*

* actual arrival time due to delay

their diurnal flying activity. Whereas, in No. 15 and No. 23 flights, it is surmised that *Culex*, *Anopheles* and *Mansonia* mosquitoes invaded into the aircrafts in Bangkok or Bombay, due to their nocturnal activity. As another reason, *Ae. aegypti*, *Culex gelidus* Theobald, *An. subpictus* and *Mansonia uniformis* (Theobald) are known to be the commonest species at the environs of those airports, respectively.

1. House flies

The house flies were the most abundant pests found in the passenger cabins. In an instance, when the investigators entered the cargo aircraft, which just flown in from Khabarovsk, 20-30 house flies were found flying in the cargo compartment, which was empty, but scattered with vegetable wastes on the floor.

As it is morphologically impossible to

distinguish them whether the flies captured are domestic or foreign. Therefore, the susceptibility tests of those flies against some insecticides were conducted. After colonization of the females collected in the aircrafts, the knockdown-time tests on the insecticide residues were conducted. Flies originated from two aircrafts, Antonov (No. 3) from Khabarovsk and B 747 (No. 5) from Hongkong through New York, London and Delhi, were tested. The susceptibility of F 1, F 2 and F 3 colonies to DDT and Diazinon residues, 50 ml/m² of 0.5 % acetone solution on filter paper each, were evaluated with KT-50 values. The "Denken" strain, which is susceptible to organo-phosphorus compounds and highly resistant to organo-chlorine compounds, was exposed to the same residues, as the control for comparison.

As shown in Table 6, the insects brought from Antonov (No. 3) showed quicker knock-

Table 6 Susceptibility tests of the house flies, captured in the international aircrafts, to insecticides

Aircrafts	KT-50 values (min.) to diazinon			Resistance to DDT
	F ₁	F ₂	F ₃	
Antonov (No. 3)	13	12	16	low
PAA (No. 5)	25	17	—	high
Denken strain (Japanese)	25.1	—	—	high

down time on Diazinon residues and lower resistant level to DDT than those from B 747 (No. 5) and of the "Denken" strain. We conclude from the data that the flies from Antonov (No. 3) is most likely to be the intruder from U.S.S.R. However, we could not distinguish those from B 747 (No. 5) from the Japanese strain, since both the colonies showed a similar tendency of susceptibility to the insecticides. Nevertheless, considering scarcity of house flies in the apron of Tokyo International Airport and the capturing time just after the landing, it is also reasonable to consider those flies are the intruders.

2. Mosquitoes

Seven mosquito species, excepting unidentified species, were captured during the survey. Of them, *C. fatigans* was most common both in the cabins and the cargo compartments and it was distinguished clearly from *Culex pipiens pallens* Coquillett, which is common in Japan, by the morphological character of the male genitalia. It is noteworthy that *Ae. aegypti*, *An. subpictus* and some other species, which do not occur in Japan, were found out. They were captured when flying and resting on the wall, and some of them were fully engorged. It must be emphasized that the majority of the aircrafts carried such important pest species were the flights from Bangkok, Hongkong or Manila.

3. Cockroaches

Two species, *Supella longipalpa* (Fabricius) and *Blattella germanica* (Linné), were collected, but the individual number collected

was small. It was difficult, however, to catch alive cockroaches, due to their hiding habit in lighted condition. According to the witness of the land service personnels, the cockroach infestation is suspected to be heavier.

DISCUSSION

The insects of medical importance introduced to Japan from abroad on ships and aircrafts are controlled by quarantines under the International Health Regulations and National Quarantine Law. At Tokyo International Airport, according to the general declarations which are submitted to the quarantine by captains of aircrafts, most of them have been treated with insecticides about 30 minutes prior to departure or before landing. Nevertheless, unexpectedly abundant insect pests were found in the aircrafts just after landing on Tokyo International Airport. The insects captured by the investigators in the aircrafts, do not always mean insects which invade the country. But, on the other hand, it seems likely that many overlooked insects remain there, escaping the examinations.

Whitfield (1939) composed world wide records of insects taken in aircrafts, and investigated the insects collected from aircrafts at Khartum, to appraise the relation between air transport and the possible spread of malaria and yellow fever. He collected nearly 3,000 insects belonging to 146 species, after the examination of over 2,000 aircrafts. Laird (1952) collected 100 species of insects from 16 aircrafts which had arrived from the Pacific Islands. Of them, 26 species were of medical and economic importance. On the other hand, a number of experiments has been conducted to ascertain the ability of insects to survive long distance air travel, especially under condition of low temperature and reduced pressure (Whitfield, 1939; Sullivan *et al.*, 1958). It may be concluded from the previous observations that insects are able to withstand long journey if flight is under 12,000 feet or less. But, Sullivan *et al.* (1958) obtained high mortality of *Ae. aegypti*, *M. domestica* and *B. germanica* when exposed in unpressured and unheated sections

of jet fighters and bombers. It is reported, at the height between 36,000 and 66,000 feet, the standard day temperature is -69°C , and the atmospheric pressure is one-fifth of that at sea level. According to the information of Japan Airlines, the most of passenger aircrafts surveyed were generally kept at atmospheric pressure of 0.775-fold of that at sea level. Moreover, the cargo compartments as well as cabins were heated, and the temperature was kept between 5°C and 20°C in DC 8 and B 747, according to the observation at one time. It may be considered that the insects are able to survive in the space conditioned as above.

Recently, Ohtomo *et al.* (1974) reported a case of malaria occurred near Tokyo International Airport. They stated that the infection route remained obscure, because there has been no indigenous malaria in Japan since 1950, besides the patient has never been abroad, and so far she had never had opportunity of acquiring induced malaria. Thus, they presumed probably to be such an introduced case, as the parasite relapse after a long time incubation period, or as a new infection by imported infective mosquito vector. On this connection, it is very important fact that several vector mosquitoes such as *An. subpictus* and *Ae. aegypti* were captured during the present survey.

At present time, the studies of aircraft disinfection at "blocks away" are being carried out by Sullivan *et al.* (1964) with the cooperation of WHO (1971). This measure is the disinfection by means of single-dose, disposal dispensers at "blocks away" which means treatment of the passenger cabin and all accessible interior space of aircraft, after the doors have been locked following embarkation and before actual take-off. Nevertheless, from our results, it is doubtful whether the disinfection operation is being actually carried out or not.

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摘 要

東京国際空港における国際線による 侵入害虫の調査

東京国際空港に着陸する国際線航空機に、着陸後直ちに乗り込み、衛生害虫を探し、侵入害虫の実態を調査した。1972年7月から1973年8月にかけて42機を調べた。4機を除きすべて旅客機であった。そのうち24機において10種が採集されたが、この他に未同定のもの数種があり、全部で個体数は102匹にのぼった。そのうち、59匹はイエバエ、24匹はネッタイイエカで約83%を占

めた。10種のうち、5種は日本に産しないもので、さらに3種は東京付近には稀のものであった。マラリアのベクター *Anopheles subpictus*, 黄熱のベクター *Aedes aegypti* が採れたことは注目されてよい。

蚊は、カイローバンコックーホンコン・マニラ経由の南まわり便に多く、イエバエは、ソウル、ハバロフスクからの飛来便に多い傾向がみられた。そして、これらの

蚊が、どこで航空機内に侵入したかを、フライト・スケジュールをもとに推理した。イエバエについては、国内産と外国産を形態的に区別できないので、殺虫剤感受性を調べて、侵入したものかどうかを検討した。その結果、ハバロフスクからの飛来便で採集したものは、明らかに日本のものとは違った感受性傾向を示した。