

Clinical studies on diseases of the eye including those of the conjunctiva, cornea, sclerotic, iris, and ciliary body / by Ferdinand Ritter von Arlt.

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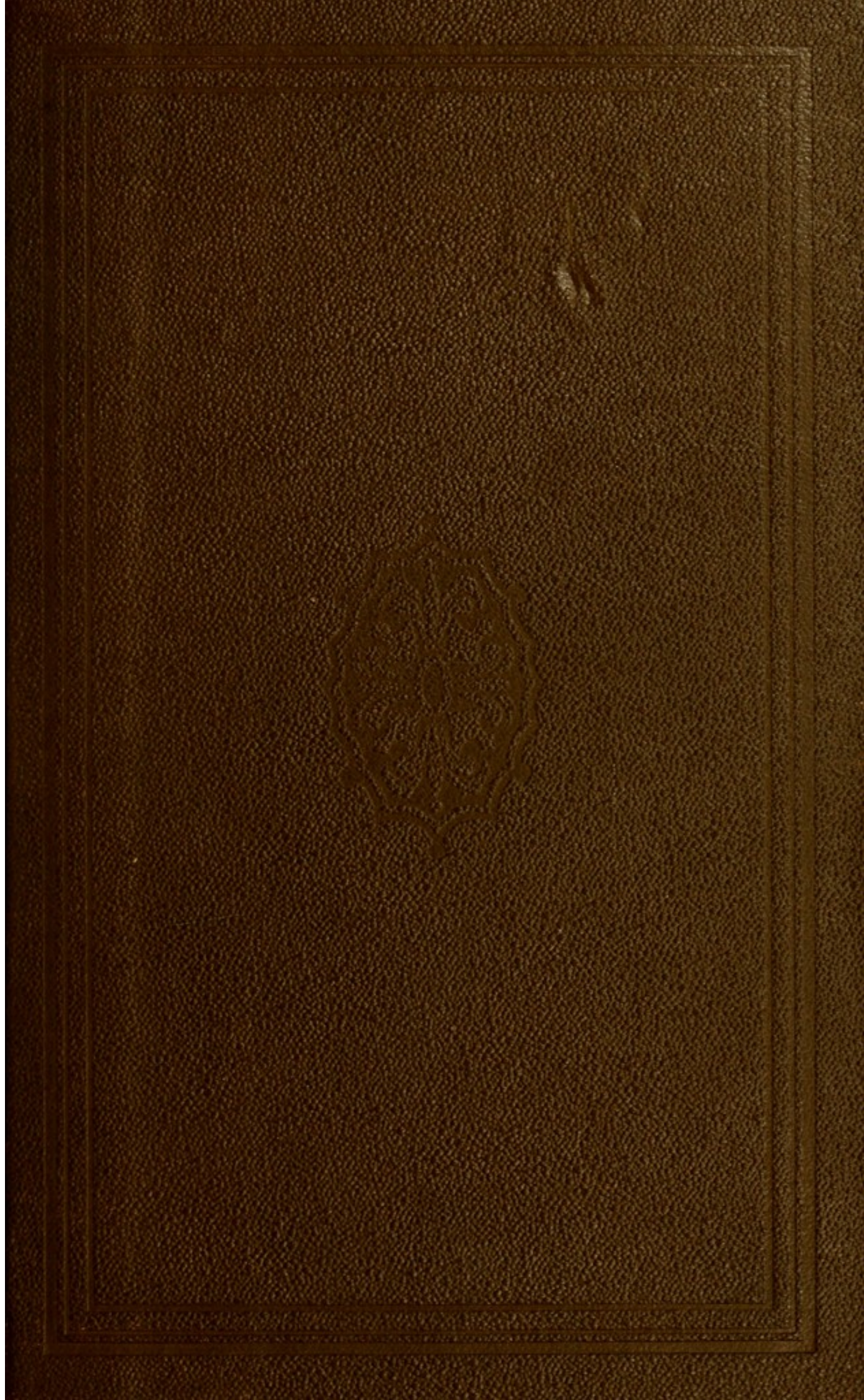
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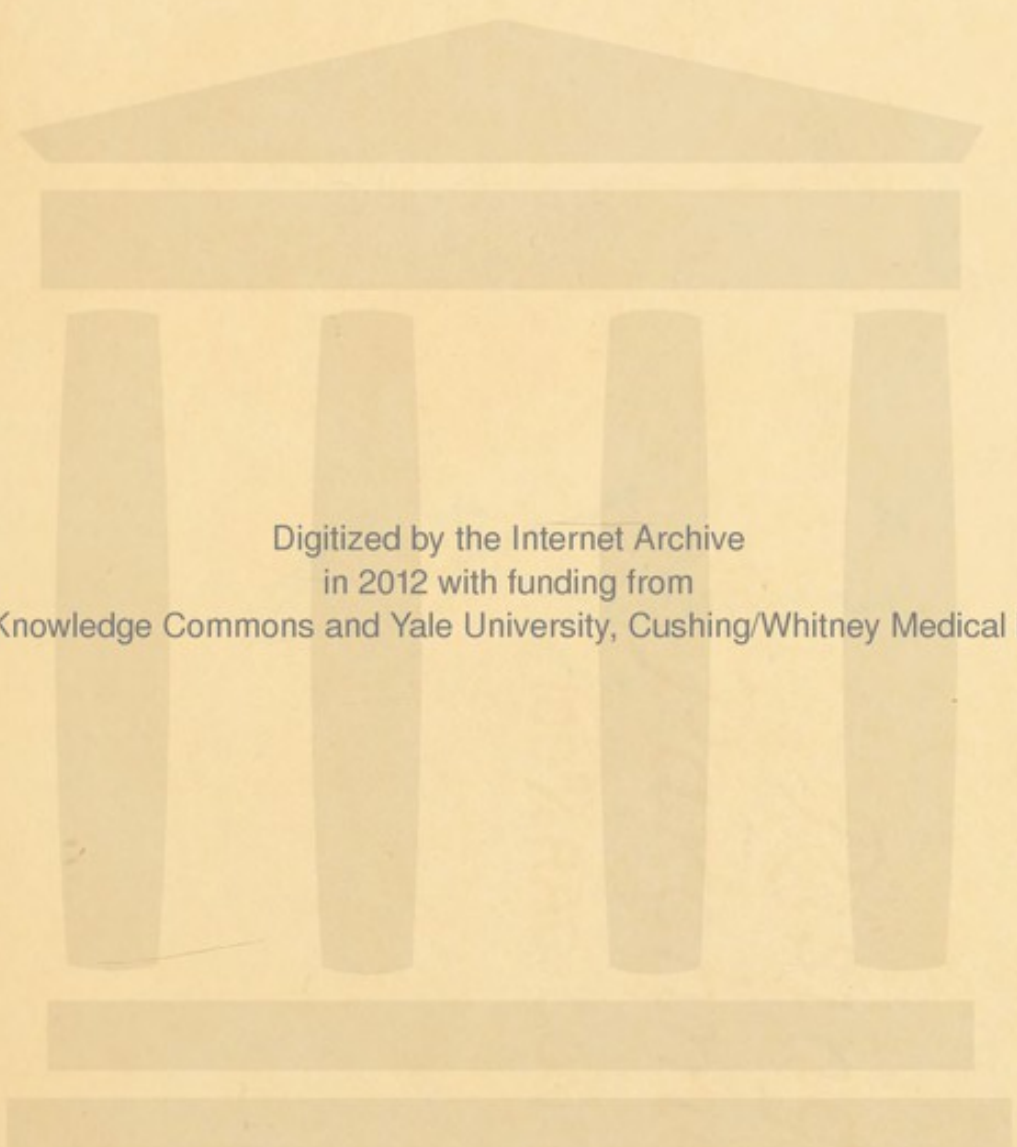
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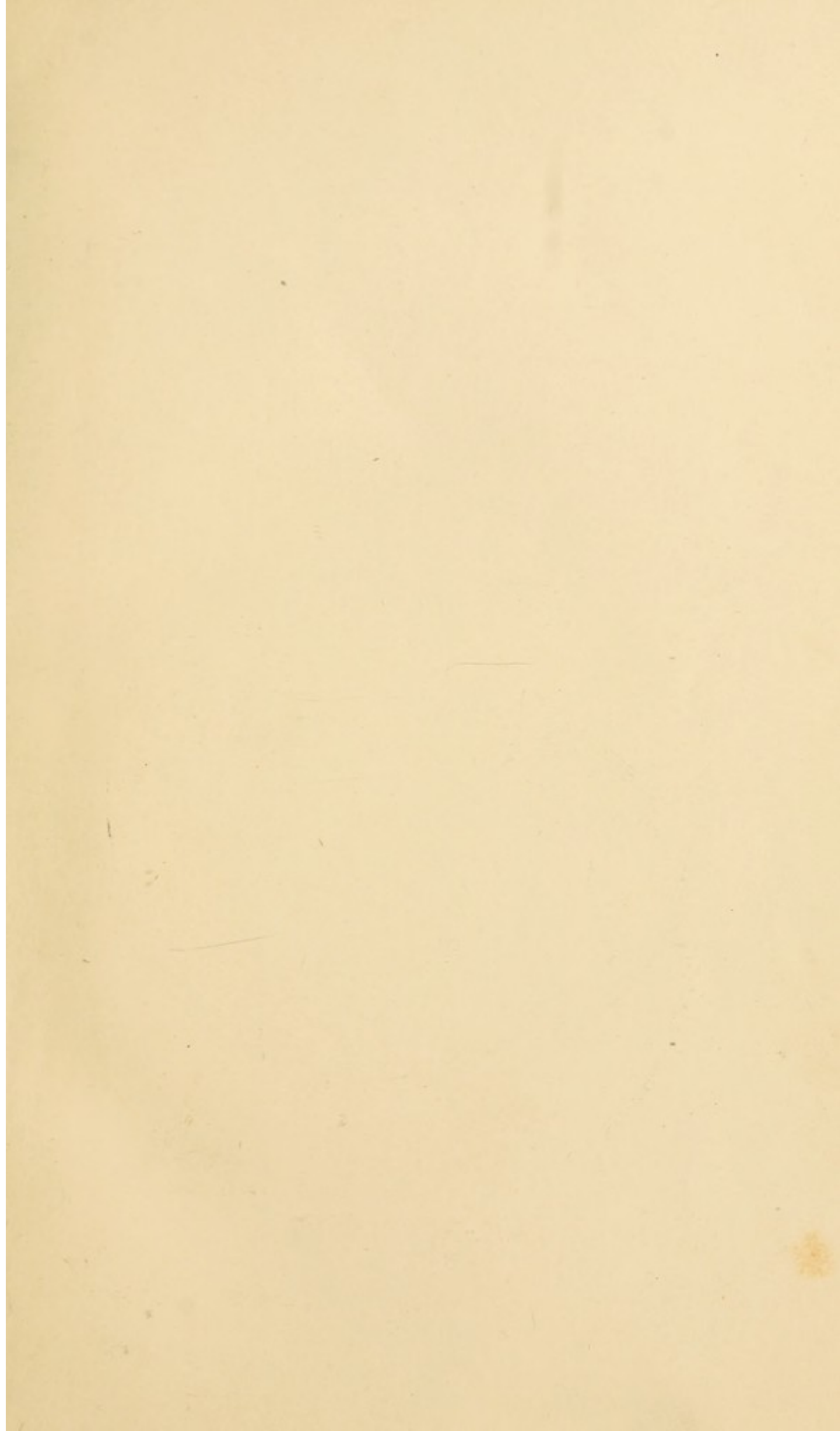


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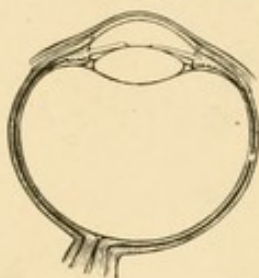


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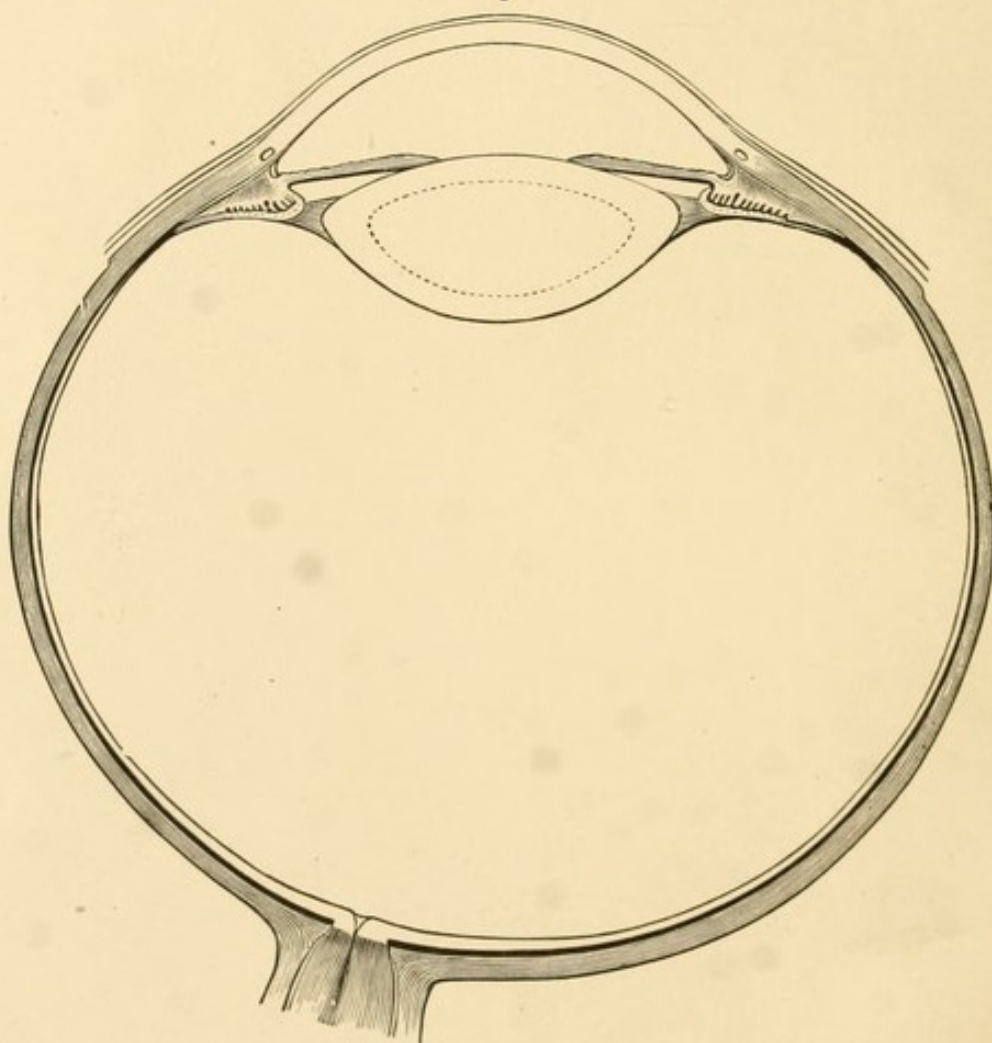
E. A. Lawbaugh



a.



b.



HORIZONTAL SECTION OF HUMAN EYE.

a. NATURAL SIZE.

b. ENLARGED FOUR DIAMETERS.

Von Arlt on "Diseases of the Eye."

CLINICAL STUDIES

ON

DISEASES OF THE EYE

INCLUDING THOSE OF

THE CONJUNCTIVA, CORNEA, SCLEROTIC,
IRIS AND CILIARY BODY.

BY

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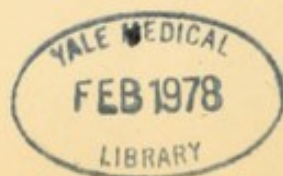
1885.

VIENNA, *January 5th*, 1884.

MY DEAR DOCTOR :—It gives me pleasure to hear, through you, that my “Clinical Studies on Diseases of the Eye” meets with the approbation of my American colleagues, and I thank you for undertaking to translate it into English. It is with great pleasure I give you my permission and wish much success to your work.

PROF. ARLT.

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TRANSLATOR'S PREFACE.

Although within the past few years an unusual number of ophthalmological text-books has been published in the English language, the translator thinks no apology necessary for presenting to the American profession an English version of Prof. Arlt's latest work. Writing in the eve of a long and useful career, the author has embodied in his "Clinical Studies" the very essence of his mature experience, which reaches over almost half a century of ophthalmic practice. A work of this kind is distinct from an ordinary text-book, and is always welcome both to the general practitioner and the specialist. To preserve the distinctive original features of the work, the translator has abstained from interpolating the text, even where his views differed from the author's, but he thought it permissible to mention, in parenthesis (at the proper places), the new local anæsthetic, which has come so rapidly into favor since the German edition was published.

The translator takes pleasure in acknowledging the favor Prof. Arlt has bestowed in permitting him to translate his book. And he also wishes to express sincere and unfeigned thanks to his friend, Dr. F. C. Hotz, to whom he is under great obligations for valuable advice, and the untiring kindness with which he assisted him in this translation.

LYMAN WARE.

Chicago, April 18, 1885.

PREFACE.

In acceding to the wishes of the numerous students whom I have taught since 1846, for a systematic collection of my clinical lectures, I regret that for the present I can offer only a part of them. The continuation of this work depends upon my health and upon the judgment my colleagues will pass upon the present volume.

My object in publishing this work was primarily to give the physicians engaged in general practice a book of reference which they could consult regarding the common and most frequent diseases of the eye; I also hoped that I could induce them to reflect more upon the various morbid processes, and to inquire into their exciting causes. To determine this etiological relation for each individual case is no less important for the practicing physician (on account of prognosis and therapy, and often, too, with reference to questions of sanitary science and forensic medicine) than to find out in which part of the organ the disease is located, what anatomical changes have taken place, and what changes are still likely to occur, according to general principles and our own experience. Such has been the aim in view in the preparation of this book.

DR. ARLT.

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DISEASES OF THE EYE

PART I.

DISEASES OF THE CONJUNCTIVA

A. INFLAMMATIONS.

I. CATARRHAL CONJUNCTIVITIS—CONJUNCTIVITIS CATARRHALIS.

Catarrhal Conjunctivitis, an inflammatory disease of the conjunctiva, is characterized by an abnormal vascularity, a serous infiltration (succulence and tumefaction) of its tissues, an altered secretion, and by more or less pain about the eye.

Symptoms.—The symptomatology may vary considerably, according to the various forms of acute or chronic, primary or secondary (consecutive) catarrh.

1. ACUTE CATARRHAL CONJUNCTIVITIS.

(a) If this affection is limited to the palpebral conjunctiva, from the free borders of the lids to the retrotarsal and semilunar folds, the conjunctiva, in its entire extent and on both lids, exhibits an abnormal redness, varying from a reticular to a uniform injection, a succulence and tumefaction—serous or sanguinolent infiltration of the tissues, especially perceptible in the retrotarsal and semilunar folds—and the secretion changed in quality and quantity, there being flakes or threads of mucus in a transparent fluid. The sensation of pressure under the upper lid, as from a grain of sand, or of burning, aggravated toward evening, about five or six o'clock; the adhesion of the cilia, or of the lids during sleep, by mucus; photophobia, especially from artificial illumination and increased

lachrymation, as well as a slight œdematous swelling of the skin along the border of the lids, are also frequent, though variable symptoms. Besides the conjunctival changes mentioned above, we often find, especially in young persons, the tarsal portion covered with numerous minute granules, like small particles of dust. But such granules, which, according to all appearances are vesicles, are frequently seen also in simple hyperæmia of the tarsal conjunctiva, especially in children who have a bad habit of constantly winking and rubbing the eyes. In closer relation to the catarrhal process is probably the proliferation and accumulation of the lymph cells in clusters, especially in the retrotarsal or orbital portion of the palpebral conjunctiva. These gray globules or granules, as large as poppy seeds and imbedded in the parenchyma, can scarcely be distinguished in some cases from the so-called trachoma granules (see chr. Blennorrhœa). They are oftener found in chronic or protracted acute catarrh. The temporary disturbance of vision and the perception of a colored halo around a flame, occasioned by thin films of mucus on the cornea, are symptoms to which I shall refer later.

(*b*) Whilst in the ordinary acute catarrhal conjunctivitis, which might be called acute blepharo-conjunctivitis, we notice on the ocular conjunctiva either no change at all or only a few blood vessels and a yellowish tinge in the peripheral conjunctival zone (behind the insertion of the recti muscles), in relatively rare cases inflammatory alterations are seen also in the anterior or pericorneal zone. This zone receives its blood, as is well known, not only from the palpebral but also from the anterior ciliary arteries. In these cases, in addition to the symptoms mentioned under (*a*), the ocular conjunctiva shows a coarse network of blood vessels here and there tinged by an ecchymotic network, which, in consequence of the serous infiltration of the conjunctiva, is freely movable, and which is easily distinguished by its bright red color from the denser purplish network of the anterior ciliary arteries, covered by connective tissue—the pericorneal, or more properly, ciliary injection. The more the inflammatory process extends toward the limbus, the more do the anterior ciliary vessels participate in the hyperæmia. The mucous secretion is generally very copious, and the lids, after eversion, are often covered with coherent but not firmly adherent fibrinous coagula,

the removal of which (by means of a moistened pencil) sometimes causes a slight bleeding of the conjunctiva. Such coagula sometimes appear in the form of viscid threads when the lids are drawn from the globe or from one another.

Among the additional symptoms may be specially mentioned an erythema, usually also a slight œdema of the skin up to the orbital border; later the epidermis exfoliates in the form of fine scales. Very often, triangular, light, but not red, spots are seen on the ocular conjunctiva, on one or both sides of the cornea; these are either pingueculæ, which, on account of their denser texture, have not been injected, or superficial ulcers (epithelial abrasions of spots exposed to the air). Epithelial abrasions appear also, especially in elderly individuals, sometimes upon the marginal zone of the cornea, near the limbus, in the form of whitish-gray points or crescent-shaped ulcers. These ulcers show a decided tendency to increase in extent rather than in depth. Only in a few very violent cases do we see a haziness of the cornea, which, after several days, disappears without leaving a trace behind. This form may be suitably designated as catarrhal ophthalmia. It affects both eyes, though not simultaneously (the second one a day or two later), is always of atmospheric origin, and in certain seasons occurs with simple blepharo-conjunctivitis so often that it may very well be designated as an epidemic form.

Another form of catarrhal conjunctivitis (ophthalmia) formerly known as pustular ophthalmia (*ophthalmia catarrhalis pustularis*) is peculiar in this, that, with the symptoms of simple acute catarrhal conjunctivitis, the ocular conjunctiva is only partially implicated. At a point varying in size from a millet to a hemp seed, several millimeters removed from the corneal border, and generally on the temporal side, we see a light grayish spot whose circumference appears densely injected and distinctly swollen, so that it might easily be mistaken for a pustule; but it is easily seen that the epithelium is wanting, and that it is a superficial ulceration. This affection usually disappears entirely, together with the other catarrhal symptoms, in fourteen days at the longest. The author has seen this form only in young persons, between fifteen and thirty years of age, and in several persons it successively reappeared for several years.

In older persons, at or near senility, catarrhal ophthalmia appears now and then in the form of œdema of the ocular conjunctiva. The ocular conjunctiva, yellowish rather than red, and expanded like a bladder, surrounds the cornea like a mound, or is pressed out between the lids, as flabby folds, the redness and tumefaction of the palpebral conjunctiva and the secretion of mucus being comparatively insignificant.

2. CHRONIC CATARRHAL CONJUNCTIVITIS.

This condition, which is often found as the sequela of a preceding acute catarrh, occurs in a variety of forms.

(a) In a series of cases we find a considerable secretion of turbid mucus with a distinctly pronounced redness and swelling of the palpebral conjunctiva. The tarsal conjunctiva appears partly or uniformly reddened, and, after being wiped, velvety or finely granular; only along the convex border of the tarsus, and toward either extremity, it is redder and somewhat thicker, but nowhere provided with isolated, knob-like prominences or deeply imbedded pale granules. The swelling and yellowish-red tinge appear most distinctly in the retrotarsal and semilunar folds, so that the fascia tarso-ocularis and the vessels can be seen but very dimly through them. The vascularity and dirty yellow discoloration extend usually to the peripheral zone of the ocular conjunctiva, and, if the disease increases, even to the limbus corneæ; and under such circumstances a marginal ulcer of the cornea may appear, accompanied by ciliary injection, photophobia, lachrymation and severe pain.

Through the more or less copious mucous secretion, which, by the closure of the lids, is pressed out upon the intermarginal border and the skin, especially at the canthi, the tears are carried over the lubricated openings of the meibomian glands to the epidermis, which is gradually softened and thrown off, while the cutis becomes red and excoriated. (Ophthalmia angularis veterum.) This process, as a rule, causes not only considerable pain (burning, smarting and itching), but also photophobia, blinking, blepharospasm and epiphora; after long duration it results, in some cases, in blepharo-phimosis, especially in elderly persons, in others in ectropium of the lower lid. If the palpebral fissure is spasmodically narrowed or altogether closed, on account

of the photophobia, the skin forms a furrow extending from the outer canthus into the temple. The skin of this furrow is excoriated by the tears, especially when it remains superficially covered with crusts of mucus. In this manner the skin of the upper lid adheres to that of the lower, forming a vertical fold in front of the outer commissure (Blepharo-phimosis). When the lids of a normal eye are separated, a thin band is easily seen at the outer canthus, uniting the tarsal cartilage of the upper lid with that of the lower. In blepharo-phimosis it is exceedingly difficult or quite impossible to perceive this band, since it is hidden by the fold of skin described above.

At the inner canthus, the punctum lachrymale, then, the middle portion of the lower lid may gradually be drawn downwards (ectropium) by the excoriation and subsequent contraction of the integument. This at first slight eversion, which frequently remains unobserved or is not properly appreciated, hinders the cure of the primary disease, as it exposes the palpebral conjunctiva to the contact of the air, which it does not tolerate, retains the tears in contact with the conjunctiva, and leads, especially in older subjects, to complete ectropium of the lower lid.

In chronic cases with increased secretion of mucus a disturbance of vision, transitory dimness, may be produced by threads, or thin layers of mucus on the centre of the cornea; sometimes bubbles of froth are created by the frequent winking of the lids; at other times a white froth accumulates along the inner border of the lid, or at the outer canthus. The perception of a colored halo around an artificial light is evidently caused by the same dioptric impediment, as it is altogether impossible, in such an eye, to discover any change in the corneal epithelium. The difficulty of working by artificial light is due to the radiant heat, which is generally not well borne by eyes affected with catarrh, be it acute or chronic.

(*b*) In a relatively small number of cases belonging to this class, in which neither the hyperæmia nor the mucous secretion is well marked, it is sometimes very difficult to determine whether we have to deal with simple catarrhal conjunctivitis or some other affection. Whilst the patients usually present themselves with such symptoms as redness of the canthi, crusts of mucus about the cilia, etc., in those cases in which the eyes exhibit no striking symptoms we often hear complaints which only the well informed

physician will refer to the conjunctival disease. The patient complains of a burning sensation in the eyes, or of an indefinite pain, or he says he feels pain only in the morning and that his lids are neither glued together nor covered with crusts; but he cannot open them until he has rubbed or moistened them. In other cases he complains that he is not able to use the eyes for any length of time, especially by artificial light; this patient must be examined for asthenopia or presbyopia, which may be present with catarrhal conjunctivitis. Other patients again complain of dimness of sight or a colored halo around the light, and only by searching questions, and after testing the vision, do we arrive at the conclusion that the dimness of sight is caused by froth or threads of mucus, which may be removed either by a few movements of the lids or by rubbing the eyes with the fingers. The probability that there is a catarrhal conjunctivitis increases if we learn from the patient that these symptoms date from a time when he suffered from an affection which caused the lids to adhere together, or that he has noticed from time to time a mucous secretion. But the diagnosis can be definitely settled only by a careful inspection of the palpebral conjunctiva, due attention being given to the age, the general health, the mode of life and occupation of the patient, and to other anomalies of the eye and its appendages.

The hyperæmia of the palpebral conjunctiva may be but little pronounced, if at the time when the patient presents himself it has subsided, or, as in catarrh which is originally chronic, it has never reached a high degree. The vascularity is generally not well marked in pale persons. In patients of a florid complexion the conjunctiva is redder also, at least in the tarsal portion. The same condition is generally found in persons who use the eyes considerably, particularly by artificial light, and remain much in a close, damp room, or an atmosphere vitiated by dust, smoke or ammoniacal vapors. As the tarsal and retrotarsal portions of the conjunctiva are also very transparent, we should be careful not to confound the sub-conjunctival vessels, which always appear purplish, with those of the conjunctiva. The transparency and want of color of the conjunctiva, always less marked in old than in young persons, will be found diminished after a long-continued hyperæmia. After a longer duration of the disease the transparency of the conjunctiva suffers especially by the accumulation

of lymphoid cells in its tissue, or by the infiltration of the coloring matters of the blood. In common with the marked swelling or thickening most likely to be perceived at the retrotarsal or semilunar folds, diminished transparency indicates the existence, or the precedence, at least, of an inflammatory condition. The question then arises, whether the other symptoms support the diagnosis of catarrh. In cases of chronic catarrhal conjunctivitis, with slight vascularity, the secretion of mucus is usually very scant. Sometimes it cannot be perceived at all, or only after the application of a solution of nitrate of silver, when it appears in the form of flakes (albuminate of silver). In some cases, often not until the upper lid is everted, a small, yellowish-gray flake is found on the retrotarsal fold; in others, on the contrary, colorless or light gray threads, which may easily escape the notice of the examiner, if they do not stretch across the cornea. The patients usually deny the agglutination of the lids, but generally admit the existence of yellow crusts at the inner canthus in the morning.

VERNAL CONJUNCTIVITIS.

(c) A still rarer form of conjunctival inflammation, described by Sämisch¹ as **Vernal Catarrh**, results in the accumulation of epithelial cells upon the palpebral and ocular conjunctiva, especially at the limbus, as the researches of Horner² have shown. The disease begins,³ according to the statements of the patients,

¹ Sämisch, "Krankheiten der Conjunctiva," in Gräfe und Sämisch *Handbuch der gesamten Augenheilkunde*, 1876, Bd. IV, s. 25.

² Ulrich Vetsch, "Inaugural-Dissertation Ueber den Frühjahrskatarrh," Zurich, 1879.

³ The first notice concerning this disease, excepting the intimations of Beer and Himley, is to be found in my paper regarding the conjunctiva (*Prager Vierteljahrsschr.* 1846, Bd. IV, s. 73.) "But even without any marked inflammatory symptoms having preceded or existing at the time, the conjunctival border of the cornea (in three cases) was elevated and more or less puffed up, through the infiltration of a grayish-yellow, transparent, jelly-like mass. I could not place this disease among any of the known types, although it was clear to me in the second case that in its character it was closely related to scrofulous conjunctivitis. I saw both cases only accidentally. The attending physicians diagnosticated pterygia, and sent them to me for operations. Applications of sulphate of copper or wine of opium were sufficient to cause the reabsorption of these exudations. In the third case, in addition to such a partial infiltration of the conjunctival border of the cornea, there was an eruption of pustules with vascularity. The youngest of the patients was ten, the

either in spring or in summer, with the symptoms of catarrhal conjunctivitis; after weeks or months the symptoms subside with the approach of the cool season, but only to return more severely the next season. The characteristic changes of the conjunctiva become manifest only after several weeks' duration, or possibly after repeated relapses of the slow inflammatory process. A smooth, firm, gray or light yellow elevation appears in the limbus of the ocular conjunctiva; it is situated either on the temporal or the nasal side, or on both sides simultaneously, of the limbus, or extends along the corneal border. While these firmly adherent glandular formations or pimples occupy a greater or less extent of the corneal border, they diminish the transparent area of the cornea, from which they are sharply divided, while toward the sclerotic their boundaries are not so well defined. In well-marked cases the transparency of the ocular conjunctiva is materially lessened, especially on the temporal and nasal sides; and even aside from the periods of exacerbation, the conjunctiva is covered by enlarged blood vessels; the glandular elevations are also often crossed by small vessels.

The palpebral conjunctiva presents, in the stage of recrudescence, the symptoms of catarrhal conjunctivitis; later also the retrotarsal (orbital) portion remains turbid and grayish-yellow, or yellowish-red, and often contains mucous flakes, even when there are no longer manifest signs of mucous secretions. The changes in the tarsal portion do not present a peculiar and characteristic appearance until after a longer or shorter duration of the disease. The conjunctiva of the upper as well as of the lower lid becomes cloudy, and the original redness and looseness of the tissues gives place to a certain paleness and firmness. When the so-called papillæ are markedly enlarged they do not appear spherical, but are more or less flattened and crowded together like paving stones. In some cases we find on the conjunctiva of the upper lid isolated papillæ rise like mushrooms over their surroundings. At the same time the tarsal conjunctiva

oldest sixteen years of age. In my "Handbuch" (1851) I referred (page 102) to this form as a rare variety of conjunctivitis. The peculiar condition of the palpebral conjunctiva, as well as the appearance and exacerbation of the disease during the warmer months, had escaped my notice. The observations of Desmarres and A. von Gräfe, cited in the dissertation of Vetsch, refer only to the affection of the limbus. Horner was the first to give a complete description of this disease.

of the lower as well as of the upper lid appears as though coated with a thin layer of milk, as Vetsch strikingly described it. "These changes of the palpebral conjunctiva, particularly the peculiar shade of color, are so characteristic and constant (absent only four times in thirty-seven cases) that in five cases the diagnosis of spring catarrh could be made without there being any alterations of the limbus and of the ocular conjunctiva, provided the typical subjective symptoms and the well pronounced changes of the palpebral conjunctiva were present. All these changes are present in both eyes; still a difference may exist in the intensity and extent of the disease.

"A further characteristic symptom of *vernal conjunctivitis* is its course and its typical recurrence in the spring and early summer months. During the spring months the alterations above described in the ocular and in the palpebral conjunctiva appear, with photophobia, smarting and burning. These continue during the summer and disappear with the commencement of winter. In other cases, they remain, though in a more chronic condition, through the winter. Only one case is reported in which the disease appeared most severe during the winter and spring. A similar case has been observed by the author.

"If the disease has relapsed several times it may heal without leaving any traces. In other cases a long duration of the process (eight to ten years) has been observed, with a final recovery; in still rarer cases the changes are permanent, a persistent enlargement of the limbus, an opacity of the cornea, similar to the arcus senilis." Malformations of the tarsus have not been observed by Vetsch or by other writers. In one of the author's cases, cured after a duration of several years, a peculiar discoloration of the quite smooth tarsal conjunctiva of the upper lid was the only trace left by the disease.

This peculiar affection was observed almost exclusively in childhood and youth. One case has been observed in Zürich, in a child one year old, and one in a patient thirty-seven years of age. Whether or not peculiar constitutions are especially predisposed to it remains to be determined by future observations. The microscopical examinations instituted here fully confirm the results observed at Zürich, which are fully stated in Vetsch's Dissertation; great masses of epithelial proliferations, a granular

surface of the stroma, which shows a slight and varying infiltration with round cells, and abundant proliferation of connective tissue, and in the granulations of the limbus numerous vessels at the time of exacerbation; otherwise, and especially in the tarsal conjunctiva, diminution of the vascularity. The epithelial proliferation is probably the primary change.

The classification of this form with the catarrhal diseases of the conjunctiva seems justified not only by usage but also in part by its clinical course. Strictly speaking, according to its anatomical condition it must be described as a disease *sui generis*. In regard to the prognosis the anatomical points have already been stated.

As regards the treatment, after the irritation has subsided, the following ointments are best tolerated and give the best results:—

	Hyd. Ammon.....	0,20 – 0,30
	¹ Ungt. simpl.....	5 – 0
Or—		
	Cupri. Sulph.....	0,15 – 0,20
	Ung. glycerini c. amylo.....	5 – 0

Etiology.—Catarrhal conjunctivitis occurs, as a primary disease, in individuals of all ages, in consequence of noxious atmospherical influences. Several cases of catarrh sometimes occur in one place, in one dwelling, or in one family, either simultaneously or successively, which can neither be traced to a local or individual cause, nor to infection from one person to another; many persons are afflicted under very different circumstances (epidemic). Sporadic cases are commonly attributed to colds, especially to the sudden cooling of the overheated body by draughts, or by a cold wind after a prolonged stay in a hot atmosphere vitiated by smoke, evaporations, etc. In a series of cases catarrhal conjunctivitis is concomitant, or simultaneous with inflammatory diseases of the respiratory organs, as nasal or bronchial catarrh, measles, scarlet fever, etc. Special mention should be made of the catarrhal symptoms which often precede the outbreak of scrofulous conjunctivitis, but more frequently, at a later period, appear and continue as a complication. Redness and swelling (tumefaction) of the palpebral conjunctiva, accom-

¹ Ungt. Petrolii alb. may be advantageously substituted for the ungt. simpl., in formulæ given, throughout the work.—Tr.

panied by a copious secretion of mucus, attain, in many such cases, so high a degree that one may be easily induced to consider it a blennorrhœal affection. The catarrh which is observed in some cases in corneal ulceration may also be designated as concomitant. As a consecutive condition we find catarrhal conjunctivitis—mostly chronic in connection with disturbances of the tear passages, with inflammation of the tarsal glands, both those enclosed in the tarsus and those about the roots of the cilia, with chalazia, with calcareous concretions in the meibomian glands, with foreign bodies in the conjunctival sac, and with imperfect adaptation of the lids to the globe. A rare but very noteworthy cause is the formation on the intermarginal border of papillomata, varying in size from a millet to a hemp seed, which are hemispherical, light gray, dense and hard, and full of fissures. Until these growths are extirpated a permanent cure cannot be expected.

Among the injurious influences which, if not inducing catarrhal conjunctivitis, aggravate, or in chronic cases maintain it, may be mentioned impure air, from living in overcrowded, smoky, dusty, damp rooms; then radiant heat (working by the fire, by artificial light, at the grate, etc.,) night watching, excessive use of spirituous drinks, especially distilled liquors. As soon as the inflammatory irritation, lachrymation and pain of the first days of the acute attack is over, eyes affected with catarrh feel most comfortable in the pure open air.

Prognosis.—Primary acute catarrhal conjunctivitis usually terminates in complete recovery, with or without medical aid, after one or two weeks, in case the return to the normal condition is not disturbed by a repetition or continuation of the noxious influences, or by irrational treatment. Abrasions of the epithelium, especially at the corneal border, render the process somewhat more painful and obstinate; only deep crescentic ulcerations, encircling more than one-third of the circumference of the cornea, can produce a change of curvature. Cases with ulcerations surrounding the entire cornea, as the author has seen only in old people, are of exceedingly rare occurrence. If iritis or keratitis supervenes without ulceration of the cornea, it is almost always caused by injudicious conduct, the irrational use of collyria, or by cold fomentations, as the application of raw meat, etc.

When a simple primary catarrh has existed for weeks, the condition of the conjunctiva, which may be described as a relaxation, demands the application of some astringent for several weeks, and the prognosis regarding the duration of the disease then depends principally upon the occupation and habits of the patient, and his moral ability to avoid the causes to which the origin or protraction of the disease must be ascribed.

In secondary catarrhal conjunctivitis we must take into account not only the above causes, but also the curability of the primary disease. We should not, however, overlook the fact that in some cases the catarrh caused by noxious atmospherical influences, will be maintained by the above mentioned abnormal conditions, even with judicious conduct on the part of the patient; whilst in other cases these are the only, or at least chief, causes of the conjunctival disease.

Treatment.—Care should be taken, in the first place, that the patient does not expose himself to noxious influences which increase or maintain the catarrh; and, in secondary cases, the inducing cause is to be removed as far as practicable.

The direct treatment must be adapted to the local condition, and varies, according to whether the conjunctiva be found in a state of irritation and active hyperæmia, or in a state of relaxation. The first condition usually continues only for a few days, and is manifested by increased redness, lachrymation, photophobia and pain.

In this stage it is advisable to abstain from all local remedies, with the exception of nitrate of silver. The desire to cool the eyes should be satisfied by frequent washings with moderately cool water, rather than by the application of cold compresses. After the injudicious application of cold compresses, the use of raw meat, green leaves, and the like, the secretion is sometimes diminished or arrested, but in its place symptoms of keratitis or iritis appear, and, in cases of bilateral conjunctivitis, only in the eye which has been thus maltreated.

Water of the temperature of the room is best adapted for washing the eyes; it is not necessary to warm it.

If an œdematous swelling of the skin, and particularly of the ocular conjunctiva, as is especially observable in old persons, with a relatively slight conjunctival vascularity, is a prominent

symptom, light dry compresses, suspended from the forehead over the eye, usually prove beneficial during the first stage of the disease. When the photophobia, lachrymation and pain are so severe that there is a constant desire to keep the eyes closed, as is especially the case when the ocular conjunctiva is implicated, a solution of atropia (atropiæ sulph. 0,04, aquæ dest. 4,00) may be instilled (or a 2 to 4 per cent. solution of mur. of cocaine—Tr.); but the same end, diminution of the sensitiveness to light, will generally be better attained by the following ointment:—

	Ext. Bellad.....	0,40—0,60
	Ungt. Cinerei.....	5,00
Or—		
	Ungt. Simp.....	5,00
	Præcip. albi.....	0,30—0,50

a quantity as large as a bean, to be rubbed into the temple and forehead every two or three hours, and a simple paper shield to be worn over it. A solution of nitrate of silver, varying in strength from one to two per cent., is unquestionably the best remedy in all acute, as well as in many chronic, cases of catarrhal conjunctivitis; applied—not as a collyrium, as was formerly the custom—but according to the excellent method of A. Von Gräfe, by means of a camel's hair pencil upon the palpebral conjunctiva.

The more pronounced the hyperæmia, and with it the mucous secretion of the conjunctiva, the more boldly may the application be made. Abrasions in the ocular conjunctiva, or the cornea, do not forbid the application, if it be limited to the palpebral conjunctiva. The lids should be everted, either singly or together. The eversion of the upper lid can most easily be accomplished in the following manner: to evert the right upper lid, place the four fingers of the left hand upon the head in the region of the great fontanelle, the thumb upon the upper lid, its tip resting upon the temporal third of the convex border of the tarsus. The patient is now directed to look downwards, and somewhat towards the chest of the operator, whilst the latter draws the skin of the lid upwards towards the orbital border, and seizing the now horizontally placed cilia in the middle of the lid with the thumb and forefinger of the other hand, which rests upon the nose, in order to draw them horizontally from the globe. As soon as this is done the thumb of the left hand is pressed slightly downwards,

whilst the middle of the free border of the lid is turned upwards and placed upon the orbital border (the eyebrow). When it is desired to keep the lids everted for any length of time the patient is directed either to look steadily downwards or to keep both eyes closed. In the latter case the cornea will be completely covered by the everted upper lid. Complete eversion of the lower lid may be difficult if the eyes are deeply set ; it is accomplished by gently pressing the upper lid upon the globe, and with the fore or middle finger of the other hand (or both together) on the skin over the convex border of the tarsus, push this portion of the skin slightly downwards and then immediately backwards into the orbit, as it were, at the same time making slight traction towards the temple ; such traction is also necessary if we desire to maintain the eversion of either the lower or upper lid, or both together, for any length of time. The eversion of the lower lid is more easily effected and maintained if the upper lid has previously been everted and so held. In infants, whose eyes are more prominent, the upper lid must be everted in the same manner as that just described for the lower lid, because the free border or the cilia cannot be seized with the fingers.

The supposition is rational and approved by experience, that the portion first affected, the palpebral conjunctiva, should be treated uniformly and as far as possible in its entire extent, whilst, on the contrary, the ocular conjunctiva and cornea should not be touched. It is not necessary after the application to wash the conjunctiva with diluted milk or with a solution of chloride of sodium ; washing with pure water suffices for the removal of the turbid fluid and coagulated mucus. When severe pain is complained of it may be alleviated by prolonged washing with water, or by the application of cold compresses. The elimination of the eschar is generally followed by an agreeable sensation, which usually disappears after several hours. It is usually sufficient to renew the application once in twenty-four hours ; still we should not fail to carefully examine the conjunctiva before each application, to ascertain its exact condition, and make sure that no eschar or raw points, bleeding easily upon eversion or slight touch, exist. The touching of such places would cause deeper cauterization and aggravate the disease.

If the patient cannot repeatedly visit the physician, or if he

objects to the applications in acute cases after several days' duration of the disease, the use of sulphate of zinc¹ or of corrosive sublimate² (aq. Conradi) is allowable, unless corneal ulcerations contraindicate the contact with these remedies.

The borders of the lids and the cilia are moistened with one of these lotions, by means of a camel's-hair pencil, a small ball of charpie or the fingers, so that in opening the eyes some of the medicine enters the palpebral fissure and is diffused over the conjunctiva. A solution of silver applied in this manner would be decomposed before it could reach the retrotarsal portion of the conjunctiva. As in most cases an evening exacerbation takes place, and as the irritation caused by treatment continues for some time, it is advisable to make the application in the morning and at noon. The more irritating astringent collyria are employed with advantage only when the disease has lasted for several weeks. For example:—

³ Lapid. Divini.....	0,60
Tinct. Opii Simpl.....	3,25
Aq. Destil.....	100,0

Or—

⁴ Collyr. Astr. Lutei,	
Aq. Destil.....āā.....	50,00

Ointments are necessary in many chronic cases. The neglected primary catarrhs with diminished redness and scarcely noticeable mucous secretion which come under treatment on account of a smarting sensation in working, or on account of an annoying dryness on awaking, require, with the use of collyria (the best

¹ Sulph. Zinci	0,10 to 0,20
Aq. Dest.....	100,0
Tinct. Opii.....	0,5

Or—

² Sublim. Corros.....	0,03
Tinct. Opii.....	0,5
Aq. Dest.....	100,0

³ Lapis divinis St. Yvesii; cupri sulph. Potass. nit., Aluminio āā 35,00; melt together, adding at the end Camphora 2,20; Beer's preparations contain the acetate instead of the sulphate of copper.

⁴ Collyr. adstr. luteum (Aqua Horsti); Salis ammon., 1,10; Sulph. zinci, 2,20; Solutis in aq. dest., comm., 175,00; adde Camphoræ in 35,00 alcoholis gravitatis specif., 3,850 solutæ 0,65 croci austr. 0,15. Mixta deger. in calore Reaum. 30°–35° ad perfectam croci extract, Refriger. filtra et exhibe usui.

of which is collyr. adstr. luteum, as given above) the application to the borders of the lids, before going to bed, of a salve consisting of

Præcipitat. albi.....	0,15 to 0,20
Ungt. simp.....	5,00

Or, instead of the latter—

Ung. anglic. albi.....	5,00
(Ung. emolliens sine odore.)	

The eyes should not be opened for several hours. Then there are secondary or consecutive chronic forms of catarrh induced or maintained by affections of the glands of the lids, which can scarcely be thoroughly cured without mercurial ointments. The details of their use will be given in the chapter on the diseases of the lids. Usually the ointment of

Præcipitat. albi.....	0,15 to 0,20
Ung. simp.....	5,00

produces a milder effect than Pagenstecher's.

Hyd. oxidi fla.....	0,15 to 0,20
Ung. simp.....	5,00

In cases of chronic catarrh, with intense redness of the palpebral conjunctiva and copious mucous secretion, touching the lids with a solution of nitrate of silver must be continued for some time. For patients living at a distance, the application of the following formula gives very favorable results:—

Hyd. oxyd. fla.....	0,15 to 0,30
Lapid. divini.....	0,30 to 0,60
Tinct. opii. liq. syd	5,10
Ungt. simp.....	5,00

In cases of extensive excoriations they should be touched with a one or two per cent. solution of nitrate of silver, after the crusts of mucus or epidermis have been softened by the ung. emolliens or ung. præcip. albi, applied at bedtime, and removed in the morning with tepid water. When, in consequence of this condition, the lower lid and the punctum lachrymale no longer adapt themselves to the globe, and the above treatment does not soon improve the condition, it may be necessary to bandage the eyes alternately for several days, or even to slit and keep open the lower canaliculus. Blepharo-phimosis or true ectropium will demand a special operation. The treatment of corneal ulcerations will be considered under diseases of the cornea.

II. CROUPOUS CONJUNCTIVITIS—CONJUNCTIVITIS CRUPOSA.

Croupous Conjunctivitis occurs only as an acute process, though, in exceptional cases, it may be much protracted by the persistence of the croupous membrane. It begins with the symptoms of a catarrhal blepharo-conjunctivitis, from which it differs as early as the second or third day, seldom later, by a more intense redness and swelling of the retrotarsal fold, with relatively slight redness and swelling of the tarsal portion, but principally by the appearance upon the tarsal conjunctiva or upon the retrotarsal portion, or upon both simultaneously, of an adherent light gray membrane, more or less thick (fibrinous coagulation), which cannot be easily removed, if at all. This affection may consequently be aptly described as catarrhal conjunctivitis with the formation of a membrane upon the surface during the acme of inflammation. Cases in which this membrane extends over the ocular conjunctiva are relatively rare.

Symptoms.—(a) The clinical appearance of the disease, at first like that of catarrhal conjunctivitis, soon acquires great similarity to that of an acute conjunctival blennorrhœa. The inflammatory œdema of the skin is often increased to such a degree that it extends beyond the orbital border, obliterating the furrow of the skin of the upper lid and crowding this downwards over the lower lid. There is a profuse secretion of mucus in the palpebral fissure and on the cilia. The lids, however, remain soft and flexible, and can easily be everted. The tarsal conjunctiva may appear redder, but it is only slightly if at all swollen or coated with a croupous membrane. If attempts be made to remove this membrane, the denuded conjunctiva bleeds. Besides this membrane the bluish-red, or cherry-red, discoloration of the enormously swollen retrotarsal or orbital portion is particularly striking.

Upon eversion of the upper lid the retrotarsal portion often protrudes so much that the diameter of the protrusion may be compared to that of a goose quill, or even of the little finger. The ocular conjunctiva may sympathize merely in its peripheral zone, but in very severe cases it may be deeply injected and infiltrated with serum up to the cornea. In the latter case, which is certainly very rare, keratitis with partial ulceration may supervene. The membranous coagula are gradually thrown off in the

form of mucous flakes, and are not formed again. Swelling and hyperæmia diminish with a somewhat more copious secretion of mucus, and the conjunctiva returns, in three or four weeks, to its normal condition, without any injury of its tissues; only, in the rare cases above mentioned, in which the ocular conjunctiva is also covered with a croupous membrane, its elimination may be followed by symblepharon.

(b) Ed. Charles Hulme¹ gives the history of three cases occurring in infants a few weeks old, which were afflicted in both eyes with a conjunctivitis that deposited a thick fibrinous membrane upon the palpebral conjunctiva. The exudations adhered so firmly to the mucous membrane that their removal was followed by bleeding and rapid reproduction. The secretion of the greatly swollen and very painful lids was watery, with a slight admixture of pus. The ocular conjunctiva and the cornea were usually not implicated. The affection lasted several months and withstood all local treatment. The author has only incompletely observed one similar case: A child, two months old, apparently healthy in other respects, was brought to the clinic on the 5th of July, 1880. Both eyes were closed, the lids scarcely swollen, and slightly reddened. After removing some mucus and separating the lids a light gray, opaque membrane was seen, which covered, and was firmly adherent to, the inner surface of both lids, and extended continuously over the globe, with which it appeared to be adherent. It formed a sac, or pocket, bulging forward. The ocular inflammation appeared when the infant was three weeks old, was pronounced diphtheria, and treated with a solution of nitrate of silver by the attending physician. The white membrane made its appearance during the last two weeks. An attempt to detach the membrane was not successful. I ordered ung. ciner., with extract of belladonna, to be applied to the forehead, and warm compresses several times daily, fifteen to twenty-five minutes at a time. After several days the bottom of the sac was ruptured by the forcible separation of the lids, and after washing away a thin, turbid liquid, the intact cornea and the ocular conjunctiva, which was somewhat vascular in its periphery, were seen. Gradually the infant opened its eyes voluntarily. This

¹ Zehender, *Klin. Monatsbl.*, 1864, page 44. (*Med. Times and Gazette*, 31 October, 1863). V. Arlt, *Krankheiten des Auges*.

membranous coating of the conjunctiva extended to the retro-tarsal portion ; its thickness might be estimated at 2 mm. The mother could only come at long intervals. At the beginning of the summer vacation the condition was nearly the same ; so, also, early in October. It subsequently died, of inflammation of the lungs, in the latter part of October. The shreds of membrane, which could be torn off with the forceps after its separation from the globe, showed a well marked lamellated structure, consisting of layers of coagulated fibrin, between which small round cells (leucocytes) were imbedded, either in single or in several layers. With these there were also found isolated, swollen, scarcely recognizable pus corpuscles. Numerous small dark dots were seen in the cells, which, perhaps, might have proved to be micrococci, had the membrane been examined in a fresh state, instead of having been preserved for several months.

Etiology.—This disease was observed by the author in children between one and six years of age. It must be considered as a relatively rare affection. Its occurrence in both eyes, either simultaneously, or in one shortly after the other, renders it probable that it is caused, as is catarrhal conjunctivitis, by noxious atmospheric influences. Infection is no more probable in the one case than in the other.

The *prognosis* is (in "a") generally favorable as regards both the termination and duration. The relatively rare implication of the cornea seems to be due to negligence and improper treatment rather than to the severity of the process.

The treatment differs from that of catarrhal conjunctivitis only in this, that so long as the formation of the membrane continues, no application should be made to the conjunctiva. In this stage the author has always limited the treatment to ungt. hydrarg. 5,0; ext. bellad. 0,30 to 0,50; rubbed on the forehead and temple, and to diligently cleansing the eyes with lukewarm water. Cold compresses are serviceable when the lids feel warm. The firm gluing together of the lids, and the collection of mucus and tears in the conjunctival sac during sleep, may be diminished by the application of a linen rag, well oiled or spread with ungt. emolliens. The stage of resolution, as in catarrh, may be perhaps somewhat shortened by the application of nitrate of silver.

III. BLENNORRHEAL CONJUNCTIVITIS.

By **Blennorrhæal Conjunctivitis** is meant an inflammatory process of the palpebral conjunctiva which is manifested not only by hyperæmia and swelling, but also by a fibro-plastic infiltration of its tissues, not tending to purulent resolution, and by a muco-purulent secretion which, if transmitted to another eye, is capable of causing the same inflammatory process. Cases belonging to this category are distinguished from those of catarrh and croup by the occurrence of plastic exudation in the parenchyma, and from diphtheria by the fact that the infiltration does not tend to purulent resolution (phthisis), but to simple reabsorption or, after a longer or shorter duration, to gradual shrinkage (atrophy) of the tissues. The process begins with symptoms of catarrh, affecting the palpebral conjunctiva of the upper and lower lids; it may be confined to the lids or extend to the ocular conjunctiva. The contagion is specifically different from that of diphtheria.

Under this head must be classified cases which present very different appearances and run different courses, unless we wish to separate what nosologically belongs together, to lose ourselves in a perplexing labyrinth of divisions. The division into *acute* and *chronic* is sufficient for the purpose of diagnosis, prognosis, and therapeutics. The expression, *acute*, here indicates the rapid, simultaneous and successive appearance of hyperæmia, swelling, infiltration and secretion, but refers only to the first days of the disease. It should therefore be emphasized that an acute case may become chronic, and that a chronic case may later become acute. This depends mostly upon the primary cause (quality of the virus), but often also upon exterior influences, especially atmospherical. The individual condition of the patient and that of the conjunctiva particularly plays only a secondary role, if any, in the causation and the course. A special disposition cannot be proved.

I. ACUTE BLENNORRHEAL CONJUNCTIVITIS.

(a) *Blepharo-ophthalmo-blennorrhæa*.—*Symptoms*.—During the first, and perhaps even on the second, day of the disease the physician cannot determine by the appearances alone whether

the case is one of catarrhal or incipient blennorrhœal conjunctivitis. Only the rapid aggravation of the symptoms, or the anamnesis, can make us suspect, if not positively assume, that it is blennorrhœa. But undoubted symptoms of blennorrhœa may exist even on the first day; indeed, the disease may attain its highest grade, the so-called third grade, in thirty-six hours.

A certain correlation exists between the anatomical alterations and the secretion, particularly during the increase of the disease; on which account the different phases of development described by Beer are usually designated, after C. F. Gräfe, as hydrorrhœa (1st grade), blennorrhœa (2d grade) and pyorrhœa (3d grade). So long as a clear, watery secretion, with isolated flakes of mucus; is produced, accompanied by lachrymation, photophobia, smarting or burning pain, the conjunctiva shows no other changes than those of acute catarrhal conjunctivitis, though perhaps an increased vascularity and a serous infiltration of the peripheral zone of the ocular conjunctiva indicate an advancement of the inflammation, which in a short time extends to the anterior zone and there causes a chemosis. The swelling of the skin along the border of the lid need not be greater than in severe cases of catarrhal conjunctivitis.

The increase of the inflammation in the conjunctiva by the appearance of an inflammatory œdema of the lids, which extends from its free edge to the orbital border, and finally results in the obliteration of the furrow of the upper lid, has already been referred to. The inflammatory œdema of the ocular conjunctiva also increases, though it does not yet extend to the corneal border; and parallel with this are increase and change of the secretion. The more copious grayish-yellow flakes float no longer in a clear, watery fluid, but in a turbid, whey-like liquid, and when we separate or evert the lids we often see viscid threads extend from one lid to the other, or to the globe; or we find the palpebral conjunctiva covered with a tenacious, semi-transparent fibrinous layer, and bleeding easily when the film is removed. The intense redness of the tarsal portion, which may be temporarily abolished by the separation or eversion of the lids, as well as the finely granular appearance of its surface, cannot be distinctly seen until the fibrinous coagulation, the mucus and the tears are carefully wiped off; but it also happens that, in conse-

quence of the uniform swelling, this part of the conjunctiva appears almost smooth. Puffiness and redness of the retrotarsal portion, uniform or specked with ecchymoses, are never absent in this stage of development. Sensitive patients have symptoms of fever. In some cases, at this time or a little later, a distinct swelling of the lymph glands in front of the ear appears, which at first causes pain, but which entirely disappears after some days. Such glands may, however, sometimes suppurate.

Finally, the inflammatory œdematous swelling of the lid attains such dimensions, even extending beyond the orbital border, that the skin becomes shiny, the upper lid is crowded over the under, and every active movement of the lids is impossible. The separation of the lids, the drawing down of the lower or the eversion of the upper lid is very difficult; the latter sometimes impossible. The redness of the palpebral conjunctiva appears more or less subdued by a gray infiltration and, in severe cases, by an exudation on the free surface, which covers it like a membrane, and is finally shed off and eliminated as a muco-purulent mass. The infiltration of the conjunctival parenchyma is so considerable, in severe cases, that the inner surface of the lid presents a gray and red punctated appearance; the lids are then hard, hot and tender to the touch. The ocular conjunctiva is infiltrated with a sanguinolent serum up to the corneal border, and in the most severe cases this infiltration is even fibrinous, thus forming a more or less dark-red, flaccid, smooth intumescence protruding from between the lids, or a firm, dense, grayish or speckled red mound about the cornea (chemosis). At the same time the always copious secretion may be purulent, thick and creamy, or thin and sanious, and mixed with denser flakes. Most patients, now tortured by pain and fear, show distinct symptoms of fever.

This condition usually continues for two or three days. A slight wrinkling of the skin is the first sign of *retrocession*. Whilst the copious muco-purulent secretion continues and the tension diminishes the circulation in the conjunctiva seems to become freer. The formation of plastic coagula upon the surface ceases, the conjunctiva, previously more or less gray and infiltrated, becomes softer and redder, the chemosis gradually subsides, and the conjunctiva recovers its normal condition, usually within

three to five weeks, provided neither corneal ulceration, nor ectropium of one or both lids, delay the recovery.

The blennorrhœa of this degree, which is aptly designated as ophthalmo-blennorrhœa, becomes dangerous to the eye by consecutive suppurative keratitis. The first symptoms of this ominous course are usually observed when the tumefaction of the lid begins to subside and the skin commences to become wrinkled. Usually a slight haziness is first seen either in the central portion or along the upper or lower border; in order to see the extent of injury to the cornea it is often necessary to lift up the conjunctival mound which overlaps the corneal border by means of a Daviel's spoon. In some cases the first examination discloses a superficial ulcer, which appears quite clear after the pus upon it is washed off. Suppurative ulcers always show a strong tendency to increase both in circumference and in depth. The deepening of the ulcer is the less dangerous accident, and the early rupture of Descemet's membrane may even be considered as relatively favorable provided a considerable portion of the cornea remains uninjured, because often then the uninjured portion of the cornea will escape the disintegration of its tissues. The turbidity of the cornea, especially at its centre, may become completely opaque before any evidence of exfoliation of the superficial layers is observable. Corneal ulcers appearing later, after the tumefaction has disappeared and the conjunctiva has again become soft and vascular, and is no longer gray from infiltration, and ulcers which have become clean, can usually be checked in their progress, at least in circumference, by proper conduct of the patient and by appropriate treatment. We must here discriminate between the ulcers which appear during or at the close of the acme, and those which occur at a later stage. Only the first ones cause the destruction of the entire cornea, except a small border partially covered by the limbus.

As regards prognosis and treatment, it is by no means immaterial which view we take of this process in the cornea. Quite prevalent is the opinion that a certain, though not definitely known, condition of the conjunctival secretion causes the destruction of the corneal tissues. After long and careful observations it still seems most plausible that the lids and the ocular conjunctiva cause, through the rapidly increasing infiltration, a pressure

upon the anterior ciliary vessels, and thereby directly interfere with the nutrition of the cornea; in other words, that this process in the cornea must be regarded as a sort of necrosis. This accounts for the known facts that corneæ previously vascular are not liable to this disintegration, and that the ulceration in question never occurs unless there has been a more or less dense chemosis. Furthermore, inasmuch as after repeated scarifications or even excisions of the chemotic conjunctiva, as well as after division of the outer canthus and even puncture of the cornea (in such ulcerations), the wounds we make show no disposition to suppurative destruction of the wounded tissues, whilst, on the contrary, in diphtheria, as is well known, we must guard against making even quite superficial wounds. It is difficult to understand why the secretion, if it possesses such deleterious properties, should exercise them only upon the cornea, protected as it is by epithelium. On the contrary, we very often see, after the rupture of the cornea and the evacuation of the aqueous humor, that the suppurative process does not proceed any further; although we cannot at the time discover any change in the secretion, either in quality or quantity. The artificial perforation of such ulcers (puncture of cornea) would probably be of a permanent benefit if such linear wounds did not close so soon (within from one to two hours), or become obstructed by the iris.

(b) *Blepharo-blennorrhœa*.—In a series of cases of acute conjunctival blennorrhœa the ocular conjunctiva is only slightly implicated, at least not in the form of well marked chemosis. The swelling of the lid, however, may be as great as in the most severe cases. The incipient symptoms, which, perhaps, might be regarded as catarrhal, are succeeded not only by greater œdematous swelling of the lid, but also by the secretion of a fluid turbid with flakes of mucus, or by a profuse uniform mucopurulent secretion. There may also be fibrinous coagula in the form of viscid threads or coherent exudations on the conjunctiva. The fibrinous infiltration of the palpebral conjunctiva is never manifested by a tenseness of the lid, and seldom by the admixture of a gray tint with the uniform redness of the conjunctiva; but more usually by a distinct granular appearance of the tarsal portion, and by a granular or puffy swelling of the retrotarsal fold. The ocular conjunctiva is markedly hyperæmic and

slightly infiltrated with serum, though, as a rule, only in its peripheral zone.

After several days or a somewhat longer period, and after the œdema of the lid has subsided, and the purulent secretion is diminished, the most striking feature is the hypertrophy of the palpebral conjunctiva, especially on everting the lids. The bright or dark red papillæ pressed closely together, and partially coalescing with each other, increase in size, especially toward the convex border of the tarsus and towards the canthi; and the enormously thickened retrotarsal portion protrudes, on everting the lower lid, in the shape of smooth or roughened folds; in the furrows between the papillæ and folds of the retrotarsal portion a muco-purulent secretion is found. The boundary between the tarsal papillæ and the smooth but plaited and uneven retrotarsal portion is often marked by a deep furrow.

Cases of this milder and slower (subacute) course, which are frequently observed in newly-born infants, and also in adults—seldom in children between two and five years of age—may likewise terminate in four or five weeks, without leaving any sequelæ. If corneal ulcerations occur, they occupy only a small portion of the cornea, and show but little tendency to enlargement either in circumference or depth. They probably originate here in the same way as in catarrhal conjunctivitis, from abrasions of the epithelium. The danger of the disease being aggravated to ophthalmo-blennorrhœa is never entirely removed until after a complete return to the normal condition, although it probably requires some unfavorable external influences, such as unskillful treatment, etc. But the cases of this kind, especially in adults, easily assume a chronic course; they cause, more frequently than ophthalmo-blennorrhœa, ectropium of the lower or upper lid, which is favored not only by the shortening of the skin by excoriations and mucous crusts (as in catarrh), but also by a sort of paralytic condition of Horner's muscle.

The above mentioned relationship of the inflammatory alterations of the conjunctiva to the secretion and to this œdematous swelling of the lid and the ocular conjunctiva, must be kept in mind, if we have to decide the question whether this œdematous swelling is to be referred to an acute conjunctival blennorrhœa, or to suppurative inflammation of the lachrymal sac, of the orbital

border, or of the tarsal cartilage, in or behind the globe. The differential diagnosis will be given when we consider these affections. If in a case of diffuse conjunctival inflammation it cannot be at first determined whether it is to be considered as catarrh, croup or blennorrhœa, the duration of the affection and the statement of the patient may serve as a clue, inasmuch as the purely catarrhal symptoms seldom last longer than 30 or 36 hours in cases which originally tend to ophthalmo-blennorrhœa.

2. CHRONIC BLENNORRHŒA OF THE CONJUNCTIVA.

This affection has also been described under the name of Egyptian, military, contagious, granular or trachomatous ophthalmia. The description is simplified by an artificial division into two classes: (*a*) In a series of cases we find a marked *mucopurulent secretion*, and the palpebral conjunctiva is for weeks or months in the condition which has just been described in speaking of the subacute course (*1 b*), the symptoms of acute or subacute blennorrhœa having preceded, often, however, without having been observed. In some of these cases, chronic from the beginning or becoming so later, we also find, scattered throughout the infiltrated, reddened and no longer transparent conjunctiva, light granules or nodules, with a relatively broad base and an entirely smooth surface, and rising but little above the level of their surroundings. Illuminated and viewed from in front they attract attention, even when small, by their light gray or wine color; by oblique illumination they appear, after the tears are wiped off, as smooth, somewhat transparent granules, seldom entirely flat. Their color and transparency may be compared to that of catgut. The completely opaque and wart-like excrescences, on the contrary, which must be regarded as hypertrophied papillæ, usually become pale and hard upon their summits only after a long existence and by vigorous development, just as they become angular or pointed by being pressed against one another and against the globe. When the lid is everted deep indentations or furrows, singly or in groups, may be seen between them, extending to their base. These indentations, lined by epithelium and generally containing some mucus, are seen, especially after applying a solution of nitrate of silver, as a fine gray net, out of whose meshes the red papillæ project.

The greater the hypertrophy of the conjunctiva the more noticeable becomes a thickness of the lid, which, in case the œdematous swelling of the integument is absent, indicates to the expert the presence of this disease, particularly when the upper lid is not sufficiently raised, or the palpebral fissure opened to its normal extent. Although the so-called papillary proliferations, which are usually most pronounced along the convex border of the tarsus, are wanting along the inner edge of the intermarginal border (in a strip about 2 mm. wide), the conjunctiva of this strip is also intensely reddened and thicker, so that the inner edge of the free border of the lid is no longer acute but obtuse; the intermarginal border, therefore, appears somewhat wider. The thickening of the conjunctiva is best demonstrated, after eversion of the upper lid, by comparing its thickness with that of a healthy lid. This hypertrophy must be referred either to the conjunctiva alone, or to the tarsus. If the lid is easily everted, if it appears neither hard nor firm, nor wider and longer, its increased thickness must be attributed solely to an infiltration of the conjunctiva. If the everted lid appears both thicker and broader in a vertical direction, and longer horizontally, being at the same time soft and flexible, then there must be an alteration in the tarsus (serous infiltration and softening?). Under these circumstances the action of the muscularis subciliaris of Horner appears somewhat impaired, just as the muscular layers of the large intestine are affected in dysentery. The lids no longer adapt themselves closely to the globe, and the relatively stronger contraction of the more peripheral and less affected muscular layers, particularly of the orbital portion of the orbicular muscle (as in weeping, in shutting against strong light), seems to contribute more to the development of ectropium, especially of the lower lid, than the hypertrophy of the conjunctiva or the shortening of the skin by crusts of mucus. But when, on account of the preceding infiltration of the conjunctiva, the upper lid can be everted only with difficulty, because of its firmness and hardness, and has lost its flexibility, whether it be wider and longer, or perhaps even smaller than normal, it is certain that the thickening is not caused by the swelling or infiltration of the conjunctiva, nor by the inflammatory softening of the tarsus alone or principally, but essentially by the dense and firm infiltration of the tarsal tissues. It is only

when this occurs that the consequences (to be considered hereafter) of the position of the cilia and the borders of the lid (distichiasis, trichiasis and entropium) are to be feared.

A spontaneous return to the normal condition has probably never been observed. In cases in which the exuberant growth of the so-called papillæ predominates, though as yet no infiltration of the tarsus, nor of its sub-conjunctival tissues, has occurred, a complete recovery may be secured in the course of months or years by judicious treatment, and proper conduct of the patient (as in catarrhal conjunctivitis); or else it results in superficial cicatrization which does not materially interfere with the extent or function of the conjunctiva. If a cured case of this kind is again seen after months or years, no vestige of the disease is observed, or the tarsal conjunctiva appears partially or entirely bluish-white, smooth and moist. The extension of the inflammation to the anterior zone of the ocular conjunctiva and to the cornea, which will be considered later, is rarely seen in the cases described in this section; it may, however, occur *before* the infiltration of the tarsus (the sub-conjunctival connective tissue).

(*b*) In a far greater number of cases which—for reasons to be given later—must likewise be designated as chronic blennorrhœa, the symptoms of acute or subacute blennorrhœa have not preceded, nor have the signs of catarrhal conjunctivitis been noticed by the patient. The changes in the conjunctiva have occurred quite slowly, and the secretion of mucus has for a long time been so inconsiderable that it is easily overlooked. But under circumstances which increase the hyperæmia of the conjunctiva—especially the sojourn of the patient in a moist, warm atmosphere, vitiated by a number of persons—the conjunctival secretion becomes more copious and furnishes the material for the infection of several persons, the propagation taking place not only by means of palpable objects, but also through the air. As a rule, the symptoms of simple catarrhal conjunctivitis in various degrees of severity appear either simultaneously with the alterations of the conjunctival tissues, or at different times during the progress of the disease. We must therefore carefully examine the palpebral conjunctiva, the seat of this disease, in order to guard against mistaking it for chronic catarrhal conjunctivitis, which also shows frequent fluctuations.

We may expect to see the incipient stage of this affection in an institution—a boarding school for example—in which a large number of eye patients demand a professional examination; we may also examine those inmates who show no eye disease and who regard themselves as perfectly healthy. Among these some will be found who are actually healthy, whilst others are only apparently so. The palpebral conjunctiva of the latter, especially in the tarsal portion, is found to be redder if the person is not leucophlegmatic; the so-called papillæ are somewhat swollen, and grayish, resembling a string of beads, and the retrotarsal folds sometimes project considerably, thickened by the accumulation of lymphoid cells. If now we find upon the tarsal surface small, light gray or light yellow, somewhat transparent, points, which on oblique illumination appear smooth and slightly elevated, we shall also find mucus in the conjunctival sac, either before or after the instillation of a solution of nitrate of silver. But it may also happen that while the papillary bodies in general appear only slightly swollen and red, we find no light gray granules, but instead of them, here and there, on the upper lid particularly, a knob-like elevation which can be accounted for by the coalescence of several papillæ, in other words, by an exudation into the tarsal portion. This condition also justifies the diagnosis of chronic blennorrhœa. Either condition points to the presence of chronic blennorrhœa, whether it be sporadic in a single individual or in the members of a family, or in an entire institution.

The light-colored granules mentioned above, which were known to Beer, but mistaken for itch pustules, and which, as “granulations vésiculeuses,” have recently been considered a pathognomonic symptom, can be distinctly perceived, in some cases, only with a lens. The beginner might confound them with the deposits in the follicles of the meibomian glands, which are sometimes found in older people, but which are at once recognizable by their opaque yellow or chalky white color. Care must be exercised not to mistake for coalesced papillæ those small granulations surrounding imbedded foreign bodies, or springing from the conjunctiva around the perforation of a chalazion; here also should be mentioned the accumulation of the lymph-like cells—the so-called lymph follicles in the retro-

tarsal portion of the lower lid, like more or less transparent, yellow or light gray, smooth tubercles, very often arranged in rows or in a thick fold. They occur in this disease, as in simple catarrh, and even in eyes which show no vestige of inflammation. The latter is often the case in young people who spend the greater portion of their time within doors (*e. g.*, in school). This condition may entirely disappear when they live in a better air and cease to fatigue the eyes with work.

Without doubt a reciprocal action exists between the air and the always moist conjunctiva, which exercises a great influence upon the condition of the ocular, as well as of the palpebral conjunctiva. And in this connection must also be considered the temperature, and the admixture of gases or mechanically suspended particles, as smoke and dust, and also the amounts of water.

The light-colored granules, as well as the knob-like elevations formed by coalescing papillæ in the tarsal portion, gradually increase in size and number. In some cases the first predominate, in others the latter; in others, again, one or the other alone is visible. Whilst the proliferation of the papillæ is usually more pronounced at the convex border and the pointed ends of the tarsus, the deposit of light-colored granules or globules occurs principally in two places, viz: where the palpebral arteries pierce the lid in order to reach the conjunctiva. The one place, or the one line, properly speaking, runs along the convex border of the tarsus, and is distinctly marked, especially on the upper lid, on account of its greater breadth; the other line runs parallel to the free border of the lid, about 3 mm. from the inner edge of the intermarginal border. At these places the nodules gradually penetrate from the conjunctiva deeper into the tarsal tissues.

As long as from the general appearance of the conjunctiva, and particularly from the softness and flexibility of the lids, we can assume that the infiltration is limited to the conjunctiva, we may hope that the conjunctiva will recover its normal or nearly normal condition. With proper treatment the number of the light colored granules, as well as of the swollen papillæ, diminishes, and without ulceration or perceptible atrophy of the conjunctiva the exudation disappears entirely, or the tarsal conjunctiva is transformed into a smooth, moist membrane, which shows a

uniform bluish white tint, or appears interwoven with a network of white streaks. The conjunctiva is often quite normal, but a white tendinous streak running along the free border of the lid sends off its ramifications towards the convex tarsal border.

In cases accompanied by the deposit of light-colored granules a uniform enlargement of the tarsus often, though not always, precedes the extension of the inflammation to the sub-conjunctival tissue, to the tarsus and the fascia tarso-ocularis. With cases in which, especially on the upper lid, the thickening (from before backwards) and spreading (from above downwards) is very considerable, there are other cases in which the deeper infiltration has taken place, especially in the line corresponding to the entrance of the palpebral arteries next to the free border of the lid, and in which the thickened lid appears already somewhat narrower in the vertical direction. In some rare cases the process terminates, after a continuance of several years, in amyloid degeneration of the conjunctiva and tarsus, with so much thickening of the latter that the differentiation from other tumors possibly necessitates a partial excision for the purpose of microscopical and chemical examination. Exudations imbedded in the form of granules or nodules displace the tissue in which they are deposited, and, by pressure, cause gradual shrinkage; they themselves are gradually transformed into connective or cicatricial tissue, which here, as elsewhere, shows a decided tendency to contract. In this manner the area of the conjunctiva in the tarsal and retrotarsal portion is reduced; this reduction, however, cannot reach a high degree so long as the same process does not take place in the sub-conjunctival tissues. This displacement by pressure is best seen in the meibomian glands, some of which appear completely choked, by retention, inspissation or calcification of the secretion, whilst others are entirely obliterated. By the supplanting of the tarsal tissue, which, for the most part, takes place along the above mentioned line about three mm. from the free border of the lid, and by the subsequent contraction, the tarsus is incurved. The narrow border between the inner edge of the lid and that cicatricial strip along the above mentioned line is gradually diminished, and the sharp edge of the inner lip (border?) of the lid disappears, so that there is no longer an intermarginal space, and the openings of the meibomian

glands are directed towards the globe. The disappearance of the inner edge of the lid in connection with the incurvation of the tarsus necessarily turns the cilia against the globe (*Trichiasis*). After a longer duration of extensive trichiasis the border of the lid may become so much incurvated that even its integument is pressed against the globe (*cicatricial entropium*). The formation of the latter is often favored by the development of *blepharophimosis*, as in the case of chronic catarrh. Simultaneously with trichiasis, but often long before the latter is fully developed, one or more cilia are seen growing, not from the normal anterior edge, but from the intermarginal border itself, and near the meibomian glands, thus forming a second row of cilia (*Distichiasis*). Although these are much finer, they may do mechanical injury to the cornea or conjunctiva, just as in the case of trichiasis. If, in cases in which infiltration of the tarsus has existed for some time, the lower lid be drawn downwards while the eye is turned upwards, the retrotarsal fold is often found abolished, vertical folds appear which unmistakably indicate an atrophy of the retrotarsal conjunctiva. This atrophy affects not only the conjunctiva in the retrotarsal portion, but extends to the underlying fascia tarso-ocularis, and even to the ocular conjunctiva and the fascia or tunica vaginalis bulbi, which, as a continuation of Bonnet's capsule, reaches as far forward as the cornea. The atrophy of these tissues produces the impression that the posterior part of the lid was adherent to the globe, and therefore Von Ammon has described this condition as *Symblepharon posterius*. It may proceed to such an extent that the convex border of the tarsus seems united with the margin of the cornea; but before this highest degree is reached the secretion of the conjunctiva suffers to a greater or less extent. The conjunctiva, although still moist, no longer furnishes its share of the lachrymal fluid. It secretes a thick, viscid mucus, which adheres to the lid, and is not removed by the tears. The application of sulphate of copper or nitrate of silver only aggravates this trouble. The following ointment is excellent for removing the accompanying infiltration of the lids:—

Hydrarg. Ammon.....	0,15 to 0,25
Ung. Emol.....	5,00.

If portions of the conjunctiva bulbi, or of the cornea, become

dry, or covered with bran-like scales (Xerophthalmus), we can only think of mitigating the evil by means of emollients. In cases in which this viscid mucus is present, operations upon the lids for trichiasis and entropium are of doubtful utility.

Whilst the inflammatory process in the lids is going on, during months or years, either gradually or with occasional insignificant exacerbations, it extends to the ocular conjunctiva and the cornea, sometimes unnoticed, again attended by violent symptoms which recur from time to time. The beginning of this transition is often discovered upon examining the semilunar fold by the presence of pale yellow, transparent tubercles. If the upper lid be raised while the eye is turned downwards as much as possible, we find the conjunctiva adjacent to the retrotarsal fold of a yellowish tint, penetrated by blood vessels, and studded with larger or smaller diaphanous, reddish-yellow granules or nodules. In other cases, which are probably further advanced, similar bodies are seen projecting midway between the retrotarsal fold and the corneal border, near to or on the limbus, or even on the cornea itself. This transition to the ocular conjunctiva, or even to the cornea, takes place in many cases long before there is any deep infiltration of the lids. The term *pannus*, which has been so long used for the corneal inflammation resulting from this disease of the conjunctiva, may be retained; but we should not expect to find the cornea, in all cases, looking as though it were covered with a cloth or skin. In some cases an essential feature of pannus, the superficial development of blood vessels, is wanting, at least at the time of the observation; in other cases we may perhaps find a clean corneal ulcer, the relation of which to the process spoken of above has yet to be established. The pannus is manifested, as a rule, by the appearance of small, roundish exudations and the formation of new blood vessels over and under Bowman's membrane. The affected portion of the cornea is, therefore, not only dull and lustreless, but rough, like a wet glass strewn over with fine sand, or full of little depressions if any of these exudations have been reabsorbed. If the blood vessels are not too dense, they appear dark red (from venous blood), and project somewhat above the surface of the cornea. In some cases the formation of blood vessels is prevalent, in others the exudation. The layer of exudation on the cornea may be 1 mm.

or even 2 mm. thick. The pannus begins, as a rule, though not in all cases, at the upper and much wider portion of the limbus. It is often limited to the upper half of the cornea, though it sometimes extends to the lower portion. Its development is usually gradual and almost imperceptible, but in some cases it is attended by violent pain, continuing day and night without intermissions, photophobia, blepharospasm, constant lachrymation and œdematous swelling of the lids. At times a zone of pannus, several millimetres in breadth, may be developed in a single night. Under proper treatment of the conjunctival affection the exudation may be reabsorbed, while the blood vessels gradually disappear; *restitutio ad integrum* is possible. If one or the other exudation breaks down and ulcerates, we may expect all the consequences of corneal ulceration, especially perforation. Extensive destruction of the cornea, however, is comparatively rare, as it is usually produced only by the coalescence of several ulcers. After a considerable time, the exudation may be transformed into connective tissue; the blood vessels disappear, the pseudo-membrane on the cornea becomes thinner, smoother and grayish, and though such portions may recover a certain degree of transparency, they can never again recover their perfect function. Finally it should be stated that, after the pannus has continued for some time, the curvature of the cornea is often altered (*Kerectasia ex panno*). Its substance loses its power of resistance and its elasticity. If the intraocular pressure is momentarily increased, as by coughing, sneezing, etc., it yields and does not at once return to its former shape. As a result, the vessels supplying the aqueous humor being under less pressure, more aqueous humor is secreted, and the anterior chamber is enlarged at the expense of the thickness of the cornea. If the pannus leaves a considerable portion (about one-third) of the cornea free, only the portion affected will become ectatic; if the entire cornea has been affected, the ectasia will be total and spherical. If Iritis (posterior synechiæ) occurs with this condition, as happens in a small proportion of cases, or if such eyes, still more rarely, become affected with glaucoma, it may be inferred that the uveal tract has been implicated, though it would be difficult to prove a direct connection with the corneal affection, unless it should be assumed that such eyes could not be affected with iritis or glaucoma from other causes.

Some attribute the development of pannus to the friction which the upper lid—covered with granular exudations—is said to create on the cornea. This idea has probably arisen from the observation that the pannus which accompanies blennorrhœa occurs principally in the upper half of the cornea, and often terminates below in a straight line, which coincides with the usual position of the lower border of the open eyelid. The pannus does not, in all cases, stop at this line, however, but may extend over the entire cornea. It may occur, not only with the large and hard granulations of the lids, but also in cases in which only a very careful observer can discover the light-colored granules or small, flat knobs between the papillæ, which are scarcely more swollen than in catarrh, and in which the lids are still quite soft and flexible. Sometimes it appears not only very suddenly, but accompanied by symptoms of great violence. But when there is actually a mechanical injury to the globe, as in case of Entropium or Trichiasis, we find alterations essentially different from those occurring in pannus (compare Keratitis). Eyes affected with Blennorrhœa are not exempt from pannus so long as the blennorrhœic inflammation exists in any part of the conjunctiva, even though the palpebral conjunctiva has long since become smooth, and though the form of the upper lid has undergone no alteration.

It is comparatively rare to find a case of chronic blennorrhœa, when the patient complains only of the disturbance of vision. A clean, more or less centrally located corneal ulcer is discovered as the cause. On inquiry we learn that weeks or months previously the patient suffered with an inflammation of the eyes, accompanied by pain, photophobia, lachrymation and secretion of mucus, but reliable information regarding the nature of the affection is only obtained by an examination of the lids and the ocular conjunctiva. In these cases it is usual to find an advanced state of chronic blennorrhœa. This must be treated in order to insure the healing of the ulcer, which is always very slow. After a long continuance of pannus we sometimes find an opacity which looks as though minute particles of lime were imbedded in the cornea.

Etiology.—We may consider it as proven that, not only the acute and subacute, but also, conditionally (under certain circum-

stances), that the chronic forms produce a contagious secretion, which, when transferred to a healthy eye, will set up the same process. It is still an unsettled question whether the acute, as well as the chronic forms can be produced by noxious atmospheric influences, and should be considered only as an aggravation of the catarrhal process, or whether the one, as the other, should be always supposed to be due to infection. Finally, it is an interesting question whether a special contagion must be assumed for the so-called Egyptian or granular Ophthalmia. The following may be of service for the solution of these questions:¹—

According to Piringer, the clear, serous, watery secretion from acute blennorrhœa of the first stage, as well as the watery fluid of chronic blennorrhœa, is not in the slightest degree contagious. The whey-like, turbid secretion of a mild type of the second stage, which contains little mucus, causes, as a rule, only a blennorrhœa of the first stage; the same may be said of the thin secretion of chronic blennorrhœa. On the contrary, the mucous secretion of blennorrhœa of the second stage produces a blennorrhœa of the third degree, as does also the thick, puriform secretion of the second or third degree, and a blennorrhœa created by this secretion always runs a very rapid course, attaining the third degree even within twenty-four hours.

The contagiousness of the blennorrhœal secretion can be diminished, or even destroyed, by dilution with water (50 to 100 parts), by desiccation, and by prolonged preservation. A linen cloth soiled with such mucus and dried in the air, may be used without hesitation for the purpose of wiping eyes not affected with blennorrhœa, if the dried mucus is over thirty-six hours old.

¹ Before proceeding to the consideration of the nature of the blennorrhœal secretion and the manner in which it is conveyed from the eye of one person to that of another, I must give the results of the experiments which, among others, Piringer (*Die Blennorrhœe am Menschnauge*. Gray, 1841), especially, has made, with the secretion of eyes affected with blennorrhœa. Piringer's statements are based upon 84 inoculations purposely made upon 49 persons, not including the carefully observed accidental cases in Vienna and in Graz. Among them were several amaurotic eyes, of which the conjunctiva, however, was quite healthy. The secretion used was taken, in some cases, from genital organs affected with gonorrhœa, in others from eyes affected with acute or chronic blennorrhœal conjunctivitis. The experiments with the secretion from eyes affected with simple catarrhal conjunctivitis uniformly gave negative results. Only a few of the most important experiments are cited.

But preserved in the same manner as vaccine virus, it is infectious for at least sixty hours. Hence, it follows how and when washer-women can be infected by the linen, or other persons by using the same sponges, wash-basins, towels, bedding, etc.; it explains also why, with the uncleanness of the poorer people, and with the great number of gonorrhœal patients, blennorrhœal conjunctivitis does not occur more frequently; and it shows the uselessness of some sanitary regulations which have been proposed and actually executed for the purpose of preventing the further propagation of the disease; such as the burning of clothing, the tearing up of floors, the whitewashing of rooms, etc. In reference to the last point, however, it should be remarked that Piringer's experiments are not in accord with the observations of Belgian physicians,¹ who state quite decidedly that the secretion adheres for several weeks to inanimate, and especially to hygroscopic substances, and retains its contagiousness.

The higher the degree of the blennorrhœa furnishing the virus and the more acute its process, the more certainly is the inoculation followed by blennorrhœa, even within from six to eight hours. The fresh, whey-like secretion of a blennorrhœa of the second grade produces an effect usually within from sixty to seventy hours; the fresh, mucous secretion of chronic blennorrhœa, within seventy-two to ninety-six hours. The mucous or purulent secretion of a blennorrhœa of the second and third grades, it seems, may cause a blennorrhœa of the first grade, even when it is about three days old or much diluted with water. The yellow and thick mucus of a chronic blennorrhœa may also occasion a severe acute blennorrhœa.

The form and degree of the blennorrhœa caused by inoculation does not depend alone upon the quality of the secretion used for this purpose, but in part also upon the individuality of the patient and upon the inoculated eye. In one case the inoculation with mucus from a very mild blennorrhœa of the second grade (from an infant) produced an extremely severe blennorrhœa, with the formation of a croupous membrane over the entire conjunctiva. The same virus produced in another person a blennorrhœa with exceedingly obstinate granulations; and in still another case, a blennorrhœa rapidly terminating in complete recovery. Healthy

¹ Hairion, "Discussion sur l'ophthalmie des armées," Bruxelles, 1864.

or catarrhally affected eyes were much more sensitive to the virus than those affected with chronic blennorrhœa, which were inoculated on account of pannus. Blennorrhœa caused by the same material resulted in the one case in large, in the other in small granulations; in one person it left a chronic tumefaction and thickening of the mucous membrane, in another it did not; and the mucus of a blennorrhœa with large granulations and all the characteristics of the so-called chronic Egyptian ophthalmia, produced, in an amaurotic woman, a blennorrhœa which had not one single peculiarity of the primary blennorrhœa. In one case was seen an example of a granular condition of the left eye, and a complete villous condition of the right.

As regards infection it should be remarked, according to Piringer, that it may be prevented if, immediately after inoculation, or within three minutes, the conjunctival sac be thoroughly washed out with pure water, and cold compresses are instantly applied for several hours. Piringer lays even more stress upon the cold compresses than upon the washing with water; and if the time above mentioned has passed, and if the inflammation has already begun, there is no better remedy, according to him, for checking the further development of the process than the energetic application of cold compresses. Washing out with water alone, with sublimate water, or chlorine water, he does not consider sufficient.

Finally, it should be mentioned as a peculiarity of blennorrhœa that an eye once cured of it is not exempt from another infection; that the chronic state is usually changed into an acute one by the inoculation of secretion from an acute blennorrhœa, so that generally the whole process runs its course rapidly, and that an incompletely cured case of blennorrhœa may, under certain circumstances, especially bad air, be aggravated to its former or even a much higher degree. The Belgian Minister of Justice, in September, 1858, addressed the question to the Academy of Brussels as to whether a completely cured case of blennorrhœa could occur again without new infection. The answer was that this could not be admitted; yet it might easily happen that a case of ophthalmia might be considered quite cured, while, in reality, it was not, and thus the inflammation might light up again without new infection.¹

¹ Hairion, "Discussion sur l'ophthalmie des armées," Bruxelles, 1864.

(a) The blennorrhœa of newly-born children occurs most frequently between the second and fifth day after birth; seldom on the first and only exceptionally later than the fifth; it runs an acute course generally as blepharo- seldom as ophthalmoblennorrhœa; the transition into a chronic form is very rare. The only known cause is infection during or after birth. As a rule, the virus is furnished by the blennorrhœal vaginal secretion of the mother, exceptionally by an infected sponge, or by the vaginal secretion of another person. The latter mode of infection should be suspected if the disease does not appear until the eighth day or later. The commonly supposed causes, as bright light, catching cold, plethora, jaundice, etc., may be well enough for the laity; we, however, should always consider the established facts and take our measures accordingly. When a vaginal blennorrhœa has existed during the latter period of pregnancy the midwife should be directed to thoroughly cleanse the eyes of the infant immediately after birth with a perfectly clean sponge or linen rag. The objection that many mothers with vaginal blennorrhœa, even of specific character, give birth to infants whose eyes remain uninfected, is no argument against cleanliness, since for infection there must be not only a vaginal blennorrhœa but contact of the secretion with the conjunctiva, which can only take place when the eyes are opened; for a notoriously infectious secretion does not always infect—as, for example, in impure coitus.

(b) *Gonorrhœal Ophthalmia*, most frequently met with in youths and men, has no other causative connection with gonorrhœa than that it is caused by the virus conveyed from the genitals to the eye by means of the fingers, towels, bed linen, etc.; it is not a metastatic or sympathetic affection, as was formerly supposed. Piringer, who was the first, so far as the author is aware, to deny the occurrence of metastatic and sympathetic conjunctival blennorrhœa, mentions a case which shows that a person suffering with gonorrhœal ophthalmia need not necessarily have gonorrhœa. A gunner affected with gonorrhœa visited his home; his brother sleeping in the same bed with him contracted gonorrhœal ophthalmia—as did also a second brother, and finally the mother. The author treated (about ten) young girls, between two and six years of age, affected with acute

gonorrhœal ophthalmia, who had vaginal blennorrhœa; in several cases attention was called to the affection by a member of the family. In seeking the cause of a case of ocular blennorrhœa the author was informed by two women that they suffered from a vaginal discharge before and after the menstrual period; at the time of examination, however, there was no vaginal discharge. All these cases subsided without chemosis, though in several children there was a croupous exudation on the ocular conjunctiva, and in all of them a frightful tumefaction of the lid with a copious muco-purulent secretion. In the case of two children ectropium of the lids occurred. The occurrence of chronic conjunctival blennorrhœa in old women of the lower classes is somewhat striking. Finally, it may be remarked here that a conjunctival blennorrhœa undoubtedly caused by inoculation from the genitals, be it very acute—ophthalmo-blennorrhœa—or subacute, as blepharo-blennorrhœa, is sometimes transformed into a chronic conjunctival blennorrhœa, which cannot then be distinguished, by its appearance alone, from one having a different origin. Such a case is described in the first volume of Von Arlt's work on eye diseases (Prague, 1851, pp. 285–287). This case also shows that the so-called light or gray granulations, which have been described by several authors as peculiar to military or granular ophthalmia, may be developed in previously healthy eyes, when they become infected with blennorrhœal virus from the genitals. This is all the more to be emphasized since we have also seen cases, with such light-colored deposits in the conjunctiva, in which the eyes, affected for a long time with chronic blennorrhœa (so-called trachoma) came under treatment on account of acute blennorrhœa caused by infection from gonorrhœal virus.

(c) The secretion causing a blennorrhœal conjunctivitis originates from an affected (blennorrhœal) eye far more frequently than from the genitals. The inflammation originating from this source may, as regards the symptoms and course, so fully agree with that due to infection from the genitals, that the history of the case alone can determine its character. It is highly important to discover the author of the infection, for prophylactic reasons, but unfortunately it is often difficult, or even impossible. The symptoms which this disease occasions in its chronic form

may be so insignificant for weeks, months or years, that they may not be regarded as especially dangerous by the patient nor by the person from whom the contagion was derived. The common people, and even he whose entire attention is not absorbed by an occupation, submit to such eye diseases with a certain indifference and resignation. Such persons do not often seek professional help until disturbance of vision or severe pain and photophobia have occurred in consequence of the extension of the inflammation from the lids to the eyeballs. Most patients date the beginning of the disease from the time of the appearance of the severe symptoms; perhaps they may admit that they have often observed redness and pain of the eyes and gluing together of the eyelids for a long time, but they remember very little about the circumstances under which the disease actually commenced, or the persons with whom they came in contact at that time. Notwithstanding this, enough can often be ascertained to decide that the disease has crept into a family after some companion with inflamed eyes was admitted; that this or that laborer got it during a sojourn at a public tavern (Herberge); at another time it was after a child with sore eyes returned to the family from a nursery, or one coming home from a boarding school; and very often from men who have previously served in the army, and who, during their service, have suffered with inflammation of the eyes, had been treated in the hospital, although they complained not at all or only occasionally. In such cases it can often be ascertained that several members of a family have been attacked, and the transmission from eye to eye in such cases has been caused by the common use of certain utensils; when not directly proven, it may generally be inferred, especially when there is no reason to suspect any other source of origin with any probability.

In those cases in which nothing justifies the supposition that the secretion has been transferred from the genitals or from one eye to another through utensils, we are compelled to assume a spontaneous origin of the blennorrhœal conjunctivitis, and to investigate the circumstances under which it may take place.

The very frequent occurrence of blennorrhœa which has been observed since the beginning of the present century is usually spoken of as epidemic, although no observer can fail to notice that

it only occurs among persons living together (corporations), and that it extends to the surrounding population only when a member of that corporation came to live with the other people. These corporations of persons are constituted of soldiers, prisoners, foundlings, pupils at educational institutions, etc. In the thickly peopled portions of a city or district the disease occurring in great number in such a corporation remains limited to it for a long time. Officers, physicians, and nurses are exempt from it, with very few exceptions. Thus in 1819 the entire civil population of Mayence, as well as the Austrian portion of the garrison, were exempt from the disease, while one-third of the Prussian portion of the garrison (1146 men) was attacked in the course of a few months. At Ancona, 158 soldiers were attacked within twenty days. There can be no doubt that the disease which has raged among the soldiers in Europe to such a terrible extent ever since Napoleon's expedition to Egypt, in 1798, and which was carefully observed and described, especially during the wars of 1812 to 1815, and at Mayence in 1819,¹ was the same affection observed to-day, though in a milder form, among corporations, especially among the military. If this identity cannot be denied then it must be admitted, from all the facts in the case, that the disease is contagious, and that it can be communicated not only by means of tangible objects, but through the air also; of course, under certain conditions, which will be considered hereafter.

The affection of many individuals at the same time or at short intervals cannot be explained by the state of the atmosphere, its degree of moisture, temperature or impurities, as in catarrhal ophthalmia; else other persons outside of these corporations would necessarily also be affected. Neither can the particular mode of living of one or another of these corporations be given as the sole cause for the great number of this disease. Military surgeons who have laid so much stress on the clothes, the fatigues, the drilling, the bivouacing, and the life in barracks, and still do to some extent, have probably failed to notice that the same disease occurs just as frequently and with as much virulence among other bodies of men, whose manner of living is entirely different, with the exception of living indoors in small or

¹ Carl Ferd. Graefe, die epidemisch-contagiöse Augenblennorrhoe Ægypteus, Berlin, 1823.

crowded rooms, and who are not exposed to any of the hurtful influences enumerated above. We may recall the repeated violent outbreak of this ophthalmia in the penitentiary of Brauweiler, which Ph. Walther¹ has described; to its occurrence in the Dublin penitentiary, as related by Kirkpatrick,² where, from 1849 to 1854 alone, 134,838 persons were affected, and to the very numerous cases among foundlings (from five to ten years of age), at Prague, in 1848, which are described in Von Arlt's "Manual of Diseases of the Eye." We should also remember that this ophthalmia has been observed as formidably, or even more so, on board ships as on land; and that it was not during the fatiguing marches that the disease has been most frequently observed among soldiers, but during the time when they were quartered in relatively small rooms; and whole divisions of the army, although exposed to the same fatigues, have remained free from it either for a long time or altogether. Finally, the affection of so many persons, either simultaneously or in rapid succession, cannot be explained by the transference of the conjunctival secretion from one person to another. The astonishingly rapid spread of the disease, which even gave rise to the hypothesis of a volatile contagion, makes this mode of propagation *a priori* improbable. The transmissibility by means of tangible objects had been established at an early day, partly by observations and partly by inoculation. But measures based on this assumption alone have proved insufficient to prevent the spread of the disease. One was forced to recur to the view of *infection at a distance*, and not until measures based upon this view were taken was the spread of the disease manifestly checked.

Very excellent remarks on the infection *par distance* are to be found in the work of the Prussian regimental surgeon, Dr. Müller, at Mayence:³ "What I have been able to learn whilst treating such patients during two years and a half, entirely agrees with this hypothesis (of contagiousness); I must consider contagion *par distance*, however, as the more frequent occurrence." "In

¹ *Graefe und Walther's Journal*, II Band, p. 66.

² *Makenzie traité pratique des maladies de l'œil*, trad. par Warlomont et Testelin, Paris, 1856.

³ J. B. Müller, *Erfahrungssätze über die contag. od. ägypt. Augenentzündung*, Berlin, 1821.

my opinion, however, three conditions are necessary for the generation of that invisible, immeasurable fluid. These are: (1) The presence of a person affected with the disease; (2) an atmosphere vitiated by many persons living together; (3) certain impulses favoring the whole act of regeneration, such as are created from time to time by atmospheric currents. Whilst I follow my vocation without any fear of contagion at the hospital, where the rooms are always perfectly ventilated and scrupulously clean, I could not be induced to pass one single night in a room where many persons sleep together, if among them there were any suffering with blennorrhœal ophthalmia, because experience has taught me that infection occurs most frequently under these circumstances, especially if the rooms are small and imperfectly ventilated." Like Müller, the most distinguished observers of this variety of ophthalmia have pronounced in favor of infection *par distance*. Thus Eble¹ says: "The most important cause is the living together of many persons in small rooms, and the resulting vitiated condition of the air. There is probably not a case known in which the disease occurred epidemically without this etiological element." According to Wernek, a higher degree of warmth and an atmosphere loaded with miasmatic emanations may convey the infection to a distance; in many cases only the atmosphere surrounding the patient, though often only that surrounding the eye itself, is charged with contagious matter. Seidlitz speaks of serous vapors arising from the purulent matter as the carriers of the contagion, which are not powerful enough to produce the more violent forms of the inflammation. Though Stellwag² denies the infection at a distance, he nevertheless says, on page 429, that "it is advisable to proceed always as though the infection through the air were an established fact."

The author's opinion that, perhaps, the small bubbles of water always floating in the air in more or less quantity, when proceeding from the eye, carry with themselves some of the blennorrhœal secretion, and keep it suspended in the air, is, as yet, a mere hypothesis; but with its aid the observations which have been made regarding this infection at a distance, can be easily recon-

¹ Eble, über die sogenannte contag. od. ägypt. Augenentzündung, Stuttgart, 1839, p. 144.

² Stellwag v. Carion, Diseases of the Eye, Amer. Ed., p. 305.

ciled with physical laws. We have only to remember that the normal conjunctiva and the cornea always give off a certain amount of moisture to the air. It is a fact established by observations that eyes affected with blennorrhœa produce a much more abundant secretion in a warm and moist atmosphere than in free, pure, cold air. The most widely spread and most destructive epidemics have occurred in damp countries, along rivers, lakes and sea shores. In such countries the disease has obtained a foothold even among the civil population, whilst in high regions it is comparatively rare. Chevalier J. Von Röser, in enumerating the causes to which this plague of Egypt is usually attributed, remarks that neither the dazzling sun light nor the dust and sand play a prominent rôle, since the "Bedouins of the desert rarely suffer from ophthalmia." "This disease which is so frequent below Cairo becomes much rarer further up the Nile." According to Volney, this ophthalmia, at the end of the last century was not found at all in districts remote from the Nile. It is impossible to prevent the living together of many persons in small rooms, either in the military or among the civil population (as in institutions of learning, factories, etc.), but it is possible, to a certain extent, to mitigate the evils of an atmosphere vitiated by animal exhalations. The analogy between this disease and puerperal fever and hospital gangrene, emphasized by the author in 1851, will probably be more appreciated since Lister's method has met with such brilliant success.

The question whether blennorrhœal conjunctivitis (acute as well as chronic) may and really does originate in any other manner than by a contagion, must be answered by saying that only the contagious origin can be considered as proven. That the blennorrhœal inflammation in many cases may be considered merely as an intensified catarrhal conjunctivitis, and, therefore, due to the same but more intensely and repeatedly active influences, is not supported by fact. It should be remembered that there has never been a case of blennorrhœa which exhibited the anatomical characteristics of blennorrhœa at the beginning of the disease. In all cases there are only the symptoms of catarrh for some time, and should we at this time declare that the disease would sooner or later prove to be blennorrhœa, we could do so only on other data, as, for example, the previous history of the

case. When this basis for the clinical diagnosis is wanting we must observe the course of the disease for several hours, one or two days, in chronic cases even longer, before we can definitely decide between catarrh and blennorrhœa. But how should we prove that a conjunctival inflammation, which at the time of our observation is decidedly manifested as blennorrhœa, had been originally only catarrhal, and had not had a tendency to blennorrhœa from the very first? If only catarrhal symptoms develop in an epidemic of the disease, and the tissue changes characteristic of blennorrhœa are not manifested, then we must assume, from the analogy of other contagia, and in accordance with the results of inoculations, that the contagion has developed but a mild conjunctivitis in such cases, because of dilatation, a shorter period of infection, or individual peculiarity of the infected person. This is the only rational explanation of the statement that military ophthalmia occurs in one case as a catarrhal, in another as a blennorrhœal inflammation. Another view, held by A. Von Graefe and his pupils, is that all conjunctival inflammations yielding a muco-purulent secretion must be regarded as contagious, and that although a certain similarity usually exists between the original disease and that resulting from the inoculation, yet, sometimes, a very mild conjunctival affection may, by inoculation, produce a very severe blennorrhœa. This view is not based upon experiments, but only upon observations in professional practice; it does not remove the doubts as to the correct interpretation of the observations. The author has often, and under different circumstances, observed infection, but it has never happened with the secretion derived from a catarrhally affected conjunctiva. There are numerous cases of acute and chronic catarrhal conjunctivitis with a copious muco-purulent secretion (for example, in the case of blennorrhœa of the lachrymal sac), but such a secretion, according to the author's experience, has never induced a blennorrhœal affection of the conjunctiva, either in the eye so affected or in that of another person. A difference must exist between the muco-purulent secretion of catarrh and the blennorrhœal secretion of the conjunctiva, though we cannot yet demonstrate it by other means than by inoculation. Moreover, if it were to be expected every moment that a catarrh might change into a blennorrhœa,

or that the secretion from a catarrhally affected conjunctiva might cause a blennorrhœa in a second person, the division of the conjunctival diseases into catarrh and blennorrhœa would have altogether lost its main purpose of guiding the physician in matters regarding prognosis, prophylaxis and therapeutics. If every eye disease with a muco-purulent secretion involves the possible danger of starting, by inoculation, an acute blennorrhœa or granular conjunctivitis, the physician who is convinced of this danger assumes a grave responsibility unless he employs the necessary prophylactic measures.

The author was formerly of the opinion that cases running a chronic course, and distinguished by the deposit of light-colored granules, with a relatively slight mucous secretion, should be separated from the others in which the proliferation of the papillæ and a more copious secretion generally predominate, and be included under the name of trachoma;¹ in other words, that the process in the conjunctiva was in causative relation with general disturbance of nutrition and especially with scrofula. But after having more often observed the blennorrhœa in its various forms and phases, especially among soldiers, and having repeatedly seen infection from cases which previously had not been considered contagious, he became convinced that trachoma also was only a purely local disease caused by infection. Whether a peculiar contagion may be claimed for the so-called granular or Egyptian ophthalmia must still be considered an open question; but it may be well to state the reasons which induce him not to separate the so-called granular ophthalmia from those forms which are generally described as blennorrhœa. Many physicians, especially the Belgian, differentiate between blennorrhœal and granular ophthalmia. They regard as a characteristic of the latter disease the development of small granules in the tarsal conjunctiva, often only visible by means of the lens (vesicular granulations), to which may be added the symptoms furnishing all the characteristics of catarrh or blennorrhœa, and its contagiousness, at a distance as well as by contact. While they consider catarrhal and blennorrhœal ophthalmia as spontaneous, and even admit their epidemic occurrence,

¹ Von Arlt, *Prager Vierteljahrsschrift*, 1848, Bd. 2, und *Lehre von den Augenkrankheiten*, 1851, 1 Bd.; p. 106.

they consider granular ophthalmia as of exotic origin, imported by the French and English from Egypt, and believe that it occurs in the manner of endemic diseases through the intervention of a volatile contagion or sort of miasm. They maintain that this disease has been transmitted to the population by the military. In the first place it can be proved that the same disease occurred in Europe in former centuries, at least sporadically; for the same alterations of the lids as are now found as sequelæ of this disease alone were observed and described. The following passage is found in Celsus: "This (roughness) is generally followed by an inflammation of the eyes, sometimes extensive, sometimes slight; and occasionally this roughness results in blearedness, which again increases the roughness, so that it becomes in some cases of short in others of long duration, so as scarcely ever to come to an end. In this kind of disease some scrape the thickened and hard eyelids with a fig leaf and roughened instrument, or even with a knife, and after turning them inside out rub them daily with medicines. This should not be done except in very great roughness of long standing, since better results are obtained by a regular mode of living and proper medicine." From Beer's work (*Lehre von den Augenkrankheiten*, 1813) it may be seen that he considered the disease in question (p. 324) as an inflammation of the tarsal glands (since he mistook what Eble described later as papillary bodies as mucous glands of the conjunctiva); in his first book on eye diseases (Vienna, 1792) he described such symptoms as to lead us to believe that he had the same disease before him. He gives there (part I, Fig. 4) a picture which agrees in all essential points with those given by C. F. Von Graefe and Eble in the passages quoted. On page 291 he states that, after the formation of small elevations on the conjunctiva, scarcely noticeable with the naked eye, the disease greatly resembles Psorophthalmia; and on page 565 explains that this miasmatic ophthalmia, which he called psorophthalmia, according to the ideas then current, was of rare occurrence in Vienna, and found only amongst the lowest classes and those who are usually unclean in their habits. "If, then, the inside of the eyelids show a rough surface similar to that of a sliced fig, it has been called trachoma or sycosis." He not only speaks of the formation of papillæ on the inner surface of the lids,

but also of the disfigured form of the borders of the lids and the tarsus by entropium and trichiasis, as a consequence of this condition. Since we find the same condition at the present only after ophthalmia militaris aut granulosa, Beer must have had the same disease under observation. If we disregard the expression, "miasmatic," Beer does not express any more definite opinion regarding the contagiousness of the disease. The origin of the forms which we have described as acute and subacute blennorrhœa, Beer ascribes to metastasis in adults, to bad air in children (in lying-in hospitals and in foundlings' homes). This also disposes of the question of exotic origin. The disease itself, in its chronic as well as in its acute form, was known in former centuries, although under different names. Its transmissibility was first recognized in our century only after its epidemic occurrence in the standing armies. Its spread among the civil population, certainly occurring from time immemorial, has only gained in extent since the above mentioned wars, through the return of infected soldiers to their homes.

The question whether another contagion (of specific nature) must be assumed for the so-called blennorrhœa granulosa, than for those cases which originate directly or indirectly from genital blennorrhœa, or whether the former is to be considered only a modification of the latter, cannot be answered definitely. The author's observation with nurses in the foundlings' division of the Prague Lying-in Hospital,¹ makes it very probable that the secretion of blennorrhœa neonatorum can also occasion infection at a distance; these forms, however, bear the character of an acute or subacute blennorrhœa, and I do not remember to have observed forms which bore the characters of the so-called granulosa. The latter, however, was decidedly the case in "restored foundlings."² On the other hand, we meet with many undoubted cases of acute or subacute blennorrhœa in the descriptions of the so-called ophthalmia contagiosa or Egyptica, and the astonishingly large number of cases of blindness from complete destruction of the cornea, supports the view that the disease of the eye then prevailing included many cases which we now observe as occurring only after the transfer of the secretion from a genital blennorrhœa.

¹ Arlt, Krankheiten des Auges, Prag., 1851. Bd. 1, page 53-58.

² Ibid, page 59.

I regard it, therefore, as most probable that the so-called granulosa is not a disease *sui generis*, but only a modified blennorrhœa, a disease originally arising from a genital blennorrhœa, being transferred to the eyes, which has lost in virulency but gained in persistency, through transmission from eye to eye, from individual to individual, and might be again intensified to its highest degree by unfavorable external influences. From citations of Rust (L. C., pages 135-150), it appears that this disease has by no means existed from time immemorial as an epidemic plague in Egypt, at least not at the time of the Greeks and Romans; but that its frequency in that country is a product of later times. "Probably this disease did not exist as endemic long before Prosper Alpinus (1646), the first physician who observed this plague in Egypt, since, otherwise, traces of it would necessarily be found in the history of the Crusades, and, therefore, its first appearance probably occurred in the period after the occupation of Egypt by the successors of Mohammed." The demoralization of the people by excesses, filth and general misery, and the climatic conditions of Egypt, render this probable.

Prognosis.—Blennorrhœa neonatorum may run so mild a course that every trace will have disappeared in from three to five weeks. In some cases, unfortunately too frequent, one or both eyes are lost by total or almost total ulceration of the cornea. Between these two extremes there are a number of cases with more or less central ulceration and its consequences (*vide Keratitis*). Regarding corneal ulcers it may be stated that, *cæteris paribus*, they are less dangerous than in adults. In every case we should pay attention to the condition of the cornea, the ocular and palpebral conjunctivæ, and to the duration of the disease. During the first three or four days it cannot be determined whether or not, even under otherwise favorable conditions, a hard and dense infiltration of the palpebral conjunctiva will take place; where it exists chemosis is either already present or soon ensues; but when chemosis is present the cornea is either already affected or soon will be. A croupous lining of the palpebral conjunctiva often precedes the dense infiltration, but is not in itself a dangerous symptom. The denser the chemosis the greater is the danger to the cornea.

The acute blennorrhœa of adults, produced by the secretion of

specific gonorrhœa, is the most dangerous form, whether the virus be inoculated directly from the genitals or from an infected eye. But when infection of the other eye occurs in the retrogressive stage of such a blennorrhœa we may expect the disease so induced to run a mild type. When within the first thirty-six or forty-eight hours after the infection a dense chemosis appears around the cornea, even if the ulcers be only marginal, there is very little hope of preserving a sufficient portion of the cornea for the future formation of an artificial pupil. This is also the case when only a relatively small portion of the cornea is destroyed, as far as Descemet's membrane, but when only a narrow marginal zone of the superficial layers is preserved.

In chronic blennorrhœa the patient should be made to realize the long duration, which may extend from one month to several years, in spite of favorable conditions of life, correct manner of living and uninterrupted treatment; and he should also know the dangers which threaten the eye from the changes of the lids (ectropium, entropium, trichiasis), and of the cornea from pannus and its consequences. This is all the more necessary when there is reason to doubt a necessary perseverance and endurance of the patient.

Treatment. (Indicatio causalis).—Should it unfortunately happen that gonorrhœal or blennorrhœal secretion gets into one's eye, it should be immediately washed out with cold water, and cold, or still better ice, compresses should be applied. The applications of chlorine water to the conjunctiva, a very dilute solution of carbolic acid, or a one per cent. solution of nitrate of silver may be also recommended. The application of ice may also be useful during the period of incubation, and even after a considerable increase of vascularity. The infection of the other eye, as well as the eyes of other persons, should be guarded against. If only one eye of a new-born child is affected, the infection of the other may possibly be prevented by allowing the child to rest only on the side of the diseased eye, all other precautions being also observed. A protective bandage cannot be applied, as in adults. In older children and in adults the other eye may be protected, after its healthy condition has been ascertained, by an hermetically-sealed bandage, applied as follows: The lids, being gently closed (as in sleep), are covered with fine court plaster or gold-beaters'

skin (*pellicules balsamiques*), the spaces over the eyeballs being filled with absorbent cotton or lint, over which strips of linen smeared with diachylon plaster are placed so that the whole border of the plaster comes in the closest apposition with the orbital border. This dressing may finally be covered with a tightly-fitting elastic bandage. This protective bandage should be removed at least once in twenty-four hours, for the purpose of a careful inspection of the eye. For the protection of the attendants, they should be informed of the dangers of infection by means of the fingers, towels, sponges, etc. For cleaning the affected eye, it is best to make use of lint or absorbent cotton, which should be immediately destroyed. Sponges are not always sufficiently cleansed before being used again. If several cases of *blennorrhœa* are in one room, we should consider the possibility of transmission through the air, and arrange for thorough ventilation. If a dropper, goose quill, or anything else is used for applying medicines, it should be thoroughly cleansed after each application, as even a minute particle of secretion adhering to it may cause infection of another eye. This applies to the acute as well as to the chronic forms. Influences which increase the inflammation should be avoided as far as possible. High temperature, moisture, and air contaminated with gas, dust, smoke, etc., aggravate the disease; we should, therefore, particularly in overcrowded dwellings, insist upon a diligent and thorough renovation of the air. The light should be moderated as far as it is consistent with good ventilation, because the closing of the lids induced by photophobia interferes with their circulation; it may even be necessary to reduce the morbid sensitiveness to bright light by medicaments, especially the application of the belladonna ointment upon the forehead.

A further indication is to frequently wash out the muco-purulent secretion, as its retention in the conjunctival sac, its drying in the palpebral fissure, perhaps also its decomposition, is the source of a mechanical or chemical irritation. Whilst the lids are held apart by two fingers of one hand, tepid water is instilled from a sponge or a wad of charpie. Still better is Esmarch's apparatus,¹ consisting of a portable tin vessel with a long elastic tube, which can be placed at any desired height, to throw a gentle spray into the eye until all the mucus is removed.

¹ Fountain Syringe.—TR.

(b) *Pathological Indications (Indicatio morbi (a).—*In the acute forms the stage of the increasing inflammation should be differentiated from the stage of retrogression. Only during the former stage are bleeding and cold applications serviceable. In newly-born infants it is better to forego the problematic advantage of blood-letting than to run the risk of inducing a prolonged hemorrhage. If local bleeding be of any service, in the case of an adult eight to ten leeches may be applied, and the subsequent hemorrhage maintained for one to two hours. The best places for the application of the natural or artificial leeches are first the temples and then the region of the mastoid process. Applied to the forehead they are useless, and to the inner canthus or anywhere near the lids they may increase the swelling. Cold applications, ice compresses if possible, should not be too thick and heavy, and should be changed as often as the temperature of the lids demands. If carelessly applied they may act as emollient cataplasms and have quite the opposite effect to that intended. When we cannot expect that they will be carefully watched and changed, it is better to apply them only for an hour, or not at all. Purgatives, which may be indicated by constipation, and irritants applied to the skin, have no influence upon this disease. On this account the author has no faith in the application of a strong solution of nitrate of silver to the outer surface of the lids, although this remedy has been warmly recommended by some authors. A free and speedy bleeding may be obtained in adults by division of the external commissure. This is accomplished by introducing the blunt end of a pair of straight scissors into the conjunctival sac, behind the commissure, and in closing the scissors the cutis as well as the muscular layer is incised to the extent of about one centimetre towards the temple. This incision also considerably relieves the pressure on the globe caused by the tense swelling of the lids. Notwithstanding this procedure, however, I have lost many eyes affected with gonorrhœal blennorrhœa. The same may be said of the incisions and excisions of the chemotic conjunctiva around the cornea. The advantage afforded by puncture of the cornea, in the case of progressive ulcerations, seems to be frustrated by the fact that such openings close again within a few hours, and the repeated attempts at re-opening are likely to irritate the eye too much. So long as the

dense gray infiltration or a croupous membrane exists no irritating remedies should be applied to the conjunctiva; we should confine our treatment to the embrocation of belladonna ointment (*vide* Catarrh) to the forehead and temple. But where there is no such infiltration, or if it has already been absorbed, the application to the conjunctiva of a one or two per cent. solution of nitrate of silver is probably the best means for promoting recovery. The redder and the more succulent the conjunctiva appears, and the more abundant the muco-purulent secretion, the more energetically may the application be made by repeated penciling. Even two applications may be made in twenty-four hours; provided, however, that all traces of the previous application have disappeared. Corneal ulcers require the precaution that the caustic does not come in contact with them, and that during the eversion of the lids no pressure is made upon the eyeball. In order to alleviate the pain after treatment cold water should be applied for fifteen or thirty minutes, or the eye should be washed out with lukewarm water. After the eschar is thrown off there occurs a spontaneous mitigation of the pain and a diminution of the secretion, which, however, will soon increase again. As the conjunctiva gradually returns to a normal condition, as shown by less swelling and less muco-purulent secretion, the intervals between the applications may be lengthened to twenty-four or forty-eight hours, but the applications should not be discontinued until the muco-purulent secretion has entirely ceased. But if it should be found that the abnormal secretion is kept up by the condition of the cornea, as by ulcers, prolapse of the iris, etc., or on account of the non-adaptation of the lids (especially the lower one) to the eyeball, a well applied pressure bandage may be the best means for checking the secretion. Eyes affected with blennorrhœa neonatorum have been lost because, after the disappearance of the most dangerous symptoms (the cornea being intact), the treatment was discontinued too soon; and there are others in which, through the same neglect, the disease persists, in a chronic form, for months.

(b) In chronic cases the medicinal treatment should be directed, in the first place, towards subduing any irritation that may be present, and, in the second place, towards stimulating the re-absorption of the exudations. Violent symptoms of irritation, as pain, lachrymation, photophobia and blepharo-spasms, may

occur, even when the cornea is not affected, though, as a rule, they are the premonitory or associated signs of the extension of the inflammation to the cornea (pannus). Under these circumstances direct applications to the conjunctiva are not well tolerated, except those of atropia.¹ The best remedy, then, is the frequently repeated application (every two or three hours) to the forehead and temple of an ointment of ungt. cinereum and extr. belladonnæ. If a continued use of the ointment becomes necessary, instead of the ungt. ciner. the ung. simpl. 5,00 with hydr. præc. alb. 0,40 should be used. In vigorous persons it may be useful to begin with a local bleeding, and to make cold applications for some time. In weakly patients, reduced by grief and want, quinine and good food are the best means of shortening the painful condition. The patients should go into the open air as much as possible, and should sleep soundly, hydrate of chloral or opiates being used if necessary. As soon as the violence of these symptoms is somewhat abated the palpebral conjunctiva should be touched with the solution of nitrate of silver. This is well tolerated, even in progressive ulcerations of the cornea, if care be taken that the solution does not come in contact with the cornea. The re-absorption of the firm exudations might be accomplished by this means alone, were it not necessary in most cases to continue it for months, even years, and did not its long-continued use produce a discoloration of the conjunctiva and episcleral tissues, known as argyrosis. It is preferable, therefore, when the above-mentioned symptoms of irritation have subsided, or if they have never been present, to use the sulphate of copper. The application with a perfectly smooth crystal of sulphate of copper is made daily at first, then at intervals of from two to four days; and it may be so continued for years, without danger. But when the above symptoms of irritation reappear it must be at once discontinued. These relapses occur without any fault on the part of the physician or the patient. Copper acts not only as an irritant and astringent, but as a caustic also, as is evident from the gray discoloration of the conjunctiva after a somewhat severe application. The conjunctiva must, therefore, be thoroughly examined before each application, to ascertain whether it is not red, covered with a gray exudation or ulcerated in some places. If this precaution be

¹ Solutions of mur. cocaine, 2 to 4 per cent., are also beneficial.—TR.

neglected we may find, on the following day, a violent keratitis with ulceration and other severe symptoms. The reaction, or the duration of the irritation after the application, will decide as to how long the intervals shall be and how energetically the application shall be made. If after using the copper for several weeks or months there be no material diminution of the infiltration we should consider whether the patient is not at fault, whether the application was too weak or too strong, or whether the solution of nitrate of silver should not be again used for a few days or weeks, since the eye is too much irritated or has become accustomed to the copper. The author, as other physicians, has used the mitigated nitrate of silver (one part nitrate of silver, two parts nitrate of potash melted together), but has abandoned it because a more intense cauterization easily causes a more marked contraction of the tissues, and because there seems to be no difference in the duration of the treatment. But in the case of hard, cock's-comb excrescences he sometimes uses the mitigated caustic, immediately neutralizing it perfectly with milk or a solution of chloride of sodium, believing in the motto: "*Gutta cavat lapidem non vi sed eaepe cadendo.*" If longer intervals be permissible and the patient can present himself only occasionally, a good substitute is:—

Ungt. glycer. c. amylo.....	5,00
Cupri sulph.....	0,20-0,25

which may be used by the patient himself.

If the conjunctival secretion be perceptibly impaired and the conjunctiva appears covered with tough, yellowish-gray mucous flakes, the condition is made worse by the application of any of the above-mentioned remedies, and the contraction of the retro-tarsal portion is only increased thereby. In these cases there is no better remedy than the application of a salve composed of:—

Ung. emolliens.....	5,00
Hyd. ammo.....	0,15-0,25

which often clears the pannous cornea very perceptibly.

Though the tarsal conjunctiva may become smooth we have no assurance against a relapse of the blennorrhœal process, or against the appearance of pannus, so long as there is any exudation in any portion of the retrotarsal sac. The good health of

the patient and the apparent or actual absence, at the time of inspection, of any abnormal secretion are not sufficient proofs of the complete disappearance of the disease. On this account every patient should be carefully examined before the disease is considered cured, and when there is any doubt the patient should be re-examined from time to time.

Pannus diminishes under this treatment primarily intended for the lids, unless it has already produced some incurable alterations; it requires no special treatment. The author has seen no benefit from the simple or double section of the blood vessels around the cornea. He has never excised a zone of 2 or 3 mm. width from the circumcorneal conjunctiva, because in a process naturally terminating in atrophy of the conjunctiva every intentional destruction of substance seems of doubtful utility. He has several times inoculated blennorrhœal secretion (after Fr. Jäger, Püringer and others) in order to excite an acute process for promoting the reabsorption of the firm exudation and the resolution of the vessels of the cornea, where the exudation had already begun to be organized, but no encouraging results were obtained and he can only regard this process as a doubtful remedy. [In such cases an infusion of jequirity is often of the greatest value (*vide* De Wecker and others in Knapp's Archives of Ophthalmology, Vol. XIII, p. 107). De Wecker considers it very important that only fresh infusions should be used in order to obtain uniform results. The seeds are first crushed, to free them from their husks, then ground to a fine powder. Cold water is then poured upon the powder and the infusion set aside for three hours, at the expiration of which time it is filtered and ready for immediate use. It ought to be slightly opalescent, almost transparent, and have the odor of fresh herbs. The strength of the infusion varies from two to ten per cent.; that most frequently used is either a three or a five per cent. The infusion is only applied once by means of a sponge, which is thoroughly rubbed upon the inverted lids and held in contact with them for several minutes.

The ocular conjunctiva should be touched only superficially unless there be a dense pannus; the cornea should be spared, especially if there are ulcers, but the infusion should be thoroughly applied to the palpebral conjunctiva and the fornix, the

latter being exposed by a slight pressure with the lids against the globe.

In the great majority of cases a single application of a three or five per cent. infusion is sufficient to produce a violent jequirity ophthalmia, and if the trachoma is not cured a second and third application is made, but with an interval of at least two or three weeks between them.

Great care should be exercised in selecting cases for jequirity treatment. In recent cases with purulent discharge it is contra-indicated.

The dangers of jequirity ophthalmia are due to two causes: first, application of strong infusions in too rapid succession, and, second, application to an eye already discharging.—TRANS.] The author has the same opinion of the cauterization of the pannous cornea either with the solid or mitigated nitrate of silver, which he has tried a few times in cases of firm exudations (1 to 2 mm. in thickness).

The procedures which may be indicated by the malformation of the lids (as distichiasis, entropium or ectropium) will be considered with the Diseases of the Lids. This much may be said, however, that where there is no danger in delay, the operation should be postponed until either reabsorption or transformation of the exudation into connective tissue has advanced so far that no considerable contraction is to be apprehended after the operation; and that if a decrease of the lachrymal secretion, by a manifest diminution of the conjunctival sac, is already observable (beginning Xerophthalmus) the condition will only be made worse by a lid operation. In case of far advanced amyloid degeneration of the tarsus its extirpation is the only remedy.

IV. DIPHTHERITIC CONJUNCTIVITIS.

Diphtheritic Conjunctivitis differs from acute conjunctival blennorrhœa, with the highest grade of which it has a great similarity, in that the exudation upon and into the tissues rapidly congeals, and after a short duration, about eight days, breaks up by suppuration, and the infiltrated portion of the conjunctiva, with the subconjunctival connective tissue, sloughs to a greater or less extent, so that the eye is not only threatened with corneal destruction, but also with a more or less extensive atrophy of the

conjunctiva and its sequelæ. The turbid secretion contains a contagium which differs essentially from that of blennorrhœa; if transmitted from one eye to another it does not produce blennorrhœa but diphtheritis (diphtheritic microspores. Klebs).

Symptoms and Course.—It cannot be determined on the first day nor perhaps on the second day, the history of the case being deficient, whether the incipient inflammation is catarrhal, croupous, blennorrhœal or diphtheritic. But when, with the appearance of much swelling of the lids, accompanied by severe pain and very high temperature of the lids, the palpebral conjunctiva shows in one or several places (seldom throughout) an opaque, grayish-white infiltration, perhaps also a grayish-white, firmly adherent membrane, while the portion adjacent to such a deposit appears more or less swollen, red and ecchymotic, we can diagnosticate diphtheritis. The appearance of a diphtheritic spot and its surroundings very much resembles an eschar produced by cauterization or by scalding. The infiltrated portion, unless it is covered by exudation on the surface, appears depressed as compared with its surroundings. The thickness of the infiltration may be easily underestimated, if it is not very extensive, and surrounded by the swollen and reddened conjunctiva. The lid which is the seat of such infiltration is not only thicker, but also so hard and rigid that its eversion is very difficult or even quite impossible. A sure evidence of the diphtheritic nature of the conjunctivitis is furnished by diphtheritic patches in cases in which there are excoriations of the lower lip, the wings of the nose or the angles of the mouth. These patches appear whitish-gray, and surrounded by a more or less swollen and reddened corona (circle); the exudation cannot be removed, until it is thrown off spontaneously.

The secretion, at first, like that of catarrhal conjunctivitis, rapidly becomes turbid by the admixture of blood and pus cells, and remains for some time (several days) a thin liquid with coherent flakes (muco-pus, shreds of the membrane or particles of necrotic tissues). Later, when the circulation in the conjunctiva has again become easier, after the deliquescence and elimination of the exudations, and when the conjunctiva has again assumed a more vascular and spongy appearance, the secretion becomes more uniformly turbid and pus-like, gradually decreases in quantity and consistency, and finally ceases altogether after complete

cicatrization of the conjunctival ulcerations. There is always more or less contraction, and frequently an adhesion of the palpebral with the ocular conjunctiva, from the retrotarsal fold forward; and in cases of very extensive or general diphtheritic infiltration total symblepharon and xerophthalmia may result. The fate of the cornea, its partial or total destruction, depends here, as in acute blennorrhœa, on the extent of the rigid infiltration in the ocular conjunctiva. If the infiltration involves only a section of the ocular conjunctiva, that portion of the cornea which is nearest (in the same meridian) the diphtheritic infiltration is the first to become hazy, infiltrated with pus and necrosed; such cases of partial infiltration still offer a chance of preserving the remaining portion of the cornea so far as it is not surrounded by a dense chemosis. Just as after partial cauterization or scalding of the ocular conjunctiva and the cornea, we sometimes see, after recovery from partial diphtheritis, a fold of conjunctiva extending like a pterygium to a scar at the corneal margin. If the diphtheritic infiltration is limited to the conjunctiva the eye may subsequently suffer from distichiasis, trichiasis or entropium.

Symptoms and Causes.—If diphtheritis could be caused by the inoculation of a catarrhal or blennorrhœal secretion, this disease would occur everywhere, and more frequently. But diphtheritis is a very rare disease compared with the acute forms of catarrh and blennorrhœa, and is observed only in certain districts (cities) and in certain seasons.¹ Its true origin must be sought in other causes. The view that an exaggerated catarrhal or blennorrhœal inflammation could become diphtheria, does not advance our knowledge of the etiology, unless the causes which are thought to effect such an exaggeration are more clearly defined: the so-called metamorphosis of diseases can be neither demonstrated nor refuted, from our nosological standpoint; it must be considered as an arbitrary view. The adoption of so-called mixed forms, now and then suggested in ophthalmology, has retarded rather than favored the study of etiology and nosology.

¹ Graefe. Archiv. f. O. T. B. 1. Abth. Jacobson, Archiv. f. O. VI. 2. Abth. Mooren, ophthalmol. Beobachtungen, Berlin, 1867. Hirschberg, klin. Beobacht. Wien, 1874. Hans Adler, Wittelshöfer's Wochenschr., 1878. Nr. 15.

The extreme virulence of the diphtheritic secretion is proven when it is transmitted to an eye by means of a tangible substance. No age or constitution protects against its effects. But as conjunctival diphtheritis, like faucial diphtheritis, was observed especially among children, it is obvious that the origin cannot be referred in all cases to infection. We should rather assume that the infantile organism, by a peculiar and indefinable disposition, has not the same power of resistance to noxious external influences as the adult organism, and that the disease may be developed in childhood also without infection. The most probable supposition is that the lower organisms (fungi, micrococci), which are easily developed in damp, overcrowded, dark and poorly ventilated basement dwellings, find a suitable soil in the mucous membrane of the throat and conjunctiva of children. The most miserable quarter of the city and the most wretched dwellings appear to be the special breeding places of the diphtheritic contagion.

In proof of the fact that the diphtheritic exudation of the pharynx may infect the eye, one of the author's colleagues, in pencilling the pharyngeal mucous membrane of a child, received some muco-pus in the left eye; although the eye was thoroughly washed at once, a conjunctivitis was developed in two days, rapidly manifested diphtheritic symptoms, and resulted in total destruction of the cornea, as well as considerable atrophy of the conjunctiva.

Prognosis.—Diphtheritis belongs to the dangerous diseases of the eye, on account of the danger of partial or total destruction of the cornea. The author has seen total destruction of the cornea in the case of a woman who had been infected by a child three years old, and in the case of the above-mentioned colleague; in a child four years old and in a boy of eight years the greater portion of the cornea remained intact, but later the operation for artificial pupil, and in the case of the boy the operation for pterygium (on the right eye), was necessary. The points for the prognosis—as regards the local condition—have already been given under the heading of symptomatology.

Treatment (a) Indicatio causalis.—Cellar and basement dwellings should not be tolerated, at least for people with small children, as they are breeding places of contagious diseases. The

sanitary regulations useful in faucial, are equally applicable in conjunctival diphtheritis. If one eye is still unaffected it must be protected by the bandage already described (*vide* Blennorrhœa). The attendants should be informed of the circumstances under which infection may take place. Infection from a distance has not been observed.

(b) *Pathological Indications.*—In vigorous persons, during the initial stage of the inflammation; local bleeding by means of leeches, best applied behind the ears, is indicated; wounds near the eyes might easily be contaminated and become diphtheritic. For the same reason neither an incision of the conjunctiva nor a division of the external commissure is advisable. The higher the temperature of the lids the more diligently should the cold applications be made, as in the case of blennorrhœa. But if in the further course of the disease the lids no longer feel hot, and especially if the applications are unpleasant to the patient, they should be stopped or warm applications substituted (*Infusum florum chamomillæ*, *Decoctum herbæ malvæ*). The warm applications, made several times during the day, for hours at a time, not only abate the pain, but also facilitate the deliquescence and elimination of the exudation. They are not contraindicated by corneal ulceration. For relieving the photophobia and pain the following remedies may be recommended: Instillations of a solution of atropia (*mur. cocaine—Tr*), applications to the forehead and temple, every two or three hours, of *ungt. cinereum* with *ext. bellad.* and *ext. opii. aquos.*; and adults may be given *chloral hydrat.*, *morphine* (or injections of morphine), *pulv. doveri*, and *quinia*. The eye is to be thoroughly cleansed, as in blennorrhœa. The greatest care should be observed in the application of irritating remedies for the purpose of diminishing the secretion, which is exceedingly abundant in the later stage, on account of the presence of erosions. Only a one per cent. solution of nitrate of silver should be applied at first, as a test. The same can also be said of the use of chlorine water, solutions of permanganate of potash, borax, etc. Even without the application of such remedies the conjunctiva returns, in a few weeks, to its natural condition, so far as it has not become phthisical. The author has seen frightful instances of salivation induced by *hyd. chlor. mit.*, or by the inunction of *ungt. cinereum*, in cases of acute conjunctival

blennorrhœa, as well as of diphtheritis; and for this reason he has never had the courage to employ such heroic remedies, which are of doubtful utility in these diseases of the eye.

V. CONJUNCTIVITIS SCROFULOSA, OR LYMPHATICA.

(*Pustulosa phlyctænulosa, Herpes conjunctivæ et cornea.*)

By **Conjunctivitis Lymphatica** we understand an inflammation which has its seat in the anterior part of the ocular conjunctivæ, or within the area of the cornea, and is characterized by the appearance of circumscribed exudations (nodules, pustules or vesicles), accompanied by ciliary injection corresponding to the seat of the efflorescence. The exudation forming such an efflorescence is imbedded in the conjunctival tissue, or rather in the conjunctival layer of the cornea, and is therefore, at least at the beginning, covered with epithelium, semi-liquid and opaque, either from the first or becomes so somewhat later; it is eliminated either by simple absorption or by suppuration, which may also attack the subconjunctival tissues.

Symptoms and Course.—The inflammatory change of the tissues makes its appearance mostly in the anterior zone of the ocular conjunctivæ, in or near the limbus as a rule, less often within the area of the cornea. It manifests itself by the appearance of one or more nodules ranging in size from that of a particle of dust to a millet seed, and by this form reminds one of some exanthematous eruptions of the skin. The eruption of each of these nodules is preceded by partial ciliary injection, and generally by more or less stinging or darting pain, photophobia, even blepharospasm and lachrymation. The ciliary injection surrounds the entire cornea when the middle region is the seat of even one single efflorescence. The peripheral zone of the ocular and palpebral conjunctiva may remain entirely unaltered, but they often show the symptoms of a catarrhal conjunctivitis. In the tarsus we find, even in the simplest forms, an abnormal injection of the vascular network surrounding the follicles of the meibomian glands, and that of the conjunctiva. In exceptional cases a small ulcer of 2–3 mm. is found on the tarsal conjunctiva near the lid border, evidently the consequence of such an efflorescence.

The contents of each point of exudation have always more or less consistency (accumulation of cells) at the beginning, never

fluid; the names, therefore, which presuppose the formation of vesicles or of pustules, are incorrect. The several nodules, especially the smaller, are reabsorbed in the course of a few days, or are transformed into ulcers by the desquamation of its epithelial layer at the summit. Such ulcers, therefore, not only show a circular form, but also (until all the exudation is absorbed) a wall-like border formed by the absorbed exudation. The ulcers in the conjunctiva, even to the border of the limbus, cicatrize ultimately without leaving any visible trace.

The course is a similar one when the efflorescences appear in the area of the cornea or encroach upon it from the limbus. When an efflorescence distinctly rises on the cornea an inexperienced observer may confound it with a foreign body. Anamnestic data are not always reliable; only a close inspection by focal illumination can give positive information. In many cases the efflorescence in the cornea does not rise in the form of a nodule, but appears more as a scarcely perceptible slightly prominent infiltration. The nodular and less prominent efflorescences in corneal area may entirely disappear in several days or weeks. As a rule, however, they break down in the centre, and terminate in ulcerations, which, by extending either in circumference or in depth, may seriously endanger or even destroy the eye, but fortunately leave, as a rule, only more or less superficial, persistent or transitory cicatrices.

From the ulcers themselves we may infer their origin, if the affection arose without any external cause and when, together with one or several ulcerations, there are nodules of exudation. In two cases, however, the significance of such an ulcer may be determined with certainty from its position and form alone. (*a*) When a round ulcer is so situated on the border of the cornea that it reaches into the cornea as well as into the scleral border, it has certainly originated from the degeneration of such exudations, provided a traumatism and Herpes zoster can be excluded; for corneal ulcers of any other origin do not involve the border of the cornea covered by the limbus, much less the scleral border itself. If, then, such ulcers lead to a rupture of Descemet's membrane, the iris is pressed forwards over the sclera, and after cicatrization has taken place, the pupil appears displaced and is often changed into a fissure, just as we

intentionally displace it by the operation of Iridodesis. (*b*) In some cases the nodule of exudation in the limbus desquamates from the summit, and forms a crater-like depression; but while the peripheral portion of the wall-like elevation is penetrated by numerous blood vessels and gradually re-absorbed, the central, epaulet-like portion remains without blood vessels, and the depression (ulceration) between the peripheral and the central portion can only be discovered by good illumination. After a few days the epaulet-like portion has advanced further into the cornea, on its concave side the ulcer and between this and the scleral border a convolution of blood vessels all together forming, as it were, a thin ribbon of vessels, which, of course, corresponds in breadth and length to the breadth of that epaulet-like infiltration and its distance from the scleral border (J. N. Fischer's vascular ribbon). For a time the ulcer advances with its epaulet-like border in a straight line; in some cases, however, it deviates so as to describe in its further course an arc, like a rocket. Any portion of the limbus may be the starting point of the ulcer, and at any point in its rectilinear or curvilinear course its progress may be arrested by healing. The course, at first plainly visible as a red streak, gradually grows less vascular, and is then distinctly manifested as a furrow; and when all the vessels have disappeared from the cornea by the cicatrization of the ulcer, a grayish- or bluish-white streak remains, which begins to clear up from its peripheral end, unless it is stationary. This streak, therefore, the presence of which even after months and years would refer to scrofulous conjunctivitis with this peculiar course, is a more or less superficial corneal cicatrix. This ulcerative process never terminates in perforation of the cornea, and does not impair vision, unless persistent opacity remains opposite the pupil.

Lymphatic conjunctivitis sometimes appears in the form of pannus. Numerous exudations, of the size of grains of sand or poppy seeds, cover a more or less extensive area of the cornea, on which also small superficial vessels appear. Generally such exudations are also scattered over the limbus and the adjacent portion of the conjunctiva. The larger nodules, situated in the cornea, sometimes change to small ulcers, and the smaller ones and those situated in the sclera gradually disappear without leaving any traces. This form, therefore, generally gives hope of

a perfect cure (*restitutio ad integrum*). In order to distinguish this form from blennorrhœal pannus, it is only necessary to examine the palpebral conjunctiva. When this is not found in the condition of chronic blennorrhœa, the pannus indicates lymphatic conjunctivitis and may be soon removed without serious consequences. This pannus seems never to attain any considerable thickness.

If we are asked with what right an inflammation occurring in the cornea is designated as conjunctivitis instead of keratitis, we may answer that this inflammation always proceeds from that corneal layer which we are warranted in taking for modified conjunctiva. "I do not hesitate to declare the so-called basal membrane of the cornea a modified part of this substance, that is, of that part of it which genetically belongs to the conjunctiva."¹ "It is easily demonstrated that the fibres into which the basal membrane is resolved pass directly into the more solid subepithelial layers of the conjunctiva, called the tunica propria. These fibres of the loose subconjunctival tissue do not terminate abruptly, but are continued into those fibres which pass directly under the anterior limiting membrane of the cornea. In the human cornea it is easy to separate, with a cataract needle, these anterior layers of the cornea from the underlying substantia propria; these fragments do not tear off at the corneal margin, but pass over into the corresponding portion of the limbus, that is, the scleral conjunctiva."² This description lends a firm anatomical basis to the view which the author had already gained from his clinical observations, that the pathological processes in the cornea, observed in chronic blennorrhœa and in scrofulous conjunctivitis, start from the conjunctiva, and, strictly speaking, belong to the conjunctival layer of the cornea. In most persons the first eruption occurs in the limbus; in very many partly in the limbus and partly near it (in the cornea), and in a great number, where the affection began in the limbus, the transparent cornea becomes involved, either by subsequent fresh eruptions, or by the extension of one or the other infiltration. Cases in which the exudation begins in the

¹ Waldeyer, mikroskop. Anatomie der Cornea, Sklera und Conjunctiva, in Graefe und Saemisch Handbuch, 1874, B. I, Thl. 1, page 202.

² Ibidem, pag. 224.

cornea and remains confined to it, are relatively rare, and even in these cases the further course is distinguished from purely episcleral eruptions only by the fact that if suppuration takes place instead of reabsorption, the suppuration, on account of the firmness of the subjacent substance (the absence of loose subconjunctival tissue), extends more deeply or more superficially. If, for the sake of systematizing, those cases in which the eruption begins in the cornea are separated from those which begin in the limbus, it is impossible to avoid inconsistencies, since in all cases of the latter kind the cornea is involved when ulceration occurs. Just as, in catarrh and blennorrhœa, we look upon the implication of the cornea as a consecutive affection, so we must here also consider the conjunctiva as the starting point of the symptoms developed later in the true corneal substance. In cases of scleritis and keratitis, when the points of inflammation are developed partly in the sclera and partly in the cornea, but really advance from the sclera more or less into the adjacent cornea, there is a relation analogous to that between the conjunctiva proper and the conjunctival layer of the cornea.

When an efflorescence appears in the limbus or next to it there is at this point a partial ciliary injection; enlarged vessels appear in the conjunctiva, after the eruption has taken place; but when an efflorescence breaks out in the middle of the cornea, or when numerous efflorescences appear in the limbus, the ciliary injection extends all around the cornea. Single eruptions may occur without being preceded or followed by manifest nervous symptoms, (often transitory pain in the eye), with the exception of increased sensitiveness to light. Children are often brought to the physician because a "spot is growing upon the eye;" that is, because the new tissue formed for the healing of the corneal ulcer is less transparent, and therefore more noticeable, whilst the preceding efflorescence has taken place with such slight symptoms that it has attracted little or no attention. As a rule, however, and without exception, in the case of several efflorescences violent symptoms occur before, during and after the eruption. The most striking and most troublesome of these symptoms is an increased sensitiveness to ordinary daylight (photophobia), which, accompanied by increased lachrymation, is frequently so intense as to cause spasmodic closure of the lid (blepharospasm).

Although these symptoms are to be considered as reflex neuroses, caused by the irritation of the ocular branches of the trigeminus, we see them occur very soon after foreign bodies have entered the conjunctival sac, and disappear just as rapidly after their removal—yet in this affection they are generally disproportionate to the visible changes in the eyeball. They are often surprisingly severe while there are only a few exudations, at the limbus or in the cornea, so that the patients cannot open the eyes for days or weeks, and scream with pain at every attempt to bring them into daylight; in other cases, on the contrary, when, from the alterations on the globe, especially in the cornea, we should expect to find a very high degree of reflex symptoms, there is not only no blepharospasm, but photophobia and lachrymation are also very slight. Still more remarkable is the fact that these symptoms are most severe during the morning hours, and show a striking remission during the afternoon, so that children then come out from the dark corners and resume their play.

In some cases the disease begins with the usual symptoms of an acute conjunctivitis and the characteristic efflorescences (generally several) appear but a few days later; more frequently, however, the catarrhal symptoms do not appear until after the suppuration of some of the exudations has taken place, or when fresh exudations make their appearance from time to time. In the latter case the conjunctiva assumes a uniform redness and swelling after some weeks' duration of the disease, and pours out such an abundant muco-purulent secretion as gives the impression of a subacute blennorrhœa. Such cases, indeed, have been described as scrofulous blennorrhœa of the conjunctiva, although they require an entirely different treatment.

If lachrymation and photophobia have lasted for some time, and especially if there is a mucous secretion, excoriations very often occur on the lids, which may easily result in blepharophimosis at the temporal canthus. Only when this has taken place entropium of the lower lid occurs now and then; but a permanent alteration in the form or position of the lids is not to be apprehended, even when the blepharospasm continues for several months. Very frequently, perhaps in one-half of the cases, blepharitis also occurs. It often exists previously, though more rarely it sets in during or after the appearance of the conjunctivitis.

This affection may be easily overlooked if the physician has not made it a rule to examine the intermarginal border closely in every case of conjunctival inflammation. For in many cases the blepharitis is manifested only by an apparent partial enlargement of the intermarginal border, due to swelling (thickening) of the anterior edge. In the places where the intermarginal edge appears broader and the border of the lid consequently somewhat thicker, the skin is studded with small red nodules in front of and behind the line of the eyelashes and as far back as the openings of the meibomian glands. Small scales of epidermis at the base of the cilia may also be easily overlooked or mistaken for dried mucus (*vide* Blepharitis).

Etiology.—This disease is, beyond doubt, the most frequent of all inflammations of the eye. The greatest number of cases are furnished in childhood, though not before the ninth month, and then in youth. The cases which appear only at the time of puberty are rarer, but at the same time more dangerous and more obstinate. Cases sometimes occur in adults, or aged persons who have previously suffered from scrofula, then appeared healthy for a long time, and subsequently broken down in health on account of unfavorable influences, as unwholesome food, imperfect ventilation, long-continued nursing, etc.

This form of conjunctivitis occurs so frequently with distinct symptoms of scrofula in other organs that the causative connection with the general disease is manifest. Even when no manifest symptoms of scrofula are noticeable at the time of the conjunctivitis the occurrences and relapses depend so little on external noxious influences that, as in the manifestations of syphilis, we are compelled to seek the cause within the organism. It is neither possible nor necessary here to enter upon a full discussion of scrofula; a previous knowledge of this widespread disease may be presupposed. If we assume scrofula only when swelling and infiltration of the lymphatic glands or caries are found, probably only one-half of the patients suffering from this disease would be considered scrofulous. But we must also take into consideration the condition of the general integument, of the mucous membranes, especially of the fauces and the nose, of the development of the body at the time of puberty, and of the nutrition. As this constitutional disease, like others, may be first

manifested in the eyes, at least the suspicion of scrofula as the cause should not be instantly rejected in the typical forms of conjunctivitis, especially if there has been no opportunity to observe the patient for any length of time. Certainly we shall have no occasion to regret it if we act upon this supposition in considering the prognosis and the treatment, whilst the assumption of a purely local disease easily results in a neglect of the proper prophylactic, and especially hygienic measures. For we have not only to deal with the present attack of inflammation, but also with the general condition of the patient, and the prevention of relapses. That the disease is especially liable to frequent relapses is admitted even by those who call it a local disease. Whilst in other diseases, iritis, for example, the causes of the relapse are often found in local alterations, consequences of the preceding inflammation, here it is often impossible to discover, in the free intervals, the slightest changes in the eye that could cause a suspicion of a relapse.

It is another question whether, in the absence of other manifest symptoms of scrofula, the patient or his friends should be told that the disease is of a scrofulous origin. Considering the views concerning scrofula now current among the laity, it will be advisable, even in eminently typical cases, to pronounce the disease as the consequence of a delicate constitution, or as recent recovery from sickness, faulty physical education, etc., in the presence of laymen, and thus gain a foundation for subsequent medical and dietetic treatment. But if the disease is pronounced a purely local affair, the patient or his family can scarcely be induced to submit to measures which will be successful only by the greatest perseverance and patience. Under certain circumstances, in cases of blennorrhœa or syphilis, we do not always tell the layman what we think or know about his disease, but treat his case according to our own convictions.

In the attempt to represent this disease as a strictly local affection some authors have been induced to reverse the order of the symptoms. This is especially true of the tumefaction of the upper lip and the alæ of the nose. These alterations, quite characteristic in many cases, are said to be brought about by the increased secretion of tears, through chemical action upon the nasal mucous membrane and the adjacent skin. It is only

necessary to advise one holding this opinion to observe and examine more carefully, and he will soon admit that such swellings are often observed days and even weeks before a trace of the eye disease is manifested. The inflammation of the nasal mucous membrane, which may, perhaps, be considered as the cause of the swelling of the alæ of the nose and the upper lip, is therefore, probably, occasioned by something different from a more abundant secretion of tears. Besides, it is often bilateral when only one eye is affected, and is sometimes markedly developed during insignificant lachrymation. Furthermore, it has been asserted that the swelling of the cervical glands is the effect of the eye disease, to which it bears the same relation as the swelling of the axillary glands to paronychia.

But as a matter of fact such swellings exist before the first attack of the ocular inflammation, and in many persons, who have previously never had an inflammation of the eyes, this first appears long after the glands have suppurated and left only the well-known disfiguring cicatrices. There are cases in which the disease is confined to the one side, the infiltration of the glands to the other. Lymphatic glands are found swollen (most frequently in acute conjunctival blennorrhœa, and also in chancre or epithelioma of the conjunctiva) in front of the ear, but not in the neck, and they decrease with the subsidence of the disease; they never attain the size of a hazelnut, nor do they perceptibly implicate the cervical glands. As to the occurrence of facial eczema simultaneously with this disease, various explanations have been given. The efflorescences on the eyeball may very well be compared with the eczematous eruptions on the epidermis. But then, the question must be asked, in every case, Is the efflorescence caused by a local irritation or by a special diathesis, and by which? If eczema occurs near the eye prior to or simultaneously with the efflorescence on the globe, the conclusion may be drawn that the ocular affection is the consequence of the cutaneous. In acne rosacea papular efflorescences frequently appear and disappear upon the limbus and cornea until the acne is completely removed. In the case of a papular syphilide covering the face, and especially the forehead, the author has seen a well marked papule at the limbus of the left cornea (inwards and upwards) simultaneous with such eruptions on the outer edge

of the intermarginal border. But numerous cases are also found in which eczema makes its appearance on the lids and cheeks only subsequently to the ocular affection, and only after the latter has existed for some time; and especially when the eyes, on account of pronounced photophobia and consequent lachrymation, are kept covered or bandaged. Here it is probable that the continuous action of the tears is the exciting cause of the eczema. Concerning external noxious influences which act directly on the eye, it may be remarked that traumatism, colds, etc., cannot be the actual causes of this affection, though they may favor its outbreak. This view is supported, not only by the frequent occurrence of this disease in children after severe illness (measles, scarlet fever and smallpox), but also by the frequent relapses, now in the one, now in the other eye (generally with blepharitis), and especially by the circumstance that often while the one eye is under treatment and the patient is watched and nursed most carefully, an efflorescence is seen to make its appearance in the other eye. There are cases in which only a daily examination of both eyes will detect the beginning of the efflorescence in the second eye.

Prognosis.—This partially concerns the general disease and partially the alterations in the eye. Regarding the former a distinction must be made between inherited and acquired scrofula. In the former case the prognosis, as regards the duration and relapses of the disease, is unfavorable, especially if the disease does not appear until puberty. It may be very difficult to distinguish between inherited and acquired scrofula, as parents who were scrofulous in their youth may beget healthy children. When there are positive indications of hereditary scrofula we must pay especial attention to the general condition of the patient in forming our prognosis, particularly to the condition of his bodily development and the state of his nutrition; and partly to the conditions which surround him and the possibility of removing unfavorable influences. With regard to the disease of the eye itself, the prognosis depends, in the first place, upon the alterations already found or imminent, especially on the cornea; and, secondly, on the surroundings and conduct of the patient. The most violent and obstinate blepharospasm, in itself, need not frighten the physician; only large (especially central) or confluent

ulcers are dangerous; and these appear and run their course, as a rule, with relatively slight irritation, for which reason they are designated as torpid. They spread and deepen, now imperceptibly, again rapidly, and, notwithstanding the most careful nursing and treatment, sometimes result in the destruction of the cornea; this termination the author has only observed in cases of manifest scrofula. The superficial efflorescences offer some hope of reabsorption, even when presenting considerable diameter, so long as they have not developed into larger ulcers (*vide* Keratitis). The other principal points of prognosis are mentioned in the description of the symptoms and course of the disease.

Treatment. (a) The "causal indication" first calls our attention to the general condition of the health, especially to the bodily development, the condition of nutrition, special local diseases, such as caries, amenorrhœa etc., and the conditions under which the patient lives, especially concerning his food, dwelling, bodily exercise and the care of his skin. The grossest blunders against the rules of hygiene are commonly committed in children, partly through unfavorable conditions, partly through ignorance and prejudice. Above all, damp dwellings, and sleeping rooms deprived of fresh air and sunshine must be mentioned as injurious to health. The rooms are often damp and musty, on account of poor building material, or because they are occupied too soon; often on account of their deep, half subterranean location; often on account of their being overcrowded, and because washing and cooking are often carried on in them; in many cases this is true only of the room used as a sleeping room, because it is not heated and is warmed from the adjoining room, which is used for cooking and washing, and thereby the air becomes more or less damp and foul. Even persons in good circumstances often use the most unfavorably situated room as a nursery. They are the very breeding centres for scrofula, not solely for the formation of mould, which may be easily recognized by the musty odor and by its appearance on shoes.

Mistakes against proper ventilation and exercise in the open air are committed, if not previously, certainly from the moment a child suffers from photophobia. Then the windows are anxiously closed and curtained until the room is completely darkened, the little ones are allowed to hide their faces against the

breast of their nurses, or in the bedclothes, or the eyes are bandaged. People are not aware that the photophobia is increased by such procedures, and that the clothing moistened with perspiration and tears causes excoriations, or eczema, which again reflect the irritation to the trigeminus. The physician who does not see these sins against hygienic laws, need not be astonished if his medicines are of no avail. After remedying these mistakes it is scarcely ever necessary to resort to those measures which, to most laymen, appear more or less cruel, as forcibly opening such eyes to the full daylight for several minutes, or immersing the faces of the children in cold water for a few seconds. It is fortunate for the children of poor parents that they have to be brought daily to the office of the physician.

Regulation of the diet is no less important. Above all, regularity in eating is to be insisted upon. It is not difficult, as a rule, to convince unprofessional people that frequent and untimely feeding, or sweetmeats, are injurious to children; very often when parents complain of the want of appetite of the children, it is found that irregularity in eating is the sole cause. Many physicians think that such children should be fed exclusively on an animal diet and be allowed to drink wine or beer. With poor people this is usually impossible, and for the wealthy often not at all salutary. As a rule, meats are more easily digestible than vegetables, and a much smaller quantity suffices as nourishment. But if meat is eaten with aversion, as, for instance, the raw meat at present so much recommended, or, if it has lost more or less of its digestibility by its preparation (as corned meat, sausage, fried in butter, etc.), or on account of too much fat, many kinds of vegetable food (except leguminous plants, sauerkraut, nuts, almonds, etc.,) are decidedly preferable. Food which is difficult to digest has a detrimental effect upon the formation of the chyle and the blood only in connection with want of fresh air and outdoor exercise; and even the best food may cause a state of poor nutrition if the children are overfed, or allowed to have food and sweetmeats whenever they wish. Children in the country thrive excellently upon an almost exclusively vegetable diet (potatoes, bread, perhaps a little butter and milk).

Concerning the care of the skin (cleanliness), the time is past when it was considered best not to treat cutaneous eruptions of

the head and face; we now know that their cure exerts a favorable influence on the general health and on the diseases of the eye. Baths (warm or cold) are, as a rule, not well borne during the inflammatory stage; later they may be of decided benefit in the treatment of the constitutional disorder. It is not necessary to discuss here the cure of the general disease by means of medicine, which, as a rule, can only be attempted after the inflammation of the eye has subsided. (*b*) *Indicatio morbi*.—Of all the local symptoms, photophobia and blepharospasm especially demand treatment. In the first place it must be ascertained that they are caused by the inflammatory process, and not by a foreign body, or by inverted cilia (sometimes at the outer canthus). If, on account of great photophobia, the examination of the conjunctiva is difficult, we should not desist on account of the struggling of the child. It should be taken on the lap of an adult, its hands held, and its head placed upon the knees of the physician, when the palpebral fissure can be easily opened, either with the fingers or by means of Desmarre's elevators. Although these symptoms are often disproportionate to the alterations perceptible upon the globe, and though they may occur in a very high degree when we can only find a dense reticulated redness of the tarsal portion, but no eruption upon the eyeball, they yield, as a rule, to the remedy generally applied only in cases of manifest eruptions. This remedy is the dusting in of dry calomel powder (*via sicca parati*) on the conjunctiva of the lower lid, but without strictly avoiding the ocular conjunctiva or the cornea. By the continued daily application of this powder, not only the above symptoms, but also the exudation upon the eyeball diminish, and the tarsal conjunctiva also finally loses its abnormal injection. If the palpebral conjunctiva has once become pale the patient is not likely to have a relapse soon.

As a prophylactic measure it is, therefore, advisable to dust the calomel in the second eye also, as yet free from efflorescence. In order to allow the calomel to fall upon the everted lid as an impalpable powder, it is necessary to hold the camel's-hair pencil two or three inches from the eye while tapping it with the finger, and the lid should be held everted for a few seconds longer. If the calomel is dusted in too freely, or the lid allowed to re-adapt itself too quickly, lumps of calomel may be formed, which, con-

verted into corrosive sublimate, act as a caustic and produce an eschar. As this may possibly occur even when it was thought that the manipulation was made with the greatest care, the conjunctiva should be most thoroughly examined before each application, to see whether it shows any eschars or raw places. For this reason the application should not be entrusted to an unskilled person. A contraindication for the use of this remedy is the appearance of corneal ulceration. An ointment of hydr. ox. flav (0,15 to 0,25) with vaseline (5,0) does just as well; a small portion, the size of a pea, is placed daily in the conjunctival sac or applied to the lower palpebral conjunctiva. Both remedies are to be avoided in cases of progressive corneal ulceration; and the same may be said of a solution of corrosive sublimate, which under the name of aqua Conradi enjoys a great reputation, though it is somewhat uncertain in profuse lachrymation, because it is washed away before it has time to affect the tissues. In cases in which the dusting in of calomel or the application of the mercurial ointment is insufficient or cannot be applied by the physician himself, and especially in cases in which these and similar remedies are contraindicated, there is probably no better means of overcoming the photophobia and blepharospasm than by the application to the forehead of an ointment of ext. belladonnæ with ung. ciner. or the white precipitate (or mur. cocaine, 4 per cent. solution.—TR). Care must be taken that the salve is rubbed into the whole forehead, from the eyebrows to the scalp and from one temple to the other, which should not be wiped off with the hands or the clothes, etc. This is most easily prevented by a simple paper shield, readily made from a quarter sheet of well-sized paper, and a small piece (about three quarters of a yard) of tape. The strength of the ointment may be—

Ext. bellad.....	0,4 -8
Ungt. hyd.....	5,00

Should it be necessary to continue the application for some time the white precipitate may be substituted and may be used in the following proportions:—

Ungt. simp.....	5,0
Ungt. hyd. pr. albi.....	0,3-5

If eczema appears in the places where the ointment is applied its use must be discontinued; usually however, with the appearance

of the eczema the photophobia disappears. The instillation of a one per cent. solution of atropine has little effect upon the photophobia, as the copious lachrymation prevents its absorption. The application of a stronger solution, or the placing in the conjunctival sac of a few grains of dry atropine (the neutral sulphate) is only admissible when the patient is capable of complaining of the toxic effects, as bitter taste, dryness in the throat, etc. These stronger applications, therefore, should not be used in young infants.

If a catarrhal conjunctivitis with a copious secretion exists at the same time, it is advisable to apply a weak solution (about $\frac{1}{2}$ per cent.) of nitrate of silver to the palpebral conjunctiva. Excoriations of the skin, in consequence of maceration, and exfoliation of the epidermis (the effect of moisture and eczema), which usually accompany photophobia, are generally healed in a few days by the use of a strong solution of nitrate of silver. When the eczematous crusts extend over the face or scalp the application of an ointment of white precipitate and oxide of zinc is very beneficial (hyd. præc. albi, oxidi zinci, āā 0,25 ungt. simp. 5,00). This may be applied at bedtime, and the softened crust may be carefully removed in the morning with lukewarm water. Small tents of charpie impregnated with this ointment may be placed with advantage in the tumefied and encrusted nostrils. Regarding the treatment of eczema with ungt. diachyli albi, with ol. jecoris, etc., the author has had little experience. The blepharitis frequently accompanying the conjunctival affection sometimes disappears with it under the same treatment, while in many other cases it persists obstinately. The special treatment necessary in the latter case will be considered under diseases of the lids.

If lymphatic conjunctivitis appears in the form of pannus, with copious eruptions and vascularity of the cornea, the same local treatment is indicated as in the isolated efflorescences; and the local irritant remedies are only to be avoided in progressive corneal ulceration. The conjunctivitis in the form of vascular ribbons (Gefäßbändchen), together with the symptoms of irritation, also yield most readily to the dusting in of calomel or to yellow mercurial ointment. When this cannot be repeated sufficiently often, the ointment recommended by J. N. Fischer may

be of service; (hyd. præc. albi, 0,20 to 0,40, ungt. simp., 5,00), to be rubbed upon the surface and borders of the lids during sleep. Only in cases in which the exudation is very extensive and the vascular layer very thick, is it advisable to divide the vascular leash by two or three transverse incisions near the corneal border. The treatment of corneal ulceration and its complications will be considered under Keratitis.

In every individual case the general condition of the patient and his circumstances must determine what remedies, if any, should be administered internally.

VI. CONJUNCTIVITIS EXANTHEMATICA.

Inflammatory Diseases of the Conjunctiva in Acute and Chronic Exanthemata.

Like the mucous membrane of the respiratory tract the conjunctiva and the conjunctival layer of the cornea participate in the exanthematous process.

In scarlet fever only a hyperæmia of the conjunctiva is noticed; more rarely the symptoms of catarrh.

In measles catarrhal conjunctivitis with especial sensitiveness to light is an early and almost constant symptom. The eye is not thereby injured, as the catarrhal symptoms disappear of themselves in two or three weeks, although in some cases an exceedingly troublesome sensitiveness to light frequently remains for months without any manifest alterations in the tissues. In some cases much benefit is derived from the application of the white precipitate ointment, together with the collyrium adstr. luteum, in the same manner as in catarrhal conjunctivitis (*vide* page 23). Sometimes the difficulty yields to the application of the eye douche, sometimes to washing with diluted French brandy (1-2 of water) or Romershausen's essence (ol. æthereum fœniculi in spir. vini solutum). In some cases muscular weakness (insufficiency of accommodation, or of the internal recti) seems to exist, as the difficulty gradually disappears after general invigorating treatment, as by lukewarm or cold baths, sea bathing and outdoor exercise with a good nutritious diet.

When, in variola, papules or pustules appear upon the conjunctiva at the beginning of the eruption upon the skin, or before the stage of defervescence, they may be regarded as variolous pustules

upon the conjunctiva, though they differ more or less, in form and course, from the cutaneous pustules. They are found most frequently on the anterior portion of the ocular conjunctiva, especially the limbus; then on the tarsal conjunctiva, near the inner edge of the intermarginal border, where they easily cause a permanent deformity of the tarsal border by the subsequent cicatrization. The efflorescences on the eyeball result in permanent changes of the cornea only when they are situated in the limbus, and when the suppuration extends more or less into the corneal substance. Efflorescences do not appear upon the cornea within the limbus, but metastatic abscesses occur there during the stage of involution of the cutaneous eruption (after the period of defervescence), as already observed by Beer, though he considered them variolous pustules. According to Hans Adler¹ variolous efflorescences also appear upon the caruncula lachrymalis, and in the semilunar fold. Adler rightly emphasizes the fact that the exanthematous eruption on the conjunctiva, which first appears on the tenth day (or later) after the cessation of the primary eruption, cannot be considered as conjunctival variola. As worthy of notice he further points out "the well confirmed appearance of variolous pustules upon the conjunctiva before the appearance of variola upon the skin." Variola endangers the eye only through eruptions on the limbus or through subsequent disease, especially corneal abscess.

The herpetic efflorescences on the eye in herpes facialis or in herpes zoster belong, strictly speaking, to the conjunctiva as the continuation of the skin, although they usually occur only in the cornea.

(a) Facial Herpes (*Herpes facialis* (Hebra). Limpid vesicles, similar to those on the lips, appear on the eyelids, and the ocular conjunctiva (properly speaking on the cornea), which very soon burst and may, therefore, be often recognized by their sequelæ—abrasions of the epithelium or superficial ulcers. The diagnosis is facilitated if the vesicles or small ulcers occur in groups—three or five or more together—if, during the existence of such ulcers, new efflorescences (small vesicles) appear—if herpetic efflorescences appear on the face, either previously or simultaneously—if a

¹ Die während und nach der Variola auftretenden Augenkrankheiten, Wien, 1874.

febrile disease, as pneumonia, bronchial catarrh, intermittent fever or intestinal catarrh has preceded; and finally, if other diseases of the cornea, especially scrofulous conjunctivitis with corneal efflorescence, can be excluded. The diagnosis may be rendered considerably more difficult when the original round ulcers, as large as a poppy or a millet seed, change their form and extent by coalescence, or by spreading in one or the other direction, or by penetrating deeper, give rise to hypopyon. When this does not take place, the affection does not endanger the eye, but usually disappears within a few weeks, though sometimes it remains troublesome for months. The primary disease probably has some influence upon the duration. In the local treatment a properly adjusted protective bandage, together with the instillation of a solution of atropine, plays the principal rôle; at the beginning of cicatrization an ointment containing white precipitate or the yellow oxide of mercury may prove beneficial.

We are indebted to Horner¹ for the first detailed description of this disease, he having read a paper on it in 1871 before the Heidelberg Society. A dissertation on the subject appeared under his special supervision in 1880. A teacher, twenty-nine years of age, previously healthy, complained, in the middle of January, of pain and redness in the left eye, which became dim on the fourth day. When, on the eighth day, he came into the hospital, there was extraordinary sensitiveness to light. The examination showed slight redness and swelling of the upper lid along the border, a dense reticulated injection of the ocular conjunctiva, under it a moderately extensive, yet intense ciliary injection upon the cornea, which was otherwise intact, four small nodules as large as poppy seeds, one about the centre, another two mm. higher, one towards the temple, and one towards the nose, forming a horizontal rhomboidal figure. The contents of these efflorescences was not limpid, but somewhat gray (turbid from the epithelium?); the surrounding cornea, and especially the portion of the cornea between them, was scarcely hazy. Further examination revealed two efflorescences on the intermarginal border of the upper lid, and one on the cutis, near the cilia; the latter had already burst, and was represented by a small yellow

¹ Horner in Zehender's klin. Monatsbl., 1871, pag. 321. Josephine Kendall über Herpes corneæ, Inauguraldiss., Zürich, 1880.

crust. A solution of atropine was dropped into the eye, and, after calomel had been dusted in once without effecting any change, a compress was applied. After a few days the nodules gradually became smaller, and after eight days of treatment nothing more was noticeable, except shallow depressions (abrasion of the epithelium), when the patient returned to his home. In another case, that of a man thirty years of age, from Wieselburg, who for several weeks had had inflammation, accompanied by photophobia and dimness of vision, were found five isolated superficial ulcers, as large as poppy seeds, on the right cornea. The patient remembered having had intermittent fever, and an examination of the spleen revealed considerable enlargement; he was therefore kept in Vienna, and treatment at once begun by the use of atropine, pressure bandages, and regulation of the diet, together with the use of Carlsbad water. A boy, ten years old (blonde, with a delicate skin), was received at the hospital, November, 1877, on account of enuresis, and on the fifteenth was transferred to the eye ward, because of inflammation of the left eye. We found, in the first place, a great number of herpetic vesicles (about 20) on each lower lid, measuring 2 cm. in the vertical and 3 cm. in the horizontal diameter; on the right side between the orbital border and the free edge of the lid, on the left side, further down towards the malar bone; furthermore, on the right half of the lower lip a vesicle of the size of a hemp seed, with yellowish pellucid contents; on the left corner of the mouth and below the nasal septum, similar efflorescences, which were partly dry. The left eye was a trifle more closed than the right, somewhat reddened and swollen. Slightly prominent grayish spots from former efflorescences were found on the intermarginal border of both eyes (in the nasal portion). Around the cornea there was intense ciliary injection. At the upper portion of the limbus there was broad, dense injection, and in places filled with sand-like nodules, the marginal zone of the cornea being slightly clouded. On the cloudy zone, especially in the upper portion, fine vesicular elevations could be seen, similar to those situated in the limbus. The centre of the cornea was dimmed and covered with a small group of more diminutive vesicles. The next day the vesicles had burst and showed in the midst of the cornea a superficial depression, the edges of which were

marked, here and there, by shreds of epithelium. On the following day a similar abrasion was discovered below and outwards from the central one described above. After eleven days every trace of the eye and skin disease had disappeared, with the exception of the superficial depression in the centre of the cornea and the one outward from and below it. The boy was discharged, about the last of November, cured.

(b) Much more serious are the cases of Herpes zoster ophthalmicus when the globe itself sympathizes, either directly or indirectly. The inflammatory process here also—as in the skin—extends deeper into the tissue of the conjunctiva or the cornea if an efflorescence appears upon the eyeball. According to Horner's observations limpid vesicles begin to appear in groups, the cornea is insensible to the touch and the tension of the globe is perceptibly reduced. Although Horner compares the loss of substance, after the bursting of the vesicles, with the superficial exfoliations after injury, still he remarks (Kendall, Dissert., p. 26) that the base of these ulcers become more easily and rapidly infiltrated with pus, and that complications, especially hypopyon, occur more readily than in cases of catarrhal Herpes (Herpes catarrhalis facialis). In a case under the author's care, after the disappearance of the cutaneous affection there remained upon the cornea, near the nasal border, a clean, shallow ulcer, which did not heal until after three months' treatment with atropine and the pressure bandage, and then left an opaque cicatrix as large as a hemp seed. The keratitis resulting from an efflorescence on the eyeball should be well differentiated from suppurative keratitis produced by imperfect closure of the lids, especially during sleep, in consequence of the diminished sensitiveness of the portion supplied by the trigeminus (*vide* Keratitis ex lagophthalmia).

(c) Only one case of herpes iris conjunctivæ has as yet been published from the author's clinic. A man 57 years old presented himself on account of inflammation of the eye, which might have been mistaken for catarrhal conjunctivitis had it not been for a grayish exudation on the tarsal conjunctiva, near the free border of the lower lid. The conjunctiva of the retrotarsal portion was only slightly swollen, and diphtheria or acute blennorrhœa could not be considered, as the acute disease had already commenced five days previously, and there was but little swell-

ing and almost perfect immunity of the ocular conjunctiva. An affection of the skin of the lower lip (near the right corner of the mouth) was noticed, but was not further examined. After the patient had been in the hospital for eight days it was evident that it was not a case of syphilis. The entire conjunctiva of the upper and lower lid was found covered with a thin, grayish-white, firmly adherent membrane. In addition to this there was found in the hollow of the left hand an exanthem, which was recognized as herpes iris. The cutis of the lid was somewhat reddened, but not swollen; the palpebral conjunctiva in places not covered by exudation was densely and uniformly injected and slightly swollen; the white membrane extended on the one side to the retrotarsal portion, on the other to the openings of the meibomian glands. This membrane, which was about $\frac{1}{2}$ mm. in thickness, could be torn off in shreds with forceps, whereupon bleeding and a rapid regeneration of the membrane ensued. The retrotarsal portion of the conjunctiva was only slightly injected and not specially swollen; the ocular conjunctiva was normal; the secretion muco-purulent and the vision undisturbed. The affection of the mucous membrane of the mouth appeared two days later than that of the conjunctiva. A membrane, in some places grayish, in others pure white, covered the greater portion of the mucous membrane of the mouth. The upper and lower lips, with the exception of the median line, were covered with large white patches, extending almost to the cutaneous border, and dried to a crust where they were exposed to the air. The membrane extended from the corners of the mouth on the inner surface of the cheeks to the arcus palato-glossus; it covered the posterior portion of the hard palate, the soft palate and the uvula, in the form of irregular plaques; the point of the tongue was free; but along the edges the membrane extended far back, and the upper and under surfaces also showed some plaques. On the frenum were several plaques in the form of a crest 2 to 3 mm. high. Here also, as in the eye, the membrane could be detached in shreds. On account of the painfulness of the oral affection the patient had eaten very little since the disease began, and perhaps for that reason was somewhat debilitated. The odor of the breath was that of fresh pus. The secretion of the saliva amounted to between 300 and 400 grammes in twenty-four hours; it con-

tained no abnormal constituents. The nasal and faucial cavities, as well as the larynx, showed no signs of a morbid affection. The exanthem of the skin appeared seven days after the affection of the eye. The patient felt an itching in the hollow of the left hand; the next morning it was covered with a series of well developed efflorescences divided into two groups, one on the thenar, the other on the hypothenar region; the former extended over the extensor surface of the thumb to the back of the hand. The more recent efflorescences consisted of a hyperæmic disc, varying in size from a millet to a hemp seed; they were not especially prominent above the level of the skin, and showed in their centres a dark red spot (a slight hemorrhagic exudation). After a short time a light-colored ring began to form around the red disc, the epidermis being raised by some serum. This elevated ring of epidermis was again surrounded by a red areola. As the efflorescences developed further there were four concentric rings (two white and two red) about the central hemorrhagic spot. The disease ran its course almost without any fever. On the second day the membrane covering the-tarsal conjunctiva of the upper lid was detached in places and disclosed the vividly red conjunctiva, deprived in a great measure of its epithelium. These red blotches appeared covered in the centre by a veil-like cloudiness, caused by the new epithelium, which was regenerated from the centre towards the periphery. On the sixth day after the admission of the patient the greater portion of the conjunctiva was free from the membrane, except the inner border of the lid. Three days later the membrane had entirely disappeared, and a slightly hyperæmic condition of the palpebral conjunctiva, with a somewhat more pronounced prominence of the papillæ, was all that remained of the disease. The exanthem of the skin, which on May 2d had begun in the hollow of the left hand, appeared next day also on the back of the right hand, then in groups on the outside of both elbows and on the soles of both feet, and, finally, some efflorescences appeared upon the fingers of both hands, several of which terminated abortively, others developing into large vesicles filled with turbid serum. The patient was discharged on the 27th of May.

Ocular Eczema (Eczema bulbi).—Simultaneous with eczema of the face there are found efflorescences in the anterior section

of the conjunctiva, especially in the limbus and even upon the cornea, which resemble the eruption of lymphatic conjunctivitis, and probably are nothing more than modified eczematous efflorescences upon the eyeball. This view is justified where the eczema occurs upon the face of persons free from the scrofulous diathesis. The author has seen several cases of eczema (vesicular or pustular) in which persistent blepharospasm existed, with insignificant or even no efflorescences on the eyeball, and subsided in a few days under proper treatment of the cutaneous affection; in eczema impetiginosum, on the contrary, many weeks may be required for its removal.

Conjunctival pemphigus is an exceedingly rare disease. The author has seen but two cases, and they had already run their course. The formation of blebs has only been observed upon the palpebral and the adjacent portion of the ocular conjunctiva. They rupture much sooner than those of the cutis. It is, therefore, quite possible that only the subsequent alterations may occur, unless the formation of blebs is repeated in other places during the medical treatment. After the exfoliation of the cuticle enclosing the turbid liquid the corresponding portion of the conjunctiva appears covered with a grayish-white, firmly adherent membrane. After its deliquescence and elimination there occurs either contraction of the affected portion, and consequently a shortening of the conjunctiva, or an adhesion, if two raw surfaces come in contact. The final result may therefore be a shortening of the conjunctival sac (even with an alteration in the form of the tarsus), or a more or less extensive symblepharon, as it occurs in an acute manner after cauterization, scalding, and diphtheria, or in a chronic form after chronic conjunctival blennorrhœa.

In the case of an old man who had been repeatedly treated for syphilis, and who was in a very poor condition, not only the conjunctiva of the four lids, but also the ocular conjunctiva of both globes, was covered with a light gray, firmly adherent membrane, while the cornea appeared quite intact, and the skin of the lids was scarcely reddened or swollen. This affection had been referred to the inveterate syphilis, until a dermatologist recognized it as pemphigus cachecticorum. It was now easy to recognize in the eye disease the same process which White Cooper,

DeWecker, Hassan Effendi Mahmoud, Pflüger and others had described.¹

The second case was that of a child, four years old, of healthy parents, which was presented on Nov. 18, 1880, on account of a disease of the right eye. The palpebral fissure could only be slightly opened, as there was an extensive union of the palpebral with the ocular conjunctiva. The grayish-red and thickened conjunctiva passed from the lid borders almost directly to the globe, so that instead of the natural conjunctival sac, there was only a shallow groove, which, moreover, towards the temple was shortened by an ankyloblepharon. Of the cornea only a small portion near the inner border was visible, the greater portion being covered by the conjunctiva, so that nothing definite could be ascertained as to the condition of the tissues. The patient was well until Christmas, 1879, when, after a febrile movement, numerous vesicles of the size of a pea and larger broke out over her entire body, especially on the head; some were filled with a clear, others with a purulent fluid. These dried up to scabs, while new ones appeared in other places. About April 1st, when there were still some sore places, a new general eruption occurred, this time the bullæ being filled with pus. A third eruption occurred in August. During the first eruption the left eye was attacked by inflammation, the right eye during the second. The left eye recovered and was not subsequently affected. On the 18th of June the disease of the right eye was considered as catarrhal conjunctiva, and treated first with aqua Conradi and later with a solution of nitrate of silver. The mother was unable to say, when she presented the child on the 18th of November, whether vesicles had ever appeared on the lids or the conjunctiva.

Cooper's case was that of a young woman, 24 years of age, of an unhealthy, chlorotic appearance. She suffered from hoarseness and had had chronic pemphigus for several weeks. Large vesicles appeared upon her arms and legs, and caused severe pain. The right eye was attacked, a week before her admission. A large bleb had formed, partly upon the inner surface of the

¹ White Cooper, Pemphigus of the conjunctiva, *Ophth. Hosp. Reports*, 1858. Nr. 4. DeWecker, in *Zehender's klin. Monatsbl.*, 1868, pag. 232. Hassan Effendi Mahmoud, *Monographie du Pemphigus*. Paris 1869, pag. 101.

lower lid, and partly upon the globe, the vesicle having ruptured and left an ulcerating surface. Cooper applied a weak solution of nitrate of silver to the eye twice a day. A week later the right eye was considerably better, but on the left eye he found, near the inner canthus, a vesicle as large as a pea, filled with turbid serum, like those caused by scalding. It was opened with a needle and a solution of nitrate of silver was applied. For three months, first one eye, and then the other, and other parts of the body also, were the seat of vesicles in various stages of development. When the patient presented herself again after two years' absence the affection of the skin had quite disappeared, and, without knowing anything of the history of the case, it might easily be assumed that some powerful caustic, such as lime, had affected the eyes. On the right eye a fleshy mass extended from the caruncle outwards along the inner surface of the lower lid, to its centre, and was adherent to the globe by its apex, near the inner margin of the cornea. There were a number of smaller adhesions between the lid and the globe, and the outer canthus also was united to the eyeball. The left eye showed a large fold, similar to a pterygium, extending from the caruncle and the inner border of the lid towards and on to the cornea. There were also several small adhesions between the eyeball and lid. Pflüger has described a case of pemphigus foliaceus with affection of both eyes, in an essay on pemphigus conjunctivæ in Zehender's *klin. Monatsbl.*, 1878, pointing out other cases also.

Acne of the face (*A. rosacea* et *A. mentagra* s. *sykosis*) is quite often followed by efflorescences upon the ocular conjunctiva or upon the cornea, which rarely persist for a long time, but usually break down after a few hours, forming small, circular ulcers. These have, though only for a short time, a gray coating, and usually continue for weeks or months without any particular tendency to spread, maintaining a more or less irritated condition of the eye. In some cases true blepharospasm exists. In many cases the tarsal conjunctiva is at the same time intensely reddened, and in some places the follicles of the meibomian glands become obstructed, representing a true chalazion. The inference that these alterations in the eye are the result of the affection of the skin is confirmed by the frequent observation that they gradually disappear after the successful treatment of the

skin disease,¹ but only to re-appear with each fresh eruption and to continue until the acne of the skin is permanently cured. In the case of a lady, whom Prof. Hebra had successfully treated a year previously, for facial acne, with simultaneous affection of the eyes, the author found two papular eruptions in the limbus on the temporal side of the right eye, and not far from them a similar papule upon the cornea, on the third day of the affection of the eyes; these disappeared, during the treatment of the skin disease, by the dusting in of calomel, which the author applies in this form even when there are ulcers present, which usually appear quite clean. Formerly the author was in the habit of applying the following mixture to the affected portions of the face in the evening, by means of a camel's-hair pencil: Acidi sulph., acidi mur., āā 4.0; lac. sulph, 8.0; aq. font., 400.0. At present he prefers the rubbing in of an ointment proposed by Kaposi—

Oxidi. zinci,
Hydrarg. ammo. pr.....āā..... 2.0
Ungt. simp..... 50.0

In papular syphilide on the forehead the author has several times seen papules on the ocular conjunctiva (in or near the limbus). They gradually disappear under general treatment without ulceration, and without any other affection of the eye during the resolution of the skin disease.²

I never saw the conjunctiva affected in pityriasis nor in psoriasis, as reported by Blazy³ and by Ferrier,⁴ nor have I met with a case of leprosy of the eye.⁵

That lupus vulgaris (Willani) not only encroaches upon the palpebral conjunctiva from the skin of the lids, but may first appear upon the conjunctiva and then later upon the face, was distinctly stated by the author at the meeting of the ophthalmolo-

¹ Arlt über Akne rosacea und Lupus conjunctivæ in der Heidelberger Versammlung, Zehender's klin Monatsbl., 1864, pag. 329.

² A gummy tumor on the ocular conjunctiva, which, as the symptoms of syphilis were less pronounced, might have been considered an epithelioma, is described in Zehender's klin. Monatsbl., 1870, page 259.

³ Blazy de la conjonctivite pityriasique, Archives gén. de méd., 1874. Mars, page 304.

⁴ Ferrier, Psoriasis de la conjonctive, Archives gén. de méd. 1876, p. 91.

⁵ Sylvester, Tuberc. lépreux de l'œil, Ann. d'ocul. 1871, p. 235.

gists in Heidelberg, in 1863. Since that time the number of observations relating to this fact has increased. Even in those cases in which no eruption of lupus can be seen anywhere on the skin, this affection of the conjunctiva can be diagnosticated partly by the characteristic ulceration and partly by the exclusion of ulcers caused by other diseases (as syphilis and tuberculosis of the conjunctiva). On the inner surface of the affected and thickened lid we find a more or less extensive ulcer characterized by a relatively slight secretion of pus, by elevated, soft, easily bleeding, dark red granulations, which lap over the adjoining surface of the conjunctiva. The proliferations at the base of the ulcer often appear constricted by fibrous threads. After a thorough cauterization of these proliferations the ulcerated surface finally appears like a network of fibrous threads, its meshes being covered by a smooth, thin cuticle. By the contraction of the conjunctiva caused by this cicatrization, the cilia, or even the border of the lid, may be inverted. During the existence of this affection of the palpebral conjunctiva (on one or both lids) eruptions appear, from time to time, on the ocular conjunctiva, or on the cornea, which closely resemble those of scrofulous conjunctivitis, but which show a greater tendency to extend both superficially and in depth. Of the persons treated at the author's clinic the youngest was five, the oldest twenty years of age. A permanent cure was obtained only after several months of treatment by the regular application of lapis infernalis, and by regulation of the diet; generally with the internal administration of cod-liver oil. A similar clinical appearance may be seen in tuberculosis conjunctivæ (*vide* Section VIII), in syphilis (Tarsitis, *ulcus conj. induratum*), and even in carcinoma of the palpebral conjunctiva (*vide* Epithelioma and sarcoma conjunctivæ). Two instructive cases of syphilis are reported in Zehender's klin. Monatsblättern (1876 Beilageheft), and a third on page 166.

VII. CONJUNCTIVITIS TRAUMATICA.

The conjunctiva may suffer mechanical, chemical or thermal injury.

Foreign bodies, acting mechanically, give rise either to mere symptoms of irritation, as pain, photophobia, lachrymation and abnormal injection, or to inflammation, and tumefaction of the

tissues, and exudation with an abnormal secretion and partial ulceration or proliferation of the conjunctiva; or, finally, to solution of continuity, hemorrhage, extravasation, cicatrization and coalescence of different portions.

Substances acting chemically or thermally, cause, according to the degree of their action, either a superficial or deep loss of substance, and as further consequences, ulceration, contraction and adhesions of adjacent ulcerated surfaces.

The most common foreign bodies found in the eye are small pieces of stone, glass, coal, iron, straw, beards of grain, seed hulls, splinters of wood or bone, cilia or hairs, gunpowder, ashës, chalk, mortar, caustic potash, mineral acids, boiling water, red hot or molten metal, etc. The symptoms arising from such injuries are usually so severe that the patient immediately seeks professional aid, and explicitly designates the cause. It is possible, however, for these symptoms to be present and the patient not know their cause, or the foreign body may not excite any symptoms until some time afterwards, when the patient has forgotten all about the intrusion of the foreign substance or does not think that there is a causative relation between it and his present discomfort. This may especially occur when the foreign body has lodged in the retrotarsal fold. It gives rise either to obstinate photophobia with blepharospasm, or to partial proliferation of the conjunctiva (imbedding of the foreign body), or only to the symptoms of a chronic catarrhal conjunctivitis. The author has seen cases in which the so-called "crab's eye" was placed under the upper lid for the purpose of removing a foreign body (really or presumptively in the eye), and remained there for many months.

If we suspect the presence of a foreign substance in the eye the entire conjunctival surface should be thoroughly examined; in some cases anæsthesia (local—Tr.) is necessary. The patient should never be placed directly opposite the light, but the light should fall obliquely on the eye. Most patients can open and move one eye more easily when the other is closed, either by the hand or a bandage. The lower lid should be first drawn down by the finger (placed upon the corresponding convex border of the tarsus), and pressed backwards whilst the patient is directed to look upwards, thus fully everting the retrotarsal conjunctiva. In more deeply set eyes the retrotarsal portion is more easily made visible when,

the upper eyelid being fixed, the patient is directed to turn the eye strongly downwards, whilst the eye is rotated outwards towards the temple; the semilunar fold and caruncle, where small foreign bodies are sometimes concealed, should be inspected. Small foreign bodies driven into the eye by the wind are most frequently found upon the inner surface of the upper lid. To accomplish their removal the lid is everted; and in order to discover small transparent bits, as of flint or glass, the glistening of the conjunctiva is utilized by lateral illumination, or the finger is moved gently over the smooth conjunctival surface. In order to detect foreign bodies in the upper retrotarsal fold the lid is drawn upwards towards the orbital border, the head being thrown back and the eye turned downwards; or the lid may be everted and the convex border of the tarsus elevated from the globe by means of a Daviels' spoon; or the same instrument may be used for probing behind the everted tarsus. If foreign bodies remain in the conjunctiva for any length of time they may cause abrasions or inflammation of the cornea, which may be mistaken by the superficial observer for a primary corneal disease; especially if the patient is not aware that anything has entered the eye. In the retrotarsal portion, such foreign bodies as stone, wood, straw, hair, etc., are enveloped by the granular proliferation of the conjunctiva, and sometimes discovered only after the unsuccessful treatment of a presumably simple conjunctivitis.

The nature of the foreign body and its position generally indicates how it is to be removed. When it lodges on the surface it may be removed with a piece of linen or a Daviel's spoon; in other cases, as when tobacco, pepper, ashes, etc., have entered the eye, the injection of warm milk or warm water is the best treatment. Fine pieces of glass adhere most easily to a probe wrapped with linen. Deeply embedded and larger bodies often require the forceps. Grains of powder and small bits of metal should be grasped with the forceps and excised with the smallest possible portion of the conjunctiva; such slight losses of substance cause no inconvenience. All the symptoms usually disappear with the removal of the foreign body. If the injury be more severe the application of a cold compress is the best treatment. If there has been at the same time a contusion, a little spirits of wine or arnica may be added to the water.

When a caustic substance (as ashes, lime, etc.), has acted on the eye, we must always see whether there is not some of it left. If we imagine that the lime still continues its caustic action it should be neutralized by dropping into the eye *a solution of sugar*; if it is mortar (lime mixed with sand), all foreign substances should be removed, yet without contusing or injuring the uncauterized portion. If the caustic substance has been thrown into the eye by an explosion, we should ascertain whether other foreign bodies (splinters of glass, hair, etc.), were not also thrown in at the same time. Sheets of molten pitch or lead adhering firmly to the globe may cause considerable difficulty in their removal, even with instruments.

In such cases the instillation of linseed or sweet oil, which gradually penetrates between the sheet and the globe, greatly facilitates the removal. After the removal of the foreign bodies, the prognosis depends upon the extent and depth of the cauterization, and upon whether agglutination between the lid and the eyeball is to be apprehended. The cauterized or scalded spots are simply excoriated or marked by a grayish eschar with swollen and often ecchymotic borders, or covered with granulations. Superficial losses of conjunctival tissue in the retrotarsal or scleral portion are easily covered by the attraction of the adjacent conjunctiva (radiated cicatrix). Deeper destructions, especially when somewhat extensive, produce perceptible contraction of the conjunctival sac, entropion and disturbance of the mobility of the eyeball. Symblepharon cannot be prevented when two raw surfaces come in contact. If the palpebral and the ocular conjunctiva are simultaneously wounded adhesion is inevitable only when the raw surfaces extend into the retrotarsal fold; if this be intact, symblepharon may be averted, in spite of a large lateral extension of the raw surfaces. Attempts should be made to prevent adhesion by the diligent application of cold compresses, by frequently repeated abduction of the lid, and by the instillation of milk, emulsion of quince seed, linseed oil, etc. The introduction of a foreign body into the conjunctival sac to avert the contact of the raw surfaces is at best useless. If adhesion of the lid with the globe (symblepharon), or of one lid with another (ankyloblepharon), occurs, only operative interference is of benefit, and then, as a rule, only after the reactionary symptoms of the injury have subsided.

As a rule, no advantage is to be expected from the continued abstraction of the lid from the globe (artificial ectropion), as the palpebral conjunctiva endures prolonged contact with the air very badly.

*Pterygium.*¹—Pterygium is the name given to a partial degeneration of the ocular conjunctiva, caused by an inflammation, its form resembling the wing of a fly; its base is directed towards the periphery of the globe; its more or less obtuse (or cut off) apex is firmly adherent to the cornea, and its edges are not only sharply defined in the region of the limbus, but appear distinctly folded over, so that it is possible to pass a probe under it for some distance. It attracts attention not only by the spot upon the cornea, but also by its abundance of enlarged blood vessels, which, proceeding from the periphery, converge towards the apex and decrease or disappear in this portion only after the subsidence of the inflammatory process; cicatricial tissue is inseparably connected with the cornea at the apex, or, more properly speaking, with the conjunctival layer of the cornea. In order to understand these anatomical alterations and their further course the consideration of their etiology is necessary.

(a) A rare form of pterygium, and one differing somewhat from that usually seen, occurs in the course of an acute conjunctival blennorrhœa. If there has been a more or less central, perforating ulcer, with a prolapse of the iris, accompanied by chemosis of the ocular conjunctiva, lapping far over the cornea, the conjunctiva adheres to the cornea, and especially to the iris, with which it becomes firmly united during the process of cicatrization; for the epithelium is more or less deficient on the chemotic conjunctiva, and thus two tissues deprived of epithelium come into contact, just as in the formation of symblepharon. If afterwards the chemosis subsides, together with the blennorrhœal process, a portion of the ocular conjunctiva remains fixed on the cornea while the adjacent portion has returned to its normal position. We see a portion of the conjunctiva, triangular in form and with inverted borders, extend from above downwards into the cornea. A curved probe can be passed along the corneal border under this swollen portion of the conjunctiva. If, after

¹ The classification of pterygium and pinguecula among the traumatic inflammations is justified because most of the alterations are of traumatic origin.

the consolidation of the corneal cicatrix, the conjunctiva is dissected from it, it will retract and the swelling will subside. After a few days we find, 5-6 mm. above the corneal border, a radiating cicatrix as the vestige of the portion formerly attached to the cornea. This kind of pterygium may be designated as bridge-like in form.

(b) Pterygia of various forms are observed much more frequently after a partial scalding or cauterization of the ocular conjunctiva and the cornea, and also after diphtheria. Usually the form is only approximately triangular, and the breadth along the limbus is often very considerable, occupying the third or fourth part of the periphery of the cornea, the base frequently extending as far as the palpebral conjunctiva, or even as far as the skin of the lids. In the latter case the cicatricial conjunctival covering of the cornea forms only an appendix of a more or less broad symblepharon, and only the inverted edges in the region of the limbus show that the adhesion of the membrane covering the cornea, is less broad than on the cornea itself; and therefore, that some of the conjunctiva has been drawn over into the cornea. Such pterygia may be developed from any part of the corneal periphery, although they are most commonly observed in the lower half. As soon as a portion of the conjunctiva with the adjacent cornea has become abraded through one of the above mentioned processes, and the conjunctiva becomes swollen to such an extent that its abraded surface comes in contact with that of the cornea, the same conditions are established as in the formation of symblepharon and blepharo-phimosis; the two raw surfaces unite with one another, and the conjunctiva or even the skin is drawn up from the periphery to cover the abraded portion of the cornea. If that portion is once covered there is no danger of a further progress; the entire process is usually completed in a few weeks. Inasmuch as in such a case of pterygium the destruction of a more or less considerable portion of the conjunctiva plays the principal rôle, it may be designated as *accessory*; the usual name, pseudo-ptyerygium, may well be called a misnomer, for they are real pterygia, although formed in an unusual manner.

(c) All pterygia originating otherwise, and these are the most common forms, are found in the palpebral fissure, and generally

on the nasal side of the cornea. They might therefore be named pterygia of the palpebral fissure. Persons with pterygium in one or both eyes are not specially rare. A pterygium on the temporal side is almost always caused either by scalding or cauterization, by blennorrhœa or by diphtheria. If a pterygium appears on the temporal as well as the nasal side, the latter is much more advanced. If three pterygia occur, that of the second eye is situated in the inner canthus. The author has seen four pterygia only in one case, two in the right and two in the left eye. From their occurrence it may be inferred that atmospheric influences have an effect upon the development of the affection. As such influences, are to be designated dust, which, falling upon the conjunctiva, injures it mechanically or chemically (as fine particles of the beards of grain, sand, limestone, etc.), ammoniacal vapors, powder smoke. This kind of pterygium is observed only in persons who are exposed to such noxious influences by their occupation. Such as farmers, day-laborers, masons, potters, coachmen, etc. The senile condition of the conjunctiva must be considered as a predisposing cause, since pterygia of the palpebral fissure occur only exceptionally in persons under forty years of age. This condition of the conjunctiva may be considered as having a greater liability to swell and to be displaced. In older people, with catarrhal conjunctivitis, the ocular conjunctiva is frequently very œdematous; in old persons the ocular conjunctiva laps over the corneal border much more easily when the cornea is cut through with a cataract knife. Considering all these factors, the origin and the course of the pterygia of the palpebral fissure explain themselves. The noxious atmospheric influences affecting the conjunctiva, principally near the cornea and on the nasal side, cause, in the first place, a loss of epithelium, and secondly abnormal injection and swelling of the conjunctiva. If the epithelial layers of the adjacent portion of the cornea have not been simultaneously injured they will more easily suffer by the continuance or re-occurrence of noxious influences, since, on account of the swelling of the limbus, they cannot be so easily removed by winking, from this portion of the cornea. (On this account a pinguecula may also be considered a predisposing cause to pterygium), but if a portion of the cornea together with the adjoining conjunctiva be deprived of epithelium, and if the raw

surface of the conjunctiva come in contact with the abraded cornea, agglutination and firm adhesion is the result, and a point or tip of the conjunctiva is fastened to the cornea. This may be the conclusion of the process; and, indeed, we do find such stationary pterygia. But generally the conditions are such that on the one hand the pterygium advances more and more on the cornea, and on the other drags more and more of the conjunctiva after it. The reason for this is that with the above mentioned occupations the effect of the noxious influences is repeated, increasing the inflammatory process in the conjunctiva, and also affecting the adjoining portions of the cornea, from which, in consequence of the partial elevation of the limbus, foreign bodies are not so easily removed by the lids. Thus the impulse seems to be given for the advance of the chronic inflammation to the cornea. In the conjunctival region the gradual thickening and contraction of the exudation seems to be the chief cause that more of the conjunctiva is always drawn in from the periphery. That the conjunctiva is drawn over on the cornea is evident from the folding of its borders and from the converging lines running towards the cornea (the apex of the pterygium). The portion lying on the cornea is clearly cicatricial tissue, bluish white, tendinous in appearance, and of cartilaginous hardness. It never advances deeply into the *substantia propria* of the cornea.

In the case of pterygia of the nasal canthus the traction towards the cornea gradually obliterates the semilunar fold and draws the caruncula, and finally, also, the conjunctiva, from the region of the canaliculi towards the cornea, thereby interfering with the conduction of the tears and the mobility of the globe. The inflammatory changes advance upon the cornea so long as there are abrasions of the epithelium. In that case the episcleral portion is also found more or less vascular, the palpebral conjunctiva more or less irritated, and often in a distinctly catarrhal condition; the pterygium is progressive. The progress is, as a rule, directed towards the centre, and may even pass beyond it. In three cases which came under the author's observation, the point or apex had advanced outwards and upwards and not towards the centre, the upper border being more folded (more undermined) than the lower, and the above named lines or furrows did not extend centripetally, but obliquely from below,

upwards and outwards. Such cases clearly show that the traction of the muscles has no determining influence upon the formation, form and direction of the pterygium, as Winther thought. That pterygia which have already advanced beyond the centre of the cornea are of relatively rare occurrence, is probably due to the fact that patients rarely wait, before consulting a physician, until "the film has covered the entire pupil;" and partly, also, because far advanced pterygia spontaneously cease to grow. The author has seen two cases in which a pterygium from the nasal side had advanced beyond the centre of the cornea, where it united with one from the temporal side.

A pterygium may become stationary in any stage of its development if the abrasions upon the cornea are healed; to accomplish which it is first necessary to stop the effect of the noxious atmospheric influences. As soon as the deficient epithelium of the cornea is repaired, as soon as there are no more erosions, the vascularity of the episcleral portion diminishes and the advancement upon the cornea is arrested. The disease gives no further annoyance if it has not already caused visual disturbance, impaired the mobility of the globe, or interfered with the conduction of the tears. Disturbance of vision is often observed when the apex has reached half-way between the periphery and the centre of the cornea, possibly by the pressure of the cicatricial tissue upon the adjoining normal portion of the cornea. At that point on the cornea where a pterygium has existed, there remains, even after the most careful detachment, a permanent opacity (a cicatrix), even if no trace of conjunctiva is drawn in to cover the abrasion.

From what has been said, the necessary points for the prognosis and therapy may be deduced. Nothing is to be expected from medical treatment. A well-fitting bandage, to exclude noxious atmospheric influences until the erosions are healed, promises good results, at least in pterygia which are not too far advanced. In the case of a stationary pterygium operative treatment has only a cosmetic effect; in the case of a progressive one, on the contrary, an operation is always to be recommended, even though the pterygium has not yet extended to the middle of the cornea. To those who have declared any operative treatment of the pterygium as useless, even the removal with subsequent conjunctival

sutures, we may say, that relapses may be due, on the one hand, to imperfect detachment of all the diseased portion and inaccurate union of the conjunctival wound, and on the other—and this is probably the more common—to the exposure of the patient to the previous injurious influences before complete recovery has taken place.

Pinguecula.—The yellowish, slightly prominent, and more or less distinctly defined triangular spots occupying the ocular conjunctiva, near the cornea, and annoying the patient by its appearance rather than by any inconvenience, are not caused by fatty deposit, as was previously supposed, but by an inflammatory thickening and condensation of the conjunctival and subconjunctival tissues, in consequence of the continued effect of noxious atmospheric influences. On account of simultaneous alterations of the epithelial layer such a portion may also appear less shiny, or even actually dry, and on account of a certain condensation of the tissues, together with more or less obliteration of the blood vessels, they remain pale even when the surrounding conjunctiva (from whatever cause) is much reddened and swollen. They are always bilateral and on both sides of the cornea, although often developed to an unequal extent. They are absent in childhood and generally in youth, and are most pronounced in prominent eyes. They withstand every form of medical treatment, and never demand operative interference.

VIII. TUBERCULOSIS CONJUNCTIVÆ.

The proof of the (certainly very rare) occurrence of tuberculosis in the conjunctiva was established by microscopical investigation during the last decade, notwithstanding the disease offers so many characteristic symptoms that they point with more or less probability to this process as the cause of the inflammatory affection of the conjunctiva. In default of sufficient personal observations the author will give a description of the disease as given by O. Haab, who has observed six cases himself, and has also made use of the earlier publications of Köster, Sattler, Walb and Herter.¹ The conjunctiva, like synovial membranes, may be attacked by a process distinguished by the formation of prominent granulations as

¹ Die Tuberculose des Auges von Dr. O. Haab in Zürich, Graefe's A. f. Ophth., XXV, 4, p. 163.

bearers of the tubercular nodules. Very frequently we have to do, not only with the local process of the conjunctiva, but also with the manifestation of a disposition affecting the entire individual, as scrofula or tuberculosis. In typical cases the lymphatic system surrounding the eye participates in a high degree in the affection; so much so, that when, for example, the left eye is attacked a simultaneous and often quite acute swelling of the lymphatic glands occurs in front of the left ear, below the angle of the jaw and towards the chin. This enlargement of the lymphatic glands may remain, for a long time, unilateral, as tubercular conjunctivitis generally affects one eye only. "It seemed to us as though in tuberculosis the swelling of the glands and the thickening of the lids occurred simultaneously,—suddenly—without there having been any previous disease of the eye." When the (usually young) patient presents himself our attention is especially drawn to the extreme thickening of one or both lids of one eye. When the process in the upper lid is considerably developed it is three or four times its natural size, and hangs down over the lower lid. The skin of the lids and their surroundings is somewhat reddened, and penetrated by single enlarged blood vessels. This swelling of the lids feels soft and elastic, and when the lid is everted the conjunctiva rolls forth, covered with exuberant granulations. When the granulations are still fresh and intact they have a scarlet or grayish-red color. But when they have existed for some time they degenerate and form, by superficial erosion, uneven, yellowish-red ulcers. A further peculiarity of these proliferations is, that, being flattened by pressure against the globe, they exhibit a moderately nodular surface, but sometimes quite deep fissures; and that those which are situated near and upon the retrotarsal fold fill the fornix in the form of cocks'-combs. The tarsal conjunctiva of the upper and lower lid may remain free, so that the proliferations proceed only from the retrotarsal fold, while the tarsal conjunctiva shows a velvety papillary swelling. A copious purulent secretion is the unpleasant feature of this otherwise painless affection of the conjunctiva; and patients do not usually apply for relief until some time after the beginning of the disease. The cornea may appear intact for a long time; later it becomes pannous. In two out of six cases the mucous membrane of the lachrymal sac was also the seat of

such granulations (as was shown when it was opened). The ocular conjunctiva is very rarely the seat of tubercular infiltration,¹ but if it does occur the granulations are less prominent and the tubercular infiltration is more noticeable, so that the disseminated, grayish translucent granules at once direct our suspicion to the tubercles.² Sattler characterizes the disease as follows: "The lids appear thickened, the palpebral conjunctiva greatly swollen, uniformly red and velvety, the retrotarsal, together with the semilunar fold and the ocular conjunctiva, uniformly reddened and swollen, the latter particularly in the lower half; in this, moreover, we found numerous berry-like prominences similar to those which are seen in trachoma. On the lower border of the cornea, and partly upon the conjunctiva, partly upon the cornea, extending on the latter as far as the central portion, there was an ulcer with an uneven, grayish border. Upwards towards the centre of the cornea was a prolapse of the iris. The upper portion of the cornea was covered with pannus. Neither in the iris (including the portion prolapsed) nor in the choroid did microscopic examination show signs of tuberculosis. Notwithstanding the above described peculiarities it will not be possible, as a rule, to make a positive diagnosis without first excising a portion of the neoplasm and examining it microscopically. From the local appearance alone it might be mistaken for lupus, epithelioma, chronic conjunctival blennorrhœa, or for a syphilitic ulcer. The personal history and an examination of the entire body may give very valuable hints as to the diagnosis. Syphilitic ulcers are generally seen on the palpebral conjunctiva, extending from the intermarginal border towards the retrotarsal portion, but have also been observed upon the ocular conjunctiva. They arise either by direct inoculation of the syphilitic virus (by means of unwashed

¹ Sattler, Heidelberger Versammlung 1877, in Zehender's Bericht, Beilageheft zum 15. Jahrgang, pag. 64.

² In the case observed at my clinic and described by Sattler, the disease occurred in a poorly-nourished woman, fifty-six years of age, and was considered as carcinoma of the eyeball, which was enucleated (after the excision of a small portion of the neoplasm for the purpose of microscopical examination, which, unfortunately, was unreliable). Had I then known that tuberculosis occurring on the conjunctiva might show a certain similarity to carcinoma, I would not have neglected examining more particularly the condition of the lungs. Infiltration of the lymph glands before the ear and on the neck were not present.

hands) or by the deliquescence of a gumma formed in the conjunctiva. In the first case a swelling of the lymphatic glands in front of the ear is observed, but only about the size of a pea or a bean. After they are healed deep scars remain. Among cases of lupus observed by the author, in two cases the lupus appeared during the treatment of the eye disease, on the cheek or on the ala nasi; the affection of the upper or the lower lid was usually more pronounced in the retrotarsal than in the tarsal portion; only once—in the case of a little girl, five years old—it reached the intermarginal border of the upper lid (not, however, as far as the skin) without any swelling of the lymphatic glands, and the disease was cured in the course of a few months by the systematic application of *Lapis infernalis*. If chronic conjunctival blennorrhœa or trachoma occurs unilaterally (bilateral tuberculosis has not yet been observed) the presence of ulcers in the palpebral or ocular conjunctiva may suffice to exclude these diseases; for in trachoma, ulcers only occur within the area of the transparent cornea as far as the limbus; moreover, swelling of the glands is occasioned only by acute conjunctival blennorrhœa. If an epithelioma upon the ocular conjunctiva has already begun to ulcerate, the palpebral conjunctiva may swell very much and even show very striking proliferations; infiltrations of the lymphatic glands, varying in size from a pea to a bean, may also have occurred. In this case probably only a microscopic examination of an excised portion can furnish positive information.

This local, or rather chronic, tuberculosis is, according to Haab, by no means to be considered among the harmless affections, though the statement of Hüter, that where local tuberculosis exists life is in the greatest danger, cannot be accepted as sufficiently proved. That the conjunctival disease may be very obstinate and very troublesome, and may even endanger the eye by implication of the cornea, is certain, from the history of many cases. The local treatment is about the same as in lupus of the conjunctiva.

B. NON-INFLAMMATORY AFFECTIONS OF THE CONJUNCTIVA.

I. WITHOUT MARKED ALTERATION OF THE CONJUNCTIVAL TISSUES.

1. Among these affections we may mention, first, *epithelial xerosis* (Sämisch), which occurs in the palpebral fissure, especially in the temporal portion of the ocular conjunctiva, and is observed most frequently in poorly nourished individuals, affected with hemeralopia (resulting from dazzling light). A triangular portion of the conjunctiva (like pinguecula, only generally much larger) appears dry, and as if coated with grease, and therefore incapable of being moistened; sometimes it is covered with small, white scales, whilst the adjoining moist portion of the conjunctiva is slightly opaque, grayish-yellow, and penetrated by several vessels. This condition creates no especial trouble, is only incidentally noticed by the physician, and recedes without any noticeable consequences. It is anatomically easily distinguished from the parenchymatous xerosis occurring more or less extensively after inflammatory processes in the conjunctiva or in the cornea.

2. *Subconjunctival Ecchymosis*.—If blood has been effused between the conjunctiva and the skin, the redness appears, at least in the centre of the effusion, of a uniform tint, dark or bluish-red, since it is covered by the semi-transparent subconjunctival connective tissue, and never reaches to the limbus, which, firmly attached to the corneal border, stands out as a white or grayish-white line (arc). Pingueculæ also are not affected by the blood, but remain uniformly light-colored (grayish-white) or punctated. Such extravasations occur very often after traumatic lesions of the eyeball or its surroundings; often also after a momentary vascular engorgement in the superior vena cava (by coughing, sneezing, etc.), frequently in children with whooping cough, and in persons of advanced age, after more trivial causes. They only cause a temporary disfigurement, and disappear spontaneously in a week or two. Alcoholic fomentations may be applied without harm.

3. *Non-inflammatory œdema of the ocular conjunctiva*, as compared with the inflammatory œdema, is a rare occurrence. In connection with a similar œdema of the lids, we see it in a lesser degree in leukæmic individuals, and in a very high degree

in dropsical patients. A sort of chronic œdema is sometimes found in the ocular conjunctiva after scleritis or sclero-keratitis; the infiltrated episcleral connective tissue is somewhat denser to the touch, and the fluid shows no tendency to gravitate. This condition is permanent. After operations on or lesions in the corneo-scleral border, the aqueous humor passes under the conjunctiva to a more or less great extent, and may be mistaken for chemosis. Circumscribed cyst-like prominences in the conjunctiva, after wounds in the scleral border, are caused by the escape of the aqueous humor; they are usually persistent, and will be described hereafter as cystoid cicatrices.

4. *Enlarged and distended lymphatic vessels* appear in the ocular conjunctiva, in rare cases, as transparent, glistening vesicles, grouped like a string of beads, and easily movable together with the conjunctiva; they are more often found in the temporal than in the nasal side, and are also found in eyes otherwise healthy. They cause no inconvenience, but for cosmetic reasons they may be excised, together with a portion of the conjunctiva.

II. NEOPLASMS—TUMORS.

1. *Granulomata and Polypi*.—Partial proliferations, analogous to the granulations of wounds, are most frequently noticed in the tarsal portion of the conjunctiva, in consequence of chalazia which have perforated the conjunctiva. At times they are flat, like buttons; at other times they resemble warts or polypi. Frequently we can find, with a probe, an opening leading into the interior of a chalazion. Usually the opening of the corresponding gland is changed and filled with a sebaceous matter, which can be pressed out like the contents of a comedone. These granulations are usually attended by a chronic catarrhal condition of the conjunctiva, which usually ceases only after cauterization or excision of the granulations, and after a prolonged application of the yellow ointment.

In the retrotarsal portion, probably only after injuries, we sometimes find broad or pedunculated granulomata. These usually envelop foreign bodies, though they may persist after the foreign body has been removed. It may also occur that after the elimination of a pedunculated polypous excrescence it is reproduced, and granulations may also spring from the subcon-

junctival tissue, after gaping wounds or deep cauterizations of the ocular conjunctiva. Well known are those occurring after tenotomy of one of the recti muscles. Their base, at first broad, is gradually narrowed and constricted by the contracting effect of the cicatrizing conjunctiva, so that they are finally attached to the globe by a very thin peduncle. On this account, it is advisable to wait until this phase is reached, and to abstain from premature excision or cauterization; for after the formation of such a pedicle, it is very easy to remove it with one stroke of the scissors.

On the caruncle and on the adjacent horse-shoe-like portion of conjunctiva, bounded by the canaliculi, we find in some cases flat or pedunculated, strawberry-like proliferations, the excision of which is often followed by a profuse hemorrhage; and in spite of an energetic application of lapis infernalis, a similar growth often re-appears, until at last we succeed in permanently removing it.

2. *Cysts below the Conjunctiva.*—The formation of simple serous cysts on the sclera has been observed after blows upon the eyeball. They are easily distinguished from cyst-like prominences of the ocular conjunctiva, occurring after rupture of the sclera (prolapse of the lens or vitreous humor), as they have no broad base, are quite movable upon the sclera, and have clear, watery contents. The cysts containing cysticerci are developed under the ocular conjunctiva, near the retrotarsal fold, gradually and imperceptibly until they become noticeable or troublesome on account of their size. By focal illumination they may often be recognized, even before their removal, by the somewhat hazy envelope, the circle of tentacles, and by the proboscis.

3. *Dermoid and lipomatous tumors* are congenital, and belong strictly to the conjunctiva, even when they extend into the corneal region. Dermoid tumors are usually situated on the temporal, rarely on the nasal, portion, half on the sclera and half on the cornea, and are firmly attached to the subjacent tissues. They consist of epidermis, derma and adipose tissue; they appear dry upon the apex, contain sebaceous and perspiratory glands, and become covered with hair at the time of puberty, if not earlier. (In calves' and pigs' eyes such tumors are thickly covered with hairs from the first.) Seized at the summit with a pair of fine forceps, they may be peeled from the cornea by horizontal in-

cisions of a lance-shaped knife, then the scleral portion may be detached with a pair of scissors. A slight opacity always remains upon the cornea.

Lipomata are probably only found on the temporal portion, and extend into the cornea only in rare cases. In a case described by the author,¹ and in one reported by A. von Gräfe,² the pale, adipose substance extended under the ocular conjunctiva from the upper and outer portion of the retrotarsal fold, down to the cornea, with which the superficial fibrous processes of the growth adhered so firmly that its complete detachment was not possible; while in the sclera the enucleation of the adipose mass (after the incision of the enveloping conjunctiva) could be completely accomplished. Less rare is the occurrence of a fatty tumor which appears like a pouch, or a wedge, between the globe and the upper or lower lid on the temporal side (above or below the outer commissure), betraying its presence by a slight protrusion of the skin, but clearly visible only when the eye is strongly rotated towards the nose. It usually becomes noticeable only after it has attained a considerable size (about the time of puberty). The adipose mass, probably continuous with the orbital fat, is covered by the conjunctiva of the retrotarsal portion and also by a more resisting and less transparent envelope (a continuation of the fascia tarso-ocularis), and can probably never be entirely removed without danger. I have always been satisfied, therefore, with excising the prominent (disfiguring) portion, sparing the conjunctival covering as much as possible, and subsequently closing the wound by sutures.

Only two cases of subconjunctival osteoma have been observed—one by A. von Gräfe and one by Sämisch.³

Although an epithelioma usually extends to the conjunctiva from the skin of the lid, yet there are cases in which the formation of the well-known nodules (round, hard, light yellow or gray) begins in the ocular conjunctiva, at or near the limbus, and may, therefore, be easily mistaken for a conjunctivitis with a circumscribed exudation. The nodules, however, are developed without any marked irritation, particularly without a corresponding ciliary

¹ Bericht über die Wiener Augenklinik, 1867.

² Archiv f. O. VII, 6, pag. 7.

³ Handbuch der gesammten Augenheilkunde, 1876, IV, B, pag. 151.

injection, and increase in size and number only after having existed for weeks or months. Even after ulceration has begun, injection, lachrymation and photophobia may be very insignificant, and the pain be limited to some transient stings. The ulcers, at times, have a very dry appearance, increase by the deliquescence of nodes growing successively in the borders, which become ragged or sinuous. They may have spread very far over the cornea and sclera before they penetrate deeply or perforate the globe. The distinction from syphilitic ulcerations may be difficult, but is always possible, after a time, by the examination of the entire body and the history of the case. When such growths occur upon the ocular conjunctiva it is more difficult, and sometimes even impossible, to differentiate them from conjunctival tuberculosis and from medullary carcinoma, without a microscopical examination. If from the seat and extension of the epithelioma on the ocular conjunctiva, it is deemed possible to excise or scrape off (with a sharp spoon) all the morbid growth without making too large a wound, so that a part of it, at least, may be closed by sutures; the operation should be performed at the earliest possible moment; otherwise, extirpation or enucleation of the globe will be necessary.

Sarcomata have been observed on the palpebral as well as the ocular conjunctiva. Horner¹ found, in a woman sixty-four years old, and very poorly nourished, a medullary sarcoma in the form of a soft, darkly-pigmented tumor, as large as a nut, with an uneven surface, bleeding upon the slightest touch and covering the eyeball from above. It was attached to the middle of the upper tarsal border by a round pedicle almost 2 cm. in diameter, and was in direct connection with the tarsus; whilst the cutis was healthy and could be moved over it with the orbicularis muscle. After incising the outer commissure the extirpation was accomplished from the inside by a single cut with a pair of Cooper's scissors, which removed the pedicle together with a zone of healthy conjunctiva and tarsus. After six days the woman was discharged, and six months later she had completely recovered. Hirschberg² describes as cancer of the palpebral conjunctiva a circumscribed tumor on the upper lid of a man, sixty-two years old. The skin

¹ Zehender klin. Monatsbl., 1871, pag. 4.

² Zehender klin. Monatsbl., 1870, pag. 191.

of the upper lid, which hung down over the lower lid, was traversed by enlarged veins; after eversion a neoplasm appeared upon the conjunctiva as a globular protuberance, the size of half a walnut; its surface was covered with many small prominences, like cauliflower, but smooth and glistening. It had a yellowish-red color and a cartilaginous consistency, but was not ulcerated. Its upper border did not extend to the fornix, and hence a radical removal of the neoplasm appeared practicable and was successfully performed. Horner has described a papillary fibroma of the ocular conjunctiva, occurring in a man sixty-two years of age; it was a soft, reddish tumor, reaching to the middle of the cornea, from which it could be elevated. Its connection with the ocular conjunctiva began 2 mm. above the corneal border and reached on either side to the commissure, and upward to the retrotarsal fold; the remainder of the conjunctiva was free. The thickness of the swelling was about 1 cm.; the surface was lobulated, each lobe consisting of an aggregation of roundish, soft, deep red excrescences, so that the whole resembled a large, soft, strongly-injected wart, and reminded one of the raspberry-like clusters of pointed condylomata. The tumor was extirpated, but the patient died of cancer of the stomach before cicatrization had occurred. The microscopical examination showed the typical appearance of papillary fibroma.

Less seldom are melano-sarcomata of the cornea-scleral border, which, like the head of a mushroom, with its thin pedicle, are firmly attached in the region of the limbus. If the pedicle is very thick, if the examination of the uveal tract and of the functions of the eye arouses our suspicion that the ciliary body is affected, enucleation of the eye should be urged. Even in melanoma, with a thin pedicle seemingly attached only to the episcleral tissues, the operator must be prepared for the possible necessity that the root of the pedicle has to be cauterized with a point of nitrate of silver, after the excision of the tumor.

PART II.

DISEASES OF THE CORNEA.

A. INFLAMMATION OF THE CORNEA.

GENERAL CONSIDERATIONS.

Inflammation of the cornea occurs either as a primary or secondary affection, in consequence of inflammation of other tissues. In many cases it induces inflammation of the adjacent structures (the conjunctiva, the iris and the ciliary body); in other cases it exists simultaneously with the latter.

We diagnosticate inflammation of the cornea when we find an increased ciliary injection (of the anterior ciliary arteries), a decrease of the transparency and lustre of the cornea, or when there is ulceration. According to the situation and the extent of the inflammatory focus, vision is more or less disturbed by the absorption, dispersion or irregular refraction of the light. Pain, in the eye alone or in the surrounding parts, may be absent or it may be exceedingly violent, accompanied by lachrymation, photophobia and even blepharospasm; in some cases the normal sensibility of the cornea is diminished.

The abnormal injection of the anterior ciliary arteries may be limited to a small spot, if the inflammation attacks only a small peripheral portion of the cornea. It is arc-shaped or circular if the inflammation is extensive or centrally located. The extent and intensity of this injection is in proportion to the rapidity, rather than to the degree, of alterations taking place in the cornea. Sooner or later the ocular conjunctiva may become abnormally injected, since its vessels anastomose with the anterior ciliary blood vessels.

A little practice enables one easily to distinguish the diminished lustre of the cornea occurring as a symptom of inflammation,

from that arising from a deficiency of moisture, and from that opalescent condition occurring in acute attacks, and in the degenerative stage of glaucoma. The surface of a simply inflamed cornea does not show any elevations or depressions unless supuration be present; but reflected images, as, for example, the contours of the window casings, do not appear as sharply defined as on the normally brilliant cornea. Perhaps the surface might be described as finely stippled. In some cases the absence of epithelial cells is clearly seen, and under the lens the surface appears, as it were, shagreened.

The cloudiness, varying from the slightest trace (perhaps only visible by focal illumination) to complete opacity, rarely appears uniform, even when it occupies the entire cornea. The degree of cloudiness depends not only upon the nature of the change of the tissues, but also upon its thickness, *i. e.*, the number of the abnormal elements. Upon a dark background (on the pupil) the same opacity appears more distinct than on a light ground. The tint of the inflammatory opacity is generally gray or yellowish-gray, never bluish or purely white. The boundary line of the cloudiness is never well defined during the inflammatory stage; such a line does not exist until the inflammation has subsided. Under the lens, especially by focal illumination, we often see, either widely spread or confined to the immediate vicinity of the inflammatory focus (ulcer, infiltration or wound), linear streaks which remind one of wrinkled oil-paper or of the frost figures on a window pane. Including the cases in which keratitis occurs after injury and those accompanying conjunctivitis, keratitis is probably the most frequent disease of the eye. It is also one of the most important affections, considering the functions of the organ. It endangers the function, and often also the form, of the eye, in many ways; by causing incurable opacities, by a permanent change in its convexity, by perforation and its sequelæ, by inducing iritis or irido-cyclitis, by destruction of a portion or the whole of the cornea, by destruction of the form of the entire globe (staphyloma, phthisis bulbi); but it may also run its course without leaving permanent, or at least injurious, consequences.

The cases in which, according to the above mentioned characteristics, primary or secondary keratitis is assumed, must be divided, as regards the prognosis of their course and termination, as well

as in regard to their treatment, into those which run their course with suppuration and those which run their course without suppuration of the corneal substance. Suppurative keratitis manifests itself at once or very soon after its beginning, in the form of an ulcer, an abscess, or an infiltration. For the non-suppurative forms we have no equally significant name, because the anatomical processes and changes are not sufficiently understood. Of all the usual designations, the expression, "interstitial keratitis," seems the least objectionable.

If the popular expression, "parenchymatous keratitis," be used in the same sense in which Schindler introduced it, it is at present incorrect, since he only intended to say that the seat of the inflammation was in the substance of the cornea itself, and not in the conjunctival layer or in Descemet's membrane, and also because he included the suppurative forms (as "keratoditis phagedænica") under that name. But his "hydatoditis" is no more keratitis than the "kératite pointillée" of Desmarres. According to Virchow's¹ more recent description, this term was only meant to indicate the imbibition of fluid by the cells (corneal corpuscles), but from a brief communication of Virchow concerning a case of keratitis examined microscopically and considered by him as parenchymatous, it is at least doubtful whether a similar condition can be supposed to exist in those cases designated as parenchymatous by later ophthalmologists. The usual expression, "keratitis profunda," can, in the case of a membrane scarcely 1 mm. in thickness, only mean that the seat of the inflammation is in the substance of the membrane itself, and not on its surface. But this also occurs in the suppurative process. The qualifying term, "diffuse" (*K. diffusa*), is applicable to the cloudiness, but not to the inflammation, of the cornea. But the opacity in many cases is not so diffuse as the opacity of the vitreous body, but permeated by very distinctly marked specks or points (nodules). As a practically useful basis for a concise sub-division of interstitial keratitis the etiological character may well be chosen, although in some cases a well-defined cause cannot be ascertained. The cases which may be attributed to a definite cause, as, for example, constitutional scrofula, show such a striking similarity to one another in their occurrence and course that he who has well observed a

¹ *Cellulärpathologie*, Berlin, 1871, page 376.

certain number of such cases will be essentially assisted by the analogy in the examination of cases in which the etiological element is not so well manifested. At all events, it is more profitable to unite those peculiarities hitherto known to exist in the course of the disease according to this or that causative element, than to describe keratitis merely anatomically, and then to enumerate every imaginable cause, and leave it to him who wishes to inform himself regarding therapeutics and prognosis to decide whether, in a case under observation, he shall presuppose this or that etiological element, or altogether disregard the etiology. There are, indeed, text books which quite ignore etiology. Just as there are cases which cannot be definitely determined etiologically, so there are others which cannot be classed anatomically, even if the many different forms be arranged into numerous subdivisions, thereby rendering the study extraordinarily difficult.

I. INTERSTITIAL KERATITIS.

Non-suppurative or interstitial keratitis is principally characterized anatomically by more or less ciliary injection, cloudiness and dullness of the cornea; and functionally by disturbance of vision. The alterations in the tissues cannot be accurately stated, on account of the lack of dissections, and because the microscopical examinations in animals have thus far been limited to keratitis following mechanical and chemical injuries, or the inoculation of putrid matter. With rare exceptions, which will be considered later, this inflammation occurs independently of inflammation of the adjoining tissues, and is limited to the cornea. Whilst it does not result in suppuration, it merely endangers the transparency, rarely the curvature, of the cornea. The symptoms may vary greatly, according to the changes in the cornea, and the finer points of prognosis and therapeutics can be obtained only in those cases in which the etiological element can be determined with more or less certainty by the appearance of the eye, by the condition of the entire system, and by the history of the case. As regards the causative elements of the disease, cases of interstitial keratitis may be divided into two classes: first, those which are certainly or with great probability related to a general disease; and secondly, those which are to be considered as purely local affections, and due solely to external causes. The first class may

be subdivided into three groups or types. In the second class each individual case must be considered separately.

(a) INTERSTITIAL KERATITIS OF CONSTITUTIONAL ORIGIN.

1. *Lymphatic Keratitis (Scrofulosa)*. *Symptoms*.—The cloudiness of the cornea appears to be composed of small, light-gray clouds, appearing uniformly tinted after their coalescence, and then white or yellowish-gray. The cloudiness, though perhaps partial at first, gradually extends over the entire cornea, reaching its deepest tint in the centre, and persists longest at this point. The surface is dull, finely stippled, and without depressions or elevations. In the substance of the cornea small centripetal vessels appear, sparse in some cases, and in others visible only for awhile; they are so dense and persistent that scarcely anything except blood vessels are seen. The ciliary injection, with which the process begins, increases at the same rate. Cases in which the vascularity of the cornea is considerable are also attended by severe and obstinate pain, lachrymation, photophobia and even blepharospasm; then the pupil is contracted and does not expand properly after the application of atropine, even though there be no iritis. In cases distinguished by intense and extensive cloudiness, with a slight and rapidly subsiding vascularity of the cornea, the symptoms of irritation, together with ciliary injection, are sometimes so insignificant that only the disturbance of vision is especially noticeable. In these cases the pupil is usually large. In many cases the sensibility of the cornea to the touch is more or less diminished. Exceptionally the eyeball appears soft, though there may be no symptoms of inflammation in the uveal tract. This diminution of tension occurs during the development of corneal vascularity, continuing for some time after its resolution, but finally disappearing without perceptible consequences.

The course is a slow one in all cases, extending through two or more months even if the process begins with violent symptoms in the vascular and nervous system and rapidly increases. The long duration is caused by the almost steady progress of the inflammatory changes until the culminating point is reached, and by the very slow retrogression, only rarely by a true relapse (fresh attacks, as for example, in many cases of conjunctivitis or iritis).

The process begins with ciliary injection around the cornea, or at first only on its upper, more seldom on its lower circumference. This deep-seated and therefore bluish redness is followed by a dark redness and swelling of the limbus, consisting of small vessels lying near and over each other, first in the upper then in the lower section, and finally all around. Along the concave border of the distinctly and intensely reddened limbus the cornea becomes dull, and gray flakes or clouds appear in it at different depths. Larger and more numerous, and finally confluent spots gradually appear towards the centre, which, by focal illumination, show saturated white dots, and often white lines. At the same time, or soon afterwards, we may see, deep in the hazy portion and near Bowman's membrane, blood vessels advancing centripetally, singly, or so dense that this portion appears quite red. Cloudiness and vascularity now advance, first from above and below, and then from the sides towards the middle of the cornea. As a rule, the vascularity does not extend to the very centre of the cornea. A spot varying in size from that of a millet to a lentil seed (generally oval), remains free from blood vessels. It might easily be apprehended that this spot would suppurate, which I have seen only twice, or become staphylomatous, which I have never seen.

In a relatively small number of cases the ciliary injection, as well as the vascularity in the limbus and in the parenchyma of the cornea, is insignificant and transitory, but these are just the cases in which the turbidity is found so intense and so extensive that the entire cornea, with the exception of a marginal zone, appears cloudy or uniformly opaque. Resolution is manifested by a gradual diminution of the vascularity and a clearing up of the cornea from the periphery. In many cases, the cloudiness, after having existed for several weeks or months, begins to dissolve into small and thin clouds and disappears completely. The permanent opacities are sometimes so insignificant that they can only be seen by focal illumination. Relatively seldom do opacities remain with imbedded fatty or calcareous granules, which resist every kind of treatment. The persistence of one or more pigmented points in the cornea is exceedingly rare. Most unfortunate, though fortunately rare, are those cases in which the cornea becomes somewhat flattened after the long continuance of a

most intense cloudiness. I have never seen ectasia of the cornea occur, even in those cases in which the cornea, during excessive vascularity, had the form of a truncated cone. Only in complications with anterior scleritis is a more or less extensive and deep sclerosis of the cornea to be apprehended.¹

Etiology.—This disease usually occurs in youth, most frequently between the 10th and 25th years, more rarely in childhood (scarcely ever before the 7th year), and only exceptionally in adult life. With rare exceptions, it is bilateral. It first attacks one eye, however, and then, after several days, weeks, or even months, the other eye. Its occurrence in the second eye, often seen, follows after the patient has been under treatment for the first eye. From these circumstances we may conclude that the true etiological element must be sought in the constitution of the patient. If we closely examine the patients, and exclude those affected with hereditary syphilis, we find that at least 70 per cent. present distinct and well marked symptoms of scrofula. They show it not only by the condition of the lymphatic glands and other prominent symptoms of scrofula, but also by their bodily development, which is strikingly deficient in those who have attained or already passed puberty, or by their state of nutrition (condition of their skin, muscular system, etc.) In women, even those who have not a chlorotic appearance, there is either amenorrhœa or the flow is retarded or very irregular (Ph. von Walter's Keratitis amenorrhœica). That peculiar inflammation of the joints, especially the knee, which is almost entirely free from danger, and to which Förster (Gräfe und Sämisch, B. VII, page 158) has called attention, I have seen about ten times since 1858 (and not in syphilitic cases); it occurs, according to the observations of the author, during the course of the eye disease; according to Förster, also, before or after it, generally uni- rarely bilateral. Regarding the etiological element, it is to be observed that this form of keratitis (with similar symptoms) takes precisely the same course in those cases in which neither scrofula nor syphilis can be proved; and that the patient will be much better cared for if

¹ The expression "sclerosis," so far as I know, was first used by Kieser, for the hereditary opacity of the corneal border. Himly u. Schmidt ophthalm. Bibliothek III, Bd. 3. Stück.

scrofula is presupposed and he be treated accordingly, than if it be considered as a purely local disease, to be controlled by local remedies only.

The prognosis can be inferred from what was said regarding the course and termination of the disease. Besides the changes which have already taken place and those still to be anticipated, we should consider the general condition, the state of nutrition, the circumstances in which the patient lives and the possibility of bettering them. Relapses are very rare before the complete subsidence of the inflammation, or a short time thereafter. Later recurrences have only been exceptionally observed. A boy whom I treated when he was eight years old was again attacked when nineteen; and in a woman who probably had been afflicted with this disease at about the time of puberty, I saw a recurrence at the critical period. The complication with scleritis or iridocyclitis, which may give a very unfavorable prognosis, will be considered later.

The treatment is local, symptomatic and constitutional, according to the etiological elements. The disease sometimes heals spontaneously, and is little influenced by general or local treatment; at least its duration cannot be noticeably shortened. Cases occur in which the disease of the eye first attacked has passed away without treatment, or under the application of various remedies, leaving only a more or less marked opacity. The progress of the disease is not strikingly affected by treatment during the first few days or weeks of the inflammation; in such cases we can only mitigate troublesome symptoms, especially the photophobia and pain, and keep up the courage of the patient, whose sight perhaps is reduced to the bare perception of light, by our confidence in his not becoming blind. The real service which we can render such patients will consist for the most part in a favorable regulation of their diet and personal hygiene, with appropriate internal treatment, when necessary. To overcome the photophobia and blepharospasm, the use of atropia (or cocaine—Tr.), by instillation or discs, and the application to the forehead and temples of the white precipitate and belladonna ointment, are especially to be recommended. If intense and widespread ciliary injection exists at the same time, these remedies are sometimes rendered more efficient by a preceding local abstraction of blood

(by means of leeches applied to the mastoid processes). As soon as the patient can go out he should be made to wear smoked glasses. Cold applications may be pleasant, but they have no other useful effect. Warm applications, used several times a day, from twenty to thirty minutes at a time, were recommended by Mackenzie, for the purpose of mitigating the photophobia; but more recently they have been recommended as stimulants, especially in those cases in which, after the acme of the inflammation, and after the disappearance of most of the vascularity, the cloudiness of the cornea still persists. At this time the clearing of the cornea may be accelerated by the instillation of tinct. opii, by the dusting in of calomel, by the application of the yellow oxide ointment, or similar irritants, which, however, are not well tolerated during the stage of active inflammation. Operative interference (paracentesis of the cornea) has been repeatedly recommended. The author has never resorted to it, since the cases with prevailing vascularity—and these were had in view—are the least obstinate, and the least dangerous.

In regulating the dietetic condition, taken in its widest sense, it should be remembered that this disease may continue for months, and that the patient demands a much more invigorating diet than would be allowed if the inflammatory process were more acute. The patient should be allowed to go out as much as the photophobia will permit. In the administration of internal remedies, special attention should always be given to the digestive system. This is particularly necessary in using cod-liver oil and the preparations of iron. The cod-liver oil, either alone or in combination with iodide, is best given in the forenoon, about a dessert-spoonful, followed by a little bread. It should not be given in hot weather. Iodide of potassium or sodium should not be given if they disturb the digestion, or cause catarrh of the respiratory organs, or acne. Mineral waters, in moderate doses ($\frac{1}{3}$ to $\frac{1}{2}$ pint), impregnated with iodine, are more easily tolerated. During cold weather they may be taken advantageously between breakfast and dinner. (From his own experience the author can recommend Hall in upper Austria, Adelheids spring near Holzkirchen in Bayaria, Kreuznach in the Rhenish province, Iwonitz in Galicia, Darkau near Teschen, Luhatschowitz in Mähren, Lipik in Slavonia. I have seen the best results from the Hall

water.) For delicate persons preparations of quinia are to be advised; in women with irregular menstruation iron in some form, alone or combined with rhubarb and aloes, and also ferruginous waters.

2. *Keratitis Syphilitica Hereditaria*.—The cases of keratitis consequent upon hereditary syphilis show a certain similarity to those considered in the preceding section, and have not previously been described separately. They also are characterized by a cloudiness and frequently by vascularity in the substance of the cornea. They also run a chronic course. The differentiation is really made possible only by the discovery of the constitutional disease; though it is usually suggested by simultaneous inflammation of the uveal tract.

Symptoms and Course.—The symptoms may be about the same as in keratitis lymphatica, but in many cases the vascularity of the cornea plays a secondary rôle. Cases occur in which no vessels are found in the cornea several weeks after the beginning of the disease; that is, several weeks after the beginning of disturbance of vision. The ciliary injection and the symptoms of irritation are relatively insignificant compared with the corneal opacity. As a rule, the patients do not seek professional advice until some time after the second eye is attacked. In the opacity, even when it appears very cloudy or intensely saturated, we usually see, on focal illumination, either with the naked eye or with a lens, saturated points or nodules, which show indistinct contours. In more advanced cases, especially when the cloudiness is concentrated near the centre of the cornea, it appears throughout, or near its border, as though composed of points or dots. Sometimes it is difficult to distinguish these points, situated at varying depths in the cornea, from precipitations which sometimes exist simultaneously upon Descemet's membrane. The latter are sometimes of unusual size (with a diameter of as much as 1 mm.), and then grayish-white (like bacon), and often only visible with a lens; again more or less darkly pigmented, but sharply defined in all cases. In rare cases, at a somewhat later period, the cornea also appears covered with isolated cartilaginous nodules, slightly elevated above the surface, as window glass containing unmolten particles, whilst the surface is perfectly smooth and lustrous.

The clinical appearance of the disease is usually more or less modified by a simultaneous inflammation in the uveal tract, especially by iritis, cyclitis or both together. In some cases it is also possible to discover anterior choroiditis after the cornea has become sufficiently clear, and the pupillary border is free, with the exception of one or two synechiæ. Cases in which the iris remains intact in hereditary syphilis are rare. Sometimes there is a thickening of the minor circle, with discoloration of the iris, or the pupil responds slightly, or not at all, to the energetic application of atropine, although there are no symptoms of irritation. Much oftener there are posterior synechiæ, or there is a thin membrane in the pupil. In other cases, with or without synechiæ, we find the above mentioned deposits on Descemet's membrane, more rarely exudation in the form of hypopyon. The formation of gummata in the iris has not been observed.

The most unfavorable cases are those in which the anterior zone of the sclera participates in the inflammation, either partially or totally. If only the one or the other portion of the anterior scleral zone is implicated, there is, in many cases, a distinct tumefaction with a dense cloudiness of the adjacent corneal portion, which afterwards becomes sclerotic. But if the entire anterior scleral zone is intensely reddened, inflammatory softening may easily take place. In some cases the base of the cornea advances, and the eyeball, with the enlarged anterior chamber, becomes pear-shaped; in other cases the iris advances *in toto*, the posterior chamber becomes larger by the separation of the iris from the ciliary body, and the corneo-scleral ring expands completely or partially, forming an annular or arc-shaped staphyloma. Extensive corneal sclerosis may also result in diminished curvature of the cornea.

The disease is prolonged, not only by a chronic course of the inflammatory process and its resolution in the cornea, but also by repeated relapses; perhaps because it is much more difficult to remove the primary disease than in scrofula. It not unfrequently happens that such cases must be treated for two or three years. Relapses of the corneal disease may occur quite independently of the condition of the iris, and cannot be attributed to the existence of synechiæ alone.

Etiology.—This form of keratitis occurs more frequently between the ninth and the thirteenth year; occasionally in childhood, from the third to the fifth year; rarely after the fifteenth year. If, notwithstanding its greater obstinacy, it is much less frequently found in our public institutions than scrofulous keratitis, this fact must be attributed to its less frequent occurrence. As the patient might easily be considered scrofulous, from his general appearance, the condition of nutrition, the swelling of the lymphatic glands, periostitis, etc., a number of other characteristics in other portions of the body should receive attention, from which, either singly or together, the inference may be drawn with certainty, or at least with much probability, that hereditary syphilis is present, although in some cases none of the usual symptoms may exist. As a rule, considering the age and conditions of life of the patients, they are imperfectly developed and poorly nourished, the complexion more or less pale, the skin non-elastic and withered. In many cases the nose appears flattened at the base, or pressed in, or the alæ seem, in a certain measure, sunken into the upper jaw, and more or less turned up. We often find, at the angles of the mouth and thence downwards, callous white scars resulting from healed fissures (rhagades). The lymphatic glands in the angle of the lower maxilla are often distinctly, though not greatly, enlarged; sometimes, also, the inguinal glands. Ulcers or cicatrices on the soft palate, and difficulty of hearing, are less frequent. In many cases there is caries or periostitis of the tibia, of the radius, of the olecranon, or of the sternum. The condition of the incisors of the superior maxilla, to which attention was first called by Hutchinson, is of great significance. The state of the permanent incisors is pathognomonic of this disease, if their edges are not rectilinear or slightly convex, but concave. In some cases, long after the second dentition, there are only three incisors, more or less strikingly deformed (peg-shaped). The upper four incisors are often represented only by ill-shapen stumps (undeveloped teeth). But it also happens that, even in well-established cases of hereditary syphilis, we find no deformed or misshaped teeth, or only such as sometimes occur in rachitis; and also in persons affected with lamellar cataract (the edges represented by three serrations, where the enamel was more or less deficient, and the

¹ Hutchinson, in *Ophth. Hosp. Reports*, 1858.

enameled surface grooved by transverse furrows). It is rarely possible to obtain correct anamnestic data when no information can be acquired from the parents. Prudence often forbids any inquiry as to infection. It is easier to ascertain whether children born in wedlock were born prematurely or dead, whether a child suffered soon after birth from cutaneous eruptions, and what was the health of children born before or after, etc. In reading attentively the model essay of Mackenzie¹ on *corneitis scrofulosa*, we see that this excellent observer made use of focal illumination² for the examination of the cornea, and the presumption is that he also observed cases of hereditary syphilis, which, however, he considered scrofulous. He expressly mentions cases of iritis, which, according to the author's observations during the past ten years, occur exclusively (almost always, at least) in cases of well established hereditary syphilis. He also mentions osseous swellings of the tibia, which I have found in individuals affected with keratitis only when there was other evidence of syphilis at the same time. He lays great stress on the use of mercury, especially in cases complicated by iritis, "in which it should be used from the beginning." The attention of oculists was first called to inherited syphilis as a cause of interstitial keratitis by Hutchinson's report. But this author has, to a certain extent, gone to the other extreme, as he wishes all cases of interstitial keratitis to be referred to hereditary syphilis. The supposition of syphilis in cases in which the most careful examination of the entire body fails to discover the least vestige, is not only unjustifiable, but objectionable also, as one is easily led to adopt a thorough and prolonged course of treatment, where a proper regulation of the diet, supported perhaps by invigorating remedies, would be quite sufficient to cure the patient. In well established cases of syphilis a mercurial or mixed treatment is necessary, as a rule, or at least justified, according to our present knowledge.

The prognosis in these cases is usually much less favorable,

¹ Mackenzie, "Practical Treatise on Diseases of the Eye," 4th ed., p. 525.

² "It is difficult, in many cases, to recognize the condition of the pupil and the iris through the nebulous and vascularized cornea. Under such circumstances it is of great assistance if the light, by means of a double convex lens, is concentrated upon the corneal surface." Ibid, p. 408.

both as regards the duration and the entire removal of the inflammatory products. Aside from the possible consequences of iritis and cyclitis, which, even at the beginning of the treatment may be recognized as incurable, the alterations of the cornea do not very often allow so complete a restoration as we generally see in lymphatic keratitis. In a comparatively large number of cases, light gray or yellowish-gray points remain stationary in the middle of the cornea; in other cases, partial or very extensive sclerosis is the result. A certain flattening of the more or less sclerosed cornea is a rare result, and a staphyloma of the sclero-corneal border is still more rare. The above mentioned points or nodules, elevated above the surface of the cornea are also persistent in some cases. In many cases we should be prepared for a relapse after months or years, and therefore, after the recovery from the first attack, the family should be reminded of the necessity of watching and guarding the general condition of the patient, and especially that of the eye, with the greatest care.

Treatment.—Quite a number of observations render it probable that hereditary syphilis, especially at the period of puberty, may gradually become extinct, even without medical treatment; at least, it does not manifest itself by inflammatory processes about the eye. I have seen cases in which, after keratitis or kerato-iritis had run their course, and in which, partly from the condition of the eye, and partly from the characteristic evidences in other portions of the body, it was safe to conclude that the eye disease was caused by hereditary syphilis, and in which the persons had remained free from keratitis, without medical treatment, through a long series of years, and only presented themselves finally in order to be rid of the residue of the disease. Yet, I would not advise one to rely solely upon local treatment and a regulation of the diet in this disease. Having learned in several cases the insufficiency of such treatment, and having repeatedly observed obstinate fluctuations in the ocular inflammation, or relapses after long intervals, I no longer hesitate to apply the same treatment which has always given the best results in acquired (or congenital) syphilis; namely, inunction of unguentum cinereum, whilst most carefully observing the well-known precautions. Corrosive sublimate (in pills or hypodermatically) and calomel (with sulphuret of antimony), have been given in only a

few cases in children. In all cases the iodides were employed, generally after the mercurial treatment, though oftener, from the first and alone. Cod-liver oil with 2 or 3 decigrams of iodine to 200 gr. ; iodide of potassium or iodide of sodium, in solution or in pill form, and Hall or Adelheid water, have also been used. Where circumstances would permit, the patients were sent to Hall, Iwonitz, Darkau or Luchatschowitz. But a complete cure was often obtained only after the (four to six weeks') treatment had been repeated several times.

3. *Keratitis After Intermittent Fever.*—During the last twelve years I have seen chronic interstitial keratitis in eight men of middle age whose appearance indicated malarial cachexia as the probable cause of the keratitis. They had a pale or sallow complexion, were emaciated, the spleen was enlarged, and in two cases there was anasarca ; these symptoms had appeared after obstinate intermittent fevers. In three cases both eyes had been affected, one soon after the other, with disturbance and loss of vision ; and it was not probable that the disease was due to an external cause in all of them. The opacity was diffused, rather uniform or cloudy, and more intense in the centre of the cornea, but in no case quite obscure. In some cases the cornea presented, under the lens, a resemblance to wrinkled oiled paper, showing saturated white lines crossing each other in various directions. The lustre of the cornea was diminished, as well as its sensitiveness to the touch ; the ciliary injection was slight, there was no vascularity of the cornea, the conjunctival and lachrymal secretions did not vary from the normal, and the iris and the other tissues were likewise unchanged. Only three of these patients were subjected to a prolonged observation and treatment at the clinic. They recovered with a slight corneal opacity, within five or six weeks, under the use of Carlsbad and Muhl waters, and then quinine and iron preparations, while their appearance greatly improved.

(b) INTERSTITIAL KERATITIS AS A LOCAL DISEASE.

In a comparatively small number of cases of interstitial keratitis, in which the etiological element cannot be definitely determined, cases occur in which, from the reliable information gained from the patient, an *injury* or a *cold* (the result of cooling

suddenly, as in a draft), may safely be considered as the cause for a simple keratitis. Certainly most corneal inflammations induced by these influences run their course with suppuration; yet there is no doubt that cases of traumatic and rheumatic keratitis occur without showing a trace of suppuration.

1. To the cases of traumatic origin belong those inflammatory opacities which appear in the vicinity of non-suppurating wounds, as for example, after puncture of the cornea, and which disappear after a time without leaving any trace. Secondly, those which are caused by a long continued friction of the cornea, especially by inverted eyelashes, and which remain stationary long after the cause has been removed; and, finally, those which appear after a slight chemical, thermal or mechanical injury (without wounds), and according to the degree of severity promise now a perfectly transparent cornea, or again permanent opacities. The inflammatory opacity near recent corneal cicatrices (punctured or incised wounds) is characterized (under the lens), by numerous light-gray lines crossing each other in various directions. Keratitis caused by friction is usually limited to the affected portion unless it results in suppurative inflammation (ulceration); it is frequently attended by a callous thickening of the epithelial layer, and generally by vascularization. The inflammatory reaction, succeeding the coagulation of the albumen of the cornea, produced by chemical or thermal injuries, generally results in suppuration and exfoliation of the injured tissues, unless it be of a slight degree (half transparent or at least strongly translucent opacity). This condition usually offers so much that is peculiar, that it is possible to discover the real cause even in cases in which the cornea alone is injured or in which the patient attributes it to another cause. A keratitis caused by a momentary compression (contusion) without severance of the tissues may manifest itself simply by cloudiness and dullness of a portion of the cornea, and also by vascularity in the parenchyma, and disappear after a shorter or longer duration.

2. Keratitis rheumatica of a slighter degree is manifested by a widespread obscuration of the cornea, the appearance of which may be compared to glass which has been breathed upon; and by the intense ciliary injection, more or less distinct œdematous swelling of the ocular conjunctiva, photophobia, lachrymation

and relatively violent pain in the region about the eye. The cloudiness sometimes appears well defined only after the other symptoms have preceded it by several days, and it generally recedes in a few days without leaving a trace. A partial desquamation of the epithelium or the formation of superficial ulcers occurs only exceptionally. To refer this condition to a cold will not be justified simply because the patient thinks it is so caused, but only if he remembers the circumstances distinctly; if he, for example, remembers having been exposed to a draft of cold air while perspiring; having improperly used cold applications or eye waters to a catarrhally affected eye, etc., and if other causes, especially exanthematous processes, can be excluded with certainty or with probability.

The prognosis is favorable both as regards duration and results. In the treatment the preservation of a uniform temperature should receive careful attention. All medicamentous applications to the eye, save of atropine, are to be avoided. In the case of intense ciliary injection and severe pain a local abstraction of blood may be useful. Laxatives and diaphoretics in small doses, as Dover's powder, etc., may be given with advantage.

From this description it must not be concluded that every case of interstitial keratitis caused by a cold will necessarily follow this course. But the more distinctly the symptoms just described show themselves in a given case, the more probable become the statements of the patient pointing towards cold, as having a causal connection with the keratitis. In cases in which the etiology cannot be definitely determined we can only deal with the anatomical changes, and these, especially in chronic cases, do not often offer sufficient grounds for treatment. A case may illustrate this: A woman, twenty-seven years of age, engaged in writing in the office of a lottery collector, presented herself on account of dimness of the left eye. The affection had begun three weeks previously, without apparent cause and without other special symptoms. I found on the lower and outer portion of the left cornea a cloudy spot of a light gray color, half transparent, nowhere sharply defined, extending on one side almost to the centre, and on the other nearly to the periphery of the cornea; the neighboring ciliary vessels were found somewhat injected, on closer inspection. The disturbance of vision was caused wholly

by the corneal haziness; the eye was in every other respect healthy, nor was there any other disease discovered in the entire body that could have any connection with that of the eye. The patient was kept under observation for the next three weeks, and as it then remained unchanged, the insufflation of calomel was tried. It produced no change during the next fourteen days. After having been at her own home for three months no perceptible improvement had occurred.

(c) CONSECUTIVE INTERSTITIAL KERATITIS.

Cases of secondary corneal inflammation without suppuration occur comparatively seldom, either after or during inflammation of the uveal tract. With the exception of those cases in which a punctated, belt-shaped opacity (see Opacities of the Cornea) is gradually, and without other inflammatory symptoms, developed in the cornea, we may here especially consider two types.

1. The first is most frequently observed after irido-cyclitis. If, as a consequence of irido-cyclitis, numerous and densely crowded precipitations are deposited on Descemet's membrane and remain there for an indefinite time, the cornea in front of these deposits is found hazy and dull, and perhaps permeated by a few vessels. The appearance of the affected part reminds one somewhat of that of a macerated cornea, and the surface is sometimes not only hazy but also uneven, or jelly-like. This condition may disappear after the removal of the irido-cyclitis and the above mentioned deposit, but it often results in a permanent opacity (sclerosis). As analogous to this may be mentioned the opacity resulting from the lens being in contact with the cornea for months or years; cases in which a calcified lens has laid for a long time in the anterior chamber. This opacity persists even after the lens has been successfully removed. Such a corneal alteration may also occur in case of cysts of the iris.

2. The other form is known as keratitis bullosa. A flaccid vesicle (rarely more than one) which contains a clear fluid and is somewhat movable, is found on the cornea of an eye which has become blind through irido-cyclitis or glaucoma, or whose functions have been considerably impaired through irido-cyclitis or a large corneal cicatrix. The wall of such a vesicle does not consist, as was formerly believed, of Bowman's membrane and the

epithelial layer, nor of the latter alone, but of a new layer of tissue inserted between the two, and of proliferating epithelial cells; accordingly, the adjoining cornea also appears somewhat hazy and less lustrous, and by focal light streaked with fine lines. The existence of such vesicles, particularly at the time of their development, is accompanied by violent pain, photophobia and lachrymation, but with relatively insignificant ciliary injection. Since at the time of the appearance of these vesicles an increase in the intraocular pressure is observed, it is probable that this liquid is not produced *in situ*, but is caused by an accumulation of liquid, which, pressed towards the superficial layers of the cornea, raises the newly-formed layer (inserted between the epithelial layer and Bowman's membrane). Larger vesicles, 3 to 5 mm. in diameter, may preserve their form unchanged for many days before their membrane breaks down and its shreds are exfoliated; smaller ones do not persist so long, and are succeeded by a superficial, scarcely noticeable, hazy abrasion at the same place or near it; another vesicle may make its appearance later, and thus the process assumes a chronic, tedious and painful course, continuing for weeks or months. Puncturing the vesicles will not prevent the formation of new ones. After spontaneous or artificial opening the pains may usually be shortened and mitigated by a compress bandage. But permanent removal can only be accomplished in those cases in which it is possible to effectively prevent the recurrence of an increase of the intraocular pressure by iridectomy. Eserine and pilocarpine can only be regarded as palliatives. In incurable cases nothing remains but enucleation of the eye, which is already in a hopeless condition, so far as the restoration of useful vision is concerned. Hasner (klin. Vorträge, Prag., 1860) obtained a permanent cure in one case in which the formation of vesicles had repeatedly occurred, by the superficial excision of the corneal section.

II. SUPPURATIVE KERATITIS.

Suppurative keratitis occurs as a primary disease in the form of an ulcer, an abscess, or a superficial infiltration; as a secondary disease, usually in the form of an ulcer. The duration of the preceding symptoms, ciliary injection, cloudiness and dullness of the affected part, is usually short, rarely exceeding a few

hours. Many ulcers result from the deliquescence of superficial exudations. The process of purulent infiltration and disintegration of the tissues may be very rapid, or it may assume a very slow course; in all cases the duration of the disease is prolonged to weeks and months by the process of reparation (cicatrization). A complete cure can only be hoped for when the infiltration is slight and the ulcer superficial; and then only under particularly favorable circumstances, of which we shall speak later.

I. CORNEAL ULCER.¹

As corneal ulcer, we designate a loss of substance of the corneal tissue, caused (or increased) by suppuration, which extends from the surface inwards, and is not covered by epithelium. If the depression cannot be determined by the front view, it is easily recognized by the reflections on the corneal surface. The bottom and the edges may be cloudy (grayish or yellowish coated), or clear and colorless. As soon as we find a corneal ulcer, we should, first of all, endeavor to discover its more remote cause. The condition of the ulcer, as regards its surface, extent, depth, position, surroundings and its accompanying or consecutive symptoms is of minor consideration. Corneal ulcers occur most frequently as a consequence of conjunctivitis. Those occurring in catarrhal conjunctivitis appear at the margin, are of the size of a poppy seed, crescent-shaped (*vide* page 11). In acute conjunctival blennorrhœa, corneal ulcers occur during the acme of the disease, or very shortly thereafter, or in the retrogressive stage (page 31), the former occurring now in the centre, now in the periphery, and the earlier they appear the more do they tend towards increasing in size, both in diameter and in depth. Even if they result in total suppuration of the cornea, they always have a marginal zone intact. As a consequence of chronic conjunctival blennorrhœa, ulcers occur only within the transparent area of the cornea; at first they are round, later irregular in shape (the result of coalescence). They form only

¹ The conditions considered here represent, as it were, only connective links of different pathological processes in the eye, and should really be considered in different sections. Still, they have so much in common, that a collective description, which may be referred to in the different sections, may be useful, for conciseness, as well as for comprehending the subject.—TR.

one of the phenomena occurring in pannus, and are then the result of suppuration of one or the other exudation deposited upon the surface of the cornea. There are cases, moreover, in which the perfectly clear cornea bears in one spot, especially the central region, an ulcer, often quite clean, the cause of which might be very easily overlooked if the palpebral conjunctiva be not carefully examined (page 42). Croupous conjunctivitis causes ulceration of a more or less extensive portion of the cornea, probably only under especially unfavorable conditions in life, or injudicious treatment (page 27). The ulceration caused by diphtheria extends not only over a more or less extensive portion of the cornea, but also to the adjoining conjunctival portion (page 68). It attacks, also, the marginal zone of the cornea. The corneal ulcers caused by lymphatic conjunctivitis or by exanthematous conjunctivitis (pp. 71, 90), appear circular until this form is lost through progressive ulceration in one direction, or through coalescence with adjoining ulcers. They may occur at any place on the cornea, either singly or in groups. Sometimes they establish themselves half on the cornea and half on the sclera, and then cause, in case of perforation, a very peripheral prolapse of the iris. The ulcers at the apex of the small vascular bands never result in perforation. Injuries may lead to ulceration of the cornea in various ways: when foreign bodies in the cornea are removed by inflammation and suppuration, when torn or contused portions are eliminated by suppuration; when healing by first intention is prevented by impurities or by the re-opening or bad adaptation of the wound. When a portion of the cornea is decomposed by chemical or thermal agents, it may slough off. Friction of the cornea by inverted eyelashes, by calcareous concretions, or by foreign bodies in the tarsal conjunctiva, may result in ulceration of the cornea. Corneal ulcers, leading to the formation of a pterygium, may be caused by mechanical or chemical injuries (*vide* Wounds of the Cornea). Keratitis, in consequence of cold, results, if not in interstitial keratitis, in abscesses much more frequently than in simple ulceration. Keratitis, as a result of desiccation of a portion of the cornea, generally designated as keratitis neuro-paralytica, soon manifests itself by an oblong ulcer, the longer diameter of which is horizontal, which considerably exceeds the

vertical (at least in the beginning). It occurs principally in persons who, in consequence of a severe disease, as typhus, cholera, pyæmia, etc., are in a somnolent condition, with the eyes half closed. At first the conjunctiva, especially in the lower half of the eyeball, becomes more strongly injected and secretes a fluid soon drying into yellow crusts; immediately such a crust extends to the cornea and adheres to it; if it is removed, the underlying cornea appears more or less hazy, already softened and changed into an ulcer with a grayish ground. If the patient does not succumb, this condition of the cornea may remain unchanged for many days and disappear, leaving only an insignificant cicatrix. (Von Arlt, *Krankheiten des Auges*, 1851, I B., page 215.) The same condition may be found in paralysis of the musculus orbicularis palpebrarum, or of the ophthalmic branch of the trigeminus, in herpes zoster (after the stage of efflorescence), in morbus Basedowii (principally in exophthalmos), and in ectropion, shortening or absence of one of the lids, so that the cornea, especially during sleep, is only partially covered. Not the paralysis of the trigeminus of itself, but the resulting exposure of the cornea, the incomplete closure of the lids, is to be regarded as the real cause of the keratitis in question, which Feuer has described as keratitis xerotica. Such an ulcer always corresponds in situation and form to the place which is constantly uncovered, or at least during sleep.¹

On the cornea of glaucomatous eyes in the state of degeneration, where the iris also is entirely or partially atrophied, the lens already hazy and the cornea quite insensitive, we sometimes see not only a permanent haziness and a jelly-like softening, but also central ulceration, which we cannot assign to any other cause than to the glaucoma. A keratitis, with ulceration, occurs in infants in consequence of deficient nutrition, which, starting from the centre, terminates in perforation or in the entire destruc-

¹ Regarding the nature of the keratitis which has been observed in consequence of paralysis of the first branch of the trigeminus, we are not yet sufficiently enlightened, notwithstanding the abundant literature on the subject (*vide* Sämisch Handbuch, IV B., pag. 282). The cases in which, on account of deficient winking and closure of the lids, an ulcer is developed in the cornea, are less rare than those in which, with paralysis of the first and second branch, a diffuse haziness is developed and kept up, notwithstanding the winking and closure of the lids of the affected eye is as energetic as in the other.

tion of the cornea. I have described this somewhat rare affection in my "Handbuch" (Vol. I, page 212), and have since repeatedly observed it. The children begin to decline (generally on account of badly prepared artificial nourishment, seldom those nursed on the breast) in a few days, and while suffering from diarrhœa, become pale and cool, have a hoarse, screeching and feeble voice, and emaciate rapidly. The cornea, generally of both eyes, without any considerable redness and swelling of the surrounding tissues, becomes hazy and grayish-yellow, and degenerates into a pulpy mass, and after this sloughs off, a perforation is usually found. If it is possible to improve the nutrition of the child and preserve its life, either by means of a wet nurse or by more careful attention and medical treatment, the ulceration may not proceed any further, and the cornea may be preserved, excepting a central opacity (with central capsular cataract and anterior synechia). The oldest of the infants under my care was fourteen months old. A. von Gräfe (A. f. O. XII, B. 6, pag. 256) attributes nearly the same condition of the cornea in infants from two to four months to a disease of the brain, which he calls, after Klebs, infantile encephalitis. All the cases observed by him terminated fatally (*vide* Förster, in Gräfe and Sämisch Handbuch, VII B., pag. 225).

The ulceration of the cornea in severe exanthematous diseases, usually terminating fatally, which has been observed especially in childhood and youth (*J. N. Fischer, von Arlt, Gräfe, Adler, etc.*) exhibits a great similarity to the above condition; it extends, after a short duration of diffused haziness, over the entire cornea, which it destroys in a few days unless death intervenes.

Finally, ulcers sometimes originate in old corneal cicatrices through fatty or calcareous degeneration. This process is most frequently observed in corneal staphyloma and in the so-called adherent leucoma; seldom in deep cicatrices. They should not be confounded with the ulcers which may arise if a circumscribed exudation has appeared incidentally in such a cicatrix and resulted in ulceration.

If the cause of a corneal ulcer is determined as certainly as possible, it will be necessary, in order to form an opinion regarding the further consequences, to examine whether it is progressive, that is, whether from its condition alone an extension superfi-

cially and in depth is to be expected, or whether there are already signs of healing. In many ulcers the latter appear only after a duration of many weeks. Aside from the indication the etiology may give for the progression, this is to be apprehended when the surface of the ulcer appears gray or yellow, when the edge is distinctly swollen, or at least surrounded by a hazy halo, when a partial or circular ciliary injection exists, with a more or less increased sensitiveness to light. On account of the swollen border, especially in small ulcers with steep edges, the floor appears to be deeper than in the absence of such swelling. In some cases only a point or crescent-shaped portion of the border is infiltrated with pus, and consequently somewhat prominent, whilst the remaining portion of the periphery appears disposed to heal. Under these circumstances a progress towards the infiltrated portion must be expected, although the symptoms of irritation have already become very insignificant or are altogether absent. On account of their tendency to progress in one or the other direction, ulcers with such distinctly overhanging edges have been designated as serpiginous ulcers (*ulcus serpens*, Sæmisch).¹ Ulcers occur, however, with a distinctly purulent surface, unaccompanied by any important symptoms of irritation, which continue apparently unchanged for days and weeks (so-called torpid ulcers), whilst, as a rule, purulent ulcers perceptibly advance from day to day, or even from hour to hour.

During the stage of progression iritis often occurs without any definite cause. The synechiæ are usually first seen in the same meridian in which a deep corneal ulcer is located. In many cases

¹*Mooren* (Ophthalm. Beobacht. Berlin 1867, page 107.) has described as rodent ulcer a somewhat rare form of progressive corneal ulceration. During ciliary injection and violent pain a superficial grayish or yellowish-gray infiltration arises at the border of the cornea, and after its deliquescence, a shallow ulcer with a gray undermined border. This border advances more and more into the cornea, whilst numerous vessels follow from the conjunctival limbus. A cessation occurs only after the entire surface of the cornea is covered, whereupon the cornea again becomes smooth, but not sufficiently transparent. This process probably occurs only in persons of advanced age. So far as I know, cessation has only been obtained by the use of the thermo-cautery, as in *ulcus serpens* (Sattler, at the meeting in Heidelberg, 1879). In a case observed by the author, the border advancing towards the centre of the cornea formed a grayish-yellow hue, descending abruptly towards the flat, somewhat uneven, though not distinctly vascularized ulcerated surface. A cessation of the process was effected by cauterization.

of corneal ulceration a collection of pus occurs in the anterior chamber (*hypopyon*), rarely a burrowing of pus in the substance of the cornea (*onyx or unguis*). Since these complications also occur during corneal abscess, and in corneal ulcers only when the deeper tissues are attacked, their description may be deferred until the former are considered.

The course and consequences of an ulcer may be very manifold, as may be apparent from the following considerations. Loss of substance of the cornea is not repaired in the same manner as that of the cutis or the conjunctiva, by the drawing in of neighboring parts, but is more or less completely filled by the formation of a new substance, which is gradually changed into a tissue homogeneous with the cornea, but more frequently only homologous (as connective or cicatricial tissue). This reparative tissue is sooner or later covered with epithelium from the adjoining epithelial tissue. But the epithelial layer may be complete even before the cavity is wholly filled. On account of the moisture it may be very difficult to determine definitely whether the ulcerated surface is already covered with epithelium, but this may be assumed when the steep edges have disappeared, and when the opacity of the substitutive tissue becomes visible. The process of reparation is most easily observed in small ulcers. The ulcerated surface first becomes clean, then the signs of progression disappear. Clean ulcers are often only visible by the reflections of light upon the cornea. With favorably reflected light clean hemispherical ulcers cast a shadow upon the iris, like a concave glass of short focal distance. Gradually the cavity diminishes in depth and circumference, not by bulging out, but by filling in from the bottom. After some time (a few weeks) the depression, though smooth and perhaps covered with epithelium, appears no longer clean and clear, but more or less hazy, not grayish but bluish-white, and this haziness becomes more intense in proportion as the cavity becomes filled. Many persons overlook the connection between this distinct haziness or opacity and the preceding inflammation, especially if for some time before its appearance no inflammation or symptoms of irritation have been visible. Finally, there is no more depression, the affected spot appears normally curved or flat, ground off, as it were, rarely elevated and uneven (not by ectasia but by excessive forma-

tion of substitutive tissue and epithelium, analogous to the formation of a callus on bone). Whether the cavity be normally or incompletely filled, a haziness remains, the diameter of which is or becomes usually much smaller than that of the preceding ulcer, and the contour of which is seldom sharply delineated. In cases of normal regeneration, which sometimes results only after many months, the opacity often decreases very considerably both in extent and degree, and under the most favorable circumstances disappears completely, so that even with focal illumination no trace of an abnormal condition can be discovered. This process may be suitably designated as regeneration of the cornea (von Arlt, *Prager Vrtljhrsschr.* Bd. II, 1844, und *Handbuch*, 1851, Bd. I, pag. 216). A partial regeneration occurs in a large number of cases. In many cases reparation follows vascular development in the substance of the cornea, especially in the more peripherally located ulcers. Sometimes one or several vessels are seen deep in the cornea (near Descemet's membrane) advancing towards an ulcer; much more frequently numerous vessels, evidently originating from the episcleral branches of the anterior ciliary artery, run under the limbus to the cornea, forming a network either about the peripheral portion or around the entire ulcer, from which now and then a fine branch extends into the surface of the ulcer. This superficial vascular network, permeating the edge of the ulcer, interposes, as it were, a bar to the advance of the ulceration, and may, therefore, be considered as a favorable symptom. But it does not protect against the extension in depth or against perforation; and the substitutive tissue which has been formed during a considerable and long lasting vascularity remains, as a rule, always opaque.

Whether complete, partial, or no regeneration of the cornea is to be expected depends upon the condition of the ulcer, upon the age and general condition of the patient, and also upon external influences, such as the conduct of the patients, and the professional treatment. Ulcers which have advanced as far as Descemet's membrane always leave a permanent opacity, at least in the deepest portion. In superficial ulcers, though they be somewhat extensive, a complete or partial clearing (regeneration) may be more certainly expected than in deep ones, especially with steep edges, even if they be relatively small. Ulcers whose re-

generation takes place with vascularization of the cornea, leave a permanent opacity. Ulcers which result in an expansion or rupture of Descemet's membrane never disappear without leaving an opacity at the affected spot. Ulcers which originate during blennorrhœa neonatorum may, even after perforation of the cornea has resulted, take so favorable a course that only a relatively small opacity remains after complete cicatrization, which is perhaps only noticeable by means of focal illumination. In childhood and youth, the condition of the cornea being the same, it is much safer to assume a complete regeneration than in a more advanced age. In persons debilitated by deficient nutrition, or depressed by cares or other things, the ulcerative process is less favorable and likely to leave a more extensive opacity than might be expected from the anatomical conditions. If the surface of the ulcer is not properly protected from dust (which may sometimes be seen by means of a lens), or if it is irritated by smoke, by conjunctival secretions in a state of decomposition, by various collyria, ointments, etc., it may easily happen that the suppurative process is aggravated or re-kindled, and that the formation of transparent substitutive tissue is frustrated, and simple connective or cicatricial tissue is formed, and that an abnormally thick and opaque epithelial layer is developed.¹ If a small ulcer with steep borders has penetrated as far as Descemet's membrane, and has continued unchanged for weeks, this may be forced into the ulcer; we then see a transparent, shining spot, about the size of a poppy seed, surrounded by the hazy border of a former ulcer, stationary or rupturing from time to time. For this condition the name "keratocele" may be reserved, though it is often used in a broader sense.

If an ulcer has reached a somewhat considerable extent, its floor (Descemet's membrane together with more or less fibres still covering it) may be pressed forwards without rupturing. If the ulcerated surface becomes coated with epithelium, the curved portion may appear not only smooth, but almost transparent, and is always surrounded by a hazy circle (the border of a former ulcer), and produces distorted, or at least considerably smaller, images than a normal cornea. An analogous change in the form

¹ Regarding the influences of septic substances in suppurative keratitis, fuller details will be given under the head of corneal abscess.

of the cornea, caused by a horse-shoe-like marginal ulcer, was mentioned on page 19. If the ulcer running along the limbus encircles about half the cornea and extends deeper and deeper, its thin floor yields and the portion of the cornea surrounded by it is pressed forwards so that the surface of the cornea loses its spherical curve and assumes more and more the curvature of a cone. Both conditions may be designated *kerato-ectasia ex ulcere*. It is the occasion sometimes, though rarely, of an increase in the intraocular pressure.

If the suppuration has proceeded as far as Descemet's membrane rupture may result, even if the patient is perfectly quiet, by external pressure, most frequently by a momentary increase of the intraocular pressure in consequence of an engorgement of blood in the superior vena cava (by coughing, sneezing, lifting, etc.). The aqueous humor is forced out, iris and lens are pressed against the cornea, the pupil becomes narrow, and the interior vessels are over-filled, because the resistance which the tension of the tunics of the globe offered to the influx of blood is abolished. Since there is no evidence that the posterior wall of the eyeball advances, the diameter of the vitreous body must be lengthened in the sagittal direction, and shortened in the equatorial. This condition of the vitreous body, or rather of the stroma carrying the vitrina, is of importance for determining the subsequent processes in such an eye. The histological elements are displaced, but still preserve the tendency to return to their former position.

If the evacuation of the aqueous humor and the displacement of the lens, which may be estimated at 2 mm., occur with great violence, a rupture of the zonula with dislocation of the lens and prolapse of vitreous humor may result. Intraocular hemorrhage may occur in cases in which the elasticity of the blood vessels is impaired by advanced age or prolonged inflammation of the globe; suppurative cyclo-choroiditis has also been observed as a result of violent rupture of the globe. The changes taking place in the ulcer after the evacuation of the aqueous humor may be generally considered as favorable, in so far as it does not become larger, but cleaner. The release of the cornea from pressure appears to have a good effect on the circulation, and thus on the nutrition, of the cornea; in this sense perforation may even be considered as

favorable, and for that reason an intentional relief (by puncturing the cornea, *paracentesis corneæ*) may have a beneficial effect under certain circumstances. The further escape of the aqueous humor is usually prevented by the mechanical closure of the opening in Descemet's membrane. This is caused, according to the location of the perforation, by the apposition of the capsule of the lens or the iris. If the rupture is located in the periphery and is not too small, a portion of the iris in the form of a vesicle will be pressed into it by the aqueous humor. The expression, "prolapse of the iris," is, therefore, not to be taken literally, any more than the expression, "escape of the aqueous humor."¹ In some relatively rare cases the mechanical closure of the opening is not accomplished, the aqueous humor oozes out continually or intermittently, causing a corneal fistule. The cornea gradually flattens, and the globe slowly atrophies. This condition may be developed immediately after the perforation if the defect in Descemet's membrane is so situated that both the iris and the capsule are in contact with it. The capsule cannot come into sufficiently close contact with Descemet's membrane, since between the two there is a portion of the pupillary border, which, by its thickness, forms a triangular sinus, whose walls are formed anteriorly by Descemet's membrane, posteriorly by the capsule, and laterally by the iris. Later a fistule may occur in the iris, if it ruptures at a smaller and less resistant spot whilst in close apposition to the cornea; this tearing of the iris sets up no inflammatory reaction and no agglutination of its borders. In that case a place is usually found only as large as the point of a needle, of dark appearance, distinctly sunken, surrounded by turbid cicatricial tissue, and often covered by a clear liquid, which rises under pressure upon the soft eyeball. The organic closure, which may be repeatedly disturbed by pressure from without or from within (increase of the intraocular pressure), or by the recurrence of suppuration, is accomplished by the same process as is observed in non-perforating

¹ The aqueous humor is not furnished by the iris, but by the ciliary processes, where they surround the posterior chamber. Cases are known in which, after the iris was torn out, the secretion of aqueous humor was continued in normal quantity; and in occlusion of the pupil the iris is very often pressed forwards by the aqueous humor, and re-establishment of the communication between the anterior and posterior chambers by iridectomy suffices to cause the iris to return to its normal position. (See Iritis and Iridectomy.)

ulcers, by a substitutive tissue advancing from the edge of the clean ulcer. Where the opening is closed through the intervention of the substitutive tissue, the lens and also the iris may return to their normal position without leaving a trace of their former connection with the cornea, but only under the most favorable circumstances and in smaller defects. The eye may become normal with the exception of an opacity of the cornea, which may perhaps be only visible by focal illumination.

Probably the points of Descemet's membrane, which have been forced outwards towards the surface of the ulcer, are again pressed back into their normal position by the substitutive tissue, and caused to unite one with the other. The return of the iris and lens is probably brought about by the fact that, after the opening in Descemet's membrane is closed and some aqueous humor is again accumulated in the anterior chamber, the muscular activity of the iris, previously paralyzed, is restored and exerts a backward traction; moreover, the lens follows the tendency of the zonula and of the stroma corporis vitrei to return to their former position when they are not opposed by pressure from without (by the recti oblique and the orb. palpeb. muscles), nor by fullness of the eye through vascular engorgement. If this view is correct, the injunction of absolute rest, especially in a recumbent position, as is usually recommended in this condition, as well as after operations in which the anterior chamber is opened, has a rational foundation.

After a central perforation of the cornea, anterior capsular cataract may arise. The opacity appears after the conclusion of the process in the centre of the anterior capsule, as a clear, white plug, variable in size, but rarely reaching that of the congenital pyramidal cataract. Small, central, capsular cataract, scarcely as large as a mustard seed, is distinguished from congenital punctiform cataracts, which always occur bilaterally and somewhat eccentrically (upwards and outwards), by the dense saturation and white (not gray) color, as well as by the distinct projection over the surface of the capsule. Exudation plugs, with large base (2 mm. and over), show a more or less distinct pyramidal form, and in rare cases the apex is connected with the hazy cornea by a thread, sometimes scarcely perceptible, again of considerable thickness. In a relatively large number of cases, a

portion of the pupillary edge of the iris is adherent to the cornea, whilst the lens, with the exudation mass, is in its normal position. Very rarely is any pigment of the iris, or a small portion of the pupillary border attached to the side of the plug. The larger this plug the more distinct is the opacity of the cortical substance underneath it. This opacity is stationary. Sometimes radial folds, corrugations, of the adjoining capsular portion may be seen around the plug. In that case there is usually a diminution of the equatorial diameter of the remaining transparent lens. The origin of these different forms, in consequence of a central defect in Descemet's membrane, obstructed by the capsule alone or by it and a portion of the iris, is easily understood by supposing that the plastic mass furnished by the clean borders of the ulcer becomes united (adheres and coalesces) with the capsule, and that by the process of cicatrization this plastic tissue is so much constricted that it adheres only with the capsule, being actually cut off from the cornea. In a similar manner wound granulations, as after section of the internal rectus muscle, often begin with a broad base and grow exuberantly, and gradually become so constricted by the cicatrization of the conjunctival opening at their base that they are finally connected with the sclera, like a pea to its pod, and even fall off spontaneously.

The development of this central capsular cataract has been especially observed after blennorrhœa neonatorum, rarely in childhood (during or after the ninth year), never later, as far as I know, probably because it requires a rapid organic closing, besides a great minuteness of the perforation, that is, a rapid reparation of the loss of substance. If the capsule remains denuded for some time, and the opening is large, a rupture of the capsule may easily result, possibly with the escape of the lens, especially by external pressure or by the increase of the intraocular pressure through engorgement of the vena cava. Here, also, the sudden rupture may be followed by intraocular hemorrhage or panophthalmitis. It much more frequently happens, especially if the pupillary edge of the iris is mostly or entirely denuded, that the pupil is, for the most part, altogether occluded by the formation of an exudative membrane in front of the capsule, which coalesces with the substitutive tissue advancing from the surface of the corneal ulcer, but which seldom ad-

heres firmly with the capsule. In considering corneal staphyloma, we shall see that such a membrane connected with the iris and with the cicatricial tissue of the cornea does not remain in union with the capsule in the majority of cases.

Larger central ulcers which have left intact a zone of Bowman's membrane from 2 to 3 mm. wide, but have formed in the membrane of Descemet so large an opening that a considerable portion of the pupillary border is exposed, may result in an adhesion of the latter with the cicatricial tissue, and consequently in a partial or total anterior synechia. In partial synechia, the more or less distorted pupil is usually entirely or partially covered by the surrounding corneal cicatrix. In total synechia, the anterior chamber is so shallow that it is very difficult to open it for the purpose of forming an artificial pupil; in many cases it results in staphyloma. If total synechia has occurred in early youth, and the eye has afterwards attained its normal size, the iris may be stretched so as to become partially detached from the ciliary body (spontaneous irido-dialysis). The chamber has then gained in depth. This condition deserves our special consideration, because the prognosis regarding the formation of artificial pupil must always be very reserved, on account of the possibility of the lens having lost its normal form by central capsular deposits. In case of a peripheral location or large size of the perforating ulcer, the consequences of the exposure of the iris may be very different, according to the location and size of the ulcer and the conduct (treatment) of the patient. In contradistinction from total denudation of the iris, a partial one is called prolapsus iridis when the iris is raised over the level of Descemet's membrane. Prolapse resulting from wounds in the cornea may behave differently (*vide* Wounds and Operations). If the rupture occurs suddenly, and if the aqueous humor behind the iris cannot find an exit through the pupil, the iris may, at the moment of perforation, be pushed forwards in the shape of a vesicle. In other cases, the iris simply clings to the cornea, closing the opening, and is gradually pushed out by the aqueous humor, sometimes not until an agglutination with the ulcerated edges has already taken place. If the perforation is small (less than 2 mm.), and if the edges of the ulcer are steep, the iris is never pushed out far, as it is very soon covered and supported by suffi-

ciently firm cicatricial tissue. If the force pressing upon it is suddenly increased, as by external pressure or by vascular engorgement, rupture rather than an expansion of the denuded portion results. The iris pressed forwards at first appears black, since, in consequence of the thinning of its tissues, it allows the pigment layer and the dark background to shine through. At a later period it is covered by a more or less saturated gray membrane (slate-gray, bluish-gray), and surrounded by an opaque border. In many cases this condition is not developed until the iris has presented a pale red, finely granular, or spongy appearance, through the development of granulations upon its surface. The immediate coating with cicatricial tissue may be best observed, step by step, in small prolapses not exceeding 3 mm. in one direction, and rising obliquely in the form of a nodule. On account of an advance of the substitutive tissue from the edges of the ulcer, the base is gradually narrowed, the surface covered more and more, until it is finally completely coated, and gradually pushed back. If the perforation is not circular, but oblong, or if remnants of corneal tissue project like tongues into the prolapse, substitutive tissue, starting from them and meeting that from the opposite side, will form a bridge, constricting and, as it were, cutting the prolapse into two. The same process repeating itself in other portions, the whole prolapse may present a blackberry-like appearance; small black or slate-gray projections occur, separated from each other by a reticulated plexus of cicatricial tissue (*staphyloma racemosum* of older authors). The development of granulations, sometimes lapping over the surrounding tissue, usually delays the completion of the epithelium; but they at last are also transformed into cicatricial tissue without medical intervention. If the cicatricial tissue finds in the surrounding cornea a sufficiently firm support which does not yield to the intraocular pressure, it will force the iris back by contraction, and the cicatrix may thus attain about the same curvature as the normal cornea. Sometimes the cicatrix remains flat, or again appears somewhat convex; a slight convexity, not caused by a staphyloma of the deeper layers, but by an excessive formation of the substitutive tissue, or through morbid changes of the epithelium, disfigures the eye, but is not otherwise injurious. Prolapses, distended

like vesicles, are not pressed back at all, or only after the accidental or intentional evacuation of the aqueous humor. If we except the rare cases of healing of a small prolapse without adhesion to the corneal cicatrix, a flat corneal cicatrix with an anterior synechia is the most favorable result of prolapse; it is usually the only one that can be expected or attempted. But if a considerable portion of the iris be pushed forwards, another disadvantage may result, viz., great distortion of the pupil. For example, if the perforation occurred in the temporal portion, the iris may be immediately or gradually pushed into it, so that on the nasal side (from the pupillary to the ciliary border), it becomes at least twice its average width. There are cases in which the pupil, after having been distorted towards the temple, is changed into a narrow horizontal slit by a similar process on the nasal side. The pupil distorted in one direction may also be so situated as to be partially or wholly covered by the cicatrix. Even with relatively small perforations (not over 4 mm.), the above-described process often suffers a detrimental modification, where the superficial fibrous layers of the cornea on one side, or around the denuded iris, have been destroyed to a considerable extent, and the deeper layers gradually give way to the pressure of the aqueous humor, and the parts immediately surrounding the agglutinated prolapse are simultaneously pushed forwards with the latter. Obviously, the portion of the iris not adherent to the cicatrix, and lying between it and the ciliary border, suffers more or less traction, and this traction causing permanent irritation is probably the reason that eyes in this condition, sooner or later, become amaurotic through an increase of the intraocular pressure, in consequence of an increased secretion of serous liquid in the vitreous body.

Cystoid scars of the cornea with anterior synechia lead, almost without an exception, to increased intraocular pressure, to an excavation of the optic papilla, to a limitation of the field of vision (on the nasal side), and finally to total blindness (von Arlt, *Krankheiten des Auges*, 1855, III B., page 18). A positive support for this explanation is furnished by the visible extension of that portion of the iris lying between the ciliary border and the orifice of the hernial sac, which, after some time, is found discolored and thin. If we find eyes with the pupillary border ad-

herent to the cicatrix when separation of the iris or irido-dialysis has been obviously caused by excessive traction, we should not overlook the fact that these are eyes which, at the time of ulceration were very backward in growth, and that the distention of the iris between the ciliary and pupillary borders is produced principally by the growth of the eyeball, and therefore occurs only long after firm and unyielding cicatrization has taken place. If, in cases of partial staphyloma, we observe usually no increase of the intraocular pressure, the comparison with those cases in which this does occur furnishes a satisfactory explanation which also favors our interpretation. If the iris is pushed forwards into a narrow opening with steep borders and consequently attached to an unyielding ring, the portion of the iris stretched out between it and the corresponding ciliary border is evidently secured from traction or extension.

Very peripheral prolapses, lying partly in the sclera, as they occur after scrofulous conjunctivitis, wounds and operations, may become the exciting cause of suppurative cyclo-choroiditis, or of sympathetic affection of the other eye, though, as a rule, only after a long period, months or years. A rather frequent consequence of denudation of the iris to a considerable extent (at least over a diameter of 4 mm.) is the formation of a partial or total corneal staphyloma, a hemispherical, grape-like tumor, representing a portion or all of the cornea, filled with aqueous humor and formed, for the most part, by cicatricial tissue that is adherent to the distended iris. If, after the iris has become agglutinated to the ulcerated border on all sides, the escape of aqueous humor is prevented, and the iris is not yet covered over with sufficiently resistant cicatricial tissue it may be pushed forwards by the aqueous fluid. This may occur gradually and uniformly, but is sometimes suddenly brought about or increased by external pressure or by engorgement of the internal blood vessels (from the ascending vena cava). A small surface is easily ruptured by the violent pressure of the aqueous humor, whilst a larger surface rather expands. But if such a surface is once distended, it does not contract again, being inelastic, and a more copious secretion of aqueous humor results until the former tension is re-established. But now the already thinned staphylomatous portion can still less withstand the pressure of the aqueous humor, and consequently

the expansion gradually increases until the cicatricial tissue becomes stronger and denser. The existence of every corneal staphyloma presupposes therefore that a larger portion of the cornea was destroyed by suppuration (ulcer or abscess), that perforation of the cornea and discharge of the aqueous humor has taken place, that a smaller or larger portion of denuded iris adhered to the cicatricial tissue which filled the gap, and that then either this portion alone or the adjoining portion of the cornea also was pushed forwards, in the shape of a sphere or a cone, by the gradual or violent pressure of the aqueous humor. Hence, the covering of a staphyloma also includes portions of the cornea which have resisted the suppuration, but not the supplanting and the coalescence with the iris. For, although in prolapsus iridis, the iris lying behind the orifice of the perforation (in the anterior chamber) shows no signs of inflammation, still we find later a coalescence between the iris and Descemet's membrane, which extends more or less beyond the opening in Descemet's membrane; so that even behind tolerably transparent portions of the wall of the staphyloma no trace of an anterior chamber is found.

Every staphyloma is at first exceedingly translucent, especially where the wall is formed only by the iris and cicatricial tissue. By strong illumination the lattice-work formed by the fibres of the iris and the cicatricial threads, together with the pigment, may be very easily perceived. Gradually the wall becomes permeated by vessels and thicker in some places, while in others it becomes thinner and remains translucent. The thickest portions then appear cartilaginous and are often covered with dry, horny epithelium permeated by larger vessels. The thickness of the wall may be 2 to 3 mm., either partially or throughout. This metamorphosis may take place in eyes which otherwise show nothing abnormal and may remain stationary for many years. The complaints of the patients may then be limited to the disturbance of vision and to the disfigurement; and perhaps also to the annoyance caused by the excoriations on the lids, especially as the lower one is constantly moistened. If the staphyloma is only partial, there may still be tolerably good vision, or only distinct perception of light (with or without limitation of the field of vision), or even this may be absent. For a portion of the pupil-

lary border may still be free, and the intact portion of the cornea may have preserved its normal transparency and curvature, although it generally rises like a roof about the staphylomatous portion; the entire pupil may have been drawn into the staphyloma, and in addition to this an amaurotic condition may have been caused by the increased intraocular pressure. Every staphyloma may be designated as partial in which a portion of the cornea is still intact, so that between this and the corresponding portion of iris aqueous humor is retained, and in which, therefore, as we shall see later, the operation of iridectomy is practicable. In total staphyloma the cornea is completely, or for the most part, supplanted by cicatricial tissue; of course there may be transparent remnants near the border, but there is no trace of an anterior chamber. The projecting pseudo cornea generally has the form of a sphere, which protrudes through the corneo-scleral ring more than one-half, and therefore appears narrowed at its base (spheroidal staphyloma). More rarely it forms a cone which rises gradually from the corneo-scleral border and terminates in a blunt point (total conical staphyloma). When the entire cornea, or the greater portion of it (all but the border zone), is destroyed, and when at last the small circle of the iris is denuded all around, the pupil is gradually closed by an exudative membrane, and thus the aqueous humor is prevented from further escaping. This membrane coalesces with the substitutive tissue gradually covering the iris, and forms with this and the iris a portion of the eyeball, taking the place of the cornea. The exudative plug (at first membranous) which occludes the pupil may be displaced to one or the other side if the covering of the iris remains thinner on one side and offers less resistance to the *vis à tergo*. Then neither the exudative plug nor the vertex of the ectasia falls in the antero-posterior axis of the globe, and the staphyloma inclines to one side whilst it rises more gradually on the other; consequently it is not strictly spheroidal. If rupture of the capsule and loss of the lens occurs after the anterior capsule of the lens is denuded, and previous to the occlusion of the pupil, so great a collapse of the iris and its coverings generally takes place that a flattening rather than an expansion results, since the corneal cicatricial tissue usually becomes thick enough to successfully resist the pressure of the aqueous humor. The

lens may also be involved if the capsule is temporarily or permanently agglutinated with the membrane occluding the denuded pupil. The temporary agglutination between the pseudo cornea and the anterior capsule, as central capsular cataract, seldom occurs. This membrane is usually separated in time from the anterior capsule; still the more or less opaque and shriveled lens, or the shrunken and thickened capsule, is sometimes found agglutinated with the apex of the staphyloma. We find here, however, an increase of the intraocular pressure and amaurosis as a consequence of the traction or rupture of the zonula.

If only the central portion of the cornea has been destroyed, while all around it a broad zone has lost only its superficial layers, and the margin is entirely preserved, there appears, between the line where the iris coalesces with the edge of the ulcer and the ciliary border, a more or less broad portion of the iris at first simply in contact with the membrane of Descemet; firm agglutination takes place later. If these, with the denuded iris and the membrane occluding the pupil, the corneal strip formed by the deeper layers only, and therefore incapable of resistance, be pressed forwards, the base of the staphyloma becomes considerably larger than the original perforation, and the more this is pressed forwards, the more is that part of the iris stretched which lies between the perforation and the ciliary border. Hence probably results the loss of vision through increase of tension constantly observed in total conical staphyloma, as already mentioned. As the border of the ulcer increases in thickness gradually from the perforation toward the periphery, and as in the same ratio the power of resistance of the defective cornea gradually increases towards the periphery of the cornea, the entire protrusion must take the form of a cone. When this gradual increase in the thickness of the edge of the ulcer is absent, the staphyloma must assume the form of a sphere, the form of a grape-like tumor. If the wall of the staphyloma has remained thin at one spot, so as to be translucent, or if it has later become thinner, in consequence of an atheromatous ulcer, it may be ruptured, either by external causes or after violent increase of the intraocular pressure. In an eye in which the lens and zonula have preserved their normal position and tension, and which, excepting the iris and the cornea, may be considered healthy, such

rupture, with subsequent collapse and refilling, may occur without further inconvenience, and may be repeated from time to time; but a sudden rupture, or rupture in an eye which has become amaurotic in consequence of an increase of the intraocular pressure, may lead to tearing of the zonula, loss of a portion of the vitreous humor, hemorrhage of the choroid, and even to panophthalmitis.

Finally, total staphylomata of the cornea may cause a formidable increase in the size of the globe by the induction of an intercalar staphyloma, a partial or a general ectasia of the sclera. By intercalar staphyloma is meant a crescent or circular expansion of the anterior zone of the sclera, about 2 mm. in width. The anterior limit of this zone is formed by the limbus; the posterior may be determined by a plane (a section) through the greatest circumference of the posterior chamber, through the angle between the ciliary processes and the posterior surface of the iris. This zone, therefore, lies in the region of the posterior chamber and the insertion of the iris. After this entire zone has become staphylomatous, the base of the cornea appears to be carried forwards, and the antero-posterior diameter of the eyeball is decidedly increased. If the staphyloma is limited to about one-half of the circumference the cornea appears displaced forwards only on this side. The wreath-like protrusion, variable in width and height, appears to be composed of slate-gray or dark-blue (translucent) nodules. This condition was formerly designated as *cirsophthalmus* (*varicositas bulbi*), perhaps because of a certain resemblance to varicose veins, or because when such a globe was opened intentionally or accidentally, a severe hemorrhage resulted, which was checked with difficulty. The internal surface of the thinned sclera is always covered with the more or less atrophied iris, and only partially detached from the ciliary body. The posterior chamber is, therefore, always greatly enlarged in all directions. Of the anterior chamber no trace is left in those cases in which the intercalar staphyloma is observed after suppuration of the cornea, whether the pseudo cornea remains flat or staphylomatous. On the contrary, in those cases in which the intercalar staphyloma is induced by other inflammatory processes, especially by irido-cyclitis, an anterior chamber is found.

Intercalar staphyloma is developed during intense redness of

the anterior scleral zone, continuing for weeks, with violent pains radiating towards the branches of the trigeminus; after its development, vision is almost or wholly extinct, in consequence of the increased tension. Such eyeballs may remain *in statu quo* for a lifetime without giving any further trouble. In some cases eyes with corneal staphyloma, with or without intercalar staphyloma, increase in size on account of scleral ectasis, which is either general or limited to the ciliary body. The cause of this enlargement, which begins and continues under increased tension, and is, therefore, accompanied by excavation of the optic papilla, probably proceeds from traction on the iris and ciliary body, as has been already suggested in considering staphylomatous cicatrices with anterior synechia and conical total staphyloma; and the yielding of the sclera is probably induced by the intense hyperæmia continuing in the region of the anterior ciliary vessels, and by serous infiltration of the episcleral tissue. But the occasions for the traction on the ciliary body and for the increased secretion of a serous liquid in the vitreous body (with disintegration of its stroma) may also proceed from the lens system if it has become firmly united with the pseudo cornea (before or during the formation of the staphyloma), and has been drawn forwards, if the anterior capsule has contracted concentrically, or if the zonula has been very much stretched or torn by sudden increase of the staphyloma. Likewise a lens freely movable in the cavity of the staphyloma may mechanically irritate the uveal tract (by oscillations), and occasion an increased secretion of serous liquid.

As consequences of large perforating corneal ulcers, we have to enumerate those conditions which are known as phthisis corneæ, *applanatio corneæ* and *phthisis bulbi*. By *phthisis corneæ* is meant that condition of the cornea in which it is quite or altogether destroyed by suppuration, and more or less replaced by cicatricial tissue, which, however, is not curved perceptibly forwards, but appears rather flat or even depressed (retracted). Flattening (*applanatio*) of the cornea is usually applied to that condition in which the cornea is partially destroyed by suppuration, otherwise normal, and appears only flat or even wrinkled. Behind the transparent portion, some aqueous humor is still seen between the iris and the cornea, but the pupillary border is firmly adherent with the corneal cicatrix, and the iris has lost its nor-

mal striation and color. If there is distinct perception of light, one may be tempted to make an artificial pupil; this, however, is of no benefit, since, in such cases, the anterior layers of the vitreous body are so altered by exudation, that no image can be formed upon the retina. It is probable that the transparent part of the cornea which is not agglutinated with the iris cannot return to its normal curvature because, on the one hand, cyclitis, which has been induced by suppurative keratitis, has almost exhausted the source of the aqueous humor, and on the other hand, the inflammatory alterations of the inner surface of the ciliary body have caused insufficient nutrition of the vitreous humor. If, after a peripheral linear extraction, suppurative keratitis or irido-cyclitis have occurred, and the former has attacked only a small portion of the cornea, the latter being limited to the region of the ciliary body, the part of the cornea which has remained transparent often becomes only a trifle smaller, is gradually flattened and wrinkled, and the eyeball becomes very soft. If, in such cases not far advanced the tendency towards atrophy of the globe has been fortunately stayed by iridectomy or iridotomy, and a tolerably good curvature of the cornea, with corresponding vision, is preserved, it may well be assumed that the cyclitis was limited to the region of the cicatrix and the parts immediately surrounding it. It has already been stated, that sometimes, after a rather prolonged existence of a corneal fistule, flattening and atrophy of the globe may occur. Phthisis bulbi is very easily recognized, not only by the partial or total absence of the cornea proper, but also by the more or less considerable diminution in the size of the globe, and, as a rule, by the indentation in the vicinity of the recti muscles (quadrangular form). In cases in which there is no longer any possibility of restoring the functions of the eye, phthisis bulbi is more favorable than staphyloma, phthisis and *applanatio corneæ*, inasmuch as it does not prevent the insertion of an artificial eye, and does not further trouble the patient. Sometimes, indeed, entropion of the lower lid and epiphora occur, and then the wearing of an artificial eye may be very desirable, to overcome this annoyance. We must remember, however, that an eye that has been phthisical for a long time can occasion a sympathetic affection of the other eye if it con-

ceals a foreign body (which has caused the inflammation resulting in phthisis, but, perhaps, had produced no irritation for years, because it was encysted), or if calcareous deposits or osseous tissue are formed in the exudate which induced shrinkage of the vitreous humor, or in that which was deposited upon the inner surface of the choroid and mechanically irritate the ciliary nerves. More will be said on this subject when we consider suppurative choroiditis and cyclitis. But it should be here emphasized, that an eye which has become phthisical from panophthalmitis, even in cases in which the whole process has been induced by a perforating corneal ulcer, as, for example, by the violent rupture of a prolapsus iridis, may yet show a good deal of transparent cornea with aqueous humor behind it, especially if the pus collected in the vitreous humor has found an exit, not through the cornea, but through the sclerotic.

The treatment of corneal ulcer should correspond as much as possible to the causative indications. Inverted ciliæ, foreign bodies, or calcareous concretions on the inner side of the upper lid, must be removed. In lagophthalmos, the eye should be guarded against dryness, at least during sleep, if a radical cure cannot be obtained by a provisional or permanent tarsorrhaphy. When closure of the lids and the protective bandage are not practicable, a stenopaic disk, according to Snellen, or a kind of watch glass, may be used, or at least an oiled cloth may be laid over the eye during the night. In cases of central ulceration in infants, caused by deficient nutrition, the eyes may be saved if we succeed in restoring as rapidly as possible the digestion and nutrition. Etiological indications require also that substances acting mechanically or chemically upon a surface deprived of its epithelium should be removed as far as possible. In case the secretion of tears is not copious, grains of dust may easily adhere, especially to the bottom of large, deep ulcers, as may be seen with a lens. On this account it may be advisable to keep such eyes bandaged. Another reason for bandaging the eye is that the ulcerated surface is mechanically irritated by the edge of the upper lid in opening and closing. When a copious mucous secretion of the conjunctiva exists, whether it is induced by the continuation of the primary disease (catarrh, blennorrhœa), or because of the corneal affection or the engorgement

of tears (as, for example, in the blennorrhœa of the lachrymal sac), it is necessary not only to cleanse the eye frequently and carefully, but also to reduce somewhat the secretion of the palpebral conjunctiva by the application of a solution of nitrate of silver, by Bowman's operation, or by bandaging the eye in case of ectropion of the lower lid, etc. It has been mentioned, under diseases of the conjunctiva, that the cauterization of the palpebral conjunctiva in corneal ulcers is well borne when the conjunctiva is not only intensely reddened, but also velvety and spongy; but care must be exercised that none of the undissolved nitrate of silver comes in contact with the cornea. Whatever relates to the use of antiseptic remedies, will be mentioned in connection with corneal abscesses.

The *indicatio morbi* is governed by the state of irritation of the ulcer; when this shows signs of progression, all irritants should be withheld. The instillation of a one per cent. solution of atropine or the application of belladonna ointment are the only remedies advisable during this stage. The instillation of atropine is necessary if, on account of the depth of the ulcer, iritis, with or without hypopyon, is to be apprehended, or is already present. If the ulcer persists for several days in a torpid state, with relatively slight symptoms of irritation, whilst the edges are covered with pus (with or without perceptible increase), the attempt should be made to obtain a better line of demarcation, and a decrease of the purulent deposit by warm fomentations (95° to 100° F.), continually applied for twenty or thirty minutes; and if they are well borne, to be repeated five or six times daily. If, however, the edge of such a torpid ulcer remains yellow and swollen, all around or only in a crescentic portion, and showing signs of further progress, or if the base of a larger ulcer is distinctly bulging, we are justified in dividing the ulcer by Sämisch's method (*vide* Abscess). The ulcer situated at the apex of the vascular band (*vide*, page 73), must be excepted; this requires operative interference, the cutting of the vascular bands near the corneal border, only when they appear very wide (3 mm. and over), and puffy. Ad. Weber¹ recommends the application of eserine for such cases, since it reduces the pressure in the anterior chamber, relieving the

¹ Ad. Weber, Arch. für Ophth. XXII, 4, page 215.

cornea, and, therefore, establishing in it more favorable conditions for nutrition.

If we have to treat an ulcer whose aspect shows no traces of suppuration, we should see whether the process of reparation manifests itself in the diminution of the cavity and by the bluish-white tone which the cicatricial tissue gradually assumes, or whether the ulcer continues unchanged for weeks or months as so-called ulcer of absorption. In the first case, we have only to take care that the crystallization of the substitutive tissue—if I may be allowed the use of such an expression—be not disturbed, and that in case of a large ulcerating surface, protrusion will not be effected by an increase of the intraocular pressure. In the latter case, the attempt may be made through gentle irritants (instillation of tinc. opii, application of the yellow oxide ointment, etc.), to stimulate and accelerate the process of reparation, yet always observing and controlling the reaction, and being mindful of the experience that many remedies destroy the capacity of the substitutive tissue of gradually becoming transparent; in fact, some remedies even enter into combination with it which causes disfiguring cicatrices. Hence, all eye waters containing lead are to be avoided, and, according to Cuvier, also collyria, with metallic salts, or tinct. opii, may have the same detrimental effect. In every case, not only the treatment of the primary disease, as, for example, chronic blennorrhœa, scrofula, etc., but also the regulation of the general dietetic conditions, should be carefully attended to. The patient's mind should be diverted, and good food and exercise in the open air should be allowed, unless they are contraindicated.

If perforation has occurred, if the opening has been closed by the apposition of the iris, or the capsule (or both), if the ulcer becomes clean, and if on account of the small size of the perforation a speedy occlusion of the corneal opening may be expected, it will be justifiable to keep the patient upon his back for several days, with both eyes bandaged, as it is of importance to prevent a permanent adhesion between the cornea and the iris or the capsule. This treatment is still more important, and absolutely indispensable for the preservation of the eye in case of corneal fistule. Although it may be very tiresome for the patient, still it is

endurable for five or six days. A permanent healing of the fistule may be thus induced, or at least sufficient aqueous humor may be at times collected in the anterior chamber to permit the operation of iridectomy. If this succeeds, the fistule, almost without exception, will close, and the cornea will return to its normal convexity. In how far eserine may be beneficial in this condition future experience must determine. The touching of a fistule with nitrate of silver is not only a hazardous proceeding, but also of very doubtful utility; in the case of central fistule it is absolutely injurious. If a recent prolapse of the iris is to be treated, and if the diameter of the perforation does not exceed 4 mm., its reposition by the gradual formation of cicatricial tissue may be expected if it has the form of a cone, but not that of a bladder. In the case of a small conical prolapse, it is sufficient to keep the eyes thoroughly bandaged, and as far as possible to prevent any increase in the intraocular pressure. While the lids are kept in contact with the globe by means of a properly applied bandage, they support the thinned wall of the eyeball so that it can more easily resist the momentarily increased pressure of the aqueous humor. But a bandage improperly applied, or in any manner displaced, may do more harm than good. The bandage which I am in the habit of applying for the purpose of causing the lids to adapt themselves closely to the eyeball, and which I therefore call a "protective bandage," consists of charpie and an elliptic strip of flannel about 20 cm. long and 6 cm. wide, cut diagonally and provided at each end with a somewhat elastic band about 2 cm. wide and about 90 cm. long. The patient is instructed to close both eyes gently, as in sleep, otherwise the upper lid is likely to project over the lower, and thus favor entropion of the latter. The charpie is now put on, in layers or in balls, until the cavity between the nose and the eyebrow is filled. The bandage is then applied in an oblique direction across the face, so that one band passes under the lobe of the ear towards the occipital protuberance, where the other, carried over the frontal protuberance, meets it. This band carried from the occipital protuberance under the lobe of the ear passes forwards below the protuberance of the superior maxilla, obliquely across the eye, towards the frontal protuberance, where it finds a firm support. The other band is carried from the occipital protuberance over the

frontal eminence and over the upper orbital border, which gives it a firm support, below the lobe of the ear and thence over the occipital protuberance to the vertex, where it meets the other one and is tied. If, notwithstanding the proper application of the bandage, entropium of the lower lid occurs, or if it has already occurred, its recurrence may usually be easily guarded against by placing a cylindrical wad of charpie (about 0,6 cm. thick and 4 cm. long) upon the lower lid between its orbital and free border, in order to press the latter back by the bandage and thus keep the free border of the tarsus turned outwards (*vide* Entropium).

But if the prolapse is vesicular, if the perforation exceeds the size already approximately given, or if the surrounding parts appear to be pressed forwards, either puncture or excision, or iridectomy must be performed as soon as practicable. The greater the perforation the greater the precaution to be exercised (perhaps only under the influence of an anæsthetic) in undertaking the puncture or the excision, the patient lying always upon the back and the head and lids being firmly fixed. As the aim of the puncture is not only to evacuate the aqueous humor but to prevent its re-accumulation until the cicatricial tissue has become sufficiently firm to properly resist the pressure, it will generally be best to make a small curved incision (with a Gräfe's cataract knife) because such a wound does not close so soon. In an extensive prolapse it is better to seize a small portion with a pair of forceps and to excise it with the scissors. After either operation it is advisable to keep both eyes bandaged for a time, and have the patient remain in a recumbent posture. The attempt to excise a prolapse without previous puncture, with a pair of scissors placed upon the globe, may easily fail. The application of tinct. opii is generally useless; to cauterize it with nitrate of silver is dangerous. If cystoid corneal cicatrix or a partial staphyloma has formed after a prolapse, a portion of the iris reaching from the pupillary to the ciliary border, and not less than 3 mm. in width, is to be excised, as in glaucoma. Even older partial staphylomata with thick walls usually become retrogressive after a regular iridectomy if the patient strictly remains in the recumbent position for several days after the operation, the eyes meanwhile being well bandaged. The white

cartilaginous wall of a retrogressive partial staphyloma is permeated by numerous vessels on the second or third day after the iridectomy, and in the course of the next few days becomes flatter, then again pale, and finally flat and firm. If this result is not obtained by iridectomy, excision of the staphyloma will have to be performed, or enucleation of the eye if it has become amaurotic through increase of the intraocular pressure. If a total staphyloma has developed, and its wall is thin, K  chler's incision may be made, and after the division of the anterior capsule, the lens may be removed. In the case of total staphyloma with thick walls it is safer to perform abscission by the method of Beer, Critchett, Knapp or De Wecker, but only when the eye has not become amaurotic. In the latter case (in intercalar staphyloma, ectasia of the sclera, or conical corneal staphyloma) there is danger that at the time of, or shortly after the abscission, a severe hemorrhage from the internal vessels, especially from the plexus of choroidal veins, and subsequent panophthalmitis may occur. It is much safer to advise enucleation of the eye, and thereby spare the patient the terrible suffering of panophthalmitis, which finally, though usually not before the lapse of six weeks, results in phthisis bulbi.

If the destruction of the cornea has been so extensive as to irrecoverably destroy the power of vision, the efforts of the physician must be directed on the one hand towards preventing the formation of staphyloma, and on the other of panophthalmitis. Such patients should keep the eye well bandaged for many weeks, and during this time they should not be allowed to resume their occupations. Only when the pseudo cornea has become quite strong and is no longer anywhere translucent (being black or slate-gray), the bandage may be definitely laid aside. After a long and uninterrupted use of a pressure bandage it is generally noticed that the eye becomes softer, and appears less full than normal, which condition is very desirable in cases in which we wish to produce a flattening of the pseudo cornea.

2. CORNEAL ABSCESS.

We diagnosticate corneal abscess when we find pus in the cornea surrounded by undestroyed layers. It is differentiated from ulcer by the suppurating surface of the latter being exposed to view,

and not only the epithelial layer but Bowman's membrane is wanting, and from a purulent infiltrate which, by its deliquescence, is transformed into a superficial ulcer. Pus corpuscles may be lodged in the interstices of the parenchyma as within a felt, or may be enclosed in a cavity after the purulent infiltration has broken down. If from such a focus the pus sinks down between the fibrous layers of the cornea which, under these circumstances, probably suffers no change of texture, such a pus centre, always lying below the original, is called *unguis* or *onyx*, on account of the crescentic form in which it usually occurs. This condition should, therefore, be distinguished from an abscess proper, because the cornea at the site of such a deposit may again become quite transparent; which it will never do in case of abscess. The abscess may become an ulcer if its anterior surface is perforated or destroyed. Such an ulcer shows, at least partially, an undermined edge, which occurs comparatively seldom in primary ulcers. (Page 136.)

Symptoms and Course.—A corneal abscess is recognized as such when the opacity, during the presence of other inflammatory symptoms, especially ciliary injection, appears in the form of a disc and indicates the nature of its origin by a more or less distinct, yellow pus color. We have then to choose only between ulcer and abscess. But if a case occurs in which the number of pus globules is small, a more or less opaque disc of light-gray color is found, around which the cornea appears clear or only slightly hazy, while the more intensely opaque disc appears on the surface distinctly uneven (jelly-like, as it were), partly by elevation and partly by the exfoliation of minute portions of epithelium. Under the lens such a place sometimes shows an irregular striation resembling crumpled oil paper; in other similar cases saturated points or dots are seen with the lens, perhaps caused by the aggregation of pus corpuscles. If we find that this condition has developed within a few hours or days, especially after one of the causes to be hereafter mentioned, which, according to experience, usually results in abscess, and if the disc, especially at its border, shows a denser saturation, the presence of an abscess is very probable. This probability becomes a certainty when the lower border of the disc becomes more opaque or when *unguis* or *hypopyon* is added.

Cases with a scanty formation of pus tax the endurance both of the physician and the patient for weeks and months, until all inflammatory symptoms disappear. They leave behind an incurable though less dense opacity. In cases which distinctly manifest themselves as abscesses within the first two or three days by a collection of pus in the cornea, the disease may appear in various forms, according to the behavior of the cornea and the accompanying and inducing circumstances. First of all, the anterior wall of the deposit may bulge forwards by the copious collection of pus, and it often appears as though the posterior wall also projected into the chamber. If the quantity of pus has decreased by resorption,¹ by emigration, or after perforation of the wall, the anterior wall appears wholly or partially sunken. Strikingly resembling an ulcer, with infiltrated edges, it appears then light-gray or mottled, for the greater part, with saturated points, spots or stripes. The sunken portion looks smooth, notwithstanding the absence of epithelium, and often somewhat wrinkled; it never rises abruptly, but always gradually towards the edge and its still distinctly infiltrated (light yellow or swollen) portion. In many cases the sunken anterior portion may be displaced somewhat by the pressure and movements of the lids; in others lachrymal fluid appears to have entered the cavity of the abscess through some opening, since it presents itself in the form of a flaccid vesicle containing a clear liquid, which should not be confused with keratitis bullosa (p. 134).

The condition of the border of the pus focus requires the greatest attention. It is from that, from the centrifugal advance, that the greatest danger threatens the cornea. Sometimes the focus spreads in all directions, oftener, however, only in one direction, not only downwards but upwards or towards either side. The danger of increase continues as long as any portion of the border is distinctly infiltrated. Generally the peripheral boundary of such an infiltration is surrounded by a slightly hazy zone, which shows radiating lines under the lens. Through such a partial advance in one or the other direction the focus loses the circular form originally peculiar to it. The larger this ominous infiltrated arc, the more the cornea is threatened with destruction

¹ After commencing disintegration through fatty degeneration pus may be eliminated very rapidly.

in that direction. With the disappearance of this border, with the flattening and clearing of the infiltrated portion of the border, the danger which threatens the eye disappears. Through disintegration of the anterior or the posterior wall (which result should be anticipated, although it does not always occur), the abscess is transformed into a corneal ulcer, which may run a course similar to any other deep or perforating ulcer, but often continues to push on and results in complete destruction of the cornea. On account of this extension in the surface this process was called *ulcus serpens* by Sämisch.

Pus collects in the anterior chamber (*hypopyon*) more frequently in abscess than in corneal ulceration. A small quantity of pus in the anterior chamber may be very easily overlooked, especially in the case of a small ulcer. It easily escapes notice, on account of the corneo-scleral border, unless we look into the chamber from above. If there is sufficient pus to fill the space between the iris and the cornea to the height of the sclero-corneal border or even to rise above it, it often appears in the form of a crescent, rising somewhat higher at both ends; still, it is often bounded by a straight line. Sometimes it appears as though pus was descending upon Descemet's membrane from the abscess in the cornea; a grayish line extends from the posterior wall of the abscess to the collection of pus below. In case an improvement does not soon occur in the condition of the pus centre, the quantity of pus increases in the chamber, filling one-half or even two-thirds of it. I have only once observed complete filling of the chamber with pus, and then not in consequence of suppurative keratitis. Abscesses also occur which do not result in hypopyon, because their superficial extent is greater than that of depth. A corneal abscess may begin and advance even to complete destruction of the cornea, though accompanied by very insignificant symptoms. In many cases an abscess is developed during intense ciliary injection all around the cornea, with photophobia, lachrymation, violent pains, and œdematous swelling of the ocular conjunctiva, even to the border of the lids; but these symptoms gradually subside, and the cornea may be found in a state of complete ulceration, with relatively insignificant redness of the surrounding parts, the patient really suffering no pain. In many cases, however, the corneal abscess is a most painful disease, and, after

sleepless nights, the patients wish above all things to be relieved of the terrible pain that radiates to the occiput and to the teeth of the upper maxilla. Equally violent complaints are only heard in acute attacks of glaucoma, cyclitis, and panophthalmitis. This pain is evidently occasioned by implication of the uveal tract, through induced inflammation of the iris and the ciliary body, and it coincides, as a rule, with the appearance of hypopyon. Hypopyon certainly may appear in corneal abscess, as in corneal ulceration, without much pain, but corneal abscesses with violent pain and without hypopyon are very rare. It is the irido-cyclitis, induced by suppurative keratitis, which threatens the eye with blindness, even when the ulcer or abscess has left intact a more or less extensive portion of the cornea. The attention of the physician should therefore be directed to the condition of the iris, to the exudation in the pupil and in the anterior chamber.

Etiology.—Abscess is not a frequent disease of the eye. It furnishes only a small percentage, even among the corneal inflammations. With the exception of those occurring after smallpox (which have been observed even in infants), they are found almost exclusively in adults or senile persons who generally belong to the laboring classes, a large number of whom are poorly nourished. The relatively frequent occurrence of corneal abscess in adults, with blennorrhœa of the lachrymal sac, is very striking, to which fact Horner has called especial attention. This affection may be easily overlooked if it is not made a rule to examine carefully the lachrymal ducts in every case of corneal ulcer, even when it is plainly due to other causes. Chronic catarrhal inflammation of the palpebral conjunctiva, generally with copious secretions, is found as a result of the lachrymal affection, either alone or together with blepharitis marginalis and small abscesses in the cutis along the outer edge of the intermarginal border. Most corneal abscesses are observed after lesions (traumatism) of the cornea. The blow of a fragment of ice, stone, wood, etc., the thrust of a stalk or beard of grain during harvest, a blow with a knotted whip-cord, a switch, etc., were given as causes in a great many cases, and were long since recognized as such by careful observers. The statement of older observers, that a cold might sometimes be considered as cause of corneal abscess, I found repeatedly confirmed.

I have described in detail a striking case of the kind, in the *Archiv. für Ophth.*, B. XVI, page 13. Probably many cases in which the data given by the patient do not seem sufficiently reliable belong to this category. The circumstances inducing a cold are so seldom observed with accuracy, that the physician who is accustomed to receive the statements of patients with caution, ventures to give no opinion concerning the cause, but rather refers such cases to the class, "cause undetermined." Abscesses are observed after smallpox, either at the time of desquamation or after complete cicatrization—yet before the skin has again assumed its natural color. It is worthy of remark that in many convalescents iritis (irido-cyclitis) occurs at the same time without any other affection of the eye. In a similar manner abscesses may occur in the cornea, as in other organs, during a pyæmic progress, as for example, after typhus. A case of the latter kind has been described by von Sämisch (*Handbuch IV*, page 280).

Of great importance is the question whether the above-mentioned noxious influences, especially the injuries alone, cause the unfavorable results already spoken of, or whether through them septic substances find entrance into the corneal tissue. This question is entitled to consideration, especially on account of the strikingly frequent occurrence of corneal abscesses in eyes which suffer from blennorrhœa of the lachrymal sac and from the observation that ulceration of the cornea frequently results after operations, particularly extractions of cataract, in eyes thus affected. Furthermore, it is impossible to produce suppurative keratitis, with analogous symptoms, by simply cauterizing or wounding the cornea, unless there is also an inoculation of septic matter, or unless a conjunctival inflammation with a muco-purulent secretion is produced. It is therefore to be presumed that in many cases in which a lesion of that kind occurs, a small wound, which is no longer perceptible at the time of the observation, was inflicted, and that in those cases occurring in dacro-cystitis a wound has been inflicted unnoticed by the patient, or an ulcer has been formed during an intercurring conjunctival catarrh, and thus an entrance prepared for the septic matter by abrasion of the epithelium. But even excluding from this consideration the abscess after variola as a metastatic process, and leaving out the rare cases arising from

cold, the supposition of septic infection does not explain why, in the simply traumatic cases, injuries with contusion should open the way for the immigration of deleterious matter, when we very often see wounded and ulcerated portions of the cornea exposed to various conjunctival secretions and injurious atmospheric influences without the development of the above-mentioned symptoms ascribed to the immigration of septic matter. Opposed to this hypothesis is the striking fact that in numerous cases of small metallic splinters in the cornea, which at the time are almost eliminated by inflammation and suppuration, the characteristics of a keratitis related to septic origin do not appear then, or after the manipulations necessary for their removal. Only in wood-turners and stone-cutters do we sometimes observe, after the bruise resulting from a small fragment, as of stone, an ulcerating wound with the above-mentioned ominous infiltration of the edges; but here the suspicion of a simultaneous contusion is obvious. If a small foreign body has not penetrated deeply but on account of its prolonged presence has caused a hazy halo, the pupil is found perceptibly smaller and the iris discolored, and perhaps synechia and hypopyon have already occurred. If hyperæmia or even inflammation of the iris appears during the first forty-eight hours it may be safely assumed that the foreign body has penetrated considerably deeper, even to Descemet's membrane. Considerable injury of the cornea is often unavoidable in the removal of a foreign body, and yet after this manœuvre the so-called *ulcus serpens* has scarcely ever been observed, although many patients have at once resumed their usual occupations and manner of living. It will be said in such cases, that the second factor—the septic matter—is wanting. But how does it happen that we so often observe the occurrence of this keratitis just after a contusion, whilst injuries with contusion occur so much less frequently than wounds? Towards the close of the year 1879 I undertook the discission of cataract in a three-year-old child; both eyes being operated on at the same sitting. Unfortunately the needle was introduced too obliquely into the second eye, and consequently the cornea was contused during the subsequent manœuvres. It was at once apparent that a mistake had been made, yet I was unable to prevent the occur-

rence of suppurative keratitis in this eye. If Sämisch (*Handbuch IV*, page 250) finds it singular that his operation of splitting the cornea through the centre of the purulent focus not only prevents new infection of the corneal wound, but rather stops the process, many colleagues will find themselves in the same position after having observed the favorable results following the operation in most cases if not in all. The same may be said of the well-known favorable results of iridectomy in case of *ulcus serpens*, although it is scarcely to be assumed that in all cases it is possible to establish a closure of the wound, immediately after the operation, sufficient to prevent the entrance of septic matter. These observations are not made with the intention of belittling or decrying antiseptic treatment, but only to call attention to the fact that the destructive course of such corneal inflammations cannot be attributed entirely to the supposed infection.

The cause of the progress and extension of the pus centre towards the surface apparently depends upon the fact that the pus lies under an unbroken (intact) anterior elastic membrane, and is, as Stellwag¹ so well remarks, pushed by its pressure beyond the original focus of inflammation. This pressure not only exists as long as the pus cavity is enclosed on all sides and is well filled, but also after the anterior wall is perforated and partially sunken, although then only in one or several portions of the edge, which then appears bulging, light gray or pus-yellow. This pressure also exists in open ulcers of different origin with completely or partially undermined borders, and in the process which was described as *scrofulous conjunctivitis*, in the form of vascular bands. This latter form is distinguished from the two former by the fact that the pus never enters deeply into the substance of the cornea, and therefore induces neither *hypopyon* nor *iritis*, and further by the fact that the vessels from the *limbus* follow the advancing pus deposit. The question, Where does the pus in the anterior chamber come from? has occupied the attention of physicians for many years. On this point I would refer to the articles in Himly's *Handbuch*, which appeared in 1843, and in Gräfe and Sämisch's *Handbuch*, 1876, Vol. IV, page 184. It was known that pus may collect

¹ Treatise on Diseases of the Eye, Amer. ed., page 55.

in the chamber without any corneal disease, but it was assumed, as a matter of course, that when pus appeared in the chamber in case of a pus deposit in the cornea it must have reached the former from the latter; that the ulcer or abscess had opened posteriorly. After having frequently observed that in deep corneal ulcers iritis, with or without hypopyon, occurred without any further causes, and having concluded that in funnel-shaped corneal ulcers with hypopyon a posterior perforation could not occur without escape of the aqueous humor, I suggested in 1851 (Vol. I, page 196) that the pus did not originate directly from the pus deposit in the cornea, but that here, as in cases in which the cornea is intact, it was furnished by the iris; that the suppuration of the deeper parts of the cornea induced iritis, and that the pus in the anterior chamber was furnished by the iris. This view has met with repeated contradiction by the report of cases in which there was suppurative keratitis with hypopyon, and in which no iritis could be found. If posterior synechiæ are required in order to establish iritis, it must be admitted that it cannot be proven in all cases of hypopyon.

According to Stromeyer's¹ experiments on rabbits, the immigration of pus or white corpuscles of the blood may take place through the interstices of the ligamentum pectinatum from the ciliary body into the anterior chamber. The pus corpuscles accumulated in the cornea may pass through canals or lymph-passages existing in the cornea, and especially along the corneal nerves, the uveal tract, and through the ligamentum pectinatum into the chamber; and in case they do not speedily degenerate and become absorbed, they may induce iritis or irido-cyclitis. I have repeatedly seen pus proceed from the posterior chamber through the pupil after Sämisch's operation for the incision of abscesses, and my assistant, Dr. Fuchs, has found, in the mass extracted from eyes affected with hypopyon, not only micrococci and fatty cells, but also pigment cells, which evidently could descend from the uveal tract alone. Just as we see pus appear in the anterior chamber in pyæmic choroiditis (that is, in the case of a pus deposit in the posterior section of the uveal tract), even before the appearance of inflammatory symptoms in the

¹ Archiv. für Ophth., XIX b., pages 1-38.

anterior section, so we cannot deny the possibility that, if pus from the cornea has reached the uveal tract, it may appear in the anterior chamber before any manifest symptoms of iritis occur. If the contents of the chamber, which very often do not escape, even after a free incision, but must be seized with the forceps and pulled out, are immediately examined, pus corpuscles, with the above-mentioned admixtures, are found held together by a hyaline, unusually tough, fibrinous mass, which can only be related to inflammation of the iris and ciliary body. With this is not to be confounded the much rarer occurrence of a coherent mass which, as a plug of necrotic tissue, may be pulled out of the cornea, after which the anterior wall of the abscess-cavity distinctly sinks in. A. Weber,¹ who first called attention to this occurrence, says expressly that a true abscess cavity may form, and that in cases in which, after the opening of the abscess, white points remain in the place of the deposit, a membrane may be detached from the inner surface of the cavity and removed with toothed forceps, either as a whole or in pieces. According to Horner² a direct transmigration of pus corpuscles takes place from the bottom of the ulcer into the anterior chamber, through Descemet's membrane. This view is supported by clinical observations which can scarcely be interpreted differently. For we often notice behind the abscess and adherent to Descemet's membrane a coagulum from which a hazy streak, like a deposit on Descemet's membrane, descends to the pus at the bottom of the anterior chamber. Again, we find in some cases a more or less extensive portion of the pupillary border attached to Descemet's membrane, at the place where an abscess had been situated, although neither a perforation of the cornea had occurred nor an operation been performed. Such an adhesion in a case in which no aqueous humor has escaped, can only occur if the posterior wall of the abscess is greatly distended and bulged out towards the iris—and in some cases it looks much like it—or if a very thick fibrinous layer clinging to the cornea extends to the iris and unites with the border of the pupil. If we adopt Horner's view, the collection of pus heretofore described as "lunula" or "onyx," and located in the cornea must

¹ Archiv. für Ophth., VIII a, page 334.

² Inauguraldissertation über Hypopyon Keratitis von Marie Bokowa, Zürich, 1871.

also be considered as a burrowing of pus (secondary abscess) in the posterior layers of the cornea; it differs from hypopyon only inasmuch as here a small quantity of pus is attached to the lower portion of Descemet's membrane, whilst in hypopyon, on the contrary, pus fills the space between the iris and the cornea. Roser¹ has described as hypopyon-keratitis the form of suppurative keratitis which the author describes as abscess in accordance with the older terminology. He designates it as an ulcer, but also says: "More rarely a so-called corneal abscess is developed." He characterizes the ulcer as broad and flat, with a peculiar circular or sickle-shaped opacity of the border and with a slightly or not at all hazy ground, extending superficially rather than in depth, perforating slowly, but frequently causing, by cicatrization, a broad leucoma and often staphyloma. This description, as I understand it, contains the admission that in these cases he did not deal with open ulcers, with denuded pus deposits, but with pus which was more or less covered; in other words, with abscesses. The deposit (the so-called ulcer) appears flat, not because the ulcer is shallow, but because when the abscess comes under observation the anterior wall is somewhat sunken. The designation flat is correct, but the reference to an open pus deposit (an ulcer) is incorrect. We often see pus in the chamber in cases of an open ulcer, but then we do not observe the above-mentioned alterations on Descemet's membrane behind the ulcer, nor the other characteristic symptoms of the so-called hypopyon-keratitis.

Sämisch² has introduced the name "*ulcus corneæ serpens*" for those "forms of suppurative keratitis which are distinguished by the tendency to penetrate into the parenchyma, and to extend superficially, especially in one certain direction." He evidently had in view the same disease which Roser has described as hypopyon ulcer, and Ad. Weber as corneal abscess. But when, in his most recent publication on this subject (*Handbuch B. IV*, pag. 246) he says expressly that his "*ulcus serpens* has nothing in common with the corneal abscess" which Ad. Weber and the author described in Vol. XVI, of the *Arch. of Ophth.*, it is evident that he has created a new nomenclature without cogent reasons.

¹ *Archiv. f. Ophth.*, II b., page 151.

² *Ulcus corneæ serpens*, eine klinische Studie, Bonn, 1870.

Though Sämisch regards the condition as an ulcer, he recommends an operation which in surgery is only applied to an abscess or a fistula, namely incision.

The prognosis is unfavorable; at best a central permanent opacity, more or less extensive and intense, remains in the cornea. The opacity extends as far as the preceding pus focus had extended, and is sharply defined from the surrounding unaffected portion. It is produced after the destruction of the tissue elements (cells and fibrillæ), by a more or less thick layer of connective tissue, which unites the deeper with the superficial (anterior) layers. Where no perforation and escape of the aqueous humor has occurred, the convexity of the opaque portion may appear about normal; the chamber behind it unchanged or narrowed by a partial attachment of the iris; the pupil more or less free, or obstructed by a membrane. After the escape of the aqueous humor, a more or less extensive leucoma is developed, with partial or complete adhesion of the pupillary border, or a staphyloma, or phthisis corneæ (with flattening), or even phthisis bulbi.

The danger to the cornea depends upon the extension of the pus focus in circumference. Partial disintegration (perforation) of the anterior wall does not appear to have any influence upon the further course. Perforation of the posterior wall with evacuation of the aqueous humor mitigates the severity of the pain in many cases; but it seldom arrests the further extension of the pus focus. So long as saturated white or light yellow dots or points are present in the region of the otherwise perhaps only slightly hazy focus, we cannot be sure but that, even after apparent cessation, the process may start up again. This course of alternating cessation and progression may continue for several weeks.

In cases of chronic conjunctival catarrh, especially if caused by retention of the tears, and furnishing a copious secretion, in persons of advanced age, who are very much reduced by indigent circumstances, by household cares, by febrile diseases, etc., or in those whose frame of mind is much depressed by violent pain, fear of blindness, etc., the danger of extensive disintegration is greater than in the absence of these circumstances. Cases in which it is doubtful at first whether the affection is interstitial keratitis or an abscess, and cases with slight hypopyon (not ex-

tending to the pupillary border) do not show a further increase of the focus, although they generally run a very chronic course. Secondary iritis or irido-cyclitis, aside from hypopyon, very often results in partial or total occlusion of the pupil by a membrane, more rarely by a small synechia. Partial adhesion of the iris with the posterior wall of the pus focus may occur, as has already been stated, without a true rupture of the abscess posteriorly, and without incision of the abscess.

Treatment.—The *indicatio causalis* can only arise in those cases in which the probability, or at least the possibility, exists that pus globules, fungus formations or septic matters immigrate from the conjunctival sac into the cornea. 1. If blennorrhœa of the lachrymal sac exists, the lower canaliculus should be slit up and the duct probed by Bowman's method. Chronic conjunctival catarrh is to be treated according to the principles already discussed. As antiseptics, are recommended chlorine water, permanganate of potash, the instillation of a one per cent. solution of carbolic acid, a one per cent. solution of salicylic acid,¹ especially benzoate of soda (1 part to 20 of water). It is scarcely necessary to mention that cloths used for washing and bandaging must be kept scrupulously clean, and the air of the room purified by thorough ventilation.

Indicatio Morbi.—Local abstraction of blood (from the temples or behind the ears), may be beneficial if the inflammation is ushered in by violent pain and intense ciliary injection, or by chemosis of the ocular conjunctiva. Cold compresses are useless. Warm fomentations (90° to 95° F.) may be applied at intervals of one or several hours—partly to mitigate the pain and partly to favor the resolution of the anterior wall of the pus deposit, if we can frequently examine the case to see the exact condition of the abscess. Jamin has recommended a decoction of marshmallow, in order to allow the pus to exude through the pores of the relaxed cornea. In addition to this, a well-fitting protective bandage is to be recommended; and if the lachrymal sac is distended by pus, we may exert a pressure upon it by placing more charpie at the inner canthus. This bandage protects from atmospheric impurities, and also prevents irritation of the cornea

¹ According to Sattler (Heidelberger Versammlung, 1879) this solution is most easily and most reliably obtained by dissolving 1 part of pure salicylic acid and 3 parts of boracic acid in 100 parts of warm water; gradually cool and then filter.

by the natural movements of the lids and by their violent contraction. But it should be renewed at least once a day, and more frequently if the charpie or cotton becomes moistened. Instillations of a solution of atropine are indicated because iritis may be present or apprehended; at all events, so long as there is any prospect of keeping the pupil at least partially open.¹ If, notwithstanding the careful use of these remedies, the extension of the pus deposit continues, and if, perhaps, only a comparatively small portion of the cornea has remained intact, if the hypopyon occupies one-third or more of the chamber, and if the patient suffers from violent pain which deprives him of sleep, and which cannot be allayed by injections of morphine, hydrate of chloral, etc., then the only hope for a cure or a cessation in the extension of the pus deposit is in operative interference.

The greatest relief is to be expected from the application of the actual cautery, introduced by Martinashé, of San Francisco, and Gayat, of Lyons, to prevent progressive corneal suppuration, and which is especially warmly recommended by Sattler,² who used a small olive-shaped knob about 2 mm. thick and not quite 4 mm. long, terminating at the free end in a blunt point. The application of this red-hot iron to the infiltrated margin which tends to spread further, is neither painful nor alarming, if the healthy eye be closed and the head and the lids of the affected eye be fixed; and when the infiltration is extensive, or when there is more than one, it may easily be repeated. A clean surface appears at the point of the exfoliated eschar with a tendency to rapid healing, such as can be obtained neither by scraping off the infiltrated portion (Volkmann's method) nor by cauterization with nitrate of silver. I have seen a girl whose left cornea, to the extent of 5 or 6 mm. in length and 2 or 3 in

¹ Ad. Weber inferred, from tonometric experiments on human eyes, that atropine reduces the pressure, if at all, only in the vitreous body, whilst it always increases it in the anterior chamber above its former height, though not, or only to an extremely small degree, above that in the vitreous body; and that eserine, on the contrary, increases the pressure slightly in the vitreous body, but reduces it considerably in the anterior chamber. Hence, he proposed eserine instead of atropine, and De Wecker (*Archiv für Ophth.*, XXII, 215), has recommended this remedy most warmly. I never applied eserine in corneal abscess, and have heard opinions not altogether favorable regarding the use of eserine in keratitis with hypopyon.

² Heidelberger Versammlung, 1879.

breadth, being burned with a hairdresser's iron, became quite white two or three hours after the injury. A protective bandage was put on, and after twenty-four hours no trace of the injury was to be seen, the epithelium having quite regenerated. If, according to Alfred Gräfe's proposition, the incision by Sämich's method be not carried through the middle of the abscess, but near the peripheral boundary of the infiltrated border, the demarcation is not so certainly obtained; pus may still remain pent up, and may, if the wound closes prematurely, be forced into the healthy tissue. The procedure by Sattler's method may be considered as sufficient, unless it is necessary to open the anterior chamber on account of the copious collection of pus or the violent pain; it may also be applied after paracentesis, when this operation has not arrested the ulceration. I have seen surprisingly favorable results from this course.

Neither the simple opening of the abscess (division of the anterior wall), nor the older methods of opening the anterior chamber (division of the posterior wall), is sufficient, as a rule, to arrest the progress of the pus-infiltration. Weber (*Archiv. f. O. a. VIII*, p. 334), has the merit of having inaugurated a more rational proceeding, but Sämisch (Bonn 1870), first devised a procedure which surpasses all previous operations in its results, although in a few comparatively rare cases it also is insufficient. It differs from Weber's method, which is executed with a lance-shaped knife, in this, that the cornea in the area of the abscess is divided not obliquely but perpendicularly, for which purpose a Gräfe's cataract knife is necessary. Furthermore, the section should be so directed that the arc formed by the infiltrated margin shall be divided into two parts. If, therefore, this arc look upwards or downwards, the incision may be very difficult, especially in deeply set eyes. If the abscess tends to advance towards the nose or the temple, that is, if the convexity of the infiltrated border is directed inwards or outwards, the incision must be made in the horizontal diameter of the abscess, in order to divide the arc into an upper and a lower portion. If a diagonal section be indicated, the eye may be rotated on its axis by means of fixation-forceps applied near the corneal border, so that the cataract knife may be used in the direction of the palpebral fissure. The operator may stand at the

head or at the side of the patient. After proper fixation of the head, lids and eyeball, the operator, in case it is possible to make the incision in the direction of the palpebral fissure, inserts the knife, with the edge turned forwards, near the temporal border of the deposit (and, if possible, in the intact portion of the corneal zone), and sufficiently perpendicular, to be sure that in the insertion the point has passed through Descemet's membrane; then he lowers the handle towards the temple as much as is necessary to insure the safety of the iris and the capsule of the lens in advancing the knife, and as soon as the counter puncture is made, the fixation forceps are to be removed and the knife directed outwards, so that the incision may end in a portion of the uninjured corneal zone. The incision (from behind forwards) may be made in one or in several strokes (sawing motion), but always holding the blade so that its back is directed towards the pole of the lens; as a vertical incision through the cornea can be attained only in this manner, such an incision offers the most favorable conditions for a prolonged gaping of the wound and free discharge of the pus; wounds made in an oblique direction close much sooner. After the anterior chamber is opened, the violent pain about the head ceases, although, in some cases, pain appears in the course of several hours, when previously there was none. The pus collected in the chamber is not always completely evacuated, clots of pus often advance as far as the wound, and may be extracted wholly, or, for the greater part, with the forceps. Generally some pus is evacuated from the cornea also, and in some rare cases it is possible to extract a core—like lumps—from the corneal abscess. In every case, even after incomplete evacuation, a depression of the pus-focus is observed.

After having carefully washed out the conjunctival sac, and, if necessary, the secretion in the lachrymal sac, it is immaterial whether the eye just operated upon be simply closed and covered with a small compress dipped into a solution of benzoate of soda or salicylic acid, or whether it be bandaged with the roller bandage and cotton batting. In any case the patient should be kept quiet, in a recumbent posture, for four or five hours, and, after a second dressing, atropine should be instilled and the protective bandage applied. In favorable cases the restored chamber is found at this time, or on the next day, free from pus,

and the edges of the abscess are flatter and cleaner. If on the following day or later pus is again found in the chamber or the edges of the pus deposit again become infiltrated, it is advisable to pass a Daviells' spoon, or still better a Weber's lachrymal knife, through the entire wound. But in case the wound should be too firmly agglutinated, or if a marginal infiltration should appear in another place, another incision may be made bisecting the new marginal arc. But before undertaking a second incision, either in the former or a different direction, it should be considered whether it would not be better to apply the actual cautery. If, in cases which require operative interference, the prospect of restoring vision through an artificial pupil (to be formed later) depends upon preserving intact a portion of the cornea, it should be remembered that every incision made into such a portion of the cornea always results in a permanent, though linear, opacity. This consideration may suggest the question, whether it would not be best to arrest the progress of suppuration by iridectomy. This method, introduced by A. von Gräfe, has also given many successful results, but it cannot be performed with the requisite certainty in the case of marked chemosis and a high degree of hypopyon, and it is not at all practicable in case of a soft condition of the iris, which frequently occurs. Furthermore, the coloboma of the iris is easily closed by plastic exudation if the inflammation does not abate soon after the operation, as the aqueous humor is then rich in fibrin.

3. SUPERFICIAL PURULENT INFILTRATION.

There are cases with distinctly pronounced inflammatory symptoms, in which a light yellow, round or nearly round opacity is found in a central or more peripheral position (perhaps in two places), which might be mistaken for a flat pustule or for an ulcer, should its surface not show a distinct convexity. The turbid portion, two or four mm. in diameter, is opaque in the centre, pus-yellow, grayer towards the edge, which is not sharply defined, and often surrounded by a hazy halo. Vessels in the cornea are developed only at a later stage, if at all. Such a deposit may exist for several days almost unchanged, without any considerable symptoms of irritation; but an ulcer is usually developed in the centre, which, in its

further course, may behave quite like an ulcer otherwise induced, especially like one induced by scrofulous conjunctivitis. But in those cases in which ulceration does not occur, the pus deposit gradually becomes smaller and thinner, and finally completely disappears; the prognosis is therefore exceedingly favorable. Only on account of this circumstance does it seem judicious to differentiate this form from ulcers, as well as from abscesses. As regards treatment, the principles prevailing in general ulceration are applicable here. A. von Gräfe¹ has recommended the application of warm fomentations for infiltrations which he designates as non-irritant, if the infiltrated portion is immediately adjacent to one normally transparent, and if no gray, swollen halo be present. In the course designated as malignant by von Gräfe, extension superficially and in depth, as well as the appearance of iritis and hypopyon, are to be apprehended only when the infiltration is resolved in the centre; that is, when an ulcer has developed. The author has observed this form only in young persons, most frequently in children, and without any known external influence.

III. INJURIES OF THE CORNEA.

It is not always easy to diagnosticate a mechanical injury of the cornea and its consequences from a lesion originating otherwise. The patient may have reasons either for alleging or denying an injury, or he may even have been injured without knowing it. For this reason, and on account of the often very serious consequences of certain injuries, it seems necessary to become acquainted with the peculiarities by which an injury may be inferred, and its necessary and usual consequences.

(a) *Contusion of the cornea* usually causes violent inflammation, with the formation of an abscess, whether the foreign body penetrates into the substance of the cornea (a contused wound) or has simply rebounded (*vide* Corneal Abscess).

(b) *Abrasion of the cornea*, or even only slight scratching, by which the superficial fibrous layers are affected, causes violent pain, disturbance of vision, ciliary injection, photophobia, blepharospasm and lachrymation, which usually disappear under the application of cold compresses. But there are cases in which, after

¹ Archiv. f. Ophth., VI b., page 135.

a few weeks, and an apparent cure, these symptoms return, and repeatedly recur at intervals of from five to eight weeks. Then, upon closely and successively examining every portion of the cornea by reflected light, it is somewhere found abraded, and only upon inquiry it is ascertained that the cornea has been grazed by the finger nail, the tooth of a comb, etc. This affection may be permanently removed if, immediately after the injury or during the relapse, the eye be kept uninterruptedly and well bandaged, and, if necessary, atropine be instilled at the time of its daily renewal, until within from one to two weeks the lustre of the part affected is completely restored. A gentleman, whose eye was injured by a broom-corn, came to me at the time of his second relapse; as recovery progressed favorably, he discontinued his visits too soon, and only the third relapse induced him to persevere until the recovery was complete. For about ten years he has had no relapse. In another case a woman had suffered from relapses for six months.

(c) *Deeper wounds*, even if they heal by first intention, always leave a permanent opacity, which may be easily seen by focal illumination. By reflected light, a roof-like elevation of the edges of the wound may be seen even in linear scratches of the cornea, in consequence of the retraction of its borders and its diminished resistance to the pressure of the aqueous humor; the deeper and the longer the wound, and the more curved and zigzag its course, the more distinctly pronounced is this elevation of the edges. Flaps, or ragged edges of the wounded cornea are a hindrance to healing by first intention, in consequence of their tendency to curl; contusions or impurities in the wound easily cause suppuration. In older and poorly nourished persons, as well as in connection with affections of the tear passages, and in chronic conjunctival catarrh, the danger of suppuration is greater.

(d) *Perforation of the cornea* is indicated by the absence or shallowness of the anterior chamber, the diminished tension of the eyeball, the contact of a portion of the iris with the wound, distortion of the pupil in the direction of the injury, and prolapse of the iris or vitreous humor, especially in a peripheral wound. Filiform or conical bands connecting the anterior and posterior wall of the anterior chamber, as well as small pigment fragments of the iris on the cornea, generally indicate the preceding perfo-

ration only at a later period. Opacities after fine perforating wounds, after keratonyxis, for example, are generally visible only by focal illumination. Penetrating wounds which, on account of their form or small size, close readily and permanently, are much more favorable than very long linear, curved, or V-shaped wounds. The latter offer the possibility of an extensive prolapse of the iris, resulting in marked distortion and occlusion of the pupil, in manifold changes in the convexity of the cornea, in exfoliation and suppuration of corneal flaps, in irido-cyclitis, or in panophthalmitis. Penetrating wounds, which result in prolapse of the iris, still allow of a favorable prognosis provided the pupil be not too much distorted laterally or occluded, and in case the convexity of the cornea immediately in front of the pupil be not permanently changed. If the cicatrix covering a prolapsed iris remain distended, the eye is not secure against subsequent increase of the intraocular pressure. Penetrating wounds of the corneo-scleral border are among the most critical injuries of the eyes, even if they be not, as is very frequently the case, accompanied by prolapse of the iris or the vitreous body. (*α*) Cystoid cicatrization may result, complicated or uncomplicated by strangulation of the iris, if the conjunctival edges alone unite; then the superficial non-resistant envelope is pressed forwards, in the form of a cyst or a swelling, by the aqueous humor, with or without the iris. This may induce a permanent irritation of the ciliary body and an increase of the intraocular pressure, purulent inflammation of the uveal tract and phthisis, perhaps also cyclitis of the other eye (sympathetic affection). (*β*) After slight punctured or incised wounds in the scleral border, a cystic formation is sometimes observed in the iris at a later period (*vide* Diseases of the Iris). (*γ*) After penetrating wounds in this region, cataract may also occur sooner or later, evidently because the capsule of the lens had been punctured, although it may not be immediately noticed. (*δ*) Penetrating wounds are most dangerous in this region, on account of the simultaneous injury of the ciliary body, in which a chronic or acute inflammation may be developed; the latter terminating in suppuration, the former in a sympathetic affection of the other eye.

Treatment.—In recent corneal wounds, no objection need be

made to the generally prevailing view, that after an injury, cold applications should be made to the eye, provided other more important indications be not neglected. At the present time, there are probably few oculists who, after the extraction of cataract, *i. e.*, in a large penetrating corneal wound, immediately order cold applications; or fewer still who annoy the patient, as was formerly the custom, with ice applications. It is first necessary, after a thorough cleansing of the eye, to carefully close the palpebral fissure to prevent the movements of the lids, and, in penetrating wounds, to guard against external pressure (at least unequal pressure), as well as against every increase of internal pressure, engorgement of the internal blood vessels. As soon as possible, a well fitting protective bandage should be applied, and care should be taken that the patient maintain the recumbent posture during the renewal of the bandage. If a small tip of corneal substance, as in lacerated wounds, projects so as to retard or prevent healing, it should be snipped off. If a tip of the iris is pressed out of the wound, it should be treated in the same manner. If the vitreous humor projects, it need not be snipped off, as it does not interfere with healing by first intention, and will be gradually cast off. In the case of prolapse, it has often been advised to replace it by means of a probe, Daviell's spoon, etc., since retraction cannot be depended upon even when atropine or eserine is applied. This reposition can only be attempted with a prospect of success when the conditions of the wound are such that a speedy closure may be expected after the removal of the iris from the wound. But it should only be attempted when the patient is perfectly quiet and the eyeball fixed; consequently it must often be performed under the influence of an anæsthetic (local—TR.), otherwise the capsule of the lens might be easily injured; and it must not be forgotten that iritis is easily induced by contusion. If the prolapsed portion of the iris assume, immediately or later, the form of a vesicle, with a relatively narrow basis, it should be snipped off; if, on the contrary, it has the form of a tubercle, with a comparatively broad basis, it may be inferred that it will gradually be covered by connective tissue, become contracted and firmly retained. But if the cicatricial tissue be not able to flatten the prolapse, and if a cystoid scar is to be feared, the vesicle should be transfixed and

opened with a cataract knife, and after the aqueous humor has escaped, the protective bandage should be applied and this procedure repeated until a flat cicatrix is obtained. Should this not produce the desired effect, or if, for the purpose of improving or restoring vision, or on account of an increase of the intra-ocular pressure, iridectomy seems to be indicated, it should be no longer deferred.

(e) *Injury with the Retention of the Foreign Body in the Cornea.*—The presence of a foreign body may be ascertained with certainty by the unaided eye, with a lens, by means of reflected light and by focal illumination. Light-colored bodies are most easily discovered if the eye be so directed that the pupil forms a background; dark-colored bodies, on the contrary, are best discovered by having as a background a light-colored iris; transparent bodies refract the light differently and betray the cause by some unevenness of the wounded surface of the cornea. If, however, an inflammatory reaction has already taken place around a grain of marble, for example, it may be difficult to decide whether the hazy mass still hides a foreign body. We should seek to determine by exact inspection, aided by focal illumination, how deep, in what direction, and what kind of a foreign body has entered the cornea. The examination is probably very superficial in those cases in which a portion of seed-hull or the dark brown wing of an insect on the cornea are mistaken for a pustule or a prolapse of the iris, or when a prolapse of the iris is mistaken for a foreign body still adherent to the wound. Only gunpowder (charcoal), or sometimes small particles of lime or minute fragments of metal may remain in the cornea without causing suppuration. In all other cases, the immediate extraction of the foreign body is indicated, as we cannot know how far the cornea may be affected by the suppuration, which, in the most favorable cases, may result in the elimination of the foreign body, leaving behind an opacity of varying density; but it may also lead to perforation of the cornea and its consequences, or to consecutive inflammation of the iris, and perhaps, also, of the ciliary body, and to collection of pus in the anterior chamber or even in the vitreous body (purulent cyclitis, panophthalmitis). In children and even in adults, it may be necessary to administer an anæsthetic in order to remove these bodies, at least where they are

deeply seated. (The local anæsthetic, hydrochlorate of cocaine, will unquestionably supersede general anæsthesia in all such cases.—TRANS.) Such eyes are generally very sensitive to light, especially if attempts at removal have been made, and when considerable ciliary injection or iritis already exists. For that reason it is well to close the sound eye and to place the patient so that the light may fall obliquely from only one window. The head and lids are firmly held by an assistant; or in the absence of such an assistant, an intelligent patient may be placed upon a chair with a high back; the head is pressed backwards with the hand not occupied in operating, perhaps at the same time elevating the upper lid with the thumb. Or the head may be held by another person, and the lids separated with a speculum, the eyeball being held firmly with the fixation forceps. If the upper lid is fixed with the thumb of one hand upward, rotation of the eye may often be prevented by pressing the lower lid downwards and backwards with the ring finger of the operating hand, while the thumb and index and middle fingers hold the instrument. Many operators find it more convenient to stand behind the patient, who sits upon a low chair, and rests his head against the operator's abdomen. The one hand can then hold the lid and prevent the eye from rolling upwards. The removal by artificial illumination is recommended in the case of very small particles, which, on account of their small size or want of color, are scarcely recognized by natural light.

If the foreign body is only a small particle of metal or stone, a straight cataract needle is probably the best instrument for digging it out, and afterwards scraping out the remaining rust or dust. Others use for this purpose a gouge-like needle.¹ If a somewhat compact body penetrates deeply, we should try at the outset to get behind or under it, and for this purpose it may perhaps be necessary to make an incision with a needle or cataract knife.

After the complete removal of a foreign body the accompanying symptoms, pain, photophobia, and ciliary injection rapidly

¹ It frequently happens that small particles of iron strike the cornea while red hot (as sparks) and burn quite deeply into its substance. After their removal the eschar, which remains as a brown scale, should also be removed, in order to insure a speedy recovery.

subside, and the patient needs no further attention. But if the patient first presents himself several days after the accident, if the foreign body has penetrated more deeply, if iritis is imminent or already present (discoloration of the iris and contraction of the pupil), a solution of atropine should be used and the eye watched for one or two days. If there has been considerable loss of substance from the removal of the foreign body, or if ulceration already exists, a protective bandage and abstinence from work, together with the use of atropine, are indicated. If the foreign body is large and long or flat (metal, stone, wood, etc.), and if it has been ascertained by focal illumination how deeply and in which direction it has entered the cornea, whether it has penetrated into the chamber and whether a portion of it projects from the cornea, these circumstances and the physical properties of the body will determine the manipulations and the instruments to be chosen for the special case. Anæsthesia is usually necessary, and at least one experienced assistant should be present. If the body has penetrated obliquely and cannot be seized and extracted with a strong pair of toothed forceps, the corneal layers covering it should be divided through the middle or along the edge of the foreign body, in order that it may be more securely grasped. If a hard, oblong or flat body, which has entered the cornea at a right angle, does not project, or so little that it cannot be removed without the risk of pushing it further in, a Daviell's spoon may be passed through a lateral opening into the chamber, behind the foreign body, when it may be pushed out or so supported as to be easily seized. Desmarres has used a paracentesis needle for pushing the body out, or for supporting it from behind. In the case of a thorn, as from a chestnut burr, penetrating vertically as far as Descemet's membrane, an assistant may make an incision with a Gräfe's cataract knife, with the edge turned forwards so close to the thorn that it may be seized by its end. If it seems improbable to extract or push back the foreign body projecting into the chamber through the primary wound, it may be necessary to enter the chamber with the forceps through a new wound, during which manipulation the iris and the capsule of the lens may, of course, be very easily wounded. During this puncture the evacuation of the aqueous humor should be prevented as far as possible by avoid-

ing pressure on the eye or turning the knife in withdrawing it, because then the forceps may be more easily advanced to the foreign body than if the iris is already pressed against the cornea.

(*f*) After scalding of the eye we find either a mere haziness or exfoliation of the corneal epithelium, usually without the formation of true vesicles, or a semi-transparent, pearl-gray, or white opacity of the corneal substance (like the white of an egg), or the surface of the intensely opaque cornea is yellow and at the same time wrinkled. The reactionary symptoms (ciliary injection, redness, and swelling of the conjunctiva, pain, photophobia, and lachrymation) soon appear, varying in form if the cornea only is affected; although they are generally proportionate to the intensity of the scalding. Dryness of the opaque portion and diminished sensibility of the cornea are to be considered as unfavorable symptoms. Of substances acting chemically, recently slaked lime, especially that mixed with sand (mortar), and sulphuric acid are especially to be mentioned. The deleterious effect of the acid extends, almost without exception, simultaneously to the lids, while that of mortar is usually limited to the conjunctival sac and the cornea. Sometimes an eschar on the cornea is seen after calomel has been too freely dusted into the eye. Lunar caustic, ashes, and other cauterizing substances have intentionally been applied, for the purpose of self-mutilation. Where there is no intention to mislead the physician, the diagnosis may be much facilitated by the history of the case, especially if one has learned to recognize the forms of inflammation occurring without injury. The results of scalding or cauterization may be very slight and transitory, or severe and irreparable. If during the first few days succeeding the accident only exfoliation of the epithelium, and perhaps a slight haziness of the cornea, occurs, it may be presumed that the integrity of the cornea will be restored. The restoration of the epithelium begins at the edge, advancing towards the centre, and is completed in a week, or two weeks at the longest. If the cornea be pearl-gray throughout, or for the most part, consequently translucent and not insensible, a return of the transparency may be expected, at least of the part so affected. Portions which look like hard-boiled white of egg, and at the same time appear dry and insensible, gradually shrink, and the dirty, yellow, wrinkled

portions mortify and are rapidly or slowly eliminated by suppuration. The cornea is not only threatened in the above-mentioned manner, but as the scalding or the cauterization is not limited to it, it becomes adherent to the adjoining wounded portions of the ocular conjunctiva, or to one or both lids; and it may be quite impossible to prevent such adhesion. (*Vide* Injuries of the Conjunctiva and Pterygium, where the most important points regarding treatment are given.)

B. NON-INFLAMMATORY DISEASES OF THE CORNEA.

IV. OPACITIES OF THE CORNEA.¹

By an opacity of the cornea is usually meant a condition in which its transparency is diminished to a considerable degree, both in intensity and extent, without inflammatory symptoms. The transitory opacity of the cornea in acute cases of glaucoma, as well as the peculiar alterations in the cornea in absolute glaucoma (in the degenerative stage), will be considered under diseases of the choroid. A true understanding of these cases can only be gained through a knowledge of their appearance and origin.

1. Congenital opacity of the cornea, which is not to be considered as a result of keratitis in the foetal condition, but as a continuation of the opaque condition of the foetal cornea, may occur in an eye otherwise well formed (which is a rare case), or with microphthalmus (coloboma in the uveal tract). Schön² describes some cases, among which those of Ferra are especially interesting. He observed in three sisters, newly born, "A peculiar haziness of the cornea, which, beginning at the outer canthus, disappeared by degrees and spontaneously." The case of Kieser, related in the same place, resembles, by the rhomboidal form of the basis of the cornea, an opacity observed by the author on both corneæ, and acquires significance by the fact that the mother of the patient was said to have suffered from a similar

¹ Although various and very different conditions, which really belong to different sections, are included under this head, their common discussion in a general way may materially facilitate their study.

² Pathologische Anatomie des Auges, Hamburg, 1828, page 67.

malformation of both eyes, though in a less degree. Maclagan describes a case in which, in a newly-born infant, the left cornea was entirely, and the right partially, opaque. A few weeks later the right cornea, and three months after the examination the left, became clear, without treatment. Six months after birth only a small speck was to be seen on the right, and the opacity on the upper portion of the left was so much reduced that the child could fix the eye directly upon objects. So long as an opacity of this kind is not complete, and the eye is still growing, a gradual spontaneous clearing up may be expected.

2. Arcus senilis or gerontoxon occupies the peripheral portion of the cornea as a light-gray arc or an oval ring. The opacity, perfectly smooth on the surface, is more intense towards the limbus, sharply defined, and separated from the limbus by a narrow, transparent stripe, and its concave side is gradually lost in the central transparent area, which does not become affected, even after many years. The opaque arc always appears first above, and then below. The opacity is caused, as Cauton, Strube, and His have shown, by the deposit of fat granules in the parenchyma of the cornea, but from all appearances it is occasioned by the senile atrophy of the corneo-scleral border. Its regular form points to a mechanical cause. The corneo-scleral border in adults is always wider above than below or than on either side. The arcus senilis first appears above, therefore, and then below; and when the crescents meet they form not a round but an oval ring. In far advanced cases a sort of constriction may be found all around the periphery of the arcus senilis. The convexity of the cornea remains unchanged up to the sharply defined border of the arcus senilis, then the corneo-scleral border decreases rapidly towards the sclera, which retains its usual convexity. The arcus senilis is easily distinguished by the above characteristics from cicatrices of marginal ulcers, which occur in young persons.

3. The zonular corneal opacity¹ is characterized by a punctated appearance, and by being limited to a zone from 2 to 4 mm. wide, which is visible if the lids be about half opened

¹ I prefer this designation, chosen by me many years since, to ribbon-shaped ("bandförmig"), introduced by A. von Gräfe, because other opacities, especially those remaining after vascular bands, may appear ribbon-shaped.

and the eyes be directed somewhat downwards. Consequently it extends obliquely over the cornea, occupying a little more of the lower than the upper half. This opacity may occupy the above-mentioned zone entirely (from the nose to the temporal side), or only the two sides, or especially the centre, but in every case the upper and lower borders of the opaque portion, or at least one of them, is sharply defined, so that it is only necessary to imagine the well-defined places connected by a straight line in order to obtain the form of a broad belt. Cases belonging to this category should be separated into two classes, both on account of their form and on account of their occurrence and clinical significance.

(a) To this one class belong the cases in which the zonular opacity occurs in eyes which, in consequence of inflammation in the uveal tract (usually irido-cyclitis after various causes, as after traumatism), are already atrophied or are beginning to atrophy, but still have a transparent, though smaller and more curved cornea. The opacity is here light-gray, finely granular throughout, or permeated by large, saturated white points, which have a fatty or chalky appearance. The surface may appear smooth and bright, but often it is dim and shagreened, from the presence of small tubercles. In many cases the zone is somewhat broader on the nasal side and reaches as far as the limbus. The opacity develops gradually and without inflammatory symptoms. Age seems to have no influence. The condition seems also well defined in young persons. The author has seen it in a woman, twenty-five years of age, whose eye had become cataractous after chronic irido-cyclitis, and had gained a relatively good vision by extraction (flap formed downwards). Goldzieher¹ found, in an eye enucleated by O. Becker, a large colloid mass deposited in the superficial layers of the cornea, penetrating here and there to the surface, where the epithelium had disappeared, whilst in other places it was much thickened, extending in cylindrical and tuberculous masses into the deeper portions. Such plugs of epithelium were usually found in a state of hyaline degeneration. In the middle layers of the cornea this formation of colloid ceased; still peculiar serpentine bands were found, consisting of a granular, highly refractive,

¹ Archiv für Ophth., XV c., page 139.

fatty substance. These masses were treated with strong acids, especially with concentrated acetic acid, next with ether, without changing their appearance. I would class this case in the first division.

(*b*) The cases of the second division belong to the rarities of ophthalmology. The persons attacked are, almost without exception, old, and are affected in both eyes (sometimes only after several years' interval). The opacity is usually found in eyes, which neither previously nor at the time of consultation (on account of disturbance of vision), show any signs of internal disease. In some inflammation of the uveal tract has previously existed, but without doing any considerable injury either to the form or to the function of the eye. The opacity has, not only in the beginning but also in the more advanced stages, a grayish-yellow or grayish-brown color, a fine, granular appearance, and a smooth surface, which is rarely somewhat dim, and still more rarely slightly knobbed. Under the lens it is found to be composed of densely crowded, light-gray, and isolated black points; white points or spots seem to make their appearance only later. According to Nettleship,¹ the opacity begins sometimes in the middle of the above-named zone, sometimes at one or both ends. In the former case it spreads towards the sides and remains most intense in the centre, while it appears narrower and less intense towards the ends. If the spots begin at the sides they approach each other, and often leave for a long time, especially above, a clear opening in the centre. A. von Gräfe,² who seems to have overlooked the older observations of Dixon, Bowman, and Walton, although they are mentioned in Mackenzie's *Maladies de l'œil*,³ has described in a masterly manner the course of the disease when it proceeds from the temporal and nasal sides. I have seen it, in a woman forty-nine years of age, in a stage in which the opacity was not yet visible by the unaided eye, when the eye which suffered from posterior synechia was being examined by focal illumination. "When the patients seek medical

¹ Knapp's Archives of Ophthalmology, Vol. VIII, page 293, upon a paper read before the Medico-Chirurgical Society of London, April, 1879.

² Archiv für Ophthalmologie, XV c., page 139.

³ Mackenzie, *Maladies de l'œil*. Translated by Warlomont and Testelin. Brussels, 1857, II, page 154.

aid on account of blindness or dimness of vision, with increased sensitiveness to light, a peculiar dimness of the cornea is seen, both towards the median and the temporal borders, in the form of two rectangular portions imperfectly joined at the corneal centre; their upper and lower edges correspond in such a manner that if we continue them through the centre of the cornea they produce a ribbon-shaped transverse and opaque figure. The intensity is greatest towards the corneal border, then towards the upper and lower opaque border, and decreases towards the corneal centre, where it gradually passes over into transparent cornea. The epithelial surface is usually smooth. The saturation increases gradually, and the two opaque portions grow towards each other. Although even then the opacity is usually most intense towards the border (upper and lower boundary lines and corneal margin), still the saturation becomes more and more uniform." From Gräfe's graphic description it is evident, as Nettleship especially emphasizes, that between the opacity and the corneo-scleral border a small strip remains unaffected (as in arcus senilis), that now and then an aggregation of granules may spread beyond the zone, and that its breadth (the vertical diameter of the partially or completely opaque zone) is strikingly large, even in the earlier stages of this affection. The lower border generally corresponds to the free border of the lower lid when the eye is directed slightly downwards. (*Vide* Pterygium and Pinguecula.) Aside from the slight difference between Gräfe's description and that of the English observers, according to whom the opacity may proceed from the centre, gradually decreasing towards the sides, the views differ essentially only as regards prognosis and treatment. Whilst Gräfe affirms that the corneal affection described by him may, of itself, give occasion for an increased intraocular pressure (glaucoma), or to iritis with subsequent increase of pressure (secondary glaucoma), indicating the performance of iridectomy at an early stage, the English observers consider this corneal affection as a disease not at all dangerous to the uveal tract, and recommend the abrasion of the cornea, practiced by Dixon in 1848, by Bowman in 1849, with good and permanent success. They have observed the appearance of glaucoma neither in eyes operated upon nor in those not operated upon, although such eyes were kept under observation

for a long time (sometimes for years). Dixon, after having carefully scraped off the epithelium from the centre, came upon a thin layer of a hard substance which was united to the corneal tissue and could only be removed in small flakes; under this the cornea appeared quite clean. After dropping in *ol. ricini* the pain subsided, and after two weeks the wounded place was covered with epithelium and perfectly transparent. The flakes removed consisted of carbonate and phosphate of lime and magnesia. The patient operated upon by Bowman could read "pearl" type with the left eye. Three-and-a-half years after the operation the cornea remained perfectly clear.

4. This condition is not to be confounded with lead incrustations after the use of preparations of lead in cases of corneal ulceration, with deposits of lime in corneal cicatrices, or in pannous cornea (see page 38). The results, after their removal, as regards vision, may vary according to the depth of these deposits.

5. It is not expected that the opacity which has developed from pannus by a transformation of the exudation into connective tissue will ever completely disappear (see page 41). Improvement in some cases may be obtained by applications of *hydrargyri ammon.*, 0.15 to 0.25; *ung. anglic. alb.*, 5.00. The production of an acute conjunctival blennorrhœa, so far as my few experiments have shown, offers no reliable prospect of removing this condition.¹

6. The opacity caused by inversion of the cilia allows of no cure when it has once resulted either in a callous thickening of the epithelium (see page 132) or in haziness and vascularity of the cornea. The callous thickening of the epithelial layer presents an appearance as though a piece of grayish-white tissue paper was adherent to it.

7. Concerning the opacity remaining after interstitial keratitis, all the symptoms necessary for prognosis have already been mentioned on pages 121 and 127.

8. That a permanent opacity remains after abscess has been mentioned on page 175.

9. Opacities after corneal ulcerations are the most frequent and most diversified, and on that account require a more detailed consideration; although the leading principles for a critical ex-

¹ The Jequirity treatment is highly recommended in such cases. See p. 65—TR.

amination of their course were given in the section relating to Ulcerations and their results, on pages 141-152. In case of an opacity occurring after ulceration, we must seek to ascertain whether it is recent (has existed for a comparatively short time) or old. Recent opacities usually appear gray, somewhat dull, sometimes also flat; old opacities appear as smooth as a mirror, bluish-white throughout, or at least at the borders, if the centre be saturated. In recent opacities, if they be deeply saturated and show ill-defined borders, a gradual absorption (at least diminution) may be anticipated, the more so if the eye be still growing, and especially in newly-born infants. The older an opacity—perhaps only recognizable by focal illumination—the greater the probability that it has already attained the utmost limit of its dispersion. It is a well-known fact that there are cases in which no trace of a preceding corneal ulcer is to be found, and that in many cases the existing opacity is surprisingly small as compared to the depth and especially the superficial extent of the preceding ulceration. After blennorrhœa neonatorum, which has resulted not only in perforation of the cornea but also in central capsular cataract, the corneal opacity may be so insignificant that it is easily overlooked, unless focal illumination be used. This transformation is effected only after months or years, but without any symptoms of irritation, whilst the filling in of the cavity appears ended in the course of a few weeks or months. This transformation occurs spontaneously in many cases, especially in young persons, without the application of any remedy. But it never occurs in places which, after a duration of some months or after cicatrization, show either an incomplete filling (depression) or a prominence, on account of excessive formation of substitutive tissue and epithelium, or on account of the bulging of Descemet's membrane (after keratocele and keratectasia ex ulcere). It never occurs in places in which Descemet's membrane is ruptured, where anterior capsular cataract, anterior synechia, or adhesion of the iris-pigment with the cornea indicate a preceding perforation. Spots, with sharply defined boundaries, although surrounded by light and ill-defined borders, show no prospect of clearing up, or at best only in this surrounding hazy portion. If points or spots, which resemble fatty or calcareous deposits appear in an old opacity, or if

without external cause and without symptoms of irritation, vascularity begins to develop, a further absorption is not to be expected. Attention must be paid to these symptoms if an opinion must be expressed as to the future condition of such an eye.

When the opacities are located in front of the pupil, their influence upon the functions of the eye must be considered. Not only are the extent and intensity of the opacity to be considered, but also the convexity of the surface, and the regularity or irregularity of the refraction in the different layers of the cornea. If we remember that the distinctness of an object depends not only upon the union of the rays entering the eye in a focus on the rods and cones, but that a certain brightness of the retinal image is also required, and a certain difference in its clearness, and the illumination of the surrounding retina, we can easily understand how an opacity in this area may act injuriously. If a spot is intensely hazy (non-transparent) it may reflect so much of the light which should reach the retina from the object, that the part which penetrates the eye, even if it should be regularly refracted, would be insufficient for producing a distinct image. If the opacity occupies only a portion of the corneal area lying in front of the pupil, one-half or one-third, for example, while the remaining portion is normal, a distinct retinal image may be formed, provided the dioptric apparatus be otherwise normal; but the brightness of the image will be just so much (one-half or one-third) less distinct. In such cases a kind of correction often gradually occurs as the pupil remains habitually larger, provided this does not cause dazzling. If an opaque spot in the pupillary region is very translucent or semi-transparent, it obstructs less light, but the rays which penetrate the eye are for the most part diffused. The clearness of the retinal image is diminished in both cases. But the power of distinguishing the object is furthermore impaired by the diffused light which radiates from the opacity, as from a piece of ground glass, to all parts of the fundus, and greatly weakens the contrast of the retinal image with the illumination of the surrounding retina. The illumination of the fundus, which renders a distinct perception of the object difficult, and at the same time causes the well-known sensation of dazzling, is more disturbing, as

more light is thrown upon the translucent or semi-transparent cornea. If, by focal illumination with artificial light, we can distinctly see a slight corneal opacity, as, for example, the cicatrix after a keratonyxis, which could not be perceived by bright daylight, the perception of the dim retinal image is evidently caused by the fact that the fundus of the eye is completely shaded under these circumstances, and that only the macula lutea receives light from the illuminated disk in which the opaque spot is located. In the albino the shading of the fundus is defective, on account of the diminished quantity of pigment in the uveal tract; hence the eye is dazzled and the acuteness of vision reduced. The investment of the vitreous humor (iris and ciliary body), which is not sufficiently dark, transmits some light and spreads it by diffusion over the entire retina.

Semi-transparent corneal opacities, which are often invisible to the unaided eye, or only visible by focal illumination, may impair the vision by irregular refraction of the transmitted light, either on account of abnormal curvature, or on account of different refractive powers of the cornea in the pupillary region. If the epithelium of such slight corneal opacities is scraped off, we often find superficial cavities with an uneven surface. How it may be proved, in a given case, that irregular refraction of the cornea is a concurrent cause of the impaired vision, will be considered in discussing the anomalies of refraction, especially irregular astigmatism. The ophthalmoscope is necessary for this purpose.¹ In order to correctly estimate the further consequences of a central opacity of the cornea, the condition of the other eye, as regards its functional ability, should be considered, as well as the age of the patient. If a central opacity exists in one eye, with or without partial adhesion of the iris (*leucoma adherens v. simplex*), the other eye being blind at the same time, it is possible that the patient uses, for the purpose of vision, not the macula lutea, but an eccentric portion of the retina, because sufficient light is only transmitted through the edge of the

¹ For the sake of conciseness, non-transparent opacities of the cornea are generally called *leucomata*; semi transparent ones, *maculæ* or *nebulæ*. Very often a *leucoma* has a nebulous surrounding, and in some cases it is, in time, partially or wholly transformed into a *macula*.

opacity. If this condition has existed from early youth, the patient will be compelled to turn this eye obliquely, even if an artificial pupil renders direct vision possible, because by long practice a lateral portion of the retina has a better power of vision than has the central portion, which has become amblyopic through anopsia. If the condition of the other eye allows of perfect or at least of relatively good vision, the leucomatous or even maculous eye may be deflected, but it does not receive the rays of light on one side of the opacity in order to see, but according to the laws of strabismus; this eye does not then partake of the direct, but possibly of the indirect vision (enlargement of the field of vision.).

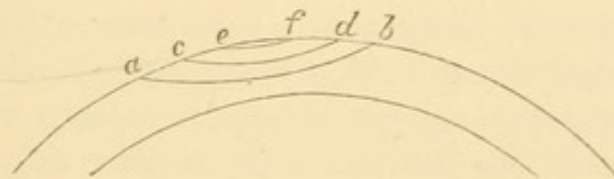
If the other eye be superior in functional capacity, on account of the absence or less degree of opacity, or on account of the better conditions of refraction, etc., the opaque eye may always participate in binocular vision, or only at a distance and when the objects are of a certain size, or it may be entirely excluded. In the one as well as in the other case the opaque eye may cause, by the diffusion of light, the sensation of dazzling, which the patient endeavors to overcome by narrowing or closing the palpebral fissure as soon as the eyes are exposed to stronger light, or if he wishes to see more clearly. The exclusion of the diseased eye from binocular vision, either constantly or only for the purpose of better vision, is usually accompanied by a deflection of the affected eye (strabismus). If the exclusion of one eye from binocular vision has occurred constantly, or at least when looking at fine objects, from the above or for other reasons, since earliest childhood (succeeding blennorrhœa neonatorum or scrofulous conjunctivitis), the vision of the excluded eye is found impaired to a certain degree; in the absence of a better expression this is designated as amblyopia ex anopsia. We arrive at this conclusion from the fact that while the acuteness of vision is considerably reduced we find a sufficient cause neither in the dioptric apparatus nor in the visible alterations of the retina (optic papilla), and this supposition is confirmed by the fact that if the patient has sufficient perseverance and endurance, the power of vision is gradually improved by a methodical and separate use of this eye. We should not forget however, that in this condition opacities which in the first and second year were opaque in the

centre, may become semi-transparent or scarcely perceptible in the fifth year.

Central corneal opacities, especially if semi-transparent, may simulate myopia, and may also, conjointly with other circumstances, gradually induce it. If binocular vision be maintained, unilateral opacity of the cornea may also occasion an elongation of the eyeball in its antero-posterior direction, as will be seen in considering myopia. Whilst the corneal opacity, aside from diffusion, prevents a certain portion of the rays of light radiating from the object from reaching the retina, the patient holds the object nearer, in order to obtain a clearer retinal image, and consequently accommodates and converges his eyes for a shorter distance. Stronger illumination of the object would at the same time occasion greater diffusion of light on the retina and increase the dazzling. As the quantity of light which reaches the cornea from an illuminating point is in inverse ratio to the square of the distance of this point from the cornea, the loss of rays through opacity is the more felt the further the objects are removed. The dilation of the pupil which occurs in looking at objects at a distance cannot compensate for the deficiency, since the dazzling is greater, not only in consequence of the dilation of the pupil, but also on account of the stronger illumination of the opaque portion by the objects surrounding the one looked at (the sky, terrestrial objects). If the eye be able, in consequence of the youth of the person, to assume a degree of refraction, to overcome weak concave glasses and thus at the same time to somewhat narrow the pupils, it might easily be considered myopic. Hence the question, whether such an eye is myopic can only be decided by a determination of its refraction by means of the ophthalmoscope. Bilateral corneal opacities beginning in early childhood may, like other irregularities that greatly disturb vision, result in those rotating or oscillating motions of the eyeball which are known as "nystagmus." They exist either uninterruptedly except during sleep, or only when an attempt is made to examine any object more closely.

Treatment.—The question, whether, in opacities which are not at once characterized as persistent, something may not be done to effect or hasten their elimination, cannot always be definitely answered. In every case of absorption of the opacity by

the application of medicaments the skeptic may maintain that the same result might have followed without treatment. But if, in opacities which have originated from ulceration, the possibility of beneficial medical treatment be denied because these opacities are to be considered as cicatrices, a condition of the skin and the mucous membranes is applied without further ceremony to a process in the cornea which may be very different from cicatrizations in the above mentioned tissues. The substitutive tissue which fills depressions in the cornea may in many cases act as ordinary cicatricial and connective tissue, and become incapable of being altered after it is once formed; but this is certainly not the case in all opacities caused by substitutive tissue, since otherwise the clearing of the cornea, visibly continuing for years without alteration in form (flattening), would be unintelligible. The depression of the ulcer is in all probability filled up by the formation of fibrillæ which may be distinguished from the normal ones only by diminished thickness and transparency. But the further the fibrous layers are removed from the normal tissue, which we may designate as matrix, the more are they removed from its transforming influences. If in the accompanying diagram we imagine *a b* to be the boundary line of a shallow ulcer, and *c d* as the boundary line of the next formed layer of substitutive tissue, the depression *e f* is possibly not filled in at all or simply by connective or epithelial tissue, which has advanced from *a b* toward *c d* and *e f*.



True corneal cicatrices (after traumatism) appear within a very short time after the disappearance of the last reactionary symptoms, as perfectly stationary, and probably no one ever boasted of having cleared up a real cicatrix. What was declared to be susceptible to medicinal treatment were only semi-transparent opacities (maculæ or the nebulous peripheries of leucomata). If we observe that where an ulcer, for example, 3 mm. in size, was located, an opacity of the same size appears, which, after becoming

gradually lighter and thinner, is reduced to a spot about 1 mm. in size, we must assume that in place of the non-transparent substitutive tissue, transparent tissue, at least in part, has been gradually furnished, evidently through the activity of the same cells which have furnished the substitutive tissue. And it may then be well concluded that this activity may be incited, aided, or accelerated by methodical treatment. All remedies used for the purpose of dispersing the opacity and clearing the cornea are more or less irritating in their effects. It has been well said that the occasioned reaction must reach a certain degree, but must go no further, and that in long-continued treatment a certain change of remedies is advantageous. We see an analogous process in the infiltrations accompanying chronic conjunctival blennorrhœa, which may indeed disappear if left to themselves, but which are removed with greater certainty and rapidity by the methodical use of various irritants (cupri sulph., argent. tinct., scarification, etc.), the temporary reaction being always carefully considered; or by an acute inflammation caused by means of inoculation (or still better, by jequirity—TR.). In neither case can we rely upon a quick success; many attempts to bring about a cure are frustrated through a lack of perseverance on the part of the patient. In every case it is necessary to examine the acuity of vision at the beginning of treatment, and then again at intervals of four to eight weeks, with the same degree of illumination.

As remedies to hasten the absorption of opacities are especially recommended: (a) Oleaginous substances: Liquamen hepatis mustelæ fluviatilis (eel-liver oil), cod-liver oil, ox or fish gall, walnut oil, juniper oil and oil of turpentine, with olive oil, which may be dropped into the eye once or twice daily, as required. (b) Aqueous solutions: Ext. cicutæ (conii), ext. chelidonii, ext. aloës aq. (1-10), vin. opii (at first diluted, later full strength), weak solutions of hydrargyri bichlor., ammonii murias, sodæ boras, barytæ murias, potassii carbonas. (c) Ointments: Hydrargyr. oxid. rubr., hydrargyr. oxidum flav. pr., pot. iodid. (.066 - ol. petrolei 40). (d) Powders: Finely pulverized glass, sugar and tartrate of potash with pulverized cuttle-fish bone, especially calomel, or red precipitate mixed with sugar. I have most frequently used in recent cases first vinum opii, then in-

sufflation of calomel and the red precipitate or yellow oxide of mercury ointment; in cases of longer standing cod-liver oil, oil of turpentine with olive oil, or an ointment of iodide of potash with carbonate of potash. In semi-transparent opacities in the pupillary region, which prevent the perception of small objects, more by diffusion than absorption of the rays of light, the stenopaic spectacles recommended by Donders¹ may render essential service. By holding before the cornea, as near as possible, a disk, blackened on the concave surface, which closely fits the entire orbital border and is provided in the centre with a small opening or slit about two mm. in diameter, and which may be fastened by means of an elastic cord, the diffused light which comes from lateral objects is reflected, and therefore the illumination of the retina around the macula lutea is reduced to a minimum, while the quantity of light coming from the object under examination and reaching the retina is sufficient to stimulate it. Simultaneously the pupil dilates in proportion to the diminished quantity of light, and the circles of dispersion, when such take place on account of inaccurate accommodation of the dioptric apparatus, become so much smaller the narrower the opening in the diaphragm. Nevertheless, this expedient has a very limited application, because its use always entails a considerable diminution in the field of vision. But for the purpose of reading, writing, etc., it may be very welcome.

The attempts to remove corneal opacities by an operation are practicable with some prospect of success and without danger, only in case of incrustations. If a zonular opacity occur upon an otherwise healthy eye (page 192) a favorable result may be expected from operative interference, according to Dixon and Bowman, by the removal of the epithelium and the anterior elastic layer. The same may be said of superficial incrustations of lead and lime (page 194), especially if, on account of the youthfulness of the patient and the condition of the eye a more or less perfect regeneration of the removed layers may be anticipated. In this case the symptoms of irritation maintained by such incrustations, or sometimes cosmetic considerations, may determine operative interference; in the latter case one should not venture to remove more than one-half the thickness of the

¹ Archiv. für Ophthalmologie, I B., a., page 266.

cornea. *The removal should not be attempted without anæsthesia, and the globe being well fixed. It is best accomplished by means of a lance knife, which, with one movement, is pushed under the incrustation as far as the convexity will allow; the thin flake may then easily be seized with a fine pair of forceps and the excision completed with the scissors. The eye should afterwards be kept bandaged for one or two weeks. This is the so-called "abrasion of the cornea" (*abrasio corneæ*). The excision of opacities situated more deeply, and their resolution by means of the negative pole of a galvanic battery, cannot be recommended, on account of the danger of subsequent suppurative keratitis. The attempts to excise a completely opaque cornea and replace it by transplanting the cornea of an animal or of a recently enucleated human eye have failed, notwithstanding many ingenious modifications devised during the last fifty years, for the reason that the transplanted cornea, even when perfectly engrafted, gradually becomes opaque and shrivels. The probability is that nothing can be effected in this direction. The history of keratoplasty may be found in an article by Hippel, *Arch. f. Ophth.*, XXIII b., page 81.

In central opacities of the cornea, partially or wholly covering the pupil, which show no signs of dispersion, either spontaneously or in consequence of medicated applications, and which cannot be removed in an operative way without danger, the possibility or probability of affording the patient any considerable degree of usefulness by the formation of an artificial pupil or by enlarging the existing one (iridectomy, iridotomy), should be fully considered. Details will be given when the formation of an artificial pupil is considered. It may be observed here, however, that in cases in which, after the enlargement of the pupil or after the establishment of a peripheral one, dazzling is to be feared from the diffusion of light, one must consider whether, in consequence of this unwelcome accompaniment, the eye is not made worse than before; whether the advantage of a pupil behind the peripheral zone of the cornea, whose curvature and transparency are problematic, can possibly fulfill our expectations, and whether the injurious effect of the diffusion of light may be mitigated by tattooing the opacity, either before or after the operation.

The tattooing of disfiguring leucomata, known in Galen's time, is especially recommended by De Wecker¹ for the above-mentioned purpose, and has been successfully practiced by several writers. In cases of adherent leucomata, which are somewhat more curved (as in staphylomatous corneal cicatrices), the irritation and the softening of the cicatricial tissue succeeding the tattooing may result in still greater staphyloma and increase of tension. In cases which are highly vascular, hemorrhage may easily prevent the absorption of the pigment, and thus frustrate the tattooing.

V. ABNORMAL CURVATURE OF THE CORNEA.

The curvature of the cornea, which may generally be referred to a radius of about 8 mm., the centre of which is therefore to be placed in the region of the posterior pole of the crystalline lens, may be approximately estimated by the shape and the size of the reflected image of a window at a certain distance. If the curvature of the cornea seems to differ from the normal, it is only necessary to compare it to the image of a window projected upon a normal cornea placed near it at the same distance; as I know from experiments with small convex mirrors, it will not be difficult to perceive a difference as long as the radius of curvature varies not less than 1 mm. In the same manner very slight deviations of isolated portions (in the same meridian), as flattening or bulging, are recognized by the increase or decrease in the eye of the image at that point; that is, by the alterations in the form of the image, as has been already intimated in speaking of ulcers and opacities of the cornea. But if, in cases of complete transparency of the cornea, we wish to accurately determine the power of refraction of an anomalous curvature, it will be necessary to use the ophthalmometer. An inexperienced operator may easily suppose the curvature of a cornea diminished or increased when the base is somewhat smaller (not rare in a high grade of hypermetropia) or somewhat larger, as in excessive myopia, especially if the iris *in toto* lies further from or nearer the cornea, the chamber consequently being shallower or deeper.

¹ Tatuage de la cornée, 1870. Union méd. Mars., und Archiv. für Augen und Ohrenheilkunde, II b., page 84.

KERATOCONUS is here to be considered as an independent disease of the cornea, with alteration of curvature, and not as a consequence of another affection or malformation of the eye (keratectasia ex ulcere, ex panno, buphthalmus—flattening of the cornea, microphthalmus). The conical malformation of the cornea previously described as staphyloma pellucidum, and classified with keratectasia ex panno (page 42), or ex ulcere (page 144), is first manifested to the patient by disturbance of vision, as in myopia, and later by impairment of vision, even for the near point, and by faulty localization. The patient's friends are often struck by the peculiar lustre and unusual brilliancy of such eyes. As soon as the cornea is examined for the cause of this presumed myopia, and the image of a window several metres distant is allowed to fall by degrees upon different portions of the surface, it is found distorted throughout, or at least in the centre. In the first stage of development it appears as though the central portion of the perfectly transparent and lustrous cornea rises conically, whilst the marginal zone, to a width of 2 or 3 mm., scarcely differs from the normal curvature. By degrees the entire cornea assumes, as a rule, the form of a cone (sugar loaf), the rounded summit of which rises in a straight line from the circumference towards the centre. In exceptional cases the form of the cornea is not conical, but in the midst of a slightly rising, marginal zone a curvature appears, more spherical than conical. This was the case in an idiotic, feeble girl of 22 years, whose mother maintained that the disease was congenital, as the eyes had always had that "glassy" appearance. The degree as well as the form may be approximately determined by a side view. Ophthalmometric measurement usually indicates a parabolic curvature. (Raehlmann, Heidelb. Versammlung, 1879). The ophthalmoscopic examination shows the characteristics of astigmatism and complete reflection, which also causes the brilliancy mentioned above. After several years' duration of the advanced disease, small irregularities may be seen upon the summit, which Brewster considers as the cause of the frequently occurring polyopia. In older cases a more or less intense white or bluish-white opacity, stellate and smooth, is found upon the apex. This affection never results in inflammatory symptoms. Rupture has only been observed in one case (by Wardrop) following a blow upon

the eye. In older subjects with keratoconus, glaucoma has frequently been observed, and consequently some causal connection might be inferred. In the cases seen by the author such corneæ do not differ from the normal, as regards the touch. He has examined the tension in a few cases only, and has not found it increased. A consideration of the dioptric conditions will easily explain the disturbance of vision. If homocentric light reaches the cornea from a great distance, the rays passing through the vertex will be united at a point anterior to the retina, corresponding to the curvature of the cornea. If we imagine the surface of the vertex composed of a series of rings or concentric zones, the rays which pass the first zone will be united at a point somewhat anterior to the retina, those passing the second still more anterior, etc. The foci of the zones lying one behind the other form, therefore, a line in the vitreous body which is directed from the focus of the vertex towards the macula lutea. The condition upon which distinct vision depends is absent, namely, that the rays of light emanating from an object should be reunited at one point upon the retina, consequently the eye is astigmatic. If the object is brought so near the eye that the rays which pass through the vertex unite on the retina, the rays passing the second or third zone will be projected upon the retina before they have united. Hence the images of near objects are always surrounded by circles of diffusion, and this disturbance can never be removed otherwise than by stenopaic spectacles, never by concave glasses, which, however, may improve distant vision (through the vertex). It will have to be ascertained by experience whether parabolic concave glasses ground to correspond to the curvature of the cornea by Raehlmann's method would be of any practical use. But this defect in direct vision is also connected with a considerable disturbance of indirect vision, and hence the uncertainty in *walking*; for the rays of light from a lateral object passing through the summit of a cone can produce, even under the most favorable conditions, only an elongated image upon the retina. Hence arises an essential disadvantage as compared with an eye affected only with simple axial myopia, whose lateral retinal portion lies, if not in, only slightly posterior to, the focus of the dioptric apparatus, and receives from lateral objects at least no distorted image. Double or multiple vision, and the halo surrounding objects, of

which patients with keratoconus so frequently complain, is sufficiently explained by what has been already said.

Keratoconus is developed as myopia gradually, first in one eye and usually after a time, in the other. Only in one of the cases observed by the author the disease had advanced, after a duration of four weeks, so far in the right eye that number 2 of Jaeger could be read only at a distance of 4 inches. S with — 30 s \bigcirc — 30 cl = $\frac{20}{xxx}$. In the left eye disturbance of vision had been observed nineteen weeks previously, and only letters of number 11 could be recognized. The disease usually makes its appearance in persons between 12 and 20 years of age. Wardrop saw a case of keratoconus in a boy 8 years of age. Only in the case previously mentioned did the report of the mother indicate that the disease had existed from infancy (congenital?). A woman who, on account of menstrual difficulties, had frequently been sent to Franzensbad, first noticed a disturbance of vision in her 25th year. A woman 45 years of age, who had seen well at a distance until she was 38 years of age, now suffers from keratoconus, strongly developed in the left, less so in the right eye, which condition has probably a causal connection with a peculiar skin disease of the face and neck. This skin disease, designated by Kaposi as chronic eczema of the face, is said to have existed since her 18th year, being alternately better or worse. The skin was everywhere of a dirty, light red color, covered with numerous small, dry scales; now and then clear watery vesicles were said to appear, sometimes so numerous that the patient "appeared as though attacked with smallpox." In May, 1873, she noticed a disturbance of vision in the left eye, and on that account presented herself at the clinic. According to the record, there was observed at that time, in the centre of the left cornea, an oval opaque spot 2''' in the horizontal and 1''' in the vertical diameter, greatly resembling Russia leather (as though formed by numerous small vesicles) towards which the remaining clear cornea arose conically. No marked symptoms of irritation were present. After repeatedly puncturing the cornea, and after the eye had been for a long time bandaged, the patient withdrew from treatment. The vision of the right eye is said to have gradually become impaired (accompanied by similar symptoms?), when she again presented herself for treatment, in November, 1880.

We now found the palpebral conjunctiva catarrhally inflamed, with a velvety surface. The ocular conjunctiva was pale. The right cornea was conical, the summit slightly eccentric (towards the nose), and contained a fine opacity. On the left eye the curvature was much greater and approached a spheroidal shape; here also a small opaque spot was formed, but more intense than in the right eye; both corneæ, however, are perfectly smooth and lustrous, the tension of the eye not increased, but rather diminished, the pupils 3 mm. wide, round and mobile. Right eye, with a stenopaic glass, finger at 2 - 5, left 3 - 5 meters. No benefit followed the application of eserine. The majority of the patients are females; according to the author's notes, 17 women and 11 men. No external causes are known. The anatomical examination shows a thinning of the cornea which increases from the periphery towards the centre, not a thickening, as Himly has assumed.¹ Nothing but a diminution in the power of resistance of the cornea can be assumed as the cause of the bulging. This condition is probably in causal connection with the general health of the patient. If we assume the normal resistance of the cornea to be reduced, similar to that condition observed in rachitic bones which are bent through the traction of muscles, we can very easily explain the genesis of this deformity of the cornea. Perhaps the centre of the cornea, on account of this diminished power of resistance, is unable to withstand the pressure of the aqueous humor. If circumstances now arise under which the intraocular pressure is momentarily increased, as in engorgement of the vena cava, excessive effort of accommodation, and convergence of the lines of vision, an expansion of the cornea may result for the moment, as it were, but will be afterwards maintained in *statu quo* by the more copious secretion of aqueous humor, as has been explained in considering the formation of staphyloma. If this view is correct it furnishes a basis for rational prophylactic treatment of the disease in its initial stage, especially if it is not yet well pronounced in the second eye.

Treatment.—Recovery is impossible. The only questions,

¹ Sectionsbefunde liegen vor: von M. Jaeger in Erlangen (Schmidt Dissert. de Hyperkeratosi 1830); Walker, Principles of ophth. surgery, London, 1834; *Hulke*, Ophth. Hos. Rep. 11, pag. 155; *Himly*, Krankheiten und Missbildungen, Berlin, 1843, 11 B. page 74.

therefore, that can arise are, whether the development can be prevented, progression impeded, and the inconveniences experienced by the patient mitigated. Certainly the question of prevention can only arise in cases in which, after a short duration (weeks or months) of the disease in one eye, its appearance in the second eye is to be feared. From previous experience this transition is to be apprehended. Having accidentally observed keratoconus first in chlorotic girls, I determined to make use of general invigorating treatment, as recommended by Pickford,¹ with a corresponding dietetic *régime*, iron and quinia preparations and giving the eyes absolute rest. In the first of the cases thus treated the right eye remained intact as long as it was under observation (five years), and with the left the finest type could be read at a distance of three inches, notwithstanding a star-shaped opacity, formed upon the vertex during the third year. In the case of a young man, twenty-two years of age, who presented himself with a strongly developed cone of the left cornea, and whom I advised, on that account, to travel for a year, the right eye remained unaffected, so that until his thirty-eighth year, when he died, he was able to practice his profession as a lawyer. I advised a youth, fifteen years of age, whose mother was highly myopic, to abandon his intention of studying for a profession and to choose a commercial life, as the left eye had symptoms of the disease for several months. The right eye with M. $\frac{1}{2}$ and normal vision, has remained unaffected, and in the left eye, after seven years, the disease is neither markedly developed nor is there any opacity upon the summit of the cone. In addition to these three cases I have observed unilateral keratoconus only once, and that in an Italian, twenty-nine years of age (likewise in the left eye), whom I have not subsequently seen. I have methodically applied eserine (according to A. Weber's theory) in three cases, of which two were not benefited; in the third the result was doubtful. The woman from Klagenfurt, previously mentioned, observed for the first time disturbance of vision in February, 1878. In June, 1879, when she first presented herself for treatment, S. R. was $\frac{20}{1XX}$, L. $\frac{20}{XX}$; in October following, R. $\frac{20}{c}$, L. $\frac{20}{XXX}$; in November, R. $\frac{20}{L}$, L. $\frac{20}{XL}$. After the use of eserine, which was at first applied every other day, and then twice a week, S.

¹ James Pickford, on the Conical Cornea. Dublin, 1844.

in the right rose to nearly $\frac{20}{xxx}$. L. $\frac{20}{xx}$ and remained about the same degree until the beginning of January, 1881. It is uncertain how much of this favorable result is to be ascribed to invigorating treatment and complete rest of the eye, with several courses at Franzenbad; and how much to the treatment with eserine. In two other cases, one a woman of 28; the other a girl of 20 years, affected with bilateral keratoconus, no increase of curvature has occurred since the operation of iridectomy (1867 and 1870). Bilateral upward iridectomy was made in both cases after the disease had existed about a year, and a considerable improvement resulted as soon as the wound healed. Iridectomy is rationally sanctioned by the improvement it occasions in partial corneal staphyloma, as advised by A. V. Gräfe. As there is no more increase of the intraocular pressure in keratoconus than in most cases of partial spherical corneal staphyloma, its reduction by iridectomy cannot be attributed to a reduction of the intraocular pressure; it remains for the present unexplained, just as in eyes which have become soft after chronic irido-cyclitis, but which soon regain their normal tension after a successful iridectomy. (See A. v. Gräfe, A. F. O. II, 6, pag. 219.)

Tyrell undertook the displacement of the pupil¹ by drawing a portion of the pupillary border into a peripheral (artificial) corneal wound. Critchett² afterwards attached the portion thus drawn out to the adjoining conjunctiva, by means of a loop of thread, (iridodesis); and Bowman³ made use of this operation to change the pupil into a vertical slit by attaching the pupillary edge of the iris to the corneo-scleral border, first above and then below. Thus he made the iris do the service of a stenopaic pair of spectacles, because in narrowing the palpebral fissure light can only enter through the vertex of the cone; hence the disturbance of vision through the circles of diffusion is reduced to a minimum. Yet iridodesis is not without danger, as cyclitis—frequently after a considerable interval—has been known to result from it, especially when the incision for the constriction of the iris lies too far in the scleral border, causing too much traction upon the iris. In order to diminish the bulging and induce a more spherical

¹ Tyrell on the Diseases of the Eye, London, 1840.

² Critchett, Ophth. Hosp. Rep., I.

³ Bowman, Ophth. Hosp. Rep., I.

form of the cornea, A. v. Gräfe¹ excised with his cataract knife a thin lamella of the summit of the cone; two days later he cauterized the centre of this denuded spot with mitigated nitrate of silver, and repeated the cauterization every third or fourth day, thus maintaining a small ulcer. In the fourth week, the deepest portion of the ulcer was punctured and closure of the opening prevented by the introduction of a small probe. After complete cicatrization (in the ninth week), an intense whitish-gray opacity appeared $\frac{1}{2}'''$ in diameter, and surrounded by a light gray halo, so that the diameter of the entire opaque portion was a little more than $1'''$. Whilst the patient (43 years of age) had formerly been able to read only Jaeger 16 at $1\frac{1}{2}''$, she could now read number 7 fluently at $1\frac{1}{2}''$, and felt especially happy on account of the "general view" she had with this eye (eccentric vision). In Knapp's Archives² is found the latest publication regarding the favorable results obtained by this method, the object of which is to produce a central cicatrix in order to induce flattening by its contraction, but which, probably, also acts beneficially by maintaining for a considerable time a fistulous opening. Bowman and De Wecker³ have described a small trephine, by means of which the portion to be excised may be defined.

¹ A. f. O. XII b, p. 215.

² Archives of Ophthalmology, Vol. II, p. 166.—Steinheim.

³ Ann. d'Ocul. T. LXVIII.

PART III.

DISEASES OF THE SCLEROTIC.

I. INFLAMMATION OF THE SCLERA—SCLERITIS.

The sclera is comparatively seldom the seat of an independent inflammatory process. In reality, we only know inflammation of that zone of the sclera situated in the neighborhood of the anterior ciliary arteries; that is, anterior to the insertion of the four recti muscles. Primary inflammation of the portion posterior to this line is proven neither clinically nor anatomically. If the sclera be implicated during the inflammatory processes of the uveal tract, the symptoms which become noticeable are more those of inflammatory softening, directly resulting in staphyloma (*Staphyloma scleræ*). In suppurative cyclo-choroiditis, the anterior half of the sclera is sometimes perforated, and the evacuation of pus is followed by cicatrization and atrophy of the globe (*Phthisis*).

Idiopathic scleritis—which alone is now to be considered—occurs either isolated or in combination with inflammation of the cornea, the iris, and the ciliary body.

I. SIMPLE SCLERITIS.

This disease, formerly designated by the author as partial scleritis, and by later observers as episcleritis, was first described by Sichel¹ as partial choroiditis.

Symptoms and Course.—A more or less dark-red or bluish-red spot, in which numerous ciliary vessels terminate, appears upon the sclera, usually 3 to 5 mm. from the corneal border. This spot very soon changes to a light-colored nodule, sometimes covered by congested blood vessels, as though a pustule were about to

¹ Sichel, *Bulletin génér. de Thérapeut.*, Mars, 1847.

form in the conjunctiva. It is easily shown, however, that the infiltration is not in, but under, the conjunctiva. This infiltration appears as a firmly-seated, dense elevation, in some cases as an aggregation of pale yellow granules, which are united into a distinct nodule by the swollen conjunctival tissues and numerous blood vessels. After such a nodule has existed for several weeks, it gradually becomes flatter and is supplanted by a dark violet, then slate, or lead-gray spot, sometimes slightly depressed, which remains permanent, or disappears after a few weeks. Suppuration, induration and staphyloma are never seen. The process may terminate with the formation of a single nodule, or two or three may follow in rapid succession. Usually, however, the course is such that whilst one nodule is retrograding, another appears upon an adjoining portion, and thus the duration of the disease is extended many months. Sometimes relapses occur after several years. One eye may be exempt, or both may be affected, either alternately or one soon after the other. The patients, especially elderly persons, are usually reminded of their disease only by the redness, by a disagreeable sensation of pressure in the eye, or by a dull headache, less by sensitiveness to light and the keen air. Nevertheless, cases may occur, accompanied by very troublesome photophobia, as by sharp pain in the eye and the surrounding parts, so severe as even to disturb sleep. Disturbance of vision (diminution of acuity of vision) is complained of only when an inflammatory deposit situated near the cornea has caused the haziness of the cornea to extend to the pupillary region. However obstinate and troublesome the disease may be in the latter cases, it causes permanent injury neither to the function nor to the form of the globe.

Etiology.—This form of scleritis occurs most usually in old age, though it also occurs in adult life, and even in youth. Its occurrence without external cause, and the relapses in various portions of one or both eyes, notwithstanding a correct dietetic régime, renders it probable that it has a causal connection with some general disturbance of health, although this cannot be definitely pointed out in many cases. De Wecker¹ refers it to chronic rheumatism, and in several cases observed by the author the history favored this view; in others there were distinct symp-

¹ De Wecker, *Ocular Therapeutics*, English Ed., p. 161.

toms of scrofula. It scarcely ever occurs in its simple or isolated form as a consequence of syphilis.

Treatment.—When no reliable causal indication exists, a rational régime should be insisted upon, above everything. In elderly persons, gentle resolvents and laxatives are most effective, especially the use of mineral waters, bitter waters in small doses, as the Eger salt spring, Marienbader Kreuzbrunnen, Kissingen, Kreuznach. An old gentleman, accustomed to a very generous diet, and who had suffered with this disease for almost a year, with unusually severe pain and great photophobia, was greatly benefited by a few doses of salicylate of soda (grs. xxx, *in die*), a restricted diet, with exercise in the open air, and by the continued use of bitter waters. I have thus far made no use of injections of pilocarpine, as recommended by De Wecker, and my experience is that no advantage is to be expected from scarifications of such centres, as advocated by Schöler,¹ nor from the use of local remedies. In younger persons the same treatment is to be recommended as for interstitial keratitis.

2. COMPLICATED SCLERITIS—KERATO- OR UVEO-SCLERITIS.

In kerato-scleritis deposits similar to those in the simple form appear, either nearer the cornea or half in the sclera and half in the cornea, and in several places simultaneously, or soon after one another; the redness, swelling and infiltration of the pericorneal tissues are diffused, rather than circumscribed. In some cases the symptoms of interstitial keratitis predominate, in others those of scleritis. With these symptoms may also appear those of iritis or irido-cyclitis, though they may be wholly absent. If the latter have preceded, the scleritis must be considered as a secondary affection, and the general condition of the eye is to be judged of more by the primary disease. If the corneal disease predominate, the eye is principally endangered by a persistent, incurable opacity of the cornea (Sclerosis, pages 123 and 127). If the inflammation is first, or for the most part, situated in the sclera, only the marginal zone of the cornea becomes permanently opaque, the area of the clear cornea thus becoming more or less contracted and irregular. The pupillary region of the

¹ Jahresbericht der Ewers'schen, Augenklinik, Berlin, 1878, page 21.

cornea remains free, or at most contains here and there a small opaque spot.¹

The changes of the sclera may present very different phases in the course of the disease. (*a*) After the termination of the inflammatory symptoms, the episcleral connective tissue, to the extent of 3 to 5 mm. around the cornea (or in a certain portion), remains thickened, opaque and uniformly white, with a shade of violet or pink (sclerosed), which appearance I formerly described as porcelain-like.² This permanent change in the episcleral tissue, which might be easily mistaken for chronic cedema, surrounds the cornea in the form of a low mound. (*b*) In some cases the process, after having continued for a long time, leads to an alteration in the form of the globe, which may be designated as pyriform.³ In those portions which were previously occupied by the inflammatory deposits the sclera becomes slate-gray, and somewhat flattened; the globe, anterior to the line of insertion of the recti muscles, becomes mottled gray and constricted, as it were; whilst the base of the cornea is pushed forwards. The pyriform appearance is more distinctly marked if simultaneously with the cornea the above mentioned sclerosis of the episcleral connective tissue is also present. In cases which present this change of form only in one eye, it is not difficult to show the advancement of the corneal base, and therefore the elongation of the globe in its antero-posterior axis. (*c*) Better known than the above mentioned alteration in form is that which is usually designated as staphyloma of the ciliary body. In the anterior scleral zone, which corresponds to the position of the ciliary body, the sclera

¹ In some very rare cases the inflammation is limited to a more or less extensive arc of the corneo-scleral border. A light gray or light yellow infiltration appears at some portion of the periphery of the cornea, accompanied by intense ciliary injection, photophobia and pain; it extends somewhat into the cornea, appears slightly elevated, and presents the form of a narrow meniscus or hoop. The concave margin is shaded by a faint gray halo, and in consequence of the vascularity the peripheral border is not sharply defined. If, after several weeks, the symptoms of irritation have disappeared, and the infiltrated portion is transformed into a flat, grayish-white arc or circle, it may be easily mistaken, when superficially examined, for an arcus senilis; but it is uninterruptedly connected with the sclera, its concave margin sharply defined, and, for the most part, irregular. This affection differs from rodent ulcer in never producing a progressive ulcer, and, hence, no extensive opacity of the cornea.

² Von Arlt, Krankh., II B., page 12.

³ *Ibid.* I B, page 190, and II B, pages 12 and 14.

gradually becomes slate-gray during the subsidence of the inflammation, and at the same time staphylomatous (centrifugally pressed outwards, expanded, attenuated); this is naturally succeeded by a projection of the corneal basis forwards. The globe therefore appears elongated in its antero-posterior diameter; but chiefly enlarged in the transverse diameter of the above-mentioned scleral zone, and therefore increased in its entire size. Then, also, posteriorly to this zone the sclera has lost its firmness, though it does not appear perceptibly discolored. The staphylomatous projection which rises perpendicularly just posterior to the corneal basis gradually flattens backwards (towards the region of the ora serrata). The base of the cornea remains clearly visible as a white ring, and its curvature is rather diminished than increased. Moreover, the form and size of the globe may be considerably altered by the partial or circular development of an intercalar staphyloma.¹ Between the intestine-like pouch, which corresponds to the position of the ciliary body, and the light-gray circle which marks the corneal basis, another epaulette-like or annular pouch appears, which is more convex and of darker color, and coated externally by a thin layer of scleral tissue and conjunctiva, internally by the enormously distended and atrophic iris.

In a young woman, twenty-five years of age, who had suffered from interstitial keratitis, scleritis (and probably irido-cyclitis), in consequence of syphilis, we found a large portion of the cornea of the left eye sclerosed, and in the temporal side of the right eye a perpendicular, hemispherical, scleral staphyloma, with an almost circular basis (about 8 mm. in diameter), upon the inner surface of which several atrophied and somewhat distended ciliary processes could be distinctly seen by transmitted light as dark lines; the base reached almost as far back as the equator; between the region where the ciliary processes were situated and the slightly opaque cornea, the curvature of which was scarcely changed, there was inserted an epaulette-like pouch which was at once recognized as an intercalar staphyloma, as it was separated from the cornea by a light-gray line, and the iris proceeded from its anterior border. After a free iridectomy (on the nasal side), which was followed by the discharge of a large quantity of clear

¹ Von Arlt, *Krankh.*, II B., page 12.

liquid and collapse of the staphyloma, but not of the globe, during the next few days the intercalar staphyloma disappeared and the scleral staphyloma then became flattened, but did not wholly vanish. The patient was then lost sight of. The staphyloma was nearly flat though dark-colored (transparent), the tension of the globe diminished, and sensation of light (from the temporal side) was preserved.

In all these alterations (*a, b, c*), the condition of the iris may be normal, and the disturbance of vision may correspond to the dioptric changes. The ectasia is not developed in consequence of increased tension, but in a manner analogous to keratoconus and spheroidal staphyloma of the cornea; that is, as a result of a diminished power of resistance of a portion of the parietes of the globe. Such an ectasia may exist for years without causing a permanent increase of pressure, or an excavation of the optic papilla. This ectasia should therefore be separated, as regards prognosis, from that form which occurs secondarily, if iridocyclitis, choroiditis, dislocation of the lens, etc., has produced adhesion between the sclera and uvea, increase of tension, and secondary inflammation and ectasia of the sclera. As regards the iris, unless iritis exists, it shows only the signs of tension. It lies sometimes apparently (in sclerosis of the corneal border), again really, deeper in one plane, and shows a round pupil surrounded by the projecting pigment-layer, a broader sphincter zone, and somewhat sluggish mobility. The further its ciliary border is drawn towards the periphery the greater is the distance between the pupillary and ciliary border. From what has been said it must not be inferred that such eyes are secure against loss of sight (so-called secondary glaucoma) from an increase of tension. The more the circle described by the ciliary processes is enlarged, by the ectasia over the ciliary body, and especially by the addition of intercalar staphyloma, and the further back the peripheral attachment of the zonula, the greater must be the traction exerted by the zonula upon the ciliary processes; and this alone may result in an increased secretion of serous fluid into the vitreous body, and consequent increase of tension. It may result, moreover, in a separation or laceration of the zonula, or in a dislocation of the lens and its consequences. According to the author's experience, a sympathetic affection

of the other eye is not induced, at least not with fibro-plastic exudations.

Etiology.—This form of scleritis is found only in young persons. In many cases the presence of scrofula, in others that of hereditary syphilis, can be proved. The affection is more frequently unilateral than bilateral. A woman, who was first attacked in her twenty-ninth year, with kerato-scleritis in her left eye, and after a course at Hall (including three summers), had not suffered any relapse, was again attacked, during her fortieth year, with exceedingly severe pain in the same eye, which, notwithstanding the most careful general treatment (residence in the country, Hall water), local application of atropine, belladonna ointment and warm fomentations, exacerbated from spring until autumn, and was permanently relieved only after a several weeks' use of salicylate of soda. The globe is now somewhat elongated, the transparent portion of the cornea somewhat contracted here and there, from sclerosis of the border, and in the centre of the cornea there are two light gray spots as large as poppy seeds; the chamber is not increased in depth, and the iris is normal. The cornea is surrounded by a scleral zone varying in width from 3 to 4 mm., which, on account of the thickening of the episcleral connective tissue, appears somewhat swollen, and, by a white color tinged with violet, contrasts strongly with the immediately adjoining zone, which is of about equal width, slate-gray and variegated, and appears constricted to a certain extent. The tension of the globe does not differ from that of the normal right eye. The woman reads Jäg. No. 12 with this eye at a distance of six inches. In the following case, intercalar staphyloma resulted at the same time: A servant girl, twenty-nine years of age, came to the clinic in 1877. In her twenty-first year she was said to have suffered from redness of the eyes. In her twenty-third year, first the left, and four weeks later the right eye became affected, this time accompanied with disturbance of vision, the diagnosis being keratitis and scleritis. She was first treated with instillations of atropia and Haller iodine water. Later, an upward iridectomy was performed upon the right eye, and about eight weeks later the patient was discharged. But the eye remained red for a long time afterwards, and vision was always impaired. In her twenty-eighth year, after the red-

ness of the right eye had long disappeared, the left was attacked, and on this account the patient came to the clinic again. She was then eight months pregnant. The right globe was strikingly enlarged, the scleral zone surrounding the cornea, which was 10 mm. in width in the upper half, slate-gray, bulging and showing upwards and inwards isolated recent inflammatory deposits in the form of flat nodes. On account of the scleral ectasia, the corneal base appeared to be moved forwards, and as the ectasia was considerably greater above, it appeared to be placed obliquely. The cornea seemed slightly flattened, and showed several central spots deeply situated. The iris was deeper, the lower segment retracted by atropia to a small border, the upper showing an opening (coloboma) over 10 mm. wide, which, as the cicatrix was only 5 mm. long, evidently had not attained this size through excision alone, but with the assistance of the subsequent retraction of the iris. On the anterior capsule was a thin layer of pigment; vitreous opacities were not present. The fundus of the eye, especially the optic papilla, showed nothing abnormal except the distortion consequent upon the changed curvature of the cornea. Fingers at 4 meters with 8 D; left eye at 5 meters. The ocular conjunctiva was intensely injected around the cornea; small nodules, sensitive to the touch, were seen under it in some places; in other places, a slate-gray color, nowhere an ectasia. The cornea showed light gray spots in the centre and along the border, with fine deposits in the lower portion upon Descemet's membrane. The pupil was dilated to its greatest extent by means of atropia; the iris was slightly discolored, but the details of the fundus were not distinguishable. Tension was not abnormally increased in either eye. Fingers at $4\frac{1}{2}$ meters with — 5.50 D. S. $\frac{6}{8}$ O. The patient had to be discharged uncured, after three weeks, on account of her approaching confinement. She came to the clinic again three years afterwards. She had taken cod-liver oil for some time, at her own home, and had again lived out as a servant; seven or eight weeks previously—in January, 1880—inflammatory symptoms again appeared in the eyes. Early in March no trace of recent inflammation in the sclera of the right eye was visible; the staphylo-matous zone around the cornea was distinctly divided into an anterior intestine-like pouch, which is to be considered as inter-

calar staphyloma, and a posterior portion, which was separated from the anterior one by a slight furrow, less high and less dark (less transparent), which posterior was gradually transformed into the normal sclera, and corresponded in position and width with the ciliary body. The intercalar staphyloma in the upper half was somewhat wider and higher, and was separated from the cornea by an opaque light gray circle. The cornea showed several marginal spots, and in the centre a white, smooth opacity as large as a hemp seed. The iris was present only in the lower half, and lay rather near the cornea. The fundus was only indistinctly seen, but aside from the astigmatic distortion, it showed nothing abnormal, the papilla, especially, being neither discolored nor excavated; tension normal, S. = fingers at not quite 2 meters. Left eye: no abnormal ciliary injection, the sclera attenuated in a similar manner as in the right eye, only not to such an extent, and also staphylomatous, and hence the globe was likewise strikingly enlarged at the expense of the anterior scleral zone; in the cornea were several small marginal spots; otherwise, it was transparent and normally convex, and showed only in the centre two grayish-white stains as large as hemp seed; of the deposits, only a single point was to be seen, which was as black as ink; the iris, light brown, as in the right eye, showed no change of structure, and reacted perfectly to light; the pupil, in ordinary light, 3 to 4 mm. wide, not quite round, yet without synechia; the width of the small iris circle was striking as compared with that of the larger circle and the prominence of the pigment on the pupillary border. The fundus of the eye was not distinctly visible. T. n. S. finger at 5 and 6 meters. No limitation of the field of vision.

Treatment.—In the treatment of complicated scleritis, the same precautions should be taken as in the simple form, except that the condition of the iris should be especially watched, lest synechiæ form. If the inflammation has induced alterations in the form of the globe, and if qualitative vision still exists, such an eye should be regarded as "Nole me tangere;" but if the pupil is occluded (atresia pupillæ), and there is hope of restoring some vision by means of an iridectomy, this should be undertaken, yet we should be prepared to find synchysis of the vitreous body. If the perception of light be destroyed by increase of

tension, all that has been said regarding corneal staphyloma is applicable here. If an attempt be made to diminish such a globe by the insertion of a thread (as recommended by Flarer and A. von Gräfe), a strict watch should be kept over the patient, lest suppurative cyclo-choroiditis be induced by allowing the thread to remain in for too long a time.

II. INJURIES (WOUNDS, RUPTURE) OF THE SCLERA.

Penetrating wounds of the sclera are recognized, aside from a simultaneous injury of the conjunctiva, by diminished tension of the eye, by the appearance of portions of the uveal tract (iris pigment), and by prolapse of the vitreous humor. Cicatrices show fixation of the conjunctiva, pigmentation, radial contraction. Very small cicatrices, as result from the puncture of a needle, or the penetration of small foreign bodies, may later become invisible.

An incised or penetrating wound generally heals without any especially severe inflammatory symptoms, provided that no portions of the uveal tract, lacerated pigments of the lens capsule, or considerable quantity of vitreous humor be incarcerated in the wound. Wounds in the corneo-scleral border may result in prolapse of the iris, in cystoid cicatrization, or in the formation of iridic cysts, but they are especially dangerous, because they easily induce cyclitis of the eye attacked, and even of the other eye (sympathetic irido-cyclitis). The details concerning this complication will be given in considering diseases of the iris and the ciliary body.

Wounds which perforate the tunics of the globe further back, thus injuring only the flat portion of the ciliary body, or parts behind the serrated extremity of the retina, and consequently only causing escape of the vitreous humor, may cicatrize without unfavorable consequences, after the prolapsed vitreous humor has become opaque, constricted and cast off. But if a considerable portion has been lost, they may lead, sooner or later, even after apparent good recovery, by shrinking of the stroma of the vitreous, to partial or total detachment of the retina, especially if the scleral cicatrix be drawn inwards (centripetal). The globe then becomes more or less atrophied.¹ For when the sclera is

¹ A. v. Gräfe, *Archiv. f. O. III B.*, page 391.

perforated, the choroid, although not wounded, cannot remain unaffected during the process of cicatrization, and the occurrence of inflammation is an inevitable result. But this inflammatory process may easily lead to the formation of a cicatrix, towards which the adjoining retinal portions are drawn; and this traction causes a detachment of the retina in the vicinity.

If the sclera ruptures in consequence of a sudden and severe compression of the globe, or as the result of a thrust or blow made by some blunt instrument, the laceration rarely lies in the corneo-scleral border, but usually 2 to 5 mm. posterior to and parallel with it. I have never seen a rupture of the cornea. Since such a laceration results at the moment of the greatest tension of the globe, it also extends, in every case, through the uveal tract, but through the conjunctiva only if the rupture is near the cornea; that is, in a zone in which the conjunctiva is already closely adherent to the sclera. If the conjunctiva be also lacerated, the lens may be forced out through the opening, and, therefore, be absent; then, perhaps, only a portion of the iris and vitreous body may be found in the wound. If the conjunctiva remains intact, it is raised into a kind of bladder, in which aqueous and vitreous humor, lens and blood may be contained. The presence of the lens under the ocular conjunctiva, unless it is invested by blood, is easily recognized by its form and color, or rather by its want of color, transparency and reflection of light. Its absence from its normal position in such cases is indicated by the deeper position and partial deficiency of the iris, and may, after the re-absorption of the blood extravasated into the anterior chamber, be easily proven by testing the condition of refraction and by the ophthalmoscope, as well as by the absence of the reflected images of the capsule (according to Purkinje and Sanson).

In order to understand the immediate consequences of sudden compression of the globe, it should be remembered that the non-compressible contents of the globe are enveloped by membranes which are distensible only to a very slight degree, and that the sclera is uniformly surrounded, for more than one-half of its extent, by the very elastic and abundant adipose tissue of the orbit, and which occupies the space between the globe and orbital bones. If a foreign body acts upon the envelope of the globe

with a certain sudden force, without perforating it, the force may exhaust itself simply in bruising the tissues with which it comes in contact, or it may result, according to its size and form, in a local indentation or flattening. But a high degree of indentation, or flattening, is impossible, without a simultaneous alteration in the form of the entire globe, on account of the incompressibility of the contents. If the point of contact be regarded as the pole, and the direction of the blow as the axis of a sphere, the eyeball must become enlarged in the equator of this sphere. If it is considered that the contusing foreign body cannot very well strike the eyeball from any other direction, except from below, or from below and without, and that probably the eye, at the moment of danger, turns (with the corneal centre) upwards, or upwards and inwards, the point of contact usually falls upon the sclera, between the lower corneal border and the equator of the eye. And then the place where we most frequently observe the laceration of the sclera lies almost exactly in the circle which must be designated as the equator, in reference to the direction of the blow (the axis of the sphere). When the sclera undergoes the greatest tension in this zone, it will be most easily ruptured where it is not supported by cushions of elastic adipose tissue; that is, near the corneal border. If the blow strikes the globe above the uveo-scleral portion, rupture occurs downwards and inwards.

Although numerous cases of rupture of the sclera with prolapse or escape of the lens have been known, in which the eye subsequently resembled one upon which extraction had been performed, yet this injury in many cases results in a loss of function, or even of the form of the eye, and, what is still worse, sometimes results in sympathetic irido-cyclitis of the other eye. The reaction in the wound as the direct consequence of the injury does not easily reach a high degree, probably on account of the continued reduction of the intraocular tension. The chief danger consists in too great a loss of vitreous humor, which may induce sub-choroidal extravasation of blood, and in the subsequent irritation of the iris, either from its incarceration in the cicatricial tissue, or from the displaced lens pressing upon it and the ciliary body. (See Luxation of the Lens.) If the lens remains under the conjunctiva there will certainly be no very great loss of vitreous. It may continue transparent for

weeks, or it may become opaque, shriveled and calcified. If much vitreous has been lost, either severe reaction and suppurative choroiditis, or free choroidal hemorrhage are to be immediately feared; or there is danger of retinal detachment, which manifests itself more gradually in the course of weeks or months. If chronic cyclitis develop, with flattening or infiltration of the cicatrix, there is danger of the sympathetic affection of the other eye.

Treatment.—The first question is, how to prevent further evacuation of the contents of the globe. For this purpose, it is necessary not only to enjoin a quiet position on the back for the first few days, with the application of cold compresses, but also the prevention of any lid movements, by bandaging both eyes, and withholding everything which may impede the reflux of the blood through the descending vena cava. If a considerable portion of the vitreous or iris protrude from the wound, it may be excised, either with or without anæsthesia, as the individual case may demand; but, as a rule, it is not necessary. The protruded vitreous becomes opaque after a few days, constricted at the base, and is finally cast off. A small prolapse of the iris may be gradually bridged over and flattened; a larger one, however, requires excision. In long or lacerated scleral wounds, it may be advisable to bring the edges together by means of fine sutures, the patient being anæsthetized. If the conjunctiva has not been torn, but only pressed forwards in the form of a cyst, the opening and evacuation of this should be delayed until it may safely be inferred, from the tension of the eye, that the rent in the sclera and uveal tract has closed. If purulent cyclo-choroiditis (distention of the globe with pus) develop, phthisis bulbi is scarcely to be prevented. Still the severe pains may be mitigated and shortened by the early application of the compressive bandage, by first cold and later lukewarm applications, with the aid of opiates and hydrate of chloral; finally, if the pus is slow in breaking through a somewhat bulging portion of the sclera, an incision into the most protruding part may be the only means of giving the patient a speedy relief from his sufferings. If symptoms of chronic cyclitis appear, the other eye should be watched with double care, and in case precursory symptoms of sympathetic affection make their appearance, enucleation of the

wounded eye is to be at once proposed. If the symptoms of sympathetic inflammation are already well marked, it is very doubtful whether its progress can be stayed by the enucleation of the wounded eye; in that case, enucleation could only be justified if every hope had vanished of ever rendering the wounded eye in the least degree capable of performing its function. In an old woman, whose lens had been forced under the conjunctiva of the upper half of the cornea of the right eye, and which had later been removed, chronic irido-cyclitis had developed in the left eye, which, notwithstanding the greatest care of the patient, and in spite of repeated iridectomies, finally resulted in incurable blindness of this eye. With the right eye, which resembles very closely an eye after peripheral extraction of the lens with a broad coloboma of the iris, and a slight infiltration of the sclera along the cicatrix, the woman obtained $S \frac{20}{LXX}$ with a convex glass. The sympathetic affection of the left eye was in this case probably not induced by the condition of the right eye, but, as was ascertained too late, unfortunately, by the patient repeatedly and secretly reading and writing during the healing process in the right eye.

III. ECTASIA AND STAPHYLOMA OF THE SCLERA.

If, as is usually the case, every partial bulging of the sclera is designated by the term "staphyloma," then conditions widely differing from one another, as regards pathology, anatomy and etiology, are grouped together under one name. First, we have a congenital partial bulging, which Ammon has designated as scleral protuberance; it occurs solely in eyes with congenital choroidal coloboma, and can be conclusively proven only with the ophthalmoscope (*Vide Diseases of the Choroid*).

The general uniform bulging of the sclera, which is observed simultaneously with an enlargement of the cornea from earliest youth, and usually designated by the term "buphthalmus," is still too little known in its anatomical and etiological relations. Nothing is known of the causes of the general enlargement of the eye and the loss of vision (under intraocular pressure). This very rare disease usually occurs in both eyes simultaneously. I have only once seen it unilateral, and that was in a child otherwise well developed.

Ectasia of the sclera in the region of the posterior pole, which forms the usual basis of myopia (axial myopia), is frequently designated staphyloma posticum, since Scarpa found it in cadavers, though he did not recognize its relation to myopia. Although in this condition the choroid, together with the retina, lies upon the thinned sclerotic, which is more or less expanded in form of a cupola, yet it is not adherent to it; and, therefore, this ectasia is no evidence of past sclero-choroiditis, as we shall see later in the discussion of myopia. Hence, this ectasia deserves the name of staphyloma as little as does keratoconus or the *keratectasia ex panno vel ex ulcere corneæ*. If the expression "scleral staphyloma" is reserved only for that condition in which, analogous to the corneal staphyloma, a portion of the sclera appears united to and distended with a corresponding portion of the uveal tract, in consequence of an inflammatory process, it is only necessary to determine whether the inflammation originated in the uveal tract, and subsequently led to an increase of intraocular pressure, or whether the ectasia was induced by an inflammatory process proceeding from the sclera, in which case, as we have seen in speaking of scleritis, increase of tension and excavation of the papilla may or may not be the result. Scleral staphylomata which may have been induced by suppurative keratitis have already been considered on page 155. Those which may occur after chronic irido-cyclitis, in cases of glaucoma and with dislocation of the lens, will be discussed in the sections treating of those subjects. It remains only to mention those ectasiæ which are caused by pseudo plasmata in the globe, especially by sarcomata in the ciliary body, or rather in the choroid. How such ectasiæ are to be distinguished from the scleral staphyloma, will be mentioned in the section devoted to diseases of the choroid.

If light can be transmitted through a bluish or slate-gray prominence in the anterior section of the sclera, it is certainly due to the attenuation of the sclera and that portion of the uveal tract adherent to it. As a rule, such prominences or tuberosities may be easily somewhat indented with the head of a probe. In very small prominences, of the size of hemp seed for example, these means are no longer applicable, and the diagnosis can only be made by other means, especially by testing the tension of the

eye and by the aid of the ophthalmoscope. In one case a knob-like prominence appeared upon the sclera after the eye had been struck by a link of a chain; the rupture, which occurred about 3 mm. above the upper margin of the cornea, was limited to the ciliary body and the deeper layers of the sclera, while the episclera and conjunctiva were only distended. This prominence first became distinct after the blood which had extravasated into the chamber was reabsorbed; then a rupture of the upper half of the anterior capsule could also be seen, through which the opaque and swollen lens was pressed into the anterior chamber. Neither rent nor retraction of the iris was observable. The patient is now twenty-six years of age and still under treatment, partly on account of the swollen lens and partly on account of pain in the moderately reddened eye. The retina did not appear to be injured.

PART IV.

DISEASES OF THE IRIS AND THE CILIARY BODY.

A. INFLAMMATORY DISEASES.

Although the uveal tract may simultaneously be the seat of inflammatory process in its entire extent, yet, as a rule, the inflammation originates in and is limited to one of its three principal divisions. We are, therefore, warranted in speaking of iritis, cyclitis and choroiditis as separate diseases. But while isolated inflammatory centres occurring in the true choroid, that is, in that portion lying behind the ora serrata, usually extend rather to the overlying retina than to the ciliary body and iris, the inflammation occurring in the iris usually extends over the entire iris and frequently to the ciliary body; and an inflammation occurring at first partially or all around the ciliary body only exceptionally remains restricted to this portion, the symptoms of iritis soon supervening. The site of cyclitis is the continuation of the choroid in front of the ora serrata of the retina; it forms a smooth belt around the vitreous, and then passes over to the ciliary processes. After sending the zonula towards the capsule of the lens, it descends abruptly towards the periphery of the iris, joining the latter at an acute angle. According to all appearances, the ciliary muscle never becomes the centre of inflammation in the ciliary body, and does not undergo anatomical alterations until later. The alterations in the choroid proper can be recognized only by means of the ophthalmoscope. Iritis and cyclitis, on the contrary, may be diagnosticated without this; but the opacities in the vitreous induced by cyclitis, as well as the diseases of the retina and choroid which may be simultaneously present, cannot be definitely determined without its aid. This

condition of the different portions of the uveal tract in inflammatory processes, that is, in the majority of its affections, and the analogous condition of the muscular elements of the iris and ciliary body, justify a separate consideration of the diseases of the anterior uveal section, the iris and the ciliary body, from those of the posterior section, the choroid proper, whilst heretofore the separation into diseases of the iris and choroid—ciliary body and choroid proper—was customary. The anatomical reason that iritis and cyclitis so often occur simultaneously, or one soon after the other, is probably due to the fact that the iris and the ciliary body possess a common vascular system, the long posterior and the anterior ciliary arteries; while the choroid proper, with its peculiar *venæ vorticosæ*, is almost exclusively supplied by the short posterior ciliary arteries. Besides, the ciliary processes, where they bound the posterior chamber (between the zonula and iris), are the source (matrix) of the aqueous humor, which, surrounding the iris on all sides, can scarcely fail to influence it by any changes in its chemical composition.

I. INFLAMMATION OF THE IRIS—IRITIS.

(a) GENERAL CONSIDERATION.

Iritis is often found associated with inflammation of other portions of the eye. In the course of an ocular inflammation, the iris is frequently the primarily and most prominently, though often the secondarily affected portion; but it may pass alone through all those changes which characterize the inflammation. Hence, the understanding of many pathological conditions of the eye is based upon a knowledge of iritis and its consequences.

Symptoms.—In a series of cases of primary iritis (especially in the acute form), pain and redness remind the patient of the inflammatory nature of his disease. In other cases (in the chronic form), the patient refers the diminution of his visual power rather to the formation of cataract than to inflammation. Secondary iritis is most frequently induced by diseases of the cornea, often by diseases of the ciliary body, rarely by those of the retina or choroid.

Iritis can only be assumed when ciliary injection, discoloration of, and exudation into the iris or the anterior chamber is found; the latter being derived only from the iris. When no exudation

referable to the iris can be found, perhaps only an abnormal ciliary injection and discoloration, hyperæmia of the iris, and not inflammation, may be diagnosticated. Where, even during a prolonged examination of the eye, no abnormal ciliary injection is noticed, it may be assumed that the other two factors are to be referred to an iritis which has already run its course. With these still other symptoms may exist directly connected with iritis, especially disturbance of vision, photophobia, sluggishness of the iris and pain; but their absence in a given case would not be sufficient ground for denying the existence of iritis.

1. The increased injection of the anterior ciliary arteries is noticeable as a pink border on the sclera around the cornea. It may be partial if the iritis is partial. In chronic cases it frequently becomes distinct only when the eye is momentarily irritated by dazzling light, keen air, weeping, etc. In case of violent inflammation, it becomes 5 or 6 mm. wide, and with a concurrent affection of the conjunctiva is now covered by a more or less dense, scarlet, or dark red vascular network, now by a uniform redness and swelling of the conjunctiva (chemosis). It is generally the first initiatory symptom; its abatement the first sign of the decline of the inflammation. It occurs not only in iritis, but also in inflammation of the anterior zone of the conjunctiva, the sclera, the cornea and the ciliary body.

2. Discoloration of the iris, which is only definitely recognized in cases of unilateral iritis, and where both eyes, in the healthy condition, were of the same color, shows different tints of gray, green or red. It is the second symptom distinctly perceptible in beginning iritis. It frequently remains for a long time after the abatement of the process of exudation, and should not be confounded with that which results from shrinking exudations, from accumulations of pigment or from distention of the iris. Aside from opacity of the cornea and from turbidity or discoloration of the aqueous humor, occasioned by an increased percentage of fibrin, coloring matter of the blood or the bile, the color in which the iris appears to us is evidently influenced by hyperæmia, tumefaction and serous infiltration, and further by the deposit of fibrinous exudations in and on the iris; and in some cases by the appearance of blood vessels. That even mere hyperæmia may cause a discoloration of the iris is seen in cases in which,

during the presence of a foreign body in the cornea, accompanied by partial ciliary injection, photophobia and lachrymation, the pupil appears strikingly narrow and the iris discolored; but all these changes disappear spontaneously within a few hours after the removal of the foreign body, leaving behind no trace of exudation.

3. The exudation occurs partly in the parenchyma and partly on the surface, and thence passes into the aqueous humor. Sometimes one predominates, sometimes the other.¹ The exudation into the parenchyma may be limited to a small portion, but usually extends over the entire minor circle, and in severe cases, over the entire major circle. Aside from the formation of gummata, the infiltration in the minor circle manifests itself by its becoming wider, thicker and darker, and by a more felt-like than finely fibrous appearance; whilst the major circle still preserves its fine delineation with trabeculae and crypts, though, perhaps, appearing somewhat gray or greenish, and at the same time somewhat duller. If the infiltration has extended to the entire iris, it completely loses this clear delineation, and assumes throughout a velvety, cloth, or felt-like appearance, whose dull color often has a reddish tinge, and allows small vessels to be seen. The chamber is then shallower, on account of the increased thickness of the iris. This condition should be well distinguished from the crowding forwards of the iris by the aqueous humor, or by exudative layers between the iris and the capsule, in which, also, isolated vessels (veins) may be perceived. In eyes which are beginning to atrophy in consequence of irido-cyclitis, the iris, together with the lens, may be pressed forwards so much that the chamber is almost abolished.

The exudation poured out either upon the surface of or into the aqueous humor, is most frequently seen in the pupil, less so in the anterior chamber (either suspended or precipitated). The

¹ Ammon, therefore, in his prize essay, "De iritide, Leipzig, 1838," separated them into a parenchymatous and a serous iritis—the latter as posterior or anterior, or uveitis—in conformity with the anatomical views of his day, considering the parenchyma as the seat of the former as well as that of the latter, and then assumed serous coating of the anterior or posterior surface of the iris. Later, the expressions "parenchymatosa" and "serosa" were used in an entirely different sense, the latter, also, for inflammatory processes which, originating in the ciliary body, must, therefore, be designated as cyclitis.

exudation in the pupil is seen in the form of synechiæ or a membrane (plug). Synechiæ usually form isolated point-like connections between the pupillary border and the capsule, and are visible, when the eye is shaded, as dark, pigmented, teeth-like projections into the pupillary region. In case of contraction of the pupil (on account of photophobia or under strong illumination), their presence is either not betrayed, or only by an irregular (not circular) form of the pupil. Since the latter may also occur without iritis, especially in elderly persons with habitually very narrow pupils, it is sometimes necessary to make use of a mydriatic (atropia) in order to establish the diagnosis with greater certainty. If a portion of the pupillary border be free between two such synechiæ, it is drawn towards the circumference by the contraction of the radial fibres of the iris; the pupil is, therefore, irregularly dilated. Continuous circular synechiæ may originate at an early period, but they usually occur only after a long continuance (and in chronic cases) of iritis; they will be further described among the sequelæ of the disease.

In many cases of acute iritis, even after a relatively short duration, a membrane is found in the pupil, which completely or partially occludes it. If it occupy the entire pupillary area, it may adhere to the pupillary border all around, or, like a spider's web, only at single points, so that in the usual condition of the pupil, or, at least, when artificially dilated, interstices between the membrane and the iris remain free. Such membranes may be firmly coherent with the capsule, but usually they are not. As regards prognosis and operative interference, they must be distinguished from those membranes which occur in the pupillary area with circular synechiæ, and which are defective in the centre or covered over by a film of lymph, often only recognizable by focal illumination, but which are white and opaque near the pupillary border, with which it is firmly adherent as well as with the capsule (*vide* Sequelæ of Iritis).

The suspension of fibrinous exudative matter in the aqueous humor occasions first a diffuse turbidity of this liquid or a scarcely perceptible haziness of the pupil. That this does not arise from the cornea, may be assumed with certainty if the latter still shows its normal lustre. In very violent cases it may happen that the suspended exudation hangs before the pupil like a cloud,

its outline gradually becoming better defined, and then for several days remains before the capsule as a light gray, semi-transparent disk; it becomes smaller by degrees and well separated from the pupillary border all around, until it entirely disappears. In less violent cases the diffuse turbidity of the aqueous humor disappears, either by absorption or by the precipitation of the gradually coagulated fibrin upon the walls of the chamber, or, finally, by sinking between the cornea and iris. Precipitations upon the iris cannot be recognized as such, but can scarcely remain without an influence upon the color. Precipitation in the pupillary region is certainly the most frequent cause of synechiæ and of the membranes in the pupil adhering only with the iris. The precipitation upon Descemet's membrane may appear at first as a uniform haziness, but may be very soon perceived, especially in the lower half of the cornea, with the naked eye or with the magnifying lens, as sharply defined gray or grayish-brown points. Exceptionally, cases occur in which such sharply defined gray points are to be seen upon the anterior capsule; but they should not be confounded with the pigmented points resulting from the detachment of posterior synechiæ. These points or dots deposited upon the anterior capsule, as well as those upon Descemet's membrane, entirely disappear in time. By the deposition of a considerable quantity of exudative matter in the anterior chamber, either adhesion between the iris and cornea at the periphery or hypopyon may occur.

The exudation seems to occur principally during the night. Aside from the pain appearing especially or exclusively during the night, and aside from the increased exudation frequently found in the morning, there are cases in which turbidity of the aqueous humor is found in the morning, of which nothing, or scarcely a trace was visible the night before. Regarding the formations of synechiæ and membranes in the pupillary space, the following points are of importance: Often, after the iritis has run its course, if the pupillary border has become free, either spontaneously or by the instillation of a solution of atropine, we find upon the anterior capsule numerous specks, or aggregations of uveal pigment, or gray points covered with pigment, so arranged that, if we imagine the intervening interstices filled in, they would form a circle corresponding to the size of the pupil during sleep; and when several

synechial points or teeth project into the pupil, we find that their pigmental points form the contours of a similar circle. The apparent diameter of this circle varies in different persons, is never less than 2, and seldom more than 3 mm. The coalescence of the pupillary border with the capsule must, therefore, result during sleep, and the connecting medium must be external to the iris; it cannot originate from the iris at these points, else we should have to ask why the adhesion should not be continuous, and why, after their detachment, fibrinous particles, with more or less pigment, should remain adherent to the capsule, instead of appearing as an appendix to the pupillary border. If we assume that during sleep a fibrinous clot floating in the aqueous humor has sunk into the groove which the pupillary border forms with the capsule, it will indeed be capable of effecting a union at this point between the iris and the capsule, and maintaining it after the patient awakes, when the tendency of the pupil is to dilate. At first it adheres to the capsule, which has no epithelium, more firmly than to the pupillary border, coated with pigment cells. Even later, the union between the iris and the fibrinous mass is, as a rule, more easily broken up by operations than that between the fibrinous mass and the capsule. Hence, we understand that synechiæ only occur, when the pupil is narrow, where the iris and capsule come in contact; when the pupil is dilated, only at those points (as in the formation of gummata) where the iris is pressed backwards and lies upon the capsule. When the iris and capsule come in contact and coalesce, after wounds (operations), the conditions are quite different, and will be discussed later. Assuming that the connecting fibrinous exudation originated from some spot in the iris, we would seek in vain for a reason why this mass should never advance so far as the centre of the pupil, and never beyond the line of the above-mentioned circle. If, in all cases in which synechiæ are formed after primary iritis, or after iritis with cyclitis, their situation be noted, they will be more frequently found in the lower than in the upper half of the pupillary border, which fact will correspond with the precipitation of fibrinous clots in the aqueous humor, though not with the anatomical relations. Again, if an exudative membrane be formed in the pupil, interstices between it and the iris are more often found—if at all—in the upper than in the lower half.

Membranes which cover the pupil partially or entirely, and adhere with the pupillary border, not continuously, but by serrated processes, seem likewise to originate from exudations in the anterior chamber, and are as easily detached from the iris as from the capsule; whilst membranes which gradually form, as in case of annular synechia, adhere inseparably, both to the iris and the capsule.

Cases with deposits on the posterior surface of the cornea, which were formerly described as hydro-meningitis,¹ aquo-capsulitis,² or keratitis punctata,³ later, and frequently even now, as iritis serosa, often present the symptoms of simple iritis, but more frequently those of cyclitis. If the iris or the ciliary body, where it bounds the posterior chamber, has supplied the aqueous humor with fibrinous exudation which has coagulated into small clots, these may be evenly suspended in the chamber, but they generally increase in size and number in the lower portion, and by the movements of the eyeball are thrown, by centrifugal force, against Descemet's membrane, where they adhere as points or coagula of varying size. Such sharply-defined, rarely grayish-white, generally grayish-brown, puncta, are usually so small as to be recognized only with a lens, seldom being as large as poppy seeds; they may occupy the entire surface of Descemet's membrane, but usually only the lower half. Larger, round, fatty, bacon-like nodules are at times found just opposite the pupil, in syphilitic iritis; there may or may not be smaller nodules. If numerous large and small points are present, they are so arranged that the larger ones form a sort of oblong nucleus (similar to that of a candle flame), while the smaller ones, gradually decreasing, are found on both sides and above. Sometimes several of the larger puncta, which are sharply defined below and laterally, show above a process with indistinct borders. These points usually persist for weeks or months after the inflammatory process has ceased, but finally completely disappear. Sometimes, however, succeeding the grayish-brown spots, pigment may be found, as a

¹ Jüngken, *Lehre von den Augenkrankh.*, Berlin, 1836, p. 171. Himly, *Krankh. und Missbildungen*, Berlin, 1843, II Bd., page 181. J. N. Fischer, *klin. Unterricht*, Prag, 1832 (*Hydatoditis*).

² Mackenzie, 4th English edition, p. 565.

³ Desmarres, *Maladies des Yeux*, Paris, 1847, page 271.

black point, years afterwards. That such gray points may be washed out by the aqueous humor, if they do not adhere too firmly after opening the chamber, has been mentioned by Wardrop.¹ It is not difficult to distinguish them from the punctate opacities in the corneal substance if the cornea be smooth and lustrous. Interstitial keratitis, accompanied by a dense coating of Descemet's membrane, has already been considered (page 134). The grains of pigment evidently originate in the posterior chamber, and may pass into the anterior chamber with the aqueous humor, between the capsule and the iris, unless the pupil is closed by annular synechiæ. In many cases it appears as though the fibrinous particles originating in the posterior chamber remained adherent between the capsule and the pupillary border, causing a coalescence (punctated or arc-shaped) between the iris and the capsule.

4. Partial or complete immobility of the iris and contraction of the pupil are more or less distinctly pronounced in iritis. When there are adhesions here and there of the pupillary border, the free portions react promptly and distinctly to the stimulus of light, and when both eyes are subjected to the same illumination, the pupil of the eye unaffected by iritis may appear narrower than that of the inflamed eye. Dilatation of the pupil beyond the normal appears to occur only in those cases in which cyclitis exists, and is especially indicated by sediments on the cornea.

In simple iritis, the mobility of the iris is lost only when either the pupillary border is completely adherent to the capsule, or when the symptoms of sponginess, swelling and infiltration also become visible in the major circle. Under such circumstances atropine is ineffectual. If, in cases of recent iritis, notwithstanding correct and repeated applications of atropine, the iris resists its influence, and if its absorption is not prevented by lachrymation or by corneal alterations, it may be safely assumed that, on account of a high state of irritation of the ciliary nerves (intense ciliary injection, photophobia, lachrymation, pain), the sphincter is in a permanent state of contraction. If a solution of atropine be dropped into both eyes of a patient who has a foreign body in the cornea, the pupil of the uninjured eye dilates sooner and to a greater extent than that of the injured one, even

¹ Edinburgh Med. and Chir. Journal, Vol. III, 1807, and Morbid Anatomy of the eye

if the latter shows neither iritis nor keratitis, and all irritation disappears within twenty-four hours. This shows that the pupil may appear very narrow, on account of the great contraction of the sphincter in consequence of the exalted state of irritation, and not on account of fixation of the pupillary border to the capsule. If, after the termination of the symptoms of irritation the iris itself shows no parenchymatous changes, it may not unfrequently respond, notwithstanding the presence of a pupillary membrane, and notwithstanding numerous synechiæ, provided they are not annular (*vide* Spasmodic Myosis).

5. The disturbance of vision, especially a reduction of its acuity, always corresponds to the dioptric obstruction in or before the pupil; but the disturbance of function may be considerably augmented by the increased sensitiveness of the ciliary nerves, as well as by the contraction and immobility of the pupil. A greater reduction in the acuity of vision than would be anticipated from these causes, arouses the suspicion of simultaneous turbidity of the vitreous humor (through cyclitis) or of an affection of the choroid or the retina.

6. Pain in the eye alone or conjointly (sometimes principally) with pain in the region of the supra- or infra-orbital nerve (from the forehead to the occiput, teeth of the superior maxilla), increased sensitiveness to light and to every effort of accommodation, photophobia, from the lowest to the most violent grade, and lachrymation, are symptoms caused by the affection of the sensitive branches of the ciliary nerves. At times they are scarcely perceptible, at other times well marked. In conjunction with the injection of the ciliary arteries, they afford the most reliable standard by which to judge the acute or chronic course, as well as the increase and abatement of the inflammation.

7. The tension of the eyeball is, in acute uncomplicated iritis, rather diminished than increased. Manifest reduction or increase of the intraocular pressure only results in simultaneous or consecutive cyclitis.

8. In the acute course, the œdema of the ocular conjunctiva, and even of the cutis along the border of the lid, may be referable to iritis; but more frequently it indicates simultaneous cyclitis. The same may be said of febrile and gastric symptoms, which may likewise be referred to the ocular affection (irritation

of the ciliary nerves) in acute cases, particularly if no other cause exists.

Course and Duration.—In cases in which iritis begins with distinctly pronounced symptoms of irritation, and which are, therefore, designated as acute, the inflammatory process may completely run its course in from two to three weeks, sometimes even in a few days. But according to the cause, the behavior of the patient, and the various pathological conditions induced by the exudative process, it may be protracted to a much longer period and even become worse from time to time; or having disappeared for a period, it may be rekindled. Such cases, which have become chronic after having been acute, should be distinguished from those originally chronic, in which neither the redness nor pain of the eye, but the dimness of vision induces the patient to consult the physician, who is first led to discover other inflammatory symptoms by the presence of exudations.

(a) In a series of cases of independent and primary iritis, the symptoms of mere hyperæmia of the iris exist for some time (a week or more); ciliary injection, a slight discoloration of the iris, increased sensitiveness to light and work, lachrymation and various degrees of pain. Then dimness of vision first becomes distinctly prominent, with exudations in the pupil, in the aqueous humor or in the iris, and the pain sometimes attains to such violence as to be alarming. In another series of cases the patient is apprised of the incipient inflammation by the sensation of pressure or fullness of the globe, soon also, by more or less violent pain in the course of the supra- or infra-orbital nerve, and the physician finds, with the symptoms of iridic hyperæmia, the pupil of medium size or narrowed, the iris sluggish, less smooth, now earlier, now later, not only discolored, but spongy and swollen, especially in the minor circle, and the pupil less dark and distinctly hazy and often distorted by synechiæ.

(b) In other cases which have been usually designated as chronic iritis, the iris is probably drawn into sympathy by the ciliary body, at least the alterations of the iris during a long period may be insignificant in comparison with the disturbance of vision and the further affection of the eye. Most patients become alarmed about the condition of the eye only on account of the disturbance of their vision. A few gray points on the

posterior surface of the cornea, or perhaps only partial swelling or discoloration of the iris, one or several projecting serrations on the pupillary border when the pupil is artificially dilated, or perhaps a thin membrane in the pupil, and with it a considerable injection of the anterior ciliary arteries and veins, and an abnormal sensitiveness to bright light and use of the eyes, which latter symptoms often appear distinctly only on a critical examination of the eye; such may be the symptoms which disclose the presence of iritis (irido-cyclitis) to the physician.

Sequelæ.—Iritis generally terminates: 1. In complete recovery, without leaving a trace behind. This result is rather to be expected in acute than in chronic cases, and, aside from the cause, is less endangered by the violence of the symptoms than by the exudation during the course of the disease. 2. Recovery with isolated synechiæ and more or less functional disturbance of the eye. Isolated, punctated synechiæ may be detached, even after the termination of the inflammation, spontaneously or by the instillation of a solution of atropia, at least during a few weeks or months; seldom after having existed for years. They may be completely detached from the capsule, or leave upon it gray points (with or without pigment) and without any perceptible indentation or prominence at the previously attached points of the pupillary border.¹ In many cases one or the other synechia is gradually stretched so that the movements of the iris are only slightly impeded. Persistent isolated synechiæ, limiting more or less the mobility of the iris, interfere in the first place with the adaptation of the pupil to light (especially on going from the light into the dark), and may also reduce the acuity of vision (by obstruction, by diffusion of light), especially in distant vision, when the iris cannot properly respond to the impulse to dilate, in which case the obstruction and diffusion of a certain quantity of light is of great importance.

3. Several isolated, but especially wide or arc-shaped synechiæ, which may continue unchanged, notwithstanding the energetic application of atropine, may act injuriously, by protracting or rekindling the iritis. According to Gräfe, "the persistency of

¹ When a considerable quantity of pigment remained upon the capsule, with a more or less free pupillary border, it was formerly designated as pigment cataract (*cataracta pigmentosa*).

the posterior synechiæ, especially the broad and more unyielding, is the main cause of iritic relapse." Whether it be a certain traction which the iris suffers in the alternating impulses to contract and dilate, or whether they influence the circulation of the blood injuriously, remains undecided for the present. Inasmuch as the decision above cited does not deny the influence of other causes, syphilis, for example, repeatedly taking cold, former or recent gonorrhœal affection, it is to be maintained provisionally, and at all events it is worthy of consideration. It should not be overlooked, however, that such synechiæ may continue to exist for years, in some eyes, without relapses, and that such relapses (renewed iritis) have been repeatedly observed, although no synechiæ remained from one or several previous attacks. A young man who had suffered repeatedly from inflammation of the knee joint, and from iritis of the right eye, after a gonorrhœa, was finally discharged with posterior synechiæ (below and arc-shaped). After ten days, he presented himself again with the condition of the right eye unchanged, but with pronounced iritis in the left, which had heretofore remained unaffected. Ciliary injection existed, with synechiæ of the lower part of the iris.

4. In chronic cases of iritis, a condition which may be designated as posterior annular synechia, is frequently found. The pupillary border becomes adherent by means of an exudative zone which is variable in width. This zone is light gray or brown, occupies one-third, one-half or the whole of the pupillary border, and attaches the iris permanently to the capsule. Its position to the pupillary border is often such that it appears as though pressed between the iris and the capsule from the posterior chamber. This zone or border gradually disappears towards the centre of the pupil by becoming thinner and thinner; only the centre of the pupil is, therefore, free from the exudation. Upon a closer examination, it is often seen that the pupil is not free, but covered over by a thin membrane, into which passes the thin edge of the thick (opaque) exudative border along the pupillary margin. As long as such a border (whether it covers the centre of the capsule or not), still shows an interruption, so as not to form a complete circle; as long as one or more interstices may still be perceived (at least after the use of atropine) between it and the pupillary margin; as long, therefore, as communication still exists between

the posterior and the anterior chamber, the disturbance of vision may correspond altogether to the dioptric obstruction. But so soon as this communication ceases and the pupil is occluded, cyclitis occurs in every case, if it has not previously existed, and threatens the eye with destruction of vision, even of the perception of light, through increase of intraocular pressure or through the induction of atrophy of the vitreous and consecutive detachment of the retina.

In cases in which cyclitis leads first to an increase of tension, the iris changes its position and color. After the ciliary border has partially or completely adhered to the periphery of Descemet's membrane, and the pupillary border has become firmly adherent to the capsule, the intermediary zone of the iris bulges forwards so that the iris becomes crater-shaped. "The iris in such cases always becomes thin and gradually atrophic. It generally shows a light, slate-gray color, and in places, where its fibres recede from each other, it shows dark spots or stripes. The exudation which unites the iris and the cornea along the periphery is sometimes so thin that, at a later period at least, it cannot be distinguished as the connecting link."¹ In cases in which, after such an irido-cyclitis, the globe gradually becomes softer and smaller (compressed in the region of the recti muscles), the anterior chamber is found shallower, but not on account of the above described bulging forwards of the iris, which is characterized by the umbilical depression of the pupillary border, but from a diminished secretion of the aqueous humor or by the advancement of the lens. (*Vide* Sequelæ of Cyclitis.) It is quite right that (according to Gräfe) a distinction should be made between occlusion and exclusion of the pupil. In exclusion of the pupil (complete annular or circular synechia), the centre of the pupil may be quite free from exudation, and hence relatively good vision may still exist. In occlusion of the pupil, on the contrary, the "pupil may be completely obstructed by exudation;" consequently, the formation of a retinal image is impossible. Von Gräfe has made use of the expression "total posterior synechiæ" for cases in which the entire pupillary border has coalesced with the capsule. It seems better, however, to

¹ Arlt, Krankheiten, II Bd., page 46. Arlt, Operationslehre in Gräfe et Sæmisch, Handbuch, III B., page 349.

reserve this name for another condition, namely, that in which the posterior surface of the iris is altogether, or, for the most part, adherent to the capsule. Since such widespread exudative layers are, as it were, crowded out from the ciliary body between the iris and the capsule, this condition can only be described under the head of cyclitis. The distinction between annular and total posterior synechia is desirable, especially in operative interference, in order to have special designations for conditions which are different as regards prognosis and anatomy.

5. It may happen that a patient with an exudation in the pupil, which appears as membrane or plug, cannot distinguish objects, although neither occlusion of the pupil nor disease of the organs lying posterior to the iris (lens, retina, etc.), is discovered. It may be that interstices still allowing communication between the anterior and posterior chamber are covered by pigment, which lines the pupillary border, or is deposited on the capsule of the lens opposite the opening in the pupillary membrane. By testing the tension of the eye, but especially by the use of atropine, in case it produces a noticeable though slight retraction of the pupillary border, we may ascertain that we have to deal only with an obstruction of the pupil. (In pupillary membranes which are, to a great extent, continuously, not interruptedly, coalescent with the iridic border, newly formed vessels may be seen, though very rarely.) In some cases of acute iritis, after the inflammation has continued for a long time, we find, together with the ordinary posterior synechiæ, a trabecular membrane, which is not adherent to the pupillary border, but rather to the anterior surface of the iris (anterior to the sphincter), and which, by contracting, draws towards itself the opposite portions of the minor circle, so that the iridic tissue appears, to a certain degree, pulled into the pupillary area, whilst the remaining portions of the pupillary border are adjacent to the capsule, therefore, deeper. This must not be confounded with persistent pupillary membrane. (Memb. pup. pers.)

6. By a deposit of exudation upon the capsule, opacity of the lens may be induced, first of the subjacent cells, and later of the fibres proper and even of the entire lens; nevertheless, extensive opacity of the lens, as well as partial thickening and opacity of the capsule, usually arises only in cases in which the iritis is

occasioned by inflammation of the ciliary body or choroid, or by detachment of the retina. (See Cyclitis and Cataract.)

Etiology.—Cases of iritis must be divided, first, into those in which the iris is either the first or the only portion of the eye attacked by inflammation—*primary* or *substantive iritis*; secondly, into those in which the iritis is induced by inflammation in other portions—*secondary* or *consecutive iritis*. Those cases in which the iris is inflamed simultaneously with other organs, and in which a reciprocal dependency cannot be proved, are to be designated as combination, as, for example, kerato-iritis, irido-cyclitis, and are to be considered like the primary in their etiological relation.

Iritis induced by suppurative keratitis has been repeatedly discussed in the sections devoted to corneal ulceration and abscess. The affection of the iris during inflammation of the ciliary body occurs so soon that such cases may be considered as irido-cyclitis from the first. In detachment of the retina, on the contrary, a species of iritis occurs, in very many cases, months or even years after the primary lesion, which manifests itself in the beginning, usually by one or several posterior synechiæ, slight discoloration and scarcely noticeable ciliary injection. This synechial formation gradually and imperceptibly increases, and, after the occurrence of opacity of the lens, terminates as cataract. (See Cataract.) Probably it is the traction which the detached retina exercises upon its ciliary portion through the fluctuation of the sub-retinal fluid, and, therefore, upon the ciliary body, which induces chronic cyclitis and iritis. Iritis which is found associated with chronic conjunctival blennorrhœa and pannus, may possibly be primary, but in cases in which ectasia of the cornea co-exists, it is probably secondary and dependent upon the corneal affection. In the latter case, a thin membrane is usually found, which partially or wholly obstructs the pupil. Primary iritis, combined with keratitis, cyclitis or retinitis, or occurring at first merely in the iris, may be of traumatic origin, after contusion of the globe, after perforating wounds (especially those leaving a foreign body in the eye), after operations which necessitate opening the capsule of the lens or cause bruising or traction of the iris. How much may be attributed to taking cold (sudden cooling) as a cause of iritis, will be considered subsequently. Iritis during gonorrhœal

rheumatism is an exceedingly rare occurrence. On the contrary, syphilis, whether inherited or congenital, is a very common cause of iritis. In a similar manner scrofula, especially in youth, is frequently the cause of iritis, as is, likewise, defective nutrition after typhus, intermittent fever, etc. The so-called sympathetic iritis is really cyclitis at the beginning, although the symptoms which indicate iritis are distinctly pronounced at an early stage of the disease. Iritis (irido-cyclitis), which has been observed during the desquamative stage of variola, is to be considered as a metastatic inflammation, like the corneal abscess occurring during the same stage. In some cases, finally, no reliable conclusion can be drawn regarding the etiology of the disease. Posterior synechiæ may, in many cases, be given as the direct cause of iritic relapses; it will be necessary, however, to examine each case carefully, to be certain that the same cause which produced the first attack has not become active again. A young man was admitted with syphilitic iritis of the left eye, whose right eye showed an occluded pupil as a result of acute iritis, evidently of syphilitic origin. He was treated by inunctions, then with iodide of potassium, and discharged, after a treatment of ten weeks, without a trace of synechia in the left eye, and without any manifest symptoms of general disease, after the function of the right eye had been restored by an upward iridectomy, and only the lower pupillary border remained adherent to the capsule. After six months he returned, with iritis in the right eye, the coloboma of which was unchanged, though the minor circle of the iris was spongy and permeated by numerous small vessels, which could be distinctly perceived by the magnifying glass. The inunction treatment was again resorted to, and the man was finally completely cured.

Which symptoms should be especially kept in mind, when it is necessary to determine the etiology of a case under consideration, will become evident in the description of the different types of iritis. The determination of the cause may be very easy in some cases, and very difficult, or even impossible, in others. It requires not only a general knowledge of all the causes previously observed, in order to be able with certainty, or at least probability, to exclude the one or the other (according to the condition of the eye, or according to reliable data furnished by

the patient), but also a knowledge of the modifications usually offered by the appearance and the course of the disease, according to the variety of the etiological characteristics. This does not mean that a definite conclusion may be drawn in every case as to the etiological element, by merely observing the eye. The physician has to take into consideration not only the diseased organ, but also the condition of the patient, and his former as well as his present relations to external injurious influences. Only after a critical examination of all these conditions are we in a position to form an opinion regarding the disease of the eye in a given case. We have not to deal with diseases, but with diseased persons, or rather with the diseased organs.

The prognosis depends partly upon the course of the disease and upon the alterations which have already taken place, or are to be expected, and partly upon the etiological element, and to a great extent upon the treatment and the co-operation or conduct of the patient. Recent cases of simple iritis, which should generally be treated medicinally, and chronic cases which require surgical treatment, offer the most grateful field for medical activity.

Treatment—Besides the indications suggested in a given case by the etiology, every case of iritis requires a moderation of the light and abstaining from every kind of labor that necessitates accommodative effort. We cannot expose one eye to the light or work with it, without irritating the other eye also. In acute cases, especially those accompanied by intense photophobia, it is necessary that the patient should remain in a uniformly dark room. In mild, and particularly in chronic cases, in which prolonged confinement might be injurious, it may be dispensed with, and shell-shaped, smoked glasses, either with or without a shade or veil, may be sufficient to moderate the light. If the case presents itself with acute symptoms, especially with intense and widespread ciliary injection, photophobia, and radiating pain, it will be well to confine the patient to his room, if not to his bed, to restrict his diet, and to apply eight to twelve leeches behind his ear or upon the temple, keeping up the bleeding for about two hours. This, at least, can scarcely be omitted if, after the free use of atropine, dilatation of the pupil does not follow within a few hours, especially between the synechiæ, and if the radiating pain abates only for a short time, or not at all, after the applica-

tion of the opiate ointment to the temple, or perhaps even a hypodermic injection of morphine. The beneficial effects of narcotics are often only developed after the abatement of the hyperæmia. The effect of the local abstraction of blood under certain circumstances may be still further maintained by the administration of a laxative (a neutral salt alone, or the infusion of senna, calomel alone or combined with jalap, etc). If, notwithstanding the repeated use of the usual one per cent. solution of atropine every two or three hours, the pupil does not appear to dilate as widely as the adhesions will allow, the application of a small portion (about half the size of a hemp seed) of the dried sulphate of atropine is to be preferred to the frequent instillations; but more care must be exercised, in order to prevent the atropine from passing into the canaliculus, which is best done by drawing down the lower lid, thus preventing lid action, or by compressing the lachrymal sac with the finger for about two minutes. With the laceration of the synechiæ—and in acute cases it may be expected—the progress of the inflammation is checked. In some cases atropine, even if neutral, is not at all well tolerated; it causes intolerable dryness of the throat, notwithstanding all precautions after the instillation; in elderly persons (according to De Wecker¹) tenesmus and dysuria; or it produces an erysipelatous swelling of the eyelids, sometimes so great as to render the opening of the eye impossible. Then either a one per cent. solution of duboisine, or a half or a quarter per cent. solution of hyoscyamine² should be substituted. If the conjunctiva, after a long and frequent use of this remedy, appears somewhat reddened and swollen, and covered with small, opaque, vesicular elevations, it is poorly adapted for the further reception of atropine and for transmitting it into the aqueous humor. Its use should therefore be discontinued for several days, until the conjunctiva has again become quite normal by the application of a one per cent. solution of nitrate of silver. Although many cases show favorable results without mydriasis, the treatment with atropine is much safer. In old and originally chronic cases it will probably be possible, from what has been said regarding the condition of the exudation in the pupil, to form an opinion as to the efficacy of atropine.

¹ De Wecker, in Gräfe und Sämisch Handbuch, IV B, page 507.

² Knapp's Archives Ophthalmology and Otology, Vol. IV, page 157.

In cases in which atropine has been thoroughly applied and no favorable results have followed, or are to be expected, all remedies should be abstained from for a short time, after which iridectomy may be performed. The more intense the symptoms of irritation, and the more distinctly the iris tissue is in a condition of inflammatory sponginess and swelling, or even infiltration with vascularity, the more are we to expect a soft, friable condition of the iris, an abundant effusion of blood and subsequent closure of the coloboma by fresh exudations. In cases in which the pupil is occluded, and the tension of the eye diminished instead of increased (as is usually the case after sympathetic cyclo-iritis), care should be taken not to perform iridectomy too early (see Cyclitis). The details regarding the admissibility and the advantage of cold and moist fomentations, paracentesis corneæ, and general (internal or external) treatment during and after iritis, will be given in considering the different types of iritis.

(b) SPECIAL CONSIDERATION—TYPES OF IRITIS.

If iritis be clearly diagnosticated in a given case, the next step should be to ascertain whether only iritis exists, or whether some other disease of the eye may not also be present, and whether the latter is to be considered as cause, consequence, or complication. If the iritis or cyclo-iritis is to be considered as the primary disease, it will be necessary to ascertain the cause, which is to be sought in a diseased condition of other portions of the body, or in external noxious influences which have affected the entire body or the eye alone. When such a cause cannot be found, we must refer to the anatomical diagnosis (which has been mentioned in section (a) of the General Consideration).

Relative to external noxious influences, the data given by the patient may direct our attention to the etiological agent, but it may, also, mislead us. A foreign body may have penetrated the eye without being noticed, or an injury (as in children) may be intentionally concealed. Iritis is often imputed to sudden lowering of the temperature (catching cold, draughts, etc.); this may be the only cause, or it may have been only the exciting cause, as a further examination reveals the true etiological element, as syphilis, for example. In the examination of patients, such statements, resulting from ignorance, prejudice and even intention,

must be expected. Even reliable statements concerning the previous life (former diseases), do not always furnish positive information regarding the etiology of the disease under consideration. Positive statement and proof of infection, and treatment of syphilis at a previous period render it probable, but by no means certain, that the iritis under treatment is of syphilitic origin. An examination of the entire body furnishes grounds for a surer inference, and is necessary in every doubtful case; although, for various reasons, it cannot always be insisted upon, and does not in every case yield the necessary information. It is well established by experience, that the manner in which an iritis makes its first appearance and further develops, is more or less distinctly influenced by the exciting cause. This was recognized by the physicians at an early period, soon after they had first learned to diagnosticate the affection. That they went too far and pretended to be able to read the cause in the anatomical condition of the eye alone, must not induce us to deny or ignore this influence. Since it is to be expected, *à priori*, that the reaction of an organ or the entire organism, in consequence of a definite noxious influence, may assume various forms, not only on account of its different degrees of severity and of different individual powers of resistance, but also on account of the simultaneous or additional effect of other noxious influences, it must not be inferred, in the description of the different kinds of iritis according to the various causes, that representative types exist, to which it is only necessary to refer in order to ascertain, in a special case, this or the other previously known cause of a disease. Such a description can only emphasize the peculiarities which have been observed in cases in which one and the same cause was well established, and which, on account of their frequent occurrence, are referred to one and the same etiological element. Considered in this light, certain symptoms of the eye may not only furnish us noticeable hints for further investigation as to the etiology, but also a certain control of the results of this investigation (personal history, examination of the body). If we take the character of the exudations as the basis for the subdivision, and thus subdivide iritis into serous, plastic, suppurative and parenchymatous, we shall have not only to admit the so-called mixed forms, but also to add some forms based upon

etiology. That which, in more recent times, has been described as serous iritis, and which was previously known as hydro-meningitis, upon closer investigation is really found to be cyclitis combined with more or less iritis. The appearance of pus in the anterior chamber is, in itself, of no special significance either in a prognostic nor in a therapeutical consideration. If iritis is merely sketched in a general sort of way, setting aside every subdivision, it becomes difficult for the beginner to gain information regarding prognosis and therapeutics.

I. IRITIS AS THE RESULT OF INJURIES—TRAUMATIC IRITIS.

The causative connection between inflammation of the iris and traumatic attacks is established partly by accidental injuries, partly by operations and by experiments upon animals. It may be direct if the iris has been contused, dragged upon or brought into permanent contact with a foreign body. In numerous cases iritis is induced, sooner or later, by keratitis (suppurative), or by cyclitis or cyclo-choroiditis, by detachment of the retina, but especially by injuries and dislocations of the lens. In many cases, again, it occurs after operations performed strictly in accordance with well-known rules, without our being able to indicate any other reason for a direct or indirect connection than the sequence of the results. If the inflammation be caused by contamination or by reopening of the corneal or scleral wound, it appears as irido-cyclitis, and the real exciting cause can only be recognized with certainty by early inspection of the wound. These conditions should be considered, both in regard to the prognosis and treatment, and also, under certain circumstances, in their medico-legal relation.

The recognition of the traumatic origin may be very easy or exceedingly difficult; the latter, when the injury is not noticed or is disregarded, when it is intentionally denied or concealed, or when, in such cases, a cicatrix can neither be discovered in the cornea nor in the sclera. Small particles of stone, metal, glass, etc., may, if thrown into the eye with great violence, cause a perforation which, after two or three days, is no longer visible, especially if it has penetrated the sclera or the scleral border. They may lie posterior to the scleral border, between the cornea and iris, or they may be adherent to or imbedded in the iris or

behind it; and it is possible that they may not excite inflammatory symptoms until after many weeks, months or years. It also happens that a foreign body which originally entered the lens is, at a much later period, crowded out of the capsule and occasions inflammation only when it comes into contact with the iris. Partial ciliary injection and sensitiveness to pressure in the corresponding portion may suggest the presence of a foreign body; the iris is usually narrower at this point and the pupil distorted. Focal illumination may be useful unless blood, exudation, opaque fragments of the lens or haziness of the cornea interfere. In many cases the presence of a foreign body in the anterior chamber or in the iris is suspected, after inflammation has occurred, by an intense yellow or yellowish-white projection which surrounds it as an envelope, or by the apex of the foreign body protruding through this envelope or the iris into the chamber, and plainly recognized by focal illumination. If the foreign body cause inflammation of the iris (or the ciliary body), hypopyon usually appears at an early date. If, in consequence of a wound (stab, cut, foreign body), the anterior capsule be opened, and the capsular wound comes in contact with the iris (which may be intact or simultaneously wounded), permanent adhesion readily takes place between it and the adjoining iris without any manifest symptoms of iritis. After the early closure of the capsular opening a condition of quiescence may follow, or chronic iritis or irido-cyclitis may be induced by the continued tension upon the iris. Iritis is always to be apprehended if the lens swells *in toto*, or if portions of it lie in the anterior chamber. Aside from the increase of the intraocular pressure in consequence of the sudden swelling of the lens, the mechanical irritation of the iris by the extracapsular lens matter appears to induce iritis. For when an isolated fragment of the lens lies between the cornea and the iris, we observe a partial ciliary injection in the corresponding meridian, which may disappear without leaving a trace behind, but which, unless widespread iritis or irido-cyclitis intervene, may produce partial structural changes of the iris with a permanent distortion of the pupil in this direction.

If, after a wound or operation, extensive general iritis be found, it may be assumed that cyclitis is also present. Such cases are always distinguished by abundant plastic or purulent exudation,

later, often by an effusion of blood into the chamber. In violent cases following a general turbidity of the aqueous humor, a cloud is often seen floating before the pupil and the iris; it gradually becomes denser, does not adhere with the iris, except where the iris was wounded; it rests upon the capsule as a thin disk, and finally disappears. In other cases, the pupil is partially or totally closed, or even altogether occluded, by a membrane. Much more frequently the exudation is manifested in the iris by a distinct swelling of the tissues and a disappearance of its fibrous structure, perhaps also by a distinct development of blood vessels in the iris. Hypopyon, or ecchymosis, or both together, may occur sooner or later. These alterations in the interior are announced and accompanied not only by extensive ciliary injection and severe radiating pain, but also by an inflammatory œdematous swelling of the ocular conjunctiva (increasing to chemosis), and even of the skin along the lid border; in severe cases, also, by gastric and febrile symptoms.

As regards the prognosis in cases of accidental wounds, it is of the greatest importance to determine whether the foreign body which penetrated the eye still remains, either as a whole, or any portion of it; whether only the cornea and iris were injured, or the ciliary body also, and whether, if the capsule was lacerated, mere opacity, or also swelling of the lens existed or was to be apprehended (see Penetrating Wounds of the Cornea, p. 181). It is of importance to ascertain whether the wound in the cornea or sclera has been contaminated, and whether the patient suffers from blennorrhœa of the lachrymal sac (see Corneal Abscess). The worst cases are those in which, either by infection or repeated opening of the wound, iritis (irido-cyclitis) with purulent exudation is induced, which appears, at first, with slight turbidity of the aqueous humor, in the form of a gray or yellow pus ring, between the cornea and iris, increases more and more, and terminates with partial or complete ulceration of the cornea, and at all events causes occlusion of the pupil.

Treatment.—(a) When a foreign body is present in the anterior chamber, in or posterior to the iris, we cannot depend upon its being tolerated, or becoming permanently encysted. An especially favorable condition of the foreign body (as an eyelash, a minute splinter of iron) and the absence of symptoms of irrita-

tion, notwithstanding the lapse of considerable time, allow further postponement, though the case should be continually watched. Recent hemorrhage, or great chemosis, if they are to be attributed to the injury rather than to the irritation caused by the foreign body, render a delay in the attempt at its extraction desirable, perhaps necessary, until antiphlogistic measures have been employed to abate the inflammation. In cases of iritis or irido-cyclitis, it is advisable to mitigate the symptoms of irritation, as in acute iritis, by local abstraction of blood, cold applications, laxatives and narcotics; but, if a perceptible abatement of the inflammatory symptoms does not follow in a short time, the operation should not be deferred. The operation in some cases simply consists in the removal of the foreign body; this, however, can rarely be accomplished without excising a portion of the iris at the same time. In other cases, especially if the pupil be already closed, the formation of an artificial pupil may be desirable, or even necessary. If the capsule has been wounded, or is unavoidably injured during the extraction of the foreign body, the propriety of extracting the lens at the same time will have to be considered. For the purpose of removing the foreign body, or rather introducing forceps, the strength of which should correspond to the size of the foreign body and the existing adhesions, the original wound may sometimes be utilized, even though it be closed; and it may be opened again and enlarged according to the exigencies of the case. It is usually necessary to open the chamber by a new incision with a cataract or lance-shaped knife. Peripheral incisions, extending into the scleral border, are usually to be preferred, especially if the knife can thus be pushed partially or wholly behind the foreign body. It must not be forgotten, however, that prolapse of the iris follows more readily in such wounds, if they exceed one-quarter of the corneal circumference, and that excision of the iris may become necessary on this account. In other cases a wound made in the centre of the cornea is better, or only adapted for the seizure and extraction of the foreign body. Care should be taken in selecting the location, direction and size of the incision, in order that the undisturbed foreign body may be seized most conveniently and firmly with the forceps, and that when the preservation of the iris, and especially the capsule, is concerned, the removal of the foreign

body may be accomplished without much turning and twisting. If the capsule has been injured and the lens is more or less hardened, as usually occurs after the thirtieth year, its immediate extraction should be recommended. In young persons, iridectomy may suffice, after the removal of the foreign body, and the lens may be left to be absorbed, or simple linear extraction may be undertaken, care being taken, at the same time, that neither fragments of the lens or capsule, nor shreds of the iris remain incarcerated in the wound.

(*b*) If the capsule has been wounded, in addition to the rules for the guidance of the patient, which should be similar to those given in cases of acute iritis, the pupil should be dilated ad maximum, and the pressure of the swelling lens upon the iris should be reduced as much as possible. Ice-cold applications are the most efficient means against the too rapid swelling of the lens. The tension of the globe, ciliary injection and pain, should be diligently watched. If the tension increase, or if, in addition to the ciliary injection, œdematous swelling of the conjunctiva appear without other cause, the cornea should be punctured in time, either merely to draw off the aqueous humor, or also to evacuate fragments of the lens which may have fallen into the anterior chamber. But if the hard nucleus of the lens (the age of the patient, and the senile yellow color will disclose it under focal illumination) irritates the iris because it is pushed into the pupil and appears incarcerated by the sphincter, either iridectomy, with partial removal of the lens, or extraction must be performed. After a partial or total removal of the lens, the chances are less favorable than after a mere puncture.

(*c*) If symptoms of cyclitis are prominent from the beginning, or after a certain time, the antiphlogistic treatment becomes the more important the more violent the symptoms exhibited by the vascular and nervous symptoms. Atropine should also be used most energetically until every prospect of its efficiency has disappeared, by occlusion of the pupil or by infiltration, and especially by sponginess and vascularization of the tissues of the iris. In some cases of cyclitis, relatively insignificant symptoms are exhibited by the iris. This is especially the case after extraction of cataract, if adhesions have occurred between the pupillary border and the wounded edges of the capsule, in consequence of which the

pupillary border is drawn in a centripetal and somewhat posterior direction, or if, after a peripheral linear extraction, or after accidental injuries with analogous anatomical conditions, a portion of the iris has become incarcerated in a very peripheral corneo-scleral wound. In such cases atropine is rather detrimental than useful. Constant photophobia exists, accompanied by an oedematous swelling of the upper lid (along the border), and of the ocular conjunctiva, and by pain in the teeth, especially during the night, in the root of the nose, the forehead and occiput. Besides a slight turbidity, extravasation of blood, seldom a collection of pus occurs in the anterior chamber.

This chronic condition, which sometimes continues for several weeks, and readily results in obstruction of the pupil, with or without occlusion, is shortened or alleviated by warm fomentations (applied several times a day from ten to thirty minutes at a time), by injections of morphine, or by the administration of quinine and opium, which, under certain circumstances, may be preceded by the local abstraction of blood. Operative interference, even in occlusion of the pupil, is to be undertaken only after a subsidence of all the inflammatory symptoms, and especially the ciliary injection, which perhaps may only be perceptible after a critical examination of the eye. Unless limitation of the field of vision become observable in consequence of increased intra-ocular tension, induced by the occlusion of the pupil, the operation should be delayed until all abnormal injection has disappeared, or at any rate until such injection is only noticeable in the region of the corneo-scleral wound.

2. IRITIS AS A SEQUELA OF COLD—RHEUMATIC IRITIS.

There are cases in which inflammation of the eye is developed a short time after catching cold, being principally manifested by the symptoms of iritis. Usually the ocular conjunctiva, often also the cornea or the ciliary body, is found in an inflamed condition simultaneously with the iris. This iritis, like rheumatic keratitis, is not unfrequently preceded by a catarrhal conjunctivitis, which may continue or quickly subside after the iritis becomes manifested.

There are also cases in which the patient attacked with photophobia, lachrymation and severe pain in and about the eye after

a cold, and, perhaps, also with slight dimness of vision, the eye exhibits only a bright red border around the cornea, a reticulated redness and œdematous swelling of the ocular conjunctiva, and not until several days do the symptoms of keratitis or iritis, or of both, become manifest. In other cases the disease also begins with violent stinging or cutting, continuous or intermittent pain in and about the eye, with a red zone around the cornea, severe photophobia and copious lachrymation; but an excessive contraction of the pupil, a diminished mobility and a visible discoloration of the iris indicate the seat of the inflammation beyond question. During this early period, when the iritis is just beginning, as it were, the ocular conjunctiva around the cornea and as far as the retrotarsal portion, often, also, the skin along the border of the lid (especially the upper one), are found in an inflamed and œdematous condition. Only in the further increase of the disease do the swelling and sponginess of the iris tissues, and the secretion of a fibrinous exudation in the aqueous humor become distinctly perceptible. In some cases the anterior chamber appears deeper, and no fibrinous elements are visible. Only after a severe or repeated cold do turbid exudates appear in the anterior chamber. Even in these severe cases the swelling of the parenchyma of the iris does not easily reach a high degree. This type of iritis is principally observed in adult life, rarely before the twentieth or later than the fiftieth year. It usually occurs only in one eye, but is also observed simultaneously in both, or in one shortly after the other. Persons who have suffered from it once are easily affected again, either in the same eye or in the other. Such a recurrence is observed in some persons after months or years of continued good health; it cannot be referred to any visible alterations in the eye (*synechiæ*) or to any general disturbance of the health (rheumatism). As regards a special predisposition, we can only say that some persons suffer more readily, after cold, from affections of various organs, than others; this condition or predisposition is usually termed *rheumatic*. I have particularly noticed relapses without fresh cold, in young men who were prematurely bald. Such cases may be readily confounded with those to be discussed under Section 3.

Prognosis.—As compared with other types, the prognosis is favorable, even in those cases which are ushered in with violent

symptoms, provided extensive adhesions of the pupillary border to the capsule have not already taken place or suspicious changes have not occurred in consequence of simultaneous cyclitis. The inflammatory process may terminate in from ten to twenty days, if the patient does not bring on a relapse through imprudence or negligence.

Treatment.—Great care should be exercised in moderating the light of the room and in maintaining a uniform temperature. The patient should, as in acute iritis, not only remain in his room, but also in bed. If he be allowed to go about as usual, only in his own room, mistakes may easily be committed without being immediately noticed. In case of intense ciliary injection and violent pain, the treatment should begin with local abstraction of blood and instillations of atropine. The atropine should be used at short intervals until the pupil is well dilated, then less frequently. In case of continuance or recurrence of the pain, the following ointment may be rubbed upon the forehead and temple: Ungt. Hyd. 5.00; Ext. Opii aq., 0.50–0.60. Afterwards a piece of paper and a cloth or cotton batting, may be applied over it, so that the surrounding parts are maintained at a uniform temperature. Injections of morphine are more efficient and certain. In a selection of internal remedies, we should be guided by the peculiarities of each case. Special mention, however, is to be made of Doveri pulv., opium and quinine. *A priori*, we should expect good results from injections of pilocarpine. I have not, however, had sufficiently frequent opportunities to test their efficacy in this disease. In order to protect such persons from relapses, the gradual hardening of the body by cold bathing would probably be more efficient than the wearing of flannel jackets, etc.

3. IRITIS AS A SEQUELA OF GONORRHŒA—GONORRHŒAL IRITIS.

Cases in which iritis in one or both eyes is etiologically connected with a preceding or existing gonorrhœa, may be easily mistaken for iritis due to a cold, as the inflammation begins and runs its course accompanied by violent symptoms of the nervous and vascular systems, and is simply attributed to cold or to a supposed rheumatic affection, by the patients. The peculiar-

ities of this form are so strikingly characterized in Förster's¹ description that they can scarcely be better given than in his own words. "If the existence of this iritis be still doubted by some, the reason lies entirely in the fact that they have not been in the habit of examining the urethra. He who does this in every case, and inquires especially into the exact history, will find, in a short time, a series of cases in which no trace of syphilis is to be found, but discover a connection with a preceding gonorrhœa. That this connection is not accidental, is shown by the fact that in the same person repeated gonorrhœa is accompanied by repeated iritis. Usually, numerous posterior synechiæ are found, and the patients simultaneously suffer from recurrent inflammations of the joints which, as a rule, are described as rheumatic or gouty. Both eyes are always attacked, though not at the same time. I have never seen a protracted case in which one eye remained quite free. There are no special characteristics in the eye by which this iritis can be recognized as gonorrhœal. Still it is distinguished, according to my experience, by the fact that the plastic exudation is not so rapid and so abundant as in syphilitic iritis. Turbidity of the vitreous body is frequently found. Nothing definite can be said of the way in which gonorrhœa and iritis are connected, although several cases have been observed by me in which, with a renewal of the inflammation of the joints, iritis—without fresh gonorrhœal infection—and a moderate thin purulent discharge from the urethra appeared simultaneously." "A wealthy farmer, fifty-four years of age, who had formerly suffered much from gonorrhœa, but had not been infected for more than twenty years, was attacked by iritis for the first time, twenty-five years ago. Since that time he suffered several months in almost every year with muscular and articular rheumatism, also had a relapse of iritis about every fourth or fifth year, sometimes in the right, sometimes in the left eye. In 1868 he was iridectomized by A. v. Gräfe, in the left eye. The brown iris-pigment which covered the entire artificial pupil showed an exudative layer adherent to the capsule of the lens. In 1869 he was again in von Gräfe's clinic in Berlin, for three months, on account of a relapse of the iritis, notwithstanding the iridectomy. The attacks of iritis did

¹ Förster, in Gräfe und Sämisch Handbuch, Bd. VII, page 86.

not always coincide with those of rheumatism; sometimes they would precede, at other times follow it. Whenever the rheumatism reappeared, a thin yellowish discharge from the urethra always occurred.

The recognition of the etiological connection between iritis and gonorrhœa and the so-called arthritic gonorrhœa is of inestimable importance as regards the treatment. This form of iritis is much more rapidly and safely cured with large doses of quinine and iodide of potassium than with the mercurial preparations which are indispensable in some other forms. The continuous use of iodide of potassium for six or ten weeks is very useful in preventing relapses in such cases of iritis. While many such patients would like to avail themselves of the hot springs, on account of their rheumatism, they are often prevented by iritic relapses, which may be averted by a course of iodide treatment, thus allowing the methodical use of the baths. According to my experience, the use of iodide of potassium in connection with the special treatment of iritis is to be highly recommended. I have been in the habit of combining quinine with the aqueous extract of opium, on account of the severe pain.

4. IRITIS AS A SEQUELA OF SYPHILIS—SYPHILITIC IRITIS.

The form of iritis which is to be considered as a manifestation of syphilis usually appears without external cause, although it is frequently developed after an injury or a cold. Its relation to the general disease may be very easily proven if, as is usually the case, other secondary symptoms are noticeable or can be found upon a critical examination; but it is exceedingly difficult if the disease appear in the eye before it makes its appearance in other portions of the body, or if it be denied or cannot be easily ascertained, on account of the particular surroundings or position of the patient. The symptoms in the eye, aside from complication with cyclitis, choroiditis, retinitis, keratitis or scleritis, may vary exceedingly, according to the character of the syphilis, whether hereditary or acquired, recent or chronic, repeatedly or seldom treated; and whether the origin or course of the inflammatory process has been more or less influenced by external circumstances. Nevertheless, the assertion that in many cases the appearance of the eye suggests syphilis as the cause, is

in conformity with facts. It is incorrect, however, to say that every case of iritis caused by syphilis shows a definite and characteristic appearance, and it would be very careless if, on account of certain appearances of the eye alone, further examination concerning other manifestations of syphilis and the personal history of the case should be omitted. The pathological alterations found in an eye are of themselves of no greater diagnostic value than those of the skin, mucous membrane, bones, etc.

As regards iritis in hereditary syphilis, although the manifestations of hereditary syphilis usually appear in the eye about the time of puberty, syphilitic iritis may appear earlier, even in children at the breast. It is important to know this, since it may be the inflammation of the eye which indicates the probability that the case is one of syphilis. Primary iritis (irido-cyclitis) in childhood or youth, when no injury or any general disease (variola, meningitis) has recently preceded, always excites well grounded suspicion of syphilis, whether it dates from foetal life or has been inoculated later (by the nurse, vaccination, etc). Hereditary syphilitic iritis (irido-cyclitis) occurs much more frequently in combination with keratitis or kerato-scleritis, than isolated or with choroiditis (disseminata). (See Keratitis Interstitialis, page 120, and Scleritis, page 211.) Two interesting cases of simple hereditary syphilitic iritis in nursing children have been described by Mackenzie (*Practical Treatise on Diseases of the Eye*, 4th English ed., p. 546). The inflammation attacks first one eye then the other after a short time, and is manifested less by ciliary injection than by a copious effusion of the lymph into the pupil and anterior chamber. In one of the cases (Dixon's) there was no appearance of syphilis at the time of the first examination, either in the mother or in the healthy looking child; but after the second eye was attacked, a more critical examination was made, which revealed, beyond a question, the existence of congenital syphilis. In the author's experience, gummata of the iris or of the ciliary body do not occur in hereditary syphilis.

Iritis as a sequela of acquired syphilis occurs most frequently in youth and adult life, more rarely in persons of advanced age, and only exceptionally among children. It may occur under

various forms. The appearance of the disease may, moreover, be considerably modified by external influences or by the above mentioned complications, either from the very first or later in its course. The possible existence of syphilis should be considered in every case of iritis. In a series of cases the disease is manifested by rather insignificant symptoms, such as slight ciliary injection, sensitiveness to dazzling light, and some pain and dimness of vision. Upon closer examination, a punctated deposit is found on Descemet's membrane, especially in the lower portion of the cornea, which causes the disturbance of vision. Discoloration of the iris may also be found, as well as synechiæ, here and there, but the pupil is not especially contracted, and may even be perceptibly dilated. In another series of cases a broad red zone is developed around the cornea, and, perhaps, also injection of the ocular conjunctiva with noticeable sensitiveness of the eye to light and some pain; but no symptoms of keratitis or iritis are found. If a mucous secretion exist in addition to this, we may be easily misled into diagnosing catarrhal conjunctivitis. If, meanwhile, such cases be observed for several days, and especially if it is known that such persons are suffering from syphilis (perhaps are being treated for it at the time), it may be soon ascertained that the above-mentioned symptoms are but the precursors of iritis or irido-cyclitis, which becomes manifest in a few days by the formation of synechiæ or gummata. In still another series a gumma is found in one or several places, and then the inflammation may be limited to a small portion of the iris. The nodules which Beer,¹ in his excellent description of this iritis, has compared with condylomata (papules?) of the skin, appear either upon the pupillary or ciliary border of the iris, or, perhaps, more correctly speaking, in the region of the minor or the major circle of the iris, and thence spread in all directions. The pale yellowish mass constituting them is embedded in the parenchyma of the iris. If such a nodule in the minor circle grows larger, it comes in contact with the capsule, and may cause synechiæ, even though the pupil be not especially contracted. Anteriorly, it rises, knob-like, towards the cornea, extending more into the pupillary area. In every case it appears surrounded at

¹ Lehre von den Augenkrankheiten, Wien 1813, I Bd., page 556-558.

the base by numerous vessels, which, by branching towards the apex, give a reddish (orange-colored) tinge to the whole. They are distinguished from tubercles of the iris more by a yellowish than by a grayish tinge, and more especially by the vascularity. During their retrogression they become gradually paler, and may entirely disappear. A slate-gray and somewhat excavated spot remains at the point where a large nodule was situated. In many cases no gumma, but a vascularity upon a small and somewhat tumefied spot of the iris, or in the entire minor circle, may be found. Small nodules near the ciliary border of the iris may be easily overlooked; larger ones are pressed forwards from the angle between the cornea and the iris into the anterior chamber. If they become very large—and they seem to have this tendency to a greater degree than those growing from the minor circle—they may crowd the sclera and cornea outwards, and simulate a collection of pus under the more or less bulging tunic. Atrophy of the globe follows their gradual retrocession, the more certainly the further the simultaneous inflammatory alterations have advanced in the ciliary body (see Cyclitis). A gumma may be developed without the patient being warned by pain, photophobia, disturbance of vision, or redness of the eye. A well-pronounced gumma, with partial ciliary injection corresponding to its location, though unaccompanied by any other symptoms of iritis, may be found when the patient has attended to his business on the previous day, or when he is under treatment for secondary symptoms. More violent symptoms and extension of the inflammation over the entire iris (in the beginning of the attack), are probably caused by external agencies. They may appear later in the course of the disease, notwithstanding the most judicious conduct on the part of the patient. If a sanious or purulent exudation be found in the anterior chamber, cyclitis is probably always present. The violent pain, especially at night, occurring in the temple and extending to the occiput, is also to be referred to cyclitis, and, therefore, appears later in the course of such an iritis, if the inflammation (formation of gummata) be not first developed in the ciliary body (see Cyclitis). In a similar manner nodules, varying in size from that of a poppy to a millet seed, of a light-gray, bacon-like color, which may be seen upon Descemet's membrane, point to syphilis as a cause of the pre-

ceding iritis (irido-cyclitis). More than two or four of these nodules are seldom found, and they are rather in front of the pupil than in the lower half of the cornea. Smaller, more or less grayish-brown points may be seen near them, especially in the lower half; the usual symptoms are seen in the iris, or there may be great swelling and vascularity. These deposits also gradually disappear without leaving a trace. As regards prognosis, not only the apparent alterations and the implication of other parts of the eye are to be considered in every case, but also the general condition of the patient, and especially the question whether the syphilis is inherited or acquired, and if to be treated at all, in what manner. Cases occur in which, at the conclusion of treatment, every symptom of syphilis has entirely disappeared, and in which, nevertheless, iritis once more appears sooner or later, and again has to be referred to syphilis. In cases in which iritis reappears, after a thorough course of general treatment, the determination whether remaining synechiæ, external noxious influences, or syphilis not completely eradicated, induced the disease may be very difficult, especially if the same eye has been again attacked. Inveterate, repeatedly treated—or maltreated—cases of syphilis, as is well known, give little hope of a thorough cure, and require great perseverance. Syphilis in persons advanced in life is difficult to cure, and demands persevering, rather than energetic treatment. Sometimes an acute iritis is found in one eye, and in the other perhaps the traces of an iritis which ran its course months or years previously, although no medical treatment had been received, and the history indicates that this was also of syphilitic origin, but resulted, nevertheless, only in isolated synechiæ, or in the formation of a pupillary membrane. In spite of the continuance of the general disease, the eye may remain quiet. Filiform, or membranous exudations, as well as annular synechiæ, remain unchanged, even under mercurial treatment.

Treatment.—The local treatment is to be regulated by the general rules given for iritis; the general treatment by the primary disease, and by the age and state of health of the patient, the preceding treatment being taken into consideration. It would occupy too much time to give here the details, or even the outlines of treatment. It need only be said that such patients

should not, as a rule, be treated in the dispensary. The importance of the organ in question gives the physician sufficient authority over the patient and his surroundings to insist upon a thorough and consistent treatment. In many cases the treatment fails because the patients continue in their ordinary habits of life, and commit all kinds of excesses.

5. TUBERCULAR IRITIS—TUBERCULOSIS IRIDIS.

Tubercular iritis was first diagnosticated and anatomically demonstrated by Gradenigo,¹ and somewhat later, on the living subject, by Perls.² Since that time, numerous cases have been published.³

Symptoms and Course.—The disease may appear in one eye, or in both. It begins with the usual symptoms: ciliary injection, turbidity of the aqueous humor, discoloration and sponginess of the iris, and the formation of posterior synechiæ. The implication of the ciliary body is manifested by deposits upon the cornea, turbidity of the vitreous, and sensitiveness to the touch in the region of the ciliary body. After a certain time, the first tubercles appear (sometimes suddenly, during a single night), nodules varying in size from a poppy seed to that of a millet seed, of a light or yellowish-gray color, often with a yellowish-red halo. At times, only one or two nodules are formed, or again several form simultaneously, or new ones form rapidly, while old ones disappear. In this manner the disease may continue for a whole year, with short intervals of apparent recovery. In less severe cases recovery ensues, whilst the nodules gradually disappear and only synechiæ remain as sequelæ of former inflammation. In more severe cases the symptoms of chronic plastic iridocyclitis are developed, and the eye is finally destroyed and atrophy results (according to Haab). Tubercular iritis usually attacks persons under twenty years of age. Many of them are of weak constitution, pale complexion (chlorotic girls); many have enlarged lymphatic glands in front of the ear, on the lower jaw, or the neck. In many cases an examination of the chest reveals tubercular disease of the lungs. It frequently happens that such patients succumb later to the lung disease, whilst others

¹ Annales d'Ocul., LXIV, page 179.

² Arch. f. Ophth., XIX, 1, page 221.

³ Haab, in Arch. f. Ophth., XXV, 4, page 188.

visibly improve, after the eye disease has terminated. In some cases, however, the patients are healthy from the beginning, and remain so while under observation. In this respect tubercular iritis differs very much from the tuberculosis of the choroid which is found in the last stage of general tuberculosis—often just before death—so that it may be considered as a tubercular diathesis affecting many organs. Tuberculosis of the iris, on the contrary, seems to occur in many cases as a local disease (primary tuberculosis), which may finally disappear without permanent harm to the general organism (according to Haab). So soon as nodules have made their appearance the diagnosis can only lie between tuberculosis, syphilis and sarcoma. The last may be excluded by the fact that it usually occurs singly, and, until it attains some size, is unaccompanied by iritis. As to the differentiation between gumma and tubercle, it is to be observed that the former has a more yellowish-red, the latter rather a grayish-white color, on account of the absence of blood vessels. Tubercular iritis usually occurs at an age when gummata are very rarely observed. In any case a most thorough examination of the entire body is indispensable. The anatomical investigation is made partly on portions of iris which have been excised by iridectomy, and partly on the entire globe. The most recent nodules consist of a cluster of small, round cells, similar to lymph corpuscles. At a later stage, epithelioid cells are found in the centre of the nodules, among which one or several giant cells are concealed. The central portion of the nodules frequently become caseous. Haensell,¹ moreover, believes that he has seen very fine granules, moving both within and without the cells in the blastema, which he considers minute organisms (Tubercle corpuscles, Klebs). Cohnheim² first succeeded in producing tuberculosis experimentally by inoculation. The virus used for inoculation is best obtained from the caseous mass of tubercular lymphatic glands or joints, and must be entirely free from decomposition; otherwise purulent irido-choroiditis would be induced. The virus introduced into the anterior chamber of a rabbit is very soon enveloped by a fibrous capsule deposited from the aqueous humor, which, with the virus, is absorbed in the course of a week. Twenty to thirty

¹ Arch. f. Ophth., XXV, 4, page 1.

² Schles. Gesellschaft für vaterl. Cultur., Sitzungsber, vom 13 June, 1877.

days after inoculation, according as the eye has remained free from irritation during the period of incubation, hyperæmia and swelling of the iris occur, in which minute gray points may very soon be discovered. These increase quite rapidly during the next few days, and soon attain the size of the large nodules which finally extend to the posterior surface of the cornea, and in which numerous vessels, and sometimes nodules, have formed. The cornea is finally perforated, and the tuberculous mass protrudes in the form of a large tumor, the greater part of which, later, undergoes caseous degeneration. The greater number of the animals experimented upon die, sooner or later, of tuberculosis of internal organs.

There is a recent disposition to classify the so-called granuloma iridis with tuberculosis (Leber, Haab, Baumgarten and others). Granuloma of the iris, of which twelve cases have now been published, more usually occurs in young persons. In the lower section of the iris, usually near the ciliary body, a round, yellowish excrescence is developed, which grows slowly until it reaches the posterior wall of the cornea, against which it becomes flattened and gradually fills the entire chamber without exciting any special symptoms of irritation. Perforation then occurs near the corneal border, and the soft mass, resembling granulations, protrudes. But instead of growing indefinitely, as do malignant (sarcomatous) tumors, it undergoes disintegration and contraction, which finally terminates in atrophy of the globe. Microscopic examination shows that the granuloma consists of numerous tubercular nodules, which are minute and typical. It would, therefore, represent conglomerated (solitary) tubercle of the iris in contrast to tubercular iritis, which is to be considered as disseminated tuberculosis.

Prognosis.—The prognosis of tubercular iritis is doubtful as regards the eye, because, in consequence of a long continuance of the disease obstruction of the pupil, exudation into the vitreous and slight atrophy of the eye are the result. (See Cyclitis.) In case of granuloma of the iris, the eye is almost always lost. The prognosis, as regards life, must be cautious, as many patients later succumb to general tuberculosis.

Treatment.—The aim of the treatment of tubercular iritis should be, as soon as the disease is clearly recognized, and espe-

cially if syphilis is excluded, to improve the general condition of the patient as much as possible; and the general rules already given for treating iritis should be followed. Scarcely anything is to be expected from iridectomy (excision of the portion containing the tubercles), because fresh tubercles are easily formed in other places. After the termination of the inflammatory symptoms, an iridectomy may become necessary on account of occlusion of the pupil. In case of granuloma of the iris, enucleation of the eye which has become blind might at least save the patient the suffering consequent upon the perforation of the cornea. In addition to this, it is of great importance, as influencing the general health of the patient, to consider the possibility of the granuloma—at first only a local disease—becoming the source from which the entire organism is infected with tuberculosis.

6. IRITIS AS A SEQUELA OF SCROFULA—SCROFULOUS IRITIS.

There are cases in which iritis, usually cyclo-iritis, occurs without external cause, first in one eye and then in the other, and relapses after intervals of varying length. The patients are usually between the twelfth and twenty-fifth year of age. In cases in which the outbreak is not caused or increased by external noxious influences, the inflammation becomes noticeable on account of disturbance of vision, and is usually found in the other eye also, because it is very often neglected as long as it is limited to one eye. The disturbance of vision may be caused by turbidity of the vitreous if the inflammation proceed from the ciliary body; but turbidity of the aqueous humor and deposits of punctated gray or grayish-brown exudates very soon appear upon the posterior wall of the cornea. Posterior synechiæ, single or arc-shaped, and discoloration of the iris follow sooner or later, and the pupil, in many cases somewhat wider at first, becomes narrower after the formation of synechiæ, until finally it is partially or wholly covered by a membrane, or occlusion of the pupil and its consequences are produced. Such cases have many symptoms in common with syphilis, these symptoms being also found in persons who have been very much reduced by depressing influences, as protracted sorrow, bad and insufficient food, severe diseases (typhus, remittent fever, abuse

of mercury, etc.). When, in a case under observation, the examination of the entire body and the history exclude, or at least render very doubtful, the last mentioned etiological elements, while, on the other hand, marked symptoms of scrofula are present or have previously existed, the supposition of scrofula as the cause of the iritis (cyclo-iritis) is certainly as well justified as in conjunctivitis, keratitis or scleritis; and in the treatment of such cases the general disease should receive attention, since we have to take into consideration not only the diseased organ, but the entire organism and the surrounding conditions. Since, in a majority of cases, the persons belong to the poorer classes, it is often difficult to decide whether to attribute the cause to scrofula or to depressing influences. In many cases it cannot be determined whether or not hereditary syphilis is the primary cause. I have seen undoubted cases of scrofula which could be attributed to no other cause.

At the present time many physicians deny that scrofula is a principal or primary cause of iritis. On account of its absence at the age in which scrofula most frequently occurs, it is obviously not to be inferred that scrofula cannot be the cause of iritis occurring at the time of puberty or even later. In hereditary syphilis, the disease of the eye appears about this time in very many cases, and we do not so very rarely see manifest symptoms of scrofula appear for the first time during youth; especially under the influence of bad dwellings, bad or insufficient food and other debilitating agencies. Since A. von Gräfe has proved that posterior synechiæ, especially those which are broad and non-distensible, are a frequent cause of iritic relapses, and since he has represented it as very probable that the attack of the second eye may be due to sympathy,¹ a great many take no notice (in their writings) of the influence of the general condition of the body (excepting as regards syphilis). Formerly, only the etiological condition was considered, and recovery was expected by combating the cause, and too little attention was given to the local changes and their further consequences; iridectomy was, therefore, performed only on account of the dioptric impediment. The results which Gräfe had obtained by the application of sulphate of atropia, and especially by the anti-

¹ Archiv. für Ophth., II Bd., 6, pages 206 and 249.

phlogistic effect of iridectomy, lead, in a measure, to a disregard of the exciting cause and to merely local treatment, although on this point von Gräfe had expressed himself much more reservedly. "Many will probably doubt the occurrence of such sympathetic inflammation, and rather explain its bilateral appearance as a result of internal dyscrasia. I do not deny that such a connection may frequently exist, but I would warn against immediately taking refuge in that assumption without sufficient grounds, overlooking in the meantime the local conditions, the management of which we have more in our power." I believe that I have closely followed von Gräfe's directions, and my experience leads me to confirm their correctness; but it should also be said that in several cases, after the iridectomy was correctly performed and the wound healed, I have but rarely observed relapses of iritis, but often subsequent attacks of cyclitis (with turbidity of the vitreous), which were permanently cured by a dietetic and medicinal treatment of the general disease, especially scrofula.

It may be true, in some cases, that the affection of the second eye is sympathetic. This affection, however, occurs in many cases after a comparatively short time, and with the primarily affected eye in a condition which cannot well be regarded as the cause of the sympathetic affection. (See Sympathetic Iridocyclitis). In many cases the previously diseased eye still has power of vision, or at least is capable of vision after the formation of an artificial pupil. Besides, the prospect of a successful iridectomy is much more favorable in such eyes than in those which we know have become blind from manifestly sympathetic inflammation, in which the technical part of the operation usually fails, and even a successful operation rarely gives the desired results. Cases occur in syphilis in which it might be inferred, from the changes which have taken place in the primarily affected eye (exclusion of the pupil), that the affection of the second eye resulted from sympathy; but the appearance of gummata in this eye indicates that the general disease must be regarded as the cause; and in very debilitated persons, especially after remittent fever, both eyes are usually affected within so short a time (often within a few days), that sympathetic affection cannot be assumed. Whilst sympathetic inflammation once begun progresses continuously,

notwithstanding favorable surroundings, and terminates in a few weeks or months, on the other hand, inflammation which originates in scrofula remits, and even intermits, for months or years at a time. As regards prognosis and treatment, it will suffice to refer to the remarks on iritis and interstitial keratitis.

7. *Sympathetic Iritis*; 8. *Iritis after Remittent Fever*; and 9. *Iritis after Meningitis*, will be discussed in the Section following, since the inflammation begins in the ciliary body, and sooner or later extends to the iris. The iritis occurring after variola should probably be considered as cyclo-iritis in the majority of cases. In the few cases seen by the author, it appeared in a mild form and terminated favorably.

This outline of iritis, especially with reference to the etiological element, lays no claim to completeness, as though no other exciting causes than those already given exist, or to exclusiveness, in the sense that every case the existing cause of which can always be definitely ascertained must appear and run its course in the above described manner; but being founded upon correct observations, it should furnish a basis upon which the diagnosis, prognosis and therapy may be more easily determined.

II. INFLAMMATION OF THE CILIARY BODY—CYCLITIS.

(a) GENERAL CONSIDERATION.

The expression cyclitis is based upon the older designation of the ciliary body, as annulus or circulus ciliaris (orbiculus ciliaris), though referring only to the choroidal processes; that is, to that portion of the choroid which lies between the ora serrata and the iris, encircling the anterior section of the vitreous, and is distinguished from the choroid proper (posterior to the ora serrata), not only by more abundant pigment, a different arrangement of the vessels, and a firm connection with the retina (its pars ciliaris), but also by the formation of numerous folds. The ciliary muscle, the second principal constituent of the ciliary body, is scarcely ever the centre of the inflammatory process unless it has been injured. In order to better understand the processes in cyclitis, a short description of some of the anatomical and physiological conditions may be useful at this point.¹ (a) While the pos-

¹ Further details may be found in Gräfe und Sämisch Handbuch, B. I, pp. 23, 270, and B. II, p. 345.

terior short ciliary arteries supply only the choroid proper, the posterior long and the anterior ciliary arteries are especially distributed to the ciliary body and the iris; only a few small branches which originate in this vascular region (the recurrent branches) extend into the choroid, where they anastomose with the posterior short ciliary arteries. The capillary network arising from the latter and lining, as it were, the interior surface of the choroid—the chorio-capillaris—extends from the periphery forwards, as far as the serrated border of the retina. Whatever portion of the uveal tract lies anterior to this boundary line, is supplied only by the posterior long and the anterior ciliary arteries. After the two long posterior ciliary arteries have penetrated the ciliary muscle and have divided into an upper and lower branch, these four branches form a vascular areola near the periphery of the iris. Branches of the anterior ciliary arteries, which are situated several millimetres from the corneal border, and have penetrated through the sclera into the ciliary muscle, also participate in the formation of this circle. The iris and the ciliary processes are chiefly supplied from the *circulus arteriosus major*. The arteries of the ciliary muscle receive small branches not only from this circle, but also directly from the long posterior and the anterior ciliary arteries. "As soon as the long posterior ciliary arteries have penetrated the ciliary muscle, and before they produce this arterial circle, they give off branches which supply chiefly the ciliary muscle and the anterior portion of the choroid, as also do the anterior ciliary arteries; the latter form still another circle of anastomosis, posterior to the major circle, lying somewhat deeper and somewhat less complete—*circulus arteriosus musculi ciliaris*. The arteries of the ciliary muscle consist of a large number of fine branches which anastomose like the twigs of a tree, and form a rather dense interlaced network which permeates the entire muscle and differs essentially in its appearance from the overlying network of the ciliary processes.

The arteries of the ciliary processes originate in the major circle (*circ. iridis major*) from its inner periphery, often in common with the arteries of the iris. Each ciliary process either receives a single artery, or a somewhat larger one supplies two or more neighboring processes simultaneously. The arteries then enter

the processes anteriorly, and, like those of the iris, must first pass through the ciliary muscle. They rapidly divide into a large number of branches which frequently anastomose with each other and, considerably dilated, pass over into veins.

The thin capillary veins form, by frequent anastomosis, a highly vascular network, which constitutes the principal mass of ciliary processes, and which permeates their numerous projections and furrow-like depressions. The smooth portion of the ciliary body (*orbicularis ciliaris*, Henle) is simply penetrated by the recurrent arteries without giving off any branches to the fine vascular network which permeates it.

The arteries of the iris arise as numerous branches, frequently with the arteries of the ciliary processes, from the anterior edge of the *circulus iridis*, and regularly enter the iris at the insertion of the ciliary processes.

"The *venæ vorticosæ* (*v. cil. posticæ*) collect the venous blood from all portions of the choroid. They are by far the most important evacnants, and in the region of the equator of the globe they pass from the choroid into the sclera as four or six rather large vessels. The anterior branches of the *venæ vorticosæ* originate in the iris, the ciliary processes, the ciliary muscle and the most anterior portion of the choroid. The veins of the ciliary muscle originate in its vascular network as numerous fine branches, which join the veins of the ciliary processes on the inner surface and the posterior border of the muscle. A few of its veins pass out through the sclera in its anterior portion, connect with the *circulus venosus corneæ* and empty into the anterior ciliary veins. The veins of the ciliary processes unite into a large number of parallel vessels which, after having received the veins of the iris and the branches from the ciliary muscle, run backwards through the smooth portion of the ciliary body, and finally empty into the *venæ vorticosæ*. The veins of the iris enter the ciliary body, turn towards its internal surface, in order to unite with the veins of the ciliary processes, and then to pass into the *venæ vorticosæ*. Veins do not appear to pass directly from the iris into the sclera" (Leber).

Sattler¹ describes a dense network of exceedingly fine capillary vessels which he found (in somewhat more than one-half the

¹ Ueber den feineren Bau der Chorioidea, A. f. O. B. XXII, page 31-36.

number, observed with special reference to this, and which showed no other sign of disease), inserted between the large meshes of the anterior choroidal zone and the very fine veins of the orbiculus ciliaris. "If we consider that those delicate vessels inserted between the unyielding hyaline membrane and the comparatively large capillaries of the immediately underlying layer must necessarily be unfavorably influenced by a congestive condition of the latter, it seems not improbable that, in eyes with the above-named anomalous conditions, disturbances of the circulation within those fine capillaries may be more easily brought about than in other eyes. Now, just in those forms of inflammation which we designate as choroiditis serosa anterior, after von Gräfe, and which are chiefly manifested as punctiform and flocculent opacities of the vitreous, must the seat of the disease be located in the most anterior section of the choroid; and this supposition was confirmed by a minute anatomical examination of a case which I have recently seen, and I can but think that the above described anatomical arrangement produces a special disposition for the easy occurrence of inflammation in that locality. This is the more plausible since the process in question occurs most frequently in feeble, anæmic persons, who are predisposed to disturbances of the circulation, and in the majority of cases without any noticeable external cause."

(b) Upon the inner surface of the ciliary body, lined by the hyaloid membrane of the uveal tract, the pigment membrane of the choroid which, according to Schultze, belongs to the retina, extends as a dark brown, velvety, easily lacerated covering, from the ora serrata over the flat, smooth portion of the ciliary body (orbic. cil., Henle) and between the seventy or seventy-two large ciliary processes, as far as the posterior surface of the iris and the pupillary border, which this pigment layer somewhat overlaps. The ciliary portion of the retina, which is joined to the pigment membrane, consists of the *limitans retinæ externa*, of cylindrical cells like those of Müller's fibres, which may be easily traced to the height of the ciliary processes, and of the *limitans interna*, which here forms also the envelope of the vitreous body; at least it cannot be separated from it. In the ciliary portion of the retina, and beginning at its posterior border, very fine fibres arise, partly from the *externa* and partly from the *interna limi-*

tans, which run forward on the ciliary processes and approach each other, then, having reached the summit of the processes, leave it and run to the border of the lens in order to be inserted partly in the anterior and partly in the posterior capsule. At the summit of the ciliary processes they diverge, fan-like, from one another. The anterior fibres unite in a membrane, clear as glass, which, as the zonula Zinii (the free portion of the zonula ciliaris), runs from the ciliary processes and their interstices to the anterior border of the capsule, and forms a firm connection between this and the ciliary body. The posterior fibres leave the inner surface of the ciliary body somewhat sooner, and follow the course of the *limitans interna* (hyaloid), which turns towards the posterior border of the capsule in order to line the fossa lenticularis, and are then inserted into the posterior capsule. The interstice between these anterior and posterior fibres, formerly known as the canal of Petit, is filled by the middle fibres, which are adherent to the equator of the capsule. The interfibrillar space is filled by a clear liquid. The width of the membranous ring, between the summit of the processes and the line of insertion in the anterior capsule, may be estimated, on an average, as somewhat more than 1 mm.¹

(c) Anterior to the line where the zonula leaves the ciliary body the ciliary processes form a part of the wall of the posterior chamber. The ciliary processes, receding very abruptly to the origin of the iris, form with it an acute angle, which may be called the posterior angle of the iris, in case it is desirable to call the much deeper sinus between the iris and the corneo-scleral

¹ According to Gerlach (Beiträge zur norm. Anat. des menschl., Auges, Leipzig, 1880, p. 60), the fibrous bundles of the zonula are not only attached to the anterior surface of the capsule, but a large portion of them are also adherent to the posterior capsule. They partially intercross in their course to the capsule, so that a number of the anterior fibres are attached to the posterior capsule, and a number of the posterior fibres are attached to the anterior capsule. Between the bundles of the zonular fibres are small communicating interstices, similar to those in the angle between the iris and the cornea; these are the canal of Fontana. The origin of the zonular fibres extends from the ora serrata as far as the summit of the ciliary processes. Their attachment is a trifle nearer the axis of vision on the anterior surface of the capsule than on the posterior. Their line of insertion anteriorly is slightly zigzag; posteriorly, it is rectilinear. The course of all the fibres of the zonula is purely meridional. Fibrous bundles, running in a circular or equatorial direction, do not occur in the human eye.

border the anterior angle.¹ That the portion of the ciliary processes which bounds the posterior chamber, should be considered the matrix of the aqueous humor has already been mentioned (p. 144). Whilst the lens obtains its nourishment from the folds of the ciliary body, probably in the region of the zonular fibres (the canal of Petit), the remaining portion of this formation, which has an immense surface extending as far as the ora serrata, may well be considered the matrix of the vitreous body.

The theory of cyclitis and its consequences only becomes intelligible when one has learned to recognize the changes produced by cyclitis from dissections. For this reason the former attempts to give a systematic diagnosis of cyclitis, without a pathologico-anatomical foundation, were fruitless (Tavignot, Hasner). Only the results of the dissections made by H. Müller, and their interpretation,² have placed the theory upon a reliable foundation, and only since then could conditions which were previously considered as results of choroiditis be rightly referred to inflammation of the ciliary body.

(a) A fibro-plastic exudation is the most characteristic product of cyclitis. The exudation takes place, not so much into the parenchyma as upon the inner surface of both the smooth and the plaited portions. The exudate may pass from the anterior surface of the latter to the aqueous humor, or through the ciliary portion of the retina into the vitreous. In purulent cyclitis, pus is also found in the canal of Petit. The plastic exudation secreted by the zonula may, if suspended in the aqueous humor, cause its turbidity, deposits upon Descemet's membrane, adhesion of the iris to the cornea in its peripheral border, the formation of posterior synechiæ or occlusion of the pupil. It may cause adhesion of the iris to the ciliary processes (retraction of the peripheral portion of the iris), to the zonula, to the anterior capsule (total posterior synechiæ), or extending upon the posterior surface of the iris as far as the pupillary border, it forms a dense membrane which is firmly united with the pigment layer of the iris, but not with the capsule, and may therefore be lacerated by an operation, without injuring the capsule. In many cases the plastic mass is

¹ Arlt, *Krankheiten des Auges*, Prag. 1851, also A. f. O., III B, page 87, and Supplement.

² H. Müller, A. f. O., IV a, page 363.

found between the parenchyma and the pigment layer of the iris, especially near its base.

The exudation occurring posterior to the zonula (posterior to the canal of Petit) may remain limited to the adjacent portion of the vitreous, but in many cases it extends to the anterior layer surrounding the fossa lenticularis, and penetrates in some cases very rapidly, in others gradually, into its posterior portion. Whilst the stroma of the vitreous serves to convey the elements entering from the ciliary body, the humor becomes diffusely turbid, and is, later, permeated by flakes, threads or membranes, unless reabsorption occurs. Since these filaments and membranes are gradually changed into connective tissue, and are coherent with the exudative layer upon the inner surface of the ciliary body (which is transformed in a similar manner), they may form a more or less dense septum between the lens and the posterior portion of the vitreous, which still remains free. The organs lying posterior to the ora serrata, especially the retina and the choroid, are little or not at all changed, although the vitreous body has usually become liquefied and has probably decreased somewhat in volume. But in cases in which the vitreous, either at the time of the first or after repeated attacks, becomes completely or partially permeated by large quantities of exudative material, the subsequent contraction leads to a total detachment of the retina (firmly united with the hyaloid) from the choroid. The space between the choroid and the retina is filled, as the vitreous contracts, with a serous or sanguineous fluid. The plastic exudation which is secreted upon the denuded inner surface of the choroid probably takes place later, and is to be referred to secondary choroiditis. The hardened exudation is frequently transformed into a cartilaginous lining of the choroid, and sometimes forms the substratum for calcification or even ossification. Through the centre of this space, which is surrounded by the choroid and filled with fluid or hardened exudation, the retina extends—folded up like the clapper in a bell—from the entrance of the optic nerve forwards towards the fossa lenticularis. Without completely reaching this the retina spreads out in the form of a funnel, in order to reach the ora serrata. In attempting to form an idea of the position of the retina caused by shrinkage of the vitreous, which is permeated by

connective or cicatricial tissue, we must bear in mind the fact that the retina remains firmly connected with the orbiculus ciliaris in the region of the ora serrata, and that the exudative membrane on the inner surface of the ciliary body and the above mentioned layer of connective or cicatricial tissue which permeates the vitreous humor just behind the fossa lenticularis, are the fixed points towards which the retina is drawn. Since traces of the vitreous body are found in the folded portion of the retina, even to the entrance of the optic nerve, it is to be assumed that, notwithstanding the traction exerted by the above mentioned shrinkage, the connection of the hyaloid with the retina and with the papilla is not broken. Between the posterior capsule and the radiating, funnel-shaped retina, there is a more or less extensive rudimentary layer of vitreous and connective tissue; but in the periphery the retina is so closely connected with the inner surface of the ciliary body that its inner surface seems bent outwards, bulging further forwards, therefore, behind the canal of Petit, and then again passing back towards the anterior end of the corded retina. The form of the retina, therefore, usually resembles that of a corolla of convolvulus more than that of a funnel. This makes it probable that the detachment of the retina, its traction inwards and forwards towards the inner surface of the ciliary body, begins at the periphery, either in isolated spots or in the entire circumference; and while the functional activity of its central portion is tolerably good the field of vision is very much narrowed.

As a result of the formation of connective tissue in the anterior layers of the vitreous, the lens may be crowded forwards. Its posterior pole lies about in the plain of the ora serrata, consequently, behind the fixed points of the newly formed connective tissue permeating the vitreous body, and which has a tendency to shrink; nothing opposes this traction except the resistance offered by the retina and the hyaloid attached to the papilla. Under certain circumstances, this traction towards the papilla may predominate, especially if the space between the retina and the choroid be only slightly filled; then the sclera behind the equator shrinks (is folded or pressed inwards by the recti muscles, atrophy of the globe); the iris and the lens are drawn towards the posterior pole of the eye, and the anterior chamber

appears deepened. In some cases, especially if the cyclitis accompanied by a fibro-plastic exudation be of traumatic origin, the ciliary body is found drawn inwards, that is, towards the antero-posterior axis of the globe, and thus separated from the sclera; the space between them being filled with a sero-fibrinous fluid. But anteriorly, at the corneo-scleral junction, the ciliary body remains firmly united to the sclera; and behind the ora serrata, in the region of the *venæ vorticosæ*, and even more posteriorly, the union between the choroid and sclera is not severed. This condition occurs only in more or less atrophied eyes. Usually, the exudation secreted for the purpose of encysting a foreign body offers a fixed point towards which the ciliary body is drawn. The more it is drawn inwards in the development of these conditions, the greater the danger to the other eye by the induction of sympathetic irido-cyclitis.

(*b*) When, in cyclitis, the exudation is exclusively or predominantly serous, the eye is threatened with blindness, from the increase of the intraocular pressure by the introduction of serous fluid into the vitreous (from the ciliary body). The optic papilla and lamina cribrosa yielding, as the *pars minoris resistentæ*, to the distention of the vitreous, a hemispherical excavation appears at the entrance of the optic nerve, which first results in a limitation of the field of vision and finally in complete blindness. This is the most frequent of the sad results of cyclitis with serous exudations. If, as is usually the case in young persons, the sclera be somewhat yielding, an enlargement of the entire globe may take place before blindness is induced by the increased intraocular pressure (excavation). More frequently, however, a partial rather than an entire enlargement of the globe results, because the scleral zone which covers the ciliary body and through which, as is well known, the ciliary vessels pass, becomes softened by inflammatory action, and together with the ciliary body is pressed outwards towards the periphery, either all around or in some portions. The sclera then adheres to the ciliary body. An anterior scleral or ciliary staphyloma is developed, which is not to be confounded with intercalar staphyloma. That such a staphyloma may be induced by an inflammation in the anterior scleral zone has already been mentioned in discussing scleritis. Sooner or later a fibrinous secretion takes

place from the ciliary body in an eye attacked by cyclitis with serous exudation, so that the consequences of the latter (those already mentioned under (a) may also be developed in an eye which has become blind by an increase of the intraocular pressure (excavation of the papilla).

(c) The anatomical changes following suppurative cyclitis may be more or less analogous to those of the plastic type. The exudation secreted by the zonula may pass from the posterior into the anterior chamber and become noticeable as hypopyon, with or without the admixture of blood; unless resolution occur, it leads rather to occlusion of the pupil than to the formation of isolated synechiæ. In some cases pus corpuscles pass through the meshes of Fontana's canal into the anterior chamber. Sometimes, also, the canal of Petit is found permeated by pus globules. The exudation secreted in the vitreous humor may be limited to the vicinity of the inner surface of the ciliary body, or it may extend to the centre of the anterior zone of the vitreous, but in very severe cases it permeates the entire vitreous body. In the former case a light yellow reflex is seen from the fossa lenticularis, and shrinking of the globe, as in simple plastic cyclitis, is the result. In the latter case the well known appearance of panophthalmitis is developed with violent symptoms, especially with protrusion of the eyeball. The details of the anatomical changes following suppurative cyclitis will be given after the exciting causes have been considered.

Symptoms.—The symptoms which indicate in a given case that we have to deal, not with iritis, or not with iritis alone, but with cyclitis, are now more, now less prominent. In many cases the exciting causes which, according to previous experience, usually lead to cyclitis, must be considered in order to conclude as to the probability of the existence or the dangers of cyclitis. On this account it is advisable, after a short general outline, to consider the symptomatology in connection with the etiology.

The ciliary injection may be limited to a portion of the anterior scleral zone (partial cyclitis), but it usually involves the entire circumference. It may be scarcely perceptible (as in some chronic cases), or it may attain a breadth and intensity which is seldom reached in mere inflammation of the iris. In some cases, with fibro-plastic or purulent exudation, it may be more or less con-

cealed by a chemotic swelling of the ocular conjunctiva, in which case an inflammatory œdema of the skin over the tarsus will exist.

The depth of the anterior chamber may be diminished; (*a*) if, in case of occlusion of the pupil, the iris be pushed forwards by fluid secreted behind it (a bulging forwards of the middle zone, umbiliform retraction of the small circle); (*b*) if a firm exudation occupy the interspace between the iris and the anterior capsule, in which case the iritic tissues appear at first tumescent and penetrated by blood vessels; (*c*) or, if the iris be brought into closer contact with the cornea, in consequence of the lens being pushed forwards. The manner in which this displacement (ectopia) of the iris may be brought about has already been considered. That a diminution in the size of the chamber may be induced by cyclitis at the expense of the curvature of the cornea will be shown later. An increase in the size of the chamber may occur in cyclitis with an exudation exclusively, or principally, provided the sclera be correspondingly yielding. In cyclitis with a fibroplastic exudation, the chamber is not unfrequently increased in size, especially at first, the peripheral zone of the iris nearest its ciliary border appearing drawn backwards, most probably by a coalescence of the iris with ciliary processes (agglutination of the posterior angle of the iris). It is rare that the iris is drawn backwards together with the lens.

The contents of the anterior chamber may appear perfectly clear or turbid, from the admixture of fibrinous matter. In the latter case the question first arises whether it is derived from iritis, or is to be referred exclusively or partially to cyclitis. Especially after an injury of the eye in the region of the ciliary body, a cloud-like exudation is found suspended before the pupil, which can scarcely be derived from the iris, because it completely disappears without coalescing with it. Deposits on the posterior wall of the cornea (see p. 232) may be the more certainly referred to cyclitis the slighter the changes in the iris. Cases also occur in which no inflammatory changes are perceptible in the iris, and in which the pupil immediately dilates to its full extent after the application of atropia. The above mentioned deposits on Descemet's membrane then indicate cyclitis. Hypopyon always indicates cyclitis, or suppurative choroiditis; in the

absence of suppurative keratitis it may also occur without perceptible alteration in the iris. Sometimes it is only temporary. In the same manner a collection of blood in the anterior chamber may, in many cases, be referred to inflammatory changes in the ciliary body (and thereby impeded reflux of blood to the *venæ vorticosæ*).

Turbidity of the vitreous body, especially of the anterior zone, which is surrounded by the ciliary body, is one of the most constant and reliable symptoms of cyclitis. But in the beginning of the disease, and in mild cases, it is so slight that it is difficult to detect it with the ophthalmoscope, and the attention is only called to it by the disturbance of vision. In severe cases its perception by means of the ophthalmoscope is often rendered difficult or impossible by the narrowness or obstruction of the pupil. It depends upon the immigration of fibrinous elements into the vitreous, and consequently appears at first diffused, later, in the form of points, flakes, membranes, or as a coherent, light gray or light yellow opacity behind the lens, corresponding to the *fossa lenticularis*.

If the tension of the eyeball be manifestly increased, and if other causes of intraocular pressure (glaucoma, neoplasms within the globe) be excluded, the existence of cyclitis may be safely inferred. A diminution of tension may occur in a lesser degree at an earlier period, but usually it becomes manifest only when the quantity of vitreous humor has considerably diminished in consequence of cyclitic changes. Increased tension may be succeeded by diminished tension, and between the two a transitional stage may exist, but only manifest deviations from the normal tension have any diagnostic value.

Of very great significance is sensitiveness of the anterior scleral zone to the touch, especially if the patient refer it to this or that spot in contradistinction to other spots. Gentle pressure may be exerted upon the globe (through the upper or lower lid) by means of a rounded ivory pencil, or simply the finger. This sensitiveness, especially in connection with diminution of tension, is of great diagnostic value.

Pain in the eye alone, or within the region of the first and second branches of the trigeminus, may be very slight or very severe. In cases of radiating pain, which is sometimes referred

to the upper teeth, and sometimes to the occiput, gastric symptoms and febrile disturbances usually appear. Acute cyclitis is one of the most painful affections. The more important points as regards etiology, prognosis and therapeutics, will be given in considering the different types of cyclitis.

(b) SPECIAL CONSIDERATION—DIFFERENT TYPES OF CYCLITIS.

In cyclitis, as in iritis, the cases should be divided, first, into those in which the cyclitis is induced by anatomical changes in the neighboring organs, and, second, those in which it is observed originating, either in the ciliary body, or, as it were, passing over from the iris to the ciliary body (or simultaneously in both). In the first series (induced cyclitis), belong all those cases in which the cyclitis (with serous exudation) is developed in consequence of occlusion of the pupil (p. 240), or staphylomatous corneal cicatrices with anterior synechia (p. 150), or on account of ectopia of the lens; and also those cases in which cyclitis with purulent exudation is induced by suppurative keratitis.

The cases of primary cyclitis, or irido-cyclitis, which form the second series, may be caused by the same etiological factors as are met with in primary iritis, and are therefore to be designated in an analogous manner. It seems unnecessary to recapitulate the symptoms upon which is founded the distinction of the different types of cyclitis, according to their etiology, but those exciting causes which particularly lead to inflammation of the ciliary body should be considered.

I. CYCLITIS FOLLOWING INJURY OF THE GLOBE.

(a) Contusion (impinging of a foreign substance in the region of the ciliary body—on the entire globe) may cause cyclitis or irido-cyclitis, although generally only the symptoms of distention or laceration (effusion of blood, paralysis of the ciliary or iritic muscle, change in the form or the position of the lens), with or without irritation, distinctly appear.

After a slight blow upon the eyeball, possibly only zonular ciliary injection, lachrymation, photophobia, pain in and about the eye, with more or less disturbance of vision, may be present without any signs of extravasation into the anterior chamber, into the iris or behind the lens, and without a trace of blood extrava-

sation in the anterior chamber, the vitreous, the retina or the choroid. The pupil is not contracted, and fully and normally responds to the action of atropine. After two or three weeks' treatment with atropine and the protective bandage in two cases under the author's care, these symptoms gradually disappeared without causing any further injury. Even when hypopyon exists complete recovery may be expected.

(b) Penetrating wounds in the region of the ciliary body may, in consequence of their size and depth, lead to cyclitis and produce an unfavorable effect by the contraction of their cicatrices and surrounding tissues. They frequently induce suppurative cyclitis through rupture or contamination of the wound, either at the time of the accident or subsequently. In other cases it is the incarceration of a portion of the iris, the capsule or fragments of the lens, rarely the vitreous, which sometimes causes an acute, sometimes a chronic cyclitis (cyclo-iritis).

Different operative procedures afford a better opportunity for studying the effects of penetrating wounds than accidental injuries. In a series of cases of peripheral extraction of the lens or of iridectomy (in the scleral border), it may be seen, on the first or second day, by a careful examination of the conjunctiva, that the incipient iritis or irido-cyclitis is caused by suppuration of the wound. As a rule, there is pain, at first stinging and transitory, appearing not immediately, but several hours after the operation; it indicates the beginning of inflammation, and is succeeded by a copious secretion of tears and later by an abundant mucous secretion from the conjunctiva. There are cases, however, in which the initiatory process is not announced by pain. The skin along the border of the lid becomes gradually swollen and reddened. If turbidity of the aqueous humor appear, with more or less ciliary injection all around the cornea, though, perhaps, only visible by focal illumination, the affection is certainly iritis or irido-cyclitis. A collection of pus in the anterior chamber, at first as hypopyon or occupying the entire iris angle (also known as circular abscess), as well as a distinctly œdematous swelling of the ocular conjunctiva (chemosis), allow no doubt that the iris and ciliary body are inflamed. About the same time, sooner or later, the inflammation extends from the

wound to the cornea, and threatens it with partial or total purulent infiltration and destruction.

In many cases—and these may be considered as comparatively favorable—the infiltration of the cornea is limited to a section of the scleral wound, but subsequently the curvature, even of that portion of the cornea which has remained transparent, is flattened by the succeeding contraction of the cicatrix. The pupil in such cases is always occluded and distorted in the direction of the scleral cicatrix. Frequently a dense exudative layer is developed, which not only occludes the pupil but extends partially or completely over the posterior surface of the iris. If this result from the loss (extraction) of the lens, then such exudations may unite with the fragments of the capsule and lens and form a dense diaphragm behind the iris. Such eyes may retain distinct perception of light long after the inflammatory process has subsided; but blindness eventually occurs from intraocular pressure (on account of exclusion of the pupil) or from detachment of the retina on account of the shrinking of the vitreous humor. Liquefaction of the vitreous is to be expected in every case.

In more unfavorable cases a still further distention or suppurative destruction of the entire cornea occurs, or, at least, a copious suppuration takes place from the iris and ciliary body. Suppurative cyclitis is accompanied by chemotic swelling of the ocular conjunctiva, and, as a rule, by very severe pain, the effects of which may be limited to the anterior portion of the vitreous, though they usually permeate its entire substance, causing protrusion of the eyeball (in consequence of an inflammatory œdematous swelling of Tenon's capsule), panophthalmitis and finally phthisis bulbi.

(c) In another series of cases, the existing cause of cyclitis is found in the traction exerted upon the uveal tract by faulty cicatrization of the scleral wound. The immediate coalescence of the wounded corneo-scleral surfaces with each other may be prevented by the interposition of iris, capsule or fragments of the lens, and, indeed, for some time, by portions of the vitreous. This interposition in the corneo-scleral wound may take place at the time of the accident or operation, or some time later. If the iris protrude from the scleral opening as a nodule or vesicle, or if

fragments of it lie in the wound, they are very easily perceived as such, especially if, at the same time, a distortion of the pupil is readily recognized. But a portion of the iris may be incarcerated in the wound next to Descemet's membrane without projecting above the sclera. The diagnosis depends, therefore, upon the position of the iris, or rather of the pupil. If only fragments of the lens or capsule adhere to the inner opening of the scleral wound in case of injury to the lens system, a persistent tumefaction may excite a suspicion of such a constriction, but is never to be accepted as absolute proof. This condition, however, seems to become dangerous only as portions of the iris or lens are subsequently crowded in.

If the iris, in the form of a nodule or vesicle, remain incarcerated in the scleral border, although it be superficially covered with cicatricial tissue, it may easily exert a traction that may lead to cyclitis, with serous or sero-plastic exudation and its further results (page 274). The history of irido-dialysis and iridodesis has furnished many examples.¹ But eyes with such prolapses of the iris become affected later, perhaps after the lapse of years, with suppurative cyclitis (panophthalmitis) after extraction otherwise successful, as well as after scrofulous conjunctivitis (when there are adhesions of the prolapsed iris with the sclera) when no other cause can be discovered.

If points of the iris fall into the wound, and thus prevent close adaptation of the inner edges, the aqueous humor, after the wound in the conjunctival and episcleral tissues has completely healed, may be pressed forwards beneath these yielding structures, and the portion of the iris lying in the wound is drawn towards the periphery. This condition has been described by von Gräfe as cystoid cicatrix. Whether following injuries or operations (iridectomy or extraction), it may continue for a lifetime without occasioning further trouble; but frequently it causes cyclitis with serous, fibro-plastic or even purulent exudation, either spontaneously or after being subjected to noxious influences which would have little or no effect upon a healthy eye.

Whilst coalescence of the iris with a corneal wound usually results in cyclitis (with serous effusion in the vitreous) only when the cicatrix has become staphylomatous, incarceration of the iris

¹ Von Arlt, Operationslehre, in Gräfe et Sämisch Handbuch, page 345.

in the corneo-scleral border may excite an unfavorable traction upon the uveal tract, even though the staphyloma of the wound may be scarcely noticeable. If a portion of the iris be adherent to a corneo-scleral cicatrix, it is drawn away from the anterior surface of the ciliary processes; its posterior angle is increased even to its obliteration, and hence the affected portion is more and more displaced by every circumstance which causes the corneo-scleral cicatrix to yield. In such adhesions the pigment layer of the attacked portion may be seen in the scleral cicatrix, and the iris is retracted at its base.

(*d*) As regards the lens, cyclitis, at first with a serous or fibro-plastic exudation, may be induced, either when the lens becomes encapsulated after wounds (operations), by which the swollen lens substance mechanically presses on the iris or ciliary body, or after the remaining portions of the lens have united the iris with the capsule, and the contracting mass exerts a centripetal traction upon the ciliary body (through the zonula), or if a luxated and more or less displaced lens acts as a foreign body, either permanently (through pressure) or at intervals, when, as a result of sudden movements, it is thrown against the uveal tract. In cases of congenital luxation of the lens,¹ which is distinguished from simple ectopia (with more or less obliquity) by the fact that the transparent lens, surrounded by its capsule, changes its position and is found sometimes before, at other times behind the iris, there is always danger of blindness during cyclitis with serous effusion in the vitreous. Extraction is then the only means of preserving such an eye from certain destruction, which would overtake it sooner or later. A wound which could be sustained without danger by a healthy eye would, in case of insufficient connection of the lens with the ciliary body (congenital or acquired), be sufficient to produce luxation of the lens, and with it the dangers of cyclitis.

(*e*) The recognition of a foreign substance in the ciliary body, as the cause of cyclitis, may be very easy or exceedingly difficult. The inflammation may be connected with the injury in one of the ways mentioned above (*a-d*), or it may be occasioned by the foreign body exciting reaction which may lead to its becoming encysted or to suppuration. After a foreign body has

¹ Von Arlt, Krankheiten, II B., page 272.

become encysted and remained in the eye for months or years without exciting any noticeable symptoms of irritation, the inflammation may be suddenly or gradually rekindled, and the diagnosis may be especially difficult or even impossible if there be no recollection or any sign of injury to the eye.

Treatment.—Cyclitis may have already begun after an injury, or it may be anticipated from the changes explained above.

(a) Prophylaxis. If a foreign body has penetrated into the vitreous, the question arises whether it can be removed with instruments (particles of iron by means of a magnet, by Hirschberg's method), without losing too much vitreous, or bruising the uveal tract too severely. The larger and heavier the foreign body, the less the chance of its becoming permanently encysted, because, unless it be imbedded in the walls of the eyeball, its position is changed by every movement of the eye.

In the case of very small particles (of metal, glass, stone, etc.), which do not at first cause any noticeable symptoms of irritation, palliative treatment may be employed, though the eye should be kept under observation for weeks, or until it is capable of accommodative efforts without manifesting any trace of irritation. When the symptoms of irritation are slight we should endeavor to keep the reactionary symptoms in check until the foreign body is completely encysted, by a strict diet, subdued light, atropine, cold applications and abstinence from all kinds of occupation, especially if there be a prospect of preserving the eye. Should such not be the case it will be advisable to propose an early enucleation of the eye. In such cases we have to consider not only the wounded eye, but also the preservation of the function of the other eye, which may be sympathetically affected, in consequence of the cyclitis induced by the foreign body.

If the inflammatory reaction end in suppuration of that portion which surrounds the foreign body, it is to be considered as comparatively favorable, and not indicating immediate enucleation, for, under such circumstances, the foreign body near the scleral opening may possibly be eliminated. In less favorable cases not only the surrounding tissue, but the entire anterior portion of the vitreous also (near the fossa lenticularis) are permeated by pus, the process becomes chronic and finally terminates in atrophy of the eyeball and detachment of the retina. The

shrunk globe may then remain quiet for a long time, though, sooner or later, the symptoms of inflammation or irritation may be rekindled by external noxious influences, or in consequence of gradual changes in the cicatricial tissues surrounding the foreign body. Herein lies a new source of danger of sympathetic affection of the other eye, demanding the enucleation of the injured one as soon as signs of irritation (pain, sensitiveness to touch, redness in ciliary region) appear.

The elimination of a foreign body often takes place soon after having penetrated the eye, or at a later period, by the development of very acute cyclitis with suppuration, which permeates the entire vitreous and causes protrusion and immobility of the globe (panophthalmitis). In consequence of the inflammatory œdema in the tunica vaginalis and the ocular conjunctiva, accompanying the acute suppurative process, the eyeball is pressed forwards uniformly, the action of the ocular muscles is impeded, the conjunctiva forms a wall about the cornea, and the lids become swollen by inflammatory œdema. Violent pain and photopsia—probably induced by the sudden displacement of the eyeball, usually also febrile and gastric symptoms, accompany this process, especially during its ascendancy. In most cases perforation of the sclera occurs, usually in the anterior zone, at all events a few millimetres in front of the equator. The spot where the perforation is about to occur may generally be recognized a few days before, by a well-marked, knob-like prominence, which does not always correspond to the position of the foreign body. The process, or at least the pain, may be considerably shortened by a meridional incision of this bulging spot. The inflammatory action in such an eye does not usually subside until after the sixth week. In case of spontaneous perforation the foreign body may be eliminated without being observed, or it may be found adherent in the opening, or in the conjunctival sac. Ulceration of the cornea only occurs when the injury has taken place in it, or in the corneo-scleral border. Frequently, in eyes which have shrunk after perforation of the sclera by suppuration, the cornea is found quite clean, although somewhat smaller and altered in its convexity.

If a foreign body has lodged in the lens, and the opening into the capsule has not again closed, it may subsequently excite

cyclitis by falling into the posterior chamber as the lens is gradually absorbed. The question, therefore, immediately arises, whether it is possible to extract it with the lens surrounding it.

If cyclitis be feared, on account of great swelling of the lens, operative interference becomes necessary. The danger is manifested by circular ciliary injection, increased sensitiveness to light, and pain. In this stage the inflammatory symptoms may be subdued by ice-cold applications (especially after a local abstraction of blood), atropine, and modifying the light. As soon as the eye becomes hard, with, perhaps, œdematous swelling of the ocular conjunctiva, an incision should be made into the anterior chamber (*punctio corneæ*), in order either to evacuate simply the aqueous humor (which operation must be repeated from time to time), or at the same time to remove the lens, with or without iridectomy, through a larger or smaller opening, according to the hardness of the nucleus. In these manipulations it is of the greatest importance that no fragments of the lens, capsule, or iris, remain adherent in the wound. When there is a prospect of reducing the tension by the evacuation of the aqueous humor (to be repeated if necessary), by means of an opening 2 or 3 mm. in length, until further absorption of the lens is obtained (which is usually the case in persons not over twenty-five years of age), its extraction should be avoided, as it requires a larger opening. If chemosis has occurred, the technical part of iridectomy or extraction may be beset with many difficulties, and it is exceedingly doubtful whether cyclitis already begun can be averted.

Eyes in which the lens is permanently or occasionally in the anterior chamber, or eccentrically located, or wandering from place to place, can only be saved by extraction (which is usually best accomplished by means of the flap operation and the spoon-shaped scoop).

Wounds in the corneo-scleral border or in its vicinity may lead to cyclitis in various ways; suppuration may originate in the conjunctiva on account of uncleanness, infection, non-adaptation of the edges of the wound, or an extensive exudation with subsequent shrinkage, appears upon the inner surface of the ciliary body, on account of the large size of the wound; but the most common cause is that rapid and firm cicatrization is delayed or hindered by the interposition of the iris, portions of the capsule,

or fragments of the lens, perhaps also by the vitreous. From this it is apparent what the physician should do in case of wounds and operations, in order to prevent cyclitis as far as possible. The conjunctiva should be kept scrupulously clean, and the edges of the wound should be adapted as closely as possible. Coagulated blood, fragments of the lens, and points of the iris are to be properly removed. *Blennorrhœa* of the lachrymal sac is also to be considered (see *Keratitis*, page 168). In all operations in which the iris must be excised, the excision should be performed at the moment of greatest tension (admissible without danger of dialysis), since in that case the portions not excised and drawn into the wound will retreat more easily from it. The coloboma should be examined to ascertain whether its edges are equally distant from the centre, and whether the one or the other, or both, are not drawn towards the wound. So soon as, from the position of the edges, we can infer that the iris is engaged in the wound, an attempt should be made to replace it by means of Daviel's spoon, which can be done without danger if the eyeball be firmly fixed. If a prolapse of the iris occur in the sclera, it should be treated according to the principles already given on page 160, in order to obtain a firm and flat cicatrix; if this end is not to be attained, iridectomy should be performed as near it as possible. In cystoid cicatrices, a close abscission sometimes suffices to obtain a firm and flat cicatrix; sometimes an incision has to be made at the peripheral side of the cyst, as though for iridectomy, in order to divide that part of the iris which is united with the peripheral portion of the cicatrix, and to liberate it as much as possible, and subsequently to excise as much as necessary of the collapsed cyst.

(*b*) If cyclitis be threatened, or has already begun, the exciting causes should be taken into consideration, and the increase of the inflammation prevented as far as possible by antiphlogistic remedies, such as local abstraction of blood, cold applications, laxatives and regulation of the diet. Instillations of atropine are useful only so long as they produce and maintain dilatation of the pupil. In some cases every application aggravates the condition, and increases the pain or effusion of blood in the anterior chamber so much that it must be discontinued. In such cases, as well as in those in which hypopyon appears, warm fomentations, used

for fifteen to thirty minutes every hour, or every few hours, give most relief. The conduct of the patient has a great influence upon the condition of the unaffected eye. The light should be moderated, and on no account should accommodative efforts be made. If this advice be not followed, not only will the inflammation in the wounded eye be maintained or increased, but the other eye also is in danger of sympathetic disease. If purulent infiltration appear in the vitreous, nothing but warm fomentations and narcotics can mitigate the condition of the eye. In some cases it is possible to avert panophthalmitis by the continuous application of the compressive bandage for several days. When protrusion of the eyeball has once occurred, its enucleation is no longer safe under any circumstances. Several cases of this kind have ended fatally in consequence of thrombosis, probably because the œdematous tunica vaginalis was already permeated by pus cells. It is exceedingly dangerous to wear an artificial eye upon a phthisical eyeball which still shows symptoms of irritation, such as pain, sensitiveness to the touch, easily becoming red, and especially if it be at all probable that calcification or ossification exists.

2. SYMPATHETIC CYCLITIS—CYCLO-IRITIS.

We designate a cyclitis or cyclo-iritis as sympathetic when it is induced by a cyclitis in the other eye. But an eye injured by cyclitis induces a sympathetic inflammation only when the inflammatory process is still active or has been rekindled, at least in the uveal tract, whether by external noxious influences, as by the wearing of an artificial eye, or by later changes in the interior of the eyeball; as, for example, by calcification or ossification of the exudation caused by cyclitis or cyclo-choroiditis, by changes in the position of the lens, etc. In order to establish the sympathetic nature of an affection, there should at all events be a continuous or at least a temporary increase in the inflammatory or irritative condition of the uveal tract of the eye first attacked, which is manifested by pain or sensitiveness to the touch in the ciliary region, increased ciliary injection, increased sensibility to the usual light and increased secretion of tears. The eye inducing this inflammation may be entirely blind, even shrunk to a small stump, or it may still be capable of vision,

as much as its dioptric conditions will allow. Only very rarely and under circumstances to be considered later, does an eye suffering from increase of intraocular pressure cause sympathetic trouble. If the pain in the eye causing the inflammation be not continuous, many patients notice that the exacerbations in the second eye occur at the same time as or soon after the paroxysms of pain in the first.

Symptoms and Course.—Sympathetic cyclitis usually runs a chronic, rarely an acute course. It never leads to suppuration in the vitreous or the anterior chamber. Even if the exudation be at first serous, it later becomes plastic, and it is this which threatens the eye with blindness (see page 273 *a*). Cases are exceptional in which the sympathetic affection has led only to serous secretion in the vitreous, and through it to increase of the intraocular pressure with excavation of the papilla. The sympathetic nature in such a case was proved by A. von Gräfe,¹ when, immediately after extirpation of the enlarged globe, which was causing the sympathetic inflammation, a decided improvement took place in the eye which had been threatened with blindness from increase of the intraocular pressure.

The sympathetic inflammation begins with increased sensitiveness to the usual daylight, even though the eye primarily affected be well bandaged and lachrymation be easily induced. Simultaneously or somewhat later, accommodative asthenopia supervenes, as does a gradual recedence of the near point. The pupil may be contracted or markedly dilated. Many patients begin about this time to complain of the floating of light clouds before the eyes in distant vision. These symptoms may be designated as prodromal, because at this period of the disease inflammatory products are not discoverable, and the ciliary injection surrounding the cornea is not sufficiently pronounced to indicate unmistakably the existence of inflammation. But if manifest signs of cyclitis appear, it is easily seen that they are the initiatory symptoms of the affection of the ciliary nerves, and that the haziness probably results from the immigration of cells from the ciliary region into the vitreous, but which are too few to be distinctly seen with the ophthalmoscope or to interfere with the acuity of vision. The prodromal symptoms may disappear without being

¹ Archiv. f. Ophth., III B., p. 442.

followed by inflammation, and they may render the patient incapable of any occupation for months or years, even though his vision be unimpaired, until they are permanently removed by the enucleation of the eye primarily affected.¹

Inflammation is certainly present if we can prove the existence of exudation. Aside from the diminution in the acuity of vision, the examination with the ophthalmoscope, especially when used with little light, gives us the most reliable information regarding the condition of the vitreous, provided posterior synechiæ do not interfere with the inspection. Turbidity of the vitreous, at first diffused, later granular or flocculent, may be detected before changes are perceptible in the aqueous humor. The aqueous humor may be slightly turbid, from the admixture of fibrin, and may cause the pupil to appear less black. The exudation secreted in the anterior chamber is generally manifested by deposits on Descemet's membrane or by isolated posterior synechiæ. These deposits may appear very gradually and almost imperceptibly, especially if unaccompanied by striking ciliary injection.² It may, however, tax the endurance of the patient as well as of the physician by the excessively violent radiating pain, unendurable photophobia and intense redness all around the cornea, which may continue for weeks without a remission. During the continuance of the exudative process, the tension of the eyeball may be distinctly increased, but gradually and usually very soon it decreases, and finally such eyes become softer, and, unless the inflammation ceases, are doomed to irreparable atrophy, with amaurosis and detachment of the retina. Limitation of the field of vision is probably caused by an advancement of the inflammation from the ciliary body to the adjoining portions of the choroid and the retina.

So soon as posterior synechiæ have formed, the disease may resemble a simple iritis, and for this reason the affection has been frequently described as sympathetic iritis. But other symptoms appear in its further course, especially if circular synechia has occurred, which are not observed in iritis due to other causes. The discolored iris becomes spongy and permeated by fine vessels, not only in the minor but also in the major circle; the

¹ Compare Hirschberg, in A. f. O. XXII, 3, p. 136.

² Such cases were often designated as iritis serosa; they are the least dangerous.

anterior chamber becomes shallower and the cornea apparently flatter and smaller, and the densely injected and perhaps swollen limbus becomes broader. The eyeball is now decidedly softer and sensitive to the touch in the ciliary region, either in its entire circumference or in a particular spot which often corresponds to the inflammatory centre in the primarily affected eye. If the disease be now arrested, the iris loses its felt-like vascular appearance, and becomes mottled, rather slate or lead-gray, or perhaps spotted brown or dark gray, and is uniformly convex, in the form of a dome; either because an exudative layer is interposed between it and the capsule of the lens, or because the lens is simultaneously pushed forwards by a membranous exudation in the fossa lenticularis (page 274). When, however, in the course of primary iritis, the occlusion of the pupil leads to bulging of the iris, isolated, knob-like prominences appear in its middle zone, and the eyeball is somewhat hard (page 240). When no protrusion of the lens occurs, and the pupil is only obstructed by a thin membrane, a comparatively good power of vision may be maintained unless opacity of the lens or a fresh inflammatory attack occur later. This comparatively favorable termination may probably be hoped for in young persons. If we can succeed in checking the induced inflammatory process before the formation of numerous synechiæ or occlusion of the pupil has occurred—and this condition cannot really be expected until the offending eye has been enucleated or has spontaneously ceased to be troublesome—such an eye may remain *in statu quo* for a lifetime. Complete recovery is then possible.

Etiology.—Injuries (wounds in the region of the ciliary body, foreign bodies within the eye), are the usual though not the only causes of cyclitis or of sympathetic (induced) inflammation. Peripheral prolapses of the iris caused by ulcers (scrofulous conjunctivitis, Herpes zoster), may eventually induce sympathetic cyclitis as well as the prolapses occurring after injuries. An encysted cysticercus in the posterior chamber, the shrinking of plastic exudation after cyclo-choroiditis originating from any cause, or its subsequent calcification or ossification, as well as the sudden injury to the ciliary nerves by a dislocated lens, especially if calcified, have been known to excite sympathetic inflam-

mation. Mooren¹ gives detachment of the retina in three cases as the cause of sympathetic disease, but he mentions the reactive inflammation in the ciliary body as the intermediate link: In those cases in which the history was fully given, a continuous traction was exerted upon the ciliary nerves by the shrinking of the exudations or by a peripheral incarceration of the iris, or the frequently repeated mechanical injuries done to these nerves by hard bodies in the interior of the eyeball. In staphylomatous conditions (staphyloma of the cornea and the sclera in the region of the ciliary body), which lead only exceptionally to sympathetic cyclitis, with serous effusion in the vitreous and permanent or temporary increase of the intraocular pressure, traction upon the ciliary body by the zonula or dislocated lens may cause sympathetic disease. In such cases the ciliary nerves have usually lost, entirely or for the most part, their power of conductivity; they are not abnormally sensitive to the touch in the region of the ciliary body, often even less so than usually.

It may be assumed, *a priori*, that shrinking exudations in the vitreous, even if not caused traumatically, generally lead to sympathetic irido-cyclitis of the other eye; but in cases in which external injuries may be excluded, and the existence of a constitutional cause assumed with certainty or probability, it is difficult to determine whether and how much the affection of the eye first attacked has contributed to the disease of the second. (See page 267.) The fact that the cyclitis induced by an injury scarcely ever appears before the fourth or sixth week, corresponds with the time which usually elapses before the process of shrinking in the cicatricial tissue surrounding a foreign body, or occurring after a large wound, etc., has attained a considerable degree. We notice this especially after a peripheral extraction of the lens, if only a slight cyclitis has appeared; the inflammatory action in such eyes does not usually subside sooner than the fourth or sixth week, and if on account of exclusion of the pupil or secondary cataract a subsequent operation becomes necessary, and is undertaken before this period has elapsed, the danger of again exciting the inflammation is incurred. According to all experience, it never happens that foreign bodies, after having been long encysted, or an exudation long since ossified, cause a

¹ Ophth. Beobacht., Berlin, 1867, p. 144 and 155.

sympathetic affection of the other eye without symptoms of inflammation or irritation in the eye first affected. Such enveloping membranes may atrophy in time or may be torn, as is well known, after the reclamation of a hard cataract; and chalky concretion or pieces of bone may not cause irritation until they have attained a certain size or have acquired a sharp edge, or until their position has been changed by some external force.

That irido-cyclitis of one eye may be the principal cause of irido-cyclitis in the other—aside from the frequent successive occurrence after injuries—is proved by the fact that in many cases the mere enucleation of the eye first attacked is sufficient to arrest the pathological process in the other eye. The question as to how the disease is transmitted from one eye to the other has been differently answered. Mackenzie,¹ to whom we are indebted for the first exact observations regarding sympathetic ophthalmia, regarded the retina as the starting point of the inflammatory symptoms in the sympathetically affected eye, and consequently the optic nerve as the transmitter. The author² long since stated that in some cases of this disease the symptoms of iritis predominate, in others, those of choroiditis (with which he formerly classed cyclitis), and that the transmitting agent should probably be sought rather in the ciliary nerves than in the optic nerve (whose neurilemma extends to the chiasma). H. Müller,³ Donders,⁴ A. von Gräfe⁵ and Bowman subsequently supported this view; while the two former based their opinions especially upon the result of dissections, the latter particularly pointed out that if sympathetic trouble develop in one eye from an injury to the other, the ciliary injection and sensitiveness to the touch in the former corresponds to the spot in which the wound is situated in the eye primarily affected. Knies⁶ has recently concluded, from the dissection of a case of bilateral irido-choroiditis ("iritis serosa" non-traumatic), that the inflammatory process advanced from the uveal tract of one eye through the sheath of the optic nerve to the chiasma, and thence to the

¹ Pract. treatise of the Diseases of the Eye, London, 1844 and 1854.

² Arlt, Krankh. des Auges, II B., Prag 1853, p. 50.

³ Müller, Archiv f. O. IV a., page 368.

⁴ De Maatz, Jahresbericht der Utrechter Augenheilanstalt, 1865.

⁵ Archiv f. O. XII B., page 154 (correspondirende Empfindlichkeit).

⁶ Knapps' Archiv. Ophthal., Vol. IX, page 125.

uveal tract in the other eye, and that, therefore, it is not necessary to recur to the irritation of the ciliary nerves. If the affection of the second eye be caused by the propagation of the inflammatory process through the sheath of the optic nerve to the chiasma, and thence to the uveal tract of the other eye, it is still to be explained why the inflammation in the second eye should not first become noticeable in the optic nerve or choroid proper by impairment of its functions, or by means of the ophthalmoscope. The danger of sympathetic disease generally lies, not in the affection of the posterior section of the uveal tract, but the anterior, in the formation of membranes. In inflammation of the optic nerve, especially in descending neuritis, a continuance of the inflammation to the ciliary body and iris has not been observed. As is well known, suppurative choroiditis of one eye never induces inflammation (irido-cyclitis) of the other eye directly, but indirectly, by atrophy and calcification, if at all. This view, in my opinion, is also contradicted by the fact that the acuity of vision of the eye first attacked may be preserved, so far as the dioptric conditions will allow, whilst that of the other eye is entirely destroyed. An eye which for years has been deprived of all sensitiveness to light, which, perhaps, is shrunken into an insignificant and painless stump, may still excite sympathetic disease, though it may be impossible to discover any sign of inflammation of its uveal tract other than sensitiveness to the touch. The irritation which the ciliary nerves suffer in one eye in consequence of mechanical injury, either from within by calcification or ossification, or from without from an artificial eye, seems to induce, in the corresponding ciliary nerves of the other eye, first a disturbance of the circulation and then inflammation. The suggestions recently made by Mooren on vascular reflexes in the eye should not be disregarded.

Quite remarkable are the cases of Mooren² and Brecht³ regarding concentric narrowing of the field of vision in sympathetic inflammation without any ophthalmoscopic changes or symptoms of cyclo-iritis. As in the case observed by Brecht, a diminution of the power of accommodation preceded the contraction of the

¹ Mooren and Rumpf, *Centralb. für med. Wissenschaften* 1880, Nr. 19.

² *Symph. Gesichtsstörungen.*

³ Brecht, *Archiv f. O.* XX a., page 97.

field of vision, the presumption is that the sympathetic affection first appeared in the ciliary body, perhaps only as hyperæmia of the orbiculus ciliaris, and thence extended to the periphery of the retina, which, although external pressure could excite luminous sensations—phosphenes—did not regain its function until the other eye, which contained a foreign body, was enucleated.

Prognosis.—A favorable prognosis can only be given during the prodromal stage, and when the patient absolutely submits to medical advice. If inflammation be apparent, the following conditions should be observed: (*a*) The condition of the eye primarily attacked; whether the inflammation has already subsided or is beginning to subside. (*b*) The condition of the eye sympathetically affected. If the exudation be exclusively or principally serous, or so long as there is only a slight turbidity of the vitreous, deposits on Descemet's membrane, or, perhaps, also a few synechiæ, which may be detached by atropine, we may still hope to save the sympathetically affected eye, provided the inflammatory action in the eye primarily affected has subsided or the eye has been enucleated. (*c*) Other things being equal, the prognosis is rather more favorable in young patients. The more pronounced the tendency towards the formation of membranes between the iris and the capsule, the more felt-like or vascular the iris, the more diminished the tension of the globe and the narrower the field of vision, the greater is the certainty that the eye will be lost, even though the eye primarily affected has been removed, or the inflammation has spontaneously subsided. The changes which have once taken place in an eye sympathetically affected advance spontaneously until the power of vision is lost.

Treatment.—We can do much to prevent, little to remove the effects of sympathetic inflammation. The etiological indications coincide with what was said about the treatment of the inducing cyclitis (285). The patient should be subjected to the strictest régime as soon as one eye shows a condition which, according to all experience, is very likely to result in or has already induced a cyclitis. The warning of Beer,¹ that many who have lost an eye in consequence of a violent inflammation, become blind in

¹ Augenpflege, Wien, 1802.

the other eye if they resume their accustomed occupation too soon, has been much neglected in the recent literature on sympathetic affections. It is dangerous to perform an operation (iridectomy, discission) upon an eye which has suffered a severe injury or operation before the reactionary symptoms have entirely disappeared, or to expose the other eye to a bright light or allow it to be used.¹ In this way, eyes which have been successfully operated upon by extraction have become dangerous, by lighting up an irido-cyclitis in the other eye. It is not often advisable to make an exception of the old rule which allows the use of cataract glasses only after the eighth week. Cases have been recorded in which the eye became sympathetically affected after the injured eye was enucleated, although at the time of the operation no symptoms of irido-cyclitis were manifest. It is possible that in such cases the operation of enucleation was not properly performed, but it is more probable that the patient exposed himself too soon to a bright light, or attempted to use his eyesight too soon. Mooren (*Ophthal. Beob.*, page 160), describes an instructive case of this character; but what he attributes to a contusion of the optic nerve during the enucleation, may be equally attributed to a contusion and laceration of the ciliary nerves. The author has never thought it advisable to discharge a patient, still less to allow him to wear an artificial eye, until all inflammatory symptoms following this operative interference had disappeared. Since the publication of the very favorable results relative to sympathetic ophthalmia, which Prichard² obtained by enucleation of injured eyes (by Bonnet's method), the removal of the offending eye is the first etiological indication. An

¹ Himly, *Krankh. und Missb.*, Berlin, 1843, Vol. I, page 450. "A wound penetrating deeply into the eye, and which induces severe and general ophthalmitis, frequently has as a sequel a quite similar destructive inflammation in the uninjured eye, even after the injured eye has long been lost, perhaps completely atrophied. This is especially the case if the uninjured eye has been much irritated by light or accommodative efforts during the disease of the wounded member. If the sympathetic inflammation has not appeared until many weeks after the injury, the cause might be sought in the unaccustomed effort and in the congestion of the ophthalmic artery; but more probably there is a chronic inflammation of the optic nerve which gradually extends to the other eye through the chiasma. The prognosis is very unpromising; the prophylaxis consists in the greatest care of the uninjured eye for many months."

² *Association Medical Journal*, October, 1854.

operation which removes the permanent danger of irritation, and causes the disappearance of all reactionary symptoms in eight or ten days, has much in its favor. But in cases in which the sympathetic inflammation is already in progress, it should not be forgotten that the changes in the sympathetically affected eye may, in themselves, be the cause of the continuance and progress of the inflammation; and, indeed, unfortunately, they frequently are, especially when the plastic exudation is copious. We have, as yet, only a few general indications, no reliable symptoms, as to how far the changes may advance in the secondarily affected eye and still afford a prospect of arresting the induced inflammatory process by the enucleation of the eye primarily affected.

The prophylactic value of enucleation after certain injuries is undisputed. (See page 285.) Even though the prodromal symptoms of the sympathetic disease be present, the enucleation may be undertaken almost with the certainty of preserving the other eye. But if decided signs of sympathetic cyclitis or irido-cyclitis be present, the success of enucleation is quite doubtful; under certain circumstances it may even be injurious. The probability of a favorable result is greater if the sympathetic affection be not ushered in with violent symptoms, but appears more gradually and runs its course more slowly and manifests itself especially by diffuse turbidity of the vitreous, by deposits on Descemet's membrane, and by isolated posterior synechiæ. It is the less favorable the more the tissues of the iris appear changed, the greater the exudation surrounding the pupillary border, and the more the iris seems pushed forwards by membranous exudation or by the lens.

But even when the probability of success is small, the enucleation of the primarily affected eye may be indispensable if the condition of the eye be such as to produce a permanent or occasional source of irritation, if it contains a foreign body, calcified (ossified) exudation, or a dislocated, hard or calcified lens.

If, on the contrary, the inflammatory process in the offending eye has wholly subsided, and there is complete absence of irritability, especially absence of pain to the touch in the region of the ciliary body, and if its condition be such that a reappearance of the inflammation or irritation in its uveal tract is not to be

apprehended, it is advisable not to perform any operation upon it until the sympathetically affected eye has completely recovered, or is free from all irritation. If the primarily affected eye is still painful, but shows a tendency to become less so under proper treatment, it is better to postpone enucleation, at least until the symptoms of acute inflammation in the secondarily affected eye have somewhat subsided, since the irritation caused by the operation, although only continuing for a few days, cannot be considered as absolutely harmless to the other eye.

If the primarily affected eye still retain its function, as, for example, after a rupture of the sclera with loss of the lens and a peripheral incarceration of the iris, and if its condition be such as to give some hope of the preservation or restoration of its functional ability, its enucleation will scarcely be warranted, even if the symptoms of sympathetic inflammation be not yet manifested; still less so if they are; for this would be equivalent to sacrificing something certain, or nearly so, for something uncertain. Attempts have been made to substitute enucleation by excision of the anterior half of the eyeball, by the intraocular division of the ciliary nerves of the inducing eye in the region of the sensitive portion, and by the external (extra-bulbar) division of all (or nearly all) the ciliary nerves. These different operations offer much less certainty of success. The cicatrization may again result in traction and irritation, and the reunited nerves again become conductors, as is shown by experience in neuralgia.

Pathological Indications.—So soon as a sympathetic inflammation is apprehended or has begun, every irritation of the ciliary nerves through the retina, as bright light, shining or dazzling objects, severe accommodative efforts, or from psychical emotions (weeping), should be prevented as much as possible. It will generally be necessary for the patient to remain in a moderately darkened chamber for a number of weeks or months. Scarcely any benefit is to be expected from bleeding, or warm or cold fomentations. Atropine is only of service so long as it produces distinct, though perhaps only partial dilatation of the pupil; nor is any direct benefit to be expected from internal medication. The inunction cure has been repeatedly employed, but seldom with much success.¹ In case of occlusion of the pupil iridectomy should not

¹ De Wecker, in Gräfe und Sämisch Handbuch, IV, page 528.

be performed until several weeks have elapsed after the disappearance of all inflammatory symptoms. If, after the subsidence of all symptoms of irritation (ciliary injection, photophobia, lachrymation and pain), the eye again becomes reddened or even sensitive in some spot, the operation should be postponed, for notwithstanding it might be successful the opening will soon be closed by a second inflammation. If, in such a case, limitation of the field of vision distinctly advance (which may be ascertained by means of the flame of a candle), it may perhaps be saved only by an iridectomy or by removal of the other eye. In most cases a permanent opening may be obtained only by an operation similar to Wenzel's method of extraction. The lens should be sacrificed even if it be not yet opaque. Eyes thus affected bear Beer's corneal section without danger of suppuration of the flap. It is not necessary, however, that the incision include half the corneal base. The points of entrance and exit may be 1.5 to 2 mm. below the horizontal meridian. The knife, which had best be one of Beer's, and should have a base only 0.4 or 0.5 mm. in width, is thrust directly through the iris and the exudative membrane lying behind it, then lowered, and finally pushed through the anterior cortical substance to the point of exit and completion of the section. The corneal flap, about 10 mm. long and 3 to 4 mm. in height, allows Blömer's forceps to be introduced so that one blade can be pushed before, the other behind the iris, and within the capsule as far as the centre, and then closed; in this way iris, membrane and capsule may be seized together. In the same manner a fine pair of scissors may be introduced into the eye in order to make an incision in the form of a triangle, first on one side and then on the other, the two incisions meeting above the centre, thus excising all that has been seized by the forceps. Through this opening the nucleus of the lens and the remaining cortical substance may be easily removed. As the incision falls entirely in the transparent cornea it is easy to see that the closure of the wound is not prevented by cortical substance or the iris. The tendency to coalesce is so great, and the tension is so much reduced that the wound heals very readily; but, unfortunately, openings in the iris although more than 2 mm. in length (on either side of the triangle) frequently become obliterated by exudative matter.

3. CYCLITIS (CYCLO-IRITIS) AFTER RECURRENT FEVER.

The inflammation of the eyes which has been observed epidemically in some localities (Ireland, Finland, St. Petersburg, Moscow, Berlin, Silesia) after typhus fever (*febris recurrens*), and which is brought into causative connection with the general disease, partly on account of this occurrence and partly on account of its reaction to the therapy, and has therefore been designated *ophthalmia post-febrilis* (Mackenzie), is anatomically similar to cyclitis. It has also been considered as cyclitis or choroiditis by later observers,¹ whereas former observers² located it in the retina. Whilst in other forms of cyclitis (traumatic, syphilitic, sympathetic) any portion of the ciliary lining may become the centre of disease, here, according to all appearances, the inflammatory process caused by the general disease originates exclusively in the *orbiculus ciliaris*, that is, in the flat zone of the ciliary body, distinguished by a peculiar arrangement of the vessels; it then extends forward, especially upon the iris.

Symptoms and Course.—The disease is first manifested by a disturbance of vision, which is principally caused by an exudation into the vitreous. The turbidity of the vitreous may be so slight as scarcely to be perceived by the ophthalmoscope, or it may be so considerable as to render an ophthalmoscopic examination of the fundus impossible. Logetschnikow has recorded a diminution of the range of accommodation in several cases. In some cases the adjoining portion of the retina also seems to be sympathetically affected, thus leading to contraction of the visual field. Perceptible external symptoms of inflammation do not appear until later. Turbidity of the aqueous humor begins with more or less distinct ciliary injection, accompanied by photophobia, pain, which sometimes is very severe, deposits on Descemet's membrane, not unfrequently an exudative deposit in the form of hypopyon and posterior

¹ *Estlander*, *Choroiditis nach Febris recurrens*, A. f. O. XV, b. 108. *Blessig*, *Compte rendu de Congrès périod d'ophth.* Paris, 1867, page 114. *Logetschnikow*, *Entzündung des vorderen Abschnittes der Choroidea (des Ciliarkörpers) als Nachkrankheit der Febris recurrens*, A. f. O. XVI, page 353. *Pelzer*, *Erkrankungen des Choroidealtractus nach Febris recurrens*. *Berliner klin. Wochenschrift*, 1872, Nr. 37.

² *Wallace*, *Med. Chir. Trans.*, vol. XIV, p. 286, London, 1828. *Mackenzie* (4 Edition), traduité par *Warlomont et Testelin*, Paris, 1856. T. II, page 102.

synechiæ; more rarely by exclusion of the pupil. The tension of the eye is usually distinctly diminished. Mackenzie observed this softening of the eyeball in one case, even before the symptoms of iritis made their appearance, and he remarks that the tension does not become normal until long after the disappearance of the inflammatory symptoms. He mentions that *muscæ volitantes* are a source of constant complaint on the part of the patients, especially after the cessation of the acute symptoms.

Prognosis.—This is favorable as compared with the traumatic and sympathetic types; at least if, in its extension to the adjacent tissues, no great or probably irreparable changes have occurred, such as occlusion of the pupil, hard cataract, or detachment of the retina. "The time," says Estlander,¹ "required for the disease to run its course varies according to the age and circumstances of the patient. In children it generally assumes a lighter form, and even without medical treatment runs a more rapid course. In the youngest patient, a boy six years old, all the symptoms of iritis were present and quite severe; but within nineteen days the disease had disappeared as much as is usually the case in four or five weeks. If the patient lives under bad conditions six months may elapse before he may be considered cured. The average duration of the process is about ten weeks. If the intensity be not especially severe from the first, and if iritis be not superadded, it may run its course even in a shorter time. Thus, one of the patients, without other treatment than atropine, read as fine print after six weeks as before he was attacked."

Etiology.—This disease occurs at every age, except in children under six years of age, but is most frequent in youth, perhaps because deprivation of the necessary food is felt more at that period than in adult life or old age. The retarded circulation caused by continued deprivation appears to cause engorgement of the finer capillaries of the orbiculus ciliaris, and subsequently the inflammatory symptoms.

Treatment.—Attention should be principally directed to the general health; medical and dietetic treatment should be correspondingly invigorating. The local treatment will be in accordance with that given for iritis.²

¹ l. c. p. 139.

² At various times middle-aged people (20–30 years of age) from some moun-

4. CYCLITIS AFTER MENINGITIS.

In consequence of meningitis, especially cerebro-spinal meningitis, an inflammation is developed at once or within a few weeks, either in one or both eyes, the symptoms of which are ciliary injection, slight irritation, and as it advances a striking disturbance of vision, rarely an œdematous swelling of the ocular conjunctiva and the borders of the lid. The inflammation begins, to all appearances, in the orbiculus ciliaris—which is distinguished by a peculiar arrangement of its vessels—with the formation of numerous pus corpuscles, which are first seen upon the inner surface, and advance further and further into the vitreous body. Sooner or later pus corpuscles appear in the iris, with distinct symptoms of iritis; frequently also in the anterior chamber, forming a slight transitory hypopyon. If numerous synechiæ or exclusion of the pupil do not altogether prevent an examination of the fundus, opacities may be seen in the vitreous, or rather, the vitreous behind the lens, permeated by pus, throws a peculiar gray or yellowish-white reflection into the eye of the observer, so that he is reminded of an extensively detached retina, or a glioma of the retina, although the reflecting mass shows neither vessels nor undulations. Pus corpuscles also appear to penetrate the choroid proper, the retina and the interspace between these membranes; for very soon a total extinction of the sensation of light follows. The discolored and spongy iris very soon advances so near the cornea as almost to obliterate the anterior chamber; rarely, and probably only at a later period, does the iris appear partially or completely retracted and atrophied. About the time when the symptoms of purulent infiltration of the vitreous and iris are most pronounced, the tension of the eye is perceptibly diminished; it gradually becomes visibly smaller, and finally shrivels into a painless stump, with a strikingly clear cornea and a comparatively deep chamber. Perforation of the cornea or sclera by the pus occurs very seldom, if

tainous region where misery and poverty are permanent, and who are greatly reduced by all kinds of privations, particularly if they have led a sedentary life, are admitted to the hospital with bilateral irido-cyclitis. Their condition resembles in a striking manner that which is observed in patients recovering from recurrent fever. Preponderance of the white blood corpuscles and diminished heart's action appear to predispose the orbiculus ciliaris to inflammation.

ever. Protrusion of the eyeball, so characteristic of acute sup-puration of the posterior section has, in my experience, never been observed. In slight cases the pupil is found occluded, the tension of the eye not perceptibly changed, but the power of vision totally or nearly totally extinct.

Etiology.—The disease generally occurs in children from one to six years of age, being more often bilateral than unilateral; yet it has been observed in the tenth, fourteenth and eighteenth years. Whilst most authors consider this affection of the uveal tract as a continuation of the meningeal inflammation by means of the lymph passages of Schwalbe (communication of the sub-arachnoidal space with the intra-vaginal space of the optic nerve), Oeller's¹ recent exact and critical dissections contradict this view.

"In order to explain the origin of the suppurative process in the eye, we are not obliged to resort to fungous embolism. The thrombosis of the vessels by columns of white blood corpuscles, and the disturbance or even stagnation of the circulation which they occasion, are sufficient to produce an acute disintegration of the red corpuscles. These disintegrating masses, like the conglomerations of the white blood corpuscles, become thrombi, and a copious diapedesis is the natural consequence. Essential factors in causing the process to reach so high a grade in the *pars plana corporis ciliaris*, are probably the narrow network of the anterior capillary loops of the chorio-capillaris, and perhaps, also the inosculation of the minute capillary system. In the choroid proper the process is still limited within relatively narrow bounds, the facility of collateral circulation compensating for a time any obstruction."

Medical treatment is of little avail in this condition. If only one eye has been affected, the other had better be treated as in cases in which sympathetic affection is apprehended, although at present no cases of sympathetic affection have been observed in this (unilateral) disease. If the tension be tolerably well preserved and the perception of light good, an iridectomy may be undertaken later.

5. SYPHILITIC CYCLITIS. 6. SCROFULOUS CYCLITIS.

These affections should be mentioned here, because in many cases the inflammation proceeding from the ciliary body attacks

¹ Knapp's Archives of Ophthalmology, Vol. IX, page 1.

the iris. In syphilis, when the pupil can be fully dilated, gummata may be distinctly seen in the flat portion of the ciliary body, and in scrofula the symptoms indicating cyclitis with sero-plastic exudations may exist for a long time before distinct signs of iritis appear. As regards syphilis, it has already been mentioned, in the description of iritis (page 258), that in many cases the inflammation appears in the ciliary body sooner than in the iris. Von Arlt has described¹ the dissection of an eye with a gumma of the ciliary body.

B. NON-INFLAMMATORY CHANGES OF THE IRIS (CILIARY BODY).

I. CONGENITAL.

1. ANOMALIES OF COLOR.

There are persons who have irides of different colors; the iris of one eye being very dark—brown or brownish-black—while that of the other eye is very light—gray or blue; in other respects they will be quite normal. In some persons only one-half or a certain section of the iris is differently colored, in others it is darkly mottled. In elderly people with light-colored irides, dark or dark brown spots are frequently found disseminated in the iris without a trace of inflammation being discoverable in the uveal tract. In eyes in which the iris is very dark, throughout or partly, the sclera in some cases exhibits dark ink-like spots.

In albinos the iris is so deficient in pigment as to transmit the red light reflected from the fundus; in many cases, even the border of the lens and ciliary processes are seen through it. In some cases of albinism, the dazzling caused by deficient pigmentation decreases somewhat towards puberty, partly by the development of pigment and partly from the increased thickness of the tissues (sclera and uvea).

2. PERSISTENT PUPILLARY MEMBRANE.

The knowledge of this congenital condition of the iris is necessary in order to distinguish it from the sequelæ of iritis. Light or grayish-brown bands extend from the iris into the pupil, con-

¹ Knapp's Archives Ophthal. and Otology, Vol. VI, page 318.

verge towards the centre, and often cross it to be inserted at a point diametrically opposite. At times they form a fine network or a thin membrane in the pupil, but they never become adherent to the pupillary border. In many cases a filament extending into the pupil is connected with the iris by other radiating threads into which it is divided. The characteristic feature is that these filaments originate from the anterior surface of the iris, really in the boundary line between the major and the minor circle, *in front* of the sphincter, without being connected with it, and run towards the centre. The muscular action of the iris is, therefore, in no way impeded by these remains of the foetal membrane, neither as regards the influence of light or effort of accommodation, nor as regards mydriatics or myotics; and in all other respects it may be quite normal. Alfred von Gräfe¹ describes a case in which the persistent pupillary membrane exhibited openings which resembled a case of polycoria, especially when the pupil was dilated.

3. COLOBOMA OF THE IRIS.

Congenital cleft of the iris, usually with a corresponding cleft in the choroid, and often simultaneously with microphthalmus, is sometimes unilateral, again bilateral, generally in the lower or lower and inner portion of the iris, and varies in form and size. In most cases the condition is easily perceived as such. The form of the pupil is pyriform, or that of a key-hole; the pupillary border extends almost or quite to the periphery, with the edges of the coloboma either convergent or more or less divergent. In every case the upper half of the iris is perceptibly broader, and on this account the pupil appears to be somewhat eccentrically situated. If the sphincter (the minor circle) be closely examined, it does not appear truncated at the spot where the natural pupil passes over into the fissure, but is rounded and gradually disappears in the sharp edges of the fissure, being finally represented by a gray line similar to a cicatrix. In such cases the sphincter is drawn more or less towards the periphery, and is deficient only in the middle of the coloboma. Whenever the coloboma extends to the extreme periphery, its edges are always retracted, the traction being towards the ciliary processes. In

¹ A. f. O., XI, page 209.

case the coloboma has the form of a key-hole, the sphincter reaches out on both sides of the fissure into a small, blunt, wart-like appendix. Here, also, the sharp edges of the coloboma are drawn backwards. The lowest degree of coloboma is a slight indentation of the pupillary border, in which a similar condition of the sphincter exists, or from which a gray raphé extends downwards through the iris. Sometimes a V-shaped stripe reaches downwards from the indentation of the pupillary border, which appears of lighter color on account of the absence of the uveal lamina, as the author has ascertained by dissection. It is rare that the fissure in the iris appears to be separated from the pupil proper by a gray band which unites the two ends of the sphincter like a bridge (double pupil).

This fissure extends, in most cases, as we shall see when in considering the deformities of the choroid, from the iris through the entire uveal tract.

The coloboma of the iris—especially the pyriform—causes in itself less disturbance of vision than would be expected. The cause of the disturbance is rather to be sought in the continuation of the fissure, which may even affect the optic papilla in the general defective development of the eyeball (*microphthalmus*), or in anomalies of curvature of the lens or cornea; aside from this the power of vision may be enfeebled from early youth by non-participation of such an eye in binocular vision.

The coloboma appears either in one eye only, usually the left, or in both, and in a corresponding direction. The congenital deformities with which it has been observed, aside from the choroidal cleft, are *microphthalmus*, oval form of the cornea, which on the border in front of the coloboma is opaque, pyramidal cataract, coloboma of the upper lid, hare-lip, hypospadias, hydrocephalus and encephalocele. In many cases it is hereditary.

4. CONGENITAL IRIDEREMIA.

Congenital absence of the iris is more frequently total than partial. In the latter case the iris is altogether absent below, and above there is only a crescent about 2 mm. in width, which occupies about one-third of the periphery of the anterior chamber. In some cases of total irideremia the ciliary processes, and their advancement during the effort of accommodation, may be seen;

in other cases they are not visible, either because they are less developed or because of the greater breadth of the corneo-scleral fold. The lens may be normal or it may exhibit anterior or posterior polar opacity, but it seems to be more predisposed to uniform opacity (the author has performed extraction in two cases, discission in one); its attachment and relative position to the ciliary body are often found to be abnormal. Abnormal curvature of the cornea, partial or extensive opacities and irregular form of its base have been observed.

The function of the eye is imperfect, even in the absence of these accompanying deformities, on account of the dazzling. As the condition is almost without exception bilateral, such persons are generally considered myopic. Frequently, also, they suffer from nystagmus and apparent ptosis of the upper lid. Even if the refractive media are normal, the pupil appears less dark, and if the observer is favorably placed as regards the light, the well-known red reflection may be perceived.

In most of the cases observed heredity was evident. Stenopaic spectacles with a narrow but somewhat longer slit (in the horizontal direction) were rejected in one case in which I had recommended them, because the sensitiveness to light had gradually diminished, perhaps, also, because they had been found inconvenient or disfiguring.

II. ACQUIRED ANOMALIES—NON-INFLAMMATORY.

I. MYDRIASIS.

By mydriasis is meant a condition of the iris in which there is a remarkable dilatation of the pupil, and in which the iris, notwithstanding a sufficient sensitiveness of the retina to the impression of light, reacts very slightly or not at all to the usual influences of light and shade (accommodation convergence of the visual axis), although its tissues appear nowise changed. The immediate cause is to be found in a disturbance of innervation—paralysis of the sphincter or spasm of the dilator. Severe irritation of that portion of the trigeminus which is distributed to the eye, as, for example, by applications of tinct. opii, cauterization of the conjunctiva near the limbus with nitrate of silver, causes a transitory contraction of the pupil in most cases. The pupil appears less dark because more light penetrates to the fundus, and consequently more light is reflected.

The more remote causes may be of different character, and may be found in the eye itself or in very distant organs. If in an eye appearing otherwise normal the pupil be found larger than in the other eye, or if both pupils appear simultaneously larger than would be expected from the age, the condition of refraction, the illumination or the functional capability, we have good reasons for suspecting a disturbed innervation of the ciliary nerves, which may consist in paralysis of the dilator, supplied by the oculo-motorius, or in spasmodic contraction of the radial fibres innervated by the sympathetic nerve.

(a) *Toxic Mydriasis*.—The well known mydriatics, the preparations of belladonna, hyoscyamus, datura and duboisia, may have been introduced into the eye from the conjunctiva (or even from the lid or the temple) by instillations, fomentations, inunctions or contact with unclean fingers, or they may have been received into the general circulation after their introduction into the stomach, the rectum, by endemic applications, or by hypodermic injections. In the former case the dilatation is unilateral; in the latter bilateral, and usually, though not always, accompanied by other toxic symptoms. The local as well as the general toxic effect may be the result of an accident, or may have been produced for the purpose of deception. Mydriasis has also been observed after sausage poisoning.

The pupil may be dilated *ad maximum*, and the perfectly immovable iris be retracted into a ring scarcely 1 mm. wide; it may, however, differ little in width from the normal, in which case slight mobility is usually noticeable. The more noticeable the dilatation the greater the paralysis of accommodation, though during the first and last stage of toxic symptoms this relation between mydriasis and accommodation is not manifest. The effect is prolonged, according to the intensity of the mydriatic and the frequency or duration of its application, yet it rarely continues longer than a week. The best antidote for the general toxic symptoms is, as is well known, an injection of morphine; eserine and pilocarpine are local antidotes.

(b) *Mydriasis as a Consequence of Intraocular Pressure*.—This may occur unilaterally or bilaterally in the so-called simple glaucoma, even without any manifest inflammatory symptoms of the eyeball. In inflammatory, and especially in acute glaucoma, the

pupil is always dilated and rigid, very often irregular, rather oval than circular. The irregular dilatation which frequently occurs may be due to a larger or smaller portion of the iris being reduced, at one or several points, to a narrow strip, from atrophy. The atrophied spots appear of a slate or bluish-gray color, the pigment layer on the pupillary border is, as it were, pushed forwards, and the difference between the major and minor circles and the fibrous structure of the iris is indistinct. The mydriasis can be overcome only by iridectomy. If the iridectomy be attempted on an atrophied portion, it has no influence upon the intraocular pressure, even if successful. This mydriasis, often very slightly pronounced, may be designated as transitory, as it increases or diminishes with the intraocular tension, and consequently may be only occasionally perceived.

(c) *Mydriasis from Sudden Compression (Contusion) of the Eye.*—This rarely occurs without other symptoms which indicate the source of injury (as blood in the anterior chamber, luxation of the lens, inflammatory reaction). The dilatation is usually irregular, the iris being narrower at one side. The accommodation is paralyzed, the refraction often astigmatic. This affection is probably due to a rupture or distention of the ciliary nerves in the ciliary body, as Berlin showed experimentally in rabbits. As these changes cannot be seen it is, as a rule, impossible to give any reliable prognosis. In recent cases the treatment is the same as for contusion.

(d) *Mydriasis After Exposure to Cold.*—The assumption of this is based upon the statements of reliable observers, who have not only seen one immediately follow the other, but have also repeatedly seen complete recovery after merely local treatment, especially by the constant current, as this has also been observed in paralysis of one or the other muscles of the eye, especially of the abducens. But if in a given case it be necessary to determine the cause for the sake of prognosis and therapy, prudence demands that we should not form an opinion hastily, basing it upon the mere statements of the patient, but should take into consideration the entire organism and the previous life of the patient; and consider cold as the cause only after all other etiological factors are excluded.

(e) *Syphilitic Mydriasis.*—Syphilis is frequently found to be the

cause of a unilateral mydriasis, which appears suddenly without external cause, and is attributed to taking cold, or to rheumatism. Dr. Alexander, of Aix-la-Chapelle, who, on account of his position, has at his command very rich material for observations, has published some very interesting notes regarding this affection.¹

(f) *Diphtheritic Mydriasis*.—Mydriasis and paralysis of the accommodation after diphtheria, which is always bilateral, is easily diagnosticated. Cases belonging to this type usually occur in children, and are brought to the physician during the stage of convalescence from the throat affection, on account of defective vision on resuming their studies. A nasal intonation often leads to an examination of the velum palati, and the pallor of the child often causes us to make inquiries regarding a preceding illness. In many cases we ascertain, only after a most thorough investigation, "that a slight inflammation has existed in the throat a few weeks previously," but has not been treated medically. The prognosis is exceedingly favorable. The affection disappears in the course of five or six weeks, possibly even without medical treatment. I have sought to aid the recovery by a general invigorating dietetic régime, by baths, at first warm, later cold, by preparations of quinine, iron, and similar means. To enable the patient to moderately use the eye until the power of accommodation has sufficiently recovered I have at first directed strong convex glasses; later weaker ones.

(g) *Mydriasis with Oculo-motor Paralysis*.—In mydriasis and paralysis of the accommodation with simultaneous paralysis of the oculo-motor, the pupil is found considerably dilated, though not *ad maximum*, and may be still further dilated by mydriatics. This mydriasis in reality forms only a part of the paralysis of the oculo-motor, and its prognosis and therapy depend entirely on the etiology of the latter.

(h) Mydriasis in amaurotic conditions will be considered under the latter head.

Mydriasis due to predominating contractions of the dilator muscles occurs in some cases temporarily, in others persistently, lasting for weeks and months, or longer, according as the irritation of the N. sympathicus which causes it is transitory or

¹ Alexander, Ueber einseitige Accommodationslähmung und Mydriasis auf syphilitischer Basis, Berliner klin. Wochenschr., 1878, Nr. 20.

permanent. It has been observed as transitory in cases of hemi-crania, mental disturbances and helminthiasis, and as permanent in affections of the upper cervical ganglion. This subject is more fully treated of by Förster, in Gräfe und Sämisch Handbuch, Vol. VII, page 126.

2. MYOSIS.

1. The expression myosis designates an unusual narrowness of the pupil in one or both eyes, which, in the absence of any special lesion of the eye must be referred to a faulty innervation of the muscles of the iris.

In this affection the pupil, entirely clean and free from exudation, the diameter of which may be estimated at from 1 to $1\frac{1}{2}$ mm., even in distant vision, cannot be properly dilated either by mydriatics or by the influence of light; the anterior chamber is shallow and the range of accommodation does not correspond with the age. The narrower the pupil the greater the disadvantage of stenopaic spectacles. Even if the retina be in a normal condition the patient requires a strong illumination in order to perceive even those objects which lie in or near the visual axis. Myosis produced by drugs, as eserine or pilocarpine, continues only for a short time—a few hours—during which vision for the far point is destroyed or greatly impaired.

In infancy and old age the pupil is normally very narrow. Hypermetropes also have usually a comparatively narrow and apparently not quite round pupil. Persons who are habitually engaged in fine work, especially watchmakers, engravers, jewelers, etc., in later years usually acquire an exceedingly narrow pupil, which generally causes no other disadvantage than the necessity of greater illumination or stronger convex glasses. In all these cases the contracted pupil may still be considered as physiological, especially if the eye does not particularly resist the influence of mydriatics.

2. Myosis as a result of spasmodic contraction of the sphincter, appears with symptoms of irritation or inflammation of the eyeball, and has been already considered. The contraction of the pupil also, which has been observed in meningitis, before attacks of apoplexy, in many cases of poisoning (alcohol, opium, nicotine, etc.) during the stage of excitement, as well as in hysterical and epileptic attacks, may well be referred to irritation of the branches

of the oculo-motorius supplying the sphincter iridis, and is therefore to be considered as transitory.

Myosis due to paralysis of the cervical sympathetic may occur as a single isolated symptom, as in a case described by Kæmpf¹ after a stab in the right side of the neck, or associated with other symptoms of the corresponding side of the face, which was first described in detail by Horner.² The patients, as well as other persons, are struck by an apparent diminution in the size of the eye. The explanation is that the palpebral fissure, in the absence of all irritative symptoms, is not sufficiently opened on account of the paralysis of the smooth fibres of the orbital muscle (*m. palpebralis sup. et inf.* of Müller) supplied by the sympathetic. The upper lid sinks somewhat downwards, whilst the lower one, on the contrary, is drawn up somewhat higher than in the normal condition. In addition to this alteration in the palpebral fissure, which Horner has described as a peculiar form of ptosis, we find during the first few days an increase of the redness, temperature and perspiration of the corresponding side of the face (forehead); later the affected portion becomes pale and cooler, and does not perspire at all. (In the case of a man, the striking difference in the perspiratory secretion may be determined by the lining of the hat.) During the stage of transition, it is self-evident that this difference may not be noticeable for some time. A reduction of the ocular tension and a retraction of the globe into the orbit are less striking symptoms.

This very rare affection has been observed in men as well as in women, mostly during the latter part of their lives, and only in a few cases could the more remote cause be definitely or presumptively ascertained. In Kæmpf's case (which, unfortunately, is indefinitely described), a wound had previously been inflicted in the neck. In a case described by F. von Willebrand,³ recovery was effected after a swelling of the glands under the sterno-mastoid muscle, which had also caused pain in the arm, had been resolved by means of mercury and potassium. In the case of a

¹ Gesellschaft der Wiener Aerzte, Anzeiger 1872, Nr. 10.

² Zehender klin. Monatsbl. 1869, page 193. Nicati, la Paralysie du Nerv sympathique cervicale, Lausanne 1873. Dissertation.

³ Archiv f. Ophth., B I., page 319.

man thirty years old, De Wecker¹ also succeeded in removing the strumous diathesis which was supposed to be the cause, by means of iodine, and with it the myosis. In the case of a woman about thirty-five years old, no exciting cause could be ascertained as having any possible connection with the sympathetic except tænia; as she was unwilling to submit to the treatment proposed for this, she was not seen again. Reuling, of Baltimore,² successfully treated a case of myosis and neuralgia of the arm, following cicatrization of a gunshot wound in the left side of the neck, by means of the constant current and inunction of ung. cinereum with ext. hyoscyami applied upon the cicatrix.

Myosis spinalis is usually bilateral. It is in etiological relation with some disease of the spinal cord, especially with gray degeneration of the posterior columns, and is therefore observed as preceding or accompanying atrophy of the optic nerve with narrowing of the field of vision. On close examination other ataxic symptoms may be observed, such as constipation, partial evacuation of urine, impotency, unsteady gait and formication.

3. *Change of Position. Disturbance of Continuity.*—How the position of the iris with regard to the cornea may be changed after its perforation, after iritis, cyclitis, or scleritis, has already been considered. The different positions in case of myopia and hypermetropia will be explained in considering the anomalies of refraction. Only the following conditions, therefore, call for discussion here.

(a) Iridodonesis, tremulous iris. When the eye is suddenly turned, the iris is seen to oscillate or tremble, because, as in extreme cases of myopia, there is a large quantity of aqueous humor not only in front but behind it also, or because the lens is absent, perhaps sunken into the vitreous humor, or because on account of deficient fixation to the ciliary body the lens is set in motion by the oscillation of the aqueous humor and the vitreous body. (See Diseases of the Lens.)

(b) Irido-dialysis, partial detachment of the iris from the ciliary body, is usually traumatic, the result of a sudden and violent blow; but it may be spontaneously produced by gradual distention or traction, as has already been mentioned (page 148). Trau-

¹ Gräfe und Sämich, Handbuch, B. IV, page 564.

² Knapp's Archives Ophthal. and Otology, Vol. IV, page 228.

matic dialysis is always the result of a violent contusion or compression unless perforation of the cornea has occurred. The cornea being momentarily flattened the circle described by the corneo-scleral border and the ciliary body, with which it is firmly united, is extended, whilst the sphincter iridis is contracted, the serrated connection of the iris with the ciliary body is torn to a greater or less extent and a second communication is formed between the anterior and posterior chambers, which may have the appearance of a second pupil. The next symptom is extravasation of blood into the anterior chamber. Sometimes, even shortly after the injury, only a small quantity of blood is found at the point of laceration, and perhaps covers it. Yet it is manifest, even when no opening is discoverable, by the peculiar irregularity of the pupil. As the sphincter meets with no resistance at the point where the dialysis occurred, it passes from the form of an arc into that of a chord, and the pupil becomes more or less kidney-shaped, especially on dilatation. If the arc of detachment describe a third or a half of the circumference, the peculiar pupil may be transformed into a slit or be entirely closed. In a case of complete dialysis, under the care of the author, the iris shriveled into a small gray lump lying at the bottom of the chamber. The patient was finally able to count fingers, and to distinguish copper and silver coin by color and size. Small detachments are unimportant of themselves, but they demand an examination of the lens as to its position and form, on account of the possible laceration of the zonula and the possibility of the laceration extending into the ciliary muscle or into the choroid or the retina.

(c) Oblique lacerations may occur in the iris simultaneously with the dialysis, and extend from the pupillary to the ciliary border, or they may appear, so to speak, as fissures of the sphincter, probably caused by the contusion of the hard lens against the distended iris at the time of the violent shock.

(d) Apparent absence of the iris may be simulated by the iris being entirely or for the greater part folded backwards upon itself, if in consequence of a severe blow on the eyeball the lens be dislocated into the vitreous and then pressed forwards. O. Becker has pictured such a case in his atlas.

(e) Cysts in the iris are easily recognized as such if their con-

tents are more or less limpid. A vesicle arises in the anterior chamber from a more or less broad base, and extends from the anterior angle of the iris towards or up to the pupil. Some patients perceive the existence of such a formation at the periphery of the cornea long before it advances towards the pupil. The anterior wall is in close contact with the cornea, and its transparency is only impaired by the opacity of that portion of the cornea which covers it. The posterior wall is not translucent, because it is still covered by a layer of iris pigment. It may appear dark or present a steel-gray reflection. Upon either side the vesicle is convex, and therefore distinctly defined from the surrounding healthy portions of the iris, over which it projects somewhat. The convexity of the vesicle is most distinct towards its centre, where it forms a dome whose posterior wall lies in contact with the lens-capsule without being adherent to it. All these conditions are easily comprehended when we consider that a vesicle has formed in the parenchyma of the iris, at a point where it is connected with the anterior surface of the ciliary body, and gradually developed in the direction in which it met with the least resistance. At first the iridic tissues lying in front of the cyst are pushed against the cornea, later they are divided into a posterior and an anterior layer and are pressed to either side and towards the pupillary border. In cases which have not yet progressed so far, the minor circle of the iris may be easily seen, or at least the pupillary border, which only in advanced cases comes in contact with the posterior wall of the vesicle so as to be hidden from view, although in the portion extending towards the pupillary border, which forms a distinct angle with the surrounding iris, especially in brown eyes, iris pigment may still be perceived upon the wall of the cyst. Frequently such a cyst shows a lustre similar to that of mother-of-pearl, perhaps because its enveloping membrane is coated with epithelial cells.

If the contents of the cyst be turbid or more or less solid the diagnosis is more difficult, or perhaps possible only by excluding other iridic neoplasms. Monoyer¹ has described and drawn such a case as pearl epithelioma.

In a case published by Richard a two-lobed cyst of opal blue color contained a gelatinous liquid. In one described by Turner,

¹ Epithelioma perlé ou margaritoide de l'iris, Paris 1872.

and another by Feuer the contents of the cyst were partially turbid. A. von Gräfe describes the contents of a cyst which also included short hairs, as sebaceous or puffy; and in another case, in which the cyst had been caused by a cilia in the anterior chamber, the sebaceous-like contents consisted of large, flattened epidermal cells, on which account the cyst was designated as epidermoidal. In such cases either the vesicular character or the discovery of a previous injury may greatly facilitate the diagnosis.

In almost every case hitherto published the patient acknowledged that a few months or years previously the eye had been wounded by some instrument which was capable of perforating the cornea. Usually, the point of a pair of scissors, a knife, fork or a fine wire, etc., was designated as the cause of the injury. In almost every case the cicatrix which marked the point of injury was found in the corneo-scleral border; that is to say, in that region in which the neoplasm originated, where it had been noticed by observant patients long before its advance into the vicinity of the pupil had led them to consult a physician. In the case described by Monoyer, the corneal cicatrix was located near the centre, whilst the tumor had developed outwards and below (from the anterior iridic angle), and a smaller one was developing diametrically opposite (inwards and upwards). In the case which A. von Gräfe minutely observed and described in Vol. VII of his Archives (second part, page 139), and in Vol. X (second part, page 211), the perforation lay in the lower border of the cornea, and after two years an exceedingly white, almost glistening cone with a broad base was developed above from the anterior angle of the iris. But in the one as well as in the other case, the cyst developed from a cilia which was driven into the eye at the time of the perforation. Even if, in a given case, no injury has been mentioned, and even if no cicatrix can be found, it should not be forgotten that we sometimes find a foreign body in the eye, especially in the lens, without the patient having any remembrance of injury, and when the perforation, if it lies in the scleral border, may be cicatrized so completely as to be wholly overlooked.

Concerning the origin of iridic cysts and their connection with the previous wound, Rothmund first called attention to the fact

that in such wounds not only cilia, but also particles of skin or of the epithelial coating of the eyeball may be driven into the iris at the time of the injury, and thus lead to epithelial proliferation. Sattler, who in the main accepts this view, remarks, concerning the development of serous cysts: "Since we know that detached layers of epithelium and endothelium, pieces of muscles, etc., introduced into serous cavities continue to live and produce from the old cells new and even giant cells, it may be safely assumed that the elements of tissue introduced into the fissures of the iris may remain alive or may even proliferate to a certain extent. At all events, it is probable that in consequence of the irritation, however slight, but continued by the presence of the foreign body, the surrounding tissue is stimulated to increased activity and the interstices are enlarged by serous exudation. Thus an interspace filled with serum may form, around which the tissue becomes somewhat thickened and coated upon the inside with an endothelial layer of cells, by which it is, in a measure, closed. In this condition the small cyst may exist for a longer or shorter time until, through some external influence, increased exudation and rapid enlargement is suddenly induced, or the enlargement may be gradual, as the presence and growth of the neoplasm may, in itself, maintain a certain degree of irritation. Since we have to deal with a pathological neoplasm, it need not excite astonishment if, by proliferation of the endothelium, a layer of several strata is sometimes formed; and we can easily understand that if the irritation increases beyond a certain degree, pus or blood may appear at the bottom of the cyst. The occurrence of cysts containing several separate chambers is explained without difficulty by this assumption. If we wish to arrange the serous iridic cysts into one of the well-known categories of cystic tumors, we are most warranted in placing them among the exudation cysts." It may be added that in order to engraft an epidermal or epithelial element upon iridic tissue, only that portion of the iris is suitable which is resting upon the ciliary body, and, therefore, has an unyielding basal membrane. Possibly the fine trellis-work of the ligam. pectinatum offers a specially favorable soil for the reception and development of the engrafted tissue. In the cases with sebaceous contents (Monoyer, Gräfe), it may be assumed that greater irritation

has been excited by the cilia being forced into the peripheral portion of the iris. What De Wecker¹ has designated as cystic formation after invagination and sacculation of a portion of the iris, has not as yet been examined anatomically, but its clinical features are entirely different from what has been previously otherwise described.

Iridic cysts become dangerous by advancing into the pupil, which they may finally entirely obstruct. A further disadvantage may be occasioned by pressure upon the lens. The cases of iritis or irido-cyclitis and consecutive sympathetic inflammation in the other eye are probably caused not by the cyst alone, but by the simultaneous presence of cilia or external noxious influences. A partial dialysis of the iris near the cyst, which has been several times observed, may have occurred at the time of the injury or subsequently during a rapid growth of the tumor.

If the neoplasm be sufficiently large, a wound about 4 or 5 mm. should be made in the scleral border with a lance-shaped knife, care being taken, in its introduction, not to perforate the cyst; on withdrawing the knife, it is to be slightly turned so as to open the sac and evacuate its contents through the wound. If the escaping aqueous humor does not force out the enveloping membrane, it should be seized with a pair of fine forceps, drawn out and snipped off closely. The advantage of this method is that no remnant of the cyst remains in the eye. The anterior wall, which forms the principal part of the enveloping membrane, may be excised almost entirely, together with the lateral walls, as it is not united to Descemet's membrane, or, at most, is only adherent, and it is desirable that the peripheral portion of the posterior wall, which is supplied with pigment, should remain in the eye. But if the cyst be so small or opaque that this operation cannot be performed with a probability of success, it will either be necessary to make a flat arc-shaped incision with a Gräfe's knife, as is customary in extraction of the lens in case of a very shallow anterior chamber, or to make an incision near the cyst with a lance-shaped knife, and afterwards enlarge it with a blunt-pointed knife so that a curette may be introduced and the cyst drawn out through the wound.

4. As Telangiectasis, Mooren has described a tumor on the

¹ Gräfe und Sämisch Handbuch, B. IV, page 543.

external portion of the iris of the right eye resembling a blackberry in appearance and size. It touched the cornea, and its anterior surface was traversed by several dilated blood-vessels. It had been observed during the previous year, and caused impairment of the sight only temporarily; when the head was violently shaken and suddenly bent forwards, the anterior chamber filled with light-colored blood, which completely disappeared after a few minutes' rest. Operative interference was declined because the disease had not otherwise caused the slightest inconvenience. Four years after the first examination the tumor was diminished to about one-third its original size and had assumed a dirty gray color; and instead of the enlarged vessels, numerous isolated deposits of pigment were present. Blood had not been observed in the anterior chamber for a year previous to the examination. Glaucomatous symptoms appeared and the eye finally became blind.

5. A. von Gräfe observed a stationary congenital pigment-tumor of the iris in a girl fifteen years of age. It was situated upon the lower pupillary border, measured $1\frac{1}{2}$ lines horizontally and 1 line vertically, and extended almost to the cornea. The color was dark brown, like the pigment of the pupillary border, the surface smooth and the outline uniformly rounded; it moved perfectly with the iris, and slightly narrowed the pupil. The author has seen, in a woman seventy years of age, a similar, somewhat smaller and more circular tumor in the lower segment of the iris of the right eye, which had become cataractous. Later, cataract was also developed in the left eye, and after four years observation no alteration could be perceived in the growth or appearance of the tumor. Peripheral extraction (upwards) was performed, and the best result obtained.

6. Regarding granuloma of the iris (tuberculosis iridis) and

7. Syphiloma or gumma of the iris, which at first may be easily mistaken for granuloma, sufficient has already been said.

8. Melano-sarcoma may originally be developed in the iris, to which it remains limited for a long time; but it probably more frequently originates in the ciliary body or the choroid, and after a few months extends to the neighboring organs. In a case observed at von Gräfe's clinic, and described by Hirschberg,¹ a dark

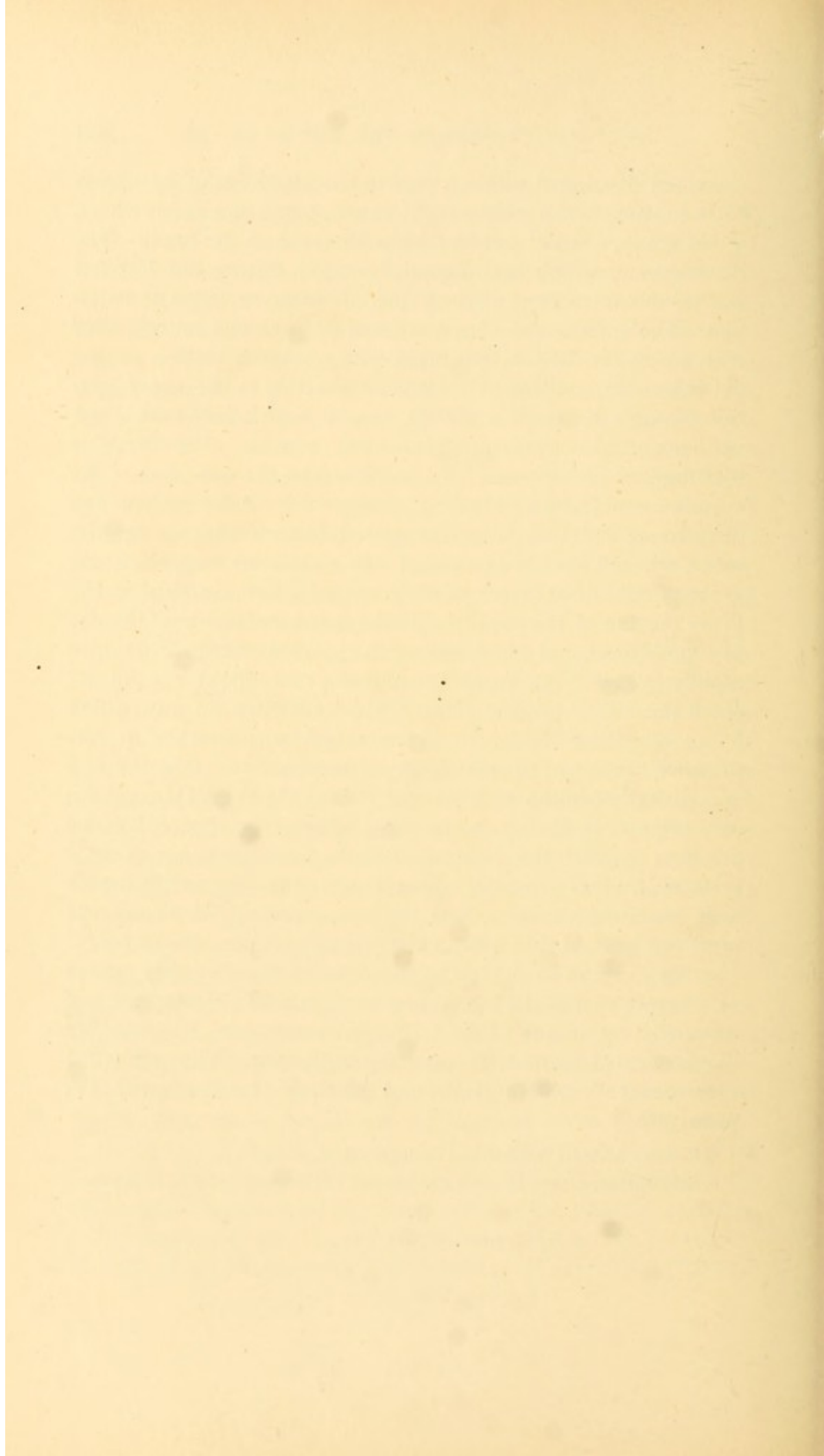
¹ A. f. O., XIV, c 285.

mass had developed within a year in the right eye of an apparently healthy farmer, thirty-eight years of age, at a point where, in his youth, a dark spot had been observed in the pupil. The development, which was especially rapid during the last few weeks, was unaccompanied by pain, redness, or signs of irritation. The anterior chamber was found to be almost entirely filled with a peculiar dark brown mass, with a smooth surface, so that the otherwise unchanged iris was visible only in the upper portion, though the pupil could be seen as a dark half moon, and neither central nor eccentric vision was reduced. The diagnosis—malignant tumor—was fully confirmed by the condition of the eye after enucleation. Healing progressed favorably without any disturbance and the patient presented himself after six months much rejoiced over his recovery. In a vigorous man, thirty-six years of age, who, twelve years previously, had observed at the lower portion of the pupillary border a red nodule about the size of a pin's head, and which during the previous month had grown rapidly (7 mm. high, 5 mm. broad and 4 mm. thick) but did not reach the ciliary border, Chas. Kipp¹ undertook an extirpation by an operation similar to that adopted² by the author in two previous cases, and found, eighteen months later, that the eye was perfectly healthy with normal vision. In vol. VIII, page 82, of his Archives, Knapp reports three other cases, observed in his practice, in which the extirpation of the tumors was successfully performed. It is generally advisable, after the diagnosis has been well established, to enucleate the eye, especially if we are not positively certain that we can completely extirpate the tumor.

9. Cysticercus in the iris or the anterior chamber may appear as a simple cyst of the iris, but on more critical examination, and especially by means of focal illumination, it may be definitely diagnosticated by its well known peculiarities. The published cases are collected in Gräfe und Sämisch Handbuch, vol. IV, page 576.

¹ Knapp's Archives Ophthal. and Otology, vol. V, p. 34.

² Arlt, Operationslehre, in Gräfe und Sämisch's Handbuch, III Bd., page 420.



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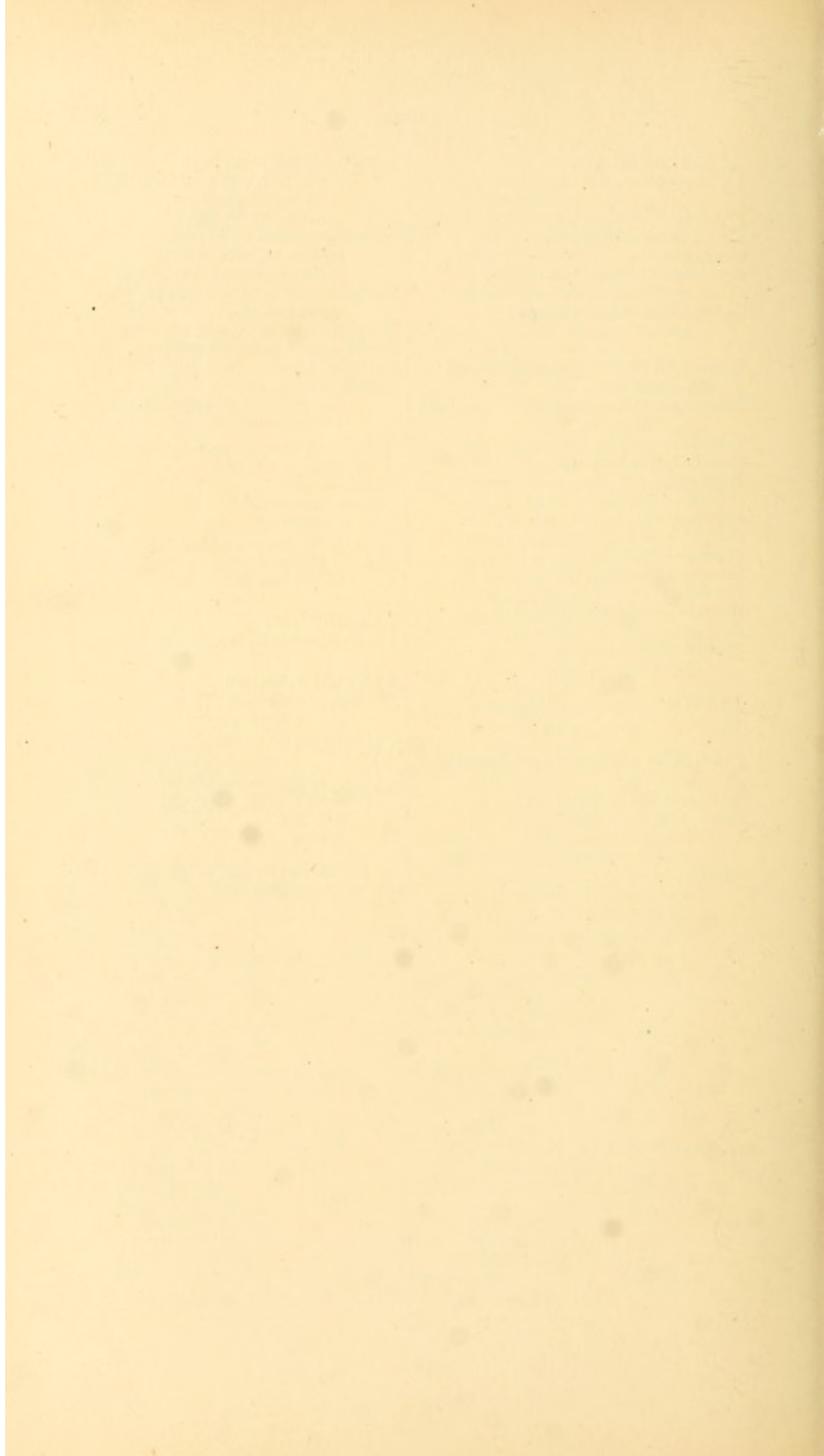
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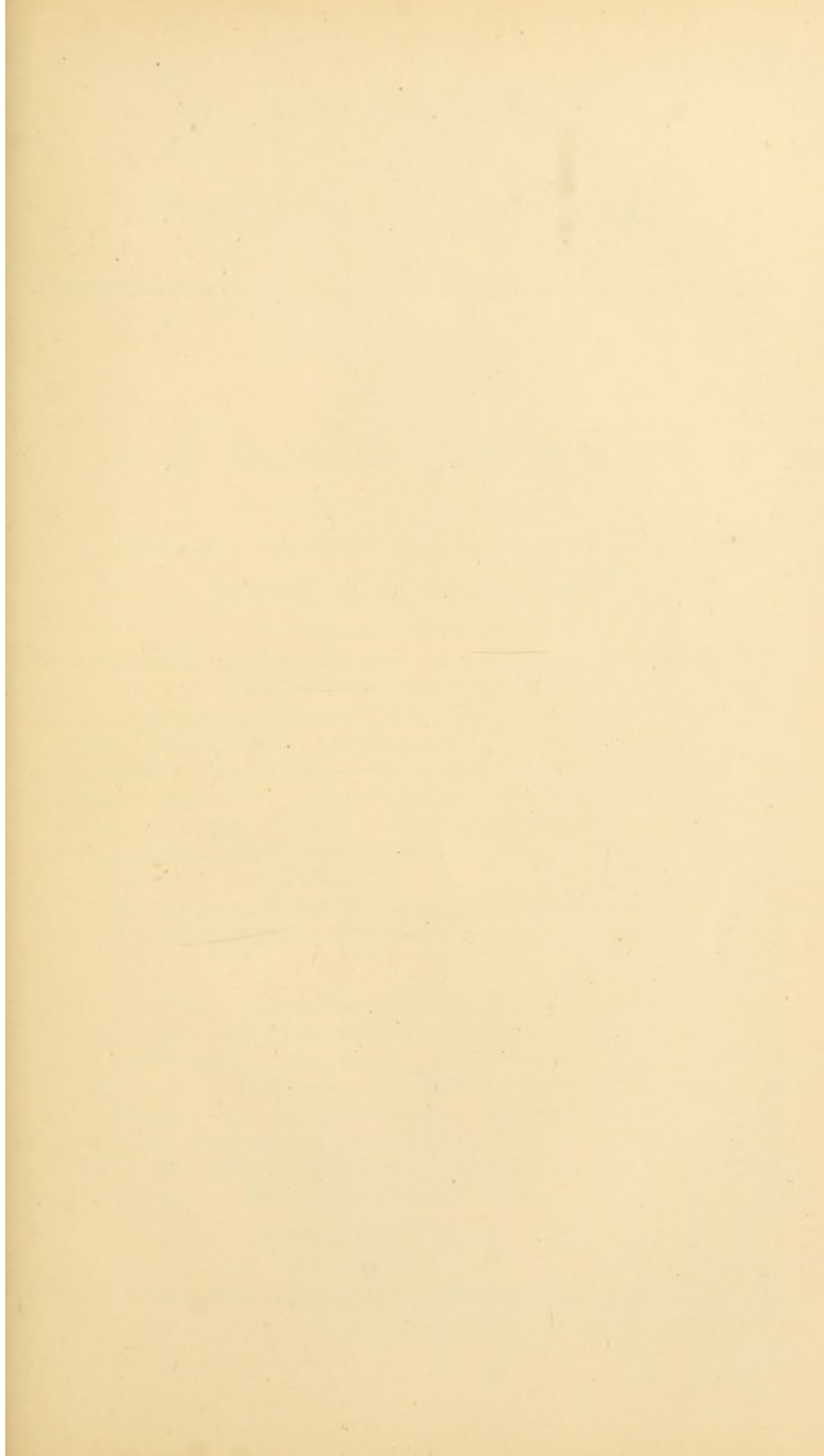
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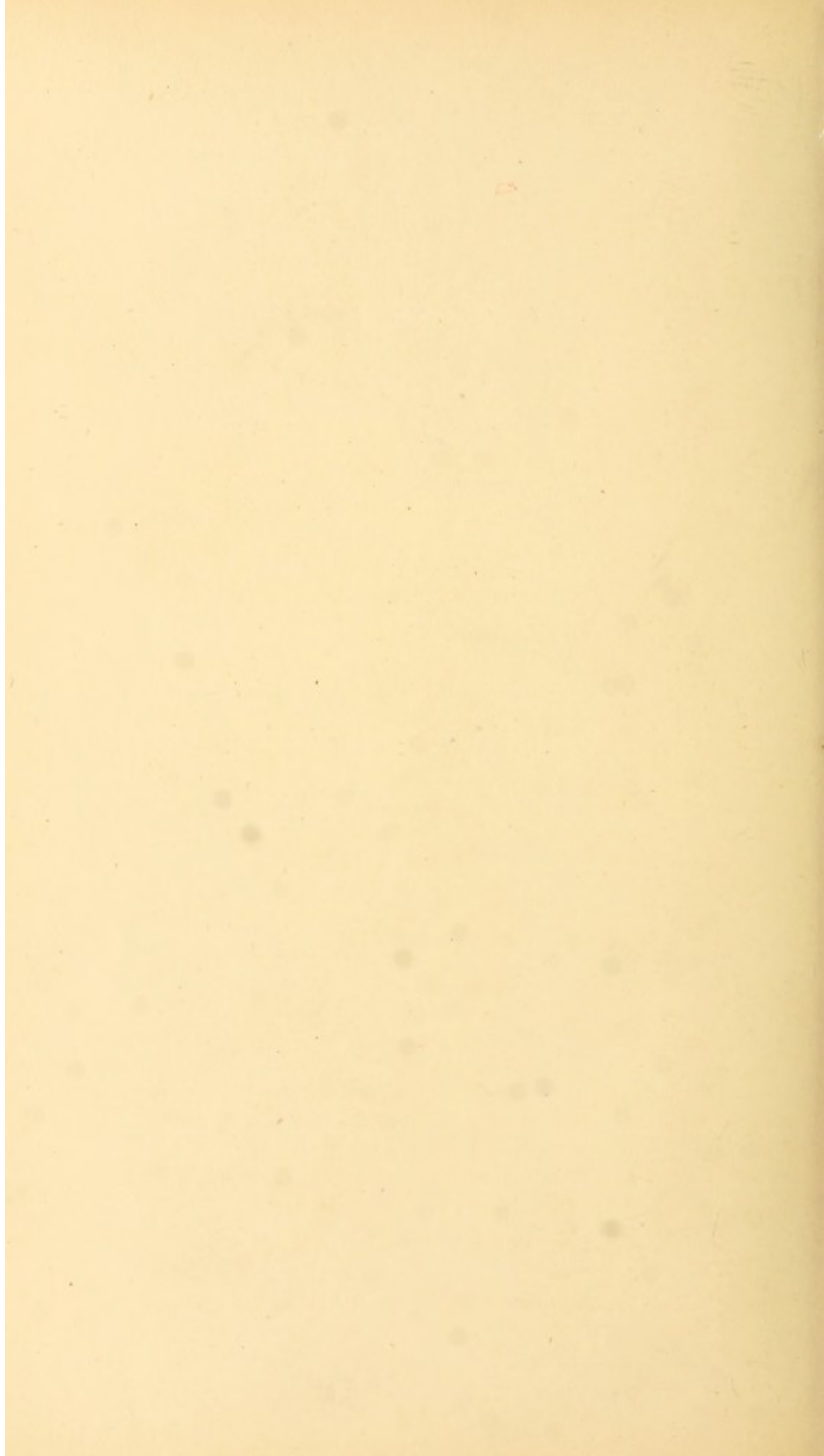
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
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
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
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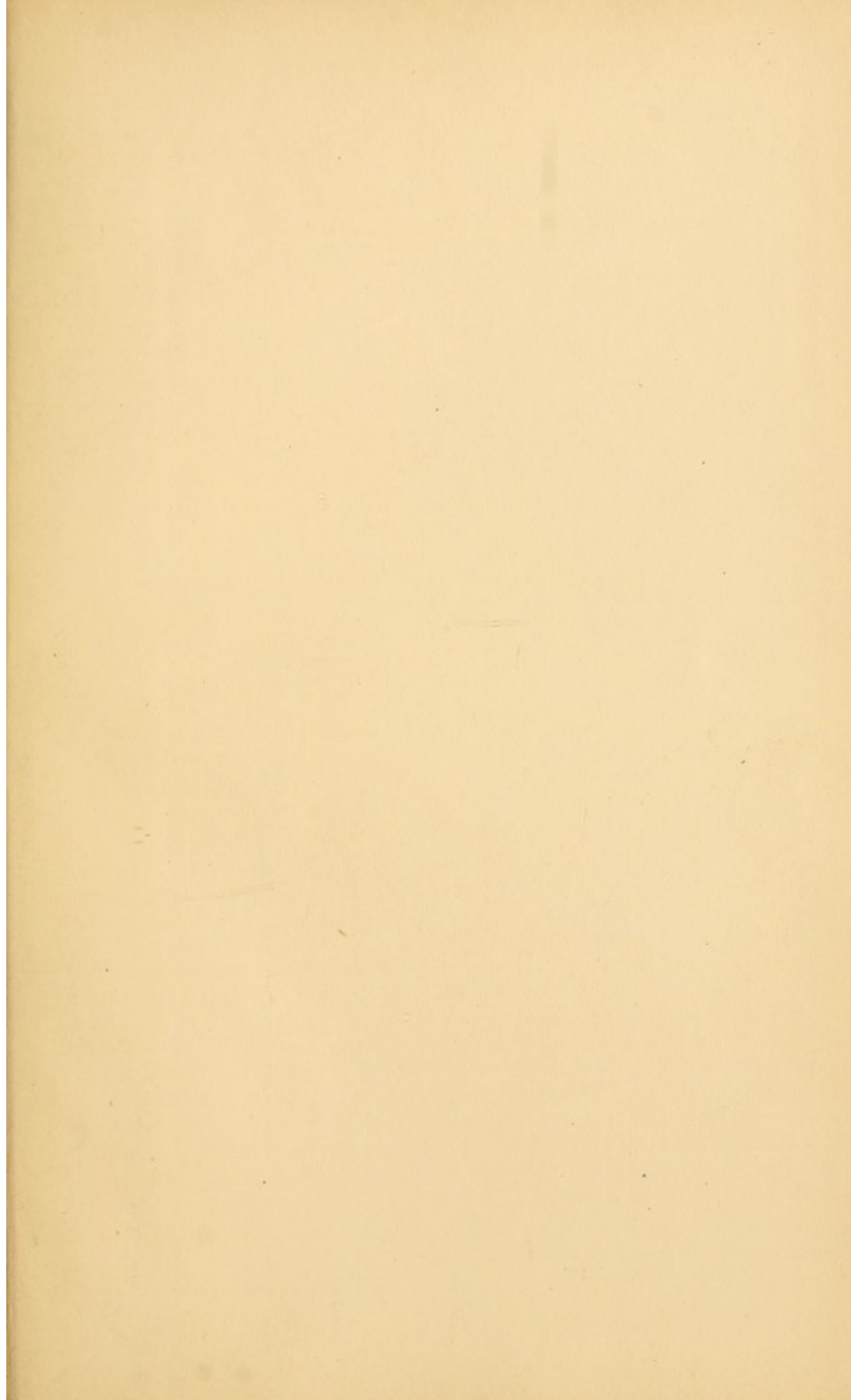
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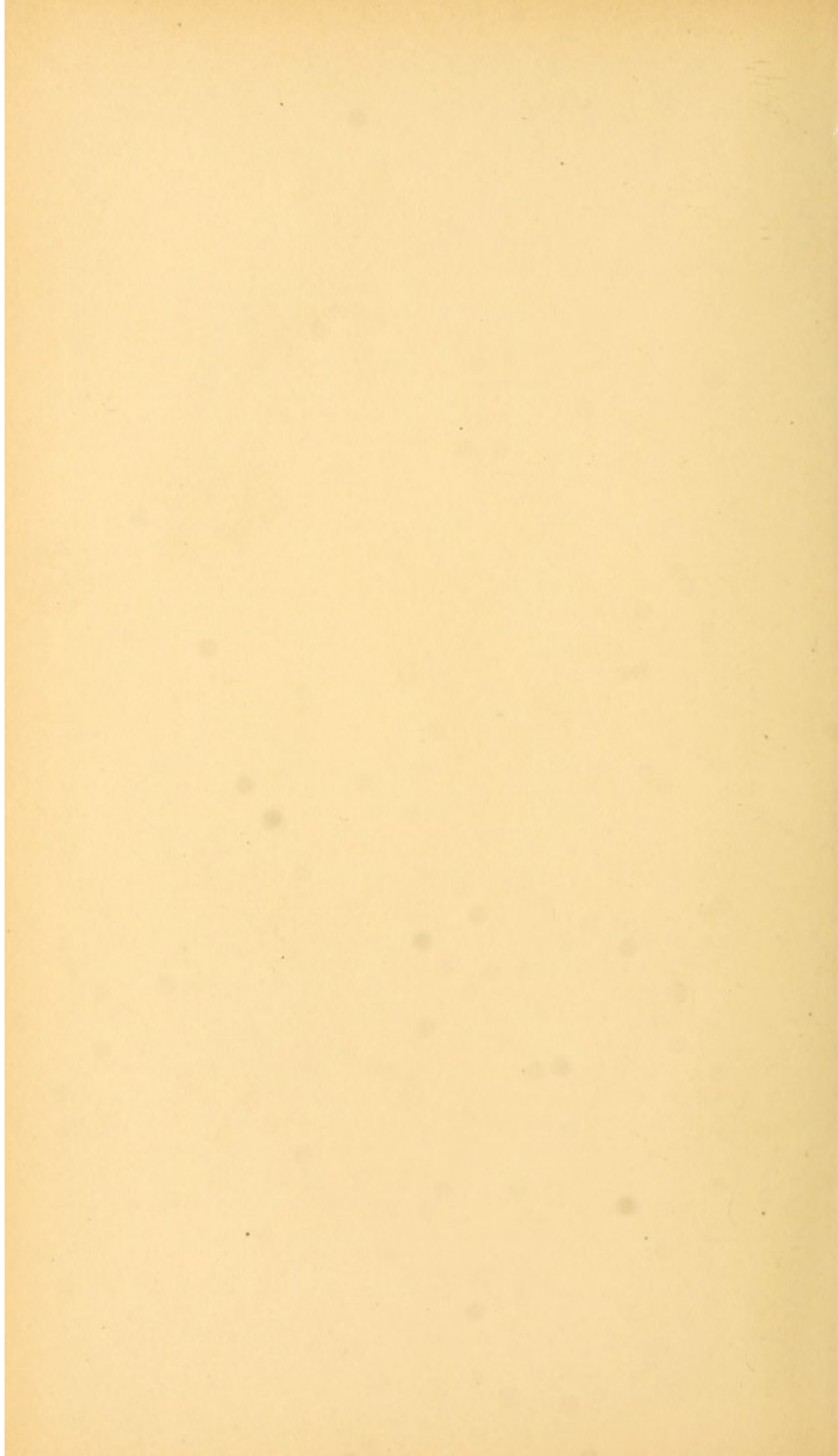
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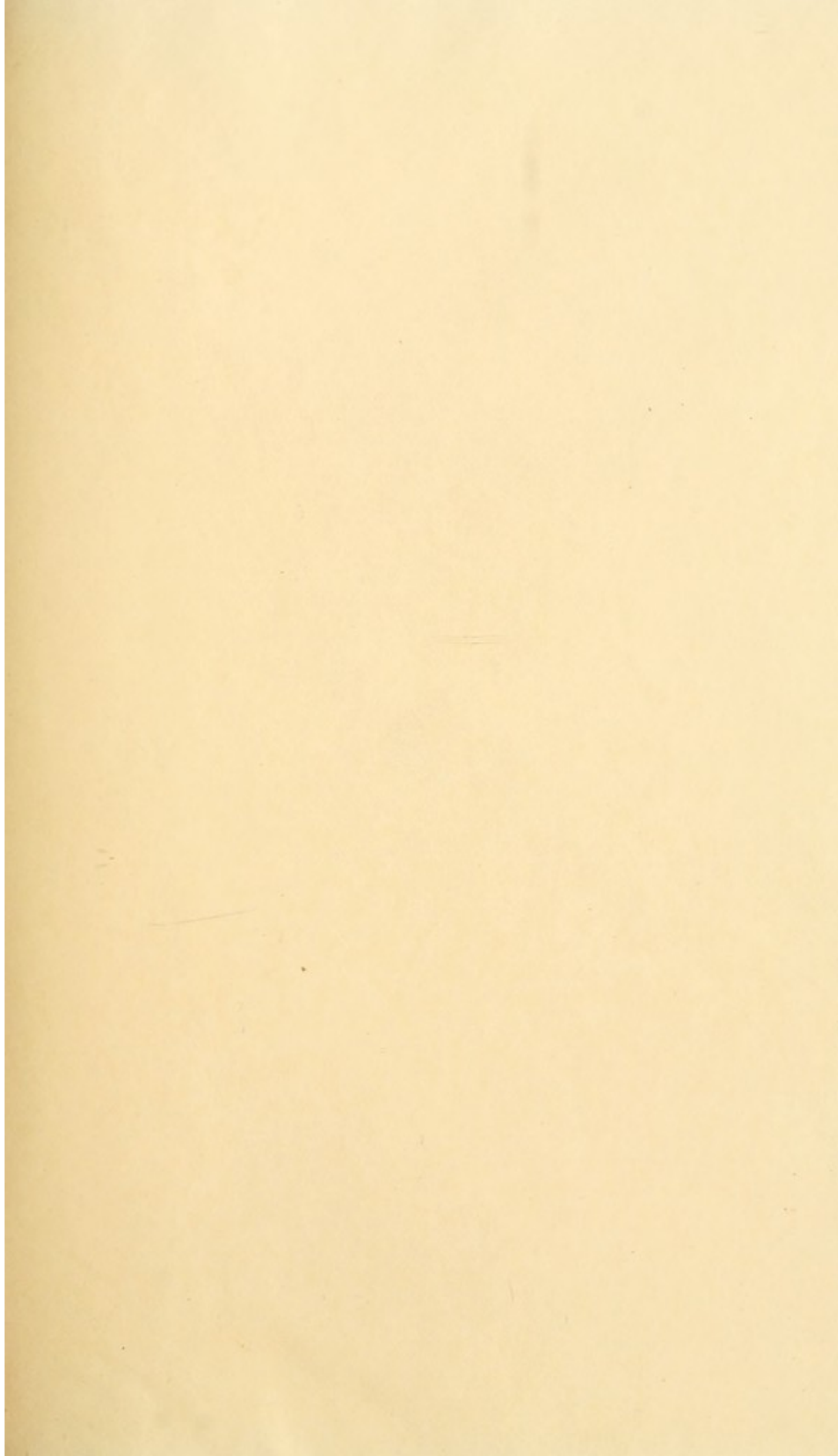
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