STUDIES ON CHICK SALMONELLOSIS

II. *SALMONELLA SENFTENBERG* INFECTION IN CHICKS

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The writers[2,6,13] have already reported that in Japan not only *S. pullorum* but also *S. senftenberg*, *S. thompson*, *S. bareilly* and *S. new brunswick* respectively play a part in chick salmonellosis. Moreover *S. montevideo*, *S. paratyphi B*, *S. typhi murium*, *S. cholerae suis*, *S. potsdam*, *S. enteritidis*, *S. give* and *S. newington* in poultry have been detected by IWAMORI and SHIMAKURA, OCHI et al.[10,11] and MIURA et al.

However, as *S. senftenberg* among these salmonella organisms, except *S. pullorum*, seems to infect chicks the most frequently, some experiments to ascertain the mode of infection and the influence of *S. senftenberg* on baby chicks were undertaken.

Some parts of these studies were reported at the Symposium[4] of "Enteric Organisms of Domestic Animals" of the 35th Meeting (1953) and at the 39th Meeting (1955)[5] of the Japanese Society of Veterinary Science.

ON THE MODE OF *S. SENFTENBERG* INFECTION IN NEWLY HATCHED CHICKS

As reported previously, though both newly hatched chicks and dead-in-shell-chicks came from the same incubator with a difference of only 3~5 days, the rate of *S. senftenberg* infection in newly hatched chicks which died was always superior to that in dead-in-shell-chicks[2,4]. In systematic bacteriological investigation on baby chicks which died of a pullorum-like disease, chicks under 5~10 days old showed the highest rate of infection with *S. senftenberg*. Though some positive reactors to the rapid agglutination test for *S. senftenberg* infection were discovered in field work, the detection of *S. senftenberg* in these reactors' bodies resulted negative with one exception of a 3 months old chick[3,4]. *S. senftenberg* has not yet been found in any egg laid by reactors positive to the agglutination test[4].

When the above noted results were taken into consideration, it was presumed that the mode of *S. senftenberg* infection to eggs and baby chicks is different from that of *S. pullorum* infection, and that baby chicks may have the most frequent opportunities

TABLE 1. *Results in T and Ts*

POINT OF OBSERVATION		DATE OF T Hatchery										
		14/I	24	2/II	5	13	17	19	23	2/III	7	13
Frequency of Detection of Salmonella Organisms from Newly Hatched Chicks Killed Immediately after Hatching*		Originated from			A Incu.		B		C			D
					P.3/10		P.3/10		0/10			S.5/10
Minutes for Exposure of SS Agar Plate in Incubator		80	80	80	80	80	80	80	80	70	50	30
Mean No. of Salmonella Organisms Detected in Hatching Compartment of each Incubator	A	0	0	0	0	·	·	0	·	·	0	·
	B	0	·	0	0	0	0	0	0	0	0	0
	C	0	·	·	0	0	·	0	0	0	0	0
	D	0	·	·	·	·	·	·	0	0	0	0
		Originated from			A Incu.		B		C		A~D	
Salmonella Organisms Detected from Dead-in-Shell-Chicks*	Surface of Embryo	·	·	·	0/30	·	P.2/30	·	0/30	·	P.3/136	·
	Yolk-Sac	·	·	·	0	·	0	·	0	·	P.2	·
	Surface & Yolk	·	·	·	P.1	·	P.2	·	0	·	P.4	·

* The denominator: the number of samples examined, the numerator: the number

Notes: S···*S. senftenberg.* P···*S. pullorum.* B···*S. bareilly.*

to be infected with *S. senftenberg* in an incubator. Therefore, some experiments to prove these presumptions were planned as follows. That is, in T, Ts and F hatcheries in Sapporo, before the beginning of hatching the insides of all 12 incubators were thoroughly cleaned up, disinfected with formaldehyde gas and then were confirmed to be free from salmonella organisms. With the beginning of hatching the conditions of contamination with *S. senftenberg* in hatching compartments of incubators, dead-in-shell-chicks and newly hatched chicks were investigated bacteriologically at frequent intervals.

For detection of *S. senftenberg* in incubator hatching compartments 4~9 Endo or SS agar plates were used and cultured for 24~48 hours at 37°C after being exposed in hatching cabinets for 80~10 minutes. All surfaces of egg-shells, some amount of egg-white on embryos and some amount of egg-yolk of embryos in regard to dead-in-shell-chicks, and, pieces of respiratory, digestive and other organs of baby chicks were respectively examined

Hatcheries in 1953

HATCHING IN													
				Ts Hatchery									
19	25	31	1/V	24/II	5/III	10	17	26	2/IV	8	11	17	21
	A~D												
·	S.16 / 20	·	·	·	·	·	0 / 5	P.2 / 10	·	·	S.9 / 10	S.1 / 10	(S.3 P.3) / 6
15	10	10	10	80	80	80	80	80	80	60	30	30	10
·	S.23	S.23	(S.18 P.0.5)	0	0	0	0	0	·	S.0.3	S.0.3	(S.0.3 P.0.3)	S.7
·	(S.74 P.0.2)	S.92	S.19										
0	(S.53 P.0.3)	S.62	S.30										
S.1	S.58	S.34	S. 4										
A~D	A~D	A~D											
S.4 / 116	S.5 / 106	B.2 / 78	·	·	·	·	0 / 64	·	0 / 41	·	0 / 42	P.2 / 60	S.1 / 62
(S.1 P.2)	S.5	S.2	·	·	·	·	0	·	0	·	0	P.1	P.3
(S.4 P.2 B.4)	(S.13 P. 1)	(S.6 P.1 B.1)	·	·	·	·	0	·	P.3	·	0	P.3	P.4

of Salmonella organisms positive cases.

by direct and enrichment culture methods.

Results obtained are tabulated as tables 1, 2 and 3.

In 1953, materials originating from T hatchery equipped with 4 incubators and Ts hatchery with 1 incubator were inspected. As shown in table 1, in T hatchery *S. senftenberg* was suddenly found first in D incubator on the 24th day (on 19, March) after the beginning of hatching (incubator A which began to hatch at first had already worked for 63 days up to this time), and after 6 days *S. senftenberg* could be found not only in D but also in A, B and C incubators. Afterwards *S. senftenberg* was found out in all incubators in the following inspections.

On the other hand, in regard to dead-in-shell-chicks, on that day when *S. senftenberg* was first detected in D incubator, *S. senftenberg* had already been found out from dead-in-shell-chicks originating not only from D but also from each of the other incubators.

TABLE 2. *Results in T Hatchery in 1954*

POINT OF OBSERVATION		DATE OF HATCHING														
		19/I	30	6/II	11	13	17	23	1/III	6	12	18	24	30	24/V	29
Frequency of Detection of Salmonella Organisms from Newly Hatched Chicks Killed Immediately after Hatching		Originated from			B.C Incu.		B.C		A~D		A~D		A~D			A~D
					P.2 / 17		P.1 / 12		S.2 P.2 / 15		S.5 B.4 / 10		S.7 B.3 / 7			S.5 T.2 / 5
Minutes for Exposure of SS Agar Plate in Incubator		60	60	60	40	30	30	30	20	15	15	15	15	15	15	15
Mean No. of Salmonella Organisms Detected in Hatching Compartment of each Incubator	A	·	0	0	0	0	0	0	0	S.1 P.0.3 B.0.5	S.38 B.2.5	S.6 B.2.5	S.12 B. 1	S.10.5 B. 2	S. 2.5 B. 0.5	S.31 B. 0.5
	B	0	0	0	0	0	0	0	0	S.3 P.0.3 B.1.3	S.8 B.1	S.6 P.0.5 B.0.5	S. 8 B. 1	S.11.5 P. 3.5 B.11.5	S.74 B.45	S.37.5 B. 1.5
	C	0	0	0	0	0	0	0	S.0.3	S.1 P.0.8 B.1.5	S.9.8 B.0.5	S.65 B.2.5	S.14	S.24.5 B. 9.5	S.31 B.1.8	S.6 B.1.8
	D	·	·	0	0	0	0	0	0	S.8 P.0.3	S.2.3 B.2.8	S.5.5 P.0.5 B.0.5	S.82.5 B. 1.5	S.12.5 B. 6	S.8 B.3	S.4 B.5.3
		Originated from			B.C Incu.			A~D	A~D	A~D	A~D	A~D	A~D	A~D	A~D	A~D
Salmonella Organisms Detected from Dead-in-Shell-Chicks	Egg-Shell	·	·	·	·	·	·	·	·	·	·	·	·	·	S.22 B. 2 / 30	S.12 B.12 / 30
	Surface of Embryo	·	·	·	0/46	·	·	0/48	0/44	0/47	0/50	0/50	S.1/50	0/47	S.1	0
	Yolk-Sac	·	·	·	0	·	·	0	0	P.2	0	P.4 B.1	B.1	S.1	0	0
	Surface &Yolk	·	·	·	0	·	·	0	0	P.1	P.1	S.1 P.2	S.2	P.1	S.1 P.1	S.2 P.1 B.1

Note: T···*S. thompson.*

Afterwards *S. senftenberg* was always found out from some materials originated from all incubators.

As concerned with newly hatched chicks, *S. senftenberg* had already been detected from 5 of 10 chicks hatched in D incubator only on 13, March, namely before 19, March on which day *S. senftenberg* was first found in D incubator and dead-in-shell-chicks originated from each incubator.

That is, in T hatchery, *S. senftenberg* was found out in newly hatched chicks prior to the finding in incubator or dead-in-shell-chicks. However on the other hand, in Ts hatchery the first detection of *S. senftenberg* was in an incubator on 44th day after beginning of hatching, and then in newly hatched chicks and later in dead-in-shell-chicks. (It is much to be regretted that the chicks hatched on 2 and 8, April, and the air of hatching compartment of incubator on 2, April were not inspected.)

Furthermore in successive inspections in T hatchery equipped with 4 incubators and F hatchery with 3 incubators in 1954, as shown in table 2, *S. senftenberg* in T hatchery was suddenly found out in C incubator as well as in newly hatched chicks on 1, March, namely on 42nd day after beginning of hatching. Detection of *S. senftenberg* in dead-in-shell-chicks was about 17 days later.

As shown in table 3, first detection of *S. senftenberg* in F hatchery was on egg-shells of dead-in-shell-chicks as well as in A incubator on 15, March, on the 45th day after starting to hatch, but in newly hatched chicks *S. senftenberg* was found out in 6 of 20 chicks 5 days later. (Unfortunately, chicks hatched on 15, March were not examined.)

On the ground of the above described results, it may be said that in the incubator *S. senftenberg* in the hatching compartment begins to be found if it continues to operate for about 50 days. And if *S. senftenberg* is found out in an incubator once, it is usually detected from that incubator successively onward from that time. And soon after *S. senftenberg* came to be found out in any incubator once, it will certainly be found in all incubators operating in the same room. This phenomenon is presumed result in following facts: when the leaf of the incubator in which *S. senftenberg* had multiplied, was opened to inspect the incubated eggs, *S. senftenberg* flowed out and mixed in the air of the incubator room and then invaded other incubators. In fact it was certified that the number of *S. senftenberg* which multiplied in an incubator decreases by opening the leaf of that incubator, but if the leaf of that incubator is closed and the incubator is continued to hatch as before, *S. senftenberg* again multiplies in it. On the other hand, at that time when the leaf of incubator with multiplied *S. senftenberg* was opened, in bacteriological examination of the air of the room containing such incubator, *S. senftenberg* was found out. And in a more severe case *S. senftenberg* comes to be found out too in the stockroom of hatching eggs separated from the incubator room.

One more important cause of transmission of *S. senftenberg* from one incubator to another is directly traceable to workers in hatchery. They infect their fingers, test-lamp etc. with *S. senftenberg* unintentionally by touching the infected cabinets, eggs, chicks etc. at first, and then transmit *S. senftenberg* to the cabinets, eggs, chicks etc. of other steriled incubators by retouching with their dirty fingers or instruments.

In spite of absolute non-finding of *S. senftenberg* in chicks hatched during the term

TABLE 3. *Results in F*

POINT OF OBSERVATION		DATE OF 29/I	5/II	8	15	19	25	3/III	10	15
Frequency of Detection of Salmonella Organisms from Newly Hatched Chicks Killed Immediately after Hatching		Originated from				A Incu. 0/22	·	A.B 0/20	A.B P.1/20	·
Minutes for Exposure of SS Agar Plate in Incubator		80	80	80	60	60	40	30	15	15
Mean No. of Salmonella Organisms Detected in Hatching Compartment of each Incubator	A	0	0	0	0	0	0	P.3	0	S.1.3 P.4
	B	·	0	0	0	0	0	0	0	0
	C	·	·	0	0	0	0	0	0	0
		Originated from		A Incu.	A	A.B	A.B	A.B	A.B	A.B.C
Salmonella Organisms Detected from Dead-in-Shell-Chicks	Egg-Shell	·	·	0/10	0/10	0/66	0/68	0/65	0/70	S.2/80
	Surface of Embryo	·	·	0	0	0	0	0	0	0
	Yolk-Sac	·	·	0	0	0	0	0	0	0
	Surface & Yolk	·	·	0	0	0	0	0	0	P.2

which *S. senftenberg* is never detected in any incubator, if *S. senftenberg* once begins to be found out in an incubator, immediately before or almost at the same time *S. senftenberg* comes to be detected in newly hatched chicks originated from such infected incubator too. Moreover afterwards, it is successively detected in day-old chicks as well as in the incubators.

On the ground of the above mentioned observations, one of the important causes of S. *senftenberg* infection in newly hatched chicks is presumed to exist in an incubator. That is, it may be concluded that, in regard to the S. *senftenberg* infection in newly hatched chicks, many baby chicks are infected with S. *senftenberg* through their respiratory and digestive organs in the incubators in parallel with the grade of contamination of hatching compartments of incubators.

ON THE APPEARANCE OF *S. SENFTENBERG* IN AN INCUBATOR

Though the bacteriological examinations were carried out under the presumption that hatching eggs may bring *S. senftenberg* into an incubator, as shown in tables 1, 2 and 3,

Hatchery in 1954

HATCHING									
20	26	1/IV	6	13	19	26	2/V	7	13
A.B.C		A.B.C	A.B.C		A.B.C				
S.6 P.6 / 20	·	S.15 P.12 / 20	S.3 P.1 / 7	·	S.5 / 5	·	·	·	·
15	15	15	15	15	15	15	15	15	15
S.0.5 P.0.5	P.0.3	P.3.3	P.8	S.3	S.17 P. 2	S.3 P.0.3	S.15 P.0.8	S.0.5	S.6.5
0	P.0.8	S.0.5 P.2.3	S.0.5 P.1	S.7	S.18 P.1.5	S.1	S.2	S.2.5 P.1	S.18
P.0.3	0	S.0.3 P.0.3	S.0.8 P.0.8	S.2	S.2 P.1	S.28.7	S.8	S.2.2	S.12 P.0.8
A.B.C	A.B.C	A.B.C	·	A.B.C	A.B.C	A.B.C	A.B.C	A.B.C	A.B.C
S.5 / 79	S.37 P. 2 / 75	S.7 P.7 / 77	·	S.13 / 73	S.37 / 75	S.67 / 78	S.60 / 64	S.8 / 40	S.12 / 38
0	0	0	·	0	0	0	0	S.1	0
0	0	0	·	S.1	0	0	0	S.1	0
0	0	P.1	·	0	P.4	S.2 P.1	S.1	S.2 P.1	S.1

S. senftenberg has not yet been detected in dead-in-shell-chicks originated from the incubator in which *S. senftenberg* had not yet been found out, but if *S. senftenberg* once appears in an incubator, it also comes to be detected in dead-in-shell-chicks originated from that incubator. And in field work, when slide tests or tube tests for detection of *S. senftenberg* infection were used, some positive reactors are often discovered. However, *S. senftenberg* had not yet been detected from egg-shell, egg-white and yolk of eggs laid by such positive reactors[4], and the writers could not yet find out *S. senftenberg* in any part of bodies of positive reactors except in under 3 months old chicks[3,4].

If one takes into consideration the above described results, he finds that there seems to be a difference between the manner of *S. senftenberg* infection and that of *S. pullorum* infection in adult fowls. Therefore there is a tendency to deny that *S. senftenberg* as well as *S. pullorum* is brought into an incubator through the egg. However, one must not forget the reports introduced by IWAMORI and SHIMAKURA and OKAZAKI et al. That is, as IWAMORI and SHIMAKURA (1954) reported that they had found *S. senftenberg* in an unabsorbed yolk-sac of a 1-year old hen and OKAZAKI et al. (1956) reported that *S. senftenberg* had been detected in ovary, oviduct and left kidney of a 1.5-year old hen, the

transmission of *S. senftenberg* to egg can not be denied completely. Therefore there seems to be need for further and more careful investigations to ascertain how *S. senftenberg* is brought into the hatching compartment of an incubator.

On the ones with flawless egg-shell among dead-in-shell-chicks infected with *S. pullorum* only or *S. senftenberg* only, the frequency of existence of salmonella organisms on surfaces of embryos and in yolk-sacs drawn into abdominal cavities of embryos was investigated. The results are shown in table 4.

TABLE 4. *Frequency of Detection of Salmonella Organisms from Surfaces of Embryos and Yolk-Sacs Drawn into Abdominal Cavities of Embryos in Dead-in-Shell-Chicks*

TYPE	ON SURFACES ONLY OF EMBRYOS	IN YOLK-SACS ONLY	BOTH ON SURFACES AND IN YOLK-SACS			TOTAL
			Nos. on Surfaces >Nos. in Yolk-Sacs	Nos. on Surfaces =Nos. in Yolk-Sacs	Nos. on Surfaces <Nos. in Yolk-Sacs	
S. pullorum	5	17	2	24	5	53
S. senftenberg	12	12	8	20	3	55

The data show that there is a tendency for the rate of infection of surfaces of embryos with *S. senftenberg* to be higher than that with *S. pullorum*. And the possibility of penetrating egg-shell of *S. senftenberg* was experimentally certified by the senior author[3]. If the assumption that *S. senftenberg* can penetrate egg-shell in incubators operating with normal temperature and humidity is allowed, taking into consideration the above mentioned results, it may be said that the egg itself will more likely be attacked by *S. senftenberg* in an incubator than the staining of an incubator with *S. senftenberg*. However, on the other hand, as shown in table 4, *S. senftenberg* also is detected in yolk-sacs only of some dead-in-shell-chicks as well as *S. pullorum*, though the frequency of detection of it is inferior to that of *S. pullorum*. This fact may suggest that *S. senftenberg* has an ability to penetrate into a yolk-sac in adult hen's body as well as *S. pullorum*.

Anyhow, it is sure that *S. senftenberg* can grow and multiply in the hatching compartments of incubators working with normal temperature and humidity; however, it can not yet be proved how *S. senftenberg* is brought into the hatching cabinet of an incubator or the hatchery premises. It is necessary to pay attentions to rats, wandering birds, flies, feeds and visitors with regard to such bringing of *S. senftenberg* into a hatchery premises. Especially rats and over-wintered flies may be one of the important infective origins in the succeeding year. But

the possibility that *S. senftenberg* is brought into hatching compartments of incubators by egg should also not be neglected.

As shown in tables 1, 2 and especially 3, it was proved that *S. pullorum* also comes to appear in the hatching compartments of incubators with the repetition of hatching. Therefore the inhalation-infection of *S. pullorum* among newly hatched chicks in an incubator may also occur as well as in *S. senftenberg* infection. But the multiplication of *S. pullorum* in the hatching compartments of incubators being operated under the normal temperature and humidity is not so remarkable as in *S. senftenberg*.

Especially as shown in table 2, *S. bareilly* too appears in the hatching compartments of incubators.

All species of these salmonella organisms which appear in incubators are effectively destroyed by the fumigation of formaldehyde gas. As FRANK and WRIGHT reported, when use was made of 1.5 ml of formalin for every cubic foot of incubator space all salmonella organisms were completely killed within 30 minutes.

Nowadays in some special hatcheries paying their attention to hygienic methods of poultry raising, the raisers are preventing the infection with *S. senftenberg* and others of newly hatched chicks in incubators by the periodic disinfection of the hatching compartments using formalin at intervals of 30~40 days after the beginning of hatching.

ON THE PRESENCE OR DISAPPEARANCE OF *S. SENFTENBERG* IN CHICKS' BODIES AFTER INFECTION

In the former chapter, it was stated that an incubator plays an important role in *S. senftenberg* infection in newly hatched chicks. Table 5 explains the relation of *S. senftenberg* infection between the incubators and the newly hatched chicks in more detail.

As shown in this table, soon after the beginning of first hatching in T hatchery, the distribution of *S. senftenberg* in baby chicks' bodies killed immediately after hatching as well as the appearance of *S. senftenberg* in incubators were investigated. *S. senftenberg* was not detected in chicks' bodies hatched on 11th and 17th February when no *S. senftenberg* was found in the hatching compartments of the incubators, but the frequency of detection of *S. senftenberg* in baby chicks' bodies hatched after 1st March when *S. senftenberg* began to be found out in one incubator increased in parallel with the multiplication of *S. senftenberg* in the incubators. Further, it is interesting that the frequency of detection of *S. senftenberg* from digestive organs of newly hatched chicks was higher than that from respiratory organs. This phenomenon is not considered to have resulted from the absorbing *S. senftenberg* contained in yolk-sac before hatching. *S. senftenberg* which have invaded into the blood stream from respiratory organs may rather settle and multiply in digestive organs, or it may settle in digestive organs as effects of pulling feather, picking vent

TABLE 5. *Appearance of Salmonella Organisms in Newly Hatched Chicks' Bodies in Relative to Presence and Multiplication of Salmonella Organisms in Hatching Compartments of Incubators in T Hatchery*

POINT OF OBSERVATION	DATE OF HATCHING: 11/II '54					17/II		1/III								
No. of Chicks Killed Immediately after Hatching	1~4	5	6~11	12	13~17	1	2~12	1~5	6	7~9	10	11	12	13	14	15
Regions Examined: Trachea	·	·	·	·	·	p	·	·	·	·	·	·	·	·	·	·
Lung	·	p	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Heart Blood	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Liver	·	·	·	·	·	·	·	·	·	·	P	·	·	·	·	·
Spleen	·	·	·	p	·	·	·	·	·	·	P	·	·	·	·	·
Kidney	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Testicle	·	·	·	·	·	·	·	·	·	·	·	s	·	·	p	·
Egg-Yolk	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Esophagus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Crop	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Proventriculus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Gizzard	·	·	·	·	·	·	·	·	s	·	·	·	·	·	·	·
Small Intestine	·	·	·	·	·	·	·	·	s	·	·	·	·	·	·	·
Caecum	·	·	·	·	·	·	·	·	s	·	·	·	·	·	·	·
Rectum	·	·	·	·	·	·	·	·	s	·	·	·	·	·	·	·

POINT OF OBSERVATION	DATE OF HATCHING: 12/III										24/III						
No. of Chicks Killed Immediately after Hatching	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7
Regions Examined: Trachea	·	·	·	·	·	·	s	·	·	·	b	s	·	·	s	·	s
Lung	·	·	·	·	·	·	·	·	·	·	S	S	·	·	·	·	S
Heart Blood	·	·	·	·	·	·	·	·	·	·	·	S	·	·	·	·	·
Liver	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Spleen	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	S
Kidney	·	·	·	·	·	·	·	·	·	·	S	·	·	·	·	s	·
Testicle	·	·	·	·	·	·	·	·	·	·	s	·	·	·	·	·	s
Egg-Yolk	·	·	·	·	·	·	·	s	·	·	s	·	·	·	·	S	s
Esophagus	·	·	·	·	·	s	·	S	·	·	s	S	·	·	·	S	S
Crop	S	·	·	S	·	S	·	S.b	·	·	·	S	S	·	·	S	S
Proventriculus	·	·	·	·	·	s	·	·	·	·	S	·	·	·	·	·	·
Gizzard	·	·	·	·	·	s.b	·	·	·	·	S	s	·	s	·	s	s
Small Intestine	·	·	·	·	·	·	·	·	·	·	·	S	s	·	s	·	S.B
Caecum	b	b	·	·	·	·	·	·	·	·	S.b	S.b	·	S	S	s	S.B
Rectum	b	·	·	·	·	b	·	·	·	·	S	S.b	S	S	·	·	S.B

Mean No. of Salmonella Organisms Detected in Hatchery Compartment of Each Incubator		11/II '54	17/II	1/III	12/III	24/III
	A	0	0	0	S. 38, B. 2.5	S. 12, B. 1
	B	0	0	0	S. 8, B. 1	S. 8, B. 1
	C	0	0	S. 0.3	S. 9.8, B. 0.5	S. 14
	D	0	0	0	S. 2.3, B. 2.8	S. 82.5, B. 1.5

Notes: S ···Direct culture, s···Enrichment culture of *S. senftenberg.*
P ··· " " , p··· " " " *S. pullorum.*
B ··· " " , b··· " " " *S. bareilly.*
· ···Negative result.

and pecking feces or spicules of fluff contaminated with that organism before feeding. Besides there is a possibility of thrusting *S. senftenberg* into bowels of newly hatched chicks by the using of non-disinfected chick sexing instrument.

Then investigations were carried out to ascertain how *S. senftenberg* settled in respiratory or digestive organs of a baby chick disappears as a chick grows on healthily. That is, studies were made of the distribution of *S. senftenberg* in bodies of 2~5 apparently healthy chicks killed immediately after hatching or killed at one-day intervals or killed at regular intervals after brooding. These investigated chicks were sampled at random from 2 groups of male White Leghorns originated from F or T hatchery. All materials examined were cultivated on media directly and for enrichment. The regions of chick's body inspected and the results obtained are shown in tables 6 and 7.

It was proved that the frequency of detection of *S. senftenberg* is especially high in respiratory and digestive organs in both F and T groups. In F group, the frequency of detection of *S. senftenberg* in baby chicks less than about 9 days old is considerably high but no *S. senftenberg* came to be found out in bodies of chicks sacrificed when more than 25 days old. On the other hand, in baby chicks under 3 days old of T group, *S. senftenberg* was always detected with considerable frequency; in chicks' bodies of 5 to 30 days of age it was seldom detected; in over 40 days old chicks it came to be not found out at all.

In brief, it was ascertained through the results obtained on baby chicks of F and T groups that *S. senftenberg* invaded into newly hatched chicks' bodies in incubator was detectable with considerable frequency during the first about 7 days and afterwards, though the frequency of detection decreased, *S. senftenberg* itself was carried for 20~30 days, and it tended to lurk in the digestive and respiratory organs especially.

It was concluded that, even in the newly hatched chicks infected with *S. senftenberg* in incubator, so far as they were hatched in good health and maintained their health during rearing under good feeding, management and sanitation, most of the chicks usually overcame *S. senftenberg* and grew up soundly without being influenced by *S. senftenberg*.

When such chicks grew up to more than 40 days old, they generally showed no reaction to *S. senftenberg* in rapid whole blood agglutination test.

The fact that, even if the baby chicks in first about 7 days of age looked to be completely healthy, they always carry *S. senftenberg* in considerable numbers is in close agreement with the writers' previous report[13] that, when large numbers of baby chicks are brooded by poultry raisers in field, the outbreak of a sickness caused by *S. senftenberg* brings the greatest loses in chicks under 5~10 days of age to the raisers. That is, it is not so difficult to presume that, in the newly hatched chicks that had weak constitution or are brooded under poor management and sanitation, *S. senftenberg* which invaded into chick's body in incubator comes to be active and multiplies to result in death by septicemia within the first 5~10 days of life.

TABLE 6. *Distribution of Salmonella Organisms in Apparently*

DAYS AFTER HATCHING		1 (19/IV '54)					2					3					5				
NO. OF CHICKS EXAMINED		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
REGIONS EXAMINED	Trachea	·	·	·	·	·	·	S	s	·	·	·	·	·	S	·	·	·	·	s	·
	Lung	·	·	s	·	·	s	s	·	s	·	·	·	·	s	·	·	s	s	S	·
	Heart Blood	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	s	·
	Liver	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	Spleen	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	Kidney	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	Testicle	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	Egg-Yolk	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	Esophagus	·	·	·	s	·	s	S	s	s	·	s	·	·	S	S	·	S	·	·	·
	Crop	S	·	S	S	S	S	s	S	s	S	S	s	S	S	·	s	·	S	S	·
	Proventriculus	·	·	·	·	·	·	·	s	S	·	s	·	·	·	·	·	·	·	S	·
	Gizzard	·	·	·	·	·	·	·	·	S	·	S	S	·	S	·	·	·	·	·	·
	Small Intestine	·	·	·	·	s	·	s	·	·	S	·	S	·	·	·	·	·	·	S	s
	Caecum	·	S	·	S	s	·	s	·	S	S	s	·	S	S	·	·	S	S	S	s
	Rectum	·	S	·	s	S	S	s	·	S	S	S	S	·	S	·	·	S	S	·	S

Notes: S ···Direct culture, s···Enrichment culture of *S. senftenberg.*
· ···Negative result.

TABLE 7. *Distribution of Salmonella Organisms in Apparently*

DAYS AFTER HATCHING		1 (29/V '54)					2					3					5					7		
NO. OF CHICKS EXAMINED		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
REGIONS EXAMINED	Trachea	s	S	S	·	S	s	·	S	·	·	S	·	·	·	·	·	·	·	·	·	·	·	·
	Lung	s	s	·	S	S	S	·	S	·	S	S	·	·	·	·	s	s	·	·	s	S	·	·
	Heart Blood	·	·	·	·	S	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	Liver	·	·	s	·	·	·	·	s	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	Spleen	·	·	·	·	s	·	·	s	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	Kidney	·	·	·	·	·	·	·	·	·	·	S	·	·	·	·	·	·	·	·	·	·	·	·
	Testicle	·	·	·	·	S	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	Egg-Yolk	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
	Esophagus	·	s	S	S	S	s	S	S	·	S	S	s	·	s	·	·	·	·	·	·	·	·	·
	Crop	s	s	S	S	S	s	S	S	S	S	S	s	s	s	·	·	S	·	·	·	·	·	·
	Proventriculus	·	s	·	·	s	·	·	·	·	·	·	s	·	·	·	·	·	·	·	·	·	·	·
	Gizzard	·	·	·	·	S	s	·	·	·	·	s	·	·	·	·	·	·	·	·	·	·	·	·
	Small Intestine	·	·	s	S	·	S	·	·	·	S	·	·	·	S	S	·	·	S	·	·	·	·	·
	Caecum	s	S	s	S	S	S	S	S	·	S	S	·	·	S	S	·	S	·	·	·	·	·	·
	Rectum	S	S	S	S	s	S	S	S	S	S	S	·	S	S	S	·	·	·	·	·	·	·	·

Notes: S ···Direct culture, s···Enrichment culture of *S. senftenberg.*
· ···Negative result.

Healthy Chicks' Bodies Originated from F Hatchery

7					9					11					15					20		25	30	40	50	60
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43 ≀ 45	46 ≀ 50	51 ≀ 55	56 ≀ 60	61 ≀ 65	66 ≀ 70
S	·	·	·	·	·	·	S	s	·	·	·	·	·	S	·	s	·	·	·	·	·	·	·	·	·	·	·
·	·	s	·	s	·	·	·	s	s	s	·	s	s	·	·	·	·	s	·	·	s	·	·	·	·	·	·
·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	s	s	s	·	·	S	·	·	·	·	·	·	·	·	·	s	·	·	·	·	·	·	·	·	·
·	·	·	·	·	s	·	·	S	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·	s	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	S	S	·	·	·	·	S	S	·	s	·	·	s	·	·	·	·	·	·	·	·	·	·	·	·	·
S	·	S	·	·	·	·	·	·	·	·	s	·	·	s	·	·	·	·	·	·	·	·	·	·	·	·	·
·	s	·	·	·	s	·	·	s	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	S	·	·	·	·	·	·	s	·	·	·	·	·	·	·	·	·	·	S	·	·	·	·	·	·	·	·
·	S	·	·	·	·	·	·	S	·	·	·	·	·	·	·	·	S	·	S	·	·	·	·	·	·	·	·
S	S	S	s	S	S	S	·	S	S	·	·	·	·	·	·	·	S	·	·	·	·	·	·	·	·	·	·
·	S	S	·	·	·	s	·	·	S	·	·	·	·	·	·	·	S	·	S	·	·	·	·	·	·	·	·

Healthy Chicks' Bodies Originated from T Hatchery

		9					11					15					20					25			30			40	50	60
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52 ≀ 54	55 ≀ 57	58 ≀ 60
·	·	s	s	·	·	·	·	·	S	·	·	s	·	·	·	·	·	s	·	s	·	·	·	·	s	·	·	·	·	·
·	·	s	S	·	s	s	·	·	S	S	s	s	·	S	·	·	s	·	·	·	·	s	·	·	S	s	·	·	·	·
·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	s	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·	·	s	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	S	·	·	·	·	·	·	s	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·	·	S	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·	·	·	·	·	·	·	S	·	·	·	·	·	·	·	·	·	·	S	·	·	·	·	·
·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
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·	·	S	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	S	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·

SUMMARY

Experimental studies were carried out to clarify the mode of *S. senftenberg* infection in newly hatched chicks in some hatcheries situated in or near Sapporo and to clarify the presence or disappearance of *S. senftenberg* which invaded into baby chicks' bodies. At the same time the reasons for the appearance of *S. senftenberg* in hatching compartments of incubators and the influence of *S. senftenberg* upon baby chicks were discussed.

The conclusions obtained are summarized as follows:

1. In any hatchery so far as the writers have investigated, *S. senftenberg* came to be detected in the hatching compartments of incubators at time over 6～7 weeks after the beginning of hatching (Tables 1, 2 and 3).

2. The newly hatched chicks originated from such incubators are usually infected in the incubators with *S. senftenberg* through their respiratory and digestive organs, and the rate of *S. senftenberg* infection among chicks tends to run parallel with the rate of multiplication of *S. senftenberg* in the incubator (Tables 1, 2 and 3).

3. These infected chicks carry the greatest numbers of *S. senftenberg* during first about 1 week of life, but so far as they are brooded under good feeding, management and sanitation, they remain healthy in appearance. They usually eliminate *S. senftenberg* from their bodies in 4～6 weeks without therapeutic measures (Tables 6 and 7) and may be expected to exhibit no sequelae by *S. senftenberg* in future.

4. The regions where *S. senftenberg* lurks in baby chicks' bodies are the respiratory and digestive organs (Tables 6 and 7).

5. It is sure that *S. senftenberg* multiplies in hatching compartments of incubators working with normal temperature and humidity. However it is not yet proved what may bring, and how *S. senftenberg* is brought into the incubator for the first time.

6. As *S. senftenberg* contained in incubator is readily killed by formaldehyde gas, the hatching compartments of incubators should be cleansed and disinfected with the fumigation of formalin at intervals of 6 weeks after the beginning of hatching.

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