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NOTICE TO SUBSCRIBERS.

The Author proposes to issue further numbers of this work from time to time, as he meets with specimens suitable for illustrations. In future, the execution of the illustrations will be superior to the first two parts, and at least equal to the illustrations of Sputum, the Kidney, and Epithelium, in the present number. Where necessary, coloured plates will be introduced. Each part will contain from four to eight octavo plates, with descriptive letter-press, and two or three will be issued in the course of the year. The price of each part will be 2*s.* 6*d.*

Part IV will be published as soon as possible; but, from the nature of the subjects to be illustrated, a longer time must elapse than heretofore, as it is difficult to meet with specimens adapted for illustration.

The Author hopes still to receive the co-operation of friends in procuring specimens, and he desires to thank many for very valuable help.

The subjects to be illustrated in future parts are—Vomit, Sputum, Discharges from the Alimentary Canal, Saliva, Bile, Animal and Vegetable Parasites, &c.

A new title page is furnished with the present part, for the convenience of those who may desire to have the CONSTITUENTS OF THE URINE, URINARY DEPOSITS, and CALCULI, bound at once.

*** The binder is requested to insert Plates XXIII and XXIV, with the explanations, after Plate XXII.

The plate of the Kidney is to face the title page.

ANATOMY OF KIDNEY

ILLUSTRATIONS

OF

THE CONSTITUENTS OF

URINE, URINARY DEPOSITS, AND CALCULI.

BY

LIONEL S. BEALE, M.B., F.R.S.,

LICENTIATE OF THE ROYAL COLLEGE OF PHYSICIANS, PHYSICIAN TO KING'S COLLEGE HOSPITAL, AND PROFESSOR OF PHYSIOLOGY AND GENERAL AND MORBID ANATOMY IN KING'S COLLEGE, LONDON, HONORARY FELLOW OF KING'S COLLEGE.

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ANATOMY OF THE KIDNEY.

In order to obtain an accurate idea of the manner in which casts are formed, and to understand the morbid changes taking place in disease, it is necessary to be acquainted with the minute anatomy of the Kidney, and it has been thought desirable that this drawing should be added to the plates of Urinary Deposits.

There can be no doubt that, in most cases where blood comes from the kidney, it escapes from the vessels of the Malpighian tuft.

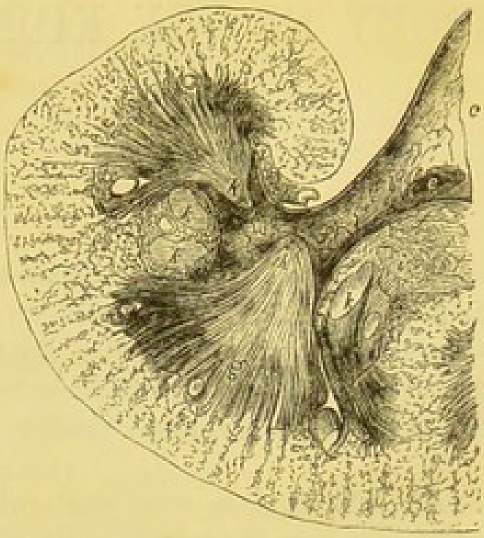
Casts are, for the most part, formed in the convoluted portion of the uriniferous tubes, and from the microscopical characters of the casts found in the Urine, we are, in many cases, able to form an accurate idea of the changes taking place in the Kidney at the time of its formation.

There is reason to believe that some of the largest casts are moulds of the straight portion of the tube, and there can be little doubt that such casts as that marked *b*, plate XVI, are formed originally at one part of the uriniferous tube, while new material is afterwards deposited upon it. Its length and straightness render it certain that this deposition must have taken place in the straight portion of the tube, for the contortions of the tubes in the convoluted portion are far too numerous to permit of the formation of such a cast.

The frontispiece illustrates the anatomy of the Kidney. The portion represented extends from below *g* in the medullary portion to the external surface of the cortex, as shown in the accompanying woodcut, fig. 1, which is a drawing of a Kidney, in which the arteries had been injected, divided longitudinally a little on one side of the centre. The woodcut is of the natural size.

The drawing in the frontispiece is divided into three parts, in order to avoid the confusion which would result from endeavouring to represent, on so small a scale, all the structures as they really exist in nature.

Fig. 1.



a. Cortical portion. *b*. Medullary portion. *c*. Pelvis of Kidney. *d*. Infundibulum *e*. Opening of another Infundibulum into Pelvis. *f*. Calyx. *g*. Pyramid. *h*. Mamilla, or Papilla. *i*. Adipose tissue. *k*. Large veins divided in making the section. Small arteries are also seen cut across in different parts of the section, the largest being situated between the cortex and medullary portion of the organ.

On the left are represented the uriniferous tubes, with Malpighian bodies, the *vessels* not being shown. Next, towards the right, are seen arteries with their tufts. At the lower part, the efferent vessel of a tuft is observed to divide into a number of straight branches, which pass to the medullary portion of the Kidney.

On the right, the capillary vessels of the cortex and pyramids are seen. To form an idea of the real condition, the reader must imagine all these structures, which are represented separately, in close relation to each other.

The relative size and relation of the parts has been carefully preserved. If reference be made to the explanation below, it is hoped that the drawing will be understood.

EXPLANATION OF THE PLATE.

Fig. 1. Part of the cortex, with the commencement of the medullary portion of the Kidney, magnified 15 diameters.

a. Branches of artery.

b. Afferent vessels of tuft.

c. Malpighian tufts.

d. Efferent vessel of tufts.

e. Network of capillaries, into which the blood, after having traversed the capillary loops of the tuft, is carried.

f. Small radicles of renal vein, by which the blood is returned to the large trunks.

g. Long and almost straight vessels (*vasa recta*), into which the efferent vessel of those tufts situated at the bases of the pyramids, divides. These straight vessels may be traced for some distance towards the apex of the cone.

h. Veins in the same situation, which return the blood to the large venous trunk, *i*.

k. Capillary network in the pyramids.

l. Portion of the capillary network of the cortex, where the meshes are elongated, corresponding to the direct course which many of the uriniferous tubes take, at regular intervals, in the cortex.

m. Network of other parts of the cortex, in which this arrangement is not observed.

n. Malpighian bodies not injected.

o. Convoluted portion of uriniferous tube.

p. Tubes having a direct course towards the cones, situated at regular intervals through the cortex. At *l* would be situated another parcel, and at *q* a third. The arteries pass in the intervals between these, as represented.

q. One of the tubes isolated. I have never been able to demonstrate the branches represented, in the human subject, but from their existence in some of the lower animals it is probable that a similar arrangement may be found in the higher. The branches *r* must therefore be considered merely diagrammatic.

r. Branches continuous with the convoluted portion.

s. Wavy portion of uriniferous tube, at the commencement of the cones.

t. Capsule of Kidney.

u. Uriniferous tube, with Malpighian tuft and capillary vessels complete.

v. Capillary network, with fragments of uriniferous tubes, from which the epithelium has been washed out (the so-called *matrix* of the Kidney).

Fig. 2. Uriniferous tube, with dilated extremity, which embraces the vessels of the malpighian tuft. The epithelium is seen in the convoluted portion of the tube, but cannot be traced within the capsule in the human subject.

Fig. 3. Small artery, with tuft and capillary network, accurately copied from a specimen. The artery is seen to divide into three or four branches, and each of these gives off capillary loops, which divide and subdivide for some distance before they communicate with those of another division. The letters refer to the same parts as indicated in fig. 1.

Every part of fig. 1, with the exception of *q*, *r*, has been copied from actual specimens, prepared from a number of Kidneys. The separate drawings thus obtained have been grouped in their proper position, in order to complete the drawing.

Fig. 2 is partly copied from nature.

Fig. 3 is entirely traced from a preparation. The injection employed for making the specimens was the Prussian blue fluid.*

* "How to work with the Microscope."

INTRODUCTION.

It has long been my desire to publish drawings of Urinary deposits, and other objects of interest to the student of clinical medicine, but the difficulty of obtaining plates at moderate cost has hitherto rendered this impossible. Representations of objects, to be of any real assistance to the practitioner, must be very numerous, or he experiences great inconvenience and disappointment from constantly meeting with specimens which are not delineated in his atlas of plates, and the nature of which he is unable to discover. Students of every branch of natural science must feel how very much more may be learned from objects and from drawings than from mere description. This is particularly the case in those departments of practical medicine in which the microscope is of real importance, as in the investigation of diseases of the kidney, chest, stomach, skin, &c.

The representations given have been accurately copied from the objects in the microscope, with the aid of the neutral tint glass reflector. The image has been traced on properly prepared paper, from which it has been directly transferred to the lithographic stone. The drawings have all been made under my immediate superintendence, and, in some instances, by myself.

The greater number of the drawings are quite new, but a few have been copied from my work on "The

Microscope, and its Application to Clinical Medicine" (nearly out of print), and have been repeated to render the series as complete as possible. These will be found in plates XI, XII, and XIV.

The magnifying power of every object-glass employed for copying the objects has been ascertained, and the number of diameters which it is magnified, is affixed to every figure; thus, $\times 45$, $\times 215$, signifies that the object is magnified 45, or 215, diameters. To each drawing is also appended a *micrometer scale, magnified in the same degree as the object itself;* thus, 1000ths |___|___|___|___| $\times 215$, means, that each division represents the thousandth of an inch magnified 215 diameters.

If the object extends over one division, it is 1-1000th of an inch in diameter, if over two, it is, of course, 2-1000ths, which is equal to 1-500th, if over two and a half divisions it is 2-1000ths and 1-2000th, or 5-2000ths, or 1-400th. These figures may be more clearly expressed in fractions. Supposing the object to extend over two and a half divisions, it equals 5-2000ths, or $\frac{5}{2000}$ths, or $\frac{1}{400}$ of an inch. If only over a quarter of one division, it equals the $\frac{1}{4}$ of $\frac{1}{1000}$th $= \frac{1}{4000}$, or, in other words, the *thousandth of an inch* is divided into four parts, of which the object covers one, or *an inch* is divided into 4000 parts, of which one corresponds to the diameter of the object.

By carefully comparing the objects delineated with the divisions of the scale, the diameter of every object can be at once ascertained, care being taken that both are magnified in the same degree; thus, fig. 1, plate I, which is magnified 130 diameters must be compared with the upper scale, which is also magnified 130 diameters, while the lower scale is magnified 215 diameters, and can therefore only be compared with those figures magnified in the same degree.

The explanation of each plate is inserted immediately opposite to it, and on the other side of the page a short description of the general characters of the deposit, and of the tests employed for its detection, is given.

The *figures* have no pretensions to be considered beautiful drawings, or to be looked upon as works of art, but it is hoped they will be found accurate, although somewhat rough, representations of nature, as the greatest pains have been taken to render them faithful copies. Where it is necessary I have alluded to the most important chemical tests, and added references to my "TABLES FOR THE MICROSCOPICAL AND CHEMICAL EXAMINATION OF URINE."

It is my intention, from time to time, to publish numbers arranged upon the same plan as the present. The second number, which will be ready in October, will also contain representations of Urinary deposits; but I hope to be able to publish drawings of the most important characters of sputum, vomit, and other objects of clinical interest, some of which will be printed in colours.

PATHOLOGICAL LABORATORY,
27, Carey Street, W.C.

June 20th, 1857.

PLATE I.

EXTRANEOUS MATTERS COMMONLY FOUND AMONGST URINARY DEPOSITS.

Tables for the examination of Urine, § 29.

Fig. 1. *Portions of hair from a blanket.*

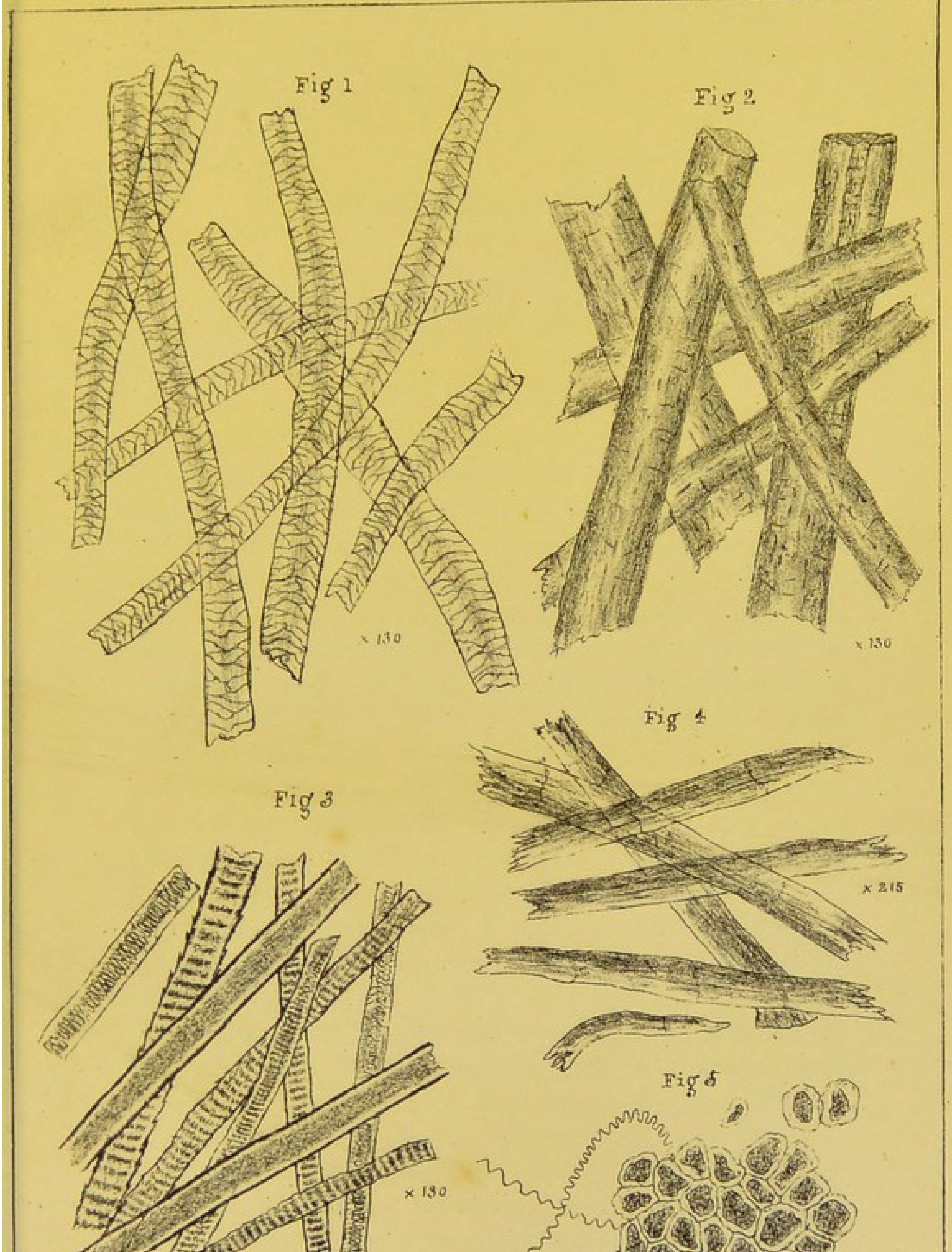
Fig. 2. *Fragments of human hair.* In one the central canal occupied with the soft cells of the medulla is represented.

Fig. 3. *Fragments of cat's hair.* Some of them near the apex, and others close to the root of the hair.

Fig. 4. *Portions of flax fibres.* Their characters should be carefully contrasted with those of cotton. (Plate III, fig. 16.)

Fig. 5. *A portion of tea leaf.* Fragments of spiral vessels are seen projecting from several parts of the margin, and in the upper part of the figure may be noticed some separate cells, which must not be mistaken for epithelial cells derived from any part of the genito-urinary mucous membrane.

URINARY DEPOSITS I.



EXTRANEOUS MATTERS.

PLATES I, II, III.

EXTRANEOUS MATTERS.

I BELIEVE that the greatest difficulty with which the student has to compete when he commences to examine objects in the microscope, arises from the presence of foreign substances, which have become accidentally associated with the specimen under examination. The microscopical character of many of these extraneous matters is very striking, and unless the observer is familiar with their appearance he is very likely to mistake them for structures which he is looking for. Indeed, practical observation will alone enable any one to describe and interpret with confidence what he has seen under the microscope. He must not be led into the error of giving a name to what he sees, because it appears to him to resemble in appearance a structure of which he has merely read a description, or of which he has only seen a bad drawing.

I think it will be admitted that I am not overstating the importance of this matter, when it is stated that portions of feather have been gravely described and figured as lymphatic vessels, fragments of vegetable hairs as portions of nerve fibres, and numerous other blunders, not less culpable or ridiculous, have been made and promulgated. Of all substances likely to be examined by the medical practitioner, urinary deposits are liable to contain numerous structures which are of accidental

PLATE II.

EXTRANEOUS MATTERS COMMONLY FOUND AMONGST URINARY DEPOSITS.

Fig. 6. *Potato starch.* Distinguished by its ovate form, and by the *hilum,* or point around which a number of concentric lines are arranged, being situated near one extremity.

Fig. 7. *Wheat starch.* Distinguished by its circular form. The hilum is seldom visible, but its situation is central.

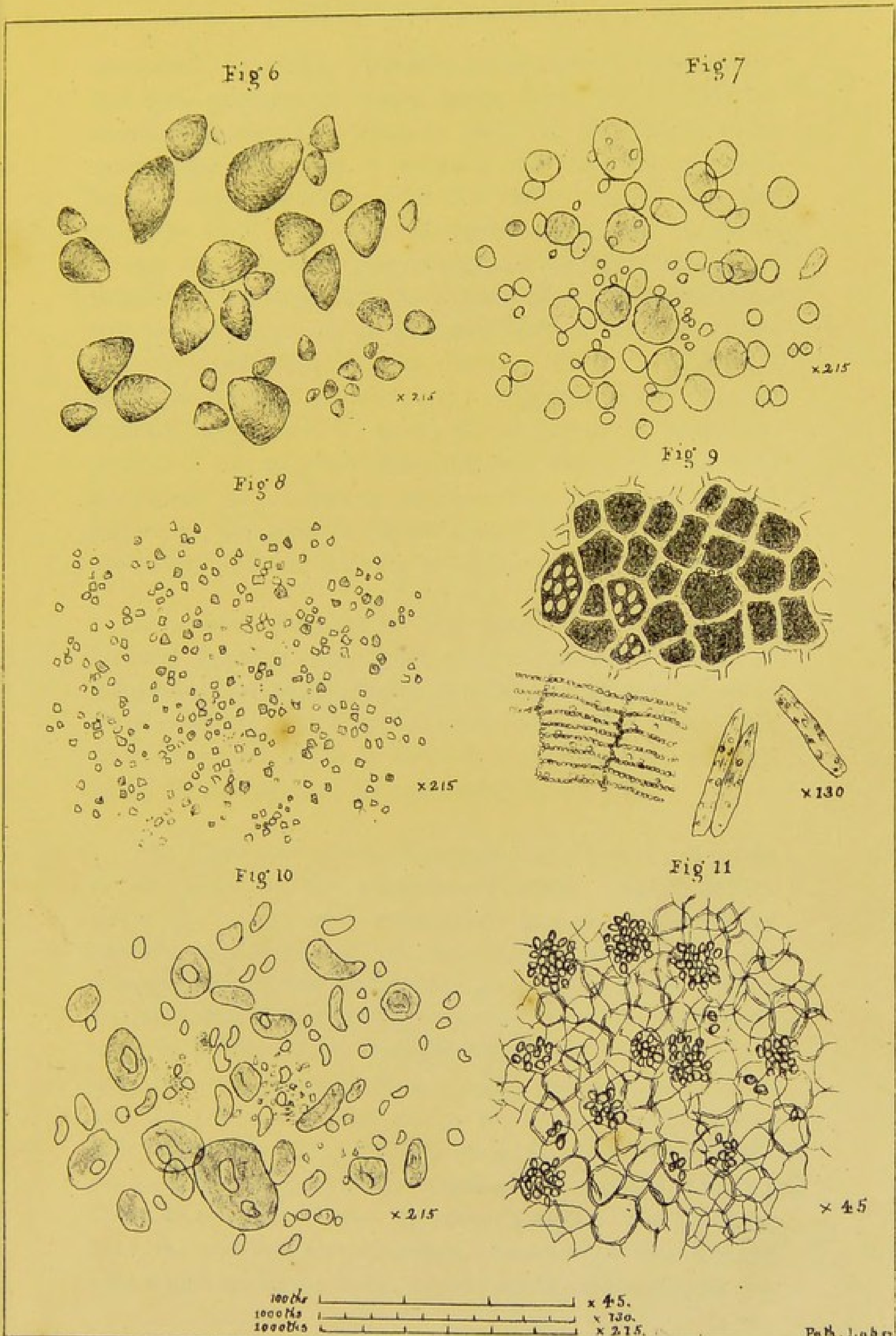
Fig. 8. *Rice starch.* Distinguished by the very minute size and irregular form of the corpuscles.

Fig. 9. *Testa of wheat,* which forms the external covering of the grain.

Fig. 10. *Bread crumbs.*

Fig. 11. *Cells of potato,* in which the starch is contained. A few of the cells are filled with starch granules.

URINARY DEPOSITS II.



EXTRANEOUS MATTERS.

presence. Carelessly placed in an uncovered vessel under the bed, particles of down, hairs from the blanket or counterpane are very likely to fall into the Urine, while every time the room is swept a vast number of other bodies, comprehended under the term "dust," are sure to make their way into the vessel containing it, which is also the acknowledged receptacle for every species of rubbish which requires to be got rid of. The practitioner will not be surprised at the multitude of strange bodies he will meet with in the deposit which is collected for microscopical examination. Though much trouble and difficulty would be saved if the ingress of these was prevented by carefully covering the fluid; yet as it is practically impossible to enforce this precaution in all instances, the observer must guard himself against the possibility of being led into error from such a cause.

In a work devoted to the practical examination of Urinary deposits and their recognition as a means of diagnosis, it seems desirable that the characters of some of the extraneous matters most commonly met with, should be first given, so that the observer may at once guard himself against the possibility of mistake.

The fragments of hair delineated in Plate I are liable to be mistaken for portions of casts. Their higher refractive power, and consequent greater thickness of outline, the markings on the surface caused by the arrangement of the imbricated scales upon the surface of the hair, and the projecting edges of the latter frequently seen in profile at the margins, their firmness and hardness, the striated appearance visible in the human hair, and the peculiar disposition of the internal part of the hair in the case of the cat and many of the lower animals, are some of the points which will enable us to distinguish them from casts of the uriniferous tubes. At the same time, the observer should rather depend upon that general idea which he forms from examining these structures fre-

PLATE III.

EXTRANEOUS MATTERS COMMONLY FOUND AMONGST URINARY DEPOSITS.

Fig. 12. *Air bubbles.*

Fig. 13. *Free oil globules.*—Oil which has fallen into Urine accidentally, is to be distinguished from oil contained in cells or in casts found in Urine in cases of fatty degeneration of the kidney. Plate XIV, fig. 2.

Fig. 14. *Portions of feather.*—The knotted pieces represented, are obtained from the lower part of the shaft of the feather.

Fig. 15. *Fibres of deal* swept from the floor. These are very liable to be mistaken for casts. The round pores characteristic of the fibres of coniferous trees, might very readily be mistaken for epithelium. They are, however, distinguished by the irregularity of their outline, by the very regular arrangement of the pores, and by their refractive power.

Fig. 16. *Cotton fibres.*—A very small fibre in the lower part of the figure, is seen to be twisted round a larger one. Cotton fibres are distinguished by their flattened form, and by the cross markings in the central part of the fibre.

URINARY DEPOSITS III.

Fig 12

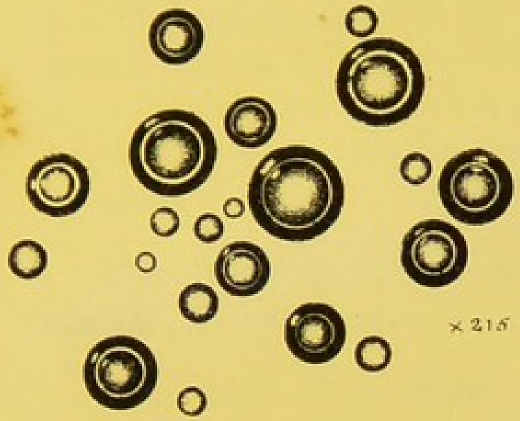


Fig 13

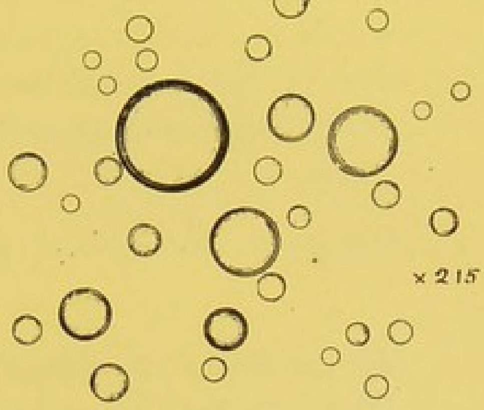


Fig 14

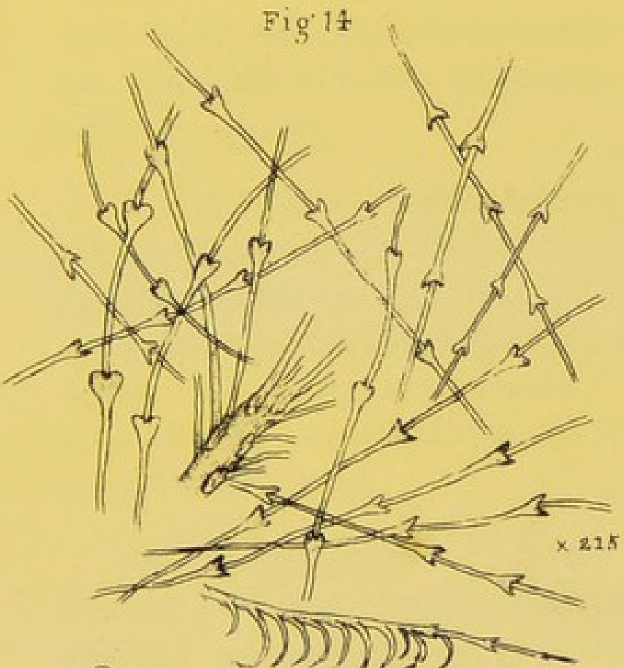


Fig 15

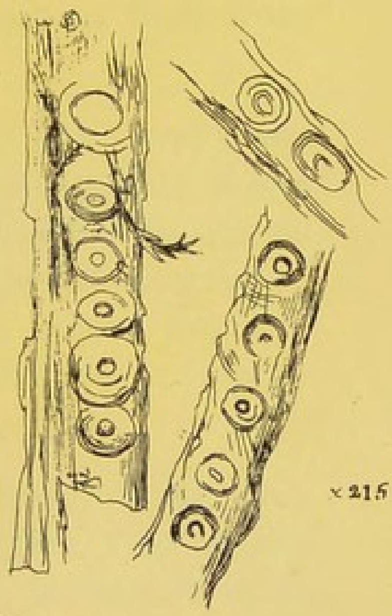
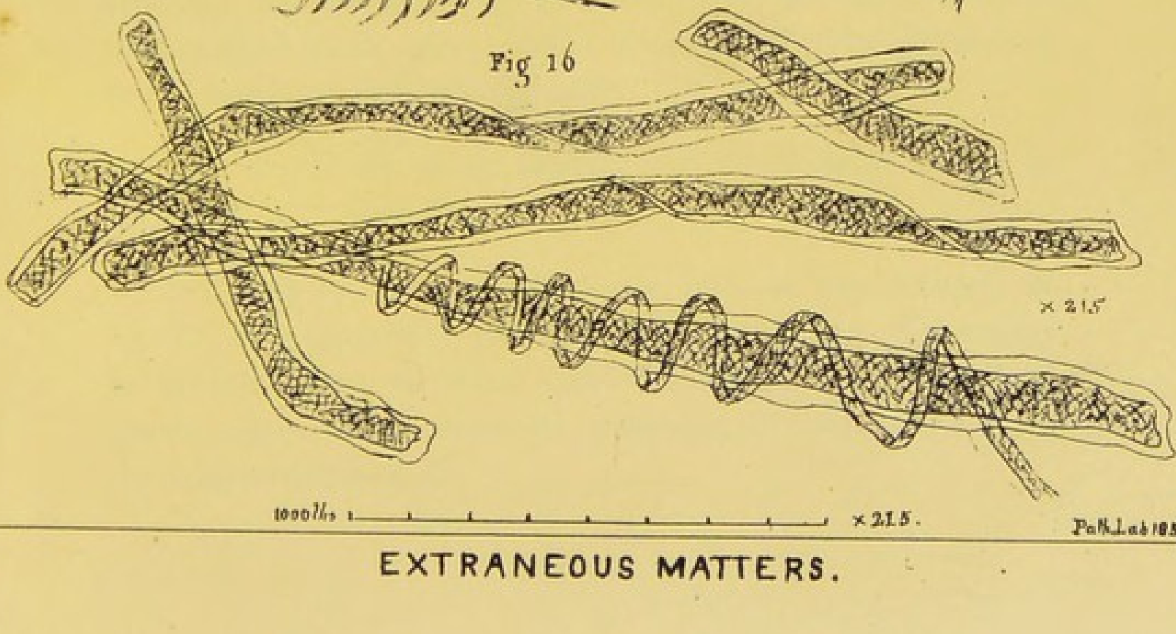


Fig 16



1000ths × 215.

Path Lab 1857.

EXTRANEOUS MATTERS.

quently, for enabling him to recognize these bodies with certainty, than upon characters which may be expressed in words. All practically acquainted with such subjects, feel, that every observer must educate his own eye, and render himself familiar with the general characters of the several objects with which it is desirable he should be well acquainted, and which he ought to be able to recognize at a glance.

Flax fibres are known by their jointed structure and slightly fibrous nature.

Fragments of tea leaves can hardly be mistaken for any other structures; the dark appearance of the cells, their large size, and the number of spiral vessels which are connected with the fragments, distinguish them from other substances.

Wheat starch, Potato starch, and Rice starch are readily distinguished from each other. The grains of the first are perfectly circular, of the second egg-shaped, while those of the third are very minute, and of irregular form. The different characters which starch granules present, when examined in air, fluid, or Canada balsam, should be observed.

The starch granules in bread are usually found much swollen and very transparent. Sometimes they appear cracked, but usually they preserve their general form, as represented in fig. 10. Bread crumbs are very commonly found amongst urinary deposits.

The characters of *air bubbles* and *oil globules* should be very carefully observed.

Oil globules, when they occur free, as represented in fig. 13, are generally present from accident. They may be derived from an oiled catheter which has lately been passed, from the accidental presence of butter, or from the admixture of milk.

PLATE IV.

URIC OR LITHIC ACID, $C_{10}H_4N_4O_6$.

1. *Curious form of uric acid* crystals precipitated by the addition of nitric acid to Urine. These crystals have the form of quadrilateral pyramids.

2. Common form of *Uric acid* deposited in Urine.

3. *Masses of uric acid* crystals, often termed *Cayenne pepper grains.* The specimen from which the drawing was made, had been preserved in naphtha and creosote fluid * upwards of five years.

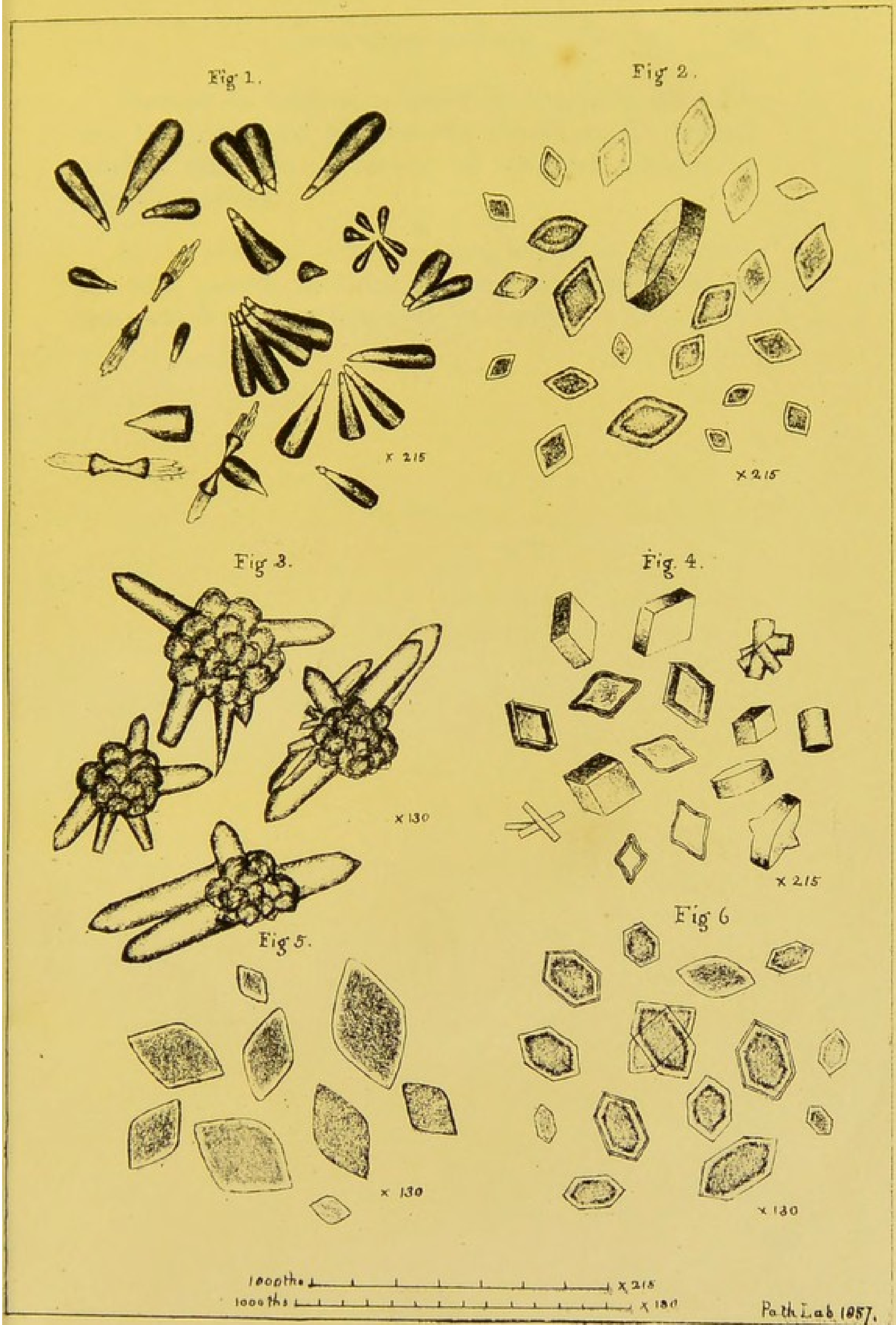
4. *Common rhomboidal form of uric acid* crystals from Urine.

5. *Very large crystals of uric acid* deposited from Urine after standing.

6. *Six-sided crystals of uric acid.* This form is not very common. It is distinguished from cystine by its colour, and by not being deposited in the same crystalline form when an ammoniacal solution has been allowed to evaporate.

* How to work with the Microscope, page 36.

URINARY DEPOSITS IV.



URIC ACID.

Portions of feathers, as would be supposed, often fall into the Urine, and the observer should render himself familiar with the characters of different varieties of common feathers.

Cotton fibres of various colours, as well as colourless, are often present in Urine, red and blue being perhaps those which are most frequently met with.

PLATE V.

URIC OR LITHIC ACID, $C_{10}H_4N_4O_6$.

Fig. 7. *Lozenge-shaped crystals of uric acid,* precipitated by the addition of acid to Urine.

Fig. 8. *Crystals of uric acid* obtained by the addition of acid to Urine.

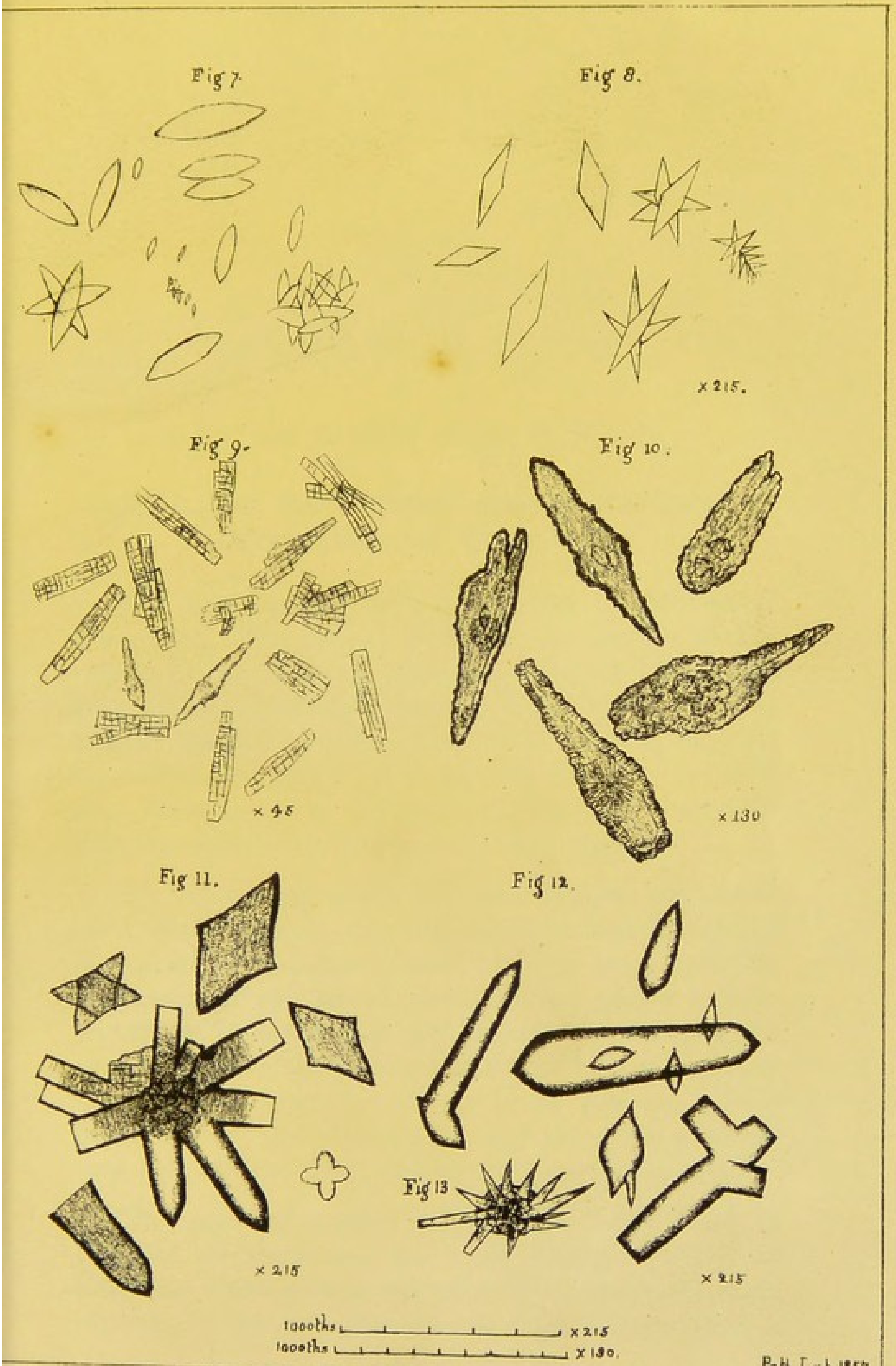
Figs. 9, 10. *Curious forms of uric acid* deposited in the Urine of a case of fatty degeneration of the kidney, magnified in different degrees.

Fig. 11. *Mass of uric acid crystals* with *rhomboidal* and *fleur-de-lis* forms, from Urine.

Fig. 12. *Curious forms of crystals* of uric acid from Urine.

Fig. 13. Amorphous mass, probably consisting of *urate of soda* with sharp crystals of *uric acid* projecting from it.

URINARY DEPOSITS V.



URIC ACID.

PLATES IV, V, VI, VII.

URIC OR LITHIC ACID, $C_{10}H_4O_4N_6$.

Tables for the Chemical and Microscopical Examination of Urine, § 17.

Uric acid deposits have a granular or crystalline appearance. The deposit sinks to the bottom of the vessel. It increases for some time after the Urine has been passed, is usually absent in Urine which has just left the bladder, and often is not to be detected until the lapse of several hours. It is probable that it is removed from the organism as a *urate*, which becomes decomposed with the separation of the insoluble uric acid.

The crystals of which uric acid deposits are almost invariably composed, vary very much in size, sometimes appearing as crystalline masses, so large as to be visible to the unaided eye (the so-called Cayenne pepper grains), sometimes so small that the deposit, by its granular character, is very liable to be mistaken for a *urate*, while the individual crystals are only to be detected with a quarter of an inch object-glass, and are often not more than the 1-2000th of an inch in their longest diameter.

The colour of crystals of uric acid varies much in different specimens, and we meet with every shade of tint, from a rich dark-brown colour to perfectly colourless crystals. It is rare, however, to meet with crystals of

PLATE VI.

URIC OR LITHIC ACID, $C_{10}H_4N_4O_6$.

Fig. 14. *Uric acid* crystals from Urine. These crystals were given to me by my friend and pupil Mr. Atchley.

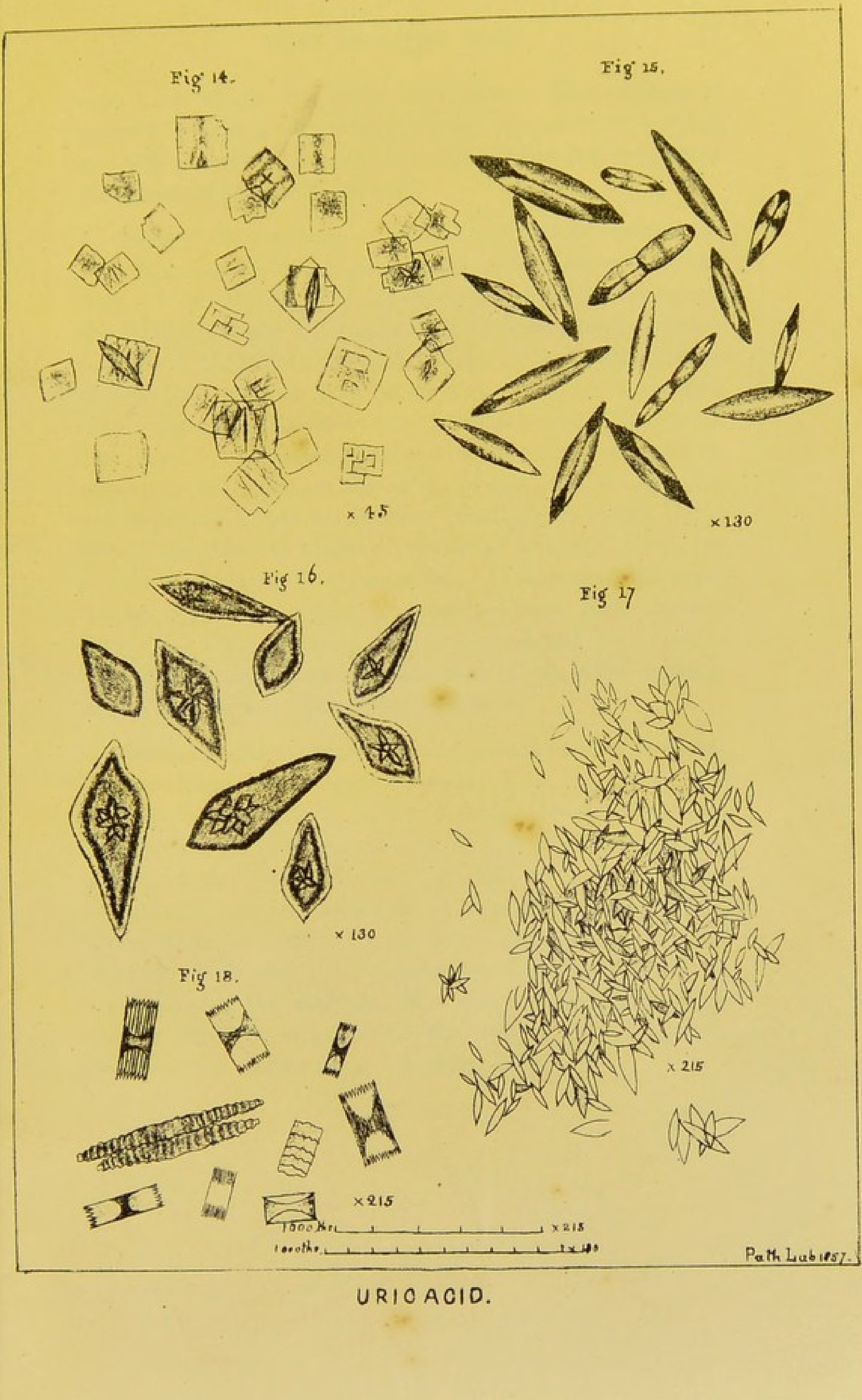
Fig. 15. *Some of the same crystals* as represented in fig. 14, more highly magnified, and seen in a different position.

Fig. 16. Crystals of uric acid from Urine. Preserved in glycerine.

Fig. 17. *Small uric acid crystals* connected together so as to form plates.

18. Curious forms of uric acid produced by rapid crystallization after the addition of nitric or hydrochloric acid to Urine.

URINARY DEPOSITS VI.



URIC ACID.

uric acid which are quite colourless. This substance appears to have a very strong affinity for colouring matter, and colour may be regarded as one of the most constant characters of uric acid deposits.

Form of the crystals.—As so many different forms have been represented, it is hardly necessary to observe, that the form of the crystal is liable to great variation, although the drawings might have been multiplied to a much greater extent. I shall have occasion to give several other groups of uric acid crystals at a future time. The causes which determine these variations in form are not understood. The rapidity of crystallization may be shown to exert an important influence on the form of the crystal, and it is not improbable that some other constituents in the Urine may determine its character to some extent. The true form of uric acid is rhomboidal. It occasionally crystallizes in six-sided crystals, somewhat resembling *cystine*. (Plate X.) The latter is easily distinguished by its solubility in ammonia, and the formation of six-sided crystals as the ammonia is allowed to evaporate.

Chemical characters.—When any doubt exists as to the probable nature of a deposit suspected to consist of uric acid, it is desirable to apply chemical tests. Uric acid is insoluble in hot and cold water; it is very soluble in potash, from which solution crystals of uric acid are precipitated by the addition of excess of acid (*nitric, hydrochloric, or acetic*). Uric acid after being dissolved in nitric acid, and the solution carefully evaporated to dryness, upon the addition of a drop of ammonia, gives rise to the development of the bright purple colour characteristic of *murexide*. Tables, § 38.

PLATE VII.

URIC OR LITHIC ACID, $C_{10}H_4N_4O_6$.

Fig. 19. *Uric acid* in Glycerine.

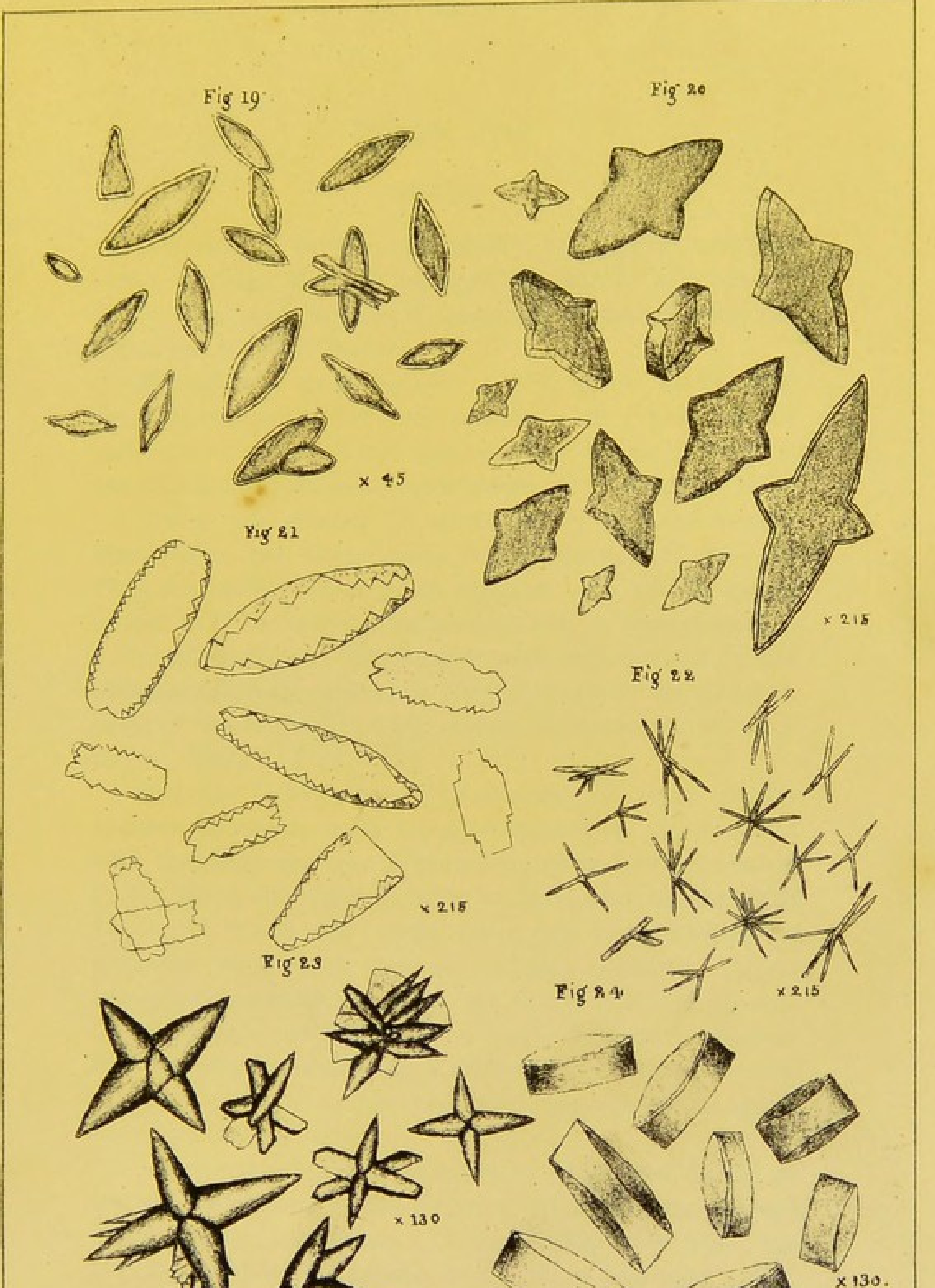
Fig. 20. *Halbert-shaped crystals of uric acid* from Urine.

Fig. 21. Curious *lamellar crystals of uric acid* perfectly colourless, given me by my friend Mr. J. W. Lawrence.

Fig. 22. *Acicular crystals of uric acid* from Urine, sent me by Mr. Lawrence.

Figs. 23 and 24. Crystals from same specimens as figs. 15 and 14.

URINARY DEPOSITS VII.



URIC ACID.

PLATE VIII.

URATES.

Deposits of urates are usually bulky and tolerably dense, leaving a clear or more or less turbid supernatant fluid. The urate is almost invariably deposited after the Urine has left the bladder.

The colour of these deposits varies greatly. Rarely they are perfectly colourless, but usually have a yellowish or pale brown colour (lateritious and nut-brown sediment), sometimes they are pink, dark brown, or even bright red.

Urates are soluble in warm water and are usually dissolved in the Urine upon the application of warmth. They are readily dissolved by alkalies. By adding excess of acid to the alkaline solution uric acid is precipitated in a crystalline form. By being treated with nitric acid and subsequently with ammonia they give rise to the development of the beautiful purple colour, characteristic of murexide. Tables, § 17, *b*. 33.

Granular appearance. The deposit of urate usually appears granular, even when subjected to examination with very high powers. Not unfrequently by the pressure of the glass, the mass is made to form lines, as shown in fig. 1, in which case these must not be mistaken for granular casts, which they very closely resemble. Upon careful examination, however, the sharp, well-defined outline, characteristic of the cast is not to be found. Masses like those represented in fig. 2 are not uncommon in deposits of urates, especially after they have been allowed to stand for a considerable time.

The beautiful spherical crystals, delineated in fig. 5, are not uncommon in the Urine of children suffering from acute febrile complaints. I have only met with the curious crystals, delineated in fig. 6, in one case.

PLATE VIII.

URATES.

Fig. 1. Ordinary granular deposit, usually termed *urate or lithate of ammonia,* but consisting of *urate of soda* with small quantities of urates of ammonia, lime, and magnesia.

Fig. 2. *Urate of soda,* forming nearly spherical masses, from various parts of which project very minute acicular crystals of uric acid.

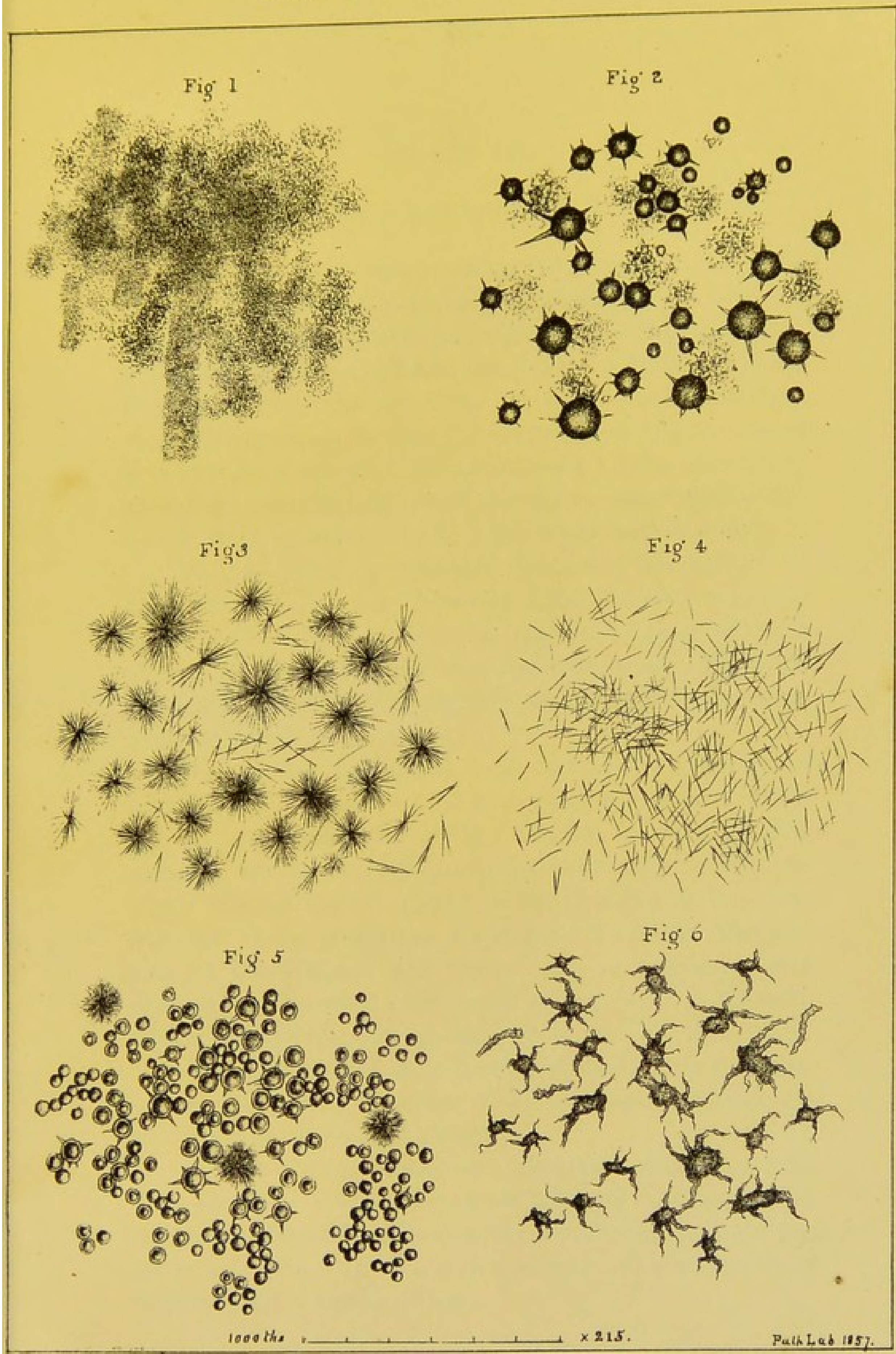
Fig. 3. *Urate of ammonia* prepared artificially.

Fig. 4. *Urate of soda* prepared artificially.

Fig. 5. *Urate of soda* in a globular form, commonly found in the Urine of children. This specimen is mounted in Canada balsam.

Fig. 6. *Urate of soda* in masses, from which irregular root-like processes project. This is a rare form of urate deposit. The specimen from which the figure is copied was obtained from the Urine of a case of peritonitis.

URINARY DEPOSITS VIII.



URATES × 215.

PLATE IX.

TRIPLE OR AMMONIACO-MAGNESIAN PHOSPHATE.

Triple phosphate always exists in healthy Urine in a state of solution, and may be precipitated by the addition of ammonia (fig. 2). The mere presence of the crystals in a deposit does not, therefore, necessarily indicate an excessive excretion of the salt from the organism, but merely shows that it exists in the Urine in an insoluble, instead of in a soluble condition. In some cases a large amount of phosphate exists in solution in the Urine, which the practitioner could estimate only by a careful chemical analysis.

Triple phosphate is insoluble in alkalies but soluble in weak acids. Urine may, however, exhibit a distinctly acid reaction although it contains an abundant deposit of triple phosphate. After having been dissolved by an acid, triple phosphate can always be reprecipitated by the subsequent addition of excess of ammonia.

This deposit, associated with amorphous granules of *phosphate of lime,* is very often present in cases in which the mucous membrane of the bladder is more or less diseased, and in cases of *paraplegia* and other conditions where the contractile power of the bladder is impaired and the Urine permitted to remain for a considerable time in the organ. The mucus acts as a ferment and decomposes the urea. Carbonate of ammonia is formed, which precipitates the phosphates in an insoluble form. When pus is formed, it is converted into a glairy mucus-like mass in which a number of brilliant sparkling crystals of triple phosphate are entangled.

Crystals of triple phosphate, when preserved as permanent objects for the microscope, must be kept in a dilute solution of muriate ammonia, in which the crystals are quite insoluble. In this solution they will preserve their brilliancy for a length of time.

PLATE IX.

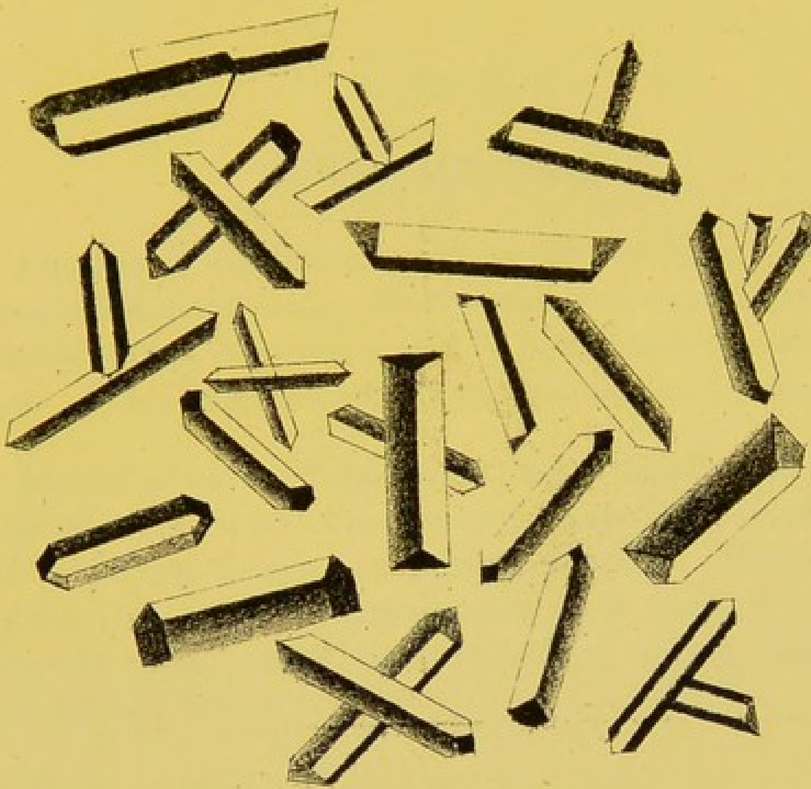
TRIPLE OR AMMONIACO-MAGNESIAN PHOSPHATE, OR PHOSPHATE OF AMMONIA AND MAGNESIA, $2MgO \, NH_4O, PO_5 + 12 \, Aq.$

Fig. 1. *Crystals of triple phosphate* in the form of triangular prisms with obliquely truncated extremities, as they frequently occur in Urine. In many cases the crystals are four-sided and occasionally peculiar forms are met with in which two prisms appear to be united. Not unfrequently the shaft of the crystal is so short that the two triangular extremities are brought quite close together, and the crystal, without care, might be mistaken for an octohedron.

Fig. 2. *Crystals of triple phosphate* formed by the addition of ammonia to Urine. The crystals being rapidly developed are precipitated in this very beautiful star-like form. If, however, these be allowed to remain for some time they gradually assume the prismatic form. The highly magnified drawing of one of the arms of a crystal, in the lower part of the figure (*a*), shows how this change in the crystalline form takes place.

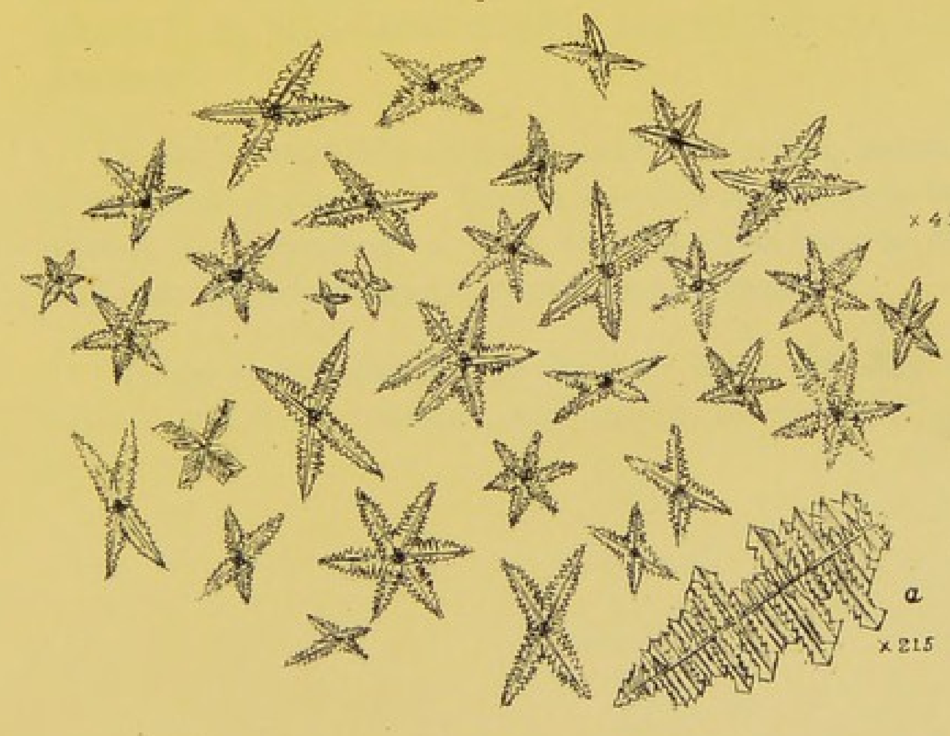
URINARY DEPOSITS IX.

Fig 1.



× 45

Fig 2



100ths × 45.

Path. Lab. 1857.

TRIPLE OR AMMONIACOMAGNESIAN PHOSPHATE.

PLATE X.

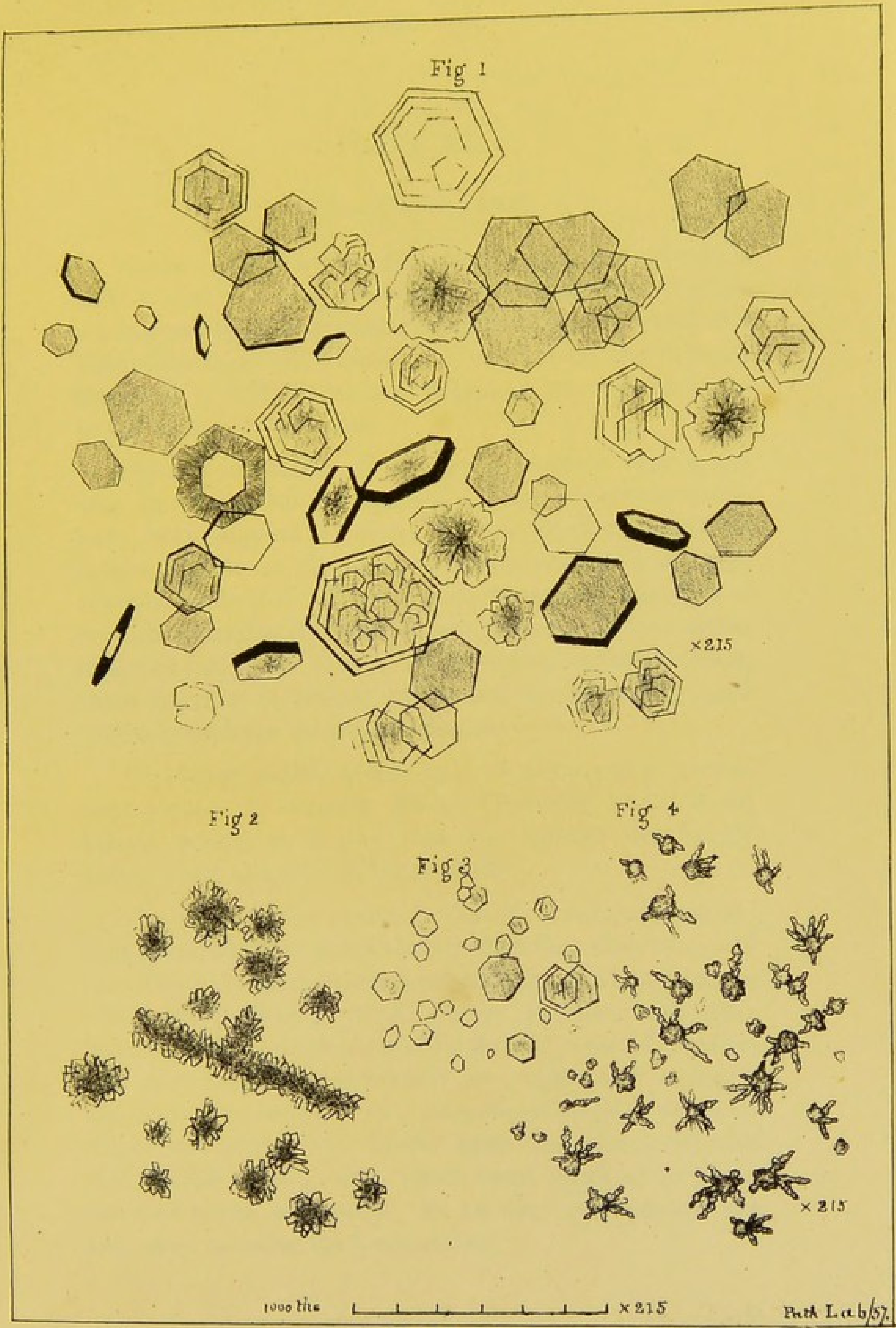
CYSTINE, $C_6H_6NS_2O_4$.

Fig. 1. *Crystals of cystine* from the Urine of an insane patient. Numerous crystals of uric acid were present in the same deposit. This specimen was kindly sent to me by Dr. Sankey of Colney Hatch.

Figs. 2 and 3. *Clusters of Crystals* which formed by gently evaporating a solution of the crystals represented in fig. 1, in ammonia.

Fig. 4. *Irregularly formed crystals of cystine* formed by allowing the ammoniacal solution to evaporate to dryness on a glass slide.

URINARY DEPOSITS X.



CYSTINE.

PLATE XI.

OXALATE OF LIME.

Oxalate of lime seldom forms a granular deposit, which sinks to the bottom of the vessel, but usually the crystals are buoyed up by the small quantity of mucus which the Urine contains. In removing a portion of the deposit, therefore, it is desirable not to plunge the pipette quite to the bottom of the glass.

Deposits consisting of octohedra increase very much after the Urine has been passed. Some specimens which have been allowed to stand for twenty-four hours or longer deposit an abundant sediment, consisting of large crystals, while the Urine may have been quite destitute of crystals immediately after it was passed. I have never observed this in the case of the dumb-bell crystals, which, there is reason to believe, are formed in the kidney, and probably undergo no further change.

Crystals of oxalate of lime may be preserved as permanent objects in creosote fluid. Glycerine and Canada balsam refract so highly that the crystals are hardly visible when mounted in these media.

The form of the crystal is that of a flattened octohedron, with one axis much shorter than the other two; and the different appearances produced by the position in which the crystal is placed are so peculiar, that some observers have mistaken these for distinct forms of crystals. The most important characters are represented in fig. 1, and these were copied from a glass model made to resemble the crystal itself. The figures have been compared with real crystals of large size, which were made to rotate in the field of the microscope, by moving very slightly the thin glass covering the preparation.

PLATE XI.

OXALATE OF LIME.—OXALURATE OF LIME.

Fig. 1. *a, b, c, d, e.—Appearances of the same crystal of oxalate of lime* viewed in different positions. The crystal is supposed to be seen first lying upon one of its broad surfaces, and then gradually rotated *from* the observer until one edge is opposite to the eye.

f, g, h.—The same crystal seen sideways, one of the lateral angles being towards the eye.

i.—An octohedral crystal mounted as a dry object.

k.—Unusual form of compound crystal of oxalate of lime.

Fig. 2.—*Dumb-bell crystals,* and allied forms of oxalurate of lime.

a to *f.*—Circular and oval forms.

g to *m.*— Crystals approximating in form to the dumb-bell.

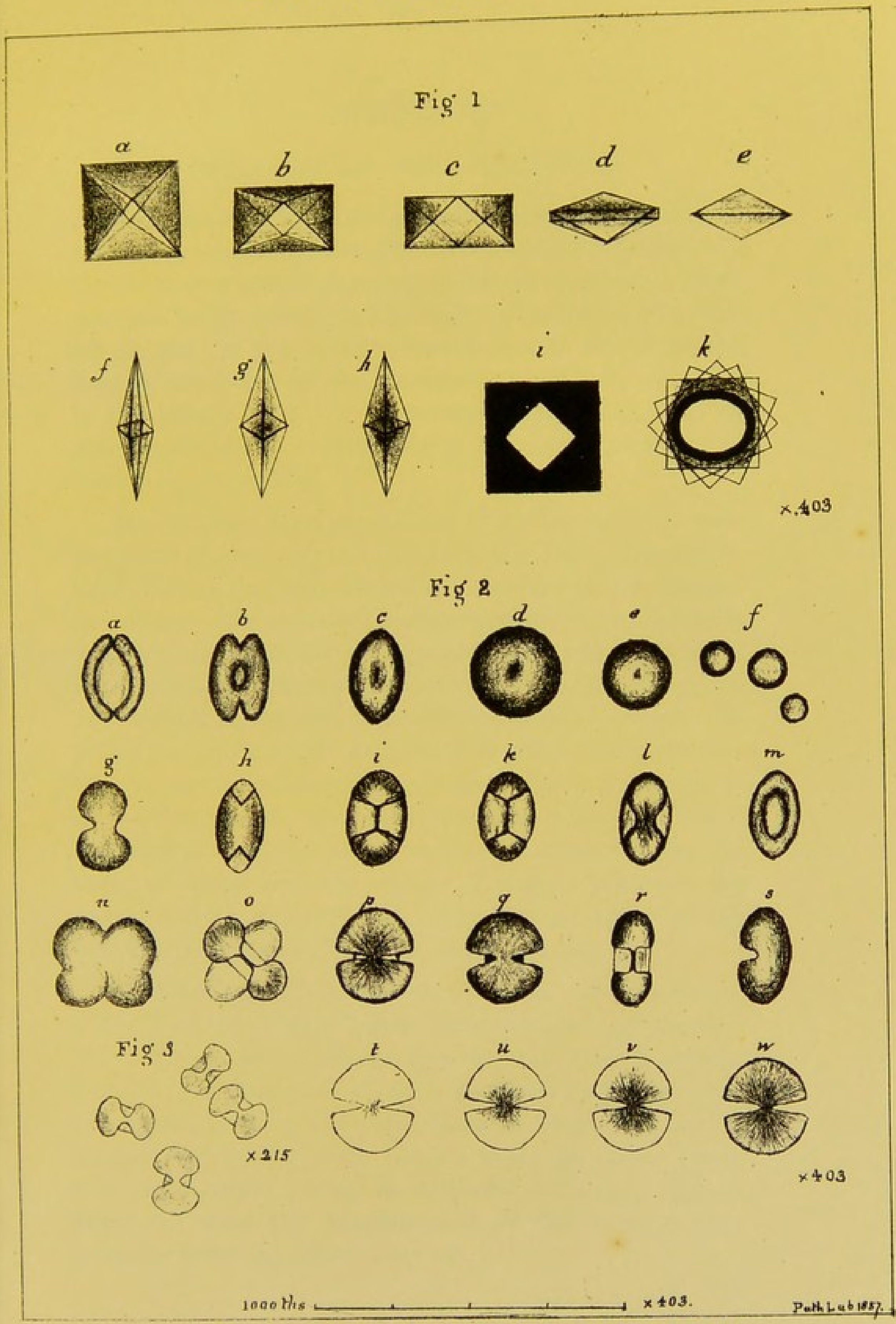
n to *s.*—Regular and irregular crystals.

t to *w.*—Perfect dumb-bell crystals. The three first figures subjected to the prolonged action of acetic acid.

t.—A crystal which had been allowed to soak for several weeks in strong acetic acid. The crystalline material is almost entirely dissolved away, leaving the organic matter in the form of a cell-wall. In *u* the action has not extended so far. In *v* the action of the acid is very slight; and in *w* a crystal is represented in its ordinary state,

Fig. 3. *Large dumb-bell crystals,* from the Urine of a child two years old, suffering from jaundice. These crystals were perfectly symmetrical.

URINARY DEPOSITS XI.



OXALATES. OCTOHEDRA, DUMB BELLS.

PLATE XII.

OXALURATE OF LIME—DUMB-BELLS.

The dumb-bell crystals of oxalate (oxalurate) of lime are not precipitated after the Urine has left the bladder, nor do they appear to increase in size by standing. Their presence in the casts (fig. 1.) renders it probable that they are formed in the uriniferous tubes, and this is placed beyond all doubt by the circumstance of their presence in the kidney itself. I have seen small collections of them, apparently impacted in a tube, several times in examining the kidney.

Dr. Golding Bird considered that these crystals were composed of *oxalurate* and not *oxalate of lime*. The dumb-bells *polarize* the light while the octohedra do not possess this power. The chemical composition of the two forms is certainly different, for the octohedra are not acted upon by acetic acid, while the dumb-bells are affected by it. The crystalline material is gradually dissolved away by the prolonged action of the acid, until at last nothing remains but the organic matter which corresponds to the original form of the crystal. It closely resembles a cell-wall, but it is probable that this appearance is fallacious. After the action of acetic acid the crystal no longer possesses the power of polarizing the light. The gradual action of the acid is represented in Plate XI, *w, v, u, t,* fig. 2.

Dumb-bell crystals are, in many cases, only present for a few days at a time, which circumstance has probably led to the opinion of this being a very rare form of crystal. The perfect dumb-bell is often preceded by the presence of irregular forms of the same character of crystal, and the circular and oval crystals (from *a* to *m*) are often found some days before perfect dumb-bells make their appearance, and after the disappearance of the latter, similar irregular forms are often observed.

PLATE XII.

OXALATE OF LIME, OCTOHEDRA—OXALURATE OF LIME, DUMB-BELL CRYSTALS IN CASTS.

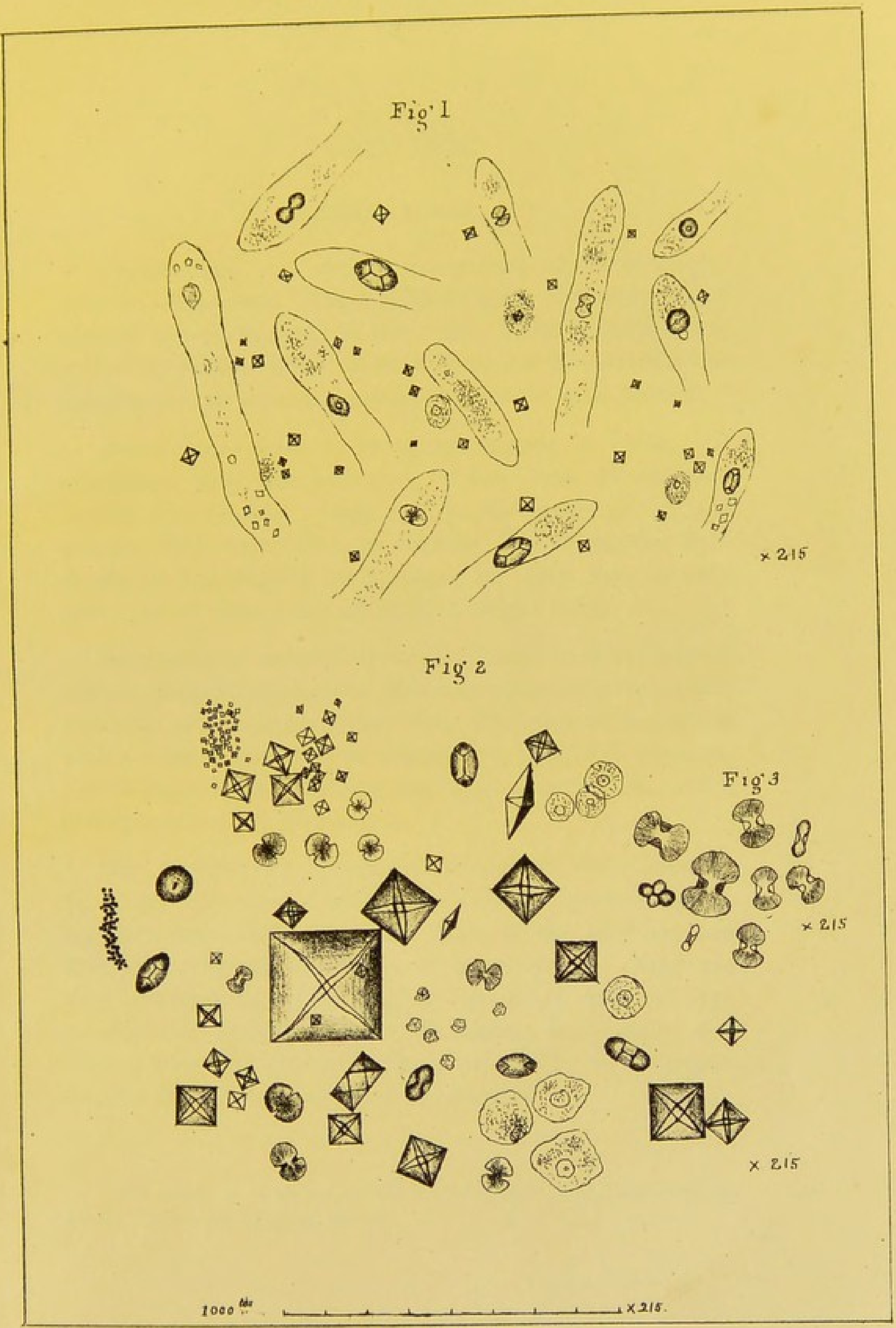
Fig. 1. *Dumb-bell crystals in casts* from the Urine of a case of cholera. The specimen containing these casts was the first portion passed after eighteen hours complete suppression. It contained a trace of albumen. Octohedra were present in the surrounding fluid, but none could be found in the casts.*

Fig. 2. *Octohedra of oxalate and dumb-bell crystals of oxalate of lime* with a few cells of bladder epethelium. On the left side of the figure are represented a number of minute octohedra of oxalate of lime, crystallized round a hair. These crystals are often so minute as to appear like mere granules, but their insolubility in potash and acetic acid distinguishes them from other substances which they resemble.

Fig. 3. Very symmetrical dumb-bells.

* This drawing was published in the Medical Times and Gazette for April 5, 1851.

URINARY DEPOSITS XII.



OXALATES.

PLATE XIII.

SPERMATOZOA.

Spermatozoa are readily recognized by their microscopical characters. They soon become disintegrated if allowed to remain long in the Urine. The secretion suspected to contain them, should therefore be submitted to examination as soon as possible after it has been passed.

Spermatozoa form a flocculent deposit in Urine, but oftentimes they are collected in the form of separate mucous-like masses. They can be distinguished with a quarter with care; but in looking for them, the field should be but slightly illuminated, for they may be very easily passed over if examined by a bright light.

Spermatozoa are not unusually found in the Urine of men in perfect health; and it is only when very frequently met with, and in cases where their discharge is associated with serious impairment of the health, that their presence can be regarded as affording any indication for the active interference of the physician.

The transparent cylindrical structures, delineated in fig. 2, are very often found in the Urine of persons suffering from irritability about the neck of the bladder, and from the frequent discharge of spermatozoa. They are very transparent, often slightly granular, and of very considerable length. They vary slightly in diameter, and form a flocculent deposit in the Urine. The figure representing them is too dark and too rough.*

* The nature of these bodies will be considered in my lectures on the Urine, Urinary deposits, and calculi.

PLATE XIII.

SPERMATOZOA.—CASTS OF SEMINAL TUBULES.

Fig. 1.—*Spermatozoa* from Urine.

Fig. 2.—*Long narrow threads* of a viscid material, often associated with the presence of spermatozoa,—from the Urine of a case of slight irritability of the bladder, with occasional discharge of seminal fluid. These are probably moulds of the seminal tubules.

URINARY DEPOSITS XIII.

Fig. 1.

Fig. 2.

1000ths × 403.
1000ths × 215.

Path. Lab. 1857

1. SPERMATOZOA. 2. CASTS FROM SEMINAL TUBULES.

PLATE XIV.

CASTS OF THE URINIFEROUS TUBES.

Deposits consisting of casts of the Uriniferous tubes have a flocculent character, usually occupy considerable bulk, and vary from a pale opalescent appearance to a dirty brown colour.

The Urine usually contains *albumen,* but very rarely specimens are met with containing casts, in which not a trace of albumen can be detected.

Diameter.—Casts vary very much in diameter, according to the state of the Uriniferous tube at the time of their formation. (Tables for the examination of Urine, § 28, page 17.) All the figures in plate XIV are magnified 215 diameters, and may therefore be compared with each other.

Contents of the casts.—The structures entangled in the coagulable material of which the casts are composed, varies according to the character of the contents of the uriniferous tube. Casts containing epithelial cells are common in cases of acute dropsy, and dropsy after scarlatina (fig. 1). The Urine in which they are found usually contains very much albumen. In fatty degeneration of the kidney, the casts contain epithelial cells, with much oil in their interior, and separate oil globules (fig. 2). In cases of chronic inflammation of the kidney, the epithelium is disintegrated, and the casts contain granules with very few cells of epithelium, or the latter are entirely absent (fig. 3). In Urine containing abundance of urates, these are sometimes deposited in the casts in very large quantity, giving them a very dark but granular appearance (fig. 4). In some cases where the epithelium of the kidney is destroyed, and the basement membrane of the tubes bare, the casts are of very considerable diameter (fig. 5) ; and, on the other hand, in cases where the epithelium is abnormally adherent, the casts are perfectly clear and transparent, but of very small diameter (fig. 6).

For a full discussion of the nature of the diseases in which casts are found, I must refer the reader to Dr. Johnson's well-known work on "Diseases of the Kidney."

PLATE XIV.

CASTS OF THE URINIFEROUS TUBES.

Fig. 1. *Epithelial casts* commonly present in the Urine in cases of acute dropsy.

Fig. 2. *Casts containing fat cells and oil globules*, from the Urine of a case of *fatty degeneration* of the kidney.

Fig. 3. *Granular casts* from the Urine of a patient suffering from *chronic inflammation* of the kidney.

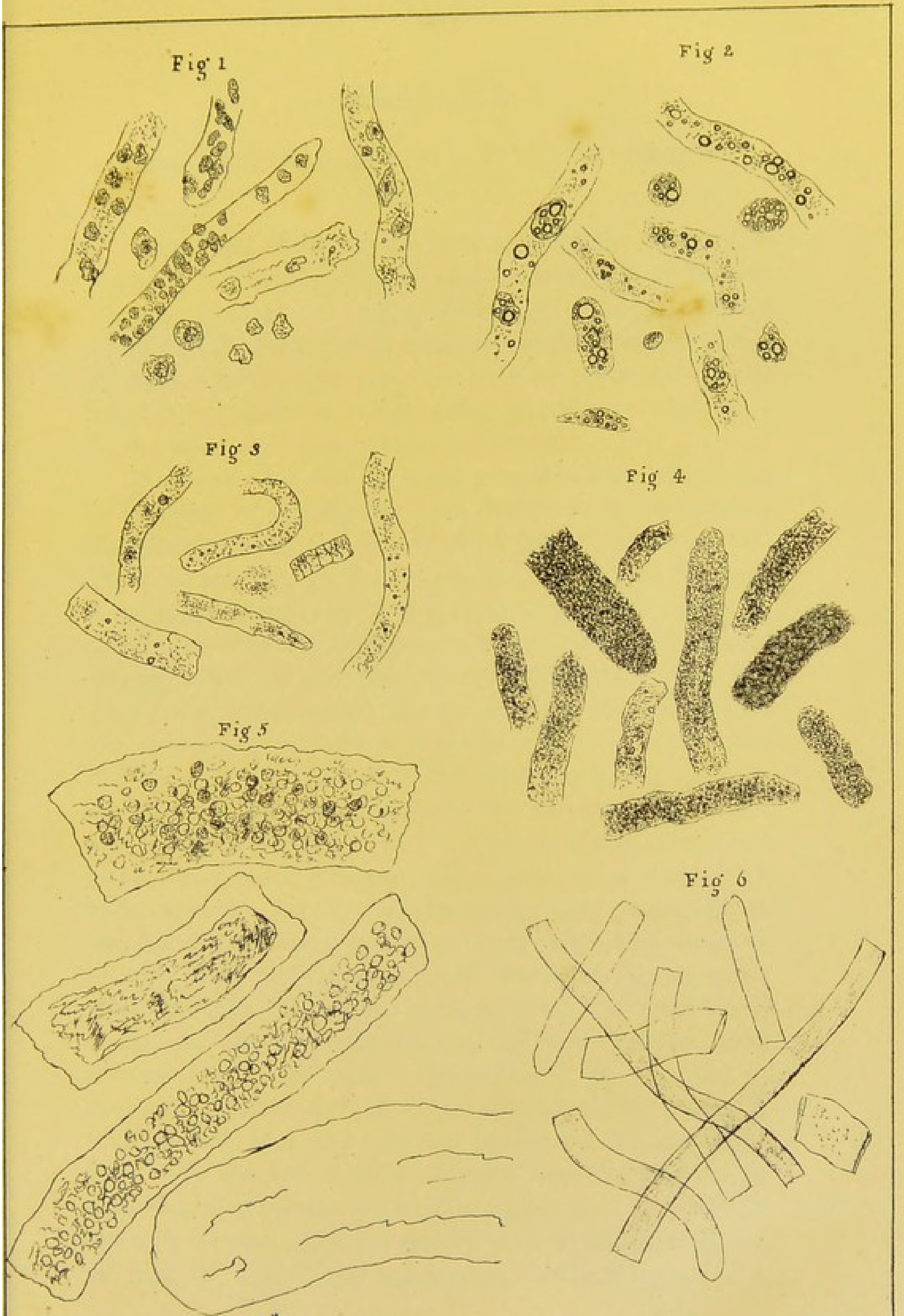
Fig. 4. *Darkly granular casts*, some of them containing a deposit of *urates*.

Fig. 5. *Large casts*, some containing many cells, others consisting of a perfectly tranparent wax-like material,—characteristic of "*desquamative nephritis*." *

Fig. 6. *Small waxy casts*, found in the Urine of cases of "*non desquamative nephritis*."*

* On Diseases of the Kidney, Dr. George Johnson.

URINARY DEPOSITS XIV.



CASTS OF URINIFEROUS TUBES x 215 Diam:

PLATE XV.

CASTS FROM CASES OF ACUTE AND CHRONIC NEPHRITIS.

Casts resembling those delineated in fig. 1 are often found in cases of acute inflammation of the kidney coming on from exposure to cold, or following scarlatina. It will be observed, however, that there are several different forms of casts which might give rise to some confusion in the mind of an observer endeavouring to form an opinion as to the acute or chronic nature of the case.

No conclusion can be based upon the presence of one or two casts of a particular kind, but it is to the general characters of the deposit we must direct our attention. Thus we may find in the deposit from the Urine in acute cases which completely, and may be very rapidly, recover, one or two cells containing oil, and one or two casts containing a few oil globules. Now, we must not, from the presence of these, be led into the error of concluding that the case is one of fatty degeneration of the kidney; but if there were *numerous* cells and casts containing oil, such an inference would undoubtedly be correct. We must not therefore expect to find in one case, epithelial casts alone, in another granular casts alone, in a third fatty casts only, in a fourth none but large waxy casts, and so on; but we must be prepared to meet with several varieties in one case, and must ground our opinion, in great measure, upon the relative number of any particular kind of cast, and upon the circumstance of other deposits being associated with the casts. For instance, the presence of uric acid crystals and blood corpuscles would render it very probable that the case was acute, and of short duration. The absence of these deposits, and the presence of a number of granular or perfectly transparent casts, which can only be seen when the greater part of the light is cut off from the field of the microscope, or the existence of a

PLATE XV.

CASTS OF ACUTE AND CHRONIC NEPHRITIS.

Fig. 1. *Epithelial and granular casts from the Urine of a woman suffering from Acute Nephritis, with Dropsy,* of a fortnight's duration.

a. Epithelial casts. The cells of renal epithelium are very distinct, and their nuclei well defined.

b. Casts containing brown granular matter and blood corpuscles.

c. Granular casts of a brown colour, many of them containing a few oil globules. The long cast near * is much twisted

d. Squamous epithelium from the vagina.

e. Epithelium from the bladder. The outline is too thick.

f. Cell containing oil globules.

g. Portion of a cast containing oil globules.

h. Circular granular cells, probably renal epithelium altered.

Blood corpuscles are seen scattered about in various parts of the field.

i. Fibre of flax of accidental presence.

Fig. 2. Casts from a case of *chronic nephritis.*

a. Dark granular casts.

b. Casts containing small granular cells of epithelium.

c. Waxy casts, consisting of a perfectly clear, glistening material.

d. Large cast, flattened by pressure, containing altered epithelium.

e. Portion of a cast containing a large cell filled with oil globules.

f. Pus corpuscles, probably derived from the bladder.

g. Collection of small oil globules.

h. Large cell containing smaller cells in the interior. Of the nature of cells of this kind I am ignorant; but I have observed them in several specimens of Urine.

i. Portion of cotton fibres.

k. Piece of a very thin human hair.

URINARY DEPOSITS-XV.

number of oil casts, render it certain that the case is chronic. The former would indicate that the kidney was becoming small and contracted, while the latter variety of casts occur when it is often of large size and fatty. Such examples might be multiplied. When we consider how very numerous the secreting tubes of the kidney are, we cannot feel surprised that a different condition should exist in different tubes at the same time, and from observations on careful post mortem examinations, we know that very different morbid appearances are often seen in different parts of the cortical portion of one kidney. It is not difficult therefore, to account for the fact of the presence of casts differing much in their diameter and characters in one specimen of Urine.

Now, the chief points to be noticed in the specimen delineated in fig. 1, are—

1. *The presence of casts containing well marked and large cells of renal epithelium, as, a, which are never met with in chronic cases.*

2. *The existence of a number of casts, as b, containing blood corpuscles. The granular matter in the casts* c, *is of a brown colour, and consists of disintegrated blood corpuscles.*

3. *A great many cells of epithelium, and numerous blood corpuscles are seen in various parts of the field perfectly free.*

4. *The Urine contains a large quantity of albumen.*

These points render it certain that the case is an acute one.

In fig. 2, a number of casts containing circular and faintly granular cells of altered epithelium are represented with a good deal of disintegrated epithelium. The chief points to be noticed here, are—

1. *The presence of a number of granular casts, which are dark without any tinge of a brown colour.*

2. *The presence of perfectly transparent wax-like casts, c.*

PLATE XVI.

CASTS. ACUTE INFLAMMATION OF THE KIDNEYS.

Casts from the Urine of a man, aged 45, suffering from *acute inflammation of the kidneys.* There was very slight œdema of the legs. The patient died comatose three weeks after the first symptoms appeared.

The Urine contained so much albumen that it became perfectly solid upon the application of heat and after the addition of nitric acid.

a. Perfectly transparent wax-like casts. The shading should be more faint than in the drawing.

b. A very long wax-like cast, consisting of material deposited at two different periods. The original cast in the interior was probably forced a certain distance further down the uriniferous tube, when a new layer of the coagulable material was deposited around it.

c. Casts filled with cells closely resembling pus corpuscles, but somewhat larger.

d. The same cells free in considerable number. The greater part of the deposit consisted of these cells.

e. Portion of feather.

f. Pieces of cotton fibre.

g. Portion of human hair.

URINARY DEPOSITS-XVI.

3. *The existence of the altered epithelial cells, and the granular material resulting from their disintegration.*

4. *The pale colour of the Urine, and the presence of a small quantity of albumen.* These characters point to the chronic nature of the case. The duration of the disease could not be ascertained, but from the number of casts containing epithelium, it was probably not of very long standing.

*** The relative number of casts containing altered epithelium, is represented as much greater than was actually the case. Several extraneous matters have been copied in these figures, which are referred to in the explanation of the Plates.

PLATE XVI.

CASTS. ACUTE INFLAMMATION OF THE KIDNEY.

The casts represented in Plate XVI, are not very often met with. They are for the most part found in the Urine of patients suffering from an uncommon, and very acute, form of inflammation of the kidney, which often goes on to the formation of pus in the uriniferous tubes, and is sometimes fatal in the course of a few days. The structure of the tubes is completely destroyed, and a number being broken down, small abscesses are sometimes formed in the cortical portion of the kidney.*

In this case, although there was no history or other evidence of long-continued kidney disease, it is most probable that the man had been suffering from chronic nephritis for a long period, and that the structure of the kidneys had been seriously impaired before the occurrence of the acute attack.

I have seen recovery take place in two or three cases in which cells not to be distinguished from pus corpuscles

* See Dr. Johnson's work on Diseases of the Kidney.

PLATE XVII.

CASTS. CHRONIC NEPHRITIS.

a. Casts of large diameter, containing granular matter scattered through them unequally.

b. A very long, clear, and perfectly transparent cast, containing only a few oil globules here and there.

c. Dark granular casts, some of them containing a few oil globules.

d. Large masses of granular matter, many of them appearing like granular cells. Most of these are derived from the mucous membrane covering the glans.

e. Cells of renal epithelium, darker and more granular than usual.

f. Mass of squamous epithelium, probably from one of the follicles of the mucous membrane of the bladder.

g. Free oil globules.

h. Portions of cotton fibre.

i. Portion of feather.

URINARY DEPOSITS–XVII.

were present in the casts in considerable number, and also free in the Urine. A very marked case of this kind was that of a boy suffering from dropsy after scarlatina, whose Urine was loaded with pus casts and pus, at least with cells exhibiting the two or three central bodies upon the addition of acetic acid, and presenting all the characters of pus corpuscles.

Many large transparent waxy casts are observed scattered over the field, from which we should infer that the epithelium in many of the tubes had been destroyed, and the basement membrane rendered bare. At the same time it seems to me probable that at least in some cases these very large casts are derived from the straight portion of the uriniferous tube in the pyramid, where its diameter is very great. Although in many instances the tube in the cortical portion of the kidney is sufficiently dilated to receive such a cast, I much doubt if the dilatation of the channel at the base of the pyramid has proceeded to an extent sufficient to allow it to pass. That the cast is formed from a material which enters the tubes from the vessels surrounding it, and not only from the Malpighian capillaries, is rendered very probable by the circumstance, that new matter is often deposited upon the circumference of the cast as it passes down the tube. In this case we have a cast apparently within a transparent tube, a very good example of which is represented at *b*, and such specimens are not very uncommon. The mode of formation of casts, and their composition, will be fully considered elsewhere.

In the present case many of the tubes were denuded of their epithelium, while in others the epithelium was undergoing disintegration. In the latter instance the function of the tube as a secreting apparatus would be impaired, while in the former it would be altogether destroyed; and the structure of the organ so much altered that the hope of any permanent improvement would be slight.

PLATE XVIII.

CASTS. FATTY DEGENERATION OF THE KIDNEY.

Fig. 1. Casts containing oil from the Urine of a case of fatty degeneration of long standing.

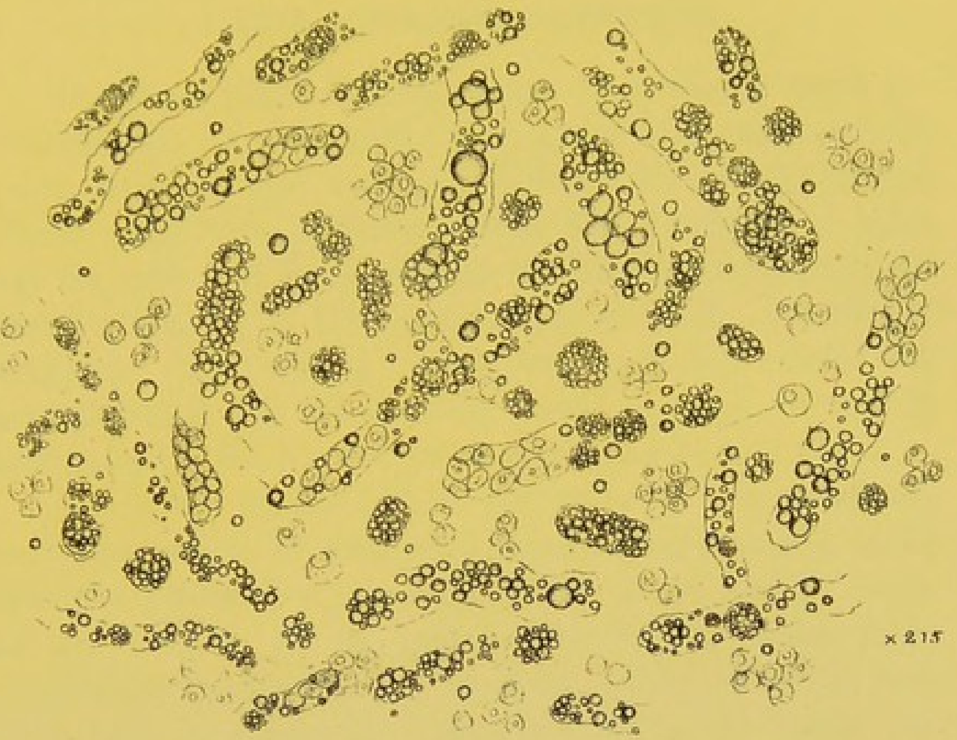
Many cells of epithelium contain no oil.

Fig. 2. Cholesterine obtained from the fatty matter in casts separated from the Urine of a case of fatty degeneration.

Many globules, composed of oily non-crystallizable fat, are seen scattered in various parts of the field.

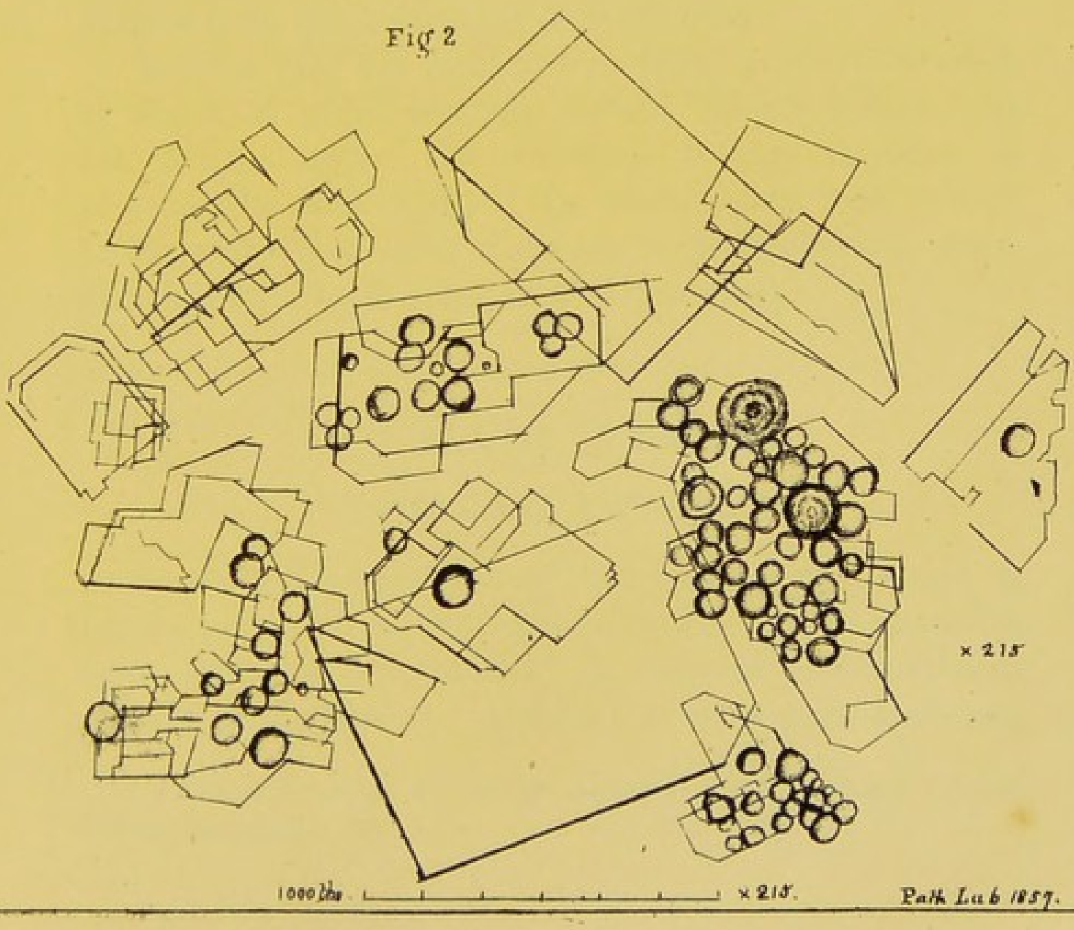
URINARY DEPOSITS–XVIII.

Fig 1



× 215

Fig 2



× 215

1000ths × 215. Path. Lab. 1857.

PLATE XVII.

CASTS. CHRONIC NEPHRITIS.

In Plate XVII several forms of granular casts are represented. In the upper part, about the centre of the page, is seen one cast containing cells of epithelium. These casts were obtained from the Urine of a man, age 34, who had been subject to chronic rheumatism for many years. The Urine contained a small quantity of albumen. The kidney disease had probably existed for several years, but its duration could not be accurately ascertained. Such casts are very commonly met with.

It will be observed that the casts in this specimen vary very much in diameter, some being scarcely more than the 1-2000th of an inch, while others are as much as the 1-500th of an inch. The former come from exceedingly narrow tubes, or from tubes in which the epithelium is abnormally adherent, while the latter are derived from tubes denuded of epithelium.

In this case the kidney is probably much contracted, in the state which has been termed "Gouty kidney," by Dr. Todd, because the condition is very common in persons who have suffered for many years from gout.* In the majority of cases there can be no doubt that spirit-drinking lays the foundation of the mischief.

PLATE XVIII.

CASTS CONTAINING OIL.

In fatty degeneration of the kidney, the Urine is usually pale, and of low specific gravity. The deposit is light, bulky, and flocculent. It contains casts and cells containing oil globules. Although in other cases of disease

* Clinical Lectures on certain diseases of the Urinary Organs and on Dropsies, p. 69.

of the kidney, a few casts and cells containing oil are not unfrequently present, a number of these never occur in the Urine unless the condition is one of fatty degeneration.

Free oil globules are also met with in the Urine in these cases; but it must be borne in mind that no opinion of the nature of the case can be formed from these, since free oil globules of accidental presence, as from passing an oiled catheter, cannot be distinguished from oil globules derived from the kidney,—except that usually a great number of very large ones are present in the former case; this, however, is a character upon which reliance cannot be placed. Casts containing oil can only be formed in the kidney, and cells containing oil usually come from the uriniferous tubes, but not invariably, as they may be derived from some portion of the surface of the mucous membrane of the bladder or urethra.

When casts containing separate oil globules, or oil inclosed in cells, are found in any number, in specimens of Urine, from the same patients, which have been subjected to examination at intervals of a few days, with or without cells containing oil, and free oil globules among them, we cannot be wrong in concluding that the condition is one of fatty degeneration of the kidney.

Some of the casts delineated in fig. 1, contain epithelial cells which do not contain oil globules, as well as cells in which the process of fatty degeneration is far advanced.

Of the presence of cholesterine.—I have examined the chemical composition of the oil globules which are present in this condition, and found that they contain a very large quantity of cholesterine.

The deposit from upwards of seven gallons of Urine was collected on a filter, washed and dried. The dry residue was treated with alcohol, and upon the evaporation of this solution numerous crystals of cholesterine were obtained. Some of these are represented in fig. 2. The large round globules consist of the oily non-crystalline portion of the fatty matter.

PLATE XIX.

ALGÆ AND FUNGI.

After Urine has been allowed to stand for some time, and in some instances even before it has left the bladder, numerous vegetable organisms make their appearance in it. Certain species occur in both acid and alkaline Urine, but there are some specimens of very acid Urine which remain free from them for a very considerable time, even for several weeks, while, on the other hand, a certain amount of acid is absolutely necessary for the development of some fungi.

The vegetable growths usually developed in Urine belong to the class of *algæ* or that of *fungi*. Among the first will be found very minute structures, which are hardly visible under a magnifying power of less than 400 diameters.* Many of the small oscillating linear bodies ordinarily termed *vibriones* belong to this class of vegetable organisms. Of fungi, the *yeast torula*, or *sugar fungus*, and the *penicilium glaucum*, are most common, while *sarcinæ* are very rarely met with.

The presence of little oval torulæ was formerly considered to be characteristic of the presence of sugar, and in the great majority of cases of diabetes, torulæ certainly occur after the Urine has stood a short time; but it is also true that not unfrequently highly saccharine Urine is destitute of these cells; as in a specimen which came under my notice a short time since, and which contained nearly 60 grains of sugar in 1000 of Urine. So, again, it is difficult to distinguish in all cases, the fungus (*penicilium glaucum*) which appears in specimens of Urine not containing sugar from the torula which is found in saccharine Urine. The sugar fungus and the penicilium are very commonly present in the same specimen of diabetic Urine.

* It is probable that these will be found to consist of varieties of *fungi* instead of *algæ*.

PLATE XIX.

FUNGI. PENICILIUM GLAUCUM, YEAST TORULA.

Fig. 1. *Penicilium glaucum* developed in acid Urine containing a deposit consisting of uric acid, with a few crystals of oxalate of lime.

a. Within 12 hours after the Urine was passed.

b. The following day.

c. Two days after the Urine was passed.

d. After standing 4 days.

e. After standing 5 days.

f. After standing 6 days.

Fig. 2. Sarcinæ from the Urine of a patient suffering from indigestion. The deposit contained also a few *vibriones* and spores of *penicilium glaucum.* Examined 24 hours after it was passed.

Fig. 3. Algæ and vibriones from pale Urine containing a deposit of triple phosphate 3 days after it was passed. It was clear, but very feebly acid when first obtained.

Fig. 4. *Penicilium glaucum,* formed in diabetic Urine 4 days after it was passed. It contained no torulæ previously. The Urine was acid, sp. gr. 1046, containing an abundant deposit of uric acid, with a few crystals of oxalate of lime. This specimen contained no sugar fungus.

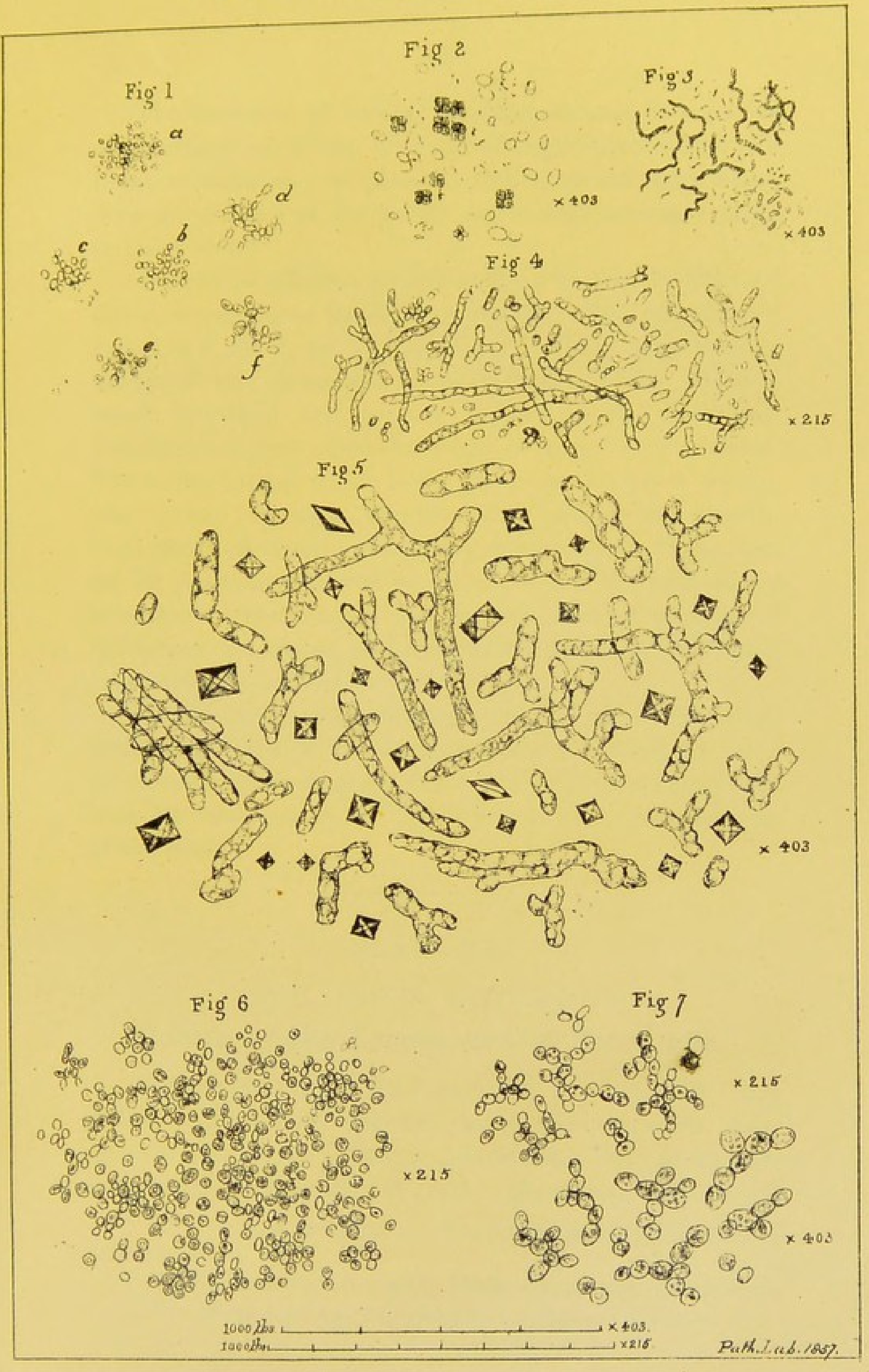
Fig. 5. Penicilium glaucum, the oval spores growing into thalli, developed in Urine about 50 hours after it was passed.

The Urine was very acid, dark coloured, sp. gr. 1024. It was passed in the evening. The deposit consisted entirely of oxalate of lime, vibriones, and a little epithelium. It did not contain albumen.

Fig. 6. Yeast torulæ from beer.

Fig. 7. Yeast added to diabetic Urine, and allowed to stand in a warm place 48 hours, showing growth of the torula.

URINARY DEPOSITS – XIX.



The existence of torulæ, therefore, cannot be regarded as an indication of the presence of sugar upon which any great reliance can be placed, neither, on the other hand, does the absence of the torula prove that no sugar exists in the Urine.*

Penicilium glaucum occurs under a variety of different forms, according to its stage of growth. The sporules are round, *a b*, fig. 1, or oval, *c, d, e, f.* These may become elongated and developed so as to form a *thallus,* which is much branched and spreads rapidly in all directions. Sometimes it goes on to the stage of *aërial fructification.* The sugar fungus, which is the same as the yeast torula, also passes through corresponding stages of growth. Penicilium glaucum grows very commonly in Urine, but for its development free access of *air* and the presence of *albuminous substances,* either in the form of *albumen* or *epithelium* and *mucus,* and a certain amount of *free acid,* are absolutely necessary.†

Sarcinæ are very rarely met with in Urine. They are commonly found in the vomited matters in certain cases of disease of the stomach, but have been occasionally met with elsewhere, as in the Urine, and even in the ventricles of the brain.‡

PLATE XX.

PUS. BLOOD. EPITHELIUM.

Tables for the Examination of Urine, § 34.

The microscopical characters of pus are very well defined. The nearly uniform size of the corpuscles, their circular form, and granular appearance, distinguish pus from every other urinary deposit. Some years ago much

* For the tests for sugar see **Tables for the Examination of Urine,** p. 20.

† See Dr. Hassall's paper in the Medico-Chirurgical Transactions.

‡ The Microscope, and its application to Clinical Medicine.

PLATE XX.

PUS. BLOOD. EPITHELIUM.

Fig. 1. Pus from Urine. The corpuscles are precisely similar to those found in ordinary pus.

Fig. 2. Pus corpuscles treated with acetic acid. Those on the left are magnified 215, and those on the right 403 diameters.

Fig. 3. Pus corpuscles magnified 403 diameters, showing their granular character more clearly than is represented in fig. 1.

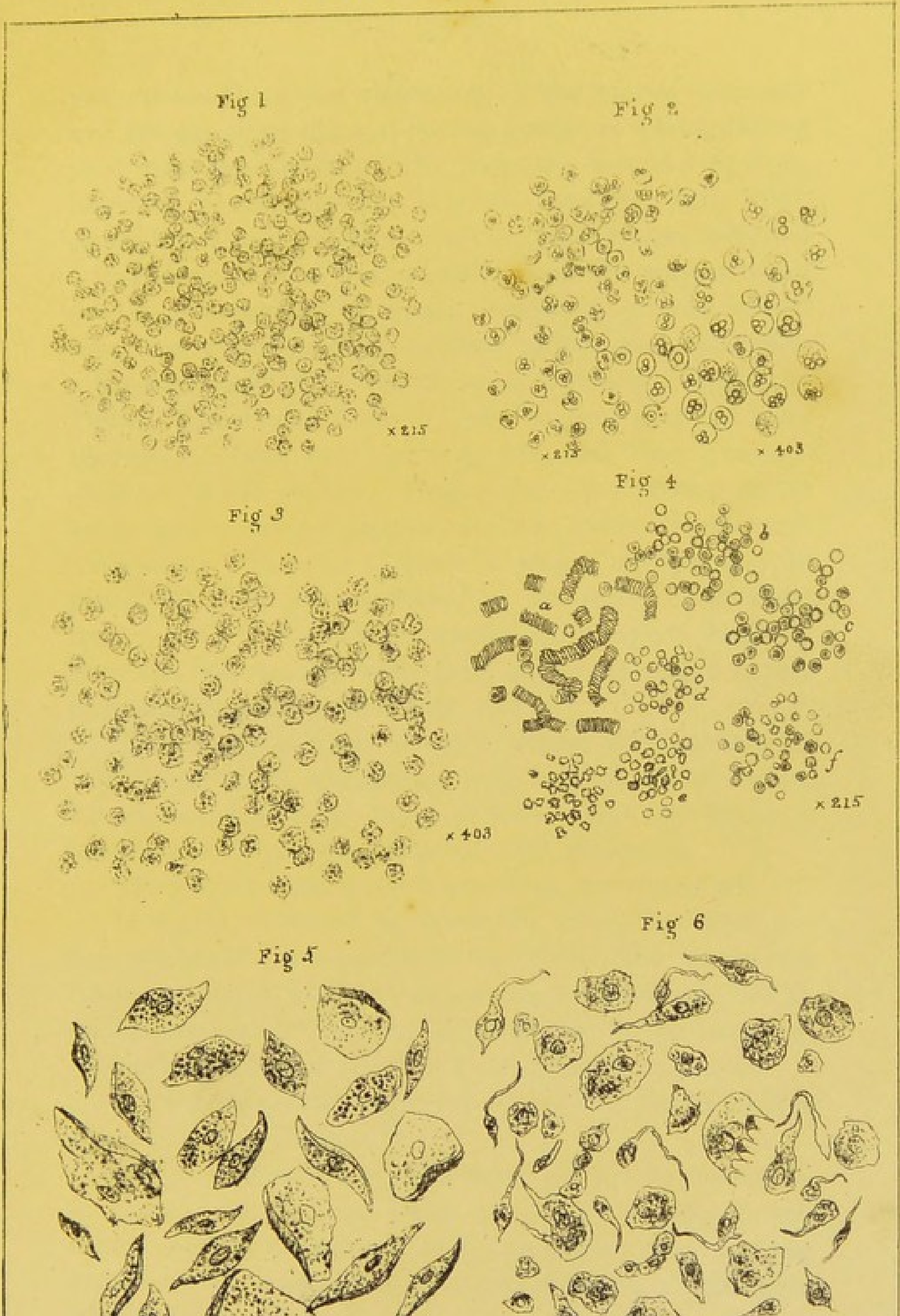
Fig. 4. Blood corpuscles, *a, b, c,* taken from the living body; *d, e, f,* from Urine. At *d,* the corpuscles are seen to be smaller than natural. At *e,* their circumference is serrate and ragged; and at *f,* a somewhat similar change is represented.

These alterations are due to physical and chemical changes, effected by the constituents of the Urine.

Fig. 5. Vaginal epithelium from the Urine.

Fig. 6. Epithelium from the bladder, found in Urine. Many of the larger cells lie on the summit of the columnar and caudate cells, and their under surface often presents several cup-shaped depressions, into which are received the latter. One of these cells is represented in the centre of the figure. Large and very characteristic cells from the bladder are also represented in Plate XII, fig. 2.

URINARY DEPOSITS XX.



was written about the characters of the mucus corpuscle and the pus corpuscle, and the importance of distinguishing them from one another. The so-called mucus corpuscle, however, is nothing more than an epithelial cell, often somewhat altered, entangled in the viscid mucus, which is formed in greater or less quantity upon the surface of all mucous membranes. A small quantity of mucus derived from the genito-urinary mucous membrane entangling a few small cells of epithelium, is always found in healthy Urine. These cells, however, vary in size: they are more transparent than the pus corpuscle, and their granular character is less marked. Such cells, when acted upon by acetic acid, entirely disappear, or they become much more transparent. In some of them a single nucleus may be perceived. The pus corpuscle, on the other hand, when treated with this re-agent, swells up, becomes perfectly clear and transparent, while from one to four small highly refracting corpuscles come into view.

This change is shown in fig. 2, where some corpuscles will be observed containing only one of these bodies, others two, and some three or four. Half the figure is magnified 215, and the other half 403, diameters.

This change distinguishes pus from everything else.

It should, however, be borne in mind, that after pus has remained for some time in Urine, the corpuscles become softened, and their characters less distinct; but in such a case, should there be any doubt as to the nature of the deposit, we must resort to a chemical examination.

For the chemical characters of pus, see *Tables for the Examination of Urine.*

Blood corpuscles are often much altered by remaining in Urine. In alkaline Urine the blood retains its red colour, but the normal acid of Urine renders the colouring matter brown, whence the smoky appearance of acid urine which contains blood.

The corpuscles are often found to be much smaller after they have lain for some time in Urine. The cor-

PLATE XXI.

VARIOUS URINARY DEPOSITS.

Fig. 1. Pus and blood corpuscles, with crystals of triple phosphate, in the Urine of a man suffering from fungus growths connected with the mucous membrane of the bladder.

Fig. 2. Spermatozoa and cells of vaginal epithelium removed from the vagina of a little girl, a few hours after a rape had been committed.

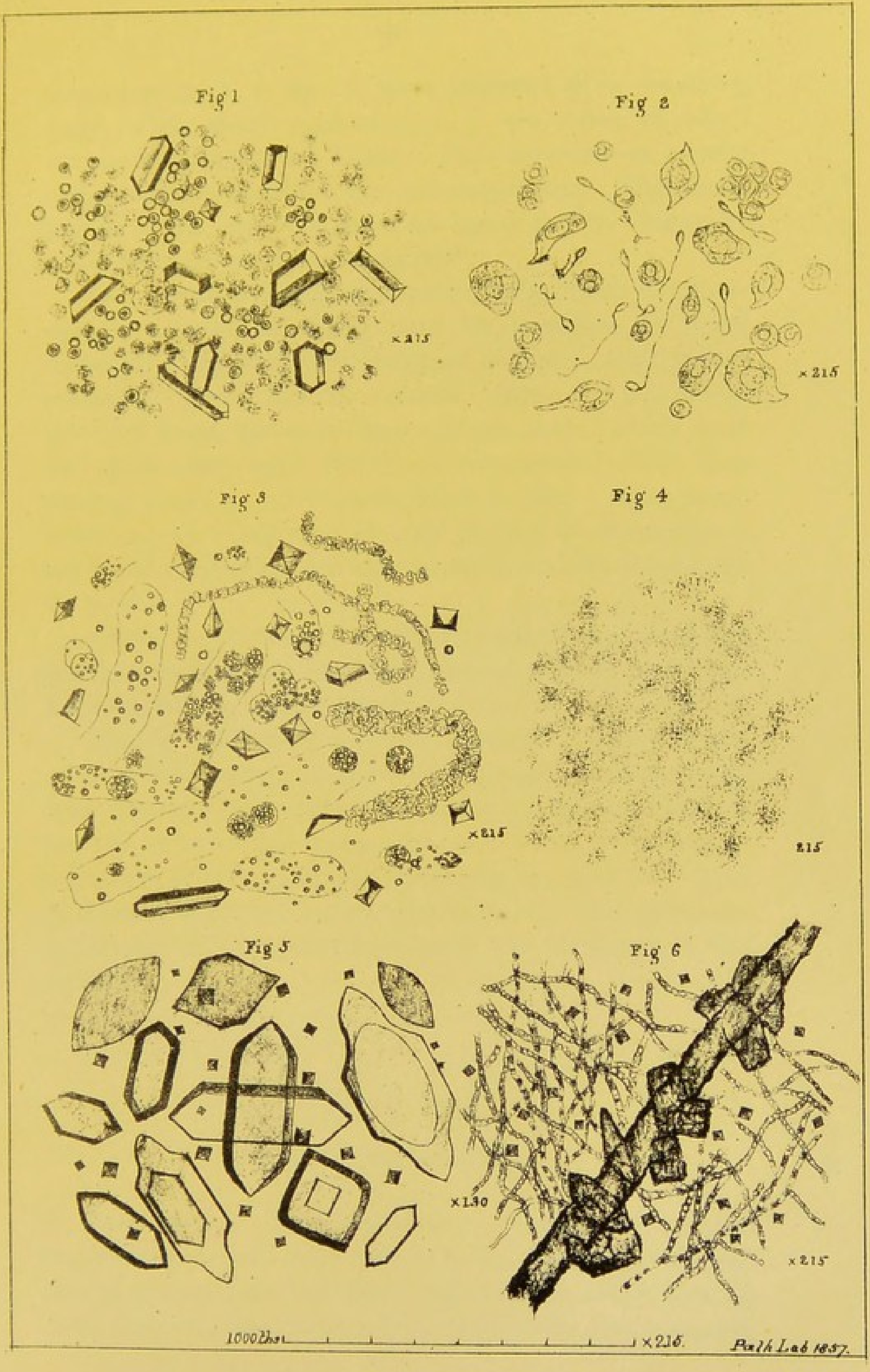
Fig. 3. Crystals of triple phosphate, many of which closely resemble octohedra of oxalate of lime, with epithelial casts, and casts containing oil from the Urine of a case of chronic nephritis, with partial fatty degeneration.

Fig. 4. Deposit of phosphate of lime in an amorphous form, from the Urine of a man who was suffering from an attack of sick headache.

Fig. 5. Large crystals of uric acid, with a number of octohedra of oxalate of lime from the Urine of a boy, aged 18, suffering from diabetes. The crystals formed after the Urine had been allowed to stand for 8 or 10 hours.

Fig. 6. Penicilium glaucum and oxalate of lime, crystals of uric acid crystallized round a hair, from the Urine of a patient suffering from chronic bronchitis and emphysema, and habitually passing large quantities of uric acid.

URINARY DEPOSITS XXI.



puscles in *a, b, c,* fig. 4, were obtained from the living body, while those marked *d, e, f,* are copies of blood corpuscles taken from Urine. The corpuscles in *e* and *f* exhibit characters which are not uncommon. Their outline is rough, many of them having a stellate character, while some are almost disintegrated.

Some small perfectly circular crystals, which are occasionally present in Urine, may be mistaken for blood corpuscles; but if they be examined carefully, their highly refracting power will be noticed. They are soluble in tolerably strong nitric or hydrochloric acids, which exert but little effect upon the blood corpuscles, further than causing them to shrink somewhat in size. The point, however, can usually be at once decided by examining a few blood corpuscles, and comparing them with the doubtful bodies.

Vaginal epithelium is easily recognized by the large flattened cells which are often folded over at the sides. Each contains a distinct nucleus.

Bladder epithelium varies in character. Many of the cells are columnar, and upon the summits of these, large oval cells are often seen, the under surface of which is marked by numerous depressions, into which the extremities of the cells of columnar epithelium are received. Two or three of these are represented in fig. 6. The columnar epithelium is very abundant near the openings of the ureters.

PLATE XXI.

VARIOUS DEPOSITS.

Pus. Blood. Triple Phosphate.—The case from which the urinary deposit represented in fig. 1 was derived, was that of a man who had been suffering for many months from obstinate hæmorrhage from the bladder, accompanied with great pain, evidently caused by the presence of fungus growths. The patient gradually sank. Upon post mortem examination, a great number of pendulous growths were found connected with the mucous membrane of the bladder. Pus and phosphates were also almost constantly present. The small bodies, with the sharp well-defined outline, are the blood corpuscles.

Spermatozoa in the mucus from the vagina, in a case of rape.—The case will be found described in Number I of the Archives of Medicine.

Casts containing oil and epithelium. Triple phosphate.—The deposit represented in fig. 3 was obtained from a man about 50, who was suffering from phthisis and chronic renal disease, accompanied with œdema of the legs, and slight ascites. The duration of the disease could not be ascertained with any degree of accuracy.

Phosphate of lime.—The amorphous phosphate represented in fig. 2 consists entirely of phosphate of lime. The Urine containing it was slightly alkaline, and the deposit was in it when passed.

Uric acid in the Urine in a case of diabetes.—It has been stated that uric acid was never present in cases of diabetes, and that in this condition hippuric acid took the place of uric acid. This, however, is not true universally. The Urine, in the present instance, deposited much uric acid in the form of large crystals, represented in fig. 5, and contained between 50 and 60 grains of sugar in 1000 of Urine. In this Urine no hippuric acid could be detected. It was sought for according to the method given by Lehmann.

Oxalate of lime, uric acid, penicilium glaucum.—The oxalate of lime crystals in fig. 6 increased in number and size as the fungus was developed. The deposition of the oxalate seemed to be connected with the growth of the fungus. At the same time the uric acid crystals lost their sharpness, and were evidently undergoing solution.

PLATE XXII.

The crystals delineated in all the figures in Plate XXII consist of a peculiar form of phosphate of magnesia, or ammoniaco-magnesian phosphate, but I have never been able to ascertain their exact composition with certainty. I examined some specimens, and found them to be readily soluble in the mineral acids, and they were dissolved slowly by acetic acid. Upon adding excess of ammonia to the acid solution crystals of ammoniaco-magnesian phosphate were precipitated. They were not much altered by exposure to a red heat. In figures 3, 4, and 6, various forms approaching the ordinary crystals of triple phosphate may be observed.

These crystals form a white flocculent deposit, which often occupies a considerable bulk. The Urine which contains them is acid, and in many cases a considerable number of crystals of oxalate of lime were also present.

I have found these beautiful crystals in the Urine in so many different cases, that I am led to conclude that their form is determined by other constituents of the Urine, or is dependent upon the rapidity with which they are crystallized. Their presence does not seem to be due to any special morbid condition.

PLATE XXII.

Fig. 1. Rare form of crystals of triple phosphate and octohedra of oxalate of lime, from the Urine of a girl suffering from icthyosis. Mounted in fluid.

Fig. 2. The same crystals dried and incinerated.

Fig. 3. Two forms of triple phosphate, mounted in Canada balsam.

Fig. 4. Deposit from the Urine of a man suffering from gouty kidney, consisting of a peculiar form of triple phosphate, with granular casts. Given to me by Dr. Johnson.

Fig. 5. Crystals from the same specimen of Urine, as in fig. 1. Crystallized round hairs.

Fig. 6. Forms of triple phosphate and oxalate of lime, from the Urine of a young man enjoying good health, but taking little exercise.

URINARY DEPOSITS XXII.

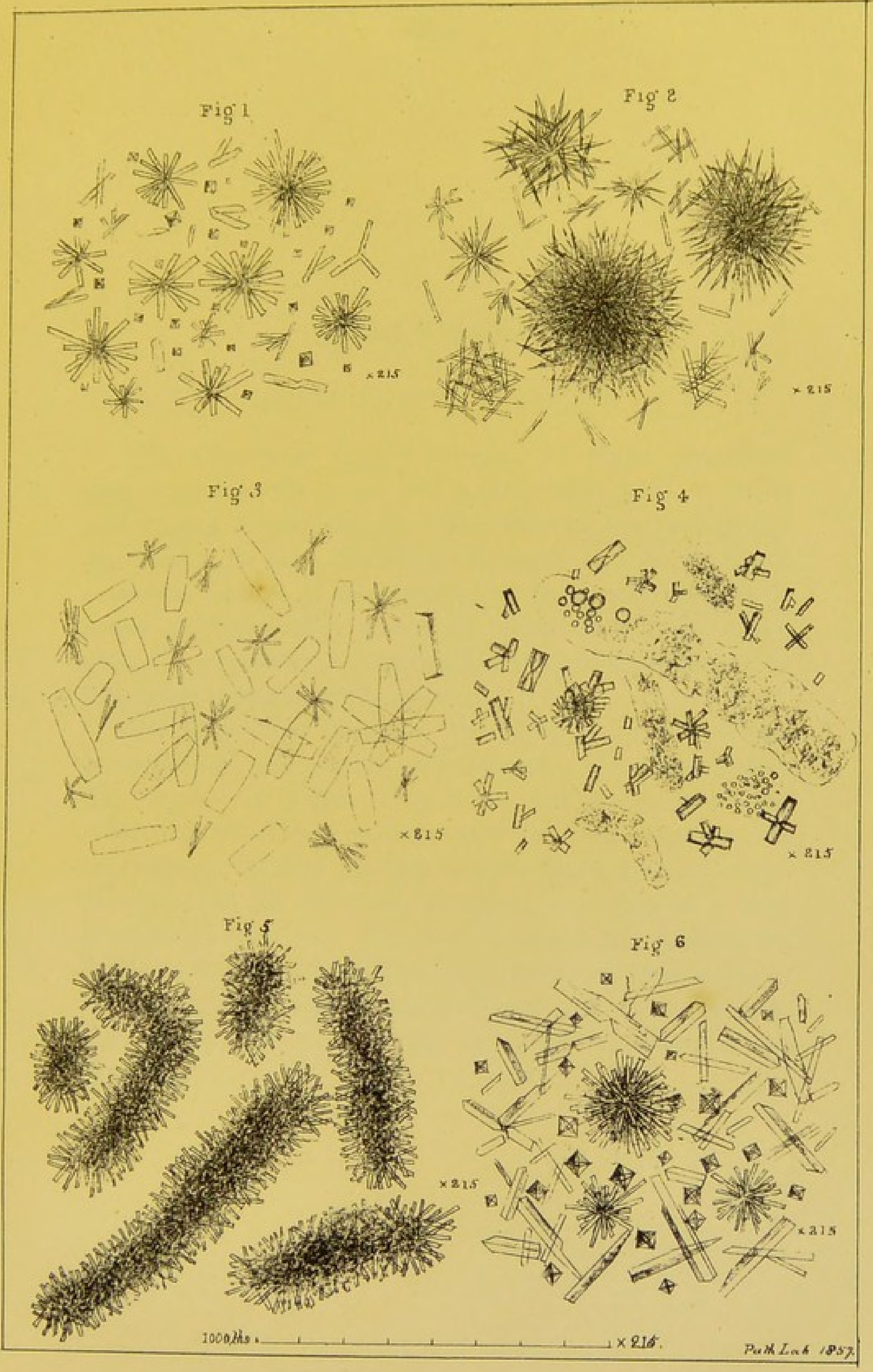


PLATE XXIII.

TRIPLE PHOSPHATE. FUNGI.

The very large ragged crystals of triple phosphate represented in fig. 1 are occasionally met with in urine undergoing decomposition. The crystals are in part re-dissolved. In cases where the observer may be in doubt as to the nature of the crystal, he need only add a little acetic acid and then excess of ammonia. Triple phosphate is dissolved by the acid, and re-precipitated in foliaceous crystals by the ammonia.

The fungi represented in figs. 2, 3, and 4, are of very curious form, and are the only examples I have ever seen. The urine in which they were developed contained octohedra of oxalate of lime and dumb-bell crystals, but otherwise presented nothing remarkable in its characters. It contained no albumen or sugar, and was of a very strong acid reaction. The filamentous fungi represented in figs. 4 and 5, seem to have been developed from sporules formed in the dilated portions (Sporangia) of the fungi in figs. 2, 3, and 4. In fig. 5 numerous sporules are represented.

PLATE XXIII.

TRIPLE, OR AMMONIACO-MAGNESIAN PHOSPHATE. FUNGI.

Fig. 1. Crystals of triple phosphate and urates from Urine which had been allowed to become decomposed. Dr. Eade, of Norwich, kindly forwarded to me the specimen from which the drawing was made.

Fig. 2. Curious fungi formed in the Urine of a young man passing much oxalate of lime. The Urine was voided on November 5th, 1857.

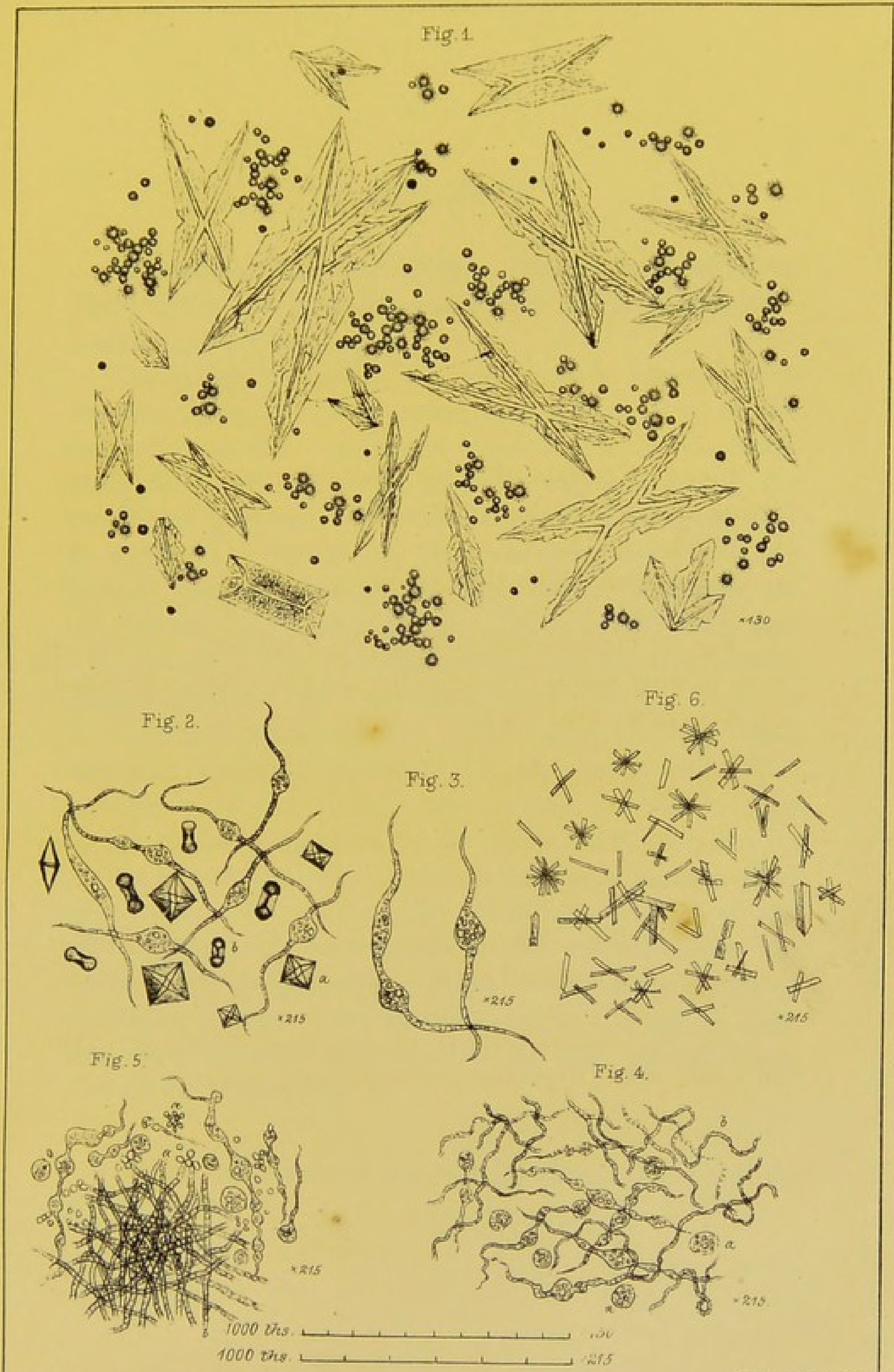
Fig. 3. Some of the same fungi, on November 6th.

Fig. 4. The same, on November 9th. Numerous linear fungi were now observed.

Fig. 5. The same, on November 11th. A few sporules of *Penicilium glaucum* are now to be distinguished.

Fig. 6. Curious form of triple phosphate in the Urine of a tall, weak, hypochondriacal man, aged 23.

URINARY DEPOSITS. XXIII.



Path. Lab. 1857.

PLATE XXIV.

Epithelium from the Kidney, Ureter, aud Urethra. These specimens were obtained from organs which were healthy and perfectly fresh.

The vessels of part of the kidney were injected with Prussian blue fluid,* in order that the relation of the capillaries to the uriniferous tubes might be distinctly made out. The character of the epithelium lining the convoluted portion of the uriniferous tube is represented at *e* (fig. 1). Generally, the cell does not exhibit a distinct outline as is usually represented, although, on the contrary, the outline of the nucleus is very sharp and well defined. The material around the nucleus usually appears granular, and I am not satisfied as to the existence of a distinct cell-membrane. The nuclei are very large, and may easily be mistaken for the entire cell. The epithelium in the straight part of the uriniferous tube in the medullary portion of the kidney is flatter, and its outline is more distinct. In the cortex, the epithelium takes part in *secretion,* but in the medullary portion of the organ it probably corresponds to the epithelium of the *ducts* of glands generally. Many vessels in this part of the kidney pursue a very straight course, and are of large size, their diameter being equal to, or even greater than, that of the tubes (*d* fig. 2).

* For the composition of this fluid, *see* "How to work with the Microscope," page 78.

PLATE XXIV.

EPITHELIUM OF URINIFEROUS TUBE, PELVIS OF THE KIDNEY, URETER, AND URETHRA.

Fig. 1. Convoluted portion of uriniferous tube with epithelium, from the cortical portion of the kidney.

a. Basement membrane.

b. Epithelium.

c. Part of tube from which the epithelium has been squeezed out, leaving only the basement membrane.

d. Capillary vessels containing transparent injection, showing their relation to the wall of the tube.

e. Separate cells of epithelium magnified 403 diameters.

Fig. 2. Straight portion of uriniferous tube from the base of a pyramid.

a. Basement membrane.

b. Epithelium.

c. A tube from which the epithelium has been removed.

d. One of the large straight vessels found among the tubes in the pyramids.

e. Capillaries also present in this part of the kidney.

f. Separate epithelial cells magnified 403 diameters.

Fig. 3. Epithelium from the pelvis of the kidney, in part tessellated (*a*) and in part columnar.

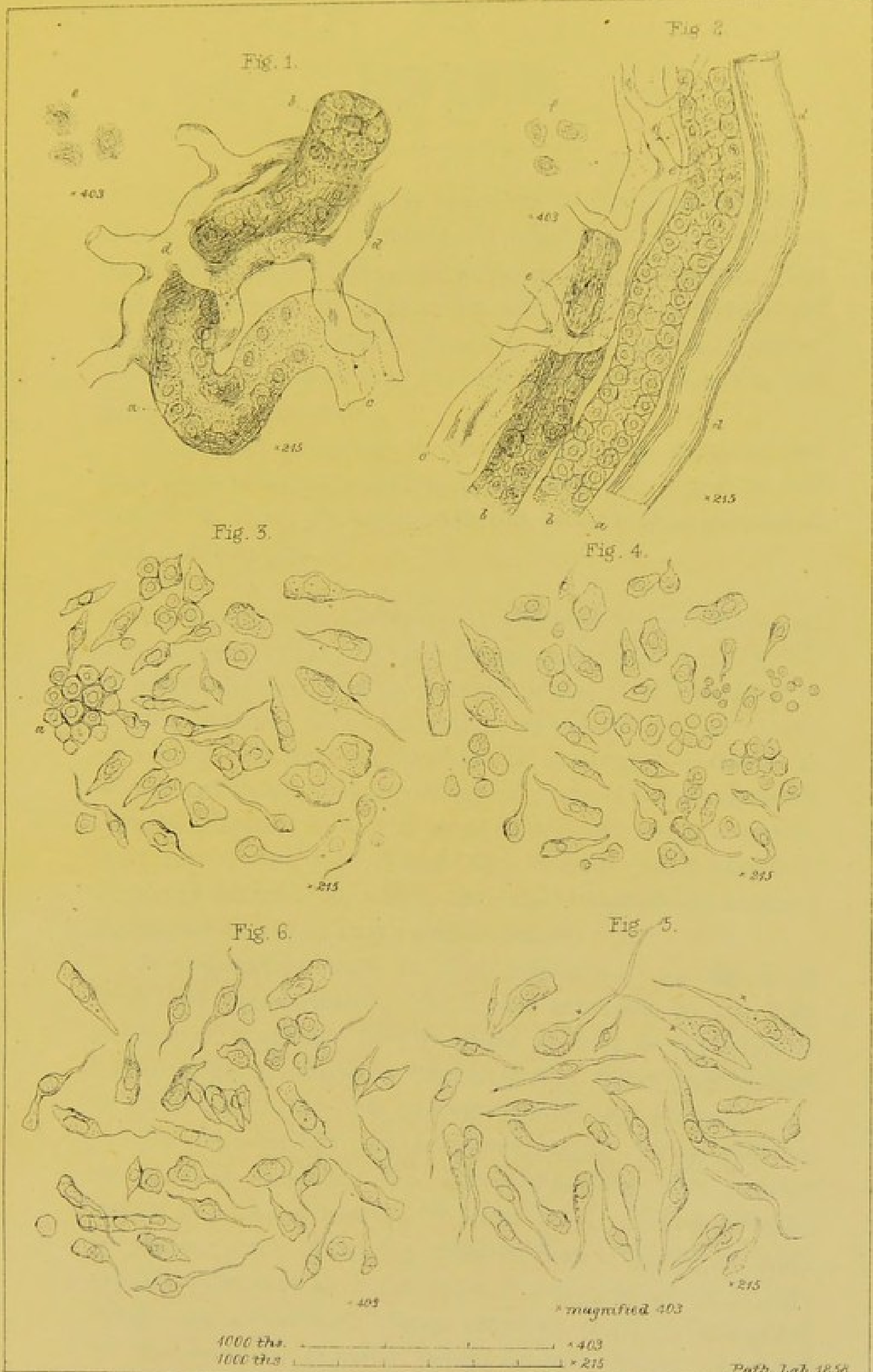
Fig. 4. Epithelium scraped from the surface of a pyramid.

Fig. 5. Epithelium from the ureter, entirely columnar.

Fig. 6. Columnar epithelium from the urethra.

⁂ The specimens from which all these drawings were copied, were taken from the organs removed from the body of a man, aged 40, who died of pneumonia, otherwise healthy.

URINARY DEPOSITS. XXIV.



URINE.

Under this head it is intended to give illustrations of all those crystalline constituents which are to be obtained from Urine, but which exist in solution in that fluid. The most important of these are *uric acid* and *urates* (of which illustrations will be found in Part I.), *urea, creatine, creatinine, hippuric acid, lactates, ammoniacal salts,* and several *inorganic salts.*

It is also proposed to give drawings of many of the crystalline substances derived from these, such as *nitrate and oxalate of urea, murexide, alloxan, alloxantine, parabanic acid, lactates,* &c.

On concentrating Urine.—In concentrating Urine and other organic fluids for the purpose of obtaining crystals of certain of their organic constituents, it is necessary to employ the heat of warm water instead of the direct heat of a lamp. If the evaporation is conducted by the heat of a naked flame, decomposition of some of the compounds invariably takes place. In some instances even a temperature several degrees below the boiling point produces chemical changes, in which case the evaporation must be conducted in vacuo over sulphuric acid.

A preparation such as that represented in fig. 1 is made by concentrating the Urine carefully to the consistence of a syrup. While warm, a drop is placed upon a glass slide, carefully covered with thin glass, and allowed to stand for some hours, so that crystals may form.

On incinerating the solid residue of Urine.—When we wish to examine the inorganic salts, the organic matter must be destroyed by a red heat. This is effected by placing some of the *dry* solid residue of Urine or other organic substance in a platinum capsule, or shallow dish, which, supported on a triangular piece of wire, is exposed to the heat of a spirit lamp, or gas lamp. As very

URINE.

PLATE I.

ORGANIC AND INORGANIC SALTS OF HEALTHY URINE.

Fig. 1. *Crystalline residue of healthy Urine, obtained by concentrating the liquid over a water bath.*

a. Spherical masses, consisting of aggregations of crystals of urate of soda. Many of these are seen deposited upon a film, consisting of phosphate of lime and ammoniaco-magnesian phosphate.

b. Cubical crystals of chloride of sodium.

c. Octohedral crystals of chloride of sodium, which crystallizes in this form in the presence of urea.

d. Large crystals of common phosphate of soda. $2NaO,HO,PO_5+26Aq$.

e. Sulphates.

Fig. 2. *Crystals of inorganic salts of healthy Urine, obtained by incinerating the dry residue, decarbonizing it, and extracting it with water.* The solution being concentrated to the proper degree, readily crystallized.

a. Crystals of common salt, obtained by evaporating the solution nearly to dryness.

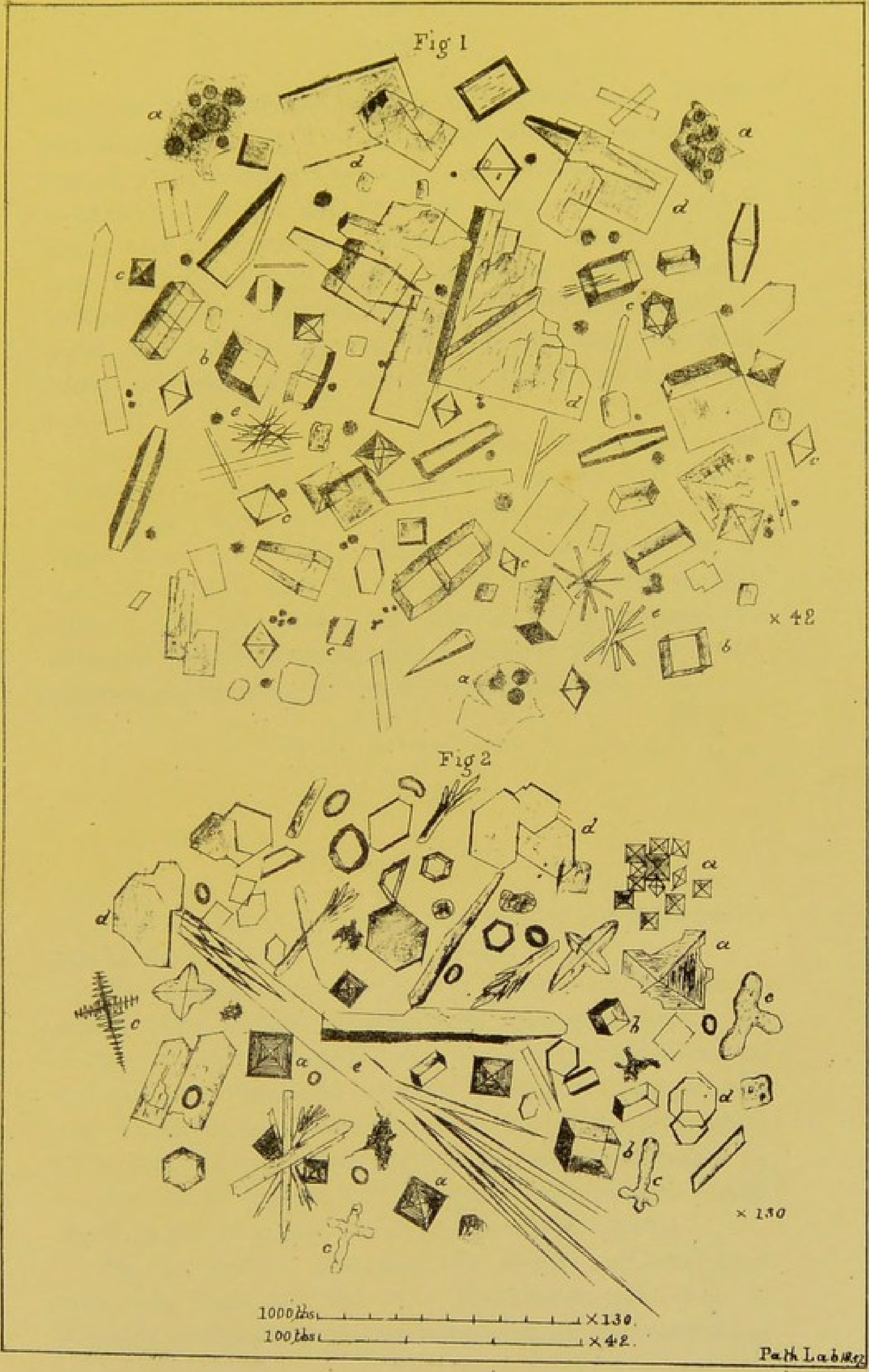
b. Crystals of common salt, formed in a concentrated solution.

c. Crosslets of common salt, obtained by evaporating the solution very rapidly to dryness.

d. Crystals of phosphate of soda.

e. Crystals of sulphates.

URINE I.



Path Lab

offensive fumes are developed in this operation, it should not be carried on in a room. After the residue has been heated, a black charred mass remains behind. This is to be kept at a dull red heat for some hours, when the carbon unites with the oxygen of the air, and is dissipated in the form of carbonic acid, while the inorganic salts remain behind perfectly white and pure. The ash is dissolved in water, the solution filtered and concentrated by heat, when crystals may be readily obtained in the usual manner.

In endeavouring to obtain crystals for microscopical examination, the concentration should be allowed to proceed to the proper extent, and then a drop of the warm liquid placed on a slide, and *covered with thin glass*, so that the crystals may be examined in their own mother liquor. The preparation of which fig. 2 is a copy was obtained in this manner, and a similar plan has been pursued in obtaining all the crystals delineated.

PLATE II.

UREA. $C_2H_4N_2O_2$.

Pure urea may be easily obtained by the decomposition of the nitrate or oxalate of urea.

The crystals represented in fig. 1 were made by decomposing pure oxalate of urea with common chalk. An oxalate of lime is found, which is separated by filtration, and the urea remains in solution. From the nitrate, urea may be obtained by adding carbonate of barytes—nitrate of barytes and urea result; the latter may be separated by evaporation to dryness, and extraction with alcohol, which dissolves the urea, and leaves the nitrate of barytes.

For the mode of preparing the nitrate and oxalate of urea, see pages 57 and 59. Pure urea may also be obtained artificially by evaporating cyanate of ammonia to

PLATE II.

UREA, $C_2H_4N_2O_2$.

Fig. 1. Urea obtained from Urine crystallized in its own mother liquid.

Fig. 2. The same examined in the dry way. The spaces seen in the substance of the crystal contain air.

Fig. 3. Small crystals of urea formed in a concentrated solution of natural urea.

Fig. 4. Similar crystals of larger size.

Fig. 5. Artificial urea crystallized. Examined in the dry way.

The spots represented in all these crystals are little cavities within them, which are occupied with fluid when moist, but when dry contain air.

URINE-II

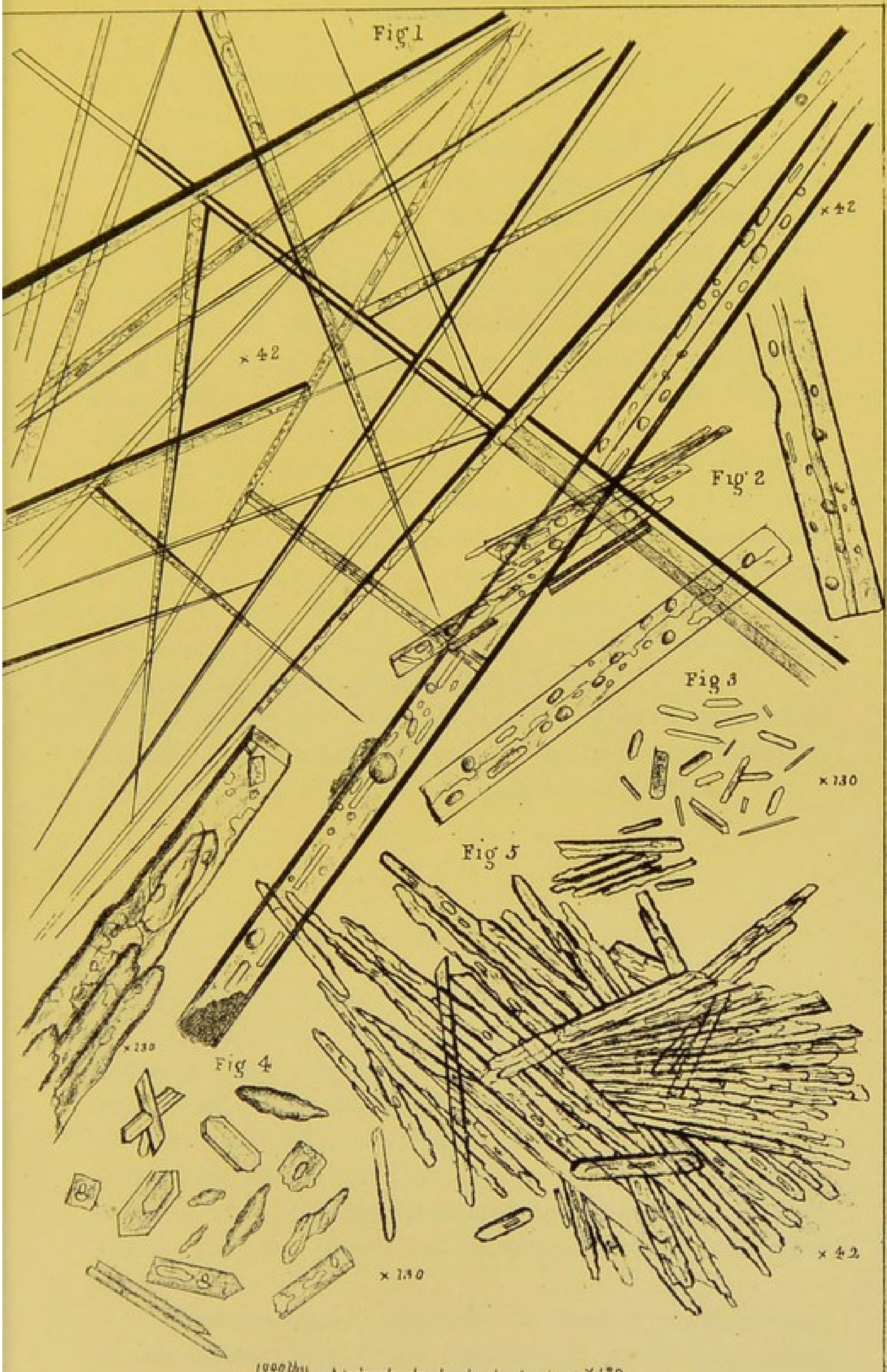


Fig 1
× 42
× 42
Fig 2
Fig 3
× 130
Fig 5
× 130
Fig 4
× 130
× 42
1000ths
× 130
100ths
× 42
Path. Lab. 1957.

dryness, dissolving the residue in water, and crystallizing in the usual manner.

Crystals of artificial urea are represented in fig. 5.

Urea crystallizes in four-sided prisms, which appear to be composed of a number of acicular crystals placed in apposition. Hollow spaces are usually present in the interior of the crystals in considerable number. These contain a fluid differing considerably in refractive power from the crystal itself. When the crystals are dried, these spaces are occupied with air. They are seen in almost all the crystals represented.

It is very curious that urea exerts a great influence upon the crystallization of chloride of sodium and muriate of ammonia. The former, which ordinarily crystallizes in cubes, in the presence of urea, assumes the form of octohedra; and the latter, whose ordinary form is an octohedron, that of a cube. Some octohedra of chloride of sodium are represented in Plate I, fig. 1.

The best test for urea consists in adding nitric acid to a highly concentrated solution of the fluid suspected to contain it, when crystals of the nitrate are formed.

PLATE III.

NITRATE OF UREA, $C_2H_4N_2O_2,HO,NO_5$.

Crystals of nitrate of urea are easily prepared by adding nitric acid to a concentrated solution of urea, or to ordinary Urine evaporated to half its bulk, or less. The crystals of nitrate soon appear in the form of scales, which are composed of a number of rhomboidal plates, of the shape represented in Plate III. The character of the crystals varies slightly according to the amount of acid added, and the degree of concentration of the urea solution.

Not unfrequently, especially in cases of acute disease, in this country, the Urine contains so much urea when

PLATE III.

NITRATE OF UREA, $C_2H_4N_2O_2,HO,NO_5$.

Fig. 1. Crystals of nitrate of urea, formed by adding excess of nitric acid to concentrated Urine.

Fig. 2. Nitrate of urea, formed by adding a quantity of nitric acid, not sufficient to combine with the whole of the urea present.

Fig. 3. Nitrate of urea, obtained by adding a moderate quantity of nitric acid to slightly concentrated Urine in a test tube, and allowed to crystallize slowly.

Fig. 4. Obtained by adding a marked excess of nitric acid.

Fig. 5. Crystals of nitrate of urea, formed by adding only two drops of nitric acid to highly concentrated Urine.

Fig. 6. Crystals of pure nitrate of urea, obtained by dissolving some of the nitrate in water, and evaporating so that crystals may form.

URINE—III.

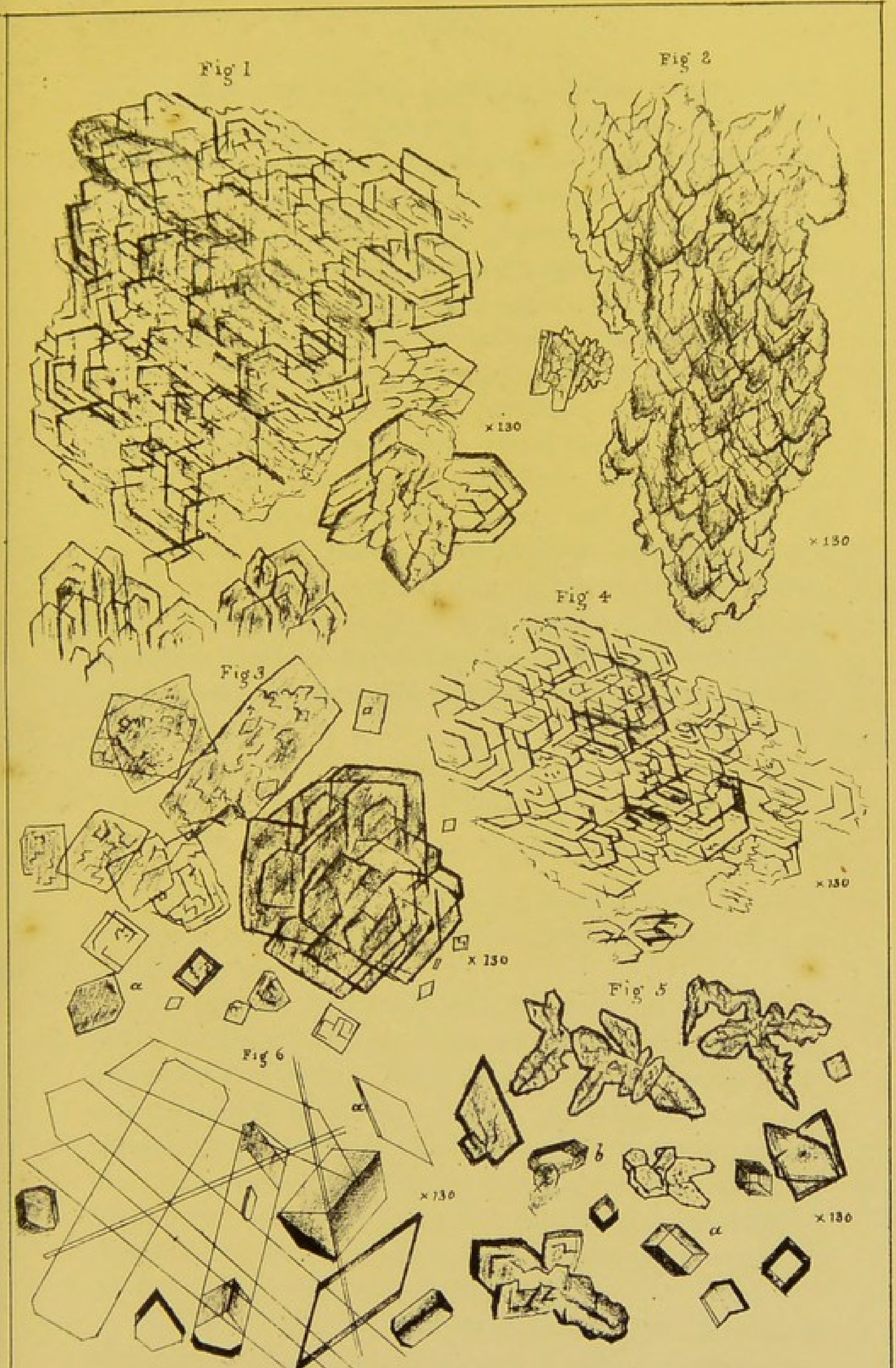


Fig 1
× 130
Fig 2
× 130
Fig 3
× 130
a
b
Fig 4
× 130
Fig 5
a
b
× 130
Fig 6
a
× 130
1000ths
× 130.

passed, that it crystallizes upon the addition of nitric acid, without previous evaporation. It appears, from the observations of foreign authorities, that such examples are rarely, if ever, met with on the continent.

The ordinary test for the presence of urea, depends upon the slight solubility of the crystals of nitrate of urea in water, and the readiness with which this salt is formed when nitric acid is added to a solution containing urea.

When, however, only traces of urea are present in an animal fluid as in blood, it is better to evaporate to dryness in the first instance, and extract the dry residue with alcohol. After filtration, the alcoholic solution is evaporated to the consistence of a syrup, and, if necessary, a few drops of water added. If urea be present, the characteristic crystals will be formed upon the addition of nitric acid. By this process the urea is separated from most of the saline matters, from albumen, and other substances, which would interfere with the formation of good crystals of the nitrate.

PLATE IV.

OXALATE OF UREA, $C_2H_4N_2O_2, HO, C_2O_3$.

Crystals of oxalate of urea are formed when a strong solution of oxalic acid is added to a concentrated solution containing urea.

The crystals frequently take the form of rhomboidal plates, much resembling those of the nitrate, only the angles are less acute. Many prisms, with obliquely truncated summits, are often present. Usually, however, the crystals of oxalate of urea take the form of plates, which are composed of a multitude of smaller crystals as those represented in *a*, *b*, *d*, Plate IV; but upon microscopical examination, the rhomboidal form of many of these component crystals will be distinctly seen.

Oxalate of urea is often prepared for the purpose of obtaining pure urea, in the manner described under urea.

PLATE IV.

OXALATE OF UREA, $C_2H_4N_2O_2,HO,C_2O_3$.

Fig. 1. Crystals obtained by recrystallizing nearly pure oxalate of urea from an aqueous solution.

a. Dendritic masses, in which the form of the crystal is not very distinct.

b. Masses of well formed crystals.

c. Perfect crystals of oxalate of urea.

Fig. 2. These crystals were obtained by evaporating healthy Urine to dryness, and extracting the residue with alcohol. The alcoholic solution was evaporated to dryness, and water added until the residue had a syrupy consistence. To this oxalic acid crystals were added, in sufficient quantity to form an oxalate with the urea present.

d. Represents the general character of the crystals of oxalate usually formed in this manner.

e. More perfect crystals.

URINE – IV.

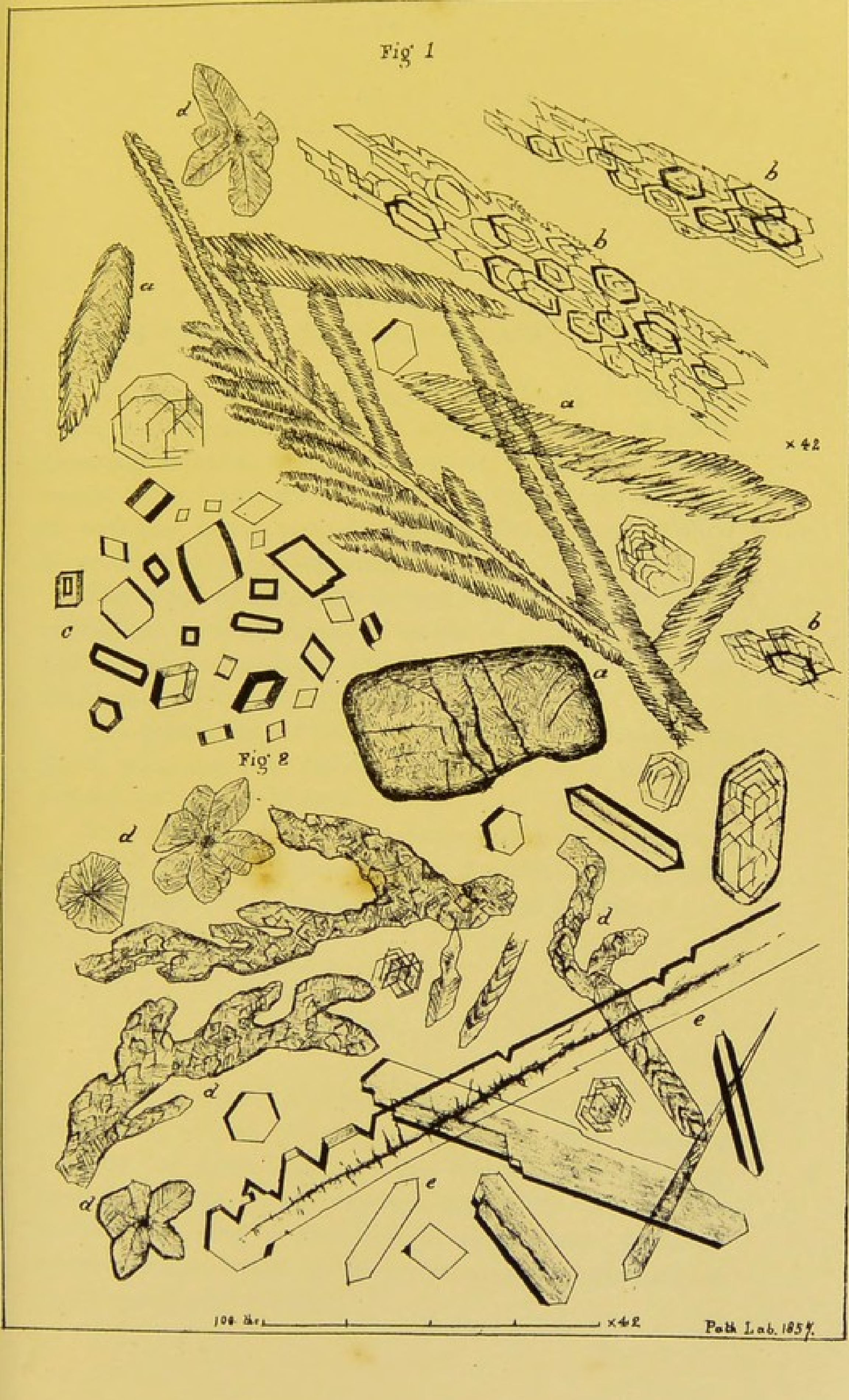


PLATE V.

URATE OF MAGNESIA. URATE OF LIME. URIC ACID.

The urate of magnesia represented in fig. 1, was prepared by the addition of sulphate of magnesia to a hot, saturated solution of urate of potash. After the lapse of two or three hours, a number of acicular crystals, collected in wart-like forms, were deposited. These were purified by re-solution in boiling water.

The urate of lime was formed by adding chloride of calcium to a hot solution of urate of potash. The precipitate was amorphous, but crystals were obtained by re-dissolving it in boiling water.

The square-shaped crystals of uric acid, represented in fig. 4, were made by adding hydrochloric acid to a weak solution of urate of potash.

The crystals of uric acid, represented in fig. 5, were obtained from the Urine of a young man suffering from slight indigestion, but otherwise in perfect health.

PLATE VI.

The crystals of alloxan, represented in fig. 1, were prepared as follows: 12 parts of uric acid were added to 17 parts of nitric acid, sp. gr. 1.412. After standing from 12 to 24 hours, crystals separated. These were purified by being re-dissolved in tepid water, and the solution concentrated by evaporation at a gentle heat, so that crystals might form.

PLATE V.

URATE OF MAGNESIA, $C_{10}N_4H_3,Mg\,O_6+6Aq$. URATE OF LIME, $C_{10}N_4H_3CaO_6+2Aq$. URIC ACID, $C_{10}H_4N_4O_6$.

Fig. 1. Urate of magnesia crystallized in tufts.

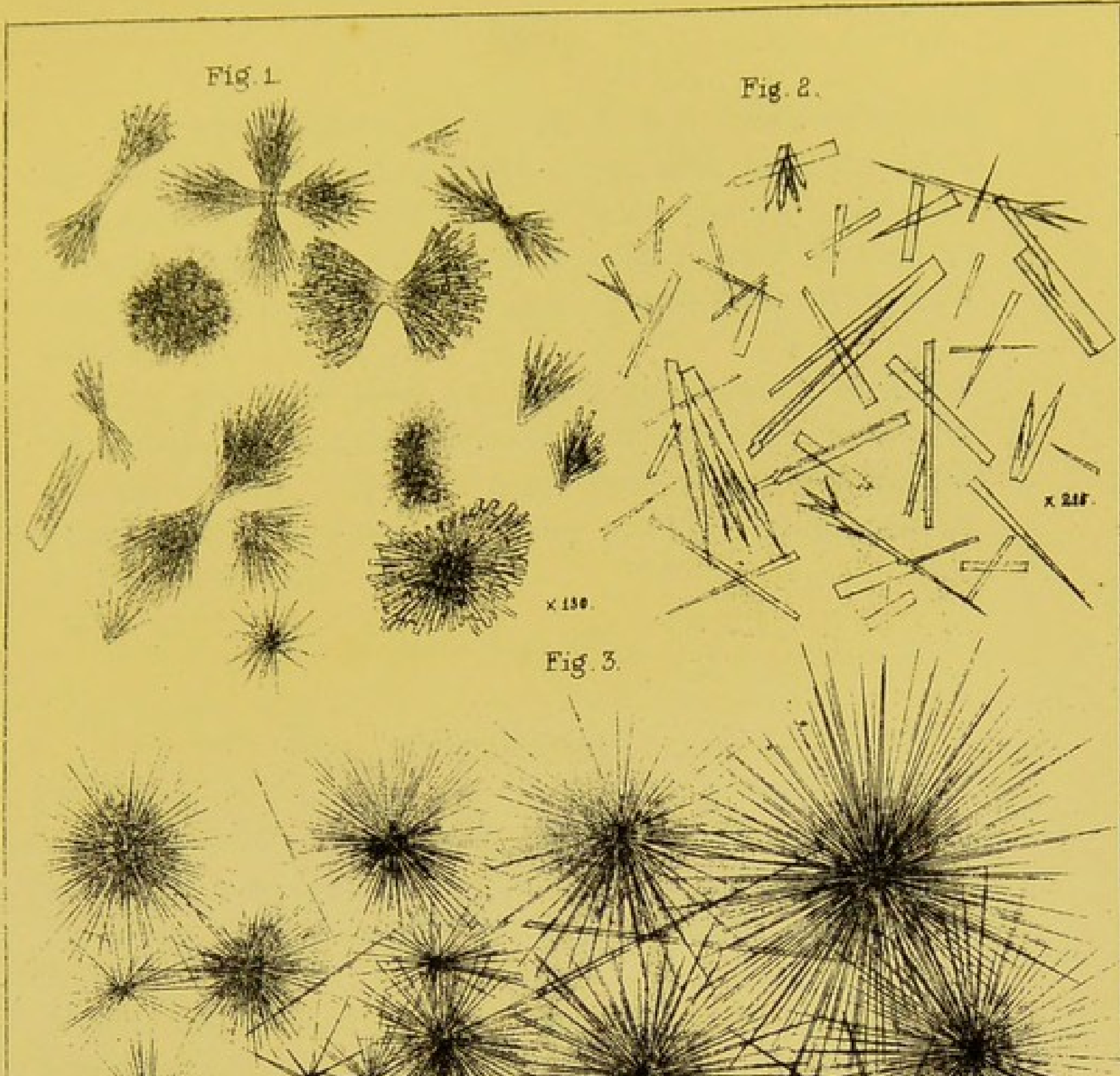
Fig. 2. Urate of magnesia, showing the separate form of the crystals.

Fig. 3. Urate of lime, crystallized in tufts composed of very long acicular crystals.

Fig. 4. Uric acid, precipitated by the addition of hydrochloric acid to urate of potash.

Fig. 5. Uric acid deposited from Urine.

URINE. V.



The crystals of alloxantin, fig. 2, were made by adding uric acid to very dilute warm nitric acid, until no more was dissolved. The solution was evaporated at a low temperature, till it became red. Crystals were formed as the solution cooled. They were purified by re-crystallization.

The parabanic acid was made by dissolving uric acid in moderately strong nitric acid, which had been previously warmed. Crystals were obtained by allowing the solution to evaporate, and were purified by re-crystallization in water.

PLATE VII.

The crystals represented in Plate VII were obtained from the Urine according to the process recommended by Liebig. A quantity of Urine was neutralized by lime water and precipitated by chloride of calcium. The filtered solution, after being evaporated to a small bulk, was again filtered from the saline residue which crystallized out, and mixed with a solution of chloride of zinc, previously concentrated to a syrupy consistence. After some days had passed, numerous warty masses of a compound of chloride of zinc and creatinine, with which the creatine was mixed, separated (fig. 1). These were re-dissolved in water and crystallized. The pure crystals (fig. 2), were boiled in water with hydrated oxide of lead, and the chloride of lead and oxide of zinc separated by filtration. The solution containing the creatine and creatinine was concentrated. The crystals thus obtained were purified by re-crystallization and treated with boiling alcohol, which dissolved the creatinine, leaving the creatine behind. By purification with animal charcoal and re-crystallization, the crystals represented in figures 3 and 4 were obtained.

PLATE VI.

ALLOXAN, $C_8H_2N_2O_8$. ALLOXANTIN, $C_{16}N_4H_4O_{14}+6Aq$.
PARABANIC ACID, $C_6H_2N_2O_6$.

Fig. 1. Crystals of alloxan, crystallized from an aqueous solution, obtained from uric acid.

Fig. 2. Alloxantin, prepared from uric acid.

Fig. 3. Parabanic acid, obtained from uric acid.

Fig. 1.

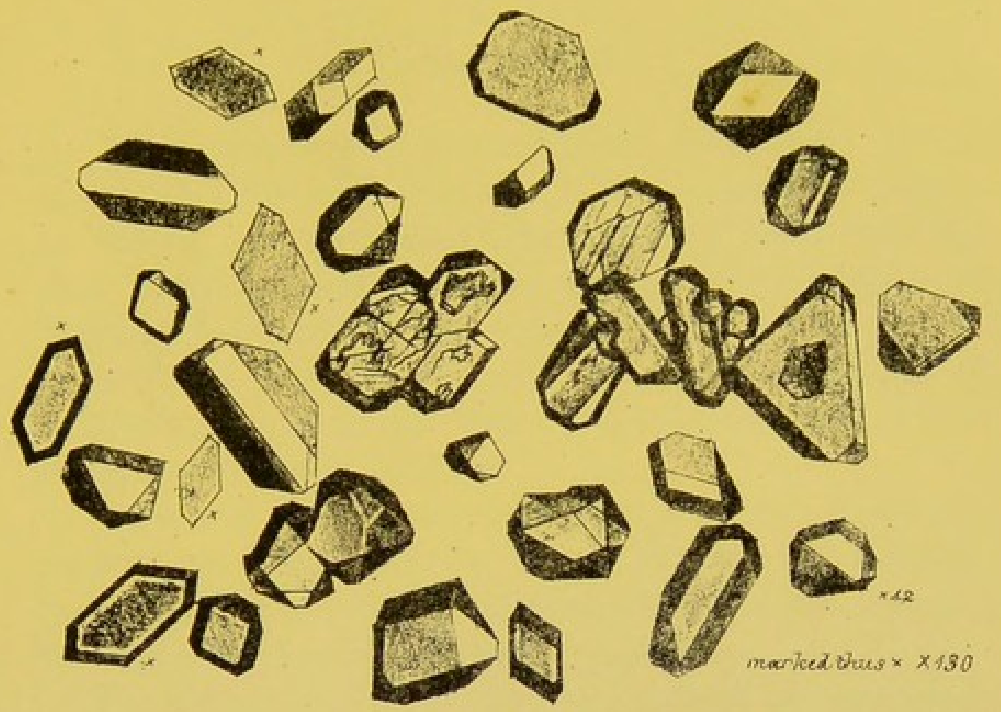


Fig. 2.

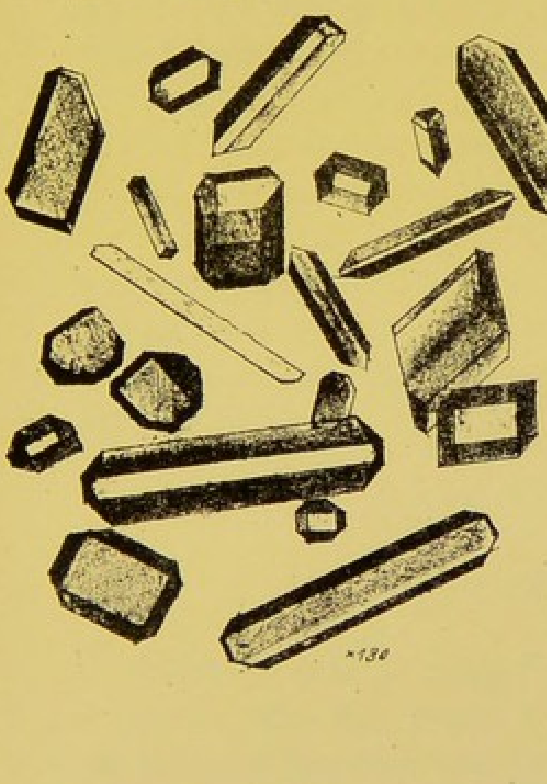
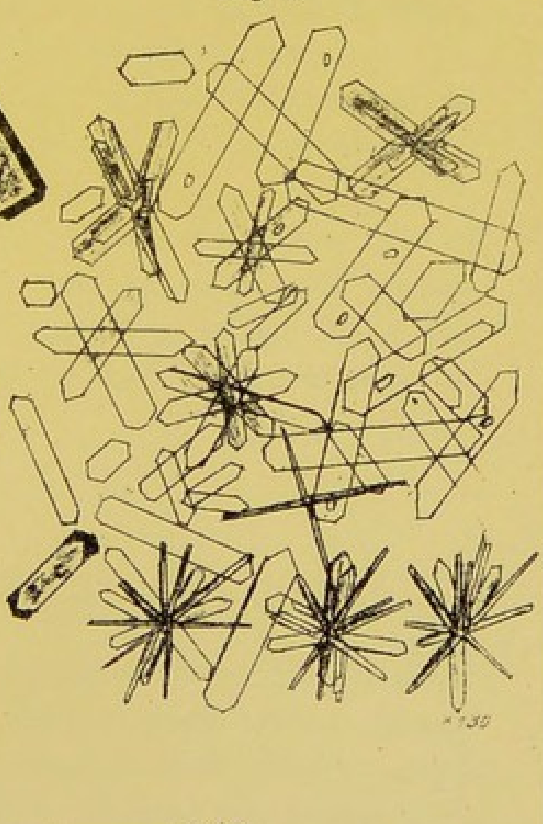


Fig. 3.



100ths. ×42.
1000ths. ×130.

Path. Lab. 1857.

PLATE VIII.

The alloxanic acid was prepared by adding baryta water to a solution of alloxan. The alloxanate of baryta so formed, was decomposed by sulphuric acid; and the clear solution, filtered from the precipitate of sulphate of baryta, was evaporated and crystallized.

Oxaluric acid was obtained by treating a solution of oxalurate of ammonia with hydrochloric acid. The oxaluric acid was precipitated.

Oxalurate of ammonia was prepared by dissolving parabanic acid in ammonia. Upon heating the solution to the boiling point, oxalurate of ammonia was formed, and crystals were obtained upon evaporation.

The oxalurate of magnesia was prepared by saturating a solution of oxaluric acid with carbonate of magnesia. By evaporating the solution, crystals were readily obtained, which were purified by re-crystallization in water.

Oxalurate of lime was made by dissolving carbonate of lime in a solution of parabanic acid. The crystals were obtained by concentrating the solution.

Uramile. A cold saturated solution of thionurate of ammonia was heated to the boiling point and hydrochloric acid added. The mixture was boiled for a few minutes longer and allowed to cool, when crystals of uramile formed.

PLATE IX.

Hippuric acid is readily prepared from the Urine of a person who has taken a little benzoic acid. About ten grains of the acid may be taken, and the Urine passed during the next few hours, concentrated by evaporation, to the eighth or tenth of its volume and filtered. When

PLATE VII.

CREATINE, $C_8H_9N_3O_4+2Aq$. CREATININE, $C_8H_7N_3O_2$.
CHLORIDE OF ZINC AND CREATININE, $C_8H_7N_3O_2$, Zn Cl.

Fig. 1. Compound of chloride of zinc and creatinine, as it is obtained from the Urine.

Fig. 2. Compound of chloride of zinc and creatinine, after re-crystallization in water.

Fig. 3. Crystals of creatine obtained from the chloride of zinc compound. Crystallized from an aqueous solution.

Fig. 4. Crystals of creatinine obtained from the chloride of zinc compound.

Fig. 1.

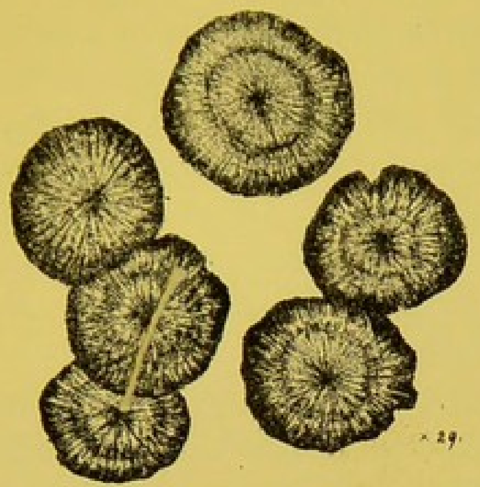


Fig. 2.

Fig. 3.

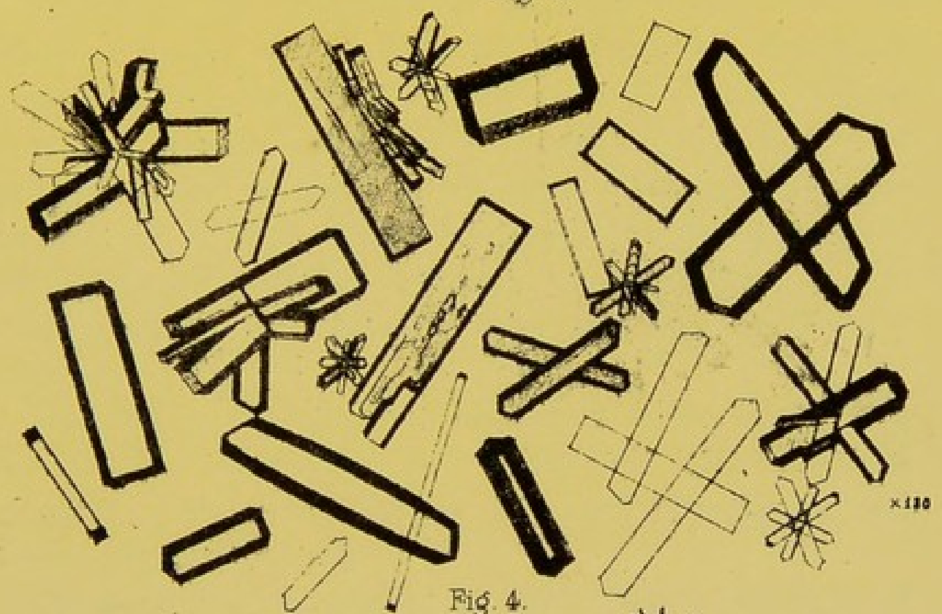
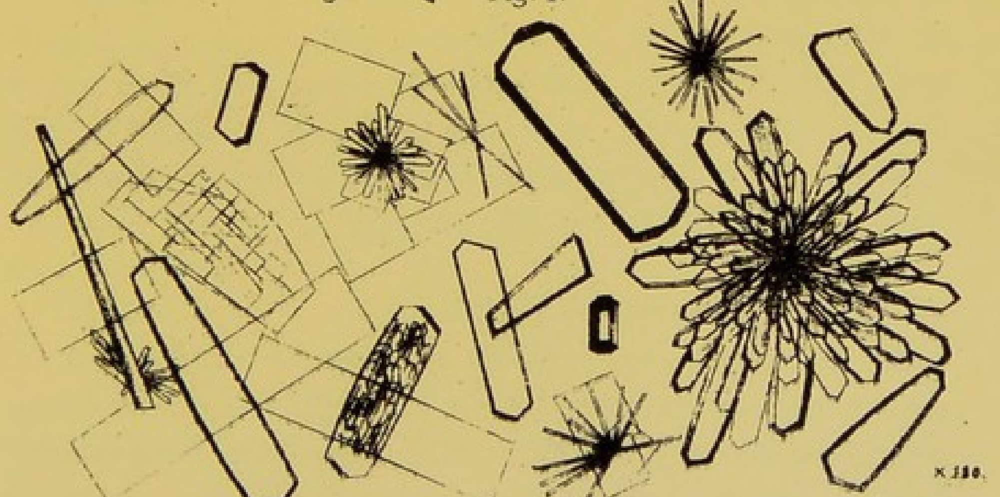


Fig. 4.



cool, a quantity of hydrochloric acid is to be added, and after standing for six or seven hours, the precipitate is collected on a filter. This impure hippuric acid is to be dissolved in water, and decolorized by boiling with animal charcoal. It is necessary to operate upon the Urine when perfectly fresh, as the hippuric acid soon becomes decomposed into benzoic acid.

The *hippurate of lime* was made by dissolving hippuric acid in lime water and filtering. Carbonic acid was passed through the filtrate, which was again filtered. The solution was concentrated that crystals might form.

Allantoin. The crystals of allantoin were made as follows: crystals of uric acid were suspended in a little water; the mixture was heated nearly to the boiling point, and, finally, powdered peroxide of lead added in small quantities as long as its color disappeared. The mixture was filtered while hot, and the crystals were obtained as the solution cooled. Urea remained in the mother liquor. The crystals were purified by re-crystallization.

Murexid. Carbonate of ammonia was added to a warm solution of alloxan and alloxantin. The murexid separated in its characteristic dark red crystals as the solution became cool.

Thionurate of ammonia. A cold, strong solution of alloxan was mixed with a solution of sulphurous acid in water, until the smell of the latter ceased to disappear after agitation. The fluid was then supersaturated with carbonate of ammonia, and kept boiling for nearly half an hour. Upon cooling, the salt crystallized in considerable quantity.

Thionuric acid. A solution of thionurate of ammonia in hot water was precipitated by acetate of lead. The precipitate was suspended in water, and decomposed by sulphuretted hydrogen. The sulphuret was separated by filtration, and the clear solution yielded crystals on evaporation.

PLATE VIII.

ALLOXANIC ACID, $C_8H_4N_2O_{10}$. OXALURIC ACID, $C_6H_4N_2O_8$. OXALURATE OF AMMONIA, $NH_3,C_6H_4N_2O_8$. OXALURATE OF LIME, $C_6H_3N_2CaO_8+Aq.$ (?) OXALURATE OF MAGNESIA, $C_6H_3N_2MgO_8+Aq.$ (?) URAMILE, $C_8H_5N_3O_6$.

Fig. 1. Alloxanic acid.

Fig. 2. Oxaluric acid.

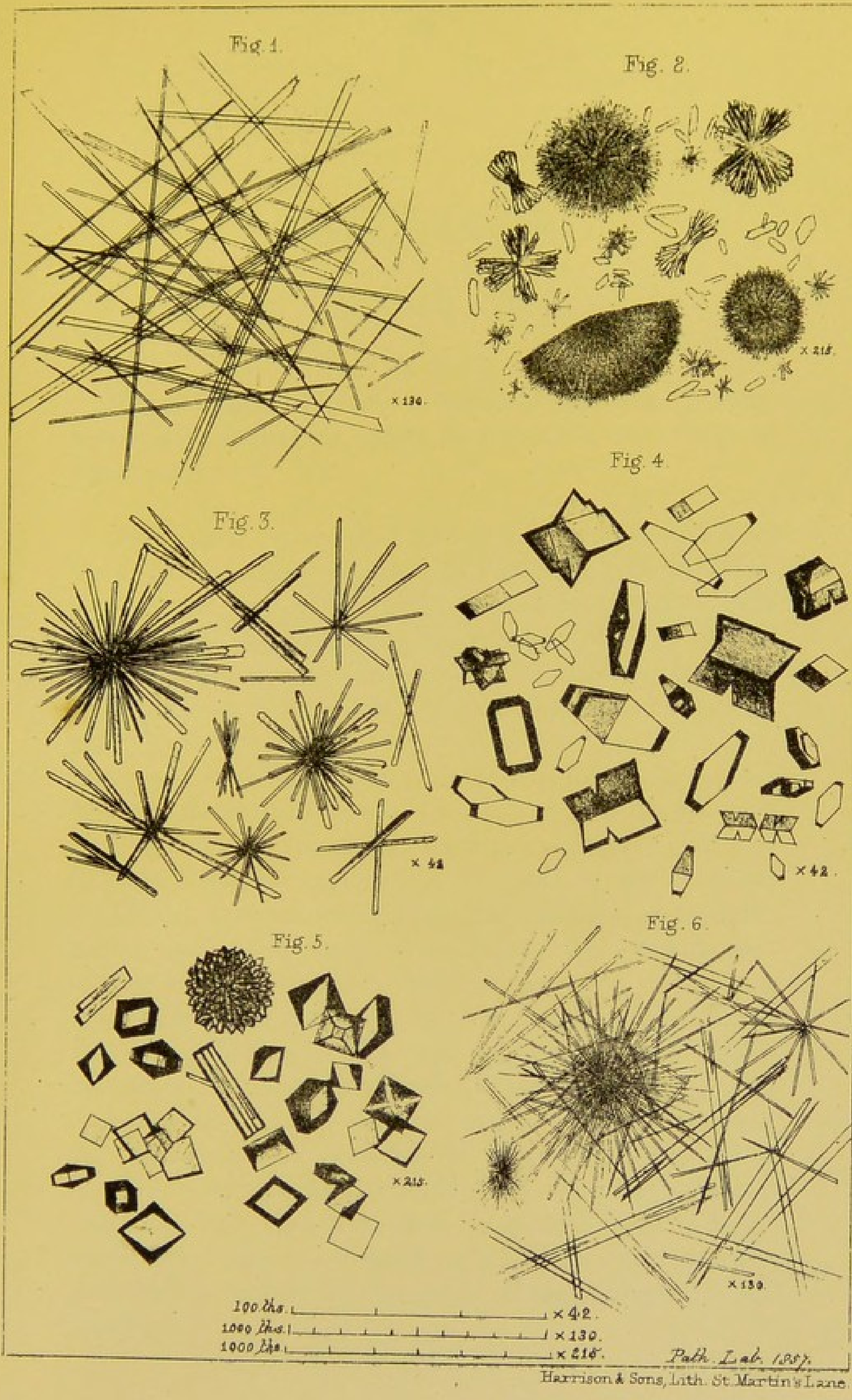
Fig. 3. Oxalurate of ammonia.

Fig. 4. Oxalurate of lime.

Fig. 5. Oxalurate of magnesia.

Fig. 6. Uramile.

URINE. VIII.



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CALCULI. I.

The calculi represented in the accompanying drawing, form a very interesting series, showing how the nuclei of calculi may be formed.

The calculi represented in fig. 1, were removed from the kidney of a man who died in King's College Hospital. The greater part of the right kidney was occupied with twelve large calculi, varying in size from a nut to that of a walnut, and, as may be supposed, the secreting structure of the gland was almost entirely destroyed. Besides these, however, was a quantity of matter, like fine sand, which was found to consist entirely of microscopic calculi. Many of these had a lamellated structure, but their centre was occupied by a granular amorphous mass, which was, in most instances, very dark. In some of the smallest, the central part was transparent, and consisted of granular matter and a few small oil globules. The greater part of the matter composing this nucleus was clearly not of a crystalline character, and consisted principally of altered epithelium, which had undergone considerable change, as the successive layers of mineral material were deposited around it. As the organic material became dry and shrunk, air rushed in to supply its place,—hence the dark centre of these calculi, which were not examined until they had been some time removed from the body. The earthy matter consisted of phosphate of lime, but with this a considerable quantity of organic matter was deposited.

PLATE IX.

HIPPURIC ACID, $C_{18}H_9NO_6$. HIPPURATE OF LIME, $C_{18}H_8N,CaO_6+3Aq$. ALLANTOIN, $C_8H_6N_4O_6$. MUREXID, $C_{16}H_8N_6O_{12}$. THIONURIC ACID, $C_8H_5N_3O_8+2SO_2$. THIONURATE OF AMMONIA, $2NH_3,C_8H_5U_3O_8,2SO_2+2Aq$.

Fig. 1. Hippuric acid.

Fig. 2. Hippurate of lime.

Fig. 3. Allantoin.

Fig. 4. Murexid.

Fig. 5. Thionuric acid.

Fig. 6. Thionurate of ammonia.

URINE. IX.

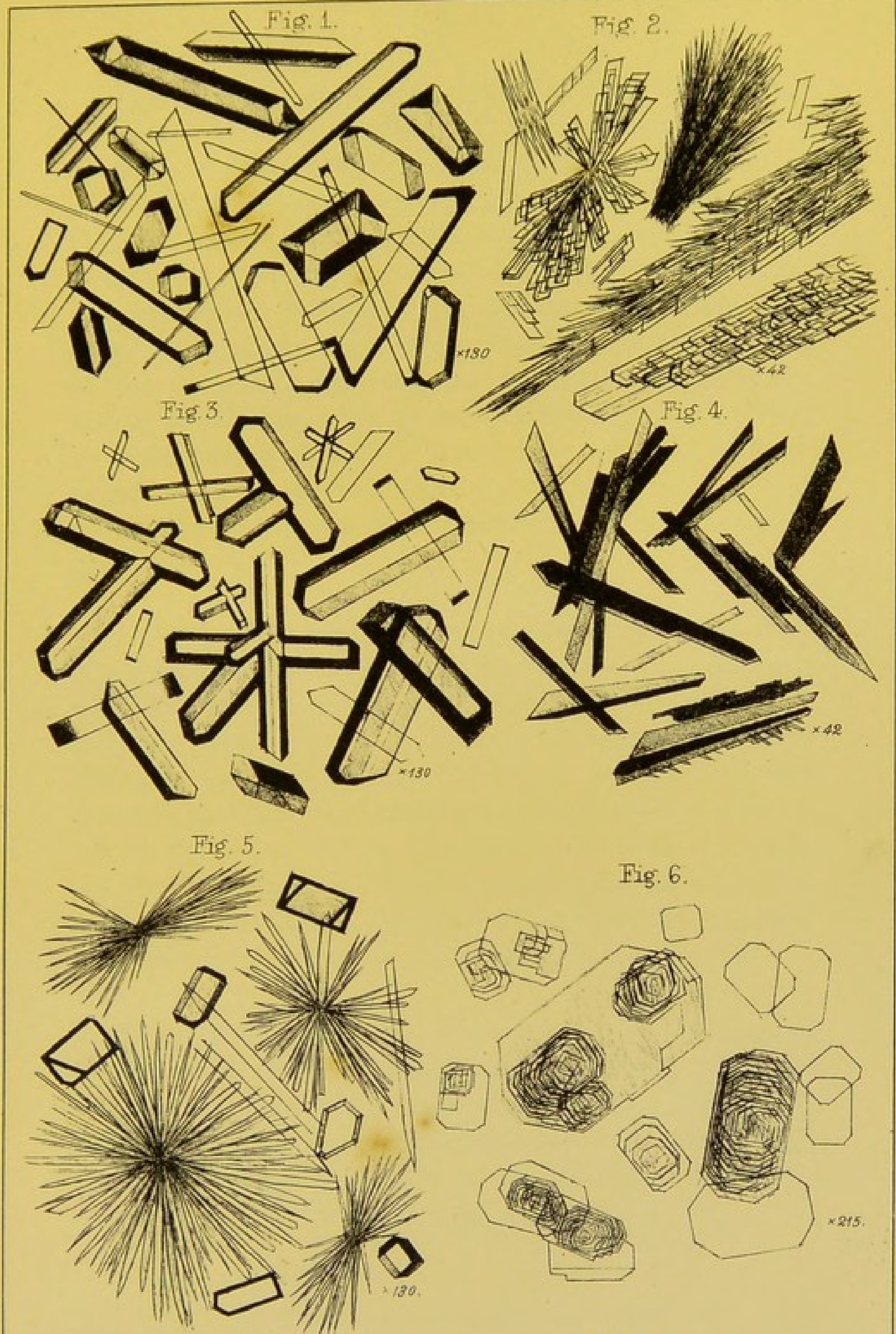


Fig. 1.
×130
Fig. 2.
×42
Fig. 3.
×130
Fig. 4.
×42
Fig. 5.
×130.
Fig. 6.
×215.
100 ths. ×42
1000 ths. ×130
1000 ths. ×215
Path. Lab. 1857.

Figs. 2 and 3 show how oxalate of lime calculi may be formed by the aggregation of dumb-bell crystals. In fig. 3, dumb-bell crystals are seen to form a considerable portion of the mass of the calculus. The deposition of the hard material still proceeding, the dumb-bell or oval form of the crystal is soon lost. I have shown that dumb-bell crystals are formed in the kidney, and I have seen many times, aggregations resembling these minute calculi, in the straight portion of the uriniferous tubes. The history of the formation of such calculi is now completed by these being found in the Urine. Several minute calculi of the same kind were present in the Urine, with a great number of dumb-bell crystals. These have been preserved.

In fig. 4 are represented some calculi from the prostate of a man, aged 40, who died of pneumonia. The nucleus is seen to be formed of well-defined cells (*c*), around which, material principally of an albuminous nature, with very little earthy matter, has been deposited. Such calculi were found in the follicles of the gland in considerable number. All the figures, as will be seen by reference to the plate, are highly magnified. The smallest calculus, *b*, fig. 4, is scarcely more than 1-1000th of an inch in diameter, and contains in its centre one single cell.

Many other views are entertained with reference to the formation of calculi, but I shall not attempt to discuss these in this work. The above remarks are intended to apply only to the specimens illustrated in the plate, and the subject of the formation of calculi will be more fully considered in a book which is in preparation.*

* "On Urine, Urinary Deposits, and Calculi."

MINUTE CALCULI. I.

Fig. 1. Small calculi from the kidney.

The nucleus is composed of a soft granular material, probably consisting of disintegrated epithelium.

Fig. 2. Small compound oxalate of lime calculus, found in the Urine of a young man who was passing numerous dumb-bells of oxalate of lime, and crystals of uric acid.

Fig. 3. Another smaller calculus from the same.

a. Dumb-bell crystals of oxalate of lime, partly incorporated with the largest mass.

Fig. 4. Very small calculi from the follicles of the prostate gland of a man, aged 40, who died from pneumonia of three weeks' duration. The structure of the bladder and prostate seemed perfectly healthy.

a. Calculi composed of a number of smaller ones.

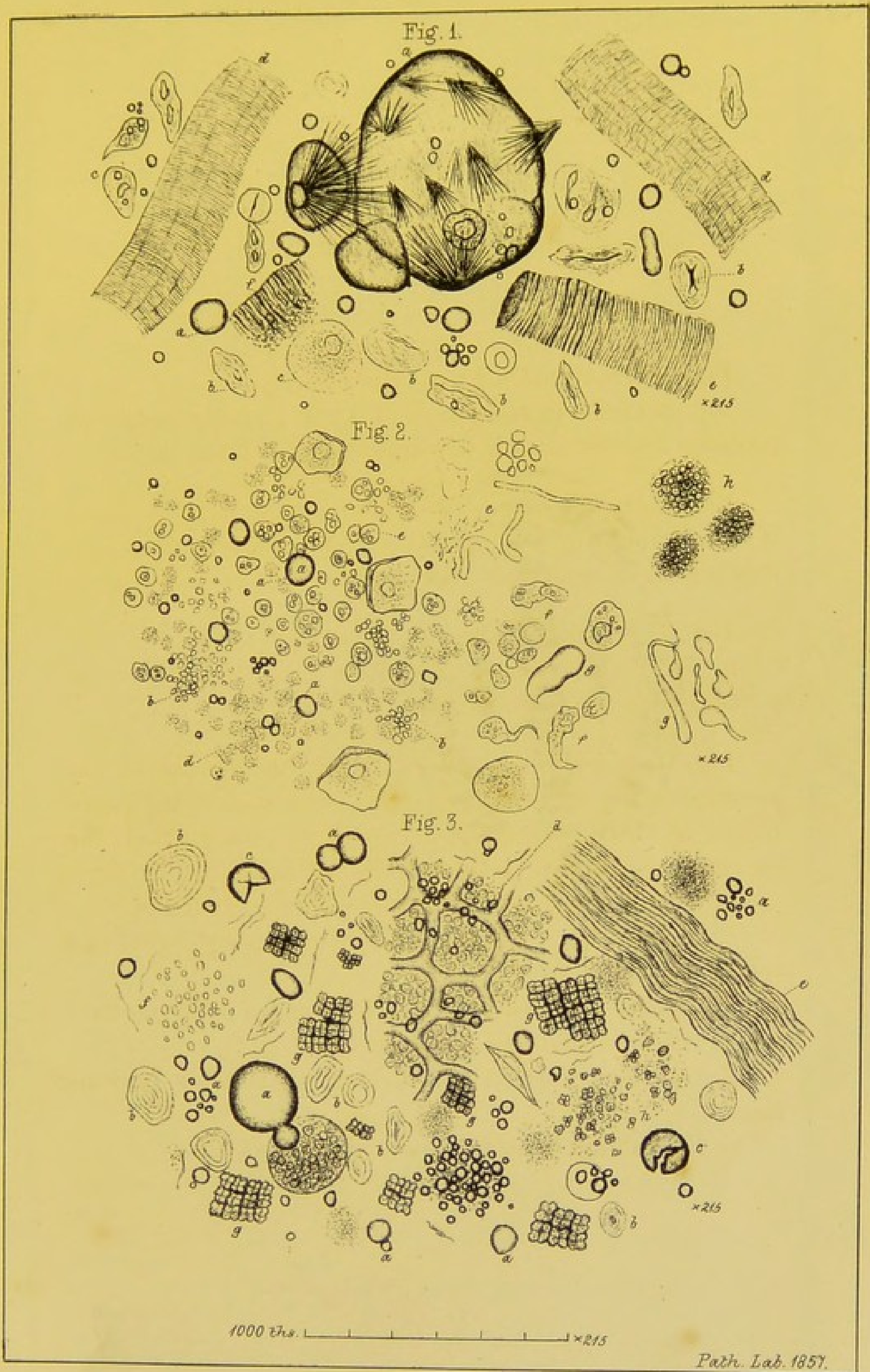
b. Very small calculus containing a single granular cell in the interior.

c. Calculi composed of a collection of cells, around which the hard material has been deposited.

d. Calculus in which the nucleus seems to be crystalline.

e. Epithelium from the ducts of the prostate.

VOMIT. I.



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