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Poliomyelitic Virus from Feces in Non-Paralytic Poliomyelitis. II. Infectivity by Various Routes.*

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In the preceding paper,[1] immunologic reactions and the non-infectivity for small laboratory animals of a strain of virus from human feces, known as the SK. strain of poliomyelitic virus were described. The results of inoculation of several species of monkeys by a variety of routes with this SK. strain is the subject of this note.

An abbreviated chart of the genealogy of the SK. strain appears in Fig. 1. This shows the source and generation of the strain used in these multiple route experiments. The positive results appear in more detail in Table I. In using this method as a means of describing the properties of a given strain, it is recognized that different strains of poliomyelitic virus and even different generations of the same strain vary somewhat in their ability to infect by multiple routes.[2] Cutaneous infectivity, for instance, has been noted in some strains recently isolated from a human source, whereas this property has not been prominent in several others.[3]

In its fourth generation, and at the time of the first multiple route experiment, the SK. strain was of moderately high intracerebral virulence (*cf.* virulence test in Nov. neutralization experiment in preceding paper[1]). It proved, at this time, to be unusually infective by the intracutaneous, intratonsillar,[4] and intranasal routes in that the incubation periods in monkeys inoculated by these routes were the same as by the intracerebral route, namely, 7 days (Table I). Oral infections occurred in the 5th and 6th generations. Later the strain did not infect by routes other than the intracerebral, Fig. 1.

As part of the multiple route experiment, 2 examples of inducing the experimental disease by feeding are presented. Experiments of

* Aided by grants from the President's Birthday Ball Commission for Infantile Paralysis Research and from the National Foundation for Infantile Paralysis.

1 Trask, J. D., Paul, J. R., and Vignec, A. J., PROC. SOC. EXP. BIOL. AND MED., 1939, **41**, 241.

2 Trask, J. D., Paul, J. R., German, W. J., and Beebe, A. F., *Trans. Assn. Am. Phys.*, 1937, **52**, 306.

3 Trask, J. D., and Paul, J. R., *Science*, 1938, **87**, 44.

4 Sabin, A. B., *J. Am. Med. Assn.*, 1938, **111**, 605.

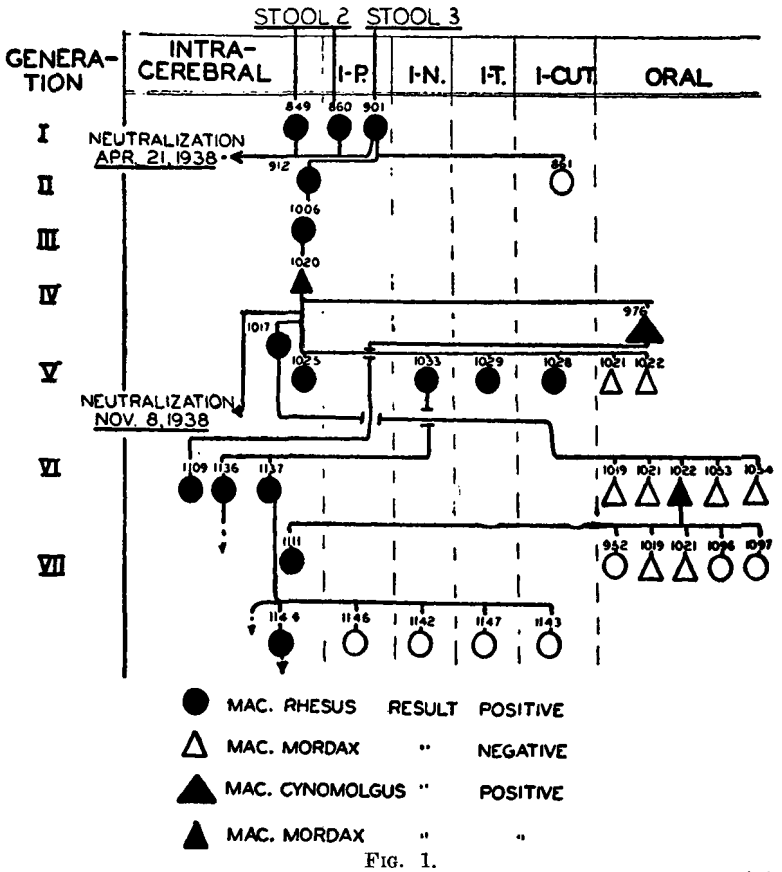

FIG. 1.

Diagram of various passages of the SK. strain with results of its administration by various routes. These are indicated by headings at the top of the chart: I-P = Intraperitoneal; I-N = Intranasal; I-T = Intratonsillar, and I-cut. = Intracutaneous.

All positive results indicate a disease typical of experimental poliomyelitis with characteristic histological findings at autopsy. They are represented by black symbols while negative results appear as open symbols.

this type with poliomyelitic virus have, in general, been unsuccessful in this country.[5] The only previously reported positive result is that of Saddington, who reproduced the disease in a *Mac. cynomolgus* monkey by feeding large amounts of virus in milk (30 cc of a 10% suspension on 6 successive days).[6] European authors, on the other hand, have recorded a number of positive results by this route, and Kling and his associates have emphasized the importance of using the

[5] Clark, P. F., Roberts, D. J., and Preston, W. S., Jr., *J. Prev. Med.*, 1932, **6**, 47. Also, Lennette, E. H., and Hudson, N. P. *J. Infect. Dis.*, 1936, **58**, 10; and Flexner, S., *J. Exp. Med.*, 1936, **63**, 209.

[6] Saddington, R. S., PROC. SOC. EXP. BIOL. AND MED., 1932, **29**, 838.

TABLE I.
Positive Result Experiments.

Date, 1938	Route of inoculation	Total dose	Monkey No.	Species	Result			
					Incubation period—days*	Paralysis	Lesions	Passage
Sept. 9	Oral	3 g†	976	*Mac. cynom.*	11	++++	++	+
Oct. 21	"	0.9 g‡	1022	*Mac. mordax*	19	++++	+	+
Sept. 21	Intracerebral	0.5 cc of 10%	1025§	*Mac. rhesus*	7	+++	+	
" 21	Intracutaneous	2 " " "	1028	"	7	+++	++	
" 21	Intranasal‖	4 " " "	1033	"	7	++	+	+
" 21	Intratonsillar	2 " " "	1029	"	7	+++	±	

*Computed from the first day of feeding or inoculation and counting this day as 1.
†Equivalent to 30 cc of a 10% suspension.
‡ " " 9 " " " " "
§No. 1025 was sick with tuberculosis.
‖Instilled into nares on 2 successive days.

Mac. cynomolgus for this purpose.[7] Reference to Fig. I will reveal that this species and the *Mac. mordax* were included in our experiments.† [8] Since finding that the strain would infect these species by feeding, we have fed at varying intervals, but without success, a total of 8 *Mac. rhesus* monkeys (3 of which appear in Fig. 1).

In conducting the feeding experiment, fillets of infected spinal cord were inserted into bananas. These were given in 3 successive days, no other food being provided until after the virus-contaminated banana had been eaten. A brief clinical-pathological description of the 2 successful feeding experiments follows:

1. Monkey No. 976, *Mac. cynomolgus,* received 1 g of infected cord on Sept. 9, 10, and 11, 1938, respectively. On Sept. 19th he developed fever, a coarse tremor, and was unusually quiet. It was also noted at this time that his voice seemed weak. The disease progressed rapidly and within the next 24 hours his neck, back, and right arm were definitely weak; he had a right facial paralysis and his voice was entirely gone. The following day the animal was prostrate and was sacrificed.

At autopsy, no evidence of gross pathology was noted. A careful search was made throughout the intestinal tract for possible erosions or abrasions. The mesenteric glands were pale and not enlarged. Histologically the medulla, cervical, thoracic, and lumbar cord showed typical and extensive lesions of experimental poliomyelitis. At the periphery of the olfactory bulbs, large, foamy cells were surrounded by an inflammatory reaction. This reaction consisted of necrotic cells, a few polymorphonuclears, and many small round cells. Passage to a second monkey by means of intracerebral inoculation of a 10% suspension of the spinal cord was successful.

2. Monkey No. 1022, *Mac. mordax,* received 0.3 g of virus-infected cord on Oct. 21, 22, and 23, 1938, respectively. On the 19th day he developed fever and appeared nervous. The following day he was tremulous, ataxic, and his voice was weak. The disease progressed slowly in this animal, but by the sixth day of illness, both legs, one arm, and his back were paralyzed; he was sacrificed on this day. Grossly, no lesions were observed. Characteristic histological lesions were found in the cervical and lumbar cord. The olfactory bulbs were negative, but serial sections were not done. Passage to a second

[7] Kling, C., Levaditi, C., and Hornus, G., *Bull. Acad. Méd.*, 1934, **111**, 709.

† *Mac. mordax* resembles *Mac. cynomolgus* in appearance but is somewhat smaller. Our attempts to classify the two species exactly have not been successful, but they are apparently very closely related.

[8] Elliott, D. G., *A Review of the Primates*, 1913, Vol. 2, 185.

monkey by means of the intracerebral inoculation of a 10% suspension of the spinal cord was successful.

These feeding experiments, considered by themselves, serve chiefly to confirm the work of Kling and his associates[7] who have long maintained that poliomyelitic virus will infect the *Mac. cynomolgus* by the oral route, but not the *Mac. rhesus*. In conjunction with the inoculations by other routes, they also indicate that the behavior of this virus is compatible with that of poliomyelitic virus, and these results thus become of supplementary value in the identification of this strain.

Summary. The SK. strain of poliomyelitic virus has been shown to be occasionally infectious by the intraperitoneal, intracutaneous, intratonsillar, and oral routes. The *Mac. mordax* species of monkey, as well as the *Mac. cynomolgus*, is susceptible to infection with poliomyelitic virus by the oral route.

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Detection of Free Polysaccharide in Blood of Pneumococcic Pneumonia Patients; Prognosis and Therapy.

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Early observations by Dochez and Avery[1, 2] and by Blake[3] demonstrated the presence of specific soluble pneumococcal substance in the blood and urine of patients suffering from lobar pneumonia. The substance, a product of the growth of pneumococci, rather than of their degeneration, was identified as capsular polysaccharide by the work of Heidelberger and Avery.[4] Of a total of 44 cases studied by Dochez

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1 Dochez, A. R., and Avery, O. T., PROC. SOC. EXP. BIOL. AND MED., 1917, **14**, 126.

2 Dochez, A. R., and Avery, O. T., *J. Exp. Med.*, 1917, **26**, 477.

3 Blake, F. G., *Arch. Int. Med.*, 1918, **21**, 779.

4 Heidelberger, M., and Avery, O. T., *J. Exp. Med.*, 1923, **38**, 73.