STUDIES ON THE TYPING OF *ERYSIPELOTHRIX RHUSIOPATHIAE*

I. SEROLOGICAL BEHAVIOURS OF *ERYSIPELOTHRIX RHUSIOPATHIAE* ISOLATED FROM PIGS

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Regarding swine erysipelas, a number of problems, especially those concerned with its infection and immunity, still remain unsolved. The main reason for this confusion is considered to be due to the lack of proper classification of the causative organisms and, accordingly, the uncertainty of the relationship between disease types and the types of causative organisms.

WATTS¹⁹⁾, ATKINSON^{1,2)}, DEDIÉ^{7,8)}, ROOTS^{14,15,16)} et al suggested the presence of at least 2 serologically different types among the causative organisms of swine erysipelas. Thus, it may be a mistake to say that all the strains of *Erysipelothrix* isolated from different types of swine erysipelas, generalized infection of fowls, localized lesions of cattle and humans, and from the body surface of marine fishes, are identical.

But, unfortunately, their investigations have been advanced into the practical field of selecting strains suitable for vaccine production and not into the field of basic studies such as the clarification of disease types and serological behaviours of the causative organisms, etc.

On the other hand, in Japan, no objections have appeared to the publication of SAKAI's paper*, which was supported by KONDO and SUGIMURA**, on the biological and serological identity of the organisms isolated from the body surface of marine fishes in relation to those isolated as the causative agents of swine erysipelas.

Stated in the following are the findings of serological investigations made on a number of *Erysipelothrix* strains isolated from pigs suffering from both generalized and localized erysipelas as well as from the tonsils of apparently normal pigs with discussions on the relationship between the serotypes and the diseases produced, namely, on the pathogenicity of individual serotypes.

MATERIALS AND METHODS

Strains Used

1. Strains isolated from apparently normal pigs

During the early summer in 1954, attempts were made to isolate the so-called *Erysipelothrix rhusiopathiae* from the tonsils of pigs slaughtered at the Shibaura Slaughter House in Tokyo, by means of mouse inoculation.

Out of the 129 pigs examined, 50 strains, biologically identified as *Erysipelothrix rhusiopathiae*, were isolated from the tonsils of 50 (38.6%), of which 40 were selected at random to be used in the present study.

2. Strains isolated from the pigs suffering from erysipelas

A total of 44 strains were used, namely, 22 strains isolated from pigs having the septicemic form of erysipelas, 19 strains of the urticarial form, and 3 strains isolated

*, **, ... will be noted in the 3rd paper of this series

from pigs having generalized infection, one from a pig having hog cholera, one from a pig after it had received hog cholera vaccine, and the other from a pig after it had been inoculated with hog cholera virus.

The majority of the above strains were isolated from the materials sent to the National Institute of Animal Health due to the suspicion of erysipelas.

3. Strains received from abroad

A total of 33 strains received from the U.S.A., Canada, Germany and Formosa, were used. Except for a few, they were strains derived from pigs suffering from erysipelas.

Five strains received from DEDIÉ, as representative strains of his serotypes, enabled us to compare his serotypes with ours.

PREPARATION OF ANTIGENS AND IMMUNE SERA

1. Agglutininogen

Broth cultures, grown for 48 hours, were centrifuged, washed once with physiological saline and resuspended to give a density of McFarland No. 1. Formalin was added up to a concentration of 1% and it was then left standing at room temperature for 24 hours.

2. Precipitinogen

Nearly pure polysaccharide, obtained by a slightly modified Boivin's method, (shown in the following chart) and dissolved in distilled water to give a concentration to 1 mg/ml, served as the original solution for the precipitation test.

3. Immune sera

Broth culture, of a strain grown for 48 hours, was centrifuged, washed once with physiological saline, resuspended to give a concentration of McFarland No. 5, and then heated at 70°C for 1 hour. Suspensions thus prepared were stored in a refrigerator during the whole period of immunization.

Rabbits were employed for the immunization and 4 injections of antigen were given

in increasing dosages of from 1 ml to 4 ml at intervals of 3 days. They were bled through a carotid 10 to 12 days after the last injection. As a preservative, mertiolate was added up to a concentration of 0.01% and it was then stored in the refrigerator regulated at 5°C.

SERO-REACTIONS FOR CLASSIFICATION

The agglutination test was first utilized for the classification of the above mentioned strains, but in view of the difficulty commonly encountered with the use of the agglutination test in the case of Gram positive organisms, namely, the delicate relationship existing between the method of sensitization and the optimal time for reading the reaction, as well as the difficulty in preserving the antigens, attempts were made to use the precipitation test.

Findings by means of the precipitation test were identical to those by the agglutination test. Thus, in spite of the complicated techniques required for the preparation of precipitinogens, it was decided to employ this test as the chief means to accomplish our serological classification.

Usefulness of slide agglutination as a routine procedure, however, will be discussed in the fourth report of the present series.

PRECIPITATION

Antiserum was dispensed into a series of MURATA's test tubes in an equal amount. Then, antigen, in progressive dilutions, was carefully introduced onto the wall of a test tube so as to form a separate layer on the surface of the antiserum. The highest dilution of antigen which produced a definite ring between the two layers was taken as the end titre of test and designated by plus signs (original, +; 1:10 dilution, ++; 1:100 or higher, ###).

RESULTS

1. Strains isolated from the tonsils of apparently normal pigs

40 strains were selected at random out of the 50 strains which had been identified as *Erysipelothrix rhusiopathiae* on the basis of their biological findings and mouse pathogenicity. In order to investigate their mutual serological relations, polysaccharide antigens were prepared from all strains, and antisera from some of them.

As shown in Table 1, the 40 strains were classified serologically into 5 groups; Group I (3 strains), Group II (22 strains), Group III (3 strains), Group IV (7 strains) and Group V (5 strains). Strains of Group V reacted only with their own sera or showed no reaction even with their own sera, namely, the latter ones showed no antigenicity.

On comparison with the strains isolated from sick pigs, as partially shown in Table 1, the strains belonging to Group I were found to be identical to those isolated from the pigs suffering from the septicemic form of erysipelas and also to the strains of Gruppe-A of DEDIÉ (shown in Table 2).

The strains belonging to Group II were found to be identical to those recovered from pigs suffering from the diamond skin disease, and also were identical to the strains of Gruppe-B, of DEDIÉ.

2. Strains isolated from the pigs suffering from erysipelas (septicemic form, urticarial form and that complicated with hog cholera)

As shown in Table 2, all the 22 strains isolated from pigs suffering from the septicemic form of erysipelas were found to belong to Group I (Gruppe-A), while 16, out of the 19 strains isolated from the local lesion or blood stream of pigs suffering from urticarial

Table 1. Results of Precipitation Tests made with the Strains isolated from apparently Healthy Pigs

Antiserum (Source & Name of the Strain used for Immunization) Antigen (Source & Name of the Strain used in its Preparation)			Fish						Pig										Duck	Results (Group)				
			Sardine II	IV	Flying fish II	Yellow-fin 100	Sea bass 106	Sardine 36	Yellow-tail 90	Sick		Healthy									Sep.			
										Sep.	Ur.	Lu.	Tonsil											
													318	Kashiwa	Nagano	1132	Iwa. 1-3	35	S.T.-1			Iwa. B-4	Chi. B-2	Kago. A-2
Strains isolated from the tonsils of apparently healthy Pigs	Aomori	A-3	-	-	-	-	-	-	++	++	-	-	-	-	-	-	-	-	-	-	-	-	-	I
	"	A-4	-	-	-	-	-	-	++	++	-	-	-	-	-	-	-	-	-	-	-	-	-	"
	Niigata	-1	-	-	-	-	-	-	++	++	-	-	-	-	-	-	-	-	-	-	-	-	-	"
	Aomori	A-2	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	II
	Chiba	B-4	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	B-5	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	B-6	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	Iwate	A-1	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	A-3	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	B-5	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	B-7	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	Kagoshima	A-3	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	Nagano	B-1	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	B-2	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	B-3	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	Shibaura	-1	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	S. T.	-7	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	-15	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	-16	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	-25	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	-42	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	-43	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	-9	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	Yamagata	-1	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	"	-9	-	-	-	-	-	-	-	-	++	++	++	++	-	-	-	-	-	-	-	-	-	"
	Chiba	B-1	-	-	++	-	-	+	-	-	-	-	-	-	-	++	-	-	-	-	-	-	-	III
	Iwate	B-2	-	-	++	-	-	++	-	-	-	-	-	-	-	++	-	-	-	-	-	-	-	"
	"	B-3	-	-	+	-	-	++	-	-	-	-	-	-	-	++	-	-	-	-	-	-	-	"
	S. T.	-1	-	-	++	-	-	++	-	-	-	-	-	-	-	++	-	-	-	-	-	-	-	"
	"	-45	-	-	++	-	-	++	-	-	-	-	-	-	-	++	-	-	-	-	-	-	-	"
	Yamagata	A-1	-	-	+	-	-	++	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	"
	"	A-2	-	-	++	-	-	+	-	-	-	-	-	-	-	++	-	-	-	-	-	-	-	"
	Chiba	B-2	++	-	-	-	-	-	-	-	-	-	-	-	-	++	++	-	-	-	-	-	-	IV
	"	B-3	+	-	-	-	-	-	-	-	-	-	-	-	-	++	+	-	-	-	-	-	-	"
	Iwate	B-4	++	-	-	-	-	-	-	-	-	-	-	-	-	++	+	-	-	-	-	-	-	"
	Kagoshima	A-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	V
	"	A-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(-)	-	-	-	-	-	"
	S. T.	-13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-	-	-	"
	Ymagata	-5	-	-	-	-	-	-	++	-	-	-	-	-	-	-	-	-	-	++	-	-	-	"
	Iwate	B-8	-	-	-	-	++	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-	"
Strains isolated from sick Pigs	Sepsis	H. C.	119	-	-	-	-	-	++	++	-	-	-	-	-	-	-	-	-	-	-	-	-	I
		"	186	-	-	-	-	-	++	++	-	-	-	-	-	-	-	-	-	-	-	-	-	"
		Kashiwa	-	-	-	-	-	-	++	++	-	-	-	-	-	-	-	-	-	-	-	-	-	"
	Urticaria	Fukushima	-1	-	-	-	-	-	-	-	++	++	++	++	+	+	-	-	-	-	-	-	-	II
"		-2	-	-	-	-	-	-	-	++	++	++	++	+	++	-	-	-	-	-	-	-	"	
H. C.		149	-	-	-	-	-	-	-	++	++	++	++	++	+	+	-	-	-	-	-	-	"	
Duck	Matsukawa	-	-	-	-	++	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	V	

Table 2. Results of the Precipitation Tests made with Swine Strains

Isolated by	History of Strains Tested (Source of Group)	Groups of Authors' Classification						No. of Strains Tested
		I	II	III	IV	V 1 2		
Murase et al (Japan)	Tonsils of Healthy Pigs	3	22	7	3	4	1	40
	Septicemic Erysipelas	22						22
	Urticarial Erysipelas	3	16					19
	Complication with Hog Cholera Virus	1	2					3
Dedié (Germany)	Source Unknown, Gruppe-A	2						2
	Source Unknown, Gruppe-B		2					2
	Source Unknown, N-Formen	1						1
Roots (Germany)	Septicemic Erysipelas, Gruppe-A	2						2
	Source Unknown, Septicemic Erysipelas	1						1
	Source Unknown, Gruppe-B		2					2
Ryu (Formosa)	Septicemic Erysipelas	3						3
	Lungs of Healthy Pigs		2					2
Stovell (Canada)	Chronic Arthritis		3					3
	Generalized Arthritis		2					2
	Acute Skin Form		1					1
	Very Acute, No Typical Lesion		1					1
(Shuman U.S.A.)	Tonsils of Healthy Pigs		1					1
	Diamond Skin Disease		3				2	5
	Complication with Hog Cholera Virus	1	2					3
	Source Unknown		2					2
Fort-Dodge, Co. (U.S.A.)	Vaccine		1					1
Total of the Strains Tested								118

Group V-1 consists of such strains as those which react positively only with their own sera, while strains of Group V-2 react negatively, even to their own sera.

erysipelas, were found to belong to Group II (Gruppe-B) and the remaining 3 were found to belong to Group I.

It was noteworthy, also, that both the strain N-2, which was isolated from the heart blood of a pig which had died 3 days after receiving an inoculation of hog cholera virus, at the Nippon Biological Science Institute, and the strain Chūshi-761, which was isolated from a pig which had developed generalized symptoms after receiving hog cholera crystal violet vaccine and was then killed because of unfavourable prognosis, were found to belong to Group II.

3. Strains received from abroad

As shown in Table 2, all the strains received from abroad (Germany, Canada, Formosa, and the United States) were found to belong either to Group I or Group II except 2 which showed no antigenicity.

Here again, the strains isolated from pigs suffering from generalized infection reacted positively with Group I sera, and those isolated from pigs suffering from localized infection with Group II sera, with only a few exceptions.

Antigens prepared from strains "20" and "27", which were differentiated, and sent

by DEDIÉ as Gruppe-A strains, reacted positively with our Group I sera, and strains "69" and "34" of Gruppe-B reacted positively with Group II sera. While, the strain "186", designated by DEDIÉ as one belonging to N-Formen because of no antigenicity, was found belonging to Group I, for the polysaccharide antigen prepared from this strain by the authors reacted positively with Group I sera, though weakly.

Out of the 5 strains received from RYŪ, in Formosa, 3 strains which were isolated from septicemic cases were identified as those belonging to Group I, while the other 2 strains isolated from the lungs of normal pigs during his stay in the U.S.A., were identified as strains belonging to Group II.

All the five strains sent by STOVELL, which had been isolated from the pigs suffering from arthritis, were found to belong to Group II.

Further, it was quite interesting that a strain recovered from a bottle of living vaccine for simultaneous inoculation, manufactured by Fort-Dodge Co., (F.D. strain) was identified as a strain belonging to Group II because of its possession of high antigenicity.

CONSIDERATION

As partially stated in the introduction of the present paper, the attempts for the serological differentiation of *Erysipelothrix rhusiopathiae* group organisms were chiefly made by German workers, and now it is believed that there exist at least two serological types.

Few descriptions were made in their papers, however, on the significance of serotypes in relation to their pathogenicity among the domestic animals of different species. They merely pointed out the fact that strains suitable for the production of killed adsorbent formol vaccine were found among those belonging to Gruppe-B because of their possession of higher antigenicity.

No experiment, moreover, has been conducted on the serological differentiation of the strains isolated from animals other than pigs.

With the intention of adding more knowledge to the basic understanding of *Erysipelothrix rhusiopathiae*, investigations and experiments have been conducted on the serological behaviours and the significance of serotypes in relation to pathogenicity employing a large number of strains isolated from pigs obtained in Japan as well as those received from abroad.

First of all, the tonsils of 129 apparently normal pigs were investigated in regard to their harbouring *Erysipelothrix rhusiopathiae* by means of mouse inoculation. Consequently, as was mentioned above, 50 strains, biologically identified as *Erysipelothrix rhusiopathiae*, were isolated. Serological investigation of 40 strains selected at random revealed that 3 strains belonged to Group I and 22 strains to Group II, all of which were pathogenic to pigs. While, the remaining 15 strains, though resembling biologically those of Groups I and II, were found to have different serological attitudes, being deficient in pathogenicity in pigs.

Recovery of such non-pathogenic strains from the tonsils of normal pigs is considered to be highly important for the epizootiology of swine erysipelas, because a number of similar strains were isolated from the body surfaces of marine fishes (a separate report will be prepared as the third report of the present series). They seem to multiply in the tonsils of pigs but are deficient in power for further invasion. It can be said, therefore, that there exist several groups serologically different from those belonging to Groups I and II and, moreover, they have no pathogenicity in pigs.

Regarding the strains isolated from pigs in which the diagnosis of erysipelas was certain, those recovered from the acute septicemic form belonged to Group I (Gruppe-A), while almost all of those recovered from the urticarial form belonged to Group II (Gruppe-B).

Accordingly, it seems that the two forms of swine erysipelas are caused by two serologically different types of *Erysipelothrix rhusiopathiae* in spite of their biological resemblance.

Strains received from foreign countries have also confirmed the above statement with but few exceptions.

Though no further evidences to support the above statement are available at present, it may not be an exaggeration to say that the acute septicemic form and the urticarial form are two different infections caused by different pathogenic agents.

As for exceptional cases, the authors think it highly important to investigate those exceptional cases having a sure clinical history in order to recognize the difference between the erysipelas of septicemic form and that of the urticarial form. One of the two exceptional strains was isolated from the blood stream of a pig which had developed generalized symptoms after receiving hog cholera vaccine, and the other (N-2) was isolated from a pig which had died from acute septicemia after receiving an inoculation of hog cholera virus. Serological investigation revealed them to be the strains of Group II in spite of the generalized infection in the host animal. These facts seem to show that the strains of Group II, though limited in their pathogenicity, may give rise to a generalized infection under some circumstances.

The present investigation revealed that the percentage of *Erysipelothrix rhusiopathiae* harboured in the tonsils of apparently normal pigs is considerably high.

Problems, such as what factors make them pathogenic, what are the roles played by non-pathogenic organisms, and what is the difference between Group I and Group II organisms, namely, is it quantitative or qualitative, are the subjects for future studies.

Now, the authors' Group I was found to correspond to Gruppe-A of DEDIÉ and Group II to Gruppe-B. It may be better, therefore, to use the designations Group A and Group B. On the other hand, though but partially, the significance of serotype in relation to pathogenicity has been clarified by the present study, so that the terms Septicemic Type and Urticarial Type may be used instead.

The others, Groups III, IV and V may be called Groups C, D and Fr, respectively. Group Fr is the group of strains from which some other independent groups may be established when further investigations are continued.

As for the strains classified as N-Formen by DEDIÉ, because of no antigenicity, the fact that his strain "186" reacted weakly positive with Group I antisera in our test may support the reliability of his opinion that they originated from either Gruppe-A or Gruppe-B by losing their characteristic antigenicity.

Lastly, it seems the strains belonging to Group B have a much higher antigenicity than those belonging to Group A, both *in vitro* and *in vivo*.

SUMMARY

1. Out of the 129 apparently normal pigs examined by the use of mouse inoculation, 50 strains identified, biologically, as *Erysipelothrix rhusiopathiae* were isolated from the tonsils of 50 pigs (38.6%).

2. Serological behaviours of 40 strains, selected at random, were examined by the use of the precipitation test. As the result of the above examination, 3 strains were found to belong to Group A, and 22 strains to Group B. The remaining 15 strains were classified into 3 serotypes temporarily designated as Group C (3 strains), D (7 strains), and Fr (5 strains).

3. All the 22 strains isolated from pigs suffering from the septicemic form of erysipelas were of Group A, while the 16 strains out of 19 isolated from pigs suffering from the urticarial form of erysipelas were of Group B, and the remaining 3 were of Group A.

4. Not a single strain isolated from sick pigs was found to belong to Groups C, D and Fr.

5. Two strains isolated from pigs, one after receiving hog cholera vaccine, and the other from pigs after inoculation with hog cholera virus, were found to belong to Group B in spite of the generalized symptoms observed in the host animals.

6. Antigen prepared from the strain "186" received from DEDIÉ, as a representative strain of N-Formen, was found to react positively with the Group A antisera of our precipitation test.

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豚丹毒菌の分類に関する研究

I. 豚由来の *Erysipelothrix rhusiopathiae* の血清学的性状について

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(昭和 33 年 11 月 24 日受付)

豚丹毒の感染と免疫については、いまだ不明確な点が多く残されているが、その主な理由は、原因菌である *Erysipelothrix rhusiopathiae* (以下 *E. r.* と略称する) の血清学的分類と病型との関係が明らかにされておらなかったことによると云える。

近年、特に独乙を中心とした欧州の 2・3 の研究者によってこの菌の血清学的型別がおこなわれたが、それらも上述の基礎的な種々の問題を解決するためというよりは、実際応用の面すなわち死菌免疫元として有効な菌株の撰択に利用されるにとどままっていると云ってよい。

著者らは、かねてから、この問題に深い関心をもち、広範囲な調査と実験を進めてきた。すなわち、由来履歴の確かな菌株を数多く集め凝集反応、沈降反応による血清学的分類を行い、その結果とそれらが由来した動物の病性との関係を整理考察してみた。

本報告においては、健康豚及び種々の病型の病豚に由来した菌株について行った試験の結果について述べたが、以下に概略を記載する。

1. 129 例の見掛け上健康な豚の扁桃腺を調べて、50 例から各 1 株ずつの生物学的性状から *E. r.* と同定される菌株を得た (38.6%) が、これらのうちの任意の 40 株を血清学的に沈降反応で分類し、暫定的に Group I (3 株), Group II (22 株), Group III (3 株), Group IV (7 株) 及び Group V (5 株... 反応上種々の態度のものを含み、今後更に多数の菌株について調査すれば新たな Group として独立すべきものを含むと予想される) とした。
2. 一方、病豚由来の菌株については、急性敗血症型例からの 22 株を同様の方法で分類したとこ

ろ、そのすべてが上記 Group I に属すべきものであることが知られ、また蕁麻疹型例からの 19 株は、3 株の Group I と 16 株の Group II に分類された。ここにおいて、原則として急性敗血症型は血清学的に Group I に属す菌株により、蕁麻疹型は Group II の菌によって発症することが知られた。しかして、この事実は諸外国から分与された菌株についてもほぼ同様であった。

3. また、豚コレラワクチン注射後に発病した例、または豚コレラウイルス接種後に敗血症症状で斃死した如き例から分離された菌株は、それらの動物が一見急性敗血症症状を呈しておりながら Group II である場合の多いことも知られた。
4. 独乙の DEDÉ らが行った分類との関係を知るため、彼より Gruppe-A, Gruppe-B 及び N-Formen に属するもの各 2, 2, 1 株の送附を受け、それらから著者らの用いた Boivin のそれを少しく改変した方法で抗原を製し試験を行ったが、彼らが Gruppe-A として送ってきた 2 株は著者らの Group I, Gruppe-B としてきた 2 株は Group II に当り、抗原性なしとの理由で N-Formen として送ってきた 1 株は、抗原性が弱くはあったが、Group I, すなわち、Gruppe-A に属すべきものであることが知られた。

よって、暫定的に著者らが呼んできた Group I, II, III, IV 及び V を、DEDÉ らの呼び方に準拠してそれぞれ Group (Gruppe) A, B, C, D, 及び Fr (Further group の意) と呼ぶこととした。