autumn, split longitudinally, and rapidly dried. It is then furrowed and wrinkled, with a black surface and bluish-gray section. It occurs mostly in pieces from one to four inches in length and of the thickness of a lead-pencil or less. Its texture is hard and horny; fracture, cellular; taste, mucilaginous, slightly bitter, and astringent.

Comfrey has been long in use, first as a vulnerary, and afterward as a demulcent and "pectoral"; its constituents are similar to most others of its class: *mucilage, sugar, asparagin, tannic* and *gallic acids*, and *starch*. Dose—a decoction may be taken *ad libitum*.

The *leaves* have a similar composition and use.

Henry H. Rusby.

COMMONWEALTH MINERAL SPRINGS.—Middlesex County, Massachusetts.

POST-OFFICE.—Waltham.

This spring is located in the extreme northern part of the town of Waltham. It yields ten gallons of water per minute, having a temperature of 48° F. the year round. An analysis by Prof. S. Dana Hayes, the State assayer, in 1879, resulted as follows:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Sodium bicarbonate	0.50
Magnesium bicarbonate	.18
Lime bicarbonate	.45
Potassium sulphate	.61
Sodium chloride	.34
Silicic acid (in solution)	.37
Iron and alumina	Merest traces.
Total	2.45

The water is naturally charged with oxygen, nitrogen, and carbonic-acid gases. It is clear and sparkling and quite free from any appreciable organic matter. The water is bottled and sold extensively in Massachusetts. It is also used in making a number of pleasant beverages. The water is said to have a satisfactory influence in some of the functional disturbances of the liver, kidneys, stomach, and blood.

James K. Crook.

COMPOSITÆ.—(*The Daisy Family.*) Taken in its broad sense, as generally regarded, this is our largest family of plants, comprising more than eight hundred genera and more than ten thousand species, though some authorities reduce the number by separating, as distinct families, a number of our sub-orders. There is scarcely any flora of the earth where these plants are not found, or even where they are not abundant. Their economic importance is great, as ornamental plants and to some extent as foods. Among the latter are the artichokes, salsify, burdock, several plants of the thistle group, lettuce, and chicory. Starch is largely wanting in the family, its place being filled by the closely related *inulin*, and this is the important nutrient constituent. Medicinally, the family represents three classes of agents, dependent upon distinct classes of constituents. We have first, stomachics and tonics, dependent upon volatile oils and bitter substances. In some cases, as in the iron weeds (*Vernonia*), the bitter element is almost alone; in others, like Erigeron, the volatile oil is nearly devoid of bitter association. In some cases, moderate quantities of tannin are also present. Occasionally, these substances are anthelmintic, as in santonica, or insecticidal, as in the insect flowers.

The second class of remedies depend upon resins or powerful volatile oils for their counter-irritant properties. Internally they are powerfully irritant, to the extent of being poisonous, like arnica, pyrethrum, or tansy.

Thirdly we have a few milky juiced plants of the suborder *Cichoriaceæ*, with laxative and alterative properties, like dandelion and chicory, or even narcotic like lactucarium. A few, like absinthium, possess peculiar properties, due to special constituents. An enumeration of all the drugs of this family in domestic and aboriginal use would carry us far into the hundreds, yet the total medicinal importance of the family cannot be regarded as other than minor.

Henry H. Rusby.

CONCA.—Queretaro, Mexico. These waters, besides being employed in rheumatism and leprosy, are supposed to be of benefit in menstrual derangements.

N. J. Ponce de Léon.

CONCRETIONS AND CALCULI.—Concretions and calculi are terms applied in medicine to aggregations of solid, more or less hard substances, which form in the body tissues or fluids and act as foreign bodies. The substances composing the aggregations are usually such as are formed in the tissues and fluids normally or pathologically, and may be either organic or inorganic substances, or a mixture of both; occasionally, however, foreign matter finds its way into some part of the body and acts as a nucleus for a calculus. Crystalline, granular, or amorphous masses may be deposited in a tissue and thus cause it to assume a hardened state; or the latter condition may result from the absorption of fluid. The terms petrifaction and calcification are applied to such hardenings so long as the tissue in which the change occurs bears its normal relation to the surrounding parts; but when this relationship ceases and the hardened area acts as a foreign body, then it is proper to employ the terms concretion or calculus, whether the mass is embedded in the tissues or lies free in some cavity.

Chemically, the change most frequently results from a deposit of calcium carbonate or phosphate with perhaps in addition a small amount of magnesium salts. The process is apt to accompany or follow degeneration or death of tissue; in fact, it seems as though tissue undergoing necrobiosis has a special attraction for calcium salts. Connective tissue undergoing hyaline degeneration with accompanying calcification is often encountered in the walls of the blood-vessels, in the endocardium, in the thyroid, and in the thickened pleura, and may be found in other portions of the body. Calcification of tuberculous areas, uterine fibroids, and ovarian and other cysts is also frequent. Under exceptional conditions, and more particularly in advanced age, the process occurs in tissue in which degenerative changes are not recognizable. In rare instances calcareous infiltration is believed to be due to an absolute increase of calcium salts in the blood, such as perhaps occurs in extensive caries and in osteomalacia. This is certainly unusual, but some observations seem to support the view.

Amyloid concretions, or corpora amylacea, are small, oval, homogeneous or laminated bodies that frequently occur in the tissues of the nervous system and in the prostate. In the nervous system they are especially apt to occur in conditions of atrophy or softening. The ependyma of the ventricles, the white substance of the brain, the choroid plexus, the optic nerve, and the spinal cord are their favorite seats. They are occasionally met with in the lungs, in mucous and serous membranes, and in extravasations of blood. Amyloid bodies were formerly believed to consist of amyloid substance. While it is true that they may assume a bluish color on treatment with solution of iodine or iodine and sulphuric acid, and resemble somewhat in structure the product of progressive amyloid change, it is now recognized that their formation is dependent on local changes, and it is not believed that they are similar to the product of amyloid degeneration. Redlich considers the corpora amylacea of the nervous system, which stain similarly to nuclei with hæmatoxylin, to be made up of the nuclei of neuroglia cells and to be a senile retrograde development of the tissue. Stroebe believes them to be composed of fragments of swollen axis cylinders, while Siegert believes them to have originated from cells. In the choroid plexus and lateral ventricles they frequently become calcified and then constitute one form of "*brain sand.*"

Biliary concretions are both frequent and of clinical importance. Europeans have found gall stones in from five to ten per cent. of all autopsies; in the East, on the contrary, they are extremely rare, only one or two cases being recorded.

The stones are usually found within the gall bladder, less frequently in the cystic or common duct and in the alimentary tract, having passed down from the gall bladder, and in rare instances they occur in the intrahepatic ducts. Biliary fistulæ are not uncommon, and through these abnormal communications gall stones have been known to pass to the outside of the body, into the abdominal cavity, into the stomach or intestines, into a liver abscess, into the portal vein, or into the urinary passages, and records are not rare in which they have entered the lungs. A single calculus may be present in the gall bladder, in which case it is usually ovoid and may be quite large; or the number may be very great, 7,802 having been reported in one case. The usual number is between four and fifty, and the average size is apt to vary inversely with the number, from that of a pinhead to a cherry. When numerous they may be the size of small grains, while, on the other hand, Meckel has described a single biliary calculus 15 cm. long and 6 broad. When more than a few are present they commonly lose their ovoid shape and show signs of mutual pressure, having a polygonal form with smooth facets. All those present in the same individual commonly have the same chemical composition and present the same physical characters, but may vary considerably in size.

Chemical analysis has shown that the vast majority of biliary calculi are composed chiefly of either or both of two substances, viz., cholesterin and the calcium salt of bile pigment, known as bilirubin-calcium. Either of the two substances may be the sole constituent or they may together form the mixed varieties, with the two substances in almost any proportion. Certain materials only occasionally enter into the composition of gall stones or do so commonly only in very small amount: such are inorganic calcium salts, notably the carbonate, sulphate, and phosphate, small quantities of copper, traces of iron, zinc and manganese, globules of mercury, fats, silica, uric acid, and foreign bodies. Of these latter the round worm, a portion of distoma hepaticum, a needle and a plum stone have each been recorded as being the nucleus of a calculus. The presence of calcium salts in mixed calculi, particularly the carbonate, contributes hardness; in rare instances the concretion may be chiefly or entirely calcareous. The bile acids and other constituents of bile are found in calculi only in such traces as are explained by the absorption of this fluid in the interstices. Again, the bile pigment in combination with calcium is not always bilirubin, but frequently in part biliverdin or bilifuscin.

It may be said that in general cholesterin predominates in the larger stones, while the smaller are more apt to contain considerable bilirubin-calcium. Naunyn, in his admirable treatise on cholelithiasis, recognizes six classes of gall stones:

1. *Pure Cholesterin.*—Usually pure white or yellowish, translucent: in rare instances dark colored. Ordinarily oval or roughly spherical in form, hard, seldom exhibit facets, not stratified or only feebly so and vary in size from a cherry to a pigeon egg.

2. *Laminated Cholesterin.*—Contain ninety per cent. or more of cholesterin, the other constituents being calcium compounds of the bile colors and calcium carbonate. Are usually hard, but occasionally when dry, brittle, and friable, more frequently facetted than the first variety, more or less distinctly laminated, with the layers perhaps differing in color, often with those nearer the centre more crystalline in structure and those nearer the surface hardened by the presence of calcium carbonate. They resemble pure cholesterin stones in form and size, but are apt to be somewhat darker in color.

3. *Common Gall Stones.*—These comprise the great bulk of gall stones, varying in size (pinhead to cherry), in composition, and in form and tint. Usually facetted and laminated. The soft nucleus may consist of bilirubin-calcium, or the centre may consist of a cavity holding a yellowish alkaline liquid. If soft when removed they harden and shrink on drying, without developing fissures.

4. *Mixed Bilirubin-calcium.*—Usually the size of a cherry, occur in groups of three or four, and are facetted. They are twenty-five per cent. or less cholesterin, the remainder being chiefly bilirubin-calcium. They have a brown color, are seldom hard, and develop fissures when they dry.

5. *Pure Bilirubin-calcium.*—Common in cattle, rare in man. Vary in size from a grain of sand to a pea, being the stones that are sometimes observed in the intrahepatic bile ducts. The smaller ones may have a wax-like consistence, with brownish-black, rough, irregular surface, while the larger ones usually are brittle, have a smooth surface, and a gray to black color with a metallic lustre. In calculi of this class bilifuscin is practically always present.

6. *Rarer Forms.*—(*a*) Amorphous and incompletely crystalline cholesterin gravel: small, often resembling pearls, and always with a nucleus of different structure. (*b*) Calcareous, consisting almost entirely of calcium carbonate. (*c*) Concretions which include foreign bodies and conglomerate stones. (*d*) Casts of bile ducts.

As to the source of cholesterin in bile, Austin Flint more than a third of a century ago presented the view that the separation of this constituent from the blood by the liver is a regular and important function of this organ. Since, however, it is not increased in bile by the character of the diet or the administration or subcutaneous injection of cholesterin, recent observers have come to believe that it is independent of the amount in the blood. It may be that small amounts are regularly separated, as Flint held, by this organ, but the observations of Naunyn, confirmed by Hunter, present considerable evidence that at least most of the cholesterin of calculi is formed *in situ*, being a product of the diseased mucous membrane of the biliary passages. This conclusion accords with its frequent formation as a product of degenerative conditions in other locations, *e.g.*, in cysts and in the secretions of other diseased mucous membranes, as, for example, its occurrence in the sputum of bronchitis. Naunyn observed myelin globules within the degenerating epithelial cells of the biliary passages, and especially of the gall bladder, which escape in a viscous condition and are to be seen floating about in the bile. On the addition of acetic acid these masses solidify into a mass of cholesterin crystals. According to this view, then, the cholesterin of concretions has never been in solution in bile at all. In further support of the local origin is the fact that although the small amount normally present in bile is held in solution by the bile salts, soaps and fats, the formation of cholesterin-containing calculi does not appear to be associated with their diminution.

Bilirubin-calcium is not a normal biliary constituent, and its occurrence in concretions, therefore, demands a further explanation than the mere presence of bile color. The exact origin has not yet been conclusively demonstrated. If lime be added to bile the formation of this compound, being hindered by the presence of bile salts, is not accomplished until large quantities have been added; the mere secretion of calcium in excess does not therefore adequately explain the formation. Moreover, calcium is not secreted in excess when it is present in increased amount in the food and drinking water, as has been held. What has been observed is that the presence of albumin overcomes the retarding influence of bile salts on bilirubin-calcium-formation; and it seems in all probability that this condition, viz., the presence of albumin in bile, is the deciding factor. Whether its presence is dependent on the disintegration of epithelium resulting from catarrh of the mucous surfaces, as was suggested by Naunyn, is not known, but it is not unreasonable to believe that at times albumin may pass from the blood through the hepatic cells into the bile in much the same way as in nephritis it passes into the urine in the kidney. If the explanations advanced are correct, it will be seen that the conditions leading to the separation of the two chief constituents of gall stones are essentially local, namely, epithelial degeneration and the catarrhal and inflammatory conditions of the bile ducts and passages that lead to the presence of albuminous substances.

Naunyn's views find support in clinical experience and are interesting, though not universally accepted. Thudichum holds that gall stones contain ingredients found in

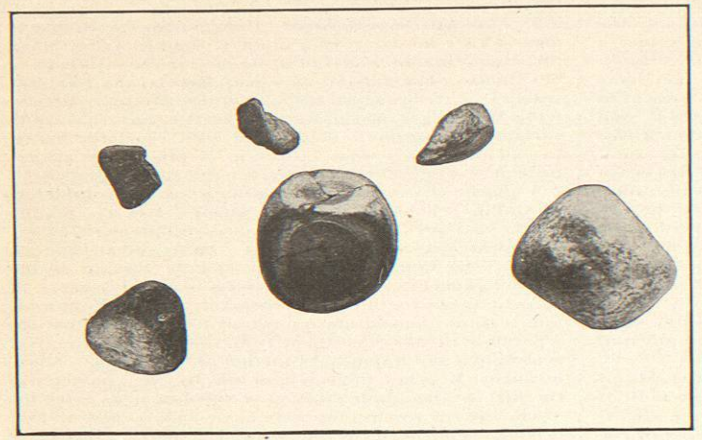

FIG. 1475.—Biliary Calculi, Facetted, of Impure Cholesterin, Removed from a Gall Bladder. (Natural size.)

bile only after its decomposition and that the mucous glands of the gall-bladder do not participate in their production (Fig. 1475).

According to the older view of Frerichs and others the etiological factors in cholelithiasis are advanced age, female sex, pregnancy, tight lacing, and sedentary habits, —conditions favoring retention of bile. From what has been said, it follows that this is so only to the extent that stagnation is a factor in the production and continuance of infection of the biliary passages, which in late years has been recognized as the immediate cause of stone formation, certainly in the great majority of instances. The infecting agents that have chiefly attracted attention are the colon bacillus and the typhoid bacillus, but it is known that in individual cases the pyogenic organisms as well are intruders.

Particular interest is attached to the occurrence of gall stones following typhoid fever: it is probable that in some cases the infection of the bile with the typhoid bacillus persists for months and even years, and that in many instances it determines inflammatory conditions of the biliary passages that directly lead to the formation of biliary calculi. It has been suggested that groups of typhoid bacilli become the nuclei of concretions, and observations seem to support this view. If so, it is not improbable that in some instances the bile, which is known to acquire the property of causing the bacilli to clump, actually leads to the formation of nuclei by agglutinating the typhoid bacilli contained in it.

The invasion of the various organs by the colon bacillus is now too well recognized to require argument of the possibility of such an occurrence in the case of the bile passages. Instances are not uncommon in which for some reason the bacillus is particularly virulent and the tissues less resistant than normal, and in which, consequently, the bacteria invade the liver and bile passages. Under these circumstances, especially if associated with stagnation of bile, the conditions are ripe that favor the formation of biliary calculi.

Calculus formation commonly originates from (1) epithelium in bile, (2) sedimentary masses, or (3) agglutinated bacilli; less commonly from the adhering together of small nodular masses of pure bilirubin-calcium or cholesterin. The growth is both by the addition of fresh layers and transformation within the calculus; this is rendered possible by the existence of minute infiltration channels through which there is continuous progressive infiltration with cholesterin and its deposit in crystalline form. Even pure cholesterin calculi do not crystallize directly from solution, but are secondary formations. The layers deposited on the surface of calculi are as a rule, hardly more than 1 mm. thick, but if rich in bilirubin-calcium they may be 5 mm. thick or more. Early in the formation of some calculi, even while they are acquiring a firm crust, changes may occur in the soft interior: either the contents may deposit on the firm crust, leaving a hollow interior, or such a deposit may leave the contents fluid. The growth of the concretion by deposit of bilirubin-calcium ceases when bile ceases to enter the bladder, but the acquisition of cholesterin from the mucous membrane may continue.

Cardiac calculi, so called, are found in rare instances, at the necropsy, lying free in the pericardial sac. Some are soft and smooth, varying in size from a pea to a bean; others firm, fibrous, occasionally stratified or calcified, either in a central nucleus or throughout. They are regarded either as polypi detached from the inner surface of the pericardium, or as results of fibrinous or calcareous deposits about some foreign substance.

Cutaneous concretions are nodular calcareous deposits in the cutis or still oftener in the hypoderm. They are usually surrounded by capsules of firm connective tissue from which septa extend into the contents of the tumor, dividing it into segments which are made up of calcified cells. True ossification of these septa has been observed, though this is exceptional, they being usually fibrinous or calcareous.

Views regarding the nature of the cellular masses differ according to the explanation of the development of the tumor which the observer accepts. Malherbe believes that the majority of cutaneous stones develop from proliferated and cystic sebaceous glands. Von Noorden reports a stony, hard, pear-shaped tumor, which hung behind the ear by a peduncle and in which the epithelial collections looked like concentric, horny pearls and which in spite of its benignancy he classed with carcinoma. Four small tumors of the skin of the scrotum, in a boy of twelve, were regarded by Lewinski to be calcified lymph thrombi. While all sorts of degenerated tissue and inspissated secretion may take up calcium salts and lead to the formation of stone, Unna believes that fat and fat products have a special tendency to this, owing to the formation of insoluble calcium soaps by the reaction with calcium bicarbonate of the lymph. He differs from Malherbe in believing that calcification involves glands only in so far as they are enclosed in fat lobules.

FIG. 1476.—Biliary Calculus from Cystic Duct: case of empyema of gall bladder. (Slightly enlarged. The actual specimen measured one inch and one-quarter in its long diameter.)

Skin concretions are of rare occurrence. They have been more frequently found in the aged.

In the course of *gout* a deposit of tophi composed of biurates is common, most often in the kidneys, skin, and subcutaneous tissue, but also frequently in the tendon

sheaths, the tendons, ligaments, synovial membranes and articular cartilages, and ultimately perhaps in nearly every tissue and organ in the body, excepting tissues of

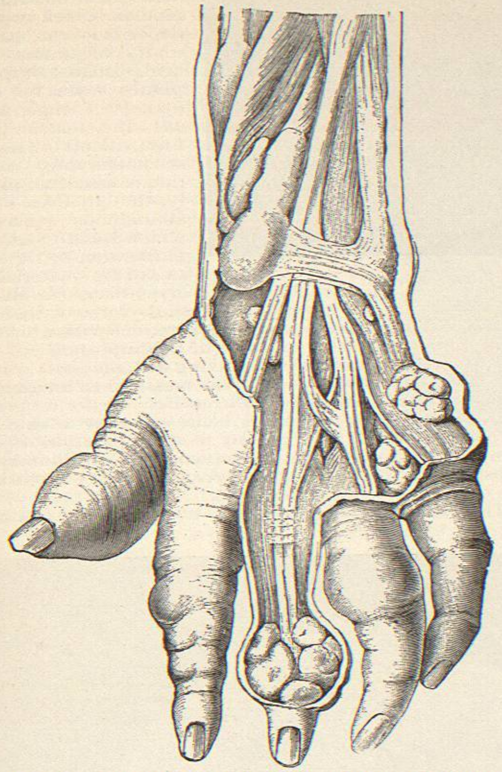

FIG. 1477.—Gouty Nodes of the Hand. (After Lancereaux.)

the nervous system. The composition is indicated in the following analysis of such a concretion by Ebstein and Sprague.

ONE HUNDRED PARTS OF SOLIDS CONTAINED:

Uric acid	59.70
Tissue organic matter	27.88
Na_2O	9.30
K_2O	2.95
CaO	.17
MgO, Fe, P_2O_5, S	Traces.

The views of various observers differ as to the cause of the formation of gouty concretions. The earlier view of Garrod and others was to the effect that uric acid is present in undue amount in the blood and separates as tophi owing to the sluggish circulation in the various locations. Ebstein advanced the opinion that the deposit is determined by tissue necrosis preceding the formation of concretions. Others (Bouchard, E. Pfeiffer) held that diminished alkalinity of the blood is the prevailing etiological factor. Von Noorden believes that tissue necrosis in gouty conditions is of such a kind as to lead to urate formation from cell products at the site of the concretion and that the material of tophi is not directly brought to the area by the blood. It is at least certain that although in leukæmia and some other conditions uric acid is formed in the body in large excess, it does not lead to the deposit of the tophi so characteristic of gout (Fig. 1477).

Intestinal calculi, or *enteroliths*, occur more frequently in herbivorous animals than in man. In certain animals, which have the habit of licking their own coats or those of their associates, the formation in the stomach and intestines of balls of felted hair is not infrequent; these hair balls perhaps attaining considerable size. Commonly, intestinal concretions are found in the colon and are very small, rarely as large as a hazelnut, so that it is very infrequent for them to cause obstruction. We have already mentioned that gall stones may enter the alimentary tract. Various foreign substances are introduced through the mouth and œsophagus, a very small percentage of which become nuclei of concretions. In most instances the central mass consists of undigested food residue or inspissated mucus, while the material composing the bulk of the calculus is commonly ammonium magnesium phosphate, perhaps with magnesium phosphate, but may include calcium phosphate and carbonate and occasionally calcium and magnesium soaps and albuminous matter. I have seen one small concretion, which the patient said passed per rectum, which appeared to be identical with urostealith, presenting the characteristic appearance and giving the chemical reactions of this substance. In countries where oatmeal is largely eaten, often as a substitute for bread, intestinal concretions resembling hair balls are not infrequent; they contain calcium and magnesium phosphate, about 70 per cent.; oatmeal bran, 15–18 per cent.; soaps and fats, about 10 per cent.

Oriental "bezoars" are intestinal concretions which probably were formed in *Capra ægarus* and *Antelope dorias*. They are usually spherical or oval and have a dark olive-green color due to biliverdin, with a smooth, shining exterior, and are composed almost entirely of lithofellic acid, $C_{22}H_{36}O_4$, soluble in boiling alcohol from which the acid separates on evaporation as small pointed rhombohedra or three-sided prisms. This acid is insoluble in water and ether, but dissolves in glacial acetic acid. It is closely related to cholalic acid. When heated, true bezoars evolve aromatic fumes.

False bezoars, which come from Eastern countries, have a brownish-black color, do not melt or evolve aromatic fumes when heated, and are composed chiefly of ellagic acid, $C_{14}H_{16}O_8 + 2H_2O$, probably derived from the tannins contained in the food consumed by the animals which yield them.

Pancreatic calculi are usually small, varying in size from a grain of sand to a walnut; multiple, numbering from one to more than a hundred, and of light gray or white color. They are usually round or oblong, sometimes elongated and branched. The surface may be smooth, rough, or spinous. They are composed chiefly of calcium carbonate, but contain some calcium phosphate and occasionally cholesterin. They may be the cause of pancreatic cysts and chronic pancreatitis.

Preputial concretions sometimes form in those cases in which the prepuce cannot be drawn over the glans, and they usually have for their nucleus dried smegma, around which may be deposited the ordinary constituents of urinary calculi, especially the phosphates. Some of these concretions have been found to consist of dried smegma and epithelial scales: one, analyzed by Zahn, was made up of epithelium, calcium salts, and cholesterin, and another examined by E. Salkowski gave fat, free fatty acids, and calcium salts.

Prostatic concretions, which are of frequent occurrence, may originate in the substance of the gland, may come from the bladder or the urethra, or may be deposited from the urine in suppurating prostatic pouches. Those that are present in the substance of the gland usually originate as the amyloid bodies already described, which indeed are so constantly present in this organ that they can hardly be considered abnormal. As they increase in size, in most instances in later adult life, they excite inflammation and become hardened by the deposition of calcium salts, particularly the phosphate and carbonate. These calculi may lie separately in pouches or several may be together in a common pouch, in which instance they are often adherent or exhibit facets. Their color is brown or black, and the surface smooth and polished.

Those coming from the bladder and those forming from urine present the characters of vesical calculi formed under similar conditions; they consist most frequently of a mixture of calcium and ammonio-magnesium phosphates. Dr. Herbert Barker has described a large prostatic calculus which was pear-shaped, measured four and seven-eighths inches in length and four and five-eighths inches in circumference, and weighed 1,681 grains.

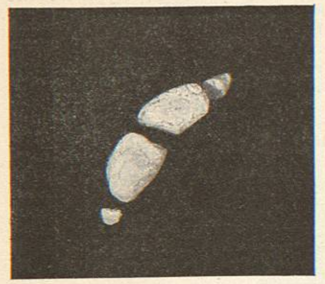

FIG. 1478.—Salivary Concretion from Wharton's Duct. (Natural size.)

Pulmonary calculi are most frequently found in the lumen of bronchi, but may occur in air vesicles and even on the walls of pulmonary cavities. Those formed in the bronchi are composed of inspissated and calcified mucus or blood, calcified broken-down bronchial glands, or incrustated foreign bodies. In pulmonary cavities or air vesicles a portion of the wall becomes incrusted or impregnated with dust of various kinds and is subsequently thrown off by necrosis. A case of lenticular necrosis in a stonecutter's lung, recently reported, had progressed to the formation of pneumoliths in an apex cavity and their subsequent expectoration. Seventy small, hard, black angular stones were found at autopsy. They varied in shape and in size up to 7 mm. in diameter.

Rhinoliths are found in the nostrils after chronic inflammation of the mucous membrane; they are usually formed by the deposition of the nasal secretion about foreign bodies as a nucleus and contain a large proportion of organic matter.

Salivary concretions form in the salivary ducts, especially in Wharton's duct, and are usually oblong in shape. They are formed by the deposition of the salivary salts and may reach a large size; one weighing 7.5 gm. is recorded. They are composed chiefly of calcium carbonate and phosphate, mixed with epithelium and organic matter (Fig. 1478).

Tonsillar calculi, amygdaloliths, are sometimes formed in chronic enlargement of this organ in which the inspissated secretion of the crypts has accumulated deep within the gland and remained for a prolonged period of time, undergoing calcification. Fragments of the calculus may be discharged; in some instances the mass has been visible. The formation of a true tonsillar calculus is rare (Fig. 1479).

Urinary calculi are of frequent occurrence. They may be found in any part of the urinary tract, but usually occur in the pelvis of the kidney or in the bladder, and according to their location are designated renal or vesical. They occasionally occur in the kidney substance, in the ureters, or in the male urethra, and have been found in sinuses between the cavities of other organs and the urinary passages. Most varieties are formed by the deposit of normal or pathological urinary solids, and are usually named from the substances of which they are chiefly composed. Thus we designate the following: Uric acid, calcium oxalate, phosphate, urate, cystin, urostealith, calcium carbonate, and xanthin. The formation of concretions is not alone attributable to the mere separation of these substances from the urine, since instances are not uncommon in which copious deposits occur, particularly of urates, uric acid, oxalates, or phosphates, even for long periods of time, without the tendency to form calculi. Another accompanying condition is essential, namely, the presence of an albuminous substance which leads to an agglutination of the separating material in crystallization. Masses thus formed increase in size and become the various concretions with which we are familiar. Further evidence of the importance of this condition is obtained by dissolving out the salts of the calculus without macerating the mass, when an albuminous or colloid framework will remain. Hence we recognize two primary factors as being essential to calculus formation, namely: a tendency to the separation of certain urinary solids, and the presence of an albuminous substance in the urine which becomes the framework of the concretion (Figs. 1480–1485).

FIG. 1479.—Tonsillar Concretion. (Natural size.)

The former factor, that is, the tendency to crystallize,

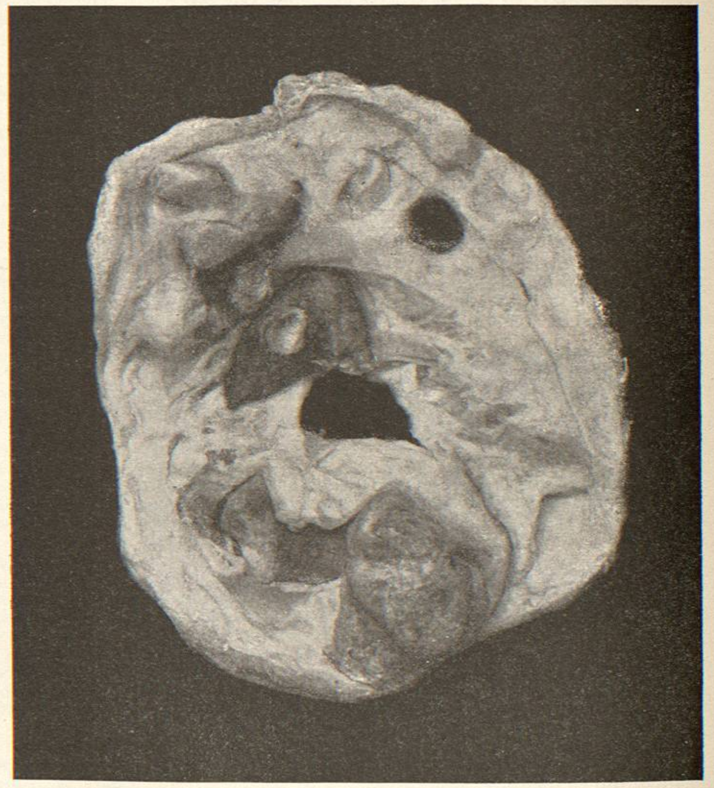

FIG. 1480.—Calculi in Kidney, Conforming in Shape to the Infundibular and Pelvic Cavities. (Natural size.)

is furnished by a considerable variety of urinary conditions, which will be mentioned in describing the constituents of calculi. The latter is dependent on a condition of renal or vesical irritation by means of which blood and serum, and perhaps undue amounts of mucus, are permitted to enter the urine. It reminds us, in a measure, of the condition essential to the formation of bilirubin-calcium, discussed in describing biliary calculi.

It is not to be understood that calculus formation is always accompanied by albuminuria. Such is not the case. Many instances are clearly recalled in which albuminuria was certainly not detected and probably did not exist. Vesical irritation, for example, introduces not necessarily serum albumin but always considerable mucus, the albuminoid basis of which is not known to us chemically, but which is probably a nucleo-proteid of some kind, not mucin as has been so generally stated. That urine contains mucus is a well-recognized fact and is proved by the formation of froth when the urine is shaken. This appears greater in concentrated specimens and in those which have remained long in the bladder. Under conditions of vesical irritation the mucus in urine is materially increased, and doubtless in some instances affords the factor which, as has been stated, is essential for conglomeration of crystallizing urinary solids.

Uric acid occurs in the body fluids and in urine in

FIG. 1481.—A Stone from the Urinary Bladder. (Natural size.)

combination with sodium, potassium, or ammonium, the salt being, according to Roberts, a quadriurate.* He states that, if an aqueous solution of this salt be allowed to stand for some time, one-half the uric acid separates from the solution as crystals and the other half remains in solution in combination with the base as biurate. The quadriurate has split into uric acid and biurate. The reaction in urine differs somewhat from this. Acid phosphates are present and they react with any biurate formed and remove some of the base, at once converting the biurate again into quadriurate. Consequently biurate is never present in such quantity that it can be detected in the urine. The separation of uric acid from the remaining quadriurate and the conversion of the biurate into quadriurate again go on till ultimately no more quadriurate remains, when all of the uric acid will be deposited as crystals, excepting the small amount that is soluble as such in the urinary fluid. In urine the separation differs not only in the particular just mentioned, but also in that it is normally inhibited or greatly retarded. The water of the urine does not so readily break up the quadriurates as when in aqueous solution, the inhibition being chiefly due to the presence of the mineral salts or the pigment of the specimen. The separation of uric acid does go on, nevertheless, under certain pathological conditions in the manner that has been described. Just what the conditions are and just why they operate to effect the result it is difficult always to say, but we believe that at least four conditions tend to accelerate the precipitation—namely: (1) high acidity, (2) poverty in mineral salts, (3) low pigmentation, and (4) high percentage of uric acid, while the opposite conditions tend to retard precipitation.

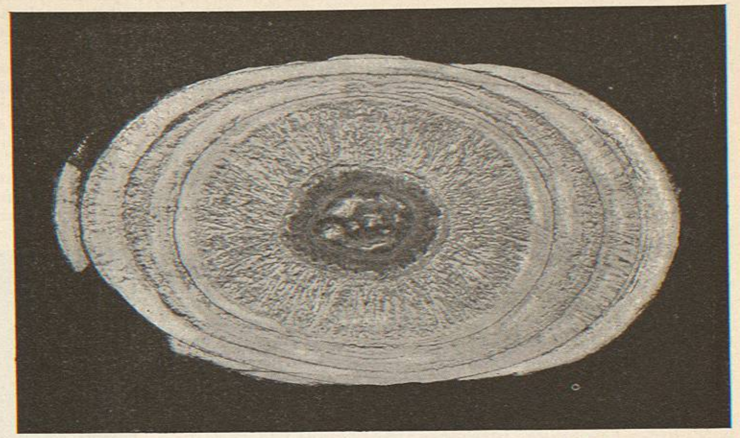

FIG. 1482.—Transverse Section of Fig. 1481. Showing the laminated body composed of magnesium phosphate and a nucleus of calcium oxalate.

The acidity of urine is due to acid phosphate, which in turn is derived from the basic phosphate of the blood. It may be increased by internal conditions, as, for example, the internal administration or production of acids or by a diminished secretion of acid in the gastric juice, under which conditions the increase is absolute; or it may be relatively increased by a diminution in the volume of water secreted. Acid is produced in prolonged muscular exertion, in diabetes mellitus, and by some of the putrefactive and fermentative changes that food may undergo in alimentation. A diminution in the volume of urine is noted in those who drink little water, in individuals leading a sedentary life, and in those who experience an increased loss of water from the body through other channels, *e.g.*, the sweat and bowels. Under these various conditions, then, urinary acidity and the consequent tendency to uric-acid separation are increased, and in the presence of the conditions of vesical or renal irritation already mentioned tend to the production of uric-acid concretions.

* Tunnicliffe and Rosenheim have very recently attacked the conclusion of Roberts as to the existence of quadriurate, and state that it is a mixture of biurate and uric acid in varying proportions.