

A Bacteriological and Clinical Study

of

CONJUNCTIVITIS

Being a THESIS presented to
the SENATE of the UNIVERSITY of
GLASGOW for the degree of M. D.

BY

W. B. INGLIS POLLOCK, M.B.Ch.B.

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I n t r o d u c t i o n

Diseases of the Conjunctiva form a considerable proportion of the affections of the Eye, which the Ophthalmic surgeon is called upon to treat, and of these, the great bulk are cases of Conjunctivitis in all its varieties. Inflammation of the Conjunctiva is, indeed, one of the diseases to which references are to be found in the most ancient medical writings. This is not surprising. The conjunctiva is a most delicate membrane, and it is exposed at all times of the day to dust and other impurities which are present in the air. The wonder is that people suffer so seldom from Ophthalmia, and this must be ascribed to the perfect arrangements by which the conjunctival sac is cleansed of impurities. The eyelids and the eyelashes act as barriers to the entrance of foreign material; when there is inability to close the former, or ^{there is} absence of the latter, the individual is subjected to repeated attacks of Conjunctivitis. The constant secretion of mucus by the Conjunctiva, and the act of winking, in which /

many that a bacteriological classification of conjunctivitis is possible. The answer to this question will be best brought out after we have considered the different bacteria in detail. The conjunctiva offers a specially interesting field for this examination, as we are able to observe all changes with a great minuteness. A great variety of organisms have been found in the normal conjunctival sac, due, naturally, to its exposed position. But the large majority of these have been found to be merely accidental contaminations, and to have very little pathological effect on the conjunctiva. Others have come to be recognised as almost normal inhabitants, viz:- the xerosis bacillus (so-called) and the staphylococcus albus; and only very exceptionally do they play any part in the processes we are about to describe. For a full list of these organisms and a critical discussion of their importance for operative work, I would refer to the excellent works of Axenfeld (1) of Freiburg.

During the last two years I have made a bacteriological examination in a considerable number of the cases /

cases of conjunctivitis presenting themselves at the clinic of Dr Freeland Fergus in the Glasgow Eye Infir^m:
:mary, and also in the cases in my own private practice. There was not sufficient time for the examination of all cases of conjunctivitis at the dispensary, as the pressure of work, and, especially, the refraction cases, require the utmost expedition possible, if the clinic is to be finished in reasonable time. The total number of patients is increasing steadily each year, as the following figures indicate:-

New Patients admitted	in	1902 . .	20,520.
(to the Glasgow	"	1903 . .	22,207
Eye Infirmary)	"	1904 . .	22,669

Want of time forbade the examination of film preparations at the dispensary. Accordingly, it has frequently happened that when a positive result was not obtained, another opportunity for making a bacteriol^o:
:ological examination did not occur, or, if it did, the case had been under treatment for three or four days, when, in many instances, the bacteriological examination again /

again failed.

No definite selection of cases has been made, except that I have kept for the most part to acute or sub-acute conjunctivitis. We see a very large number of cases of phlyctenular ophthalmia, blepharitis marginalis, and eczema tarsi. I have avoided these with a few exceptions. As many cases as possible of the sub-acute conjunctivitis of Morax (see later) were examined. Certain of them were thought to have refractive errors, but a bacteriological examination led to the correct diagnosis.

In order to let us come to a decision as to an etiological classification of conjunctivitis based on bacteriology and for statistical purposes, my cases have been divided into the following clinical classification:- The symptoms are discussed in detail under the respective bacteria. -

- (a) Acute muco-purulent conjunctivitis, including all cases with conjunctival injection and a more or less severe muco-purulent discharge. The cases of acute contagious conjunctivitis of Weeks are also among this group.

(b) /

- (b) Sub-acute conjunctivitis, as described by Morax.
- (c) Purulent conjunctivitis of adults and children.
- (d) Ophthalmia neonatorum.
- (e) Membranous conjunctivitis, or, as some prefer, pseudo-membranous conjunctivitis. Cases with a membrane over a large part of the conjunctiva.

A few cases of the following have been added, although a negative result was generally obtained, but this will be discussed later.

- (f) Phlyctenular Conjunctivitis.
- (g) Blepharitis Marginalis.
- (h) Follicular Conjunctivitis.

No opportunity has arisen of examining spring catarrh (a new formation but not an inflammation), of xerosis of the conjunctiva, or ^{of} the true diphtheria of the conjunctiva. The latter is a very rare condition in this country, and in the two cases suggestive of the disease, the Klebs-Loeffler bacilli were not found. Cases of trachoma have not been included.

It /

It is seldom that we have the opportunity of examining fresh cases. Most of our patients are in fact Russians, Germans, and Poles on their way to America. The steamboat companies refuse to take them now, as the regulations are so strict at the United States end. I have seen lately a number sent in by one of the emigration agents, who wished a certificate guaranteeing that they would not be refused on the other side of the pond. It appears that this country is acting as a filter for such diseases.

Several cover-glass preparations have been made from the conjunctival discharge in each case where present, and in more than three-fourths of the cases, culture-tubes were inoculated at the same time. The remainder from whom no tubes were taken were chiefly cases of acute contagious conjunctivitis which had been diagnosed clinically as due to the bacillus of Weeks, and where cover-glass films were sufficient to confirm diagnosis. The media have been the usual laboratory /

laboratory Agar-agar, gelatine, &c. For the first examination, combinations of agar-agar with ox-serum, hydrocoele or ascites serum, human blood, or blood serum, have been employed. I obtained, at Professor Muir's (2) suggestion, placental blood. Great care has to be taken with all these media to ensure absolute sterility. If the serum-agar does not "set" well in the proportion one to two, recourse must be had to Petri Capsules. They give a better separation than is possible in the culture-tubes.

I have to thank Professor Muir of Glasgow University for permission to work in the Bacteriological Laboratory of the University; Dr Freeland Fergus for permission to make use of his patients; Dr John H. Teacher for the use of his photo-micrographic apparatus, and Pastor Geyer for making the coloured plates.

T A B L E I.

C o n j u n c t i v i s

	Acute Mucopurulent.	Sub-acute	Purulent.	Ophthalmia Neonatorum.	Membranous.	Phlyctenular.	Follicular.	Blepharitis Marginalis.	Total
Weeks Bacillus	186	7	3	2					198
Diplo-Bacillus of Morax	9	53						2	64
Pneumococcus	6		1	2					9
Pneumococcus + Diplo-Bacillus of Morax	3								3
Gonococcus	2		5	12					19
Gonococcus + Streptococcus				1					1
Gonococcus + B. Weeks	1			1					2
Gonococcus + Pneumococcus				1					1
Staphylococcus	6				2			5	13
Streptococcus Staphylococcus etc.								2	2
B. Weeks + B. Subtilis			1						1
Indefinite	4	3							7
Negative	28	8		1		16	2	1	56
	245	71	10	20	2	16	2	10	376

The/

The K O C H - W E E K S BacillusHistorical summary

The bacillus was first observed by Koch (3) in Egypt in the year 1883. He found it in cases of "Egyptian Ophthalmia". He noticed that under this name there were included two types of inflammation. He obtained diplo-cocci, probably gonococci, in the severer cases, and the fine bacillus in the more catarrhal cases. He likened them to the bacillus of mouse-septicaemia, but was unable to obtain cultures.

The first proof of their etiological relationship to conjunctivitis was brought out in 1886 by Weeks (4) of New York. He noticed the fine bacilli lying in the pus cells of the discharge from cases of acute conjunctivitis which occurred in small, family epidemics, and sometimes also in larger circles. He obtained cultures of this bacillus, but the colonies always contained a club-shaped organism, which in contradistinction to the former was /

was stained ^{by} (in) Gram's method. Colonies of this latter bacillus were easily isolated, ^{but} (and) when he inoculated the conjunctiva of five persons, from them there was no result. ^{however,} (But) when he used the mixture of the two germs for inoculation, he produced in each case a typical conjunctivitis. The secretion from these cases when examined microscopically showed only the fine bacillus. The non-inoculated eye also became affected in all five persons. There was an incubation period of 36 - 48 hours. Weeks employed 0.5 % agar, and was able to carry growth to sixteen generations. He described the affection under the name of acute contagious conjunctivitis.

In 1890, Weeks (5) reported that he had obtained pure cultures of the organism, and that he now had observed over 1,000 cases, from first finding ^{of} the organism.

Morax (6), in 1894, completed the proof that the Koch-Weeks bacillus was the cause of the conjunctivitis by obtaining pure cultures, and from them inoculating /

inoculating typical cases of the acute contagious conjunctivitis. He employed on his own eye one drop of a serum-bouillon culture of the third generation. There was an incubation period of 48 hours, and the conjunctivitis healed in about fourteen days.

Weichselbaum and Müller (?) reported having found the bacilli in a mild epidemic in Ziersdorf. They could only obtain cultures on serum-agar, and more easily in the presence of "air-germs." They carried out ten inoculations of the human conjunctiva, mostly with pure cultures. Sometimes a severe case followed after using bacilli from a mild case. They indicated certain contradictions in the preceding works, notably that Morax observed ulcers of the cornea in some of his cases, while Weeks never saw any ulcers. This might be due to the varying intensity of the different epidemics. Morax, in his thesis, pointed out that cultures were more easily obtained from severe cases than from milder cases, and hence, perhaps, the difficulty Weichselbaum and Müller had in /

in obtaining cultures.

One of the chief causes of errors and contradictions has been the club-shaped organism, viz:- the so-called xerosis bacillus. For example Kartulis, (8) in Alexandria, found the Koch bacillus, but his descriptions of cultures are those of the xerosis bacillus (so-called). His inoculations of six human conjunctivae were consequently negative.

Kamen (9) observed a large epidemic in Czaernowitz in 1899, and was able to obtain pure cultures on human blood agar, and to continue them indefinitely. He mentioned the similarity to the influenza bacillus, and considered them to be nearly allied. Rymowitsch (10) expressed the opinion that the two germs are identical, a view also upheld by Jundell (11), but to this I will recur later.

The Koch-Weeks bacillus has been found in many parts of the earth, and is apparently wide-spread. Sidney Stephenson (12), Juler (13), and Bishop Harman (14), /

(14), have reported it in England; Morax (6), in France; Guasparini (15), in Italy; Coppez (16), in Brussels. It has also been reported in Russia, North America, and South America. On the other hand, Gifford (17) states that the pneumococcus conjunctivitis is very common in Nebraska, while the Koch-Weeks bacillus is absent. Axenfeld (1) observed the same in Marburg and Breslau, and, similarly, Junius (18) in Königsburg.

The conjunctivitis is endemic in certain places, while in others epidemics only appear occasionally e.g. Hamburg (19). In Egypt, the greatest frequency is in summer when the flies are in large numbers. Bishop Harman (14) has shown that conjunctivitis is most frequent in London in the early summer months - May, June and July - and he ascribes it to the great amount of dust in the air.

Clinical Forms.

The Koch-Weeks Bacillus has been the most common cause of muco-purulent conjunctivitis. It was present in 186 of the 245 cases, or 75.9 % of those included /

cluded under that designation. These include all the cases of Week's acute contagious conjunctivitis, but if they had been placed in a separate column, there would have been obtained a much higher percentage due to the Koch-Weeks bacillus. This clinical differentiation was not observed from the commencement of my observations, and it is unnecessary to make a separate column for later results.

The incubation period is short, as already stated; it varies from 36 - 48 hours; but Hofmann (20) reported a case in which the full symptoms developed in 24 hours. As a rule, the symptoms reach their height early - a few days after the first appearance. The large majority of cases present a fairly typical appearance. The margins of the lids may be slightly hyperaemic, and are frequently glued together in the morning; sometimes, in the severer cases, the lids are swollen. The ocular (bulbar) conjunctiva becomes very hyperaemic and has frequently ecchymotic spots situated in it. At the height of the /

the process it may be slightly chemosed. The palpebral conjunctiva is also injected and slightly oedematous. There may even be small shreds of pseudo-membrane attached to it. A muco-purulent discharge is present in all cases to a ^{greater} ~~more~~ or less ^{or} extent. At the commencement, there are only a few flakes of mucus lying in a little clear fluid in the lower fornix, but soon it becomes yellower and thicker, and may even become purulent. The eye has the appearance of being blood-shot, or what is called 'pink-eye'. (Col: our Plate I.) A few drops of adrenalin will temporarily reduce the congestion and leave visible any ecchymotic spots which are present. The patients often complain of a feeling of 'sand in the eye'. Bishop Harman (14) considers that this sensation is due to the disturbance of the endings of the sensory nerves, which are trained to report the presence of foreign bodies in the conjunctiva, and, consequently, in the inflammatory disturbance, give rise to the sensation of foreign bodies or grit in the conjunct: iva. /

iva. He is wrong in denying that the presence of purulent secretion and exfoliated portions of mucous membrane are the cause of the disturbance of the sensory nerves, because undoubtedly these must have some such effect. There is also increased lacrymation, and, at times, a frothy secretion will be observed at the margins of the lids. There is little doubt that they both result from reflex stimulation of the lacrymal gland and the Meibomian glands respectively.

Follicles of the conjunctiva are not frequent. They were very numerous in three cases; but as the conjunctivitis was not severe in any of these, and was of recent origin, I came to the conclusion that the follicles had existed before the infection by the Koch-Weeks Bacillus. We have to remember that follicles of the conjunctiva are present in a large number of all children. My own statistics of the examination of over 3,000 school children are not yet completed, but I have seen them in a large number of cases. Greef (21) has recently published an account /

account of the examination of 1,437 school children, and found follicles in the conjunctiva in 21 % of the total number. Schmidt-Rimpler (22) found 27 % of the school children affected. Markus reported an epidemic of the acute contagious conjunctivitis in a school, and he observed follicles formed early in the attack in many instances. Nevertheless, I cannot help thinking, in view of the above facts, that the follicles had existed before the invasion of the Koch-Weeks bacillus. They have never been observed in any of the inoculation cases, and it is therefore doubtful if follicles are ever due to this organism.

Small phlyctenulae may occur on the conjunctiva, especially at the limbus corneae (i.e. just at the corneal margin). Morax denies that they are genuine phlyctenulae, holding them to be filled with fluid and not with ^{leucocytes} leucocytes, as the former are. Most observers are of the opposite opinion. In one case, I saw eight or nine lying at the margin of the cornea. The /

The clinical differentiation of the acute contagious conjunctivitis, accompanied by phlyctenulae, from the phlyctenular ophthalmia is chiefly based on the character of the injection. (Colour Plate II.) With the former, it is general over the whole ocular conjunctiva, whilst in the latter, it is limited, and frequently triangular in shape, with the apex at the phlyctenule on the cornea. In the former, there is not so severe photophobia, and the discharge, if not frankly muco-purulent, has small flakes of mucus lying in the lower fornix. In the latter, there is photophobia, generally some degree of blepharospasm, and simple lacrymation. The bacteriological examination confirms the diagnosis by showing, in the one case, the presence of the specific organism, while, in the other, a cover-glass film will have only a few leucocytes in epithelial cells, and no organisms. These phlyctenulae mostly occur in ill-nourished or strumous children.

Small marginal ulcers of the cornea were present /

present in 6 cases or 3 %. These were not severe ulcers. They were single in each case. Five of the patients had suffered from phlyctenular ophthalmia in earlier life. The ulcers were shallow, and healed rapidly. In three of these cases, the ulcer commenced after the first visit to the Hospital. The following are typical cases:-

C a s e I. A lad S.A. Aet. 19 came to the clinic of the Glasgow Eye Infirmary on the 12th July 1904, with conjunctivitis of the right eye. The ocular conjunctivâ was injected and slightly oedematous. There was a small head of muco-pus lying at the inner angle. A small phlyctenular ulcer of the cornea was present at the limbus near the centre of the lower edge of the cornea. There was no swelling of the lid. He gave no history of infection. He had been to the Infirmary eighteen months previously for phlyctenular ophthalmia. Cover-glass preparations showed numbers of the Koch-Weeks bacillus both intra and extra-cellular /

cellular. They were destained by Gram's method. No staphylococci were detected. Three weeks later, the right eye was recovering, but an attack was commencing in the left eye. This soon recovered.

C a s e II. A man W.M. Aet. 24 came to the clinic on the 24th November 1903, with an acute conjunctivitis of both eyes, of five days' duration in the right eye, and ^{of} one day in the left. There was considerable ocular injection and slight oedema, with a slight muco-purulent discharge. There was more lacrymation of the left ^{eye}, and only a few flakes of mucus in the lower fornix. The eyelids were adhering in the morning. He has always had 'weak' eyes, and they become easily inflamed. Two children in the same flat have inflamed eyes. No phlyctenulae were seen. Cover-glass preparations showed numerous examples of the Koch-Weeks bacillus. On hydrocoele serum were a number of colonies of the so-called xerosis bacillus. On the 27th, he returned with a small phlyctenular ulcer at the upper part of the right /

right cornea near the limbus. The left eye was well. The right eye was brushed with a 10 % Protargol solution. This was repeated on the 1st December. On the 4th December both eyes were clear and free from inflammation and the ulcer healed. He returned a week later with a recurrence of the congestion of the right eye, but this soon disappeared.

There was, in addition, one child ^{who} had mucopurulent conjunctivitis, and had just returned home from a fever hospital, after an attack of measles. There was a central ulcer with hypopyon, which left a dense central nebula on the cornea. The culture tube showed colonies of Koch-Weeks bacillus and numerous colonies of the staphylococcus pyogenes aureus, of which the virulence was not tested. The ulceration was probably due to the latter germs and not to the bacillus. A scraping of the ulcer itself was not obtained.

Morax (23) has reported a case where ulceration of the cornea, due to the Koch-Weeks bacillus, led to perforation /

perforation of the cornea; but this is exceptional, and it appears that they only cause small superficial ulcers, which tend to heal readily if the conjunctival sac is kept as aseptic as possible.

This disease may affect patients at every age. In my series, the youngest was an infant of five weeks, while the oldest patient was over seventy years of age. Two-thirds of the cases occurred in children under fifteen years of age. It probably attacks equally all ages, although, owing to the greater opportunities for infection among children, they form a larger percentage of our cases. When it commences in a family, there are often more children than adults to be attacked. Commonly, it is introduced by one of the children, and ~~as~~ as frequently they use the same towel and soap, and are so prone to examine each other's ailments, family and school life easily allow dissemination to occur. There is often a great difference in severity among the members of the same family, as Morax and Petit (23) have pointed out, and some present extremely mild forms, while/

while others may have a very sever^e attack complicated with ulcers. The parents, if affected, are generally the worst. Adults, as Stephenson (24) points out, have frequently greater congestion and ecchymosis of the bulbar conjunctiva, giving a more blood-shot appearance to the eyes. At the same time, there is not much discharge, and only a slight oedema of the lids. On the other hand, most of my cases over thirty-five years of age ran a mild course without complications.

The mild cases show that some people react very slightly to this affection. Morax and others believe that the bacillus of Weeks is never found on the healthy conjunctiva. Yet we have such slight cases that they pass unnoticed by the parents. These may not be considered the best judges of a healthy conjunctiva, but against any such view the question of what is a healthy conjunctiva may be raised, and that would lead into a wider discussion than is necessary. It suffices to say that there is a great variation /

variation in the severity of the affection. While some may have thus only a trivial congestion of the conjunctiva, others have an intense injection and swelling of the conjunctiva, accompanied by a purulent discharge resembling in severity cases of gonorrhoeal conjunctivitis.

These severe cases occur frequently in young infants. When they are brought to the clinic, the eyelids are swollen and adherent to each other. On attempting to open them a purulent discharge bursts out. There may not be great chemosis, and the cornea is found to be free from ulceration. These cases run a course of two to three weeks, and, as a rule, recover entirely. I had three such cases. They were all under a year old, one only six weeks old. They have been classed under the head of purulent conjunctivitis. The prognosis is very much better than for gonorrhoeal cases, even of that early age. There were two cases of ophthalmia neonatorum due to the Koch - Weeks Bacillus (see later) .

Bacilli were found in one case in the conjunctival secretion after three months' duration. The symptoms resembled those of sub-acute conjunctivitis, which is associated as a rule with the diplobacillus of Morax. Such was

C a s e III. A boy, Aet. 11, came to the clinic on the 30th October 1903, complaining of irritation of the eyes of three months' duration, with occasionally more pronounced symptoms. There was at this date only a slight half-dried bead of muco-pus at the inner angle of the lids. The conjunctiva of the fornix was injected, and the congestion extended only a short distance on to the eyeball. The patient complained of a feeling of sand in the eyes. On cover-glass preparations the Koch-Weeks Bacillus was found in somewhat scanty numbers. The xerosis bacillus (so-called) was alone discovered in a blood-agar tube.

This boy shows how a mild case may run a long course unrecognised even by the parents. I had seven of /

of these chronic cases, but, it is exceptional to have them. Markus (25) and Hofmann (20) have reported a number with a tendency to papillary growth in the fornices. The bacilli are found in the furrows, and these cases may give rise, by infection, to typical acute conjunctivitis in other persons.

There has been a definite history of infection in 57 cases or 30 %. In the majority of instances, this has been from other members of the same family. I have found the Weeks bacilli in conjunctivitis in all the members of one family viz:- father, mother, and three children (five in all). I have also frequently examined and found them in two members of a family, and been informed that several others of the family have already recovered, or the symptoms have not appeared severe enough for the parents to bring them to the hospital. On several occasions, parents have stated that there are a large number affected from their village, and that their children have simply taken the infection as it was going around, or that /

that there were a number of families in the same tenement affected. I have not included in my series any cases which have not been bacteriologically examined. Most observers have reported these small epidemics limited to a family, to a few families, or to a school, and it must be definitely recognised that Weeks' conjunctivitis has a very great tendency to such epidemics. Wilbrand-Saenger-Staehlin (19) reported an epidemic involving 512 individuals in Hamburg, which, however, was complicated by a diplococcus resembling the gonococcus.

The general condition of the patient has not been affected in any of my cases, except from the pain and irritation of the local inflammation. Morax stated that there may be a little sneezing at the height of the affection, without any apparent involvement of the deeper nasal passages.

Weeks' conjunctivitis generally runs a course of two to three weeks, while, if unattended, or complicated /

:cated by ulcers or phlyctenulae, it may continue longer. It does not appear possible to shorten an attack under ten days, once it has commenced, al: though treatment may mitigate the severity of the symptoms. Both eyes are as a rule affected, either within a day or two of one another, or at a longer interval of a week or more. The fact that both eyes are affected is an aid in the clinical diagnosis of a case.

Morphology

The organism is chiefly found in the secretion from a case of Weeks' conjunctivitis during the rise and the height of the inflammation. It is a very fine bacillus of about 0.75μ to 1.5μ in length. They have rounded ends, and often the staining is fainter in the centre, suggesting a diplo-coccus to the untrained eye. They lie in groups, often large numbers together, but also scattered singly. They are found principally in the polymorpho - nuclear leucocytes, sometimes a large number in a single cell. (Figure I.)

The /

The discharge consists chiefly of pus cells.

The bacilli stain faintly with most stains, but I have found 10 % carbol-fuchsin an exceedingly useful stain. It requires 15 - 30 seconds, depending on the exact strength of the solution. One only requires to stain long enough to bring out the nuclei strongly, and the cell protoplasm faintly. The carbol-fuchsin is a diffuse stain, and, if left on, too long, the cell protoplasm is over-stained, and no intracellular microbes are visible. Carbol-Thyonin-Blue is also a satisfactory stain. Old specimens of it are apt to deposit needle-like crystals, and it should be filtered. The bacilli are destained in Gram's method. They are non-motile, and do not form spores.

Cultivation

For cultures, some form of human serum or blood-agar is almost necessary. I have obtained growths in 1% agar, but then only from a severe case, and when a considerable quantity of secretion was employed. It was /

It was impossible to obtain sub-cultures from such colonies, and the bacilli would not take on any stain after three to four days. Morax (6) and Weichselbaum and Müller (?) have found Wertheim's serum-agar most suitable. Morax was able to obtain over 100 generations on it. I have occasionally obtained cultures on ox-serum agar, but could not carry them to sub-cultures. Blood-agar and serum-agar from placental blood were my most reliable media, and from these I was able to obtain sub-cultures. My colonies were always of low vitality, as shown by their staining capacity, and this was probably due to the carrying of the culture-tubes for some hours in my waistcoat pocket before they reached the incubator. Morax (26) states that they ought to be placed in it immediately after inoculation.

Hydrocœle serum was not very successful, as I only occasionally received colonies of the Koch-Weeks bacillus upon the 'sloped' serum. Probably
an /

an antiseptic had contaminated the serum before it reached the laboratory. Ascites serum gave better results, but colonies were only present in a fifth of the cases, and they did not reach more than two generations. Morax points out that different varieties of the ascites serum have a different value for cultures, and we are not yet able to say on what this depends. The media must be moist and not too alkaline, and indiarubber caps, as suggested ~~in~~ ^{by} Monthus and Opie (27), are useful. Kamen(9) obtained cultures on human blood agar, while Hofmann (20) failed on simple agar with blood, although he was able to carry growth to 25 generations on 2 parts of glycerine-agar with 1 part ascites serum to which sterile ox or human blood had been added in the proportion of 2 to 1 of the ascites serum. Axenfeld (28) states that only exceptionally are pure cultures obtained at the first inoculation. They are almost always mingled with the xerosis bacillus (so-called).

Figure II. shows the Koch-Weeks bacillus and
the /

the xerosis bacillus (so-called) intermingled. The larger, blacker organisms are the latter, while the finer are the Koch-Weeks germs. I have obtained pure cultures of the latter, but they were so faintly stained that several attempts to photograph them failed. Short filamentous forms and chains are met in the preparations from the cultures.

The colonies of the Koch-Weeks bacillus (Fig.3) appear after 48 hours as moist transparent points or drops. With weak magnification they resemble small air-bells. They are easily removed from the surface of the medium. They are very similar to the colonies of the influenza bacillus. With a magnification of 80 diameters a fine granulation is detected. They have no tendency to become confluent. They are more granular and distinct in the neighbourhood of xerosis or staphylococcus colonies. In serum bouillon they are said to form a slight opacity which soon sinks to the foot of the tube.

The colonies require a temperature of 36° C. At 20° C. they die off, but after ten minutes at

50 °, or two minutes at 60 °, they remain capable of growth. A longer period kills them. Fresh sub-cultures must be made every three or four days.

Colonies of the xerosis bacillus (so-called) were almost invariably present in the culture-tubes taken from muco-purulent conjunctivitis. There were at times only a few colonies, but in other cases they reached a large number. As already mentioned, when the Koch-Weeks bacillus was present, the two organisms were so intermingled that it was impossible to find a field under the 1/12th inch oil immersion, in which the latter germs were alone visible. The Gram's stain followed by weak carbolfuchsin differentiated the two organisms. The colonies of these two organisms are different. The Koch-Weeks' bacillus appears as minute dots, while the xerosis colonies are larger, whiter, and more prominent, being a little more distinct than those of streptococcus pyogenes. These characters are best seen in the cultures on serum-agar.

The /

The staphylococcus albus is generally to be found in the culture tubes inoculated from cases of Week's conjunctivitis, while occasionally, the aureus or flavus is present. As a rule, there are only a few colonies, but sometimes, there are more. They have nothing to do with the affection (see later).

I n f e c t i o n

Wilbrand-Saenger-Staehlin (19) assumed that there must be an infection by air-carried germs since the Hamburg epidemic spread with great rapidity. Experimental evidence is against this view, as bacteria exposed to temperatures below 20 ° C very soon die. Even secretion from a severe case, allowed to dry for six and a half hours, was no longer capable of producing colonies, whilst after 8 hours it did not cause an experimental conjunctivitis, although fresh secretion from the same case used immediately afterwards on the same individual had a positive result. It is therefore unlikely that bacilli can be carried by dust.

Axenfeld /

Axenfeld (28) has suggested that at the height of the inflammation, bacilla^l may be swept by the lacrymal canal into the nose, and partly even into the mouth, from whence by sneezing they may be carried in a living condition for a short time in the air. In Egypt, the flies have been blamed for carrying mucus from one person to another.

In general, the infection is by direct contact. Dirty habits directly predispose to spreading the disease. As already mentioned, many epidemics affect schools, and here the use of the same towels and other means come into play. One boy told me he thought he caught the infection from another boy by going into the same swimming pond together. Hoffmann (20) has shown that mucus containing virulent germs may remain capable of infection in a physiological salt solution at 20° C. for 7 hours. Those with inflamed eyes ought to be forbidden to enter swimming ponds, and each person should have a clean towel each time. In the private baths, all towels &c. are carefully washed and dried with hot air.

Bishop/

Bishop Harman (14) has suggested that the Koch-Weeks' bacillus is similar to the bacillus coprogenes parvus isolated from the alvine discharges by Rienstock (29) and which the former once found on the healthy conjunctiva. He therefore believes that Weeks' conjunctivitis is due to a contamination with alvine discharges. There is no experimental proof to substantiate such an assumption. On the contrary, all that we know of the life-history of the bacillus indicates that its range of growth is too limited for that of an intestinal germ.

All experiments have failed to communicate the disease to animals. The toxin has also failed to produce any effect. Rymowitsch (10) believes that larger doses of toxin than those which have been so far employed might result in having a pathological effect similar to those of the influenza bacillus.

The human conjunctiva appears to be highly susceptible /

susceptible. Fourteen inoculations with pure cultures by different observers were all successful. Weeks(4) with the mixed germs had 5 positive in 6 experiments. Morax and Elmassian (30) were able to produce a slight conjunctivitis after inserting repeated drops of a solution of the toxin during several hours. There was a distinct "incubation" period of several hours after the drops ceased and before the symptoms commenced. The Koch-Weeks' bacillus is, therefore, one of the most pathogenic bacteria we know i.e. as regards the conjunctiva. A number of observers deny that it is ever found on the normal human conjunctiva. Harman (14) found it once on the normal conjunctiva of a school-boy. As indicated earlier, one of my cases was very mild, and others might have a similar appearance.

It is doubtful if immunity follows an attack, as Weichselbaum and Müller (?) were able to obtain a positive result 4 weeks after a preceding inoculation-conjunctivitis had recovered. Morax and Petit /

Petit (23) have observed recurrent attacks in the same individuals after short intermissions.

I n f l u e n z a Conjunctivitis

A considerable amount of work has been done with regard to the question of the identity of the Koch-Weeks' bacillus, the influenza bacillus, and Müller's bacillus.

Zur Weddon (31) has reported undoubted cases of influenza conjunctivitis. They occurred during influenza epidemics. There were disturbances of the respiratory passages. The bacilli were not so fine or so long as the Koch-Weeks' bacilli. They showed involution forms characteristic of the influenza bacillus, and they grew better on haemoglobin-agar than on serum-agar. They could be cultivated on pigeon-blood-agar, while this is not possible with the Koch-Weeks' bacillus. The colonies with a magnification of 80 diameters were quite homogeneous, and had a regular outline.

Jundell (11) examined the discharge in a number /

number of cases of conjunctivitis in children, who were suffering from a regular influenza fever. He claimed that the bacillus which he obtained was identical with the Koch-Weeks' bacillus, since he held that the fact that the latter grew best on serum-agar while the former required haemoglobin-agar, was not sufficient to establish different species. I have not seen the original article, but it appears that he has not had an opportunity of studying the Weeks' conjunctivitis, and that his patients were suffering from influenza conjunctivitis.

Rymowitsch (10), another supporter of the identity of the Koch-Weeks' bacillus and the influenza bacillus, has published photographs of bacilli and of their cultures, (magnified to 90 and 270 diameters), which he claimed were genuine Koch-Weeks' bacilli, but in fact they present the characters we have above associated with the influenza bacilli. The effects produced by large doses /

doses of the toxin are also those common to the influenza bacillus.

MÜLLER'S B a c i l l u s

Müller (32) claims that his bacillus is the cause of trachoma. Many observers deny this. Without entering into the question of granular ophthalmia (trachoma), it suffices to state that these workers regard Müller's bacillus simply as the cause of the acute catarrhal conjunctivitis super-imposed on the chronic condition, in the same way as patients suffering from trachoma may have a gonorrhoeal or pneumococcus conjunctivitis present as an inter-current affection. Müller's bacillus grew only on blood media, the blood of certain lower animals was sufficient, and growth was aided by symbiosis with staphylococci. While resembling the Koch-Weeks' bacillus, it is neither so long, nor so slender. But the colonies, and all these other characters, point to its identity with the /

the influenza bacillus. Müller distinguished his bacillus from the last mentioned by the absence of an influenza epidemic at the time, and of general symptoms at the height of the affection, such as influenza patients might be expected to present. From the Koch-Weeks' bacillus the morphological and culture characteristics are the differentiating points. Axenfeld (28) holds that the Müller bacillus and the influenza bacillus are identical, and the facts appear to support this view: indeed, most observers have failed to find the former in cases of trachoma, while all observers, ^{including} and Müller himself, acknowledge that patients with trachoma are very liable to inter-current attacks of acute conjunctivitis due to the gonococcus or to the Koch-Weeks' bacillus, we may therefore conclude that Müller's bacillus is not the cause of trachoma.

D I A G N O S I S

Morax (33), Zur Neddon (31), and Axenfeld (28), all hold /

hold that the following characters distinguish the Koch-Weeks' bacillus from the influenza bacillus. The former are finer and slightly longer. The cultures are even more transparent than those of the influenza bacillus, while they are somewhat granular with an irregular margin when examined at a magnification of 80 diameters. The bacilli grow as a rule for a longer time and more certainly on human-serum-agar, while the influenza bacilli require haemoglobin-agar, and not necessarily human blood. The Koch-Weeks' bacillus may grow in chains, while the other does not. Bacilli resembling the former have never been discovered in the respiratory passages. Weeks' conjunctivitis has never been communicated to animals, while the influenza bacillus is pathogenic in the peritoneum of asses, guinea-pigs, and rabbits, probably from the toxins, as the bacilli apparently do not increase in number (Beck 34)

Patients with Koch-Weeks' conjunctivitis have never /

never headache, backache, or fever, or other general symptoms. A few may have a little sneezing at the height of the inflammation, but that is only *accidental* learned by questioning them. Against this, there is to be remembered that sometimes there is very little general disturbance in diphtheria of the conjunctiva. Morax, who observed both forms, states that the Koch-Weeks' conjunctivitis nearly always runs into the third or the fourth week, while influenza conjunctivitis is milder, and terminates a week earlier. Finally the Koch-Weeks' epidemics are more limited, and are not synchronous with the influenza epidemics.

Further research is required to completely clear up this question, but we may conclude that the Koch-Weeks' bacillus and Pfeiffer's bacillus are closely related.

For diagnosis, we have to remember that an influenza conjunctivitis occurs, but that in the absence of general symptoms we may ignore both it and /

and the Müller's bacillus. With this reservation, we may say that no other organisms resembling the Koch-Weeks' Bacillus occur in the conjunctiva. Numerous very fine bacilli, negative to Gram, lying between or in the pus cells of the discharge are sufficiently characteristic. If they are not found in the culture tube from the same case, but in it colonies of the xerosis bacillus (so-called) or staphylococci, are present, it simply means that the medium was unsuited for the Koch-Weeks' bacillus, while these other germs have flourished on the medium although present in small numbers in the discharge.

The DIPLO-BACILLUS of M O R A X-
 A X E N F E L D.

Historical Summary

The diplo-bacillus was first discovered by Morax(35) in 1896, in a series of cases which he described as sub-acute conjunctivitis. Axenfeld (36) completed several details in a paper read shortly thereafter, and proposed the name of blepharo-conjunctivitis. Subsequently the recognition of acute cases has brought into general use the term diplobacillary conjunctivitis.

This affection appears to be very widespread. To mention only a few observers: Eyre(3) reports it in London, Morax (35) in Paris, Lakak and Khoury (38) in Egypt, Giarre and Pichi (39) in Italy, Gonin (40) in Lausanne, Müller (32) in Vienna, and numerous observers in Germany and America. Junius (48) reports he had not been able to find it in Königs: burg (1900), while it appears to be relatively rare /

rare in Egypt. Eyre (37) stated that $2\frac{1}{2}\%$ of all patients in the Brayley's Polyclinic were cases of diplobacillary conjunctivitis. In Bern, ²Pflüger-Simon (41) report that they form 10% of all the patients, while it appears equally frequent in certain parts of South Germany.

Characters - C l i n i c a l

A large proportion of my cases conformed to the type first described by Morax, and we must regard these as the more typical form of diplobacillary conjunctivitis. I have kept them in a separate column under the title of subacute conjunctivitis. They are characterised by a comparatively slight injection of the ocular (búlbar) conjunctiva. There is increased hyperaemia of the fornices and of the conjunctiva adjacent to the edges of the lids. The inter-marginal portion of the lid loses its clear whiteness and is very frequently hyperaemic. (Colour plate III) There may be slight excoriation of this part, but there are not, as a rule /

rule any crusts attached to the eyelashes. There is no oedema of the lids or conjunctiva, nor any obvious discharge. All that will be seen is a small bead of half-dried pus or a small flake of mucus lying at the inner canthus, either on the caruncle, or between it and the skin. If this is spread out on a coverglass and stained with any of the usual aniline stains, the diplobacilli will be discovered lying between the pus cells. Such was -

C a s e IV. Sergeant K. Aet. 32. presented himself at the clinic on the 24th August 1904, complaining of a gritty feeling in the eyes, and stated that this became worse during reading. There was a small bead of pus at the inner angles of the eyes. The margin of the lids showed small excoriations at one or two points. The caruncle was injected, but otherwise the eyes appeared normal. There was no oedema or injection of the ocular conjunctiva. The cornea was unaffected. A week later the condition had greatly improved. There were numerous diplobacilli /

diplobacilli in the pus found at the inner angles.

All cases with a similar symptomatology have been classed under the heading subacute conjunctivitis. I have examined 71 of them bacteriologically and the following table gives a synopsis of the results:-

Table II.

Etiology of Subacute Conjunctivitis

Organism	Number of cases	%
Morax-Axenfeld diplobacillus.	53	74.6
Koch-Weeks' bacillus	7	9.8
Negative or indefinite	11	15.5
Total	71	

Acute cases of diplobacillary conjunctivitis also occur. They are not very common, and resemble cases of Weeks' conjunctivitis. They are always of recent origin, and appear to indicate a /

a greater susceptibility on the part of the patient, or increased virulence of the organisms. No doubt if they had been left untreated, the symptoms would have subsided into the subacute form described above. They are milder as a rule than the Weeks' cases, although in a recent case, I have seen considerable ecchymosis. They have been included in the first column, because clinically it was not possible to be certain whether they were due to the Koch-Weeks bacillus or the ^tMorax diplobacillus, &c. I have had nine of these cases.

C a s e V. McC. Aet. 11. came to the clinic on the 14th October 1904, with a considerable inflammation of the right conjunctiva. The bulbar portion was much injected but not oedematous. The lids were not swollen. There was a moderate mucopurulent discharge, and a history of infection from a companion. Film preparations showed numerous Morax-Axenfeld diplobacilli among pus cells. The left eye was just becoming affected.

On /

On the other hand, old-standing cases occur with a considerable implication of the margins of the lids. They become excoriated, and small crusts are attached to the eyelashes. Some of the hairs are lost. The symptoms resemble those of blepharitis marginalis, and accordingly the two cases of this nature, which I saw, were included in the column in Table I under that designation. The following table gives a summary of the different clinical forms associated with the diplobacillus.

Table III.

Cases due to the MORAX-AXENFELD
Diplobacillus.

Clinical Symptoms	Number of cases	%
Subacute conjunctivitis	53	82.8
Acute Mucopurulent Conjunctivitis	9	14.1
With B lpharitis Marginalis	2	3.1
Total	64	

These /

These cases occur at all ages; one was two months old, and another sixty years of age. There were 48 adults and 16 children, or 76 % and 14 % respectively. The cases occurred at all seasons of the year. No special attention has been paid to the occupations of the patients, but three were medical men. A history of infection was only obtained in five cases. There has been no evidence of school infection, but on several occasions it was from members of the same household. Gonin (40), who had 185 cases, was also of the opinion that school infection is rare. Epidemics, however, do occur in schools, as several have been reported.

The chronic nature of this affection is marked. More than half of the patients waited three weeks or longer before seeking advice. It was the reverse with the Weeks' conjunctivitis, when patients came within the first week and frequently on the second or third day.

Ulceration /

Ulceration of the cornea was believed to be rare in diplobacillary conjunctivitis. Quite recently, Paul (42) has published a series of 26 cases of severe ulcers of the cornea, in the majority of which there were iritis and hypopyon. He found the diplobacillus in the scrapings from the ulcers. There had been diplobacillary conjunctivitis of some duration, and the ulcers dated from a recent trauma. There was no dacryocystitis, and he proved that the organism was not the diplobacillus of Petit. He gives a bibliography of this question.

Erdmann (43) in May 1905, reported 8 cases of severe ulcers of the cornea accompanied by hypopyon and iritis. Trauma could be definitely blamed in only one case. All had diplobacillary conjunctivitis. Still more recently, (Aug. 1905), Stoewer of Witten (44) has reported a further series of 32 ulcers, often with hypopyon and iritis, due to the Morax-Axenfeld diplobacillus. It is not quite certain /

certain whether some of the cases may not have been due to the diplobacillus of Petit. Stoewer suggests that the diplobacillary ulcer is on the increase in these districts (viz:- South Germany) where the conjunctivitis is frequent. I have had one case with ulceration of the cornea.

C a s e VI. J.M. Aet. 58, came to the clinic on the 24th March, 1905, with a small ulcer of the right cornea at its upper part. The ulcer was shallow and measured 2 m.m.in diameter. There was very slight congestion and oedema of the bulbar conjunctiva. A slight excoriation of the margin of the eyelids was present. The mucus discharge contained numerous diplobacilli of Morax and pus cells.

Agar-agar kept a week in the incubator at 37 ° C. failed to show any growths. There was no history of injury, dacryocystitis, or infection. There was neither iritis nor hypopyon. Four days later, the ulcer had spread considerably, involving a quarter of the upper portion of the cornea. It had /

had not become deeper. A scraping from the ulcer at this date failed to show any organisms. The patient began to improve from the next visit, and the ulcer completely healed. This was a simple "catarrhal" ulcer of the cornea in an elderly subject, and although no bacteria were discovered in the ulcer, it was in all probability due to the diplobacillus.

Phlyctenulae may also occur in diplobacillary conjunctivitis, and, as a rule, they are believed to do so in a patient who has had, or is liable to, phlyctenular conjunctivitis, although the following case does not substantiate this view.

C a s e VII. - L.F. Aet. 6 came to the Glasgow Eye Infirmary on the 31st January 1905. She complained of irritation of the eyes of two months' duration. The symptoms all pointed to diplobacillary conjunctivitis, there being slight excoriation of /

of the margins of the lids and the usual mucus at the inner angles of the eyes. On the left there was a small phlyctenule at the corneal margin.

From it, there spread out a fan-shaped area of injection of the bulbar conjunctiva. There was no history of infection, of tubercular disease, nor ^{was there} any appearance of the "strumous" diathesis.

Diplobacillary conjunctivitis shows little tendency to a spontaneous cure. While occasionally commencing as an acute attack, as we have seen, and subsiding into the subacute phase, the majority of cases assume this form from the outset, and tend to continue indefinitely for a long period unless properly treated. Patients are rarely able to state the source of any infection. This may be due partly to the fact that the condition has lasted so long.

The points of importance for a clinical diagnosis /

diagnosis are the history of a gritty feeling or disturbance of vision of several weeks' duration, with, locally, a slight excoriation of the lid margins, and the ^{presence of a} half dried bead of pus of pus at the inner angles. The name angular conjunctivitis has been applied to these cases. It very aptly describes the condition. In such instances the clinical diagnosis of diplobacillary conjunctivitis may be ventured, and in 74% of my cases it was correct. We must remember the acute cases and the possibility of corneal complications. Three cases of mixed infection with the diplobacillus and the pneumococcus will be considered after the pneumococcus cases.

M o r p h o l o g y

The diplobacillus is found often in very large numbers in the secretion, which is sometimes so slight, that it is easily missed. The platinum rod should always be drawn carefully over the caruncle /

caruncle, or between it and the lower lid. The material found at this part is more liable to contamination by skin saprophytes than that in the lower fornix, and accordingly is not suited for cultivation. The organisms are generally free and lying between the cells. The length of the diplobacillus varies from 4 - 6 u. while its breadth is 1 u. The ends of the individual portions are slightly rounded. Chains of four or six segments are not uncommon. It is thus a prominent object in the microscopical field, and contrasts markedly with other pathogenic organisms found in the conjunctival sac. (Figure IV) .

It is destained by Gram's method . It does not form spores. Some have disputed whether it has a capsule, ^{a circumstance} which was not observed by the discoverers. There is not infrequently a small unstained area around the organism, and several observers, by careful staining, have demonstrated that /

that this is a fine capsule. The unstained area is distinctly seen in Figure V.

C u l t i v a t i o n

Cultures have only been obtained in a few instances. They were upon human-serum-agar. The colonies were almost invisible, and produced small pits in the surface by liquefaction of the media. The organism has apparently little growth energy on artificial media, as growth ceased on the fourth or fifth day, and subcultures were never obtained.

Bacilli inoculated from severe cases will grow until the whole of the medium is liquefied. I have not observed this in any of my cases. Paul, Erdmann, and Stoewer all found it difficult to obtain cultures from the ulcers due to the diplobacillus. Growth also takes place in serum-bouillon and appears as a slight opacity, which sinks to the foot of the test tube. Growth rarely /

rarely occurs on ordinary agar, and this is the main distinction from Petit's diplobacillus, which is easily cultivated on gelatine, agar, &c. Axenfeld (28) has pointed out that an alkaline medium is requisite. The germs do not thrive on neutral media, while growth ceases on acid media. Consequently, if the staphylococcus pyogenes aureus is present in the culture tube, an acid reaction is so rapidly produced that the growth of the diplobacillus is prevented, although it may have been present in large numbers in the coverglass preparation. The presence of the xerosis bacillus (so-called) does not interfere with growth. The staphylococcus albus has also little effect. In culture, chains of strepto-bacilli are frequently obtained. (Figure VI. Note the delicate bond joining the segments) Involution forms appear very early, often within 48 hours. They may be simply weakly stained elements or large swollen bacilli of various /

various sizes. (See Figure VII.)

Experimental Inoculation

Morax (35) produced a typical subacute conjunctivitis by dropping a 24-hour serum-bouillon culture into the human conjunctiva. There was an incubation period of four days. Axenfeld (45), Hofmann (46), and Gifford have all obtained positive results by inoculation of the healthy conjunctiva. All attempts have failed to produce a conjunctivitis in animals, although Morax and Elmassian (30) obtained a slight reaction in rabbits after long continued instillation of a serum-bouillon culture.

I n f e c t i o n

The Morax-Axenfeld diplobacillus is only found on the human conjunctiva, and possibly in the nose. It has very slight power of growth on artificial /

artificial media, and, in consequence, it was believed that infection was by direct contact, or by mucus. The extraordinary frequency of diplobacillary conjunctivitis in certain districts has led to various attempts to discover other methods of infection, or other sources of the bacteria.

Harmann (14) suggested that, like the Koch-Weeks bacillus, this organism belonged to the intestinal germs. Most of them have much greater power of growth outside the body, and it seems unlikely that the diplobacillus is able to resist the acid and alkaline secretions of the alimentary canal.

Erdmann (43) has recently shown that linen saturated with the secretion from cases of diplobacillary conjunctivitis and allowed to dry at room temperature, can after seven to ten days give pure colonies of the diplobacillus on serum-agar. Similar pieces of linen produced /

duced a typical conjunctivitis after drying for twenty-five hours. Such experiments prove the organism has greater powers of resistance than we have been accustomed to believe.

Drying the linen for a short time at 36 ° C., for a few hours-rather shortens the period during which the germs maintain their virulence.

Biard (47), believing that the diplobacillus is a frequent inhabitant of the nasal fossae, considered that the source of infection was by migration up the lacrymal canal; while Erdmann, arguing from his own experiments, is of opinion that the germs are transferred from the nose to the conjunctiva by the pocket handkerchief.

D i a g n o s i s

It has just been mentioned that Biard (47) believed the diplobacillus was found in the nose. Erdmann has obtained them from the nose in cases of diplobacillary conjunctivitis, and it is natural

It is not safe to suppose that they were carried from the eye through the lacrymal canal. Morax and Petit (23) and other observers have not been able to confirm their observations. There is a difficulty in diagnosis and this may have led to errors. The Ozaena bacillus, the bacillus of Rhinoscleroma, and Friedländer's pneumobacillus are common to the nasal passages, and resemble each other closely. They belong to the group known as capsule bacilli. Their characters, as defined by R. Abel (48), ought to differentiate them clearly. They have a very distinct capsule, which is often absent from the Morax-Axenfeld organism, and, when it is present, is always small. They are easily cultivated on the usual media, forming distinct elevated growths and the well-known nail-like appearance on gelatine, which they do not liquefy. They have all a certain pathogenic effect on the small laboratory animals. They have other characters as a group /

group, but these suffice to distinguish them from the Morax-Axenfeld diplobacillus which seldom grows on agar and can only be cultivated on serum-agar, and is not pathogenic to animals. The diplobacillus liquefaciens described in 1899 by Petit (49) as causing certain serpiginous ulcers of the cornea, thrives on ordinary media, but it liquefies gelatine at 15° - 20° c, and is non-pathogenic to animals.

The MORAX-AXENFELD Diplobacillus and the
diplobacillus liquefaciens (PETIT)

These two organisms resemble each other very closely. The former was believed until recently to be merely the cause of a mild conjunctivitis and rarely to lead to corneal ulceration. The latter is associated with severe ulcers of the cornea, and has not been discovered in ordinary catarrh of the conjunctiva. McNab (79) work:
:ing /

:ing in Axenfeld's laboratory, attempted therefore
 with long continued cultivation to find if they
 gradually approximated. Petit's diplobacillus
 is slightly smaller than the other. It rapidly
 liquefied Loeffler's serum, while the other acted
 more slowly, and within 48 hours showed numerous
 involution forms. Petit (49) stated that the
 colonies of his bacillus were flat on the sur-
 :face, (Figure VIII.) while the other showed often
 a small tubercle in the centre (colonie mammellonée).
 But McNab observed the same with both bacteria, and
 pointed out that both forms were to be seen in the
 photomicrograph by Petit of the Morax-Axenfeld
 colonies (Figure IX.) Petit's diplobacillus grew
 easily on agar, and from it always gave subcultures.
 in bouillon, or on gelatine, which it slowly lique-
 :fied; but this power was gradually lost in con-
 :tinued cultivation. The Morax-Axenfeld, if grow-
 :ing on agar, never gave subcultures from it, and
 never /

never grew on gelatine. In his investigation, McNab discovered that the latter germ had considerable power of resisting drying, even for 4 days, and giving cultures thereafter. Since then, the discovery of the severe ulcers of the cornea (already described), due to this organism, must again ^{open} renew the question of the relation or identity of these bacteria.

ZUR NEDDON'S Diplobacillus

This organism resembles the above germs in appearance, but it thrives easily on culture, and does not liquefy serum. These characters bring it near the capsule group. It is found in certain infectious marginal ulcers of the cornea.

For diagnosis

We require coverglass preparations and cultures. The capsule bacilli, the diplobacillus liquefaciens, and Zur Neddon's bacillus are rarely present /

present on the conjunctiva, but they all grow easily on any of the usual media; on the contrary, cultures of the Morax-Axenfeld diplobacillus are only obtained with difficulty. If, therefore, a large diplobacillus without a capsule, or, at most, a small one, is present in considerable numbers in the films but absent from the culture-tube, we may be certain of our diagnosis of the Morax-Axenfeld diplobacillus. If it is present in the culture tube, then we must go through the various tests described above.

The

P N E U M O C C O C C U SHistorical Summary

This organism is present on the normal conjunctiva in about 4% of all persons, Oertzen (50), ^{and} Gasparini (51) _{however} affirmed the number to be 80%, but this has not been confirmed. From an observation of the cultures taken from cases coming to operation in Dr. Fergus's clinic, I should say that it is even a little less than 4%, but agar does not always give growths when the organism is present.

The pneumococcus-conjunctivitis was first described in 1894 by Morax and Parinaud (52) in certain cases of ophthalmia neonatorum. Since then, Axenfeld (53) and others have described a pneumococcus conjunctivitis which has certain resemblances to the Koch-Weeks conjunctivitis, but which has also differences. Epidemics have been reported in many places; cases are very frequent /

frequent in certain parts of Germany, Italy, Denmark, Switzerland, and the United States. It has been often noted that where the pneumococcus-conjunctivitis is common, the Koch-Weeks conjunctivitis is rare, and vice versa.

Clinical Characters

I have had twelve cases, of which three were in conjunction with the Morax-Axenfeld diplobacillus. These with two cases of ophthalmia neonatorum will be discussed later. Other five cases conformed to the usual type of pneumococcus conjunctivitis. There was no history of infection, or dacryocystitis (commonly due to the pneumococcus). One patient stated she had injured her eye with her finger nail, but there was no apparent traumatism. They differed from the Weeks' conjunctivitis by the less marked congestion of the conjunctiva (bulbar), and by

a more profuse muco-purulent discharge. Ecchymoses were only noticed in one case. The eyelids were oedematous, but not of the pink colour described by Axenfeld (1). There were no ulcers or phlyctenulae. My experience in this respect accords with that of most observers. The pneumococcus is frequently the cause of the severe ulcers with hypopyon, but ulceration of the cornea is rare in pneumococcus conjunctivitis. The symptoms abated rapidly, but not by a 'crisis' except in one case. Axenfeld lays great stress on this termination, but remarks that a typical course is more common in epidemics. The duration of my cases was three to four weeks; and four were adults, the fifth was ^{being} a child of six years.

The last two cases were interesting. A purulent conjunctivitis occurred in a patient two days after operation. On examining the discharge /

discharge and the agar-agar tube inoculated from the conjunctiva prior to the operation, pneumococci were discovered in both. Fortunately the case healed without serious complication, the wound had closed before the conjunctivitis appeared.

The other case was equally interesting.

C a s e VIII. M.M., Aet. 65, came to the clinic on the 7th October 1904, with a muco-purulent conjunctivitis of the left eye. There was a moderate injection of the ocular conjunctiva. A small amount of pus regurgitated on pressure over the lacrymal sac. She had incipient cataract in the same eye. Coverglass films showed the pneumococcus with capsule. There was no iritis or glandular involvement. This was a mild conjunctivitis of lacrymal origin, but the case is interesting since it is seldom that conjunctivitis complicates a pneumococcus dacryocystitis.

The /

The pneumococcus in film-preparations is easily recognised as the two lancet-shaped cocci placed end to end and surrounded by a clear unstained space, the capsule.

The adoption of special staining methods proves that the unstained portion (Heller Hof of the Germans) is a capsule. (Figure X)

Cultures can usually be obtained on agar-agar, but more certainly upon blood serum. From cultures the organism does not usually show a capsule, although Figure XI. was taken from a culture. Gordon (54) claims that a capsule is formed if the pneumococcus is grown in 12% gelatine incubated at 37 ° C. This organism is stained by Gram's method. In doubtful instances, recourse must be had to an experimental injection.

Experimental Inoculation

Gifford (55), Pichler (56), and Hauenschild (57)

have /

have each produced a conjunctivitis on the healthy human conjunctiva by the use of a pure culture of the pneumococcus. The incubation period was 48 hours in some cases, but in one it was 7 days.

Several other workers ^{however, have} failed in these experiments. This and the additional fact that 4% of all persons have the pneumococcus on the normal conjunctiva lead us to the belief that in many there is a certain immunity to the pneumococcus. A wide-spread immunity explains therefore the rarity of sporadic cases and the limitation of the epidemics. The frequently blamed 'cold' may, by lowering the resistance, be the indirect cause of a conjunctivitis. That immunity follows an attack of pneumococcus conjunctivitis is probable, but has not been proved.

Mixed Infection

There have been three cases of mixed infection with /

with the Morax-Axenfeld diplobacillus and the pneumococcus.

C a s e IX. A girl Aet. 8, came to the clinic with a severe muco-purulent conjunctivitis of the left eye. The ocular conjunctiva was greatly injected and chemosed. The lids, especially the upper, were slightly oedematous. There was considerable discharge. The right eye was affected to a less extent. Duration had been off and on for six weeks. Coverglass films showed numerous pus cells with pneumococci and diplobacilli. The other two cases had a similar appearance and history, with, in addition, a small ulcer on the cornea of one, in which the pneumococcus was more abundant in the films. There was no hypopyon and recovery was normal.

The chronicity of these cases was presumably due to the diplobacillus, while the acute phase and /

and the ulcer of the third were associated with the pneumococcus invasion. Case IX had thus been a subacute conjunctivitis (Morax) with a subsequent superimposed pneumococcus invasion. Recovery was rapid, but not exactly with a 'crisis' of the symptoms.

The

G O N O C C O C C U S

Neisser's diplococcus has been found in 23 cases, of which 15 were ophthalmia neonatorum, 5 were severe-purulent conjunctivitis, and 3 were muco-purulent conjunctivitis.

Four of the five cases of purulent conjunctivitis were complicated with corneal ulceration, in two of which the eye was completely lost, and a third patient lost one eye, but has recovered with fair vision in the other, which had also severe corneal ulceration and hypopyon. The remaining two patients made a good recovery. A coincident urethral affection was only found in two patients. In diagnosing this very grave malady, it is absolutely necessary to employ Gram's stain. Whenever organisms resembling the gonococcus are seen on a coverglass film, a second must be stained by that method. I have,
in /

in certain cases of muco-purulent conjunctivitis, seen intracellular diplococci, resembling in all respects the gonococcus, but as a rule not more than one or two pairs in each pus cell. They were positive to Gram's stain and have been named pseudo-gonococci by Axenfeld (1). They are different varieties of the staphylococcus. In one case they were found in hydrocœle serum as small transparent colonies of not more than 1.m.m. in diameter. Subcultures were obtained on ordinary agar-agar, and also showed the diplococcus arrangement. Figure XII is from a film preparation and Figure XIII from the colonies on the hydrocœle serum, stained by Gram's method.

Two cases of muco purulent conjunctivitis were due to the gonococcus. They were both ^{two} female children of three and four years respectively. There were no corneal affections. There was considerable oedema of the upper lids. They both recovered /

recovered completely without any complications. These cases belong to a well known category in which the gonococcus is found in young girls. It is also well known that this organism at times is associated with a comparatively mild affection. A third case due to both the Bacillus of Weeks and the gonococcus deserves more detail: ed narration. It has been included under the muco-purulent column.

C a s e X. A man P.M., Aet. 25, came to the clinic on the 2nd August 1904, with a severe conjunctivitis of the right eye. The left was only slightly involved. He said his right eye had been inflamed for two weeks, but on the previous day the eyelids had become swollen. There was great oedema of the lower lid, and a brawny induration of the skin. The upper lid was similarly affected but to a less extent. The /

The palpebral conjunctiva was chemosed and thrown into folds. The ocular conjunctiva was less affected, but also slightly chemosed. The cornea was clear. There was a little watery discharge with flakes of muco-pus in it. Coverglass films contained numerous typical groups of the gonococcus within the pus cells, and, in addition, the Koch-Weeks Bacillus in moderate numbers, also intracellular, both destained by Gram's method. No staphylococci on the films. Agar-agar contained a number of colonies of the staphylococcus albus and aureus, but neither of the above germs. The eyelids were immediately brushed with 30% argyrol, and Mackenzie's lotion and 5% Argyrol were prescribed for home use. He recovered completely without corneal affection. There is little doubt that the Weeks' conjunctivitis had been present for two weeks, and then the gonorrhoeal invasion was superimposed. The fortunate issue may be laid to the account of his coming at once to the hospital.

O P H T H A L M I A N E O N A T O R U M

Twenty cases of this affection have been examined, and they present a varied etiology. Twelve have been due to the gonococcus i.e. 60%, while in three other cases it has been present along with the streptococcus, the Koch-Weeks bacillus, or the pneumococcus, making in all 15 cases or 75% in which the gonococcus was present. Of the remainder, two were due to the pneumococcus, two to Koch-Weeks bacillus, and one gave a negative result, but in this instance the case had been under treatment for five weeks before examination. Ulcers of the cornea were present in two of the gonorrhoeal cases, in one of the pneumococcus cases, and in the mixed infections of the gonococcus with the streptococcus and with the pneumococcus. Perforation of the ulcer occurred in the pneumococcus case, and the mixed infection with gonococcus and pneumococcus /

:coccus. The other ulcers healed without perforation. These numbers will be more easily understood by reference to Table IV.

Table IV.

Ophthalmia Neonatorum

Organism	No Ulcer	Ulcer did not perforate	Ulcer perforated	Total cases
Gonococcus	10	2	-	12
Gonococcus + Streptococcus	-	1	-	1
Gonococcus + Pneumococcus	-	-	1	1
Gonococcus + Koch-Weeks Bacillus	1	-	-	1
Pneumococcus	1	-	1	2
Koch-Weeks	2	-	-	2
Negative	1	-	-	1
Total	15	3	2	20

These figures bear out that ophthalmia neonatorum in about two thirds of the cases is due to the gonococcus, and that the other third includes cases due to the Koch-Weeks bacillus, the pneumococcus, and the staphylococcus pyogenes aureus, while in some no definite organism can be obtained. Axenfeld (58) and Bielti (59) have found the bacillus coli communis in several cases. Moraz (60) suggested, where no definite organisms were found, ^{but} hereditary syphilis, as in coryza, might play a rôle in the etiology, but there is no proof for this assumption. I had not heard in time for this work, of the Spirochaeta^e pallida, supposed to be associated with syphilis by Schaudinn and Hoffmann (61) and also by M. Weeney (Brit. Med. Journal 1905, 1 p. 1262) . The gonococcus cases are more severe, and more liable to corneal ulceration, (Groenow (62), but the others, although usually running a mild course may /

may occasionally be as severe: e.g., one of my pneumococcus cases. The cases of purulent conjunctivitis due to the Koch-Weeks bacillus might have been brought into this series, but, as explained above, the children were each over a month old, and the inflammation was of recent origin when they came to the dispensary.

D i a g n o s i s

The gonococcus can be fairly easily recognised in microscopic films. A considerable number of diplococci lying in a number of the pus cells is most characteristic. If there are only a few diplococci in the individual cells, the diagnosis is doubtful. They are destained by Gram's method, and this must be undertaken to obtain an accurate diagnosis. Figure XIV is a very good representation of a group in the protoplasm of a leucocyte. Cultures can only be obtained on blood-agar, and even then with difficulty /

difficulty. They appear as minute opaque colonies which cannot be transferred to gelatine. The chief difficulty in diagnosis is the diplococcus intracellularis meningitidis.

Kruckenberg (63) and others have obtained organisms resembling in all respects the gonococcus, but which were generally more easily cultivated. He suggested that they belonged to Pfeiffer's micrococcus catarrhalis, or the diplococcus meningitidis, as the clinical features were so mild. The colonies of the latter run into a thin layer on serum agar, while the gonococcus colonies remain discrete.

BACILLUS SUBTILIS and the KOCH-WEEKS BACILLUS

In one case of purulent conjunctivitis these two organisms were found together. The patient was an infant of nine months old. The left eye had been inflamed for four days when she was brought to the hospital. There was no affection of the cornea. The lids were slightly oedematous. There was no history of injury. Both organisms were found in the films prepared from the pus, and in the culture tube. Spores were found in the bacillus subtilis.

Gourfein (64), in a series of 17 cases, has noted that the patients were all country people, and that there was always a history of injury when ^{or} earth had entered, or ^{had} been rubbed into the eye. The bacillus Subtilis was generally associated with the staphylococcus aureus, streptococcus pyogenes, or pneumococcus. In two cases there /

there were superficial ulcers. He produced a conjunctivitis in rabbits by scratching and rubbing a culture into the Conjunctiva, but failed to cause Keratitis.

STAPHYLOCOCCUS PYOGENES

Colonies of the *Staphylococcus pyogenes* aureus citreus, or albus, have been found in the culture tubes from a large number of the cases. There were as a rule simply a few scattered colonies, sometimes as many as eighteen or twenty small colonies, or, ^{at times} in a few instances, ^{as} a broad thick streak formed by numerous coalescent growths. On the other hand, the most careful search through film preparation, with the exception of those to be mentioned, almost invariably failed to show any staphylococci. Where a few were found, they were in such small numbers, that they might be regarded as accidental. The culture tubes inoculated from the patients coming to operation have also very frequently had colonies of the albus, and, at times, the aureus. Where there have ^{been} only a moderate number of the albus colonies, or a few of the aureus, the operation has been carried out without any serious consequences. Many observers have very frequently found staphylococci, especially /

especially the albus in the normal conjunctival sac. Repeated attempts to produce conjunctivitis by rubbing cultures of the staphylococcus aureus into the human conjunctiva have failed. Römer (65) succeeded when he mixed sand or dust with the cultures, and thus injured the surface epithelium; Meijers (66), when he closed the tear passages and sutured the lids together; Morax and Elmassian (3) produced severe irritation of the conjunctiva by repeated dropping of the toxin of the aureus upon it; and Randolph (67) confirmed this by injecting the toxin sub-conjunctively. We must therefore acknowledge that virulent staphylococcus aureus or the albus may produce conjunctivitis under certain favourable conditions.

In four cases of muco-purulent conjunctivitis there were found pseudogonococci lying among /

among the pus cells in film preparations, and staphylococci in the culture tubes. The virulence of these cultures was not tested by experiment. A fifth case followed an injury with a chip of whinstone. There was no apparent traumatism. Staphylococci were numerous in films and on the culture. A sixth case was a girl of nine with similar symptoms and bacteriological result. She had ^{had} erysipelas of the face and head five weeks previously. These cases, I believe, were due to the staphylococcus, and have been placed in the first column in Table I.

In seven cases of blepharitis marginalis or eczema tarsi, accompanied by more or less severe conjunctivitis, there were found five times the staphylococcus and twice streptococci, staphylococci and several unnamed bacilli, results confirmed by culture. These have been entered under the Blepharitis column in Table I.

Membranous Conjunctivitis

I have seen only two cases of membranous conjunctivitis, although in ophthalmia neonatorum, and occasionally in acute conjunctivitis, small shreds of membrane have been present. These were not adherent, and did not cover the whole conjunctiva, and no special attention was paid to them.

C a s e XI. This was a child of three years of age, who came to the clinic on the 22nd March 1904. She had been admitted on account of measles to one of the City Fever Hospitals four weeks prior to the visit to the Eye Infirmary, and had been dismissed three weeks later. The eyes had been inflamed before leaving the Fever Hospital, but had since become much worse. In the right eye there was a firmly adherent grey membrane over the conjunctiva of the lower and the upper lids. It did not extend ~~on~~ to the ocular conjunctiva. There was very little free discharge /

discharge. The cornea was hazy in its lower part, but there was no breach of surface. The child appeared to be seriously ill, and was thin and pale. Upon a bacteriological examination, there were no organisms seen in films, but on serum-agar a thick growth of the staphylococcus aureus occurred. The patient did not return to hospital.

It has been denied by some that membranous conjunctivitis can be caused by organisms other than the bacillus diphtheriae. Certain authors have found in cases of membranous conjunctivitis virulent staphylococci. Rietti (68) reported three cases in which the staphylococcus pyogenes aureus was the cause, ^{and} where the growths were rich and free from other organisms. Morax and Petit (26) reported a similar case due to the staphylococcus pyogenes albus in a virulent form. Jessop (69) also reported several cases. Stephenson (70) thinks that the Klebs-Loeffler bacillus is /

is present in these cases, but owing to the small number they have been overlooked. This opinion can hardly be supported in the face of the above cases and the work of Randolph (67) on the toxins of the various organisms. We may, therefore, conclude that my cases were probably due to the staphylococcus pyogenes aureus.

Phlyctenular Ophthalmia

The sixteen cases of this affection all had, in the culture tubes prepared from them, colonies of the staphylococcus aureus, or albus and the bacillus xerosis (so-called), but the most careful examination of coverglass films, prepared by several sweeps of the platinum wire along the lower fornix, failed to show any bacteria. There is a considerable consensus of opinion that this is an endogenous affection (i.e. infection not from external bacteria), and that staphylococci found in the conjunctival sac, have no etiological /

logical relationship. Leber (71) obtained infiltration followed by loss of substance at the spot where he injected sterilized tubercle bacilli into the cornea. Bruns (72) in a recent paper describes nodules which appeared suddenly at the limbus, at the muscular insertions, and at the fornix, after the injection of sterilized tubercle bacilli into the external carotid artery in rabbits. His paper does not prove the endogenous origin; it nevertheless is very strong presumptive evidence.

STREPTOCOCCUS PYOGENES

This coccus was found in three cases. Once together with Neisser's diplococcus in a case of ophthalmia neonatorum, in which there was a rather extensive shallow ulcer of the cornea. The other two patients had old-standing blepharitis marginalis. The bacteriological examination discovered large numbers of organisms, - staphylococci, streptococci, air bacilli and several indefinite bacilli and diplobacilli. There had been evidently considerable contamination of the conjunctival sac, and neither of the patients had a clean appearance. One of the above had eczema of the lids, and the pus infection had probably arisen from it.

(Figure XV.)

Schottelius (73) found in the conjunctivitis of measles, that in 40 cases which recovered, the staphylococcus aureus was present 25 times, and the /

the streptococcus pyogenes 6 times, while in 40 cases which proved fatal the streptococcus was present 20 times. He concluded that these pyogenic organisms had some action in the causation of the conjunctivitis, if not also of the measles. Axenfeld (74) supported this view, since he had obtained similar results in several cases of the same epidemic.

I have not observed any cases of the lacrymal conjunctivitis of Parinaud (75). There is always a stenosis of the lacrymal canal associated with the streptococcus. The conjunctivitis is severe and leads to iritis, swelling of the pre-auricular gland, and feverish symptoms. The streptococcus has also been described in association with pseudo-membranous conjunctivitis. Jundell (76) in such a case tried the anti-streptococcus serum, and reported that while neither preventive nor curative, it had possibly the opposite effect. The streptococcus /

streptococcus is also not infrequent on the healthy conjunctiva, and we may generally agree with Poulard (77) when he says that streptococcus conjunctivitis is always secondary to some other force either (1) lacrymal disease, - Parinaud's conjunctivitis, (2) Measles, Scarlet, ^{Jew,} or Diphtheria, or (3) conjunctivitis due to the diplobacillus, diphtheria bacillus, &c.

The BACILLUS of XEROSIS (so-called)

This organism was first described as the cause of xerosis of the conjunctiva, and later in chalazion. Since then various observers have found it in 50% of normal conjunctivae. It resembles very closely the Klebs-Loeffler bacillus, but it is not pathogenic in man and the lower animals. Some workers claim that it may become virulent. They include the diphtheria bacillus, Hoffmann's pseudo-diphtheria bacillus, and the xerosis bacillus in one group under the name Coryne Bacteria. Hala (78), after reviewing the various distinctions between the members of this class, claims that numerous transition forms occur so that none of the Morphological and culture properties are definite enough for separate types. Diphtheria bacilli have been proved to be occasionally ^{non-}avirulent.. He obtained small abscesses by injecting cultures of the pseudo-diphtheria and the xerosis bacillus into the ear, and the sub- /

sub-conjunctival tissue; and therefore believed that these two organisms had a certain, although slight, virulence. No one, however, has been able to raise the virulence to that of the diphtheria bacillus. We must await further research.

The xerosis bacillus was present in the culture tubes from nearly all my cases, and also in 75% of the tubes from operation cases, i.e. from the normal conjunctiva. It rarely appears in the coverglass films. Nevertheless the organism multiplies rapidly in all forms of conjunctivitis, especially ⁱⁿ phlyctenular ophthalmia and membranous conjunctivitis. We have already seen how difficult it is to separate the Koch-Weeks Bacillus from this germ.

Morphology and Cultivation

The xerosis bacillus resembles very closely the diphtheria bacillus. In film preparations it appears /

appears as a short rod about 2 u in length. The same form is seen in a 24 hours culture (Figure XVI.) After 24 hours a slight tapering of the bacillus appears, accompanied by an irregular staining. Club-shaped forms become frequent (Figure XVII.) The bacillus septatus of Gelpvcke is identical with the xerosis bacillus described in connection with conjunctivitis. I have observed the same organisms appear in one medium as the septatus bacillus (Figure XVIII.) and the subculture. have the regular club-shaped appearance (bacilli massue)

D i a g n o s i s

The xerosis bacillus grows on the same media as the diphtheria bacillus, but the colonies are smaller, and growth is not so luxuriant. The following are the chief distinctions:-
In neutral bouillon the diphtheris bacillus rapidly /

rapidly produces turbidity and the reaction becomes acid. The xerosis bacillus produces a few flakes which sink to the foot leaving the liquid clear; the reaction remains neutral, or becomes very slightly acid.

On serum, the diphtheria bacillus appears within 12 hours as white moist colonies which tend to become confluent. The xerosis bacillus begins to appear after 20 hours as grey, dry, colonies which remain discrete. Neisser's staining reaction is obtained within 12 hours with the former, while it is rarely present before 24 hours with the latter. The chief distinction is the ^{existence of} virulence of the one, and the absence of it in the other.

From Hoffmann's pseudo-diphtheria bacillus, the xerosis bacillus is distinguished by the greater luxuriance of the colonies of the former. The bouillon becomes rapidly turbid and more alkaline. The colonies on serum are larger and moist.

C O N C L U S I O N S

As regards the possibility of a diagnosis based on the bacteriology of conjunctivitis we must still acknowledge the truth of the remarks of Morax and Petit (23). They point out that the bacillus of Weeks, the diplobacillus, and the gonococcus have almost never been found on a normal conjunctiva; that the pneumococcus and the Klebs-Loeffler bacillus have occasionally, whilst the streptococcus and the staphylococcus have, as a rule, been found on the normal conjunctiva. Consequently the mere discovery of these latter four organisms does not suffice for the diagnosis that a given case is due to them. On the other hand, the presence of the bacillus of Weeks, the diplobacillus of the diplococcus of Neisser at once indicates that the case is related to these bacteria. It is necessary to take into account the number of the /

~~the number of~~ the microbes, their arrangement, and the conditions prevailing at the onset of the symptoms when we find any of the other bacteria, and in cases of doubt to test the virulence of the organisms.

We are not yet able to make an etiological classification of conjunctivitis, since there is no distinct type associated with each organism. It is rather the other way - a given organism may produce milder or severer symptoms in different cases. This is most easily proved by referring to the epidemics of the Weeks' conjunctivitis, where even in the same family some may have a very sharp attack, while others exhibit only a slight reaction. The same has occurred in the experimentally produced disease, as severe cases have followed the use of a culture from a mild case. In stating these facts we /

we are only repeating what is true of almost all bacterial diseases. Nevertheless certain definite results may be mentioned.

A bacterial origin was discovered in 213 of the 245 cases of acute mucopurulent conjunctivitis, being 86.9% and, as mentioned at the commencement of the paper, a second examination would probably have led to a higher percentage of definite results.

Of the 245 cases, 186 or 75% were due to the Koch-Weeks bacillus, 9 or 4% to the Morax-Axenfeld diplobacillus; 6 to the pneumococcus; 3 to the combined action of the Morax-Axenfeld diplobacillus and the pneumococcus; 2 to the gonococcus; 6 to the staphylococcus pyogenes; and 1 to the gonococcus in conjunction with the Koch-Weeks bacillus. It is not possible to draw conclusions as to the relative frequency of the different /

different bacteria, because these figures do not represent all the cases of conjunctivitis, which occurred at the clinic. This is particularly true of the next form to be discussed. Still we may say that the great bulk of the cases of acute muco-purulent conjunctivitis were due to the Weeks' bacillus. Had all cases with the typical blood-shot eyes of recent origin, and with a history of infection ^{of both eyes} or of one eye following the other, been classed together we should have had a considerably higher percentage as due to the Weeks' bacillus than the 75% mentioned.

74.6% of the cases classed as subacute conjunctivitis were due to the Morax-Axenfeld diplobacillus, while 10% were to be referred to the Weeks' bacillus. It was this form which suffered most from the absence of a second examination at the first visit. There were 15.5% of indefinite or /

or negative results. The discharge in this form is very slight, and the patient might have brushed away any that was available just before the examination. Consequently we may say that in these two forms the diagnosis of the one or the other organism would have been correct in three-fourths of the cases.

There have been only a few sporadic cases of the pneumococcus conjunctivitis, and this accords with the general experience that where these are frequent the Koch-Weeks conjunctivitis is rare, and vice versa.

A bacteriological examination can alone give the correct diagnosis in purulent and membranous conjunctivitis, ^{as} clinically it is impossible to discover their etiology, unless in certain very severe and marked cases. A negative result with the bacteriological examination may be /

be useful in some phlyctenular and refractive cases.

The following case also showed the advantage of a bacteriological examination.

C a s e XII. I was asked to see a boy J.R. aet. 11., on the 14th September 1904, with inflammation of the right eye. His left eye ^{had been} removed three years ago by another surgeon after a severe penetrating injury from a piece of glass. The parents were alarmed, having been warned about sympathetic ophthalmia. There was considerable ocular injection. No oedema of the conjunctiva or lids. A very little mucus lay in the lower fornix. There was a history of infection from another boy at school. Numerous Weeks' bacilli were found on films prepared from the mucus. The following day three small phlyctenular ulcers were present on the corneal margin. There was no discolouration of the iris, and the pupil was perfectly /

perfectly active. Under treatment the eye rapidly became better, and the diagnosis was further clinched a week later, by his sister becoming affected.

Such a case proves the advantage of a bacteriological examination. I have also seen a case of sympathetic ophthalmia in its early stage very closely resemble conjunctivitis. The complete failure to find any virulent organisms aided the diagnosis.

There is no doubt now that (a ^{many} large number of the) cases of catarrhal conjunctivitis have a microbic origin. The definite recognition of this fact is of importance for prognosis and treatment. For prognosis, since we can much more truly give the probable duration of the affection, of its liability to lesions of the cornea /

cornea, and how seriously it may affect the cornea. For treatment, since we know the severity of the measures that must be adopted, both as to prevention of extension to others, and as to cure of the patient. To be more particular, cases of Koch-Weeks' conjunctivitis, of diplobacillary conjunctivitis, of diphtherial and of gonorrhoeal ophthalmia must all be warned of the danger of affecting others. In the last mentioned, measures must be taken to protect the fellow eye. Children suffering from Conjunctivitis due to the Koch-Weeks bacillus or to the Morax-Axenfeld diplobacillus ought not to be allowed to attend school, until the discharge has ceased, or ^{until} the organisms have disappeared from the discharge. Children suffering from the other diseases will be too seriously ill to think of attending school.

We must remember that Koch-Weeks' conjunctivitis tends to cure, while diplobacillary conjunctivitis /

conjunctivitis shows no such tendency. In this latter case we ought to remember the special efficacy of the old favourite zinc sulphate.

L i t e r a t u r e.

1. Axenfeld Ergebnisse der Allgemeinen Pathologie von Lubersch - Ostertag. 1894, 95-6, 1897-9. Bakteriologie des Auges.
2. Muir and Ritchie. Manual of Bacteriology 3rd Ed. 1903.
3. Koch Weiner Med. Wochenschr 1883. Ref. Weichselbaum and Muller. (see below).
4. Weeks. Archives of Ophthalmology 1886 Ref. Weichselbaum and Muller.
5. Weeks Report of International Medical Congress 1890. Ref. Axenfeld (1)
6. Morax Recherches bacteriologiques sur l'etiologie des conjonctivites aiguës et sur l'osepsie oculaire. These de Paris 1894 Ref. Axenfeld (1)
7. Weichselbaum and Muller v. Graef's Archiv fur Ophthalmologie 1898 XLVII.
8. Kartulis Centralb f. Bakt. vol. I 1883 Ref. Axenfeld (28).
9. Kamen. Centralb f. Bakt. Parasitenkunde, u Infektionsk. 1899 vol. 26 N. 12 18.
10. Rymowitsch. Wratsch vol. 20 p. 638 1900, 1901. Ref. Axenfeld (28).
11. Jundell Influenza conjunctivitis bei Sanglingen. Mitteilungen aus d. Augenlinik d. Carolinischen med. chirurg. Instituts zu Stockholm (Widmark) Vol. 3 1902 p. 11. Ref. Axenfeld (28) and Morax (33)
12. Stephenson Centralb f. Augenklinik. 1896 p. 729.
13. Juler Brit. Med. Journal 1894 Sept. 15.
14. Bishop Harman. The Conjunctiva in Health and Disease. Balliere Tindall and Cox 1905.

15. Guasparini Annali d'ottalmologia 1895 & 96.
Ref. Axenfeld (1)
16. Coppez Arch. d'ophthalmol. 1899 vol.19 p.11.
17. Gifford Arch. f. Augenheilk. vol.34 p.183.
Ref. Axenfeld (28)
18. Junius Zeitschrift f. Augenheilk 1899 vol.1 p.43
Ref. Axenfeld (28)
19. Wilbrand - Saengar - Stoehlin Jahrbucher der Hamburger
Staats-Krankenanstalten 1894. Ref. Axenfeld (1)
20. Hofmann Zeitschrift f. Hyg.u Inf. vol.33 1900
Ref. Axenfeld (28).
21. Greef. Augenartz and u. hygien Schuluntersuchungen.
Klimeschen Jahrbuch 1904.
22. Schmidt-Rimpler Ref. Greef. (21)
23. Morax et Petit. Annales d'oculistique 1898 Vol. CXX.
24. Stephenson Contagious Ophthalmia 1900
25. Markus Munch. Med. Wochenschr. 1901 p. 2137
Ref. Axenfeld (28)
26. Morax v. Graefe's Archiv f. Opth. 1898 vol.47 p.673.
27. Monthus et Opin. Precis de Technique microscopique de
l'oeil Paris Asselin et Houzeau. 1903
28. Axenfeld Kolle ^u _p. Wassermann vol13. p.489 Fisher ^c _A 1903.
29. Bienstock ref. Harman (14)
30. Morax et Elmassian Annales d'Oculistique 1899 vol.122.
31. Zur Meddon Klin. Monatslb f. Augenheilk 1900. 3
Ref. Axenfeld (1) & (28) 1904 vol.1 p.47.

32. Müller Arch. f. Augenheilk 1900 vol.40 p.13
33. Morax Annales d'oculistique 1903 vol.129 p.156.
34. Beck Kollé u. Wassermann vol.3 p.359. Fischer 1903
35. Morax Annales de l'institut Pasteur 1896 Juin.
36. Axenfeld Heidelberger Congress 1896.
37. Eyre Brit. Med. Journal 1898 p.1964
38. Lakah et Khouri Annales d'Oculistique 1902
vol.128 p.420.
39. Giarré and Pichi La Settimana medica 1898 No.28
Ref. Axenfeld.
40. Gonin Revue med. de la Suisse Romande 1899.
Ref. Axenfeld (1).
41. Pflugger-Simon Correspondenzbl f. Schweizer Aertze 1902
Axenfeld 28.
42. Paul Klin Monatsbl. f. Augenheilk 1905
vol.I p.154.
43. Erdmann Klin. Monats f. Aug.1905 vol.1 p.561.
44. Stoewer Klin. Monats. f. Augen. 1905 vol.2 p.142.
45. Axenfeld Centralb f. Bakteriologie 1897 vol.21
46. Hoffmann Arch. f. Ophth. vol.48 p.639. 1899
Ref. Axenfeld.
47. Biard Etude sur la conjunctivite subaigue. These de
Paris 1897 Ref. Erdmann (31)
48. Abel Kollé u. Wassermann vol.3 p.871 Fischer 1903
49. Petit, Annales d'Oculistique 1899 vol.121 p.166.
50. Oertzen Klin. Monatsbl. f. Augenheilk 1899
Ref. Axenfeld (28)
51. Guasparini Annali d' Ottalm. vol.22 6 1893
Ref. Axenfeld (1)

52. Parinaud Annales d'Oculistique 1894 Oez.
53. Axenfeld Berlin Klin. Wochenschr. 1896 No.6
Ref. Axenfeld (1)
54. Gordon Brit. Med. Journal 1904. March 19.
55. Gifford Archiv of Ophthalmology vol.25 p. 314 1896.
56. Pichler Beitt 2. Augenheilk vol.25 p.19 1896.
Ref. Axenfeld.
57. Hanenschild Zeitschr f. Augenh. vol.3 No.1 1900
Ref. Axenfeld.
58. Axenfeld Bericht. der Ophth. Vers. Heidelberg 1896
59. Bietti Klin. Monatabl. f. Augenheilk 1899 p.311
Ref. Axenfeld.
60. Morax Annales d'oculistique vol.129 p. 346 1903.
61. Schaudinn und Hoffmann. Berlin Klin. Wochenschr. 1905
No.22 and 23. Ref. Dr Teacher Glas.Med.
Journal 1905 p.158.
62. Groenow v. Graefe's Arch. 51.1. 1901.
63. Kruckenbergl. Klin. Monatsbl. f. Augenheilk 1899
vol.37 Ref. Axenfeld.
64. Gourfein Internat Ophthalm. Congress 1904. Ref. Klin.
Monatsbl f. Augenheilk 1904
65. Romer. Zeitchr. f. Hygiene vol.32. 2 Ref. Axenfeld (1)
66. Meyers Mang. Diss. Jena 1898 Ref. Axenfeld (1)
67. Randolph John Hopkins Hosp. Bulletin 1903.
68. Bietti Annali de Ottalm. vol.27 1898 Ref. Axenfeld (1)
69. Jessop Trans. Ophth. Society 1902.
70. Stephenson ibid. 1902

71. Leber Bericht d. Vers. Ophth. Gesellschaft
zu Heidelberg 1901
72. Bruns v. Graefe's Archiv f. Ophth. 58. 3 1904
73. Schottelius Klin. Monatsbl f. Augenheilk 1904
1. p.565.
74. Axenfeld ibid. p.576.
75. Parinaud Ann. d'Oeil vol.110 p.252 1889.
76. Jundell Hygiea 1902 Ref. Jahresbericht f.
Augenheilk Michel-Nagel.
77. Poulard Archives d'Ophthalm. vol.23 p.382.
78. Hala Zeitschr f. Augenheilk 1903 vol.IX p.107.
79. McNab Klin. Monatsbl. f. Augenheilk 1904 I. p.54.

DESCRIPTION of C o l o u r P l a t e s.

- I. William Nelson. Aet. 44. Acute contagious conjunctivitis, duration 1 week. Ocular conjunctiva of both eyes injected. Muco-purulent discharge clinging to eyelashes.

Bacteriological examination Koch-Weeks
Bacillus.

- II. Margaret Gillies. Aet. 28. Conjunctivitis of right eye, duration 10 days. Ocular conjunctiva completely injected. Small phlyctenula at inner margin of cornea. Slight muco-purulent discharge.

Bacteriological examination Koch-Weeks
Bacillus. Left eye unaffected.

- III. Mrs Steven. Aet. 37. Sub-acute conjunctivitis, duration 6 weeks. Intermarginal space in both lids injected. Ocular conjunctiva clear. Small bead of muco-pus at inner canthus.

Bacteriological examination. Morax Axenfeld.
Diplo-bacillus.

DESCRIPTION of PHOTOMICROGRAPHS.

1. Koch-Weeks Bacillus in film x 1000. A pus cell containing many of the bacilli.
2. Koch-Weeks Bacillus and Xerosis Bacillus from culture x 1000.
Former are faint. The latter are larger and blacker.
3. Colonies of the Koch-Weeks Bacillus X 3 by Kamen (9).
4. Morax-Axenfeld Diplo-bacillus in film x 1000.
5. - Do.- x 1000. Note the faint signs of a capsule. Bacilli for most part are outside the cells.
6. Morax-Axenfeld Diplo-bacillus. Culture x 1000. Note delicate bond joining the segments. Few staphylococci present.
7. Morax-Axenfeld Diplo-bacillus. Culture x 1000. Involution forms. Note the pale staining segments lying beside the normal segments.
8. Colonies of Diplo-bacillus Liquefaciens (Petit) x 50(?) Granulation is due to the Plate from which this was photographed. Axenfeld (28) copied from Petit (49)
9. Colonies of Morax-Axenfeld Diplo-bacillus x 50(?) Some have tubercle in centre while some are flat like figure 8. Granulation due to plate in Axenfeld(28) copied from Petit (49).

Photos. Contd.

10. Pneumococcus in secretion x 1000.
11. - do.- culture x 1000
12. Pseudo-Gonococcus secretion x 1000 (centre)
13. - Do.- culture x 1000
14. Gonococcus secretion x 1000.
15. Streptococcus x 1000.
16. Bacillus Xerosis (so-called) x 1000
24 hours culture on agar.
17. Bacillus Xerosis x 1000. 48 hours culture agar.
18. - do. - (Bacillus Septatus) x 1000.
Agar 48 hours.



Plate I

William Nelson.



PLATE II.

Margaret Gillis
Abbe R. Vincent



Plate III.

Mrs

Heaven

11

Pitt St.



Figure I.



Figure II.

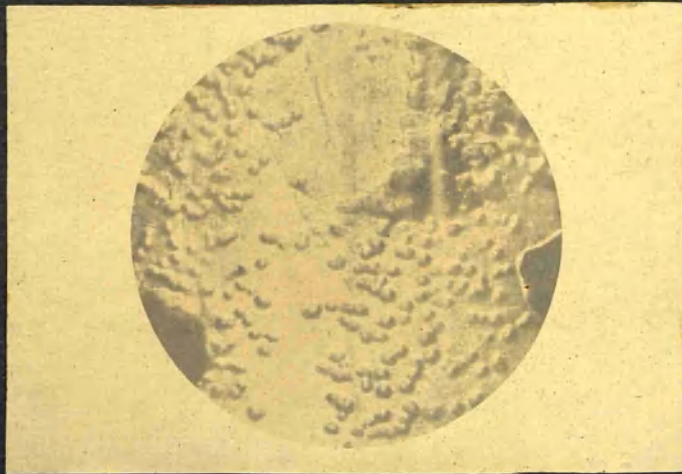


Figure III.



Figure IV.

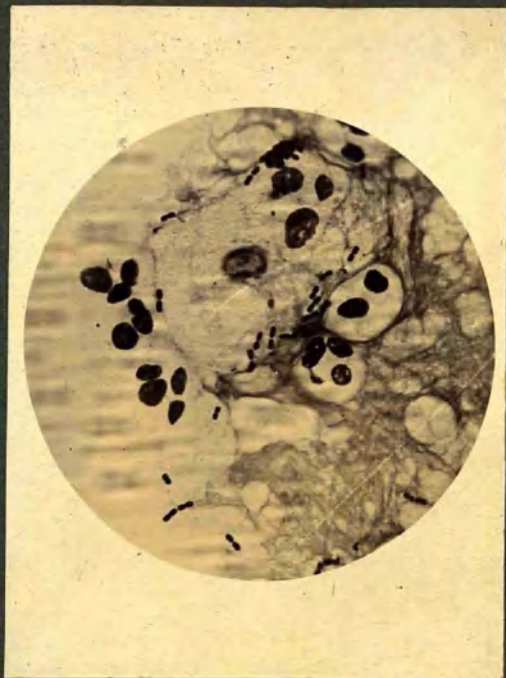


Figure V.

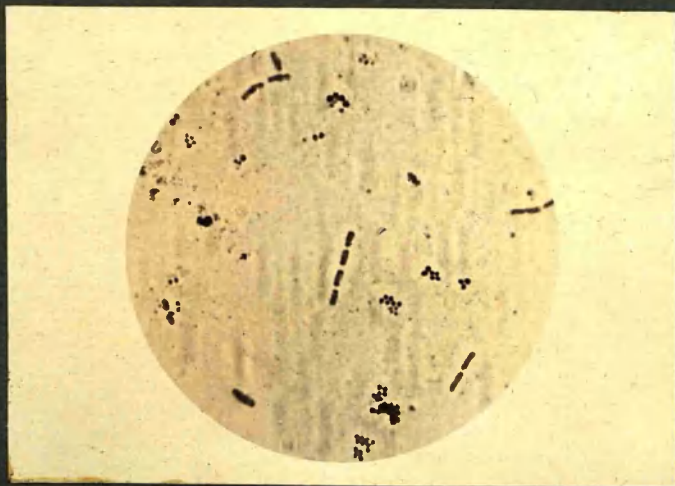


Figure VI.



Figure VII.



Figure VIII.

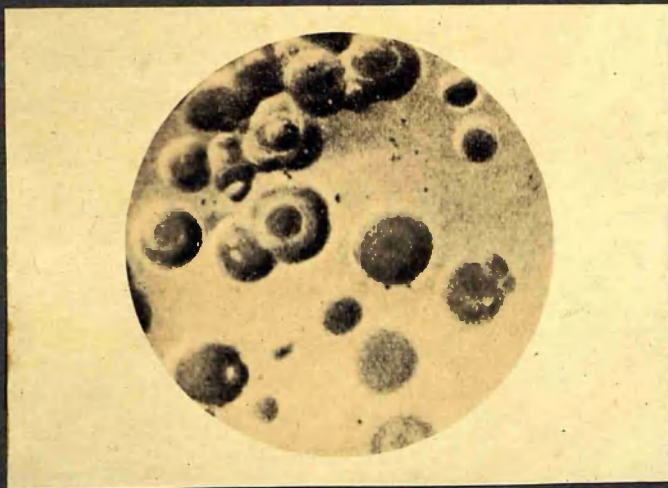


Figure IX.

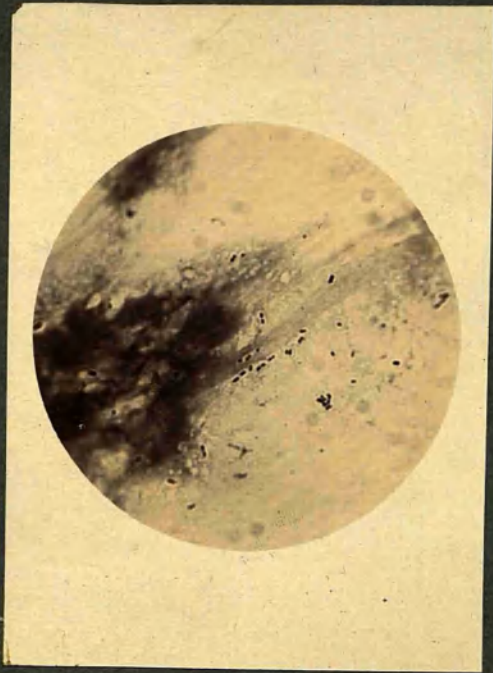


Figure X.



Figure XI.

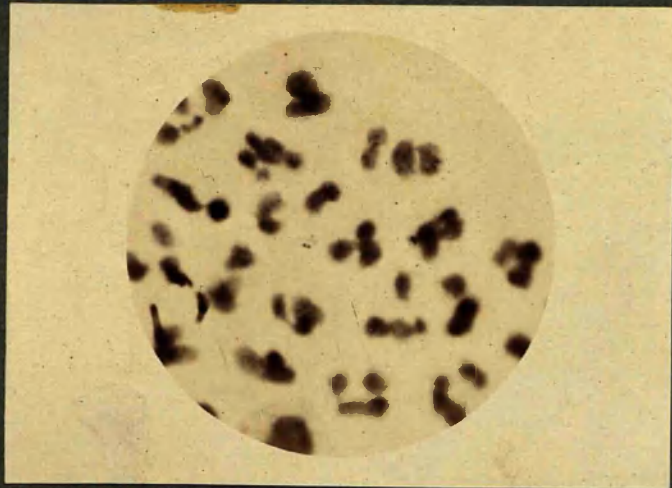


Figure XII.



Figure XIII.



Figure XIV.

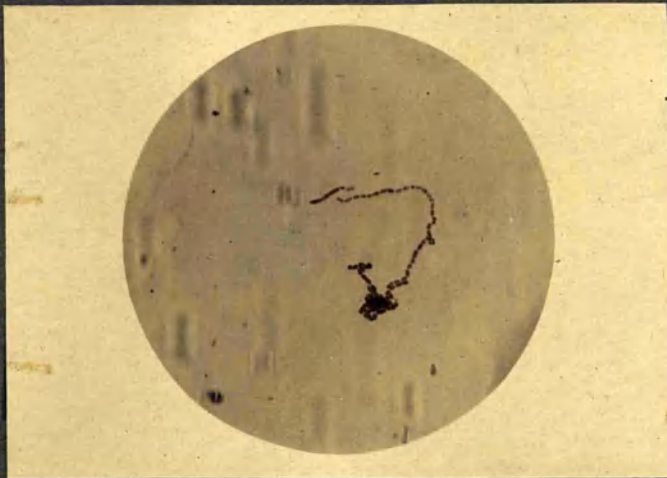


Figure XV.