FEEDING EXPERIMENTS WITH BACTERIUM PULLORUM. THE TOXICITY OF INFECTED EGGS.

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In a previous investigation on the bacteriology of the hen's egg[1] sufficient evidence was acquired to show that the contents of normal fresh eggs are, as a rule, sterile, and that even eggs which have been incubated artificially for 3 weeks remain relatively free from bacterial invasion, provided that they were fresh and clean when placed in the incubator. It was shown, however, that eggs which come from fowls that are permanent bacillus (*Bacterium pullorum*) carriers are often exceptions to the rule.

The carrier problem in bacillary white diarrhea of young chicks has assumed considerable importance in recent years.[2] It has been demonstrated beyond doubt that the mother hen is the permanent source of infection, as the result of acquiring the disease early in her existence, or after full maturity. The permanent seat of infection is the ovary, which in many instances becomes so greatly involved that the ova are discolored and misshapen, and the ovary presents a decidedly pathological appearance. The ova harbor the disease organism. Furthermore, ova which develop into apparently normal yolks frequently carry the organism, *Bacterium pullorum*, to the time of full formation of the egg. Infected eggs produce infected chicks, and although chicks succumb frequently before their embryonic development is completed, a large percentage of them emerge from

[1] Rettger, L. F., *Centralbl. f. Bakteriol., 2te Abt.*, 1913–14, xxxix, 611; *Bull. Storrs Agricultural Experiment Station*, 1913, No. 75.

[2] Rettger, L. F., and Stoneburn, F. H., *Bull. Storrs Agricultural Experiment Station*, 1909, No. 60; 1911, No. 68. Rettger, L. F., Kirkpatrick, W. F., and Stoneburn, F. H., *Bull. Storrs Agricultural Experiment Station*, 1912, No. 74. Rettger, L. F., Kirkpatrick, W. F., and Jones, R. E., *Bull. Storrs Agricultural Experiment Station*, 1914, No. 77.

the shell apparently sound and well. However, they soon acquire the disease and many of them fall a prey to the organism which they carried for a long time in their yolk. Those which survive often become permanent bacillus carriers, and thus the cycle of infection is completed. Furthermore, these chicks are a constant source of infection to other chicks and mature stock as well.

The occurrence of *Bacterium pullorum* in eggs has been a subject of serious consideration, but only from the standpoint of breeding and the perpetuation of sound stock. The system of testing breeding hens by the agglutination test, which is now being conducted in several of the states, marks but a culmination of the efforts that are being made to combat the disease through the detection and the elimination of the permanent carriers of bacillary white diarrhea.

There has been much speculation from time to time as to whether the presence of *Bacterium pullorum* in an egg renders it unsafe as an article of diet for man or any of the lower animals other than chicks, and especially for young children and infants. Little serious thought was given to this question, however, and it was dismissed with the assumption that such an element of danger, if it existed at all, was but very slight. While it is not the purpose of this paper to spread undue alarm, there is sufficient evidence on hand to show that *Bacterium pullorum*, when fed to some of the lower animals, may produce most serious consequences, and even death. In other words, it has been demonstrated that this organism may manifest itself as one of the group of so called "food-poisoning bacteria."

The marked pathogenicity of *Bacterium pullorum* for young chicks has been so frequently demonstrated that little need be said concerning it here. Chicks under 1 week of age are extremely susceptible to the influence of this organism, whether infection takes place through the mouth or the skin (subcutaneous injection), and the mortality is usually very high. It had long been supposed, however, that the ability of this organism to produce disease did not extend beyond young chicks.

Jones[3] was the first to demonstrate that *Bacterium pullorum* may be pathogenic for fully mature fowls. On a large poultry farm in the state of New York

[3] Jones, F. S., *Jour. Med. Research*, 1912–13, xxvii, 471.

a peculiar epidemic manifested itself in a flock of about 700 adult hens, the resultant mortality being 50. This epidemic was most clearly traced to infected eggs, as the following account will show. There had been no history of bacillary white diarrhea on the farm. A neighbor had been meeting with serious losses, however, and a number of eggs from his fowls were incubated on the farm which had hitherto been free from the disease. Nearly all the chicks that were hatched from these eggs died within 10 days from bacillary white diarrhea. The eggs which failed to hatch were inadvertently fed on Mar. 12 to the adult hens. On Mar. 28 a few of the fowls which had eaten the eggs died, and from that time on for a period of a month 50 of the hens died, with essentially the same symptoms. *Bacterium pullorum* was recovered from various internal organs of hens that were examined, as well as from chicks hatched from the neighbor's eggs, and from the ovaries of the neighbor's adult fowls.

We have obtained similar results, though on a much smaller scale. In a series of experiments conducted in 1913 on mature fowls, and in which bouillon cultures of *Bacterium pullorum* were fed to the fowls along with the regular dry mash, three deaths occurred in a pen of twelve hens. Two of the hens were sent to the laboratory for bacteriological examinations. From the liver, lungs, spleen, and heart of both these victims *Bacterium pullorum* was easily recovered, and the growths obtained on agar by direct inoculation were such as to indicate that the bacilli were present in the blood in very large numbers. Postmortem examinations did not reveal any marked or gross lesions. The deaths occurred within a period of 1 to 2 weeks after the first ingestion of the bouillon cultures. Other hens which appeared to be affected completely recovered in a relatively short time.

The first information as to the real toxicity of *Bacterium pullorum* for experimental animals was conveyed by Smith and Ten Broeck.[4] In comparative studies of the properties of this organism and of the bacillus of fowl typhoid these authors demonstrated that the bacterium-free filtrates of 5 to 15 day old bouillon cultures of *Bacterium pullorum* were decidedly toxic to full grown rabbits when given by intravenous injection. Death followed within 2 hours, or there was marked dyspnea followed by death over night or by loss of weight and subsequent recovery.

Gage[5] has shown that rabbits are very susceptible to even very small doses of *Bacterium pullorum* by subcutaneous injection, and that for this reason it is difficult to immunize rabbits to the organism.

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[4] Smith, T., and Ten Broeck, C., *Jour. Med. Research,* 1915, xxxi, 547.

[5] Gage, personal communication.

The present investigation divides itself into two distinct phases: first, a study of the toxicity or disease-producing properties of *Bacterium pullorum* when administered orally, either with food or with the aid of a pipette; and, second, an investigation of the heat tolerance of this organism in infected eggs which are being prepared for table use by the usual processes of boiling, coddling, frying, etc.

The Toxicity of Bacterium pullorum when Introduced through the Mouth and Digestive Tract.

The experiments were conducted on 22 rabbits, 11 kittens, 11 guinea pigs, and 4 white rats. The method of administering the test organism varied. In some instances water suspensions of slant agar cultures were mixed with the regular feed, while at other times these suspensions were given with a pipette. In a number of the experiments the yolks of eggs were employed which had been artificially infected with pure cultures of the organism by injecting relatively small numbers directly into the yolk, through the shell and white, and incubated for at least 2 or 3 days. The different animals were weighed at frequent intervals, usually each day, and their general condition was observed. Those that died were subjected to post-mortem examination, with a special effort to determine the presence or absence of *Bacterium pullorum* in the blood of the internal organs.

In Table I are given the results of the infection experiments with rabbits, in so far as the weights and deaths are concerned. It will be seen that the initial weights of the animals varied from 375 to 2,455 gm., the majority of the rabbits being half grown or smaller. More complete data are given in the individual records following the table.

Rabbits 1 and 2 were fed large amounts of suspensions of five different strains of *Bacterium pullorum* (1 to 5 cc.) daily. On the 5th day they refused to eat, and died on the 7th and 6th days. Pure cultures of *Bacterium pullorum* were obtained from the internal organs. Rabbits 3, 4, 5, and 6 received one large dose of the organism with the food. From the blood of each of these animals the bacterium in question was recovered in large numbers, after death. Rabbits 7 and 8 were given the surface growth of one tube of slant agar. Blood

TABLE I.

Rabbits. Weight in Gm., and Mortality Records.

	Rabbit No.	Initial weight.	Days after first administration of *Bacterium pullorum*.											
			1	2	3	4	5	6	7	8	9	10	40	
1	Infected	380							Dead.					
2	"	375						Dead.						
3	"	650			640		550	540	"					
4	"	420	412	405	417	435	411	387	"					
5	"	475	482	483	488	452	438	Dead.						
6	"	385			380		342	337	"					
7	"	545	558	560	540	500		495	"					
8	"	435	434	432	423	405	Dead.							
9	"	615	592	630	635			550	"					
10	"	745	700	723	730			785		850		840	1,428	Alive.
11	"	648	665	690	685			675		725		770	1,334	"
12	Control	410	412	425	420			407		480		475	1,140	"
13	Infected	2,455	2,430	2,440		2,436			2,485	After 18 days			2,390	"
14	"	885	870	925	1,010	955	1,005		1,060		1,080	After 21 days	1,120	"
15	"	1,240	1,220	1,250	1,360	1,290	1,320		1,365		1,380	" 21 "	1,350	"
16	"	1,100	1,138	1,160	1,250	1,190	1,240	1,075	Dead.					
17	"	985	952	940	805	730	735	Dead.						
18	"	1,180	1,162	1,140	1,300			1,030	"					
19	"	1,370	1,362	1,370	1,325	1,370	1,335	1,215	"					
20	Control	1,308		1,325	1,400	1,310	1,325			1,400	Alive.			
21	"	1,210		1,230	1,285	1,240	1,255			1,290	"			
22	Infected	1,980	1,835	1,845		1,770	1,720	Dead.						

tests were again positive. Rabbit 9 was fed 0.1 of a slant agar growth. Death occurred on the 7th day. *Bacterium pullorum* was demonstrated in the blood.

Rabbit 10 received 0.3 of a 24 hour slant agar culture. It continued to gain weight for 40 days. It was then given 0.5 cc. of a mixture of three strains, but continued to gain for 2 weeks. A third dose of 0.7 cc. likewise had no visible effect.

Rabbit 12 served as a control animal, and was therefore not subjected to an infection experiment. Aside from this rabbit there were at all times at least two or three rabbits which belonged to the same lots as the test animals, and which were kept under practically the same conditions, except for the administration of suspensions of *Bacterium pullorum*. None of these stock rabbits died or showed any indications of illness.

Aside from a loss of 65 gm., Rabbit 13 was apparently unaffected after receiving through a pipette 2 cc. of a suspension obtained by washing three slant agar cultures.

Rabbits 14 and 15 received 0.5 and 1.0 cc. respectively of the yolk of incubated eggs which had been artificially infected with *Bacterium pullorum*. Rabbits 16, 17, 18, and 19 were given with a pipette 1.5, 2.0, 3.0, and 5.0 cc. of the yolk of artificially infected eggs. In addition to losses in weight, and death in each instance, there were indications of a diarrheal condition. With the exception of No. 18, blood tests with each of these animals for *Bacterium pullorum* gave positive results.

Rabbits 20 and 21 were kept as controls in separate cages. They remained apparently normal.

Rabbit 22 was a good sized adult male which had been suffering from a large abdominal abscess. Although the abscess was lanced it continued visibly to affect the health of the animal. 10 cc. of the yolk of an infected egg were given by mouth. On the 5th day there were marked diarrheal symptoms, and on the 6th day the rabbit died. *Bacterium pullorum* was recovered from the heart, liver, and lungs in large numbers.

Postmortem examination of the rabbits which died apparently from the effects of infection with *Bacterium pullorum* revealed no gross

lesions or other marked pathological condition. The small intestine was usually empty and decidedly pale. At times a light yellow viscid fluid was present in the lumen. In the lower intestine the contents were often less firm than in the normal rabbit, and frequently there was evidence of a diarrheal condition.

The liver was more or less congested. The surface was often marked by minute areas which appeared to be of a necrotic character. Aside from some congestion the spleen and kidneys were to all appearances normal. No pathological condition of the heart and lungs was visible to the unaided eye. Since no investigation was made of the histological structures of the different organs no details can be given as to their minute pathology.

The internal organs of the cats that died showed no marked pathological appearances, and to a large extent resembled those of the rabbits that succumbed to infection. Congestion was apparent, especially in the liver. Culture tests upon Cats 1, 2, 6, 7, and 8 gave positive results, *Bacterium pullorum* being recovered with ease from the blood of the liver, kidney, and lungs, except in No. 7 in which only the lungs contained the organism in question in sufficient numbers to obtain positive cultures. Agglutination tests with positive fowl sera proved the organism to be *Bacterium pullorum*.

The early death of the control animal was either due to some other cause or agent, aside from *Bacterium pullorum*, or was the result of rapid infection of this kitten from the vomited matter and diarrheal discharges of other kittens that were the first to be seriously affected. These experiments on kittens are to be repeated, with enough controls kept in separate cages to make the results as conclusive as possible.

White Rats.—Four white rats weighing from 100 to 250 gm. were used in these experiments. They were given one large dose of *Bacterium pullorum* in a water suspension. None of the animals showed any signs of discomfort or illness after the treatment, and all continued to increase in weight for the entire observation period of 24 days. The rats, although small as compared with adults, were apparently unaffected by one treatment with the organism (3 to 5 cc. of the suspension).

TABLE II.

Cats: Weight in Gm., and Mortality Records.

Cat No.	Initial weight.	Days after first administration of *Bacterium pullorum* by mouth. 1	2	3	4	5	6	8	10	12	14	20	23	40
1	1,088	—	1,180	1,160	—	1,192	—	1,115	1,074	985	915	790	Dead.	
		Given 2.0 cc. of suspension of *Bacterum pullorum* (with pipette) at beginning of experiment.												
2	1,098	—	1,158	1,136	—	1,200	—	1,130	997	955	890	750	"	
						Given 1.0 cc. of suspension.								
3	928	—	940	920	—	846	—	805	776	755	750	810	795	Dead. 635
						Given 0.5 cc. of suspension.								
4	618	—	632	—	—	535	492	Dead.						
		Received 0.5 cc. of suspension of *Bacterium pullorum* in water.												
5	600	—	600	—	—	590	636	535	525	530	Dead.			
						Given 1.0 cc. of suspension.								
6	590	—	590	—	—	485	492	Dead.						
						Given 1.5 cc. of suspension.								
7	660	—	680	—	—	615	620	575	595	Dead.				
						Given 2.0 cc. of suspension.								
8	620	—	820	—	—	800	710	Dead.						
		Control. Not artificially infected, but kept in same enclosure as Cats 4 to 7.												
9	990	935	910	895	885	880	—	795	770	770	685	700	710	Alive.
						Received 0.5 cc. of suspension.								
10	990	1,000	965	980	980	940	—	990	925	905	865	880	890	"
						Given 1.0 cc. of suspension.								
11	730	740	746	725	745	705	—	710	685	695	690	650	Alive.	
						Given 0.5 cc. of suspension.								

Kittens 1 to 3 were from one litter, Nos. 4 to 8 from another, and Nos. 10 and 11 from a third. While No. 8 was not artificially infected she was allowed to be in contact with Nos. 1 to 7 which were fed suspensions of *Bacterium pullorum* with a pipette. As vomiting and purging occurred very soon in these cats, the possibility of the control's becoming infected early cannot be excluded.

Kittens 4 to 7 were fed the bacterial suspensions 3 days later than Nos. 1 to 3. Signs of disturbances became apparent in both groups at about the same time. Vomiting, diarrhea, and rapid loss in weight were the most marked symptoms in the animals that died. Vomiting and diarrhea were most acute. The temperature during the time of the most severe attacks was decidedly subnormal, and for several days before death the kittens were extremely weak and listless. Cats 9, 10, and 11 showed no signs of illness except loss in weight.

TABLE III.

Guinea Pigs. Weight in Gm., and Mortality Records.

Guinea pig No.	Initial weight.	Days after first administration of *Bacterium pullorum* by mouth, and of additional doses. 1	2	3	4	5	6	8	10	12	14	16	18	20	
1	540	—	—	560	—	540	525	528	529	525	515	510	510	538	Alive.
	Bacterial suspension of *Bacterium pullorum* mixed with food at beginning of experiment.														
2	510	—	—	512	—	502	495	482	512	498	505	518	514	555	"
	Same treatment as No. 1.														
3	717	718	710	710	700	723	702	703	—	694	710	698	705	740	"
	Same treatment as No. 1.														
4	365	370	385	—	360	340	325	Dead.							
	Given varying amounts of infected yolk daily for 6 days (1 to 5 cc. of yolk.)														
5	75	78	80	85	84	—	83	Dead.							
	Given 0.5 cc. of heavy bacterial suspension at beginning of experiment.														
6	365	370	385	360	340	325	330	275	Dead.						
	3cc.	3cc.	5cc.	8cc.	—	3cc.	8cc.	of infected yolk, given on respective dates.							
7	425	425	420	405	405	410	400	415	430	—	—	—	—	Dead.	
	7cc.	5cc.	6cc.	5cc.	4cc.	of infected yolk.									
8	315	—	310	—	330	315	—	330	—	335	—	—	—	355	"
	10cc.				10cc. of infected yolk.										
9	315	—	310	—	265	285	—	295	—	300	—	—	—	325	"
	10cc.				10cc. of infected yolk.										
10	345	320	Dead.												
	One feeding, half of an infected yolk.														
11	405	380	355	320	Dead.										
	One feeding, half of an infected yolk.														

In Guinea Pig 4 a diarrheal condition was apparent on the last 2 days. The liver and kidneys were congested. Other organs were normal. Cultural tests were negative. Guinea Pig 7 showed evidence of marked diarrhea just before death. There was some congestion of the liver and spleen, and hemorrhage in the pericardial sac. Culture tests from the different organs were negative. In Nos. 6, 7, and 10 slight diarrhea was apparent, but no other symptoms, except loss of weight and lessened appetite, were observed.

Cultural tests were again negative. *Bacterium pullorum* was isolated from the liver and lungs of Guinea Pig 11, but not from the blood of any of the other five animals that died.

DISCUSSION.

The foregoing data on the oral administration of *Bacterium pullorum* can leave no doubt as to the so called toxicity of this organism for young rabbits when given by mouth. The results of the feeding experiments with kittens of different ages are less conclusive, and require further substantiation, in view of the fact that there was no satisfactory control. They are strongly indicative, however, of a most harmful influence exerted by relatively large numbers of the organism when administered by mouth. The symptoms of the disturbance produced in the kittens were those of a food-poisoning organism, especially the vomiting and diarrhea, and the extreme emaciation. The possibility that these symptoms are due to a complication of disturbing factors, cannot be entirely ignored, however.

Adult guinea pigs are but slightly susceptible to *Bacterium pullorum*, when ingested, though six of the eleven animals employed died, some early and others late in the periods of observation. With but one or two exceptions, they were given large amounts of the organism. Further experiments with guinea pigs are now in progress. Rats, according to the above data, are immune to disturbing influences of *Bacterium pullorum* when it is given by the mouth, even in large numbers.

Although there are no cases on record of food-poisoning, enteritis, or other ailments in man which have been ascribed to *Bacterium pullorum*, the possibility of danger from infection with this organism can no longer be ignored, especially in so far as invalids and young children are concerned. Eggs are among the most common articles of diet, and for the sick and convalescent as well as for children of all ages they often rank with milk as one of the most important foods. Not only are they consumed soft boiled, but they are frequently prescribed in the raw state.

Fresh eggs, when they are infected with *Bacterium pullorum*, contain this organism in such small numbers as to constitute no real danger of disturbance even for the most infirm, or for the smallest infants. It has been conclusively demonstrated, however, that the organism multiplies very rapidly in the yolks of infected eggs, when

the eggs are held at or near so called incubator temperature.[6] Hence, eggs which are left in the nest under broody hens for but comparatively few hours, or which are not kept in cool places during storage and transportation, especially during the warm summer months, harbor the organism in large numbers. In fact, they are so abundant that the inoculation of the surface of slant agar with but a small portion of the yolk held in a platinum loop results in the production of an almost solid surface growth on the agar.

It has also been shown that in various sections of this country a large percentage of the flocks and of the individual hens are permanent carriers of white diarrhea (*Bacterium pullorum*) infection. In the survey of the conditions in Connecticut it was found that out of 107 flocks which were tested for ovarian infection with *Bacterium pullorum* 79, or 74 per cent, possessed bacillus carriers, and of a total of 13,831 fowls that were subjected to the agglutination test 1,417, or 10.24 per cent, gave positive indications of ovarian infection.[7] In an investigation recently conducted in Massachusetts similar results were obtained.[8] In some flocks over 50 per cent of the individual fowls that were tested were reactors. The same condition undoubtedly prevails throughout a large part of the Country, though no definite figures have been obtained outside of Connecticut and Massachusetts.

The common methods of boiling or frying infected eggs for the table do not necessarily render the eggs sterile, in so far as *Bacterium pullorum* is concerned, as the following data will show.

The Survival of Bacterium pullorum in the Yolks of Eggs after Various Methods of Treatment with Heat. The Influence of Cooking.

These experiments were carried on with eggs which were artificially infected with *Bacterium pullorum* in the following manner. Fresh

[6] Rettger and Stoneburn, *Bull. Storrs Agricultural Experiment Station*, 1911, No. 68. Rettger, Kirkpatrick, and Jones, *Bull. Storrs Agricultural Experiment Station*, 1914, No. 77. Rettger, *Centralbl. f. Bakteriol., 2te Abt.*, 1913–14, xxxix, 611.

[7] Rettger, Kirkpatrick, and Jones, *Bull. Storrs Agricultural Experiment Station*, in press.

[8] Gage, G. E., and Paige, B. H., *Bull. Massachusetts Agricultural Experiment Station*, 1915, No. 163.

eggs were immersed for a few minutes in alcohol, and one of the ends was flamed. A small hole was made through the shell without injuring the shell membrane. The eggs were then inoculated by injecting about 0.25 cc. of a water suspension of the organism with a sterile hypodermic syringe directly into the yolk. The hole was sealed with collodion and the eggs were incubated for varying lengths of time, usually 3 to 5 days.

Infected eggs were placed in boiling water, and held there for different lengths of time. They were then chilled in cold water and opened aseptically. Small amounts of yolk were streaked over the surface of slant agar and the tubes incubated at 37°C. The results are given in Table IV.

TABLE IV.

Time of boiling.	Coagulation of white.	Thickening of yolk.	Growths of *Bacterium pullorum* on slant agar.
min.			
1	0	0	+
2	0	0	+
2½	Slight.	0	0 + + + + +
3	+	Slight.	0 0 0 + + + +
3½	+	+	0 0 0 0 0 0 + + + +
4	+	+	0 0 0 + +

In the last column 0 indicates no growth, and + the characteristic growth of *Bacterium pullorum*. Each 0 and + sign represents an individual egg. The variation in the results of the different eggs is undoubtedly due to differences in the size of the eggs and the thickness of the shells, and perhaps in part to the differences in the numbers of bacteria in the eggs.

Poaching the eggs for ½ to 4 minutes rendered them sterile. Artificially infected eggs that were scrambled were likewise found to contain no viable organisms. On the other hand, fried and coddled eggs gave varied results, as will be seen in the following brief summaries.

In all the foregoing experiments control tests were made with eggs that had been inoculated and incubated in the same way as the others. No difficulty was experienced in obtaining an abundance of the bacilli in the yolks after the various periods of incubation of the eggs.

It should be stated that all these experiments were conducted at an altitude of 700 feet above sea level, where the boiling point of water is 99.2°C.

TABLE V.

The Effect of Frying.

Physical character of heated eggs.	Growth on slant agar.
Frying on one side only.	
Soft.	+ + + +
Medium.	+ +
Hard.	+
Frying on both sides.	
Soft.	0 0
Medium.	0 0
Hard.	0 0

TABLE VI.

The Effect of Coddling.

Time of heating.	Growth on slant agar.
min.	
3	0 +
3½	0 0
4	0 + + +
4½	+
5	0 0
7	0
10	0

The eggs were coddled by pouring boiling water over them in a granite receptacle and allowing them to stand away from a flame or stove for the different lengths of time. About 1 quart of water was employed for each egg.

The experiments on the viability of *Bacterium pullorum* in egg yolk after varying periods of heating show that the organism under the stated conditions possesses a high degree of resistance. Even boil-

ing for 4 minutes did not in every instance destroy it. This resistance is due undoubtedly to the peculiar protection which is afforded, first by the shell, then by the egg white, and finally by the yolk itself. The high per cent of fat in the yolk is undoubtedly an important factor.

It has been demonstrated by Smith[9] and others that tubercle bacilli are less readily killed by the ordinary process of pasteurization when they are held in the film or pellicle layer of milk than in the whole or mixed milk.

Other organisms of the colon-paratyphoid-typhoid group would undoubtedly show the same resistance under similar conditions of environment. Chantemesse and Rodriguez[10] report an epidemic of food-poisoning which was due to cream cakes. The meringue of the cakes was found to contain a peculiarly toxic microorganism of the *Bacillus paratyphi* type, and although the meringue had been heated to browning numerous bacilli of this type were found in the interior portion. Quite recently a small epidemic of typhoid fever was pronounced to have been caused by the consumption of baked spaghetti.[11] The typhoid bacillus was readily identified in the inner portion of spaghetti that was artificially inoculated and baked, in spite of the fact that the dish was subjected to sufficient heat to brown the surface and to char the protruding ends of the spaghetti sticks.

SUMMARY AND CONCLUSIONS.

The problem of eradicating ovarian infection in the domestic fowl assumes still greater importance than heretofore, in the light of data recently acquired. Not only is it of great significance to eliminate the permanent carriers of *Bacterium pullorum* from all flocks of fowls from the standpoint of successful poultry breeding, but also because they constitute a possible source of danger to man.

Eggs which harbor *Bacterium pullorum* in the yolk in large numbers may produce abnormal conditions, when fed, not only in young chicks, but in adult fowls, young rabbits, guinea pigs, and kittens. The toxicity for young rabbits is most pronounced, the infection usually resulting in the death of the animals. In kittens the most prominent symptoms are those of severe food-poisoning with members of the paratyphoid group of bacteria. The possibility of infected eggs causing serious disturbances in young children and in the sick

[9] Smith, T., *Jour. Exper. Med.*, 1899, iv, 217.

[10] Chantemesse and Rodriguez, *Bull. Acad. de méd.*, 1914, lxxi, 245; Abstract in *Experiment Station Record*, 1914, xxxi, 555.

[11] Johnston, H., *Health News*, 1915, xxxi, 173.

and convalescent of all ages must therefore receive serious consideration.

Ovarian infection of fowls is very common throughout this country. Hence, a large proportion of the marketed eggs are infected with *Bacterium pullorum*. When such eggs are allowed to remain in nests under broody hens, or in warm storage places, for comparatively few hours, they contain large numbers of the organism.

Soft boiling, coddling, and frying on one side only do not necessarily render the yolks free from viable bacteria; therefore, eggs which have gone through these processes may, like raw eggs, be the cause of serious disturbances in persons who are particularly susceptible to such influences, and especially to infants.

That no well authenticated instances of egg-poisoning of this kind are on record does not warrant the assumption that there have been no cases. The etiology of infantile stomach and intestinal disturbances is as yet too little understood; in fact, it may be said that many of these disorders have no known cause, and almost as much may be said regarding gastro-intestinal diseases in later life. Furthermore, since the ailments caused by infected eggs would not make themselves felt presumably until several days after their ingestion, little or no suspicion would fall upon the eggs. It may be said, too, that the wide distribution of ovarian infection in the domestic fowl has come about only in the last few years, hence its possible danger to man is one of recent development.