

Geographical Distribution of Vi-Phage Types  
of *Salmonella typhi* Isolated in East Asia ; A Review Made  
Mainly on a Basis of Results in Korea

Yoshio AOKI

Department of Bacteriology, Nagasaki University School of Medicine, Nagasaki, Japan

Doki CHUN, Jung Soo SUH, Dae You HA

Department of Bacteriology, Kyungpook University School of Medicine,  
Taegu, Republic of Korea

and

Chong Seung LEE

W.H.O. National Salmonella Center for Korea, National Institute of Health,  
Seoul, Republic of Korea

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**ABSTRACT :** Typhoid fever is now a minor cause of death, but it remains at fairly high rate in some area of Asiatic countries. In Korea it is on the increase since several years, and in Japan, to be scarce now, the case rate is stagnant since 1960. The Vi-phage typing of 399 *S. typhi* strains isolated in every place of Korea in 1962-1964 resulted as follows : M<sub>1</sub> 220, I+IV 69, M<sub>3</sub> 51, Vi(-) 22, E<sub>1</sub> 12, D<sub>10</sub> 8, type 46 4, A 3, D<sub>9</sub> 3, D<sub>1</sub> 2, and 1 of B<sub>2</sub>, E<sub>3</sub>, E<sub>8</sub>, E<sub>10</sub>, M<sub>2</sub> respectively. Thus Vi-phage types in Korea are strongly characterized by predominance of M<sub>1</sub> and M<sub>3</sub> or M, broadly speaking.

A review of typing results recorded in literature was made setting limits to Asiatic countries and dividing into two groups by periods. The first group concerns mainly data reported by NICOLLE in 1962 and partly with those collected from other reports, and the second group involves the work of YEN in the 1940's. It is an established fact that in Asia type M appears more frequently. But no reports can be found like the results in Korea in which type M in a broad sense is most predominant of all.

### Introduction

According to TOPLEY and WILSON's Handbook (WILSON and MILES, 1964), the annual incidence of typhoid fever in northern and western Europe around 1939 was less than 5 per 100,000 population, while about 25 in Japan of those days (Epidemiological Statistics of the Ministry of

Health and Welfare, Japanese Government, etc.). In Germany, Austria and Japan, in 1946, immediately after World War II, the number in this meaning revealed increase to 54.0, 85.3, and 61.1 respectively (STOWN, 1947, 1948; MURAYAMA, 1962, the Epidemiological Statistics referred above

etc.). Though from the following year in West Germany it showed only a gradual decrease and barely has gone down to one place, namely 8.5 in 1951 (GRUMBACH und KIKUTH, 1958) or 8.7 in 1952 (BRANDIS und WALDEN, 1962), a sudden decrease arose in Japan, namely 22.8 in 1947, 11.9 in 1948, 7.8 in 1949. But after that it lost its speed, and barely amounted to 1.7 in 1959 and 1.1 in 1960 until keeping stagnant around 1.0 these days. Thus at present, in urban areas in Europe and America, an outbreak of this disease has been very scarcely reported, and in Japan, to be inferior to the lands mentioned above, it is also nearly seldom. However, at certain place in South East Asia, South America and Africa, it is still regarded as one of common diseases.

In Korea, at the time of the Warfare in 1950-1951 and immediately after that, there was prevalence of dysentery, but typhoid fever and paratyphoid were comparatively few, and the results of classification of *Salmonella* strains isolated showed a large number of *S. paratyphi A* as compared with *S. typhi* (ZIMMERMAN et al., 1952 ; ZIMMERMAN, 1953 ; CHUN, 1964). In this way, typhoid fever was not much of a serious problem in Korea till around 1960 at least.

Just then there appeared the report of AHN (1962), Kyungpook Univ. School of Med., in which he stated the isolation of 61 strains of *S. typhi*, 4 of *S. paratyphi A* and 3 of C-group salmonella out of 68 strains taken from patients in the Univ. Hospital and Presbyterian Hospital in Taegu City from May to September in 1961. Next, according to CHUN et al. (1963) and to CHUN (1964), out of the total 419 strains isolated from October 1961 to the end of 1963, 388 strains (92.6%) were *S. typhi*, 20 (4.7%) *S. paratyphi A*, and there was a few number of *S. paratyphi C* and of *S. typhi-suis*. The prevalence of typhoid fever in and around Taegu of the present time, throughout Kyungpook district generally speaking, is certainly

observed in addition by increasing number of patients hospitalized since 1962 and from the fact that there can be found considerable number of *S. typhi* carriers among their families and others.

In the district of Chungpook, Chungnam and Chonpook other than Kyungpook too, the existence or prevalence of typhoid fever has been disclosed. Moreover, according to the results of examination of carriers practised on a large scale in Kyung Gee and Kang Won Do in 1964, it was revealed that there could be found salmonella-carrying persons in 1.0 per cent of the subjects under examination. Among strains isolated there were several kinds of *Salmonella* other than *S. typhi* of course, but the fairly half of them were *S. typhi*. To sum up, in Korea, the present situation of typhoid fever is greatly serious and, in the authors' opinion, proper countermeasure should immediately be taken for the prevention of this epidemic disease.

As for typhoid fever in the present Japan, it is the question point that the number of cases per 100,000 population is fluctuating around 1 for these several years and showing no marked tendency of decrease. Moreover, it must be a matter of consideration that its outbreak in mass, though small in scale and terminates before long, is occasionally reported. The situation of this disease has been surveyed by AOKI, one of the authors, in detail and the investigation has been extended to the other salmonellosis than typhoid fever ; these results will be reported fully elsewhere.

In the case of mass outbreak of infectious disease in general, the first step to be taken for prevention is tracing route of dissemination and detection of the source of epidemic. In this occasion, facilities are obtainable if there are some stable types of the causative organism. As for *S. typhi*, the biochemical types and types related to its antigenic structure had been regarded once serviceable, but at present the both are not to be relied upon, as these properties are unstable and there is no

peculiarity as to geographical distribution among types determined by these methods (AOKI, 1964).

The typing method which is said to be most reliable at present for epidemiological purpose and which is demonstrating many examples making it enable to explain rationally the case of epidemic in reality is Vi-phage typing. This method based on the studies of CRAIGIE and BRANDON (1936) and of CRAIGIE and YEN (1938), advanced greatly by follow-up studies of YEN (1940) in Union Medical College, Peiping, of LAZARUS (1940) in America, and of KAWABE (1942, 1944), Kitasato Institute, Tokyo, and was brought to its almost completion by CRAIGIE and FELIX (1947), NICOLLE et JUDE (1951), BRANDIS (1955), BRANDIS und MAURER (1955), ANDERSON and FELIX (1953), ANDERSON (1955), and others as a method of epidemiological use. Among these authors CRAIGIE and FELIX were the first to suggest the standardization of the method from an international point of view. It was supported by a committee of experts at a meeting held in Copenhagen, 1947, and at present

the International Reference Laboratory for Enteric Phage Typing in London acts as the international center of this typing under the supervision of Dr. ANDERSON. One regional center is in each region; in Korea, LEE, one of the authors, is in charge, and in Japan, FUKUMI, National Institute of Health, Tokyo is of the post.

In the first half of this report, the results of phage typing obtained from 399 strains of *S. typhi* isolated in Korea, 1962-1964, are mainly described, and the results of 50 strains collected by AOKI and entrusted for typing to Dr. FUKUMI are dealt with in addition. In the latter half, the typing records covering various countries of the Asian Continent, inclusive of the data concerning Japan and Korea of course, are collected by the authors, and a review of them is written. The first lines of this paper are not to describe and consider epidemiologically the typing results on an occasion of typhoid epidemic from case to case in a limited locality, but to compare the type distribution throughout more broad area.

## Materials and Methods

**Vi-phage for typing** : Seventy-two standard Vi-phages were prepared and kindly supplied by the International Reference Laboratory for Enteric Phage Typing in London.

**Strains tested** : As shown in Table 1, 449 strains of *S. typhi* were used, in which 399 strains were obtained in Korea in 1962-1964 and typed by ourselves using the standard phages mentioned above. For the rest 50 strains of various history, they were typed in September 1964 through the courtesy of Japan Salmonella and Shigella Center standing in the Department of Bacteriology 1., National Institute of Health, Tokyo (Head : Dr. H. FUKUMI).

Those strains obtained in Korea in 1962-1964 are divided into three groups : 53 from carriers in

the central part of the Republic for the most part, 87 from 5 foci of local epidemics, and 259 from sporadic cases. The other strains of Korean origin are those sent from Dr. Jae Kyu CHOI, the former professor of bacteriology in Kyungpook Univ. School of Med., to AOKI in Nagasaki in 1957, and stored here till now. The strains isolated in Nagasaki City in 1958 are all of patients' origin and have not an affinity with each other, while those isolated in Shimonoseki City in 1964 are originated from an epidemic case of a small scale. Ten strains from Taiwan were sent from Dr. Shu Tao Hsu, Taiwan Serum Vaccine Laboratory. We do not know certain about the history of these strains, but they seem to be of sporadic cases origin, judging from the appended

**Table 1.** Strains tested

Region	Year	Number of strains
Korea :		
Seoul	1957	2
Taegu		14
Pusan		11
Seoul		
Kyung Gee Do	1962—1964	30
Kong Won Do		35(35)
Chungpook		14(14)
Chungnam		7
Kyungpook		57
Chonpook		245 (4)
Japan :		
Nagasaki	1958	6
Shimonoseki	1964	7 (2)
Taiwan	1964	10

Note : Number of strains obtained from carriers are shown in parentheses. In Kyung Gee and Kong Won Do, there were no strains of patients' origin ; these strains in parentheses were isolated when detection of enteric pathogens was carried out 1964 on an extensive scale.

lists. Though the strains isolated in 1957-1958, having been kept for a longer time, they feared to be out of use for typing because of their having lost Vi-antigen, we felt at ease to find that their antigen were still maintained. As for these strains agglutination-test with anti-Vi-serum was carried out immediately after receiving the strains, and it was proved at that time that out of 33 strains in total 11 strains have not had this antigen since the beginning. As will be stated afterwards there were 12 strains being free from Vi-antigen. The preservation of the strains was successful in this manner is probably because they were carefully maintained in "cooked meat medium".

**Phage typing method :** The typing of the strains isolated in Korea in 1962-1964 was practised dividing into several groups, in which there were organisms belonging to a group maintained commonly for about one year as the longest period.

The typing method adopted is of what was described by the Typing Center mentioned above and it was done strictly keeping to the appended notes received together with the set of standard phages with the determined marks of the types from the center. As the Vi-phage preparations allocated were of the concentration 100 times as long as that of the routine test dilution (R.T.D.), they were used for our typing after diluting them with nutrient broth to be 1 R. T. D. When a test strain is inoculated into brain heart infusion medium and incubated for 3-4 hours, its optical density will come to correspond approximately to the density where 10<sup>8</sup> bacterial cells are suspended per ml of the medium. 0.2-0.5 ml of this suspension is let flow on a agar plate and is spread uniformly with a CONRAD's glass-stick. Then surplus suspension is removed and this inoculated plate is dried at 37°C for 10-20 minutes. After dropping of each phage preparations of 1 R. T. D. onto the plate, via a slight drying, it was cultivated at 37°C for 16-20 hours with the cover on. The phage being of such a large number of sorts of 72, it will take many hours to apply the phage preparations to each of the test-strains. Therefore, with the experience of PARK et al. (1963) in the typing on 130 strains of *S. typhi* isolated in Korea in 1962, application of phage M<sub>1</sub>, M<sub>2</sub>, and M<sub>3</sub> was performed first of all, and next, other phages applied one by one making several pools of the phage preparations in suitable combinations. When plaques were formed in this process, each phage was particularly tested. By preparing phage pools, each of them was, of course, diluted before mixing so as each phage to be 1 R.T.D.

Needless to say that the tests for biochemical properties and for antigenic structure of the test-strains were performed within the necessary limit. The judgement of phage types on a strain was done by observing the plaque formation on agar plates and in accordance with Dr. ANDERSON's

table for classification (1960). Once in a while, some strains were not agreeing with the lytic patterns in the table above as the susceptibility of the organism towards the phage was weak. However, when re-examination with more concentrated preparations was made, the results

nearly agreeing with the fixed patterns in the table could be obtained.

The typing method above concerns only our tests as for 399 strains of Korean origin. We have no particulars yet as to typing method practised in Japan Salmonella and Shigella Center.

### Results of Vi-phage typing

The typing results of *S. typhi* strains isolated in every administrative district of Republic of Korea excepting Chonnam, Kyungnam and Cheju Island, 1962-1964, are shown in Table 2 dividing in regional groups. The phage type ranking first is M<sub>1</sub> which amounts to 220 and occupies 55.1 per cent of the total. Type M<sub>3</sub> ranks second (51 strains, 12.8 per cent), taking no thought of the strains lacking Vi-antigen and of these showing resistance of the phages belonging to Vi II group. Thus, making a total of M<sub>1</sub> and M<sub>3</sub> (M<sub>2</sub> in addition, though very few in this case), it can be said that type M in a wide sense occupies nearly 70 per cent of all the test-strains, and percentage of M amounts to 88 really.

The rest is few, and they have been arranged in order of decreasing occurrence in this respect : E<sub>1</sub> 12, D<sub>10</sub> 8, type 46 4, A 3, D<sub>9</sub> 3, D<sub>1</sub> 2, and 1 of each B<sub>2</sub>, E<sub>3</sub>, E<sub>8</sub>, E<sub>10</sub>, M<sub>2</sub> respectively.

The occurrence of M<sub>1</sub> and M<sub>3</sub>, or M in a broad sense, is ubiquitous throughout the district, but D<sub>10</sub> has a partiality for Kyung Gee and Kang Won Do, central part of the Republic, and E<sub>1</sub> Chonpook. In the latter two types, D<sub>10</sub> and E<sub>1</sub>, the strains of D<sub>10</sub> are all those originated from carriers (Table 1), but as they have been found by simultaneous examination of feces of Korean soldiers, there is no gainsaying any connection among them. As to type E<sub>1</sub> strains, there is a definite information regarding their

**Table 2.** Distribution of Vi-phage types in Korea, 1962-1964

Phage type	Seoul	Kyung Gee Do	Kang Won Do	Chung-pook	Chung-nam	Kyung-pook	Chon-pook	Total	Per cent
A	0	0	0	0	0	3	0	3	0.8
B <sub>2</sub>	0	0	0	0	0	1	0	1	0.3
D <sub>1</sub>	0	0	0	0	0	2	0	2	0.5
D <sub>9</sub>	0	0	0	0	0	3	0	3	0.8
D <sub>10</sub>	0	5	2	0	0	1	0	8	2.0
E <sub>1</sub>	0	1	0	0	0	0	11	12	3.0
E <sub>3</sub>	0	0	0	0	0	1	0	1	0.3
E <sub>8</sub>	0	0	0	0	0	1	0	1	0.3
E <sub>10</sub>	0	0	0	0	0	1	0	1	0.3
M <sub>1</sub>	15	20	6	7	43	129	0	220	55.1
M <sub>2</sub>	1	0	0	0	0	0	0	1	0.3
M <sub>3</sub>	10	2	0	0	10	29	0	51	12.8
46	0	0	0	0	0	4	0	4	1.0
I+IV	0	1	1	0	2	18	0	22	5.0
Vi(-)	4	6	5	0	4	50	0	69	17.3
Total	30	35	14	7	59	243	11	399	100.0

**Table 3.** Phage types of strains obtained in cases of epidemy

Year	District	Phage types					Total
		E <sub>1</sub>	M <sub>1</sub>	M <sub>3</sub>	I+IV	Vi(-)	
1962	Kwe San, Chungpook	0	7	0	0	0	7
1962	Chinan, Chonpook	11	0	0	0	0	11
1963	Kongju, Chungnam	0	12	0	0	0	12
1964	Goonwue, Kyungpook	0	6	2	2	0	10
1964	Taejon, Chungnam	0	31	10	2	4	47
Total		11	56	12	4	4	87
Per cent		12.6	64.4	13.8	4.6	4.6	100.0

mutual relationship. As will be stated later on, the partiality of E<sub>1</sub> for Chonpook is mainly attributable to an outbreak of epidemic at a certain place in Chonpook, and because 11 out of all 12 strains are considered to be originated from a focus of infection, it does follow that this type is smaller in number than one expects.

After all we were quite surprised at the predominance of type M in a broad sense in Korea, though it was predictable from the world literatures that type M is detectable in a fairly high rate in some district of Asia and from the latest work of PARK et al. (1963) in Korea using 130 strains in which the predominance of M<sub>1</sub> especially emphasized.

There were 87 strains obtained from cases of local epidemics of typhoid fever mixed in the test-strains. As shown in Table 3, they are classified

into five groups by regions. Among them 7 strains from Kwe San and 12 from Kongju are of type M<sub>1</sub>, 10 from Goonwue and 47 from Taejon are mainly of M<sub>1</sub> partly mixed with M<sub>3</sub>, and, as stated already, 11 from Chinan are all of E<sub>1</sub>.

Among these cases it is obvious that the origin of the epidemics in Kwe San, in Chinan and in Kongju, however, as strains of type M<sub>3</sub>, of "untypable" and of "Vi-negative" other than M<sub>1</sub> are mixed in fairly high rate, we can not fix the role of phage type in epidemiology of the disease so simply. SUH (1964), one of the authors, tried once to explain these affairs venturing a hypothesis. But, we will not take up the subject here, as it is out of the purpose of this paper to refer to it.

The typing results reported from Japan *Salmonella* and *Shigella* Center through the kindness of Dr. FUKUMI and Dr. OHASHI are shown in Table

**Table 4.** Typing results reported from Japan Salmonella and Shigella Center

Phage type	Korea (1957)	Nagasaki (1958)	Shimonoseki (1964)	Taiwan (1964)	Total
A	0	0	0	3	3
A degraded	6	2	0	0	8
D <sub>1</sub>	0	0	0	1	1
D <sub>2</sub>	1	0	5	3	9
E <sub>1</sub>	1	1	0	1	3
M <sub>1</sub>	8	0	1	2	11
Untypable	0	2	1	0	3
Vi(-)	11	1	0	0	12
Total	27	6	7	10	50

4. The number of sample is too small, and the strains isolated in 1957-1958 can not always be considered to be suitable for this work of

typing, but we can not pass by it unnoticed as the strains from Korea have a tendency to be superior to others in containing type M.

### Bird's-eye view of typing results recorded in Literature

#### A. The data in the past ten-odd years

Many records of Vi-phage typing of *S. typhi* have been handed down since 1955 in Germany, France and England, while very scarce in Asia. Among the reports announced by NICOLLE of the Pasteur Institute on the typing results obtained from each regional center at the International Congress of Microbiology in Stockholm, 1958, the results obtained from India, Indonesia, Vietnam, Philippines and Japan were made public together, though in December, 1961, three years after the announcement at the Congress, they were officially accepted at last in the Annals of Pasteur Institute, which was published in February, 1963. Thereupon, in reality, the data which were acquired after the Congress were added in this report, as being confirmed by addition of the results in the year 1960 presented by FUKUMI in Japan.

The data to be added here besides those announced by NICOLLE are: (1) the results obtained by PARK et al. (1963) in Korea, 1961-1962; (2) by SUH one of the authors, in Korea, 1962-1964; (3) the results of the collected by AOKI and entrusted Dr. FUKUMI with typing (the reporter in Table 5 is named AOKI for convenience); (4) the report from FUKUMI's laboratory in 1961-1963; (5) the data by HIROKI shown concretely in the paper of BRANDIS (1955), and IMAMURA and BRANDIS (1955); (6) the data in the Annual Report of the Institute for Medical Research, Kuala Lumpur, Federation of Malaya; (7) the data from Indonesia which can be seen in the paper of LEE KIAN JOE (1950), Laboratory of Tropical Hygiene of the University of Leyden.

In the Institute in Kuala Lumpur the isolated

strains were sent every year to Dr. WILSON, Melbourne University, Australia, for typing. Five hundred and sixteen strains are reported to have been put to typing down to 1961, but the figures concretely recorded are 254 strains down to 1958. Besides these data we could know that BHAGWAT et al. and SANT, India, have reported Vi-phage types at the symposium "the Problem of *Salmonella* Infection in India" held in 1961, but as no bulletin carrying the proceeding could be found in any libraries in Japan, there is no knowing of the results announced at the symposium.

Table 5 gives data thus collected and arranged in the form of distribution percentages. In this table results of LEE, KIAN, JOE, FUKUMI and SUH have been divided into two parts, namely A and B, respectively. The column "Lee Kian Joe A" concerns with the paper of him mentioned in 1949 and "B" is the data which can be seen in the paper of NICOLLE (1962). The column "Suh A" includes all the results of the strains tested and "B" of him means only the results of the strains isolated from sporadic cases. "FUKUMI A" concerns strains isolated in 1957-1960 and "B" in 1961-1963. The fact that B<sub>1</sub> and D<sub>10</sub>, which are reported to have been found for the first time in Japan in 1961, are not included in column "A" makes this division clear. As for the results of FUKUMI in 1961-1963, the authors evaluated the original data from the Annual Report of National Institute of Health, Tokyo, for years of 1961-1963 and added them up together and showed them in percentages. As for the results in the column named AOKI, they cover Korea, Taiwan and Japan, but individual figures

Table 5. Distribution of Vi-phage types of *S. typhi* isolated in Asian countries

Country	India	Indonesia		Malaya	Vietnam	Philip- pines	Japan			Republ. of Korea			Various places
	Purandare	Lie Kian Joe		Inst. Med. Res.	Fournier et al.	Briones	Hiroki	Fukumi		Park et al.	Suh		
		A	B					A	B		A	B	
Number of strains	889	355	78	254	1, 243	130	158	264	425	130	399	312	50
A	40.0	18.6	15.0	20.2	9.18	60.0	7.0	12.0	14.1	1.5	0.8	1.0	22.0
B <sub>1</sub>	—	13.0	2.0	5.5	0.39	—	—	—	1.9	—	—	—	—
B <sub>2</sub>	—	—	—	0.8	0.49	—	5.1	2.7	—	1.5	0.3	0.3	—
B <sub>3</sub>	—	—	—	0.8	—	—	—	1.2	—	0.8	—	—	—
C <sub>1</sub>	—	—	—	—	0.15	5.38	—	—	—	—	—	—	—
C <sub>3</sub>	—	—	—	—	0.39	—	—	1.2	—	—	—	—	—
C <sub>4</sub>	0.8	—	—	—	—	—	—	0.4	—	—	—	—	—
C <sub>5</sub>	3.0	—	—	—	0.07	—	—	0.4	—	—	—	—	—
D <sub>1</sub>	2.3	1.1	1.0	13.8	1.35	0.76	3.2	4.9	0.9	5.4	0.5	0.6	2.0
D <sub>2</sub>	—	17.2	10.0	2.4	3.43	—	17.1	20.5	34.0	—	—	—	18.0
D <sub>4</sub>	1.0	0.3	—	—	0.47	—	—	—	0.2	—	—	—	—
D <sub>6</sub>	0.5	21.9	17.0	0.4	0.19	—	3.2	4.5	1.2	—	—	—	—
D <sub>9</sub>	—	—	—	—	—	—	—	—	—	0.8	0.8	1.0	—
D <sub>10</sub>	—	—	—	—	—	—	—	—	0.5	—	2.0	2.6	—
E <sub>1</sub>	12.0	16.7	6.0	7.1	7.5	0.76	17.1	12.5	6.4	8.5	3.0	0.3	6.0
E <sub>2</sub>	—	0.3	1.0	3.1	0.07	21.53	—	—	—	—	—	—	—
E <sub>3</sub>	—	—	—	—	1.43	—	—	—	—	0.8	0.3	0.3	—
E <sub>4</sub>	1.5	—	6.0	—	0.23	—	—	—	—	—	—	—	—
E <sub>7</sub>	—	—	—	—	0.23	—	—	—	—	—	—	—	—
E <sub>8</sub>	—	—	—	—	—	—	—	—	—	—	0.3	0.3	—
E <sub>10</sub>	—	—	—	—	—	—	—	—	—	0.8	0.3	0.3	—
F <sub>1</sub>	0.35	—	—	—	0.15	—	—	—	—	—	—	—	—
G	0.5	—	—	1.6	3.35	—	—	—	—	—	—	—	—
H	—	—	—	—	0.15	—	2.5	0.4	0.7	—	—	—	—
J <sub>1</sub>	1.4	—	—	1.6	—	—	0.6	0.5	0.7	—	—	—	—
K	0.8	—	—	—	1.75	—	—	—	—	—	—	—	—
L	—	—	—	—	0.15	—	—	1.5	—	—	—	—	—
M <sub>1</sub>	—	0.9	—	2.4	14.52	—	11.4	16.7	7.8	48.5	55.1	52.6	22.0
M <sub>2</sub>	—	—	—	—	—	—	—	—	—	—	0.3	0.3	—
M <sub>3</sub>	—	—	—	—	—	—	—	—	—	—	12.8	12.5	—
N	—	0.2	—	1.6	2.63	0.76	—	—	—	—	—	—	—
O	9.4	—	—	0.4	—	—	—	—	—	—	—	—	—
T	1.6	—	—	3.9	4.54	—	—	0.4	—	—	—	—	—
25	—	3.7	5.0	0.8	0.15	—	—	—	—	—	—	—	—
28	1.0	—	—	—	0.39	—	—	0.4	—	—	—	—	—
29	—	—	2.0	—	2.31	—	—	0.4	—	—	—	—	—
31	—	—	—	0.4	—	—	—	—	—	—	—	—	—
36	—	—	2.0	—	—	—	—	—	—	—	—	—	—
37	—	—	—	—	1.27	—	—	—	—	—	—	—	—
38	—	—	—	—	—	—	—	0.8	—	—	—	—	—
39	—	—	—	—	—	—	—	1.5	8.0	—	—	—	—
41	—	—	—	—	—	—	—	1.2	—	—	—	—	—
46	—	—	—	—	—	—	—	—	—	1.5	1.0	1.3	—
N + D <sub>1</sub>	—	—	—	—	—	—	—	4.5	15.8	—	—	—	—
Kito	—	—	—	—	—	—	—	1.2	—	—	—	—	—
Shigaraku	—	—	—	—	—	—	—	0.8	—	—	—	—	—
I + IV	5.4	4.0	15.0	20.2	19.39	—	10.0	2.3	3.2	3.8	5.5	5.8	6.0
Degraded	18.8	—	15.0	12.6	19.71	—	1.9	—	—	—	—	—	—
Vi negative	—	1.9	—	—	2.87	10.76	20.9	9.5	4.9	26.2	17.3	20.8	24.0

Note : The results divided into A and B have been explained in the text. The number of strains coincides with number of foci only in the case of Fukumi. There are other data presented by Fukumi (1959) which corresponds to "A", the data cited from Nicolle, viewed in the light of distribution percentages, but not agree in the total number ; the number in this Fukumi's report which means "foci" is noted in this table.



of each region being very small, they were not shown by regional groups but in their total number.

In Japan, in addition, there is a record regrading 294 strains of *S. typhi* collected by HIROKI down to 1955 from every place of Japan. The results were reported by him briefly as an additional speech at a symposium (HIROKI, 1964), but it is not included in this table as it is not carrying numeral illustrations. There is no doubt that the data introduced by BRANDIS (1955) concerning 158 strains constitute a part of his announcement at the symposium.

At a glance of Table 5 illustrated in percentages, it is to be seen that the predominance of type M, especially M<sub>3</sub> is highly characteristic in Korea. It is already known that M<sub>1</sub> exists in scattered distribution as compared with E<sub>1</sub>, A, C, D<sub>2</sub>, F<sub>1</sub>, etc. which are quite common all over the world,

the type M is more frequently detectable in some country in Asia. This is convincing indeed judging from the data presented by FOURNIER et al. of Vietnam, by HIROKI and by FUKUMI of Japan. However the appearing rate of M<sub>1</sub> in Korea is higher still; there are no numbers in double figures as to various types other than M in the data by PARK et al. and also in the data by SUH on 399 strains, particularly in the latter case, putting M<sub>1</sub>, M<sub>2</sub> and M<sub>3</sub> together into the letter of M, the total comes to approximately 70 per cent. In addition to this, the typing results of 27 strains isolated in Korea in 1957 (Table 4) might as well be foundation for consideration. Among them there are 16 strains possessing Vi-antigen, and they have been typed M<sub>1</sub> 8, A degraded 6, D<sub>2</sub> 1, and E<sub>1</sub> 1.

**Table 6.** Results of phage typing practised around 1940

Reporter	C. H. Yen Peiping 1936-1939		Kawabe Tokyo 1941	Kodama et al. Yokohama 1941-1943
	125(cases)	78(foci)	223	888
A	21(17.9)	15(21.4)	14( 7.3)	69( 7.8)
B <sub>1</sub>	-	-	3( 1.6)	3( 0.3)
B <sub>2</sub>	-	-	9( 4.7)	125(14.1)
C	-	-	1( 0.5)	-
D <sub>1</sub>	10( 8.6)	5( 7.2)	-	-
D <sub>2</sub>	-	-	83(41.0)	231(25.9)
E <sub>1</sub>	28(24.0)	16(22.8)	29(20.2)	153(17.4)
F <sub>1</sub>	-	-	1( 0.5)	-
G	7( 6.0)	3( 4.3)	2( 1.0)	-
H	1( 0.9)	1( 1.5)	10( 5.2)	50( 5.6)
L	-	-	-	14( 1.6)
L <sub>2</sub>	-	-	-	2( 0.2)
M	-	-	22(11.4)	113(14.9)
N	-	-	1( 0.5)	18( 2.0)
P 15	10( 8.6)	8(11.4)	-	-
P 16	8( 6.8)	7(10.0)	-	-
Imperf. Vi	32(27.4)	15(21.4)	18( 9.4)	110(12.4)
Vi (-)	8	8	30	?

Note : Types and actual numbers are recorded as authors' description. Percentages (parenthesized) have been calculated leaving "Vi negative" out of account.

## B. Data in the 1940's

The standard phages for typing Vi-carrying typhoid bacilli numbered more than 11 when CRAIGIE started his work in 1938. Seven phages were added soon after, and in the provisional standard method advocated by CRAIGIE and FELIX in 1947, 24 preparations of the phage were requested as the articles of necessity. After that the number of standard phage went on increasing; it came to 33 in 1951, 44 in 1954, and, as already stated, 72 preparations were supplied from Dr. ANDERSON'S Laboratory and they were used in this typing study. Thus the Vi-phage typing was bringing about step by step a change in its scope of examination and minuteness of the method as such. Therefore, in our opinion, the data at the dawn of a new age of this typing should not be directly compared with those in the 1950's and thereafter. The comparison among the results of YEN (1940) in Peiping, KAWABE (1942) in Tokyo and KODAMA et al. (1948) in Yokohama has been established from this viewpoint independently of the data enlisted in Table 5. Though the report of KODAMA was so late in publishing, the typing had been done in 1941-1943 using the same phages as YEN'S.

Dr. C. H. TEN, one of the originators of Vi-phage typing, kept back his contributions of further studies in Chinese Medical Journal in 1940, being on the staff of Union Medical College, Peiping. He used 17 standard and newly-founded phages with the object of typing 125 strains isolated in Peiping in 1936-1939, and, in 1940, 18 out of the total 19 phage preparations were turned over by him to a certain worker being on post in Kitasato Institute, Tokyo. Phages transferred were A, B<sub>1</sub>, B<sub>2</sub>, B<sub>3</sub>, B<sub>4</sub>, C, D<sub>1</sub>, D<sub>2</sub>, E<sub>1</sub>, E<sub>2</sub>, F<sub>1</sub>, F<sub>2</sub>, G, H, J, L, M, and P 15.

Table 6 shows the results of typing by these workers around 1940. As can be seen in this table Peiping is subject to frequent E<sub>1</sub>, A, D<sub>1</sub> and

P 15, while in Japan D<sub>2</sub> ranks first, and E<sub>1</sub>, M and so forth come in succession. The results in Peiping and in Tokyo-Yokohama area are impressive contrasts indeed, and, to say more exactly, the type distribution in Peiping is rather European like as against the finding in the latter area which bears some resemblance to that pattern shown in the results of HIROKI and of FUKUMI in the 1950's. There is a considerable difference as to occurrence of type B<sub>2</sub> between the data of Tokyo and of Yokohama. But, it is easily understandable, as there is a considerable sum of strains originated from an epidemic focus in the test strains of KODAMA et al. According to KAWABE (1944) these strains were type B<sub>2</sub> in all.

## C. Our view of the subject

After all it admits of no doubt that M<sub>1</sub> and M<sub>3</sub> or M, broadly speaking, are in general characteristic of Asian countries, and the latest studies of the authors on the situation in Korea put particular emphasis on this feature. That type E<sub>1</sub> is distributed throughout the world can be admissible also in the results. But in Asia it does not hold a predominant position among many Vi-phage types, for it appears in a rather low rates in every country. Type A too is possibly recognized to be common in Asia, for it ranks top in India and Philippines and it occupies considerably high percentages in other countries except Korea. According to the Annals of the Institute for Medical Research, Federation of Malaya, 1958, the state of distribution of Vi-phage types in the Federation and Singapore is mostly similar to that in Indonesia, and is nearly like that in Britain, India and Australia. According to the explanation telling that the frequency of M is becoming higher as we go down southward cannot be applied to the data of the authors, it cannot be denied that the type distribution in a part of Asia is quite similar to that in Europe.

Most of handbooks and textbooks say that type

$E_1$  is of the most common all over the world, with type A coming next, and that there is little difference if any between Vi-phage types in the western hemisphere and those in the eastern hemisphere. Careful consideration must be given to the fact that the above statement is not applicable to Korea, Japan and Vietnam, though situated in the eastern hemisphere but in its border. The authors have an idea to further their studies on distributions of phage types, and simultaneously to extend their object of studies to paratyphoid, and if possible, to enteric diseases caused by bacteria in general. And what one thinks most necessary is to grasp the actual conditions of enteric diseases of this meaning in those countries where medical investigations have not yet satisfactorily been developed.

It was proved in this paper by five small cases of epidemic in Korea that the Vi-phage typing is usefull in practice for the detection of sources of epidemic as well as for the tracing of route of

dissemination of the disease. A few examples of mass outbreak of typhoid fever, in Japan, though only in a small scale, and results of Vi-phage typing of the causative organisms isolated in every place of Japan are reported in outline every year in the Annual Report of National Institute of Health, Tokyo, most of them furnishing helpful reference to the prevention of this epidemic disease.

Another advanced idea was recently told by NICOLLE, LE MINOR et BRUNET (1963) to the effect, "the phage typing give evdence or at least arguments in favor a precise alimentary origin of the contamination, when the isolation of the germ has been performed in a food sample" And moreover, there is another group of researchers, for example BOKKENHEUSER (1964), who are performing the demonstration of typhoid Vi-phages in sewage and water, and who are aiming at utilization of Vi-phages as indicators to fecal contamination of human origin.

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腸チフス菌Viフェージ型の地理的分布  
主として韓国における成績に基いた概覧

青木 義 勇

長崎大学医学部細菌学教室

全燾基 徐廷洙 河大有

韓国慶北大学校医科大学細菌学教室

李 鍾 承

韓国国立保健院 (WHO韓国サルモネラセンター)

韓国は現在腸チフスの脅威に直面している。日本もまた、その終戦後2、3年間の急減こそ目覚ましいものがあったが、この数年人口10万に対する罹患率が1を上下しつつ殆ど停滞、時には小規模ながら集団発生もあり、欧米先進国の事態に劣っている。更に南方には根強い浸透が予測され、本病に対する関心は疎かにさるべきでない。

本病の感染源追跡に最も信頼を持たれる細菌学的方法は分離 *S. typhi* 菌株の Vi フェージ型別であり、韓国でも日本もこの点についての有意性が立証された流行事例がかなりある。しかし著者等は今回は観察の範囲を広くアジア各地にとり、各地の分離菌株の Vi フェージ型成績を比較することを主目的に本稿をなした。

実績としては韓国1962—1964年分離399株に関するものがあり、また青木が菌株を蒐集し予研細菌第1部に型別を依頼した50株の成績がある。その他はすべて資料を文献や報告書の類に求めたが、Vi フェージ型別が大体国際的に標準化されて実施に入った1950年代以降のものと、本法の創始期1940年前後に北京の YEN、我国の河辺、児玉等によって行われたものとに別ち、別々に比較を行った。前者は主として NICOLLE(1962)の報告によったが、このほかに調査によって得た若干の資料が加えられている。

韓国分離399株はM<sub>1</sub> 220, I + IV 69, M<sub>3</sub> 51, Vi (-)22, E<sub>1</sub> 12, D<sub>10</sub> 8, 46型 4, A<sub>3</sub>, D<sub>9</sub> 3, D<sub>1</sub> 2, 及び B<sub>2</sub>, E<sub>8</sub>, E<sub>9</sub>, E<sub>10</sub>, M<sub>2</sub>, 各1株と内訳される。M<sub>1</sub>のこのような高率、特にM<sub>3</sub>, M<sub>2</sub>をも合算し、広義のM型としてみた場合、分離菌の約70%がこれに該当する事実は、従来の文献にみられない特筆すべきことである。アジアにM<sub>1</sub>型が比較的多いことは文献上予測していたことであるが、今回の実績と調査の結果は全くこれを支持するものであった。日本では韓国ほどM型が高率でなくD<sub>2</sub>やAがかなり立証される。このことは1940年前後に行われた研究成績ともよく一致する。