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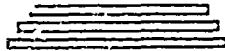
(E.I. Martsinovskii Institute of Parasitology and Tropical  
Medicine, Min. Health USSR and Institute of Malaria, Min.  
Health, Dem. Rep. Vietnam)

STUDIES IN MALARIA EPIDEMIOLOGY IN NORTH VIETNAM. 1. TOPOGRAPHICAL  
MALARIOLOGICAL EXPLORATION OF THAI-NGUYEN PROVINCE (Russian)

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(submitted 20/Nov/61)

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## INTRODU' ION

Most of the studies in malaria epidemiology in Viet Nam were performed in the years of colonial dependence of that country 15 to 25 years ago.

The techniques of these studies, the goals toward which they were directed, and many of their conclusions have either become obsolete or have become inapplicable to a country which has won its independence and is developing a public health service. Besides this, during the 8-year war of resistance in Viet Nam, intensive migration processes occurred which of necessity introduced considerable changes into the regional epidemiology of malaria. As a result of this, and also in conjunction with the need for the preparations for the elimination of malaria in the Democratic Republic of (North) Viet Nam, an urgent need arose for new studies to be performed in malaria epidemiology. The beginning of these studies were the joint observations by Soviet Malariologists and Vietnamese medical workers conducted in 1955-57 (A. Ya. Lysenko, 1959). A portion of the data from these observations was published in the article by L.I. Zalutskaya entitled "Comparative data on the biology of *A. minimus* and *A. vagus* in the environs of the city Thai-Nguyen" (1959), but the greater part has remained unprocessed and unpublished.

However, it is important that during the work of the detachment of Soviet malariologists in the DRV, numerous local cadres were trained among the malariologist-medical specialists, entomologists, and laboratory workers with whose cooperation it was possible to perform later (in 1957-59) a series of studies on the epidemiology of malaria and the efficiency of antimalarial measures. The article, the first in a series of articles covering our joint experience working in Thai-Nguyen province, on stationary experimental objects of Bac Canh

and Cho Moi, and in the autonomous district of Thai Meo.

#### GOAL, TECHNIQUE, AND SCOPE OF THE EXPLORATION

In September, 1957, the Ministry of Health of the DRV and the administrative committee of the Viet Bac district the decision to perform in the province of Thai Nguyen (one of the 5 provinces of the district) the first experimental indicative operation in the elimination of malaria from the country. Thai Nguyen province occupies a territory of 4500 km<sup>2</sup> and has a population of about 250,000. According to data from the local health authorities it is known that the infestation rate of the population with malaria is extremely irregular, and, therefore, the plans for the measures to be taken must be different. For purposes of forming such a plan, it was necessary to perform a malariological zoning of the territory of the province. The initial data for performing the zoning (systematic data on morbidity, mortality, or infestation rate of the population) were unavailable from the local health organs. Therefore, the zoning could be carried out only on the basis of data from a special malariological investigation.

Since in further operations, the zoning work was supposed to cover the entire country, the choice of the methods of zoning and the determination of that scope for the explorations which could serve as the source of the needed data acquired a very high significance, because there was a limited number of medical-worker personnel in the country and because the Institute Laboratory had a low throughput capacity, the primary problems arising concerned the economic features of the working techniques. We decided to use that technique of topographical-malariological zoning of a mountainous country that was proposed and successfully put in practice in 1954 in the Tadzhik SSR (A. Ya. Lysenko, A.I. Nemirovskaya, E.S. Kalmykov, L.V. Ivanova, 1956). The basic steps of malariological zoning of a



Fig. 1. Hypsometric routes followed by the explorations, and the topographical-malariological zones of Thai Nguyen province. A. hill-river zone, B. low-mountain-river zone, C. mountain-river zone, --- zone boundary; a. elevations, b. spleen index in the villages studied.

territory in accordance with this technique are: a. selection on a topographical map of groups for investigation which would cover all the variations in orographic conditions of the territory being zoned; b. carrying-out a complex ex-

ploration of the locality and population along the routes selected by a detachment of entomological-epidemiological workers, c. typing of the malarial foci (inhabited sites) according to the data obtained in the exploration; d. sorting by using a topographical map and by analogy with identified types of malarial foci of all other inhabited sides of the given locality and their unification into zones; e. performance of an exclusive investigation in those sections of the zones whose classification into a given zone is for any reason insufficiently well founded (accurate pinpointing of the zonal boundaries); f. characteristics of the zones based on the sum of all data available (investigative and overall-statistical) demographic, economic, etc.).

The topographical malariological exploration of Thai Nguyen province was performed in October and November of 1957. Eight complex entomological-epidemiological detachments (medic-epidemiologists, male nurse-explorers, and medic-entomologists) investigated 116 inhabited sites (out of 1344 in the province) in the great majority of which no organized antimalarial measures had been previously carried out. During the large-scale study of the population, epidemiological anamnestic data were collected from and the spleen studied in 8292 persons and thick drop of blood was taken from 7609 persons. Consideration was given to the type of inhabited site and the type of dwellings, the quantity of livestock, migration of the inhabitants, and the specific features of their everyday life. An epidemiological investigation was performed at 106 inhabited sites which included a count and a description of the water bodies, the catch of adult mosquitoes in all (in small mountain settlements) or in no less than 10 dwellings located in different parts of a large village. A total of 948 sites were studied; 461 Anopheles individuals were caught and examined.

RESULTS OF THE EXPLORATION. TOPOGRAPHICAL MALARIOLOGICAL ZONES OF THAI NGUYEN PROVINCE

During the course of the entomological investigation, all 13 of those species of Anopheles mosquitoes were found (of the 24 described for Viet Nam) that had been found in the vicinity of the city of Thai Nguyen by L.I. Zalutskaya in 1959. *A. vagus* had the greatest specific gravity (41.8%); *A. minimus* made up 17.1%; *A. hyrcanus sinensis* 12.2%, *A. jeyporiensis* 7.7%, *A. kochi* 5.6%, and *A. aconitus* 3.6%. The other 7 species together made up 12%. The basic vector of malaria in N. Viet Nam, *A. minimus*, was found with the greatest consistency at an elevation of 100 to 400 m (in 92.1% of the villages studied), less consistently at elevations below 100 m (in 65.7% of the villages). In a village at an elevation greater than 400 m, *A. minimus* could not be found. In the 948 locations studied, 790 *A. minimus* specimens were captured making an average of 0.83 individuals per day resting-place.

The greatest *A. minimus* density, averaging one mosquito per day-resting place in each village investigated, was observed in a mountain locality adjacent to the western, northern, and eastern borders of the province. In the hilly-low-mountainous central part of the province, the *A. minimus* density fluctuated in most villages between 0.25 and 1 mosquito per day resting-place; in the southern, hilly region it fluctuated between 0 (in 1/3 of the villages) and 0.1 to 1 mosquito per day resting place (in the villages where *A. minimus* was present).

The overall infestation rate of the population studied was found to be as follows: the spleen index was 43.9%; the parasite index 11.5%; most of the parasitic findings were attributed to *P. falciparum* (70%) and *P. vivax* (29.4%); the share of *P. malariae* made up 0.6% in all.

The greatest population infestation rate, in correspondence with the greatest

A. minimus density, was observed in the foci (villages) of the mountainous locality. For the most typical of these, the curve of age-specific infestation known for hyperendemic foci is characteristic: the rapid growth of the spleen and parasite indices in the lower age groups and their drop in the higher ones (fig. 2, A).

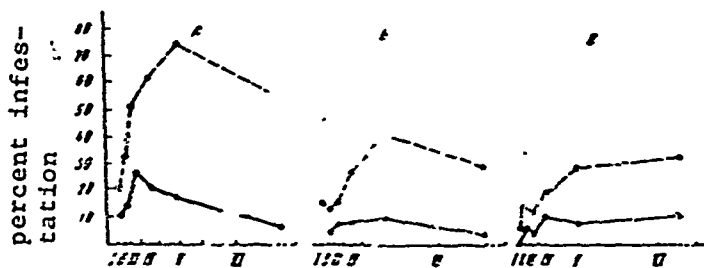


Fig. 2. Comparative age-specific infestation with malaria of the population of foci of the mountain-river type (A), low-mountain-river (B), and hilly-river type (C). The dotted line designates the spleen index; the solid line the parasite index. Age groups: I-less than 1 year, II-1 to 2 years; III 3 to 4 years; IV-5 to 8 years; V-9 to 16 years; VI-17 to 64 years.

In the foci of the hilly low-mountain the infestation rate of the population was moderate—2 to 3 times lower than in the mountainous foci. The curve of age-specific indices in the foci of this locality is similar in its basic lines to that for the foci of the mountain locality (fig. 2, B). In the foci of the slightly hilly locality, the population infestation rate is generally the same as that in the hilly low-mountain locality but varies significantly even in close-lying villages—in complete correspondence with the low but extremely irregular population density of *A. minimus*. There was a prevalence of foci of the hypo-endemic type with a characteristic population age-specific infestation rate (fig. 2, C); in a number of foci, during the period of the study, an epidemic



outbreak in morbidity took place. The quite obvious confinement of the foci to a certain topography made it possible to unite similar explored foci with unstudied foci similar to them into 3 malarial zones: mountain-river, low-mountain-river, and hilly-river zones. Besides these, there is an alpine zone in the province which is not endemic in malaria. In brief, these zones can be characterized in the following manner:

The mountain-river zone covers a territory of narrow river valleys, mountains, and low mountains directly adjacent to high mountain masses. The elevation criteria fluctuated from 50-100 to as much as 700 m. The zone has a rich water supply; the mountain masses are covered with forests. The basic breeding grounds of *A. minimus* are the mountain streams and brooks, terraced rice fields along the brooks, irrigation canals, and water bodies near springs. The villages are confined to the river valleys, and the lateral slant of the mountains, often in the immediate vicinity of the forest. The main nationalities of the zone are the Tho, the Man, and the Nung who build characteristic "two-story" houses on poles. The open area under the floor of the house is used as a stable for water buffalo, and a pig shed and chicken coop are also usually located here. The chief occupation of the population is irrigated and dry rice farming, wood cutting in the forest, and hunting. There are many domestic animals. The sanitary-hygienic level of the population is not high. Only a very small part of the Tho and Nung population use a canopy; the Man nationality as a rule has no canopies. The infestation rate of the population in the foci is regularly and consistently high. Malaria has inflicted serious, occasionally catastrophic damage on the economy and health of the population; (for example, many communities in the regions Vu Khai, and Dai Ly).

The low mountain-river zone covers a territory of broad valleys, hills, and low mountains which do not adjoin immediately high mountain masses. The elevation criteria of the zone are 50 to 100 m. The zone is sufficiently well watered. The greater part of the mountains and hills are covered with forest. The basic breeding grounds for *A. minimus* are streams, brooks, irrigation canals, rice fields, with flowing water and the filtration water behind dams. The villages are situated for the most part in open areas, often near large rivers. Settlements of Tho, Nung, and Man nationalities are intermingled with populations of Tchai and Kinh nationality who build single-story houses with dirt floors. The main occupation of the population is irrigated rice farming, wood cutting in the forest, cultivation of citrus crops, manioc, pineapples, and tea. There is a rather large number of domestic animals. The sanitary-hygienic level of the population is relatively high. Most of the inhabitants use canopies. Malarial foci are not as uniform as in the mountain-river zone. The damage caused by malaria is significant but is not catastrophic as it is in the mountain-river zone.

The hilly-river zone includes slightly hilly territory with elevation criteria of 12.5 to 100. The zone is poorly watered. Forested sections are retained only on isolated high hills. Nearly the sole breeding ground for *A. minimus* is the inconsistent brooks which dry up in the arid season and that part of the terraced rice fields directly adjacent to them. The chief population, the Kinh are occupied with irrigated rice farming, gardening, and raising citrus crops. There are few domestic animals. The population makes wide use of canopies, chiefly for protection against blood-sucking mosquitoes (*Aedes culax*). Malarial foci in this zone in view of the inconsistent and sharply differential productivity of

the anophelogenic water bodies is very nonuniform. In general, this is a low-endemic zone in whose individual foci, when conditions are especially favorable for the transmission of malaria, outbreaks of the disease may occur. A significant portion of the malaria victims, apparently, become infested outside of the local foci while visiting the low mountain-river and, particularly, the mountain-river zone (wood cutting, road work, etc). The comparative characteristics of the zones are presented on figures 1 and 2 and on the table.

#### CONCLUSION

By the method of routed, directed exploration of approximately 90% of the inhabited sites of the province, typing of the foci explored, and subsequent classification (method of analogies) of the unexplored foci, the province of Thai Nguyen was separated and classified into 4 zones: the endemic-malaria mountain-river zone, the low mountain-river, and hilly-river zone, and the non-endemic sparsely populated high-mountain zone. The differences in the zones are attributed chiefly to the physical, geographical, and socio-economic features which affect the abundance of *A. minimus* and the degree of its contact with man.

The experience in the malariological zoning of Thai Nguyen province was later successfully applied by us to the autonomous district of Thai Meo, and later, for all (N.) Viet Nam. It allowed us to develop a rational yardstick for the elimination of malaria under the conditions of North Viet Nam which was successfully achieved during an experimental-indicative operation in Thai Nguyen province and which is being realized at the present in other provinces of the country (Hoa Binh, Nge Anh, Thai Meo, et al.). The method described for the malariological zoning of a mountainous country is sufficiently simple and rapid. It may be recommended for all countries where the plan for the elimination

Comparative characteristics of the topographical-malariological zones of Thai Nguyen province

Zone	Number of Villages Studied	A. Minimus		Percent of Villages with a spleen index				Infestation rate of population (%)	
		Percent of Villages with the Presence of:	Average abundance per day resting place	Less than 10	10-25	25-50	More than 50	Spleen Index	Parasite Index
Mountain-river	61	90.1	1.2	0	3.3	31.1	65.6	57.5	13.1
Low mountain-river	22	68.2	0.8	22.5	32.0	32.0	13.5	28.1	5.5
Hilly-river	26	46.4	0.15	27.0	53.8	15.3	3.8	25.0	8.0
Total	109	73.4	0.83	11.0	21.1	27.5	40.4	45.5	10.4

REMARK: data on 7 villages are not included in the table.

of malaria must be developed in the absence of previously accumulated systematic data on the infestation rates, morbidity, or mortality of the population from malaria.

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