

## XXXIV. RESOLVING (CHRONIC) PLAGUE IN RATS.

IN previous numbers of these reports (*Journal of Hygiene*, vol. VI. p. 530 and vol. VII. p. 457) an account has been given of a condition met with in rats to which the name "chronic plague" was applied. Recent observations in Belgaum, Poona and Bombay have thrown additional light on the significance of this condition and have added considerably to our knowledge of the subject. We propose in this paper to give a short account of these observations.

At the outset we may state that we have come to regard the term "chronic plague" as an inappropriate and misleading name for the condition to which we formerly applied it. In a previous paper we pointed out that Kolle was the first to describe what he called "chronic plague" in certain experimental rats, and we referred to the fact that Simond and others had suggested that plague infection may remain latent or continue to exist for some time in a chronic form among rats (vol. VI. p. 530). We ourselves, when this condition was met with for the first time among the rats in the Punjab village Kasel, were inclined to attach considerable importance to the discovery as affording a possible explanation for the apparent persistence of infection in this village during the quiescent plague period and as furnishing a source from which the seasonable re-appearance of plague in an acute form might have its origin. Subsequent experience, however, caused us to express the opinion (vol. VII. p. 471) "that we had no direct evidence that chronic plague as it occurs in the Punjab villages, possesses any significance in the seasonal recurrence amongst the rats of the infection in an acute form, nor is any evidence available which excludes this possibility."

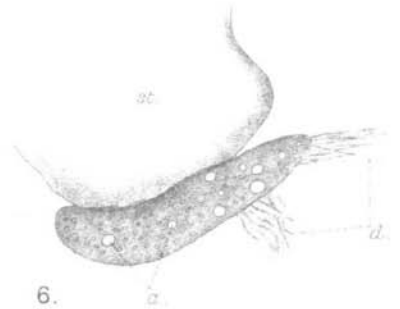
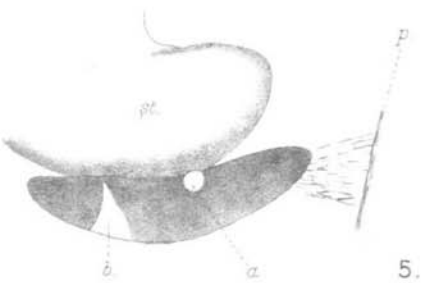
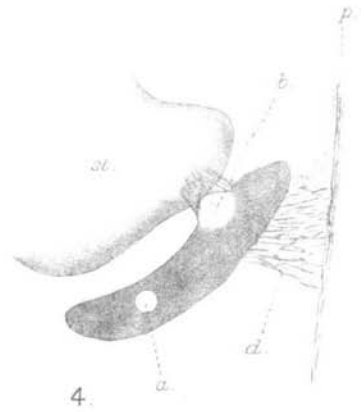
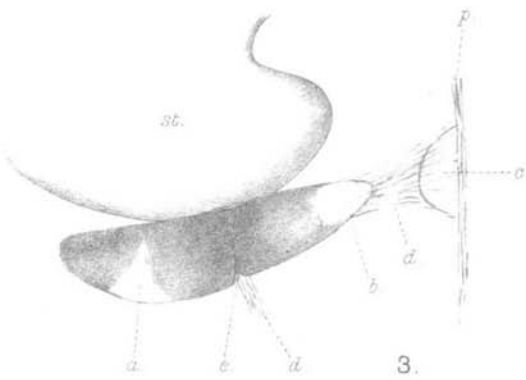
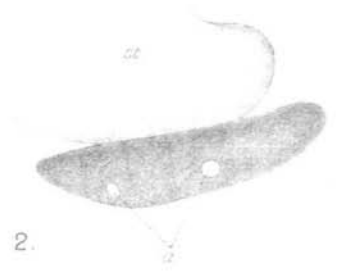
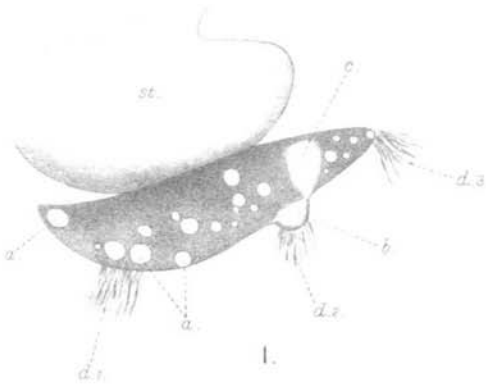
A much more extensive experience of this condition during the past two years has fully convinced us that the pathological appearances we have described as chronic plague are stages in the process of recovery from the acute disease. For the reasons, therefore, that the

## PLATE No. VIII.

*Resolving Plague of the Visceral type.*

The accompanying plate represents in a semi-diagrammatic manner the more common types of lesions met with in resolving plague of the visceral type. The sketches were made from rats met with during our Belgaum observations and are in each instance an accurate representation of the condition of the spleen. The lesions in each of the six rats illustrated were confirmed as plague by animal experiment.

- Fig. 1. (Rat No. 26008.) *a, a, a*, shot-like abscesses each containing a small bead of pus: considerable pressure was requisite to crush these abscesses between two slides owing to the thickness of the abscess wall. *b*, a thinner walled larger abscess, protruding from the surface of the spleen and adherent to the mesentery; this abscess, like the smaller ones, was pearly white in colour. *c*, a greyish yellow necrotic patch, indefinite in outline. *d* 1, *d* 2, adhesions to mesentery. *st*, stomach. The abscesses contained virulent plague bacilli.
- Fig. 2. *a, a*, two hard spherical abscesses from one of which a culture of plague bacilli was obtained.
- Fig. 3. (Rat No. 27247.) *a*, a wedge-shaped greyish necrotic mass. *b*, a similar necrotic mass, but irregular in outline. *c*, retroperitoneal abscess situated just above the left suprarenal body. *d*, adhesions. *e*, scar in the spleen adherent to the great omentum. \*The necrotic patches in the spleen as well as the retroperitoneal abscess contained plague bacilli.
- Fig. 4. (Rat No. 23570.) *a*, spherical abscess, hard shot-like containing small bead of pus. *b*, a larger thinner walled abscess closely adherent to the stomach, *st*. The spleen was united to the parietes by dense adhesions, *d*. Both abscesses contained virulent plague bacilli.
- Fig. 5. (Rat No. 22706.) *a*, a pearly white shot-like abscess. *b*, a wedge-shaped necrotic mass. A culture of plague bacilli was obtained from the abscess. The spleen was adherent to the parietal peritoneum.
- Fig. 6. (Rat No. 25505.) *a, a*, numerous small shot-like abscesses: in addition the spleen contains very many minute necrotic foci. A small portion of this spleen was crushed in sterile normal salt solution, and the resulting emulsion was injected into a bandicoot, the animal died of plague on the fourth day.



term chronic plague does not accurately express the true significance of the condition, and because that term has been associated with theories regarding the reappearance of plague in certain places (theories which in our opinion have little evidence to support them) we propose to substitute the term "resolving plague" for "chronic plague."

In compiling our previous reports on this subject, the material we had at our disposal for the study of this condition was derived from some forty-five rats, all of which were caught in the Punjab villages. For convenience of description we divided the lesions met with into two groups, viz.: (a) peripheral lesions, (b) visceral lesions. Under the former head twenty-eight cases were included; twenty-three of these cases were fully confirmed as plague by animal and cultural tests, while five others, although not confirmed in so exact a way, left little doubt in our minds that they were due to plague. Under the latter head seventeen cases were described, all of which were fully confirmed by cultural or animal tests.

In Poona and Belgaum the condition was found fairly frequently (see below pp. 347—8), and in view of our experience here it was resolved to re-examine the Bombay rats specially for resolving plague. Accordingly in 1909, from January 5th to 29th (*i.e.* just before the onset of plague) 2200 *rattus* caught alive were carefully examined and four examples of resolving plague found. Later on, between May 23rd and August 3rd (*i.e.* immediately at the close of the active plague season) in 6100 *rattus* we found 10 cases and in 3050 *decumanus* as many as 39.

In our present paper therefore we have to deal with a considerably larger mass of material, comprising thirty-six fully confirmed cases of the peripheral type and forty-one fully confirmed cases of the visceral type, together with a very large number of both types which for one reason or another were not fully confirmed, but which, in our opinion, were almost certainly cases of resolving plague; our reasons for holding this opinion will be given later. In this latter category we have placed one hundred and seventy rats with lesions of the visceral type and two hundred and eleven rats with lesions of the peripheral type. The places in which these rats were found are as follows:

Name of place	Peripheral confirmed	Visceral confirmed	Peripheral not confirmed	Visceral not confirmed
Poona	21	17	114	97
Belgaum	8	19	75	58
Bombay	7	5	22	15
Total	36	41	211	170

Our opinion regarding the pathology of this condition may be stated as follows. In a number of papers embodied in these reports, we brought forward much evidence in support of the view that in almost every instance a rat acquires plague infection through punctures made in the skin by infected rat fleas. Plague bacilli having effected an entrance into the body of a rat in this manner pass by way of the lymphatic channels to the nearest lymphatic gland. In this situation a reaction to the bacillary invasion on the part of the tissues of the host is made manifest by the development of a bubo in the majority of instances. On the one hand, the bacilli in their progress towards the blood stream may be arrested in the bubo, or, on the other hand, the bacilli may multiply rapidly and pass on through the gland to the blood stream giving rise to a bacteraemia. In the former case, either of two events may happen: (a) the reactive changes which brought about the arrest of the bacilli in the lymphatic gland may lead to the complete destruction of the bacilli, which is soon followed by the gradual disappearance of the bubo; or (b) the bacilli, although arrested in the lymphatic gland, may continue to survive and thus bring about further tissue changes in the gland resulting in necrosis and pus formation. The bubo is thus converted into an abscess. Such an abscess would furnish us with an example of our peripheral type of resolving plague. The bacilli within the abscess may ultimately be killed, in which case the abscess would be gradually absorbed. A culture from such an abscess would of course be sterile.

The plague bacilli, however, may continue to live within the abscess, which, enlarging by a slow process of necrosis, gradually approaches the skin. Ultimately the abscess may burst through the skin, discharge its contents and finally heal. But, as the outer wall of the abscess approaches the skin, before actual rupture through the skin occurs, secondary infection of the abscess contents by extraneous microorganisms is liable to occur. This secondary infection of the abscess contents is often followed by the disappearance of the plague bacilli within the abscess. If cultures are made from such an abscess other organisms may be isolated from it than the one which primarily caused the abscess. For this reason it may be impossible to prove by cultural or animal tests that a particular abscess was primarily due to plague.

We next consider the cases in which the plague bacilli have not been effectually arrested in the bubo but have gained an entrance to the blood stream producing a bacteraemia. In such case again either of two events may happen: (a) the bacteria may gradually increase

in numbers and so bring about the death of the rat, or (b) reactive changes may take place in the blood resulting in the destruction of the plague bacilli and the agglomeration and isolation of those bacilli which survive in the tissues, especially in the liver and spleen. In this latter case the infected rat may ultimately die in the struggle against the invading bacilli, or if the tissue changes which have limited the bacterial invasion finally lead to complete destruction of the bacilli the rat may survive showing in the process of recovery more or less marked pathological changes in its tissues and organs,—changes which, as the recovery becomes more complete, become less and less evident to the eye.

Considerable light has been thrown on the histology of this struggle on the part of the tissues of a rat against invading plague bacilli in the article "On the pathology of the spleen and liver in spontaneous rat plague with observations on experimental infection" by J. G. Ledingham, published in the *Journal of Hygiene*, vol. VIII. p. 359.

Ledingham divided the cases he examined into two main groups:—

(1) Those in which bacteriaemia of the spleen and liver is at a maximum and has been of recent development.

(2) Those in which bacteriaemia is less prominent or is rapidly disappearing as a result of reactive tissue changes.

It is with this second group that we are now particularly concerned.

Ledingham states that in this group definite abscess formation in the spleen is frequent and is accompanied by extensive reactive changes on the part of the plasma cells. Even with a low magnification large clumps of bacilli may be seen throughout the splenic pulp each surrounded by a zone of karyorrhectic nuclei. Outside of this zone is another of vesicular epithelioid cells and beyond this again a barrier of plasma cells. The condition is thus one of multiple small abscess formation. Very similar appearances are to be found in the liver. The number of these necrotic foci may be very great and their size may vary from a point almost invisible to the naked eye to a well defined and easily recognised abscess. Ledingham remarks that "it can readily be conceived how, provided the animal lives long enough, the reaction of the fixed tissue cells may proceed to complete encapsulation of the abscess areas and so bring about a more or less chronic condition."

The material which Ledingham examined was collected in Bombay by the Commission and was derived from a number of naturally infected acute plague rats.

Ledingham further studied the histological changes in certain experimental rats infected in England and suffering from what he regarded as "chronic" plague.

He describes in particular the lesions found in one of these chronic plague-infected rats. The tissues derived from this rat showed more advanced changes than those detailed above. In this case, he says, referring to the spleen: "In fact the organ was transformed into a veritable plasma cell granuloma with abscesses interspersed here and there. A large clump of degenerated bacilli occupied the centre of each necrotic area and all around were broken down polynuclear cells. Bounding this zone of degenerated cells was a band of epithelioid cells and numerous giant cells of tubercular type. Megakaryocytes also appeared in this zone. Enclosing the whole was a barricade of plasma cells in active division and transition forms were readily demonstrable between these latter cells and the spindle cells from which the granulation zone surrounding the abscess was being developed." The changes in the liver of this rat are particularly interesting: according to Ledingham "A section through one of the subcapsular nodules showed that nothing remained of the original abscess. The nodule consisted solely of spindle cells and fine connective tissue fibres with a boundary zone of actively proliferating plasma cells." It is important to note that the rat presenting these "chronic" lesions was killed so soon after experimental infection with plague as the eleventh day. A reference will be made later to the comparatively transient nature of these so-called "chronic" plague lesions.

It will readily be appreciated that no very hard and fast line can be drawn between the histological changes we have described above which were associated with acute plague in rats and those of this experimentally infected "chronic" plague rat just mentioned. The naked eye pathological appearances in the rats first mentioned led the Commission to regard them as suffering from acute plague although a histological examination by Ledingham showed that many of them were on the road to recovery. The naked eye pathological changes observed in the last mentioned rat however placed it without doubt in the class we are now considering, namely chronic plague rats with visceral lesions or, as we would prefer to say, the class of rats suffering from the visceral type of resolving plague.

To distinguish acute plague-infected rats from rats with resolving plague lesions we were compelled therefore to lay down more or less arbitrary rules. We were guided in this matter chiefly by our former

experience recognising as we did certain well marked pathological lesions to which we had given the name "chronic" plague. These lesions were comparatively easily distinguished by the naked eye from those we associated with the term acute plague. We decided to classify under the term resolving plague only those rats which showed:

(a) A very markedly localised plague lesion readily visible to the naked eye.

(b) The entire absence of those changes which we have described in vol. VII. pp. 526—535 which we associated with acute plague.

(c) The absence of plague bacilli from the body, except in the well defined lesions.

(d) Rats which in our opinion were not likely to die from the plague lesions from which they suffered but were in short recovering from the acute disease<sup>1</sup>.

We may now pass on to describe more in detail the naked eye appearances and the general results obtained from an examination of the material we have collected together under the heading resolving plague.

It will not be necessary here to discuss further that form of resolving plague we have classed as the peripheral type in view of the remarks we have made above regarding the pathology of this condition. It will suffice again to reiterate that in a very large number of these cases it is impossible to demonstrate the presence of plague bacilli in these lesions, either because in the process of resolution the plague bacilli have been greatly reduced in numbers, have been completely destroyed, or cannot be cultivated in the presence of organisms which have invaded the lesions secondarily.

Two lines of argument however may be put forward in support of the view that the large majority of these abscesses situated in lymphatic glands are really old plague lesions although the presence of the plague bacillus cannot be demonstrated in them.

First it may be argued from the figures we have collected in Poona and Belgaum, which are given in the annexed tables, that the number of abscesses in lymphatic glands in which plague bacilli were not demonstrated occurred each month with a frequency which closely

<sup>1</sup> The term resolving plague could without doubt be correctly applied to certain other rats which, if a microscopical histological examination had been made, would leave no option but to conclude that they were recovering from acute plague although the evidence might have shown that they had died from the disease. Such rats which had just passed out of the acute phase of the disease have been excluded from our present category.



followed the frequency with which acute plague was found among the rats. There is a distinct correlation between acute plague in rats and these abscesses in lymphatic glands in which the presence of the plague bacillus could not be proved.

Secondly it may be argued that the distribution of the abscesses in the different groups of lymphatic glands corresponds fairly closely with the usual distribution of the buboes in acute plague infected rats.

Thus for example in Belgaum throughout the year 74 rats were found with abscesses in lymphatic glands which were classed as primarily due to plague although the bacillus could not be demonstrated in them. The distribution of these abscesses in the various groups of lymphatic glands was as follows:—

Submaxillary	45 = 61 %
Axillary	7 = 9 %
Inguinal	21 = 28 %
Submaxillary + axill.	1 = 2 %
Total	<u>74</u>

We can compare these figures with the distribution of the buboes in 130 acute plague infected rats caught in Belgaum during the same period. Of the 130 rats, 112 only presented buboes and these were distributed as follows:

Submaxillary	88 = 79 %
Inguinal	10 = 9 %
Axillary	9 = 8 %
Pelvic	3 = 3 %
Submax. + inguinal	1 = 1 %
Axillary + pelvic	1 = 1 %
Total	<u>112</u>

Except then as regards the larger number of abscesses in the inguinal glands among the resolving plague group as compared with the acute plague group, the distribution of the lesions in the two groups is not very different.

Passing on next to consider the visceral type of resolving plague we may remark that abscesses in the spleen are by far the most common manifestation of this form of plague.

The abscesses in the spleen are most often spherical and shot-like. They are usually pearly white in colour and embedded in the substance

of the spleen. They can be shelled out of the splenic tissue without difficulty. In size they vary from that of a millet seed to that of a large pea. Such abscesses have very thick walls and are hard. Considerable pressure is required to rupture one of them between two glass slides. Sometimes the abscesses protrude prominently from the surface of the spleen. Such abscesses usually have thinner walls than those more completely embedded in the splenic tissue.

The abscesses in the spleen may be single or more commonly they are multiple; as many as twenty-four have been counted in one spleen. The spleen which is the seat of the abscesses is generally though not always enlarged; the enlargement is rarely very great. Spleens which have abscesses protruding from their surface in the majority of cases are adherent to the abdominal parietes, great omentum, or mesentery or to all three. The adhesions are always in the neighbourhood of the abscesses and may be long and thin, or the whole spleen may be closely bound down in the midst of dense tough adhesions. Figures 1, 2, 4, and 5 represent semi-diagrammatically some of the appearances met with in rats. In the centre of each of the smaller abscesses there is generally a small bead of pale yellow pus. The pus is often inspissated. Microscopical examination of the pus occasionally reveals the presence of involution forms of plague bacilli; prolonged search is sometimes necessary to demonstrate them: they are rarely very numerous.

Generally the bacilli are seen free in the liquor puris; occasionally, however, they are found phagocytosed within the pus cells. Not infrequently microscopical examination fails to reveal the presence of any organisms.

Cultures have on several occasions demonstrated the presence of the plague bacillus when microscopical examination has yielded a negative result. To obtain an uncontaminated culture from the smaller of these splenic abscesses is frequently a matter of considerable difficulty. On several occasions a culture of the *Bacillus pestis* has been obtained by shelling out a small abscess from the spleen, crushing it between two sterile slides and inoculating a culture tube from the minute head of pus that is adherent to one or other glass slide. It is always advisable when the abscesses are multiple to endeavour to obtain cultures from more than one abscess, as the pus in some of the abscesses is often sterile. A method that has been adopted with successful results for the purpose of demonstrating the presence of *Bacillus pestis* in minute splenic abscesses is as follows:—the abscess is shelled out of the spleen, placed in a sterile capsule and thoroughly crushed and ground up in

normal salt solution. The resulting emulsion is injected subcutaneously into a guinea pig or other susceptible animal.

In addition to this condition of splenic abscesses, rats were not uncommonly met with which had spleens containing necrotic areas or foci rather than true abscesses with purulent contents. These necrotic foci vary much in size, some are very minute but large necrotic masses are also met with. These larger necrosed areas may be irregular in shape but more commonly they are wedge-shaped. They are greyish-yellow in colour. Examples of such necrotic areas are illustrated in figs. 3 and 5. These necrotic areas may be met with alone or in conjunction with splenic abscesses. The abscesses are probably developed in connection with these necrotic foci. Virulent plague bacilli may be isolated from these areas. Smears from the necrotic material occasionally show the *Bacillus pestis* on microscopical examination, usually as involution forms. As in the abscesses, the demonstration of plague bacilli in these necrosed areas is not always easy. They are frequently not seen on microscopical examination of smears made from the lesions. Cultures may yield a growth of the bacillus when it has not been found microscopically. The easiest and perhaps the most successful method of demonstrating the presence of plague bacilli in these lesions is to grind up a small portion of the necrosed area in normal salt solution and inject the resulting emulsion subcutaneously into a susceptible animal. We may here state that the rubbing of the lesions found in visceral resolving plague into the abraded skin of a guinea pig almost invariably fails to infect the animal with plague. This can, we think, be explained by the paucity of the plague bacilli in the majority of these lesions. Our failure to detect "chronic" plague in Bombay, a reference to which has been made in vol. VI. p. 530, may be thus explained, for we then relied on the cutaneous method for the isolation of the bacillus in almost every case. The single instance of chronic plague in Bombay, which we have described in our previous reports, vol. VII. p. 468, was only detected because cultural methods were adopted in addition to the cutaneous method for the isolation of the bacillus.

We have mentioned above that splenic abscesses are frequently adherent to the omentum, mesentery and abdominal parietes by fine fibrous bands. We have observed instances in all stages of progression from abscesses contained within the substances of the spleen adherent to the mesentery by fibrous bands, to abscesses wholly separated from the spleen lying free in the mesentery or great omentum. We have been able to fully confirm the view which was only tentatively put

forward in vol. VII. p. 467 that these mesenteric abscesses originate from lesions which are first developed in the spleen, we may here also state that we have not been able to obtain any evidence in favour of the view that these mesenteric abscesses have originated from an intestinal infection.

At this stage we may put to ourselves the question: What becomes of these plague abscesses in the spleen, mesentery and liver which we have described above? We may at once state that we have not come across any instance which showed that these abscesses had been the source from which an acute plague infection had been re-established in a particular rat. No case was met with showing at the same time abscesses and the presence of plague bacilli free in the blood stream in any numbers. We have not been able to collect any evidence to show that these comparatively quiescent lesions ever pass into the acute form of the disease. On the contrary we have been able to collect some evidence which goes to prove that these abscesses tend to become absorbed and that in a comparatively short time the large majority disappear leaving behind them scar tissue to indicate their previous existence.

In the description we have given above of resolving plague of the visceral type, we have remarked on the frequency with which the splenic lesions are associated with adhesions of the spleen to the abdominal walls and viscera, more commonly to the mesentery and omentum, less commonly to the suprarenal body, kidney, or uterus. These adhesions may persist long after the splenic abscesses have completely disappeared. The only evidence of the previous existence of the abscesses is to be found in scar tissue and localised patches of perisplenitis. The fibrous bands which persist longest are found connected on the one side with the scar tissue and patches of perisplenitis in the spleen, which indicate the seat of the original abscess, and on the other side to the abdominal walls, omentum, suprarenal, kidney or uterus. These fibrous bands are in the majority of cases long, thin and delicate, or they may be thick and fibrous. The spleen may be so closely bound down to the tissues around it that prolonged dissection is necessary to free it from its surroundings. This condition of perisplenitis with adhesions is, however, not generally a permanent one; most cases resolve completely.

We are of opinion that almost every case of splenic adhesions and perisplenitis found in rats which have passed through a plague epizootic has originated in lesions of the visceral type of resolving plague and represents the final stage in the process of resolution of the

abscesses we have described above. Similar conditions may no doubt arise from other infections.

It is, of course, impossible to prove directly that the sterile abscesses and other more advanced lesions, now represented by scar tissue only, were primarily due to a plague infection; it is impossible to isolate the plague bacillus from them. But other arguments may be brought forward to support the view that they were originally caused by plague bacilli. Thus these sterile lesions have been found (1) to resemble closely both in their structure and distribution similar lesions which have been proved to contain plague bacilli; (2) to show a seasonal prevalence which is correlated with acute plague and with similar abscesses from which plague bacilli have been isolated; (3) to be associated in individual rats with peripheral lesions in lymphatic glands pointing to a primary plague infection; (4) the examination of more than 6000 rats (*M. rattus*) caught in Madras city (which for several years has been free from plague) has failed to reveal the presence of abscesses similar to those described above and which were met with in Bombay, Poona and Belgaum Cities especially towards the close of the plague epizootics: nine examples of scars in the spleen have been found.

We have been able to produce resolving plague experimentally in rats by inoculation: details will be published when a further series of experiments are completed.

#### SUMMARY.

1. The abscesses in the viscera, especially the spleen, and in the peripheral lymphatic glands, some of which contain living plague bacilli, which have been previously described as "chronic plague in rats" are shown to be plague lesions in the process of healing. The name "resolving plague" is more appropriate.

2. These lesions are found most frequently towards the close of, and immediately after, the acute plague epidemic.

3. They have been found frequently in rats in Belgaum and Poona, and a re-examination of Bombay rats shows that they also occur there. We had previously only found them in the Punjab villages.

TABLE I.

Showing total number of rats examined each month in Belgaum, among these the number infected with acute plague and the number suffering from resolving plague both of the peripheral and visceral types, showing separately under the latter heads those in which the presence of the plague bacillus was confirmed by cultural or animal tests, and those in which the presence of the plague bacillus was not demonstrated. The last column shows the number of rats with perisplenitis, adhesions and scars in the spleen (recovered plague).

Name of Month	Total <i>Mus rattus</i> examined	Acute Plague		Resolving Plague								Recovered Plague	
		Number	Per cent.	Peripheral Type				Visceral Type				Number	Per cent.
				Confirmed	Unconfirmed	Confirmed	Unconfirmed	Confirmed	Unconfirmed				
Number	Per cent.	Number	Per cent.	Number	Per cent.	Number	Per cent.	Number	Per cent.	Number	Per cent.	Number	Per cent.
June 1908	3390	—	—	—	—	1	·02	—	—	1	·02	2	·04
July	4163	8	·19	—	—	4	·09	—	—	—	—	4	·09
August	3785	12	·31	—	—	3	·08	2	·05	5	·13	14	·37
September	3786	16	·44	—	—	9	·23	—	—	5	·13	35	·92
October	3657	43	1·17	1	·02	12	·32	1	·02	9	·24	48	1·31
November	3109	19	·61	2	·06	6	·19	5	·16	5	·16	27	·86
December	2651	23	·86	5	·22	14	·52	7	·26	17	·63	65	2·45
January	1797	6	·33	—	—	10	·55	3	·16	10	·55	94	5·23
February	1732	3	·17	—	—	11	·63	—	—	2	·11	66	3·81
March	1972	—	—	—	—	1	·05	—	—	—	—	34	1·7
April	2302	—	—	—	—	1	·04	1	·04	2	·08	19	·82
May	2457	—	—	—	—	1	·04	—	—	—	—	17	·69
June 1909	2704	—	—	—	—	2	·07	—	—	2	·07	20	·73
Total	37505	130		8		75		19		58		445	

TABLE II.

Showing total number of rats examined each month in Poona and among these the number infected with acute plague and the number suffering from resolving plague both of the peripheral and visceral types, showing separately under the latter heads the rats in which the presence of the plague bacillus was confirmed by cultural and animal tests, and those in which the presence of the plague bacillus was not demonstrated.

Name of Month	Total <i>Mus rattus</i> examined	Resolving Plague									
		Acute Plague		Peripheral Type				Visceral Type			
				Confirmed		Unconfirmed		Confirmed		Unconfirmed	
		Number	Per cent.	Number	Per cent.	Number	Per cent.	Number	Per cent.	Number	Per cent.
June 1908	3977	—	—	—	—	1	·03	—	—	2	·05
July	5351	—	—	—	—	4	·08	—	—	—	—
August	5946	—	—	—	—	3	·05	—	—	1	·02
September	6115	10	·16	2	·03	14	·23	2	·03	—	—
October	4913	29	·59	3	·06	7	·14	3	·06	14	·28
November	3814	30	·78	3	·07	7	·18	5	·13	14	·36
December	2923	27	·92	7	·24	33	1·13	3	·1	34	1·13
January	2376	6	·25	4	·16	15	·63	1	·04	13	·54
February	2284	1	·04	2	·09	10	·44	2	·09	8	·35
March	2906	—	—	—	—	13	·44	—	—	5	·17
April	2644	—	—	—	—	1	·04	—	—	4	·15
May	2479	—	—	—	—	3	·12	—	—	2	·08
June 1909	2830	—	—	—	—	3	·14	1	·03	—	—
Total	47558	103		21		114		17		97	