fairly established, and local prescriptions, something in combination like the following, may be directed:

℞.—Aquæ calcis, ℥iv;
Tincturæ cinchonæ,
Tincturæ pyrethri, āā ℥j;
Tincturæ quillai, ℥ij;
Potassii chloratis, ʒj;
Aquæ chlorinatæ, ʒij;
Spiritus vini, ℥j;
Tincturæ gaultheriæ, q. s. M.
S.—To be used with the tooth-brush.

Or,

℞.—Potassii chloratis, ℥ss;
Aquæ, ℥iij;
Tincturæ capsici compositæ, ʒij;
Aquæ Coloniæ, ℥j;
Tincturæ quillai, ℥iss;
Olei limonis, *vel* verbenæ, *vel* gaultheriæ, q. s. M.
S.—To be used with the brush.

If it prove more convenient to employ powders, something like the following will be found to answer the required purpose:

℞.—Cretæ præparatæ,
Iridis Florentinæ pulveris, āā ℥ss;
Ossis sepiæ pulveris, ʒij;
Olei limonis, q. s. M.

Or,

℞.—Cinchonæ rubræ pulveris, ʒij;
Capsici pulveris, gr. x;
Potassii chloratis pulveris, ʒj;
Pulveris aromatici, ʒij;
Saponis castiliensis pulveris, ℥j;
Magnesiæ carbonatis, ℥ss;
Iridis Florentinæ pulveris, ℥j. M.

Or,

℞.—Cretæ preparatæ,
Iridis Florentinæ pulveris,
Ossis sepiæ pulveris, āā ℥ss;
Sacch. alb. pul.,
Carbo lig. pul.,
Pul. aromat., āā ʒi.

Conjoined with the local antacids, attention is likewise demanded to the functional, or it may be organic, conditions producing the acids. Different derangements of the general health will exhibit different acids. Thus, in one mouth will be found the uric, in another the lactic, in still another the nitrous, etc. These productions have their constitutional meaning and indications. As examples in such directions of practice, the presence of uric acid in the mouth, as in the urine, is apt to be found associated with deficiency in respiratory action and with circulatory sluggishness. Lactic acid in the saliva almost certainly indicates the condition of diabetes, although diabetes does not necessarily yield lactic acid to the saliva. Formic and acetic acids found continuously in certain mouths have been made quickly to disappear through treatment directed to an existing leukæmia.

Parasites.—The parasitic theory of dental caries holds good only as fungi, animal or vegetable, are added causes of deterioration. Lodged in a cavity of a tooth of soft structure, these no doubt act the part of destructive agents, by insinuating themselves into the tubular and intertubular spaces, interfering with and counterbalancing the resistive efforts of dentinal consolidation, and serving as sponge-like bodies, to hold in contact with the parts agents alike injurious with themselves, lowering also the resistive vitality through an appropriation of nutritional pabulum. The matter of parasitic relation with dental caries, properly summed up by Dr. Miller, is appended as a foot-note.*

To destroy these fungi, few agents are found more reliable than what is known as the dental carbolic acid soap. This soap should be used twice a day, and particularly is not to be neglected on retiring for the night. Powders also serve an excellent purpose, removing the offence mechanically. Acid washes, as suggested, may also be prescribed. Dr. Aitkin, of Edinburgh, recommends the production in the mouth of sulphurous acid through a solution of the sodæ sulphis:

℞.—Sodæ sulphitis, ʒj;
Aquæ, f℥j.

In proportion as the secretions are acid, the salt is decomposed, the sulphurous acid being set free. This disengaged acid will, it is affirmed, destroy the parasites in twenty-four hours.

In the case of a family of children where parasitic offence was associated most markedly with putrescent caries, a change quite wonderful in its char-

* "2. Decalcification of the enamel signifies total destruction of that tissue; of the dentine there remains after decalcification a tough, spongy mass, which becomes subject to the invasion of enormous numbers of fungi (leptothrix-threads, bacilli, micrococci, etc.).

3. The leptothrix-threads are found, with rare exceptions, only upon the surface, or in the superficial layers of the softened dentine, and appear to take but a small part in the invasion. The bacilli, on the other hand, penetrate far into the dentine, even into the finest branches of the canaliculi. Micrococci penetrate farthest.

4. In the separate tubules is frequently to be seen a gradual change from leptothrix-threads to long bacilli, from long to short bacilli, and from the latter to micrococci.

5. The fungi produce anatomical and pathological changes in the deeper layers, stop up the canaliculi, and necessarily lead sooner or later to death of the dentinal fibrils. The outer layers of dentine, thereby deprived of nourishment, die and fall a prey to putrefactive agents.

6. The invasion of the fungi is always preceded by the extraction of the lime-salts.

7. The fungi have not the power either to penetrate or to decalcify sound dentine, so that the infection of a perfectly sound tooth by a carious one seems to be excluded."

acter was produced by alternations of acid and alkaline washes. Either of these, by itself, failed utterly in any satisfactory result. The writer was led to infer, therefore, that two orders of fungi harmoniously existed,—the one impressible by acids, the other by alkalies; and the result of the treatment certainly seemed to verify the conclusion. The fluids of all the mouths were neutral. The Protococcus dentales, very minute organisms, are referred to by microscopists as being most frequently found in carious dentine, although it is not at all uncommon to meet in profusion the spirilla, amœbæ, monads, etc.

The following examinations, made by Dr. Joseph G. Richardson (author of the "Handbook of Medical Microscopy") on the first five patients coming into the office of the author after completion of the required arrangements, will be read with interest:

Specimen I.—Patient, young lady. Mouth remarkably healthy-looking; gums hard; had lost no teeth; cavities very few in number; oral fluids neutral; teeth clean; no tartar or other collections, specimen examined being a particle of carious dentine. Examination with a one-twenty-fifth-inch objective, giving with the No. 1 eye-piece a power of about twelve hundred diameters, showing multitudes of bacteria and short leptothrix filaments, all, however, quite motionless.

Specimen II.—Old lady. Teeth breaking down in every direction; diffused collection of pasty débris; gums soft and unhealthy-looking; epithelial cancer involving left half of lower lip, and passing around the commissure to upper lip; patient very deficient in vital force. Specimen examined being débris from the side of an inferior cuspis, against which rested the disease. Exhibited long bundles of leptothrix filaments, consisting of from five to fifty mycelial threads, each about one-ten-thousandth of an inch in diameter, and sometimes attaining the enormous length of one-tenth of an inch. These fibrous-looking bundles were interlaced and imbedded in a large amount of granular stroma, apparently composed in great measure of bacteria and bacteridia, as many of the former could be seen in very active movement around the margins and in the interstices of the masses.

Specimen III.—Patient, young lady. Mouth in the highest degree healthy-looking; had lost no teeth; very few cavities, and these all filled beautifully and perfectly with gold; fluids neutral; no tartar. Specimen examined was a mere particle of débris found between the inferior central incisors. This showed great numbers of comparatively short leptothrix filaments, among whose interstices floated, in molecular (Brunonian) movement, multitudes of bacteridia and nearly motionless bacteria. A few of these minute organisms manifested voluntary action, which continued in certain instances for at least thirty-six hours after removal from their parent mouth and immersion into the three-quarter per cent. salt solution.

Specimen IV.—Boy with hare-lip. Oral fluids alkaline, stringy, and tenacious. Specimen examined was carious dentine from a lower molar. It

showed immense numbers of bacteria, short leptothrix filaments, chains of spores, and occasionally a specimen of spirillum. These fungi were especially abundant around the margins of dentine scraped from the cavity; and, as they were not accompanied by salivary leucocytes, it is probable that they did not proceed from the saliva, but had developed within the tooth.

Specimen V.—A molar tooth with a large cavity in its side was extracted from the mouth of fifth patient, a scrofulous lady, with most unpromising teeth, and, after being split open, was subjected to examination. A branch of the cavity, extending into one of the fangs, was filled with a soft spongy mass, which, under the microscope, was seen to be composed of long interlacing filaments of leptothrix buccalis, such as were found in Specimen II., and to be swarming with bacteria.

A portion of the cavity at the edge of the split surface was scraped clean, and thin sections of the still firm but diseased dentine were made with a strong sharp knife. These fragments, when examined with a power of twelve hundred, were seen to be associated with many bacteria and filaments of leptothrix, the latter of which *seemed* in several instances to occupy the dentinal tubules and to project from their fractured extremities. Although being then, of course, without movement, it was difficult to say with absolute certainty that the structureless fibre-like bodies were actually portions of the vegetable growth.

Electro-chemical Relations.—Every observer must have remarked how much more common caries is to moist than to dry mouths, and how much more frequent is the failure of an approximal plug at the base-wall of a tooth than elsewhere about its circumference. These conditions have been discussed by Mr. Kencely Bridgman, L.D.S., in a paper on the electro-chemical action of metallic substances upon the teeth, with an exhibition of experimental research which commends his views to respectful consideration.

While investigating, says this observer, the action of voltaic electricity upon organic compounds, it was observed that all defects of metallic fillings in the teeth could be represented by results obtained out of the mouth. That decay might be, and probably was, a chemical action, every one was quite ready to admit; but how it could be electro-chemical did not appear to be in the slightest degree comprehended. The immediate effects of chemical action could easily be recognized as such; but the previous electric condition giving rise to this chemical action required a somewhat intimate acquaintance with the laws of physical forces to render its presence appreciable; and, consequently, the only valuable portion of the theory has hitherto been left in abeyance.

A basal experiment upon which the deductions of Mr. Bridgman are founded is as follows:

A rod of absolutely pure zinc, three and a quarter inches long, after being thoroughly amalgamated with fresh distilled mercury and drained, and weighing four hundred and eighty-seven grains, was placed half its length in cold dilute sulphuric acid, and the other half exposed to the atmosphere, in the same position as the ordinary plates of a battery. In a very short time bubbles of hydrogen made their appearance over the whole surface exposed to the acid, and after forty-eight hours the metal was found to have lost upwards of ten grains in weight. This loss, however, was by far the least important part of the results obtained. The immersed portion of the metal had not been acted upon uniformly over its whole surface; but the action had been greatest at the surface of the liquid. At the same time the exposed portion had become covered with patches of crystalline sulphate of zinc, high and dry upon the projecting portion of the metal. Therefore, not only had chemical action been exerted between the metal and the acid and the water decomposed, but there was the additional evidence that the metal itself had become polarized.

Associated with this first is the experiment by Faraday, copper being used instead of the amalgamated zinc, the color of the crystals and the coloring of the acid affording more conspicuous evidence of the results produced.

A piece of stout copper wire being placed similarly in acid, the latter very soon gave signs, by the coloring it received, of the copper commencing to undergo solution; and, after having been suffered to remain undisturbed for twenty days, it presented the appearance above the acid of a bushy rod, the portion exposed to the atmosphere becoming coated with a layer of minute and beautiful crystals of sulphate of copper, extending from near the top to within three-sixteenths of an inch of the liquid. At this intermediate portion a greater amount of chemical action had been induced, corroding the wire about half-way through and forming a neck tapering upwards.

That the action which arises between the metal and the acid is due to polarization is evidenced by the following proceeding: "A similar piece of copper wire, wholly submerged in the acid, so as to entirely exclude any portion of the metal from coming in contact with the air, has remained for many months without imparting the slightest tinge of color to the liquid; but on suffering the fluid to evaporate, so as to bring the upper end of the metal near to its surface, the instant the slightest portion becomes exposed to the atmosphere chemical action immediately commences." There is thus, where no sufficient normal affinity exists between the metal and the liquid to effect the decomposition of water, a power imparted, by the metal being polarized by the atmosphere, which renders it then capable of accomplishing it.

The atmosphere, says Mr. Bridgman, in its normal state being electro-positive, renders, by a well-known law of induction, bodies opposed to it electro-negative. The exposed end of the copper is, therefore, thus rendered electro-negative, and the acid, by the same rule, being electro-negative also, the immersed end of the metal becomes electro-positive. It is an established rule that bodies to be electro-decomposed must first be rendered electro-positive; and it is also a part of the same rule that bodies receiving an addition of matter must first be made electro-negative. Hence the exposed end of the metal has become negative and received the crystallization, while the immersed portion, being positive, has been acted upon accordingly.

The appearance, however, of the crystallization upon what was at first the dry end of the metal requires particular attention. It is one of the special effects of electrolytic action that fluids pass to, and accumulate at, the negative pole. Obeying this law, the acid immediately begins to ascend and spread itself over the surface of the unimmersed end of the metal. But now we have another special provision, which demands the most careful and attentive consideration, as it constitutes the first step in the resulting chemical action.

One metal placed in two dissimilar fluids, as the air and the acids, acquires the same condition that two dissimilar metals, or one metal non-homogeneous, assume when exposed to the air: each has become polarized, and rendered amenable to chemical action. Water, being a compound of gases chemically combined, can have its gases uncombined only by equal degree of force being antagonistic to them; and consequently the decomposition of water must be preceded by some other arrangement. Now, the atmosphere being only a mixture of gases, or gases merely in a state of mechanical admixture, which admits of their being readily separated on the slightest interference, supplies the initiatory steps by which decomposition can be effected.

The first immediate effect upon a polarized metal is to drive the oxygen of tha atmosphere to the positive end. Its combination with the metal, in oxidating or rusting it, is a chemical action determined by the electro-polar condition; and it has been established by Faraday and others that this chemical union is invariably accompanied by a development of electricity, which in its turn can be made to produce electro-chemical results of an equal degree in another direction.

The greater amount of action taking place at the neck of the copper wire will now be readily comprehended. The oxygen of the atmosphere has been driven toward the positive end of the metal; but its progress has been arrested by the acid surrounding it. The thin fibres, however, rising from its surface, being soon saturated with the oxygen, and presenting the latter in its most favorable form for acting upon the metal, facilitate its oxidation, and consequently accelerate its solution, and render the ascending acid saturated and ready for at once becoming a crystalline deposit, while little or no solution has been effected in the acid below.

It must be kept in mind that an electric state is not a fixity, but is relative, and depending upon attendant circumstances. Thus, if the copper wire had been subsequently inverted, the immersed end, which is now positive, would then have been rendered negative, and *vice versa;* or had the acid at any time been filled up to the top of the tube, the exposed portion only, however small that might be, would have remained negative, the surface of the liquid determining the line of demarkation between them.

Let us now apply these facts to the mouth. The external epithelial layer of the gum is constantly throwing off its worn-out cells, and by this wasting process it determines its electro-positive state, while the crown of the tooth, as a continuation of the epidermal layer, partakes of the like condition. Were the teeth wholly and constantly submerged, and protected from the air, it is probable that, like the copper wire beneath the acid, they too might remain intact. But as the air is constantly passing into the mouth, or even through it in the act of breathing, they are thus, having one end exposed to the air and the other to the fluid moistening the gum, subject to the same polarizing influence as the metals.

The negative portion of the polarized tooth being represented by the portion of the wire exposed to the atmosphere, it will be at once comprehended why tartar accumulates upon certain parts only of the teeth, and how it is enabled to creep over the surface and adhere with tenacity.

In the case of the partly-submerged wire it has been shown that the principal amount of electro-chemical action takes place near the surface of the fluid, this point determining the line of demarkation. Hence in the mouth this line may be taken as the existing free edge of the gums. The moisture accumulating here, in the event of any electro-chemical action taking place, it would necessarily be immediately above that line, and consequently the substance of the tooth directly above the gum would be attacked. We see this actually taking place in the peculiar decays so common at the exterior or anterior basal area of the molars, and also on the same part of the upper incisors.

In the interstitial divisions, the moisture accumulates between the teeth by capillary attraction, and in connection with this we have approximal decay as one of the commonest forms occurring. The oxygen is attracted to the part, and produces the acid so invariably present, while by electrolysis, the lime is abstracted and removed to another part, or carried away in solution. By such electrolysis, Mr. Bridgman thinks, every other phase and phenomenon of decay is to be traced and explained.

Viewing the matter strictly from the stand-point of a chemist, our author has overlooked vital resistive force. We trust we have, however, completed this lacking portion of his subject, and thus afforded him a required support in the chemico-vital aspect of his subject in which his foundation seems wanting.

We may here follow Mr. Bridgman in his consideration of filling-materials.

In a prize essay, he says, I have shown that an amalgam filling in the side of a tooth having one edge near the gum generates acid at the latter point. This is due to polarization. A body of metal having its two ends or opposite sides exposed, under different circumstances, becomes polar, and in proportion as there is any substance to be acted upon by oxygen, so is the amount of chemical action regulated. Thus, a metallic plug in an approximal cavity, or in the external basal area of the molars, will have the cervical edge continually wet, while the upper part may be comparatively dry; and hence will

be assumed the two conditions as represented by the intermediate and exposed portion of the wire. It has often been lamented that, however carefully and well these fillings may have been done, there is the ever-recurring annoyance of finding, in a few years at the most, and not infrequently in a few months, that the sides of the plugs and baso-caval surface have become defective; showing that, although all the defects may have been removed in the first instance, the cause has been retained.

With the entire range of metals and metallic compounds, it may be taken as a fact that from gold to copper and zinc it is only a question of degree, for the one cause affects them all more or less. In respect to this, gold is unquestionably the best by very far, as being one of the least oxidizable; but even with this, certain precautions are essential to success. The one indispensable condition is *that there shall be no lodgment for moisture at any point of its circumference.* The edge of the plug must be made as perfect as possible, and no fissures communicating with it are to be suffered to remain; for, if all be not right, electro-chemical action will be certain to recommence.

With amalgams, such precautions are, if possible, even more important; but with these there are other points requiring attention. The composition of amalgams is a subject which has never yet been systematically investigated, and those now in use differ considerably in character.

Zinc and copper, and their various alloys, with tin and silver, etc., form the hardest amalgams; while gold, silver, palladium, and platinum form only imperfect amalgams, which never acquire sufficient hardness to resist friction. In the latter, too, the mercury readily oxidizes and produces discoloration, while some of the former pass very quickly from oxidation to the acidifying stage, and thus soon reproduce the electro-chemical destruction of the dentine.

There is another and more serious objection still to be urged against some of the more modern preparations. Amalgams hardening under a state of polarization assume, in some cases, a peculiar surface-crystallization, but almost invariably possess coarser crystals.

I have exhibited, says Mr. Bridgman, two pieces of zinc which had been amalgamated and suffered to harden,—one under polarization, the other without it. With the polarized surface the metal had acquired a considerable amount of crystallization of a peculiar character, projecting above the level of its surface, together with a somewhat coarsely crystalline texture without; while that which had been allowed to harden without being polarized was much finer in texture, although distinctly crystalline. Two pieces of amalgam, treated in a similar manner, showed the same corresponding results. In addition, both the polarized metals exhibited more discoloration than the unpolarized ones, and all showed that amount of roughness inconsistent with a perfect filling.

Having thus traced the defects of metallic fillings, Mr. Bridgman proceeds to consider whether the objections are insuperable.

There are two proceedings indicated, he remarks, as being desirable.

The one is to prevent polarization; the other, to prevent the effects of polarization being reflected upon the dentine. The former is not by any means difficult, but it requires a thorough knowledge of the laws under which it takes place to adopt the provisions under all the different circumstances required. Insulation, however, is one of the means to be secured. This, too, is the end to be sought in protecting the dentine. Either gutta-percha, waxed tissue-paper, or allotropic sulphur—but, above all, the so-called os-stopping—forms an admirable lining for a cavity, where little success could be hoped for from an unprotected amalgam. It also compensates for the want of fineness in the texture of the metal.

There is another point in connection with the electro-chemical action of metals upon the teeth discussed in the paper under consideration. Wherever a gold band comes in contact with the exposed dentine of a tooth, injury is commonly seen to ensue, and decay supervenes if the touched part be near the gum. This is assumed to be fully explained in the experiment with the copper wire. The gold, says the observer, may touch any part represented by the blue sulphate, but at the intermediate portion—that is, that portion of the tooth just above the margin of the gum—it is fatal.

Criticism on the deductions of the experiments is anticipated in a recognition of the fact that their author considers special cases alone, and does not lay down a general rule. That the condition of many mouths is fairly exposed seems entirely beyond doubt; and it must be admitted that Mr. Bridgman has given a very satisfactory expression to the chemical aspect of the subject of dental caries. (See chapter on *Denudation.*)

Since attention was first called by the English experimentalist to the electro-chemical relations as a cause of dental caries, the American has taken hold of the matter with an earnestness that fills the dental journals with communications on the subject.

Medicines and Articles of Food.—That medicines, even the nitro-muriatic acid so frequently prescribed as an hepatic alterative, and the muriated tincture of iron used by almost every practitioner as a tonic, are not such sources of offence to the dental organs as is generally inferred, the author has come to be reasonably well satisfied. Prescribing both combinations with much frequency in his clinic as well as in private practice, he founds this conclusion on an extent of observation that would seem to render it entirely reliable. Not that the careless employment of such medicines is at all to be excused; but the inference is meant to be conveyed that caries associated with the periods of such prescriptions has explanation in the conditions prescribed for, rather than in the medicines prescribed.

Acids are not best given through glass tubes, but, being sufficiently diluted, the draught, if such care be thought necessary, may be thrown into the back part of the mouth, and swallowed in a single muscular act, after which the teeth may be rinsed with water rendered slightly alkaline by the addition of a few drops of liquor ammoniæ. The system, however, which demands an

acid medication will seldom find its dental organs injured by the reception of a share. Chalk, in place of the ammonia water, is suggested by Dr. J. D. White, he asserting that in this article acid medicaments find their quickest and most reliable neutralization.

Mercury, as a medicine, has no direct effect on the teeth,—its action having an intermediate signification; neither have any of the potash preparations as ordinarily administered.

Sugar, as usually employed, is not to be considered an agent deleterious to the teeth; locally it can only act through its conversion into acetous acid. A too free use of the agent, however, by debilitating the digestive functions, indirectly affects the teeth in common with all other parts, by diminishing the resistive force,—in other words, through malnutrition.

Vinegar, lemon-juice, the malic acid of apples, the tartaric of grapes, will all of them, in varying extent, decompose tooth-structure through affinity for the lime. When, however, their action is thus injurious, the fact is easily recognizable by the patient in the loss of that polish noticeable on touching the organs with the tip of the tongue; or in the presence of the feeling familiar to every person, of "the teeth being on edge."

It is not, however, to be affirmed or maintained that any of these articles, when brought in contact with the teeth under the circumstances of mastication, with their speedy dilution by the oral fluids—always proportioned to requirements—are sources of disease to the parts. Prudence in the use of such things is, nevertheless, to be recommended to every person having teeth of loose structure,—soft, chalky teeth. (See *Oral Fluids.*)

Of the dried fruits, raisins may, it seems to the author, be with most reason denied; they do without doubt rapidly corrode the teeth, and are most tenacious in their lodgment. That it is necessary to proscribe their use, except in the case of children, is, however, at least debatable.

The spiritus nitri dulcis,—a compound of the nitrate and carbonate of potassa, sulphuric acid, and alcohol,—freely used in the United States as a febrifuge, particularly with children, is credited with being a frequent cause of dental caries; the diluted state in which the medicine is always administered may lead this inference to be received *cum grano salis.*

CONDITION 5. *The absence of mechanical destructives*, as salivary calculi, the bands of artificial denture, etc. (See chapters on *Salivary Calculus* and *Dentures.*)

CONDITION 6. *Accidental influences.*—Under the sixth head reference is first to be made to what may be termed the gymnastics of the teeth. These organs, like all others of the body, require to be used, and, when denied the exercise of their function, deterioration universally follows. Illustration of this is markedly exhibited in slop-fed cows, the teeth refused their accustomed task quickly becoming carious and loosened; also in the case of persons using