Study on the Long-Distance Migration of the Brown Planthopper in Taiwan

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ABSTRACT

In this survey, the air-borne tow-net traps were set up along the eastern, southern, and western coasts of Taiwan, even on the separate island, to collect the migrating BPH. Besides, meteorological information from Central Meteorological Bureau were applied, in accordance with the data of BPH collected at different localities, to analyze the migrational tracks of this air-borne insect.

According to the results obtained in recent five years (1978-82),the long-distance migration of BPH in Taiwan area could induced into four patterns as follow:

1) The pattern of Spring-rain period during April to early-May, the BPH should emigrate from the Philippines to Taiwan, assisted by the reversed air-flow of high pressure in pacific ocean.
2) The pattern of Mei-yu period during mid-May to early-June, the BPH could emigrate from Canton area to Taiwan, assisted by the warm and humid air masses of low pressure in Canton.
3) The pattern of typhoon period during July to September, the BPH could emigrate from Fu-chen area or the Pilippines to Taiwan, assisted by the circulation of typhoon which pass near the northeast or southwest of Taiwan, especiality.
4) The pattern of northeastern monsoon period during October to November, the BPH could emigrate from Taiwan to southeastward of Ma-Kung, assisted by the air-flow of the northeastern monsoon.

Introduction

In recent 20 years, BPH (*Nilaparvata lugens* Stål) has become the key pest of every rice cultivation area in Asia. It caused damage of rice has been reported in many papers, which indicated that the extended new variety of rice and the improved techniques of fertilization, pesticide usage, and irrigation etc, are provide suitable condition for the reproduction of BPH. These factors are the main causes for the severe occurrence of BPH in tropical area including the Philippines, Malasia, Indonisia (Kisimoto 1981; Hirao, J. 1976; Kuno, E. 1979; Lim, G. S. 1980; Mochida 1977). However, in sub-tropical and temperate area, the other main cause besides those mentioned above is the long-distance migration of BPH (Kisimoto 1976, 1979, Cheng 1979). Therefore, many entomologist have been enthusiastic to the studies on the long-distance migration of BPH, and many points about it have been confirmed. These results have really contributed to the forecasting and control of BPH (Hirao, 1976; Kisimoto 1979, 1982; Jiang 1981-2).

Until now, Kisimoto et al, who have conducted large-scale studies on the long-distance migration of BPH and have made remarkable breakthrough, are among the most outstanding researchers. They claim that BPH in Japan immigrates from central and southern Mainland China by warm and humid air mass in front of low air-pressure in Mei-yu season during late-June to mid-July (Kisimoto 1976, 1979, 1982; Mochida, 1977). Besides, Cheng *et al.* claimed in 1979 that three regions where BPH propagates all year long, few, or none survives overwinter, respectively, could be assorted in Mainland China according to the ecology of BPH, and in all year long reproductive region, the BPH could migrate northward five times a year, and migrate from north toward south three times in autumn. This kind of studies has not been conducted in tropical area until 1979 by Rosenberg L. J. who researched in the Philippines. He indicated that the migrational tracks of BPH in tropical area was very different from that in sub-tropical and temperate area. It's migration of BPH was influenced by tropical air mass, especially, by irregular air flow caused by typhoon. Thus, its migrational route depended on short-duration airflow. According to Resenberg's deduction, a flock of BPH migrate into the Philippines from Taiwan in the morning on Oct. 15, when the sources of BPH in south-eastern Taiwan was so abundant that hopper-burn even occurred. Therefare, his deduction is believable.

The sources of BPH which caused serious damage in Taiwan has also been studied from various respects in recent years. Until now, we can confirm that just few BPHs can reproduction in Taiwan during cold winter (Chu *et al.*, 1980). When the year none or few immigrants, BPH should be impossible to cause serious damage in whole island, just by a few native BPHs in short time. Therefore, the author started to study the possibility of immigration of BPH in 1978 at Taitung area. The primary results showed that it's quite possible for the BPH immigrate from oversea. Thus, the range of collection was extended along the eastern, southern, and western of Taiwan in the next years.

Method of collection of air-borne insects

The net-trap with 3 tow nets (Fig. 1) set up on a long pole, at 5, 10, and 15 meters different high, respectively. It was set first at Taitung DAIS to study the density of the migrants in the air. The result of the investigation in the pass serveral years showed that the greatest density about 87% of BPH migrate over 10 meters-high above ground. So, all the other net-traps set at various collectional spots were as Fig. 2. The tow net set up on a 10 meters high pole. It's diameter is 1 meter, and depth is 2.5 meters. The direction of tow net can rotation with wind.

Fig. 1. The air-borne net-trap with 3 tow net set at Taitung DAIS.

Fig. 2. The air-borne net-trap set at various collectional spots.

The collectional spots set at different localities as the map of the distribution of net-traps (Fig. 3.) in this survey. The net-traps were first set at Taitung, Shao-Ma, Huo-Shao, and Hung-Tou in 1978, second set at Shang-Lan, and Chang-Bin in 1980, third set at Heng-Chun, and Ma-Kung in 1982, and last set at Chi-Mei in 1983. All the collectional spots were widespread along the eastern, southern, and western coastlines of Taiwan, even on the separate island from Taiwan. The BPH caught in the tow nets are collected once per day all year long.

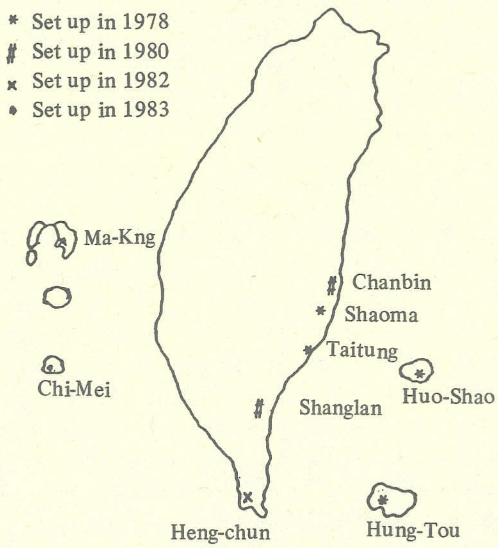


Fig. 3. The map of the distribution of air-borne net-traps.

The long-distance migration of BPH in Taiwan area

According to the meteorological conditions on the dates when BPHs were caught, the migration of BPH can be induced as four patterns:

1) The pattern of spring-rain period – in this pattern, the weather condition is the low pressure band moves southward from central mainland China, and reversed airflow of high pressure in the Pacific Ocean moves northward from the Philippines. That's two airflow meet in Taiwan area, usually.

In Table 1, we can see a lots of BPHs were caught in a day. Checking the weather condition on the dates of capture this insect, we found the weather map in these days very similar. That's as on April 13 in 1982, the low pressure band was moving southward from the north of Taiwan, and the reversed airflow of high pressure in pacific ocean moving northward. That's two airflow usually meet in Taiwan area. In this day, 33 BPHs were caught at Shan-Lan spot, however, the population density of BPH in the native paddy field was quite low. Hense, we think that those BPHs should emigrate from the Philippines to Taiwan, assisted by the reversed airflow of high pressure in pacific ocean.

2) The pattern of Mei-yu period – in this pattern, the weather condition is the low pressure formed in southern mainland China moves northeastward.

Table 1. The Number of BPH Caught at Various Collection Spot During Spring-Rain

Year	Date	Collection spot	No. of BPH caught
1978	April 9	Hungtou	1
1978	May 3	Hungtou	2
1979	May 3	Huoshao	11
1981	April 29	Shanglan	81
1981	May 2	Shanglan	53
1982	April 13	Shanglan	33

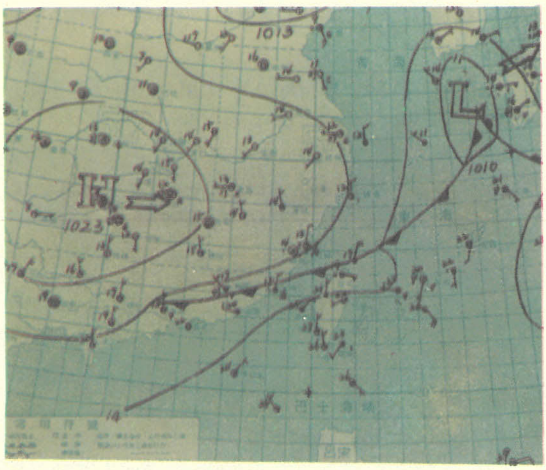
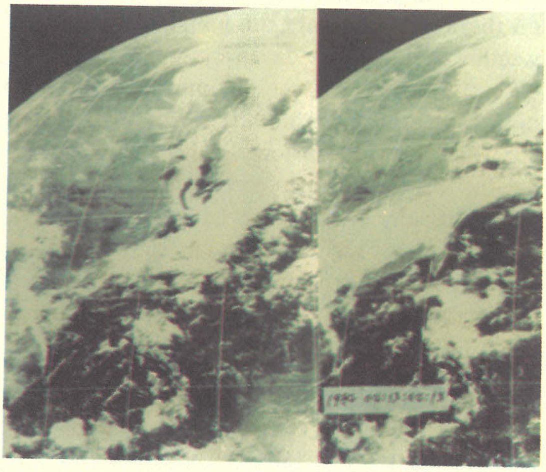


Fig. 4. The meteorological map on April 13 in 1982.



April 14 April 13

Fig. 5. The cloud map via satellite on April 13-14 in 1982.

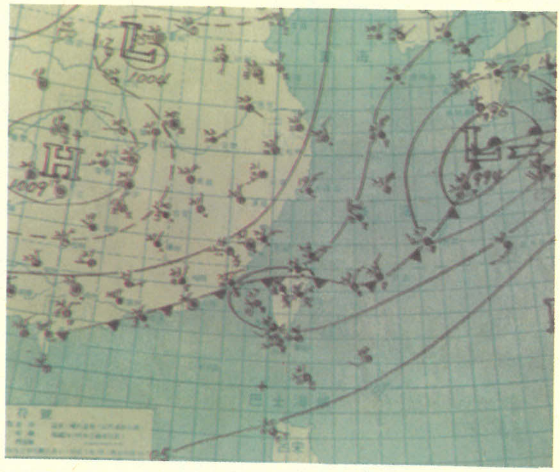


Fig. 6. The meteorological map on June 23, 1982.

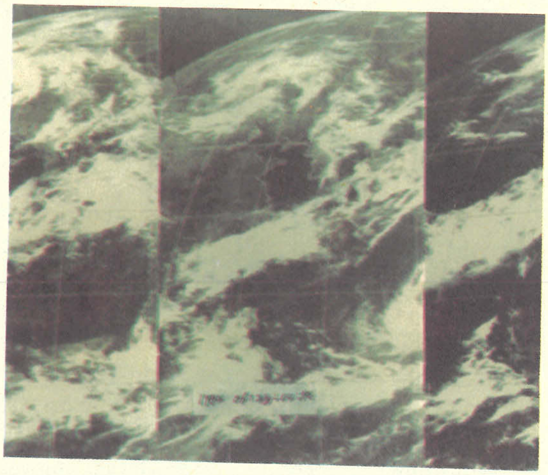
During this period, a lot of BPH were caught at Hung-Tou and Ma-Kung spots (table 2). Checking the weather map on the dates in table 2, we found that the weather type of those days were very similar as on June 23, 1982, the low pressure formed in Can-Ton area, and moved quickly northeastward with a speed of 50 Km per hour.

Base on the cloud map (Fig. 7.), we can see the air mass of low pressure hasn't moved through Taiwan on June 22, 1982. In this day, BPH has not catches at Ma-Kung spot, but in the next day, this air mass had passed Ma-Kung and 29 BPHs were caught. So we think that those BPHs could emigrated from Can-Ton area to Taiwan, assisted by warm and humid air masses of low pressure of Mei-yu period.

Table 2. The Number of BPH Caught at Various Collection Spot During Mei-yu Season

Year	Date	Collection spot	No. of BPH caught
1978	May 26	Hungtou	6
1978	May 29	Hungtou	6
1982	June 3	Makung	2
1982	June 23-24	Makung	40
1982	July 5-6	Makung	39

When the low pressure band was digressed a little south than general year during late-June to pre-July, and these air mass through to Taiwan, the long-distance migrational route of BPH may be through Taiwan to the south of Japan. For instance, 3 swarms of BPH were caught at Ma-Kung spot during late-June to pre-July in 1982 (Fig. 8.). This phenomenon is not only similar to the data in Japan but also can confirm to the long-distance migrational mode of BPH which induced by Dr. Kisimoto.



June 24 June 23 June 22

Fig. 7. The cloud map via satellite on June 23, 1982.

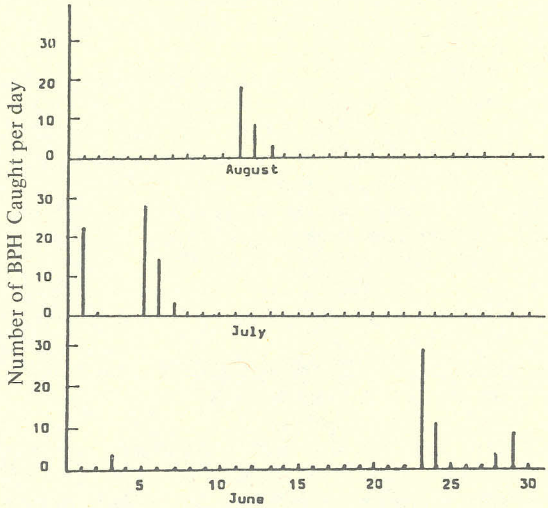


Fig. 8. The number of BPH caught at Makung spot during June to August 1982.

3) The pattern of typhoonic period – in this pattern, the weather condition is the circulation of typhoon which pass near to Taiwan during July to September.

There are three migrational routes of BPH by the different typhoons: (a) BPH could emigrate from the Philippines to Taiwan by the circulation of typhoon which pass near the southwest of Taiwan. For instance, 36 BPHs were caught at Shao-Ma spot on August 26, 1978. In this day, the circulation of typhoon Ellin was moving toward Taiwan from the Philippines. (b) BPH could emigrate from central, southern Taiwan to Ma-Kung and Fu-Chen area, assisted by the circulation of typhoon which pass near the west of Taiwan. For instance, 21 BPHs were caught at Ma-Kung spot on July 1, 1982. In this day, the circulation of typhoon which was moving toward Ma-Kung from Taiwan. (c) BPH could emigrate from Fu-chen area to Taiwan, assisted by the circulation of typhoon which pass near the northeast part of Taiwan. For instance, 29 BPHs were caught at Ma-Kung spot during August 11 to 13, 1982. In these days, the circulation of typhoon Cecil was moving toward Taiwan from Fu-Chen area (Fig. 9 & 10).

4) The pattern of northeastern monsoonal period – in this pattern, the weather condition is northeastern monsoon moves southwestward from Taiwan. For instance, 3 BPHs were caught at Ma-Kung spot during November 22 to 23, 1982. In these day, the airflow was moving toward Ma-Kung from Taiwan. So we think that BPH could migrate southwestward from Taiwan, assisted by the airflow of the northeastern monsoon. This phenomenon can also to confirm the Rosenberg's induction – BPH could emigrate from Taiwan to the Philippines, assisted by the upper-airflow on October 15, 1979.

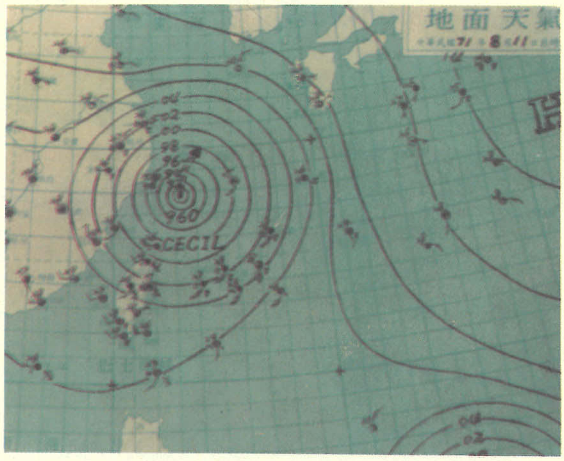
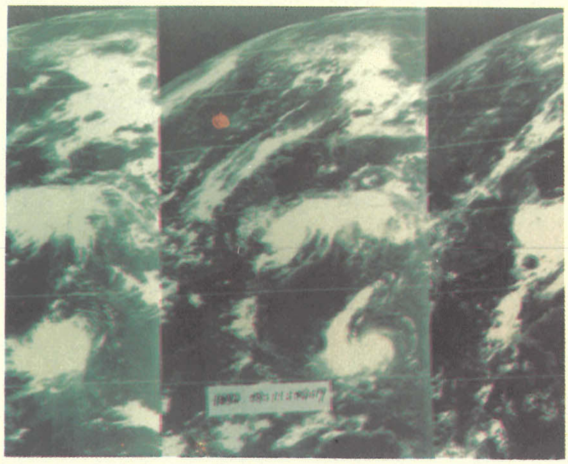


Fig. 9. The meteorological map on August 11, 1982.



August 12 August 11 August 11

Fig. 10. The cloud map via satellite on August 10-12, 1982.

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