ployed, so that only selected timber can be used. Lumbermen assert that not to exceed 300 white oak cross-ties can be cut from one acre of natural forest and in many localities the yield will not exceed 100. Such trees must be from forty to sixty years old, and at the highest yield per acre 40,000 acres of forest must be culled of its best timber annually to supply the ties in the Central Association territory. Where the softer woods are used the yield per acre is much greater, yet it is a conservative estimate that 200,000 acres of forest are cleared every year to supply the demands for cross-ties alone.

Railroad officials are deeply interested in the perpetuity of the material necessary for the maintenance and operation of their property. They are constantly seeking improved methods to reduce expenses, knowing that money saved is money earned. The form of the rail section and the weight of rail per yard have been scientifically studied and discussed; the contour of automatic couplers has had the most minute technical consideration, and in many important articles of construction and operation, the details have been logically analyzed, tested and improved. Within the experience of many operating officers, the cost of rail renewals exceeded that of ties many fold; now the condition has been reversed. While the quality of rails has been improved, tie renewals exceed the cost of rails, and are increasing, yet the cause is not being noted nor any measures being instituted to remedy or improve the situation. Timber is becoming scarce, and that of the best quality, so that inferior timber, which supplies inferior ties, is becoming the sole source of supply. No material has yet been found as a substitute for the wooden tie, and no satisfactory economical method of preserving the life of the wood or prolonging its durability has been discovered, and, excepting the minor questions of properly seasoning and piling, the use of the tie plate, suitable ballast and perfect drainage, with incidentally climatic conditions, no serious consideration of the future tie supply has been had.

Nearly all the country included in the territory of this association has been settled and developed within a century. Ohio, the oldest of the States, will not celebrate its centennial until three years hence; and when it was admitted to statehood it had less than 50,000 inhabitants. Nearly all the land east of the prairie regions of the Mississippi Valley was heavily timbered, and in the Eastern States the records preserved show that fine timber grew to the very edges of the bays and rivers. If the destruction of all this wealth, the growth of centuries, has been essential for one century's development, to what degree of distress will our successors be reduced in maintaining it? Surely reason will rap the knuckles of our children, and the sentence of Sinai will be fulfilled in visiting the sins of the fathers upon the children unto the third and fourth generation.

The experiments which have been made, in a very limited manner, in tree planting on railroad rights of way, have not been satisfactory, and cannot be on account of the limited width of such strips. Forest conditions must prevail, and these cannot exist on the right of way. Trees for timber must have trunks and not limbs, and to overcome the natural tendency to make limbs they must be grown close together, when each will seek to outgrow its fellows and reach the higher altitudes, where it can "expand." This effort on the part of each plant is commendable from the standpoint of the cultivator, and is the reward for his labor and patience.

Along every railroad are tracts of land not well adapted to cultivation, which would make desirable wood lots upon which trees could be grown for the timber required in the different railroad departments. Such plantations would perhaps be more secure if not adjacent to the road, as fire is an enemy to forestry; yet the wood lot need not be so far as to make access difficult or expensive for protection, cultivation, and supervision. Upon a plantation of catalpas, the trees should be placed 4 feet apart, which would require 2,700 plants per acre. Not all the 2,700 trees would mature, nor is it desirable that they should, but about one-fourth, or 700, would. In fifteen years the yield should be four ties per tree, or 2,800 ties per acre, and by judicious cutting a rotation of timber can be obtained. If the white oak tie is desired, the growth would not be attained under forty-five years.

The financial aspect of the undertaking is not at all unsatisfactory. A plantation of catalpas, in Kansas, in seven years began to reimburse the owner by thinning, the trees having attained a height of from 18 to 20 feet, and making two fence posts each, and the experience has been duplicated in many places. No one will assert that first-class ties will be procured fifteen years hence at present prices. If the cost per tie in 1915 be placed at 75 cents, a very low estimate, the value of an acre of ties, cultivated as suggested, will be \$2,100, with a life for the timber grown four times that of the best white oak. The land purchased will still be the property of the railway, but deduct its cost, say \$50 per acre, and \$2,050 remains as the result of the investment, or \$135 per acre per year as the value of the crop. What farmer can point to a yield so satisfactory? The expense will have been so slight that the value of the thinnings will be found sufficient to more than pay for the attention required. But it may be urged that fifteen years is a long way off, and that we should take "no thought for the morrow, for the morrow shall take thought for things of itself. Sufficient unto the day is the evil thereof." The advice may be good philosophy, but it is very indifferent practice in railroad affairs, and is not observed by any railroad official.

The cultivation of forests would not be unattended with expense and supervision; it is a kind of agriculture and not merely the planting of seeds or plants; they must be cultivated and cared for systematically and intelligently until they are sufficiently large to shade out grass and weeds, until which time grass and weeds must be destroyed; they must also have protection against fire and live stock, and be managed as an investment. In proportion to the extent of the undertaking it would require a forester who should have absolute control of the forestry; section men should be instructed by him how to protect the growing timber, not as a part of their regular work, but in the manner they now care for the telegraph line, in emergencies, until the lineman arrives. Such service would not be expensive, and the forester should be required to keep

detailed records of the successes and failures of his department for future guidance.

The National Government is ready to extend a helping hand to any railroad which desires it. The Division of Forestry of the Department of Agriculture will give practical assistance to tree planters in the selection of the right tree to plant, and in planting them rightly. The division will make examination of the ground proposed as a forest, prepare a plan for planting and caring for a plantation, which will best promote and increase the present value and usefulness of the land to the owner, and develop and perpetuate a plantation of forest trees upon it. Upon the completion and acceptance of the plan by the owner, the division will supervise the execution thereof, so far as may be necessary. If the area does not exceed five acres no charge will be made for services, but the division will not participate in the expense of planting and caring for a plantation except to defray the salary and expenses of its representative. If the area exceeds five acres a preliminary visit of inspection, if required, will be wholly at the expense of the division. If a plan is made and accepted, the owner must pay the expenses of the division officials according to a printed schedule of cost of services, which will always determine the amount of the anticipated expenditures. The department in every instance reserves the right to publish and distribute the plan for the information of others.

The general government has sounded the alarm, and as loyal citizens we should respect the warning. The progressive ideas which characterize railroad officials should cause them to be zealous advocates of a subject which concerns them so intimately and to support the State and national regulations respecting forestry. There is no way in which the present vague and imperfect knowledge of the subject can be changed into an active, earnest interest in forestry except by an accurate acquaintance and agitation of the question. If railroad men become aroused to the importance of forestry, not only to the service, but to the public of which they are a part, and with whom they must suffer any general condition, a sentiment will be awakened which will work wonders and cause future generations to rise and bless us.

DENDROBIUM × DALHOUSI-NOBILE.

THIS fine hybrid was shown by Sir Trevor Lawrence, Bart. (gr. Mr. W. H. White), at the Royal Horticultural Society on June 5, when the Orchid Committee voted it an Award of Merit, although many of the expert orchidists who saw it thought, in view of the distinct character of the cross, as well as on account of the

DENDROBIUM × DALHOUSI-NOBILE.

beauty of the flowers, it might well have been honored by a first-class certificate. The cross was originally made by R. Broome-White, Esq., of Arddarroch, the species employed being *D. Dalhousianum* (pulchellum, Roxb.) and *D. nobile*.

Although the inflorescences on the plant exhibited were few-flowered, there was indication in the attempted racemose formation of the flower-spikes that ultimately the plant may bear flowers in the same way as *D. Dalhousianum*.

The growth of the plant resembles *D. Dalhousianum* in a great degree. The flowers have the sepals and petals white at the base, the outer two-thirds tinged and veined with rose-purple. The broad shell-shaped labellum has a bluish-white base, a deep claret-colored disk, surrounded by a white zone, the apex being bright rose color. It is one of the most distinct and showy hybrid *Dendrobiums* yet raised.—*The Gardeners' Chronicle*.

CULTIVATION OF COFFEE IN INDIA.

At the end of 1898 there were 281,570 acres of land under coffee in India, all with the exception of 549 acres in southern India. The cultivation of coffee is, in fact, restricted for the most part to a limited zone in Mysore, Coorg, and the Malabar districts of Malabar and the Nilgiris. About 45 per cent. of the coffee-bearing area is in Mysore, where there were 128,079 acres in 1898. The plant is grown on 128,410 acres, forming another 45 per cent. in the British districts of Coorg (82,575 acres), the Nilgiris and Malabar (45,835 acres). If to these two areas are added 6,384 acres in Travancore and Cochin, we find 93 per cent. of Indian coffee concentrated in the elevated region above the southwestern coast. Mysore, Coorg, and the Madras districts contain 97 per cent. of the coffee-growing area. According to the United States Consul at Bombay, in the Madras Presidency, cultivation on an extended scale is confined practically to the two districts already mentioned, and to Salem and Madura. The only other province in which coffee is grown, except experimentally or to an insignificant extent, is Burma, and the cultivation there, mostly in Toungoo, is very limited. The area in Madras, after a reported contraction in 1896 and 1897, again expanded in 1898 to the level of 1894 and 1895. In Coorg, the area reported in each of the last three years is much beyond the average, but in Mysore it has been reduced approximately to the level of 1892. As regards the production of coffee, the yield in 1898 was about 23,750,000 pounds, that of 1897 having just exceeded 24,000,000 pounds. The production of both years was exceedingly poor, following a

small yield in 1896. The poverty of the crop in 1896 and 1897 was due in the main to adverse seasons in Mysore, Coorg, and Travancore. In all three cases there was a recovery in 1898, which was, however, incomplete in the case of Mysore, but to set against this recovery the Madras crop was a single failure. Since 1897 the fall in prices has removed the stimulus which had been given for a few years to the expansion of the coffee-growing area, and disease has combined with adverse climatic conditions to reduce the yield. According to returns there were, in 1898, 25,930 persons employed permanently, and 88,550 temporarily, on the coffee estates, making a total of 114,480 persons, which is equal to one person to 2.46 acres.—*Journal of the Society of Arts*.

MICROBES—WHAT ARE THEY?

By HENRY G. GRAHAM, M. D.

1. Detection of Protozoa in the body.—The presence of the protozoa in the fluids of the body is readily ascertained by the sight alone, their form being characteristic. This is true not only of the adult, but of the elementary forms as well. Certain embryonic forms, however, so nearly resemble blood and lymph corpuscles that it may become necessary to resort to some means to distinguish one kind of corpuscle from the others.

By elementary protozoa is meant the microscopic spherules, often so minute that they approach the limits of visibility, from which spring, upon the conjugation of the adult organisms, the embryonic forms.

Two agents that may be employed to distinguish blood corpuscles, lymph corpuscles, and embryonic protozoa from each other are a saturated solution of caustic potash and pure acetic acid.

If the first is brought in contact with a blood corpuscle, the latter is at once destroyed, and the nuclei, if any are present, quickly disappear.

A lymph corpuscle will gradually and evenly expand, expel its granular contents, and again contract, the stroma remaining intact.

In case of an embryonic protozoon, the corpuscle disappears only after a time and the nuclei persist indefinitely.

When the adult protozoon has become encysted, contact with caustic potash does not destroy such form, even after many days.

Application of acetic acid to blood corpuscles shows the presence of one or more nuclei, while upon embryonic protozoa no effect is produced.

From embryonic protozoa contained in the various fluids of the body mature organisms may be developed in proper culture media. Elementary protozoa on solid culture media produce other elementary protozoa.

Mature and immature protozoa may sometimes be distinguished by the coloring matter they develop. This is usually blue, bluish green, or brown.

When found in the urine, embryonic protozoa closely resemble the pus corpuscles derived from the blood. They are distinguished by the means given above and by the use of nitric acid. The latter will show the presence of albumin if the pus corpuscles are blood corpuscles. If the pus corpuscles are elementary protozoa, the presence of albumin will not be shown.

As seen in the fluids of the body, the higher forms of the protozoa often exhibit a very slight rotary motion imparted by a filament usually carried beneath the organism.

The corpuscles derived from the blood are almost uniform; those derived from the protozoa are more variable in size.

In fluids the protozoa retain their form for many months—in fact, indefinitely—while blood corpuscles, under the same conditions, speedily disappear. In urine, actively motile protozoa have been found nine months after it had been drawn with a catheter, and been kept free from contamination.

2. The Bacteria, Elementary Forms of Higher Organisms.—After a protozoon has disintegrated in a fluid, upon its former site are found:

A. Minute microscopic spherules—cocci.

B. Bacilli or spirilla, or both.

C. Embryonic protozoa.

That the first are elementary forms of the protozoon, and not foreign bodies, may be shown as follows:

In case of the *Monas fluida* and of some other infusoria, the protoplasm contained within the ectosarc has floating in it one or more large nuclei. Within these bodies are other and smaller nuclei, and these last contain the minute microscopic spherules or cocci which are the ultimate forms that can be discerned when the organism disintegrates.

If caustic potash is brought in contact with *Monas fluida* the ectosarc bursts, and the protoplasm, with the large nuclei floating in it, is set free. Presently these nuclei burst, when other nuclei are set free. Finally, when these last nuclei are broken up by the continued action of the solution, great numbers of the microscopic spherules escape and are seen to be very actively motile. That this is not a mere Brownian movement is shown by the fact that when similar bodies and foreign bodies are found just within the ectosarc of a protozoon, the first exhibit this same movement, while the second do not. We shall endeavor to show that these minute spherules are the familiar *Staphylococcus pyogenes albus*.

It will be observed that this body, the fourth within three concentric circles, was shielded by three successive barriers against the approaching caustic solution. This is worth remembering when we come to consider the manner in which this microscopic spherule is protected from the action of the juices of the alimentary canal. It should also be remembered that this spherule continues actively motile for a considerable period even in a saturated solution of caustic potash. Is it not possible that while in this condition it may enter a villus of the intestine unaided by any save its own motile powers?

If it were a foreign body, we should expect to find it within the outer instead of within the inner zone of the protozoon. The spherules are of uniform size and appearance and are always present. This is not true of foreign bodies.

These microscopic spherules, whether within the central nucleus or just within the ectosarc, reproduce themselves by fission. In an unfavorable environment, the nuclei of the protozoon disappear, the outer cap-

sule persisting. This is usually in the form of a circle or oval, and incloses a teeming mass of microscopic spherules.

Such bodies are always to be found in the saliva of persons who drink water containing living protozoa. They must not be confounded with epithelial cells, some of which they closely resemble.

The following is offered as proof that the bacilli, spirilla, and beggiatoa are derived from the protozoa. The forms called cladothrix, streptothrix, leptothrix, and myconostoc may be seen to be derived from the same source.

A small quantity of filtered solution of Mellin's food is added to pure water in a vessel. *Monas fluida* is now transferred to this culture medium. This is best selected from a colony in which most of the organisms have become encysted. After twelve hours, by means of a cover slip, the surface growth is removed to a slide. Here and there some specimens of the monad will be found that had risen to the top of the fluid. The ectosarc is spread out on its surface, where it will be seen to have become transformed into a mass of bacilli. These masses increase in size at the periphery until in from twenty-four to forty-eight hours they coalesce and form a pellicle on the surface of the water.

There are certain protozoa that remain immersed in the fluid in which they grow, and simply throw out diverticula, just as *Amœba princeps* extends its pseudopods. These diverticula are often quite long and sinuous. They soon become fixed, and after a time the protoplasm is transformed into a mass consisting for the most part of bacilli. A hyaline substance first intervenes, but after a time this disappears, setting the bacilli free.

In old colonies protozoa may be found teeming with a mass of bacilli and spirilla. Here, the conditions being unfavorable to the development of the embryonic protozoon, that body is transformed into a lustrous, slightly motile bacillus or spirillum, or the protoplasm of the outer zone disappears, the nucleus alone continuing under these lower forms. In one infusorian the nucleus and its modified forms may be distinguished from the rest of the body with the use of a stain. Carbol-fuchsin and methylene blue stain the spherule rod or spiral red, the surrounding protoplasm blue.

A spherule rod or spiral is always to be seen within an embryonic protozoon. If the spiral is the form present, every protozoon contains one. This would not be true if its presence were accidental.

The bacteria seen within a resting protozoon are usually all spherules, all rods, or all spirals, and they may lie dormant or be very actively motile. Such a resting form, filled with a mass of actively motile spirals, if seen in the tissues of the body, would appear as a formidable pathogenic agent. After the ectosarc has broken down and has disappeared these spherules, rods, and spirals remain in clumps and continue to multiply. This is the origin of the cluster of bacteria usually found in urine in diseased conditions. Sometimes the ectosarc still incloses them. In a few instances, the adult protozoon is found in urine just as it appears in water except that it is non-motile.

Old colonies of *Monas fluida* will show to good advantage the microscopic spherules; *Coleps hirtus*, the lustrous rods and undulating mass of spirals.

To study the long, delicate, serpentine filaments often seen floating in water, *Paramecium aurelium* is selected.

The organism is placed between a slide and cover slip and the excess of water removed by means of bibulous paper. Evaporation is allowed to continue for some time after the infusorian has become quiescent. While under focus the cover slip is slightly displaced. If enough time was allowed for the organism to become slightly adherent to the surface of the slide and of the cover slip, the mass of its body will now be seen to be in one place, and the long, slender, delicate, almost invisible filaments, in a compact mass and lying parallel to each other, will be seen on the former site of the protozoon. These afterward develop into very long, delicate, slightly motile, serpentine filaments. These are probably identical with *Leptothrix buccalis*.

The third form, or elementary protozoon, is always found on the site where an adult organism has disintegrated.

The protozoa propagate themselves in three principal ways:

- A. By division of the adult organism.
- B. By bud formation and extension.
- C. By development and division of their contained nuclei.

What appears as a fourth mode is only a modification of this last. Two adult protozoa move upon each other like two revolving cylinders, their surfaces in contact with each other. This rasping results in an extrusion of a portion of the contents of each protozoon, and this consists in embryonic protozoa floating in a jellylike mass of protoplasm, the whole resembling the spawn of fishes. These embryonic protozoa are bacilli. Each bacillus contains either one or two nuclei, and these are imbedded in protoplasm, the whole being surrounded by a capsule. These bacilli are all of uniform size, and are often very numerous. They are quite lustrous and present the appearance of newly formed protoplasm. In size and form they resemble the colon bacillus, the bacillus of typhoid fever, the *Bacillus lanceolatus*, etc., according to the kind of protozoon and the conditions under which it is grown.

Two organisms will come together and may be seen by the hour moving upon each other, the surface of one gliding upon the surface of the other, the jellylike mass described above collecting round the circle within which the organisms move. After the newly formed ring of protoplasm, with its contained embryos, has been greatly augmented in this manner, one protozoon escapes from the inner ring, the other usually continuing to move round and round within the now constantly narrowing circle. Finally, the other protozoon escapes, and the site it occupied is speedily obliterated. If the culture medium continues favorable, the young embryos develop into adult protozoa, but if placed upon solid culture media they propagate themselves, producing other bacilli. These in the first few generations retain the capsule, but in later cultures the capsule disappears.

When the protozoon disintegrates, the bacilli derived from the ectosarc do not form spores, while those

derived from the endosarc are spore-forming bacilli. Both kinds propagate themselves indefinitely.

In some of the protozoa the spore-forming bacilli develop into long, delicate hyphæ, having two parallel walls inclosing a lumen filled with spores. If the conditions are unfavorable, the spores bud into hyphæ; otherwise they form other protozoa.

The streptococcus derived from various protozoa may be regarded as a diminutive hypha in which the spores are large and prominent and its walls rudimentary.

A hyphæ may contain terminal or intercalated heterocysts, or both. Within these and within the walls of the hypha the protozoa develop. If the conditions are less favorable, from the nuclei within the heterocysts, other hyphæ are developed. The walls of a hypha may be regarded as a very much elongated ectosarc, its lumen as an attenuated endosarc. Such a protozoon may be looked upon as a dual organism—at one time more closely approaching the animal, at another time the vegetable kingdom. Such an organism would correspond to the protista of Haeckel. It is possible it was upon the study of some such forms that Zöph established his theory of the pleomorphism of bacteria.

We have now seen that where an adult protozoon has disintegrated we may find microscopic spherules, bacilli, leptothrix, and elementary protozoa. This very much simplifies the study of bacteriology, and, when we remove from the crypt of an enlarged tonsil all these forms, we know that the inflammation depends not necessarily on the presence of a variety of organisms, but of only one kind of organism that of its own inherent motile powers had entered the crypt from which it was subsequently removed.

3. Resistance of the Protozoa to Destructive Agents.—A saturated solution of potassium hydrate and pure sulphuric acid will reduce the protozoa to more elementary forms, but will not destroy the vitality of these forms except after prolonged contact.

When a fluid in which a protozoon exists evaporates, the protoplasm forming its body mass escapes through a rent in the ectosarc in the form of minute droplets. These were probably the "minute drops of oil" of Linnaeus and of Dutrochet, from which they produce living protozoa by simply passing a current of electricity through the fluid containing them. These minute bodies are frequently found in the urine of persons suffering from disease. They may be found in the faeces, in the pus from suppurating cavities, in the blood, in the saliva, and in the secretions from the pituitary membrane and bronchial tubes.

Boiled in a hermetically sealed flask twenty minutes each day, for three successive days, after two months, the flask having remained hermetically sealed, great numbers of the elementary and embryonic forms of *Monas fluida* will be found actively motile. Most of them will be free, but a few will still be seen within the resting forms, the ectosarc of the latter in a few instances having remained intact. This experiment shows the *Monas fluida* to be a facultative anaerobe.

The same organism sealed up in a glass tube will survive for eighty-three days, and probably indefinitely, possibly for years.

After remaining for two weeks at room temperature—about 70° F.—in a dry state, not only will the spores retain their vitality, but the ectosarc in a few instances will remain intact.

On April 5, 1899, a woman died whose urine, which was drawn with a catheter, contained great numbers of elementary and embryonic protozoa. At this writing (March 10, 1900) many actively motile but small protozoa are present in the urine, which all these months has been kept free from contamination. So long as they continue in this medium they will remain very small and stunted, for, like the northern pine, the more unfavorable the conditions under which they grow, the more they are dwarfed.

In general it may be said of the protozoa that the higher the temperature of the medium in which they exist—up to a certain point—and the more dwarfed their size, the greater is their activity. This is true as well of their elementary and embryonic forms.

In normal urine, at room temperature, under a bell jar, certain of the protozoa will develop typical chains of the streptococcus as well as pus corpuscles. After a time the urine becomes strongly alkaline, the corpuscles break down, forming a viscid mass which pours like pus to which an alkali has been added. These chains are the same in appearance and stain the same as the *Streptococcus pyogenes*.

From such a culture adult protozoa may be grown by transplantation to proper culture media.

If certain mineral substances are added to a culture of protozoa, the latter will become encysted and will be transformed into siliceous-like bodies that form rosettes of crystalline needles. They impart the same sensation as of sand pressed between a slide and cover slip. It is possible this will explain the cause of some forms of inflammatory rheumatism.

4. Virulency.—Virulency is simple in adaptation of the infecting organism to a new environment. If the new environment is similar to the old, virulency was probably acquired in some previous host. To this class of infecting organisms belong all those that produce disease by direct transmission, as in blood poisoning following the infection of an external wound or the experimental infectious diseases of laboratory animals where the infection is conveyed by means of a hypodermic syringe. Even here the infecting organism is probably often an elementary protozoon that has been transmitted from host to host, just as the protozoa in their most elementary form may be transplanted many times and propagated on solid culture media for many generations.

If the new environment is unlike the old, virulency is acquired in the immediate host. In other words, the infecting organism must adapt itself to new conditions before it can propagate itself and so produce disease. To this class of organisms probably belong those that produce the various acute infectious diseases. Herein lies the difference between the infectious diseases found in nature and those experimental diseases produced in laboratory animals by the use of the hypodermic syringe. The former, or at least most of them, can not be produced by the methods in vogue in the bacteriological laboratory, while the latter are atypical, and their counterpart is not found in nature.

The contagium, for the most part, finds its way to

the blood current through the natural channels, and it is a mistake to imagine that insects—e. g., the mosquito in malaria—are common carriers of disease. The common carriers of the natural infectious diseases are the various protozoa, and the form in which these exist in the body is that known as the bacteria. Eosinophiles and their congeners are the protozoa in their embryonic form. In normoblast and in megaloblast the protozoon is imbedded in a red blood corpuscle. Normoblasts, megaloblasts, giant cells, and elastic fibers, such as are seen in tuberculosis, may be found in old colonies of the protozoa.

That the protozoa are for the most part non-virulent is evidenced by the fact that their presence does not give rise, as a rule, to any disturbance of the vital processes of the host. That they may become virulent, however, is further evidenced by the fact that exceptionally living protozoa are found in the tissues of dead or dying water organisms. These had escaped into the tissues from the alimentary canal of the host and had adapted themselves to their new environment. Their presence in large numbers is incompatible with the continued integrity of the host. In the human being the presence of large numbers of protozoa in a tissue results in inflammation and subsequent sloughing of the part affected, for under the most favorable conditions certain of the protozoa are great pus producers.

When a protozoon enters the alimentary tract of its host, whether it will become virulent or not will depend upon two things:

1. Whether it will by its own motile powers penetrate the walls of the alimentary tract, and so reach tissue beyond.
2. Whether it will adapt itself to a new and ever-changing environment that gradually becomes more and more toxic for the host.

The development of a non-pathogenic into a pathogenic organism is well illustrated by the presence in the tissues of the body of a protozoon that eventually produces malarial infection. Its first appearance gives rise, perhaps, to no new symptoms that would arouse suspicion that an infecting organism is present in the blood or lymph. The probability is that it can be eliminated before it can give rise to any marked symptoms of infection. If, however, it is not thrown off, the protozoon will adapt itself to its new environment, and its continued presence will eventually bring on a pronounced chill. This is probably caused by the bursting of the ectosarc of the protozoa and the setting free in the blood current of the nuclear bodies, together with the fluid in which they float. It is probably at this time that the most elementary bodies of the protozoon most vigorously attack the red blood corpuscles and by means of their own motile powers penetrate to their interior.

Even now the protozoon is usually thrown off and the malarial poison successfully combated by the administration of quinine, iron, and arsenic, but it is doubtful if the most elementary form of the organism is ever completely eliminated. These latter are liable to accumulate in various tissues, especially the mucous membranes of the respiratory and genito-urinary tracts, and, as a lower temperature than that of the body is more favorable to their development, it is readily seen why catching cold gives such an impetus to their growth.

These low forms of not only the malarial parasite, but those of other protozoa, collect in the same tissues and for the same reason—viz., that of lowered temperature—and they continued to thrive here despite the most persistent efforts on the part of the rhinologist or gynecologist to dislodge them. Thus, we can see why a chronic amœbic dysentery cannot be cured and is so difficult to control, and why most operators remove the appendix vermiformis to prevent a recurrence of the trouble. It is probably for the same reason that cancer and tuberculosis are so difficult to eradicate.

If in malaria the organism grows more and more virulent, a simple malarial infection becomes malignant, and symptoms of a general septicæmia may be followed by death.

This most elementary form of the protozoon, which is an exceedingly active little body, and which invades the red blood corpuscles in such great numbers, is probably identical with the *Staphylococcus pyogenes albus*. If grown upon solid artificial culture media it exactly resembles that body in appearance and staining properties.

Such a body injected into a laboratory animal will produce death in less than twenty-four hours. The dead animal will present the appearance of having died of a general septicæmia, and the organism can be recovered from its tissues (post mortem) and grown upon solid artificial culture media.

I am indebted to Dr. Rare, of the Columbus Memorial Laboratory, for the information that this little elementary protozoon is commonly regarded as a pigment granule.

5. The Protozoa as Morbific Agents.—Elementary forms of protozoa are probably always to be found in small numbers in the blood, lymph, and urine in health. Their presence in great numbers, however, is always indicative of a diseased condition, either general or local. Embryonic and higher forms are not found in the urine in health. These are found, however, in the following diseases: Measles, mumps, scarlet fever, diphtheria, pneumonia, typhoid fever, cerebrospinal meningitis, purpura hæmorrhagica, malaria, ascites, especially of children, general dropsies, chronic nasal catarrh, follicular tonsillitis, bronchitis, cancer, tuberculosis, etc. They are found in metastatic abscesses arising from these acute infectious diseases, and in suppurating foci everywhere of "spontaneous" origin, for some of these "innocent" protozoa, under the most favorable conditions, are great pus producers.

We may expect to find these higher forms in any acute infectious disease in which bacteria are present, except where such disease is the result of direct inoculation, or where the disease is experimental, as in laboratory animals, where the infection is conveyed by means of a hypodermic syringe. These higher forms may be found in the discharge from a diseased endometrium, in the secundines after an abortion, in pus pockets everywhere, as in pyosalpinx, and they are especially abundant in tuberculous abscesses.

Of all the varieties of protozoa—and this is meant to include the monera, rhizopoda, infusoria, and spo-

rozoa—collected in the course of two years from hydrant water and grown artificially, only one has been found that possesses the peculiar staining properties of the tubercle bacillus. This organism does not stain at all with the use of the ordinary aniline dyes; but, if stained by the Ziehl-Neelsen method, the protozoon stains red and the field blue. This is probably the form in which the tubercle bacillus exists in the outside world. Even this organism does not possess this peculiar staining property throughout its entire life cycle. The bacilli derived from it do not always stain red, and in some cases of pneumonia there appear to be transitional forms that possess this staining property only to a slight degree. It is the embryonic form of this organism that is best fitted to show that a certain bacillus is really a product of the organism itself and not a foreign body. This bacillus stains red and the rest of the body stains blue. In an unfavorable culture medium that portion of the embryonic protozoon that stains blue disappears, leaving the red bacillus free. This is probably the process of infection of the lungs in the majority of cases of pulmonary tuberculosis. It may explain the manner of origin of miliary tuberculosis and why certain cases of pneumonia, measles, and pertussis result in a tuberculous infection. The infecting organism does not need to be inhaled from the outside world, but is already present.

The pneumococcus of Fränkel is an elementary protozoon in which the capsule represents the ectosarc, the nuclear body or bodies with the surrounding protoplasm the endosarc of the mature organism. On a solid culture medium this capsule will after a time disappear, leaving only the nuclear bodies to propagate themselves. These represent the most elementary form of the protozoon.

Among the protozoa, the adult organisms propagate themselves by division of the body mass. The same is true of all the forms derived from them—the bacilli, spirilla, and the minute spherical bodies that constitute their most elementary form. The multiplication of each form continues so long as the culture medium remains unchanged.

In general, it may be said of the bacteria that the spiral is the product of an earlier form, the bacillus and leptothrix, the later products of a more mature form of the protozoon.

The bacteria, then, are low forms of life derived from the protozoa.—N. Y. Medical Journal.

TAKING A DEGREE IN CHINA.

"KNOWLEDGE is power." The proverb is Western, but in China alone is it commonly and actually the case. The trader, the laborer, the soldier, are scorned and held in national and general contempt. In the scholar are focussed all Chinese ideas of honor and greatness. "Chu hain jin neng"—"Employ the able and promote the worthy" is the keynote of the system, whereby for some thousand years all the posts in the government of the Celestial Empire have been filled by competitive examination. By his knowledge and success in the Imperial examinations for the Triple Degree the poorest boy in China may become a mandarin. The system comprises a series of examinations the greatest in the world. Beside the Imperial examinations of China the sum total of University examinations in the Western World sink into insignificance, both in number and character. They are open to all Chinese, save monks, actors, and menials. The tests are threefold, roughly corresponding to the Western matriculation, intermediate, and final examinations. The subjects of the papers comprise the whole recognized Chinese literature. And the extent of the Chinese classics is sufficient to stagger humanity when confronted with them on setting forth to become master thereof. The whole of these the student is required or supposed to commit to memory. The first examination is held in about seventy centers in each of the eighteen provinces of the Empire. At each center between 1,000 and 2,000 candidates present themselves for examination for the degree of "Budding Genius." Of the 2,000,000 candidates only one per cent. successfully pass the ordeal. . . . As the day draws near, the streets are thronged with long-robed, large-spectacled gentlemen, to the number of some 10,000 or 15,000. In their wake follow armies of camp-followers—traders, painters, scroll sellers, tea vendors, candle merchants, spectacle makers, servants, and relatives and friends. The population of the provincial capital is swelled for the examination period by fully 50,000 strangers. While the names of the competitors are being received by the authorities, great preparations are being made in the examination hall. It is in reality a miniature city, enclosed by a lofty wall topped with prickly thorns. Coolies are employed pumping water into the great tanks, herds of pigs are stalled, and provisions in vast quantities stored. Butchers, cooks, doctors, tailors, printers, undertakers, take up their quarters in the various lodges of the examination arena. The thousands of narrow cells, about as big as horse stalls, for the candidates are cleaned for their coming inmates. The furniture is simple—a board for a seat and a sloping board for a desk.

The candidates having been identified and numbered are locked in their cells. The themes are handed out and the contest begins. For thirty-six hours, two nights and a day, the competitors address themselves to their tasks, food being brought to them at intervals. On the morning of the second day the papers are collected and the inmates of the hall go out for a day's well-earned rest. After an interval of twelve hours all are back again in their places. Doors are again locked, fresh questions handed out, and thirty-six more hours' toil follows. Again there is a break of a day, and then another, and the final spell of thirty-six hours' scribbling and thought. In these three sections the contest is comprehended. The physical and mental strain is terrible, and candidates have been known to die in their cells. The examination comprises essays on the sacred books, history, poetry, and the whole gamut of Chinese writings. . . . To prevent any suspicion of partiality in the awards, the papers of the candidates are copied out by official scribes, so that the examiners have no clew to the authorship of the essays. But the Imperial examinations are conducted with scrupulous fairness; they are about the only thing in China which is above suspicion.—Evening Standard.

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