## B-13.2 Study on the prediction of risks of global warming on malaria spreading

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**Abstract**

Global warming will bring about the temperature elevation, and the habitat of vectors of infectious diseases such as malaria will spread in subtropical or temperate zone. The purpose of our study is to simulate the spreading of these diseases.

(1) We conducted some field survey and data collection on malaria endemics and distribution or density of *Anopheles* mosquito in southern China. We found that they showed a clear seasonal fluctuation depending on temperature and precipitation and we determined the threshold value of some important factors of malaria transmission.

(2) We carried out *Anopheles* mosquito survey in some islands in southern part of Japan, and we determined the marginal distribution of *Anopheles minimus* at present, and discussed the future spreading into northern part of Japan due to global warming.

**Key Words** Malaria, Serological Epidemiology, *Anopheles minimus*, Temperature, Precipitation, Threshold

### Introduction

Temperature elevation due to global warming will bring about the spreading of the habitat of vectors of infectious diseases such as malaria and dengue fever into subtropical or temperate zone. On the other hand, the change in precipitation due to global warming, though it has great uncertainty both in global climate model itself and in its effect on habitat of vectors, is seemed to affect the habitat of vectors to expand. In many tropical vector-borne diseases, malaria is thought to have those risks most provably and most seriously.

### Research Objective

The purpose of this study is to simulate the spreading of malaria under global warming. Malaria is a Vector-borne disease which is infected or transmitted by *Anopheles* mosquito. Temperature elevation will accelerate the speed of larva growth and extend the life expectancy of adult mosquito, and it will shorten the period of parasite growth. And the change of precipitation pattern will affect the habitat of *Anopheles* mosquito.

There are many factors which may play important roles in malaria transmission. In this study, we aimed to clarify those factors which may determine the endemics or epidemics of malaria through reexamination of existing data and collection of some additional information by field survey. In order to have such basal data on malaria, field survey were conducted both in southern part of China and in subtropical islands in Japan.

## Research Method

1) Field survey on *Anopheles* mosquito in southern Japan

Field surveys on *Anopheles* mosquito were conducted in several islands in southern Japan, and we determined the geographical distribution of *Anopheles minimus* which is most important vector of *falciparum* malaria in Japan.

2) Epidemiological study on malaria in Yunnan Province, China

We carried out some field survey in three villages with different malaria endemicity and with different meteorological condition in Yunnan Province, China. In field survey, medical and serological examination on residents, monthly mosquito survey through out a year and collection of some meteorological data in those villages were conducted.

3) Ecological study on malaria endemics in southern China

We collected 10 years' data-set concerning malaria endemicity, *Anopheles* density and some meteorological condition (temperature and precipitation), and socio-economical information on 76 villages in southern China (Yunnan Province, Guangxi Zhuang Autonomous Region and Hainan Province). And we analyzed the relationships between malaria endemicity, *Anopheles* density and another factors such as temperature and precipitation.

## Results and discussion

1) *Anopheles minimus*, which is the major vector of *falciparum* malaria in Japan, is detected in some islands (Ishigaki island, Iriomote island and Miyako island), and is not detected Okinawa island, Amami island and Tokara Islands.

Table 1 Temperature and Precipitation in southern islands in Japan (February)

| | Temperature (℃) | | | | | | Precipitation(㎜) | |
|---|---|---|---|---|---|---|---|---|
| | average | | maximum | | minimum | | | |
| | 1994 | average | 1994 | average | 1994 | average | 1994 | average |
| **Ishigaki** | 19.2 | 18.3 | 21.9 | 21.0 | 16.8 | **16.0** | 206.5 | 112.9 |
| **Miyako** | 18.3 | 17.6 | 21.0 | 20.3 | 16.0 | **15.3** | 156.5 | 132.0 |
| Naha(Okinawa) | 17.1 | 16.3 | 19.8 | 19.0 | 14.8 | 13.9 | 111.0 | 106.0 |
| Nago(Okinawa) | 16.5 | 15.2 | 19.1 | 18.8 | 13.5 | 11.8 | 100.5 | 136.6 |
| Naze(Amami) | - | 14.6 | - | 17.5 | - | 11.7 | | |

As shown in Table 1, the difference of minimum temperature in February between Miyako and Naha (Okinawa) is only 1.4℃. In Japan there have been no occurrence of endogenous malaria from 1960s until now, but the meteorological condition in southern Japan are suitable enough for vectors to survive. The temperature elevation (1.5-4.5℃) will probably expand the survival area of *Anopheles minimus* into Okinawa island or Amami island it may increase the risk of malaria transmission or epidemics in southern Japan.

2) *Falciparum* malaria and *vivax* malaria appeared and increased in summer season, and decreased in winter season in the survey areas. These seasonal variation are synchronized with meteorological condition in particular with temperature (Fig.1). The density of *Anopheles minimus* showed the same relationship between meteorological condition as in malaria (Fig.2).

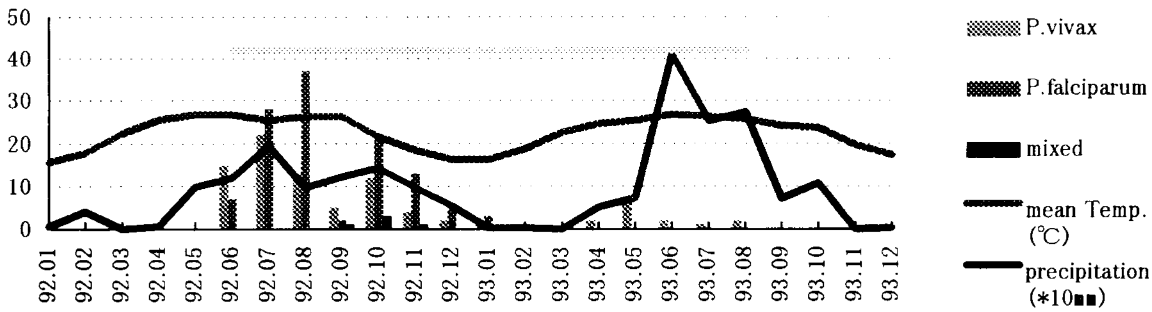


Fig.1 Seasonal fluctuation of malaria cases (at a village in Yunnan Province, China)

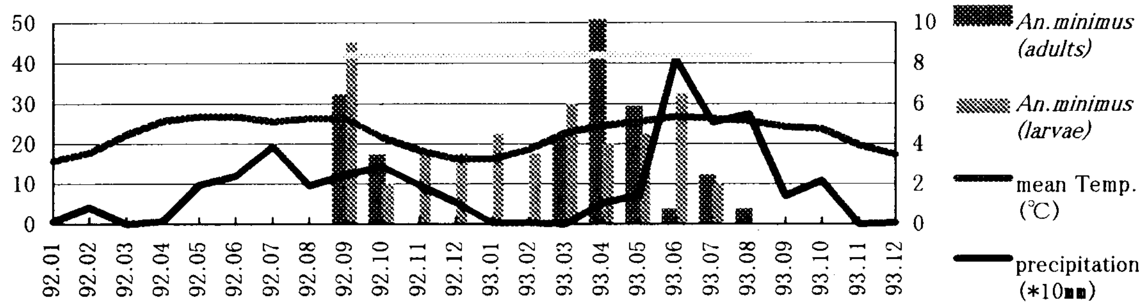


Fig.2 Seasonal fluctuation of *Anopheles minimus* (at a village in Yunnan Province, China)

3) Figure 3 - 5 show the relationship between malaria occurrence and temperature or precipitation in an endemic area. We can find that threshold temperature of both *vivax* malaria and *falciparum* malaria is 17℃ (monthly average of daily mean temperature). As for precipitation Fig. 5 shows an optimum level for *falciparum* malaria occurrence. This means that some amount of precipitation is necessary for mosquito to survive but excess amount of precipitation may destroy the mosquito's habitat

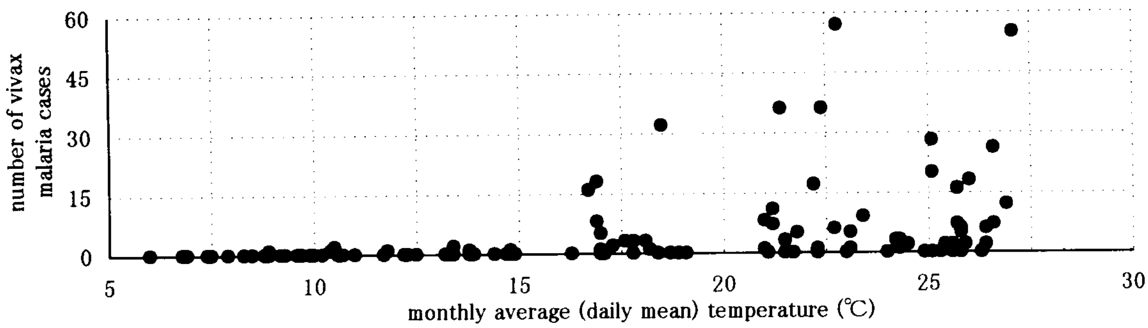


Fig.3 Relationship between malaria and temperature at an village

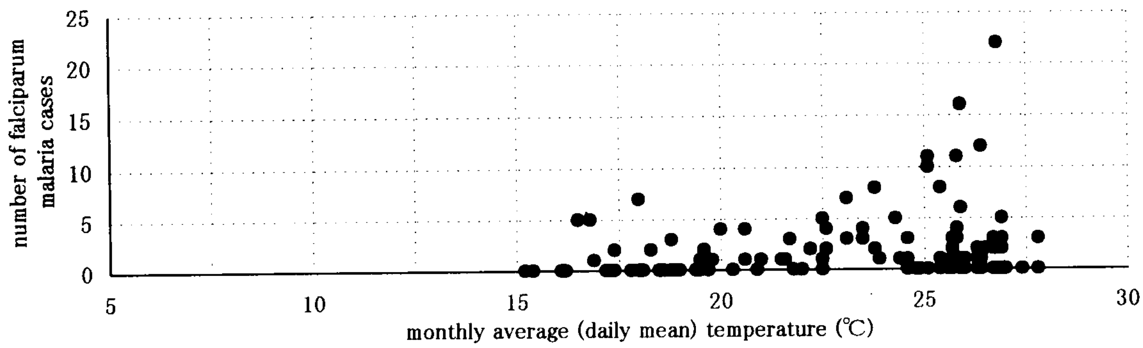


Fig.4 Relationship between malaria and temperature at an village

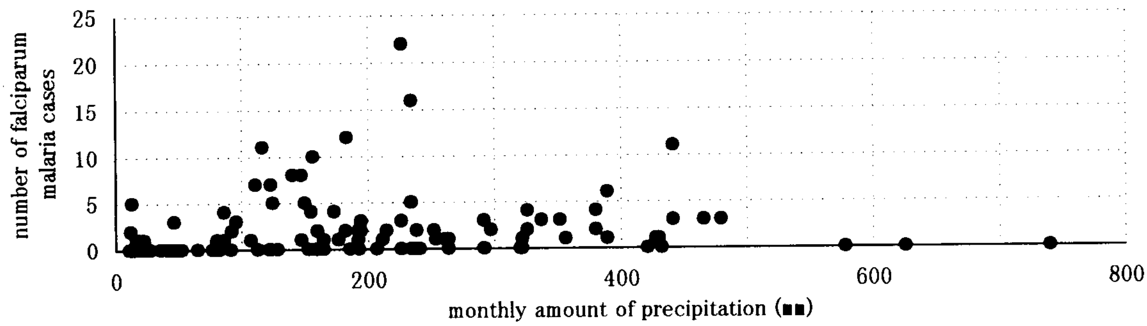


Fig.5 Relationship between malaria and precipitation at an village

Figure 6 and 7 show the relationship between malaria endemic and temperature at 76 villages in southern China. Threshold temperature (annual mean temperature) of malaria intimacies is seemed to be 17.5℃ for *vivax* malaria and 20-22℃ for *falciparum* malaria. As for precipitation we could not determine the threshold because the amount of precipitation is enough for mosquito's survival.

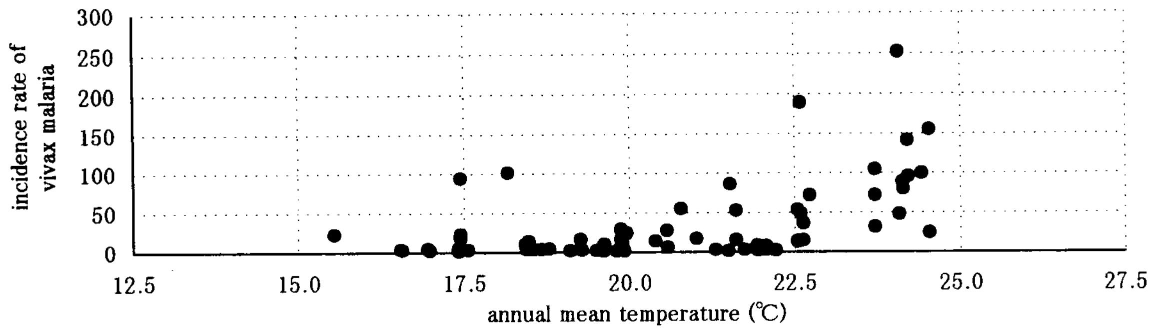


Fig.6 Relationship between malaria and temperature in South China

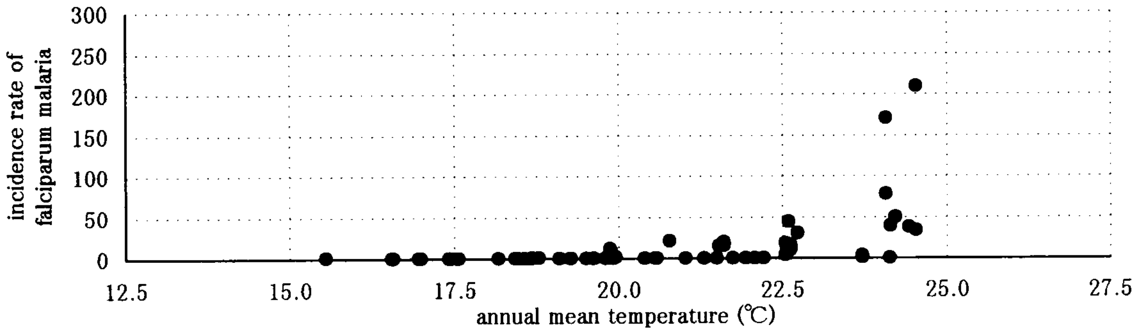


Fig.7 Relationship between malaria and temperature in South China

From these figures, it is easy to guess that a little increase of temperature may bring about the great increase of malaria occurrence. And this may appear both as expansion on seasonal (epidemic to endemic) and as spacial (non endemic to endemic) expansion.