MOSQUITO STUDIES IN CHINA, PAST AND PRESENT

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As early as 1828, *Anopheles hyrcanus sinensis* from Canton and *Culex vagans* from Foochow were collected by Trentepohl and described by Wiedemann. Fifty years later, Manson published his classical experiments with mosquitoes on the transmission of *Wuchereria bancrofti* in Amoy. Then a few specimens were collected from time to time by foreign people, such as customs workers, from the chief commercial centers along the coast like Shanghai and Hongkong.

The first check list of mosquitoes reported from China was given by Faust (1926). Since then, Chinese workers also took up the studies of mosquitoes, chiefly on general survey. As noted in Feng's (1938) paper, Li and Wu worked in central China, Chin in northeastern China, Yao in southwestern China and Feng in different parts of China, as well as Riley in Hainan Is., Jackson in Hongkong and Gaschen in Yunnan.

Since the start of the Sino-Japanese War in 1937, the studies on mosquitoes have made great progress and become enlarged in scope to include the bionomics, relation to diseases and control, as well as doing large scale survey work in the interior of China. For example, just on Yunnan-Burma Road and Railway there were five groups working on mosquitoes and malaria: (1) League of Nations Malaria Unit, headed by the late R. C. Robertson, with entomologist T. L. Chang in 1939; (2) U.S.P.H.S. Malaria Mission, headed by L. L. Williams, Jr., with the late Bruce Mayne as entomologist, in 1939–40; (3) Chefang Malaria Laboratory of the National Health Administration in cooperation with the International Health Division of the Rockefeller Foundation, headed by M. C. Balfour and the late W. C. Sweet, with entomologist C. Y. Chow, in 1940–42; (4) Yunnan Provincial Malaria Institute, headed by Y. T. Yao, with entomologist C. C. Wu, in 1940–42; and (5) U.S.P.H.S. Medical Mission, headed by V. H. Haas, with entomologists W. L. Jellison, Gordon Smith, K. C. Chen and F. W. Fisk, in 1941–42. Unfortunately, all the work of the above groups was

stopped by the Japanese invasion of Yunnan-Burma border in May 1942.

After World War II, mosquito studies were centered in Nanking and Taiwan, with the writer in charge. However, since 1949 the work has been carried on only in Taiwan.

I. TAXONOMY AND GEOGRAPHICAL DISTRIBUTION

Feng(1938) listed 98 species of mosquitoes for China, 24 being anophelines and 74 culicines, representing 12 genera and 22 subgenera. He also gave their geographical distribution. Sweet *et al* (1942) added four *Anopheles* as new records for China: *A. aconitus, A. annandalei interruptus, A. leucosphyrus,* and *A. stephensi.* Yao (1943) added *A. majidi* to the list, but so far as the writer knows, this species occurs only in India. Yao probably had mistaken *A. pattoni* for *A. majidi,* because these two species resemble each other very much. By the inclusion of Taiwan fauna, there is now a total of 39 species of anopheline mosquitoes reported in China. A key to them was made and their geographical distribution according to Feng's publication(1938) was added by Chow (1949, a). Another key to 16 species of *Anopheles* found in Taiwan was also published (Chow, 1949, b).

Bohart(1946) presented a key to 79 species of culicines, adding one genus and seven species to Feng's list(1938). However, he failed to include two of Feng's species. Among the seven species added by Bohart, all except *Culiseta niveitaeniata* and *Culex theileri* need further confirmation. Chow(1949, c) added one genus and 19 species as new to China. Thus up to present, 95 species of culicines have been reported from China (excluding Taiwan fauna), representing 13 genera. The number of species belonging to each genus is: *Megarhinus* 2, *Tripteroides* 3, *Topomyia* 1, *Harpagomyia* 1, *Uranotaenia* 5, *Orthopodomyia* 1, *Ficalbia* 2, *Mansonia* 4, *Heizmannia* 2, *Armigeres* 6, *Aedes* 34, *Culiseta* 1 and *Culex* 33.

II. BIONOMICS

A general bionomics study of the two important malaria vectors in China, *Anopheles hyrcanus sinensis* and *A. minimus,* was made by Chow(1948). The seasonal prevalence of *Anopheles* in Yunnan was reported by Chow and Balfour (1949). Hu(1935) observed the house-frequenting behavior of *A. hyrcanus sinensis* in Shanghai. At the same locality the blood preference of this species was studied by Toumanoff and Hu(1935), and Chang(1937) studied its egg production. In Chungking, Chow(1949, d) studied the time of feeding of anophelines.

As for culicines, Feng(1937, a) discussed the hibernation mechanism, and Chow(1949, e) observed the breeding habits and hibernation of plant-container mosquitoes. Wang(1938) stated that the anal gills of larvae have no importance for the oxygen absorption, the oxygen in water passing through larval skin, and that the amount of oxygen (either dissolved or free) required for survival was greatest in *Anopheles* and least in *Aedes.*

The resting habits of mosquitoes in the buildings after being sprayed with DDT are now under our observation in Taiwan.

III. RELATION TO DISEASES

A summary of this subject has been given by Feng(1935).

Relation to Malaria: Feng(1937, b) stated that the important malaria vector in Manchuria is *Anopheles maculipennis atroparvus,* in Sinkiang *A. sacharovi,* in north China *A. pattoni,* in central China *A. hyrcanus sinensis* and in south China *A. minimus.* The infection rates of anopheles with malaria parasites both naturally and experimentally were summarized by Yao (1944). Sweet *et al.* (1942) reported that in 26,372 dissections of 13 species of *Anopheles* in western Yunnan, malaria infections were found in *A. minimus* only, with an infection rate of one per cent. In Nanking, the writer was the first to find sporozoites infection in *A. hyrcanus sinensis* in 1948 and thus proved by dis-

section that only this *Anopheles* species in this locality is the malaria vector. In Taiwan we also proved by dissections that *A. hyrcanus sinensis* is important for the plains area and *A. minimus* for the foothill regions.

Relation to filariasis: As mentioned above, Manson discovered that *Culex quinquefasciatus* (*C. fatigans*) was the vector of *Wuchereria bancrofti* at Amoy. Since 1930 the studies on the transmission of filariasis in China were taken up by Chinese workers. Feng(1931) reported that *A. hyrcanus sinensis* caught in nature showed *W. bancrofti* filarial infection and some of the infected specimens had mature larvae. Hu made a series of studies on the susceptibility of Shanghai mosquitoes to experimental infection with *W. bancrofti*, from 1935 to 1939, published in the Peking Natural History Bulletin, and later (1940) with *Microfilaria malayi*. He reported a high susceptibility of *A. hyrcanus sinensis* with both *W. bancrofti* and *M. malayi*, and of *Culex pipiens pallens* and *C. vagans* with *W. bancrofti*.

Relation to dengue fever and Japanese B encephalitis: Little has been done on experimental studies of mosquito transmission of these diseases in China. However, *Aedes aegypti* and *A. albopictus* are rather common in south China and generally believed to be the vectors of dengue fever; while *Culex pipiens* and *C. tritaeniorhynchus* are suspected for Japanese B encephalitis, a small epidemic of which was reported to occur in Peiping.

IV. CONTROL

Hindle and Feng(1929) mentioned the value of local species of fish in China for the destruction of mosquito larvae. In Nanking, Yao and Wu(1935) used paris green as an anti-larval measure. However, before DDT was available, comparatively large scale mosquito control, using paris green, pyrethrum and automatic siphons, was carried out by us during wartime in western Yunnan and Chungking with the help of J. C. Carter of the Rockefeller Foundation. After the war, Carter also helped us with the DDT spraying, both the larviciding in ricefields, and the adulticiding in Nanking and Taiwan. In addition, T. T. Wang of the National Institute of Health in Chungking studied the local emulsifiers for pyrethrum, and T. N. Chen of Taiwan Agricultural Experimental Station tested local materials for insecticides.

V. INSTITUTIONS AND PERSONS WORKING ON MOSQUITOES

1. Chekiang Entomology Bureau, Hangchow: F. S. Li and S. C. Wu—Taxonomy, 1931–35.

2. Fan Memorial Institute of Biology, Peiping: C. Ho—Taxonomy, 1928–30.

3. Hongkong Malaria Bureau: R. B. Jackson — Taxonomy and bionomics, 1931–38.

4. Lister Institute, Shanghai: Stephen Hu and T. L. Chang—Bionomics and experimental infections, 1933–40.

5. Lingnan University, Canton: W. A. Riley and L. Y. Wu—Taxonomy, 1931–36.

6. Malaria Laboratory of the National Institute of Health cooperated with the Rockefeller Foundation, Chefang, Chungking and Nanking: C. Y. Chow—Taxonomy, bionomics and control, 1940–

7. National Institute of Health, Divisions of Entomology and Chemistry, Chungking and Nanking; C. Ho and T. L. Chang—Bionomics; T. T. Wang—Insecticides; 1942–

8. Peiping Union Medical College, Division of Parasitology; L. C. Feng—Taxonomy and experimental infections, 1930–

9. Taiwan Malaria Institute, Chaochow, Taiwan: Established by R. B. Watson and C. Y. Chow in November 1946—General survey, bionomics and control.

10. Taiwan Agricultural Experimental Station, Taipeh: T. N. Chen—Insecticides.

11. Yunnan Provincial Malaria Institute, Mangshih: C. C. Wu—General Survey, 1940–42.

At present, mosquito studies in China seem to be confined to Taiwan. There are only three mosquito men here: T. N. Chen on insecticides; T. L. Chang on bio-

nomics and control; and the writer on the taxonomy of culicines and of mosquito pupae, bionomics and control. A monograph on Taiwan anopheline fauna is in the course of preparation by us. In conclusion, the writer wishes to take this opportunity to thank the IHD of the Rockefeller Foundation and their representatives in the Far East, Dr. M. C. Balfour and Dr. R. B. Watson, for their cooperation, advice, and support, without which the studies of mosquitoes in China could not have made such progress.

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