Two parties are to be considered, the tuberculous persons and the community, and while the former are entitled to every consideration and attention, the good of society in general must be the principal consideration which guides our action. Fortunately, the interests of the two parties are not irreconcilable and much can be done by education to smooth the difficulties which lie in our path.

There should be in every state and in every large city societies whose objects are the study of methods of prevention and the dissemination of such knowledge in short, plainly written tracts among the people.

In addition to this, boards of health should issue circulars constantly giving such information and advice. At present only twenty-two states and seven cities issue such circulars and recommendations, while five states have societies and five cities have local societies for the prevention of tuberculosis.

These societies can do much good also in shaping legislation. States and cities should have uniform laws regarding expectoration in public conveyances, buildings and on sidewalks; overcrowding of factories and tenement houses, the construction of such buildings as regards light and ventilation, and the employment of children under age.

Health officers should have the power to force ignorant and vicious tubercular persons who persist in reckless expectoration into hospitals provided for them by the public. There should be compulsory notification and registration of persons suffering with phthisis, and apartments occupied by such persons should be thoroughly disinfected periodically, and always after death or vacation of the premises before new tenants are allowed to enter them.

The urgent need is for institutions in which the sick can be cared for and instructed. These should be of two types—sanatoria, built in open country districts in regions known to be specially adapted to the treatment of tuberculosis, and, second, hospitals for the hopelessly ill and destitute, where the maximum of comfort can be given to them and where they will cease to be sources of infection to their families and the public in general.

In spite of the enormous expenditure which would be involved in providing hospital accommodations for the indigent tuberculous, it would cost less than the present money loss to the country from deaths alone, and in a few years we could confidently expect a marked decrease in the disease.

SCIENTIFIC BOOKS.

The Diamond Mines of South Africa. Some Account of their Rise, and Development. By GARDNER F. WILLIAMS. New York and London, The Macmillan Co. 1902. Pp. 681. With 491 illustrations, 29 photogravures and 11 maps.

The most important volume that has ever appeared upon the diamond fields of South Africa, or in fact upon diamond mining in general, is that from the pen of Mr. Gardner F. Williams, General Manager of the De Beers Consolidated Mines. There is no doubt that the late Hon. Cecil J. Rhodes, who died during the early part of 1902, would have been deeply interested in this volume, and it was the desire of the author that he should see it —little realizing that this great organizer would so soon have passed away. But it must also be recognized that it was through the directing capacities and experienced mining knowledge of Mr. Williams himself that the De Beers Mines were managed in such a way that the cost of production was gradually brought down to the lowest possible limit; that theft was almost entirely done away with; and that each year had shown a decrease in the cost of production, and a greater security of these mines as an investment. To the union of these two men—one as the organizer, Mr.

Rhodes, and the other as the manager, Mr. Williams—is due a financial corporation laid out and conducted on lines of such extent and permanence that it surpasses almost any other in existence. To the credit of both be it said that they never used their positions for speculative dealings in the stock, and that neither of them ever lost faith in their great enterprise.

The title, 'The Diamond Mines of South Africa,' is slightly misleading, as the book refers only to those mines owned by the De Beers Consolidated Co., and omits some other mines in the Transvaal and the Orange Free State not under their management or ownership. These, however, represent less than three per cent. of the entire output of South Africa.

The volume opens with a chapter on the ancient Adamas, illustrations being given of all the noted historical diamonds. The second chapter treats of the traditional Ophir Land, and the facts tending to prove that the famous King Solomon's mines were in Rhodesia. To support this view, illustrations are given of the gold ornaments found in the district, and the historical evidences of the great ruins at Zimbabwe, Khami and Insiza. This theory is also sustained by John Hays Hammond, notably in a lecture delivered before the American Association for the Advancement of Science, Washington, on January 3, 1903.

It is doubtful if any one else living possesses so many facts as Mr. Williams concerning the original discovery of the African diamond mines, the early pioneers of the district and other historical data, which, if they had not been preserved here, would have been soon forever lost. These are presented in chapters III. to VII., entitled, respectively, 'The Pioneer Advance,' 'The Discovery,' 'The Camps on the Vaal,' 'The Rush to Kimberley,' and 'The Great White Camps.' These chapters give a connected and vivid account of the history of the whole region, from the Cape to the hinterland—its early settlement, its slow and scanty development through two centuries and its sudden and marvelous period of change and growth in the last thirty years.

In the 'Pioneer Advance' we have an interesting sketch of the early conditions of the Cape Colony; of the expeditions under enterprising Dutch governors and explorers, in search of the golden land of traditional Ophir, ever disappointed and turned back; of the decline of interest and of hoped-for prosperity; of the British seizure and occupation. Then follows a striking account of 'the Great Trek,' when the Boer farmers, preferring a fresh start in the wilderness to the acceptance of an alien rule, went forth to found new commonwealths on the upland veldt beyond the Vaal. The features of the country, and the strife with negro savages, are forcibly pictured; and the record, if rude, is yet heroic, and appeals very powerfully to the best traditions of our own history. After a generation had passed, in the calm, old-fashioned pastoral life of the Dutch republics, came 'The Discovery'—the first diamond accidentally picked up in the gravel of the Vaal, in 1867. In due time followed an invasion of prospectors and diamond-hunters, gathering along the valley—'The Camps on the Vaal'—the period of the 'river diggings.' Soon after came the finding of other and richer beds on the uplands to the east, and the 'Rush to Kimberley' set in, in the early 70's. This marvelous gathering, from every part of the world, is most vividly pictured, and the 'Great White Camps' that sprang up as though by magic, to give place to permanent cities and gigantic industries.

Chapters VIII. to XV. are taken up with the diamond mines themselves; chapter VIII., on 'The Opening of the Craters,' describes the early stages of mining operations, in which scores and hundreds of little private claims were worked from the surface down, until with increasing depth, the intervening roadways and then the great surrounding 'reef' or wall-rock, began to fall and cave in, so that an entire change of method was seen to be ere long inevitable. The next chapter, on 'The Moving Men,' introduces us to the history and personality, the plans, purposes, efforts and rivalries, of the two leading figures in the subsequent development of the De Beers and Kimberley mines—Cecil Rhodes and Barney Barnato—whereby was brought about

the consolidation of these extraordinary properties. Chapter X.—'The Essential Combination'—describes this result—the great achievement of Cecil Rhodes—in its history and in its bearings, both upon the mines themselves and upon the future of all South Africa.

The next chapter, on 'Systematic Mining,' gives full accounts of the methods then adopted, and now in use, for the operation of the mines in a comprehensive and economical manner. Here Mr. Williams is describing his own particular work; as the whole vast connected scheme of exploitation, under which such splendid success has been attained in the past fourteen years, and which is adapted to the further prosecution of the work for an indefinite time to come, is of his planning and execution. The modesty, however, with which he refers to himself and his unique achievements is remarkable, and bears the stamp of genuine greatness. Without the skill and ability which Mr. Williams has shown in the designing and operating of the present system, the great consolidation effected by Mr. Rhodes and his group of financial supporters might have failed of a successful result, or at least never have attained the far-reaching importance that it has.

This chapter is largely technical, and can not be readily outlined in a manner intelligible to the ordinary reader—dealing as it does of necessity with conditions, terms and processes belonging to mining engineering. In a general way, however, it may be described as a process of undermining instead of excavating. The first method had been by digging down from above, by a host of independent claim-owners, individual or corporate. The mines thus became immense pits, traversed by roads that came to stand up as narrow ridges, and walled by the vertical surrounding 'reef' of basalt and shale. As already stated, however, first the intervening roadways between the claims caved in and became useless, and then the reef-wall began to fall and cover great areas of diamond-bearing 'blue-ground' with thousands of tons of broken rock. Various tentative devices were tried for continuing the working under such conditions, but they were plainly temporary and destined to ultimate failure. Only by consolidation of all the claims could a general and comprehensive plan be adopted for operating the whole. This was brought about by Mr. Rhodes, first for the De Beers mine; next, after much contest with Mr. Barnato, by the union of this with the Kimberley mine, in which the latter had a controlling interest; then by both in cooperation, by the taking in by the great corporation, the 'De Beers Consolidated Mines, Limited,' of the Bultfontein and Du-Toits-pan mines, which together now form the wonderful group of volcanic 'necks' or 'craters' (though the latter term is hardly correct) around the city of Kimberley.

This took place in 1888; and by the beginning of 1889 Mr. Williams, as the general manager of the whole, began his new method of working. Shafts were sunk in the solid rock outside of the mine areas, and horizontal galleries run from these into the 'blue-ground' of the mines, beneath all the fallen mass that covered so much of the former workings. The blue-ground was excavated along galleries branching from these again, and thus a given area on a given level was worked out, and the overlying mass of fallen rock, its support largely removed, was allowed to sink down and fill up the empty galleries and chambers. The same process was then repeated on another level, thirty or forty feet below, and a new set of galleries opened and emptied, and whatever 'blue-ground' also had been left as supports, on the former level, was now taken out from below. It will be seen that this process admits of being carried on indefinitely downward, so far as the mechanical difficulties are concerned. The extraction is done, in each level, from the rock-wall toward the interior; and in each mine, several levels are being worked at the same time, by methods explained in the account. The extensive machinery for hoisting the material removed and for pumping out the water that accumulates, etc., is also here described and illustrated.

Chapter XII., on 'Winning the Diamonds,' is less technical than the preceding, and full of curious interest. The 'blue-ground' rock of the necks or chimneys was at first broken

up with shovels, then rudely washed and the residue picked over by hand. The various steps and stages of progress in its treatment are described, down to the wonderfully complete, rapid and accurate machine processes now employed. The rock was found to disintegrate and break up by a few months' exposure to the air, sun and rain; and thus most of the former crushing is dispensed with. The rock brought out is hauled by a very perfect system of traction to the 'floors' —large areas of smoothly rolled ground, covering several hundred acres—and there spread out, about a foot in thickness. Various processes, of steam-harrowing, occasional watering in dry times, etc., are employed to accelerate nature's effect. The removal to the washing machines, and in part to crushers, and all the devices for sorting and concentrating, are described in detail, until the last stage is reached, when the heavy concentrates are fully separated, and ready to be picked by hand. Here it appeared as though the point had been reached where machine processes had to cease and human agency alone could avail. But no! After many years of hand-picking, the discovery was made by one of the employees, Mr. Fred. Kirsten, that diamonds would adhere to grease, while the other minerals of the concentrates would not. A few experiments proved conclusive; and soon all hand-sorting was replaced by machinery—slightly inclined tables coated with a layer of grease. These are vibrated as the concentrates are made to pass over them with a current of water, and every diamond is retained, while the garnets and other heavy minerals pass on! No more simple and complete device has ever been discovered, for the saving of time, labor and loss. The diamonds thus separated are afterwards boiled in a hot solution of soda, and are then ready for the company's office and the valuator.

The succeeding chapter tells of 'Obstacles and Perils' encountered in the working of the mines, and is a graphic presentation of this aspect of the subject. The earlier dangers were chiefly from reef-falls and cave-ins; after the new methods were introduced these became unimportant. Occasional slight explosions, due to carelessness of workmen, and one disastrous fire, of unknown origin, but probably from the same cause, are described, the latter in a very vivid and feeling way. The 'mud-rushes' are the most serious liability of late; and the methods employed to prevent them are ingenious and interesting.

Chapter XIV., on 'The Workers in the Mines,' is one of great general interest, describing the conditions and regulations of life and work in the vast subterranean hive of activity, and the arrangements for housing, feeding and controlling the great heterogeneous army when above ground. About one sixth of the employees are white men, largely from the mining districts of England, though there are many Afrikanders, and a sprinkling from nearly every land on the globe. The rest, some eleven thousand, are native blacks, representing almost every tribe south of the equator, some coming from distances as great as a thousand miles. Mr. Williams gives a most interesting estimate, based on conspicuous facts, of the industrial capacity of the negro—one that impresses an American with surprise. The steadiness, persistence, contentment and capacity shown by these thousands of laborers, fresh from their native savagery, is in utter contrast to the shiftless and indolent character of the negro so largely seen in the New World, and so generally attributed to the race as such. As a sociological study this subject of the experience of the De Beers Company with African labor, on a grand scale and through many years, is worthy of most careful attention by anthropologists and philanthropists.

The moral and physical well-being of these natives are well guarded by the company in its great system of 'compounds'—walled enclosures, carefully constructed and steadily watched, where the laborers are kept in a sort of paternal confinement during their period of working. Every one engages freely for a time not less than three months, and is then at liberty to leave or renew—the great majority choosing the latter, and many remaining for years. Liquor is rigorously excluded, as ruinous to all steady or reliable service.

Good food is furnished at low rates and good wages paid. Strict sanitary arrangements are provided and maintained; and the whole of Sunday and the Saturday half-holiday, save for a little indispensable work, are granted regularly. It was found that with three shifts of men each working eight hours a day diamonds could be mined for less per head than with a twelve-hour day at the same rate of pay per day. No women may be employed in mine work, and no boys under twelve. These broad and humane provisions are an impressive object-lesson to employers and corporations not so far away.

The natural result is industry, contentment and monumental success. Much very interesting matter is given as to the ways and usages of the different tribesmen. On Sundays there is considerable missionary work done among them, and much visiting, games and music among themselves; all are cheerful and friendly, tribal enmities and feuds being excluded from the 'compound.' The native music is in itself a curious and fascinating subject, but one that can not be enlarged upon here. The De Beers compounds, however, surely present a most interesting field for study in many ways, alike in ethnology and sociology.

The succeeding chapter deals with 'The Mining Towns,' and is an account of the modern cities and suburban communities that have grown up around the diamond mines. Kimberley is described and illustrated, in its various stages, from the camp of tents and shanties of thirty-two years ago, through its next phase of brick and corrugated iron, to the up-to-date city of recent years, with its hospitals, churches, club-houses, library and school of mines, its gardens and water-works, and its refined houses surrounded with foliage and flowers. The tale is a wonderful one, though paralleled by much in our own western development, with the difference that in the case of Kimberley there is ever present as the leading factor the one great corporation, and its master-spirit, Mr. Rhodes.

Chapter XVI., on 'The Formation of the Diamond,' is the one possessing the highest interest in the book, from a scientific point of view. Both to the general reader and to those who have followed the very active discussion among geologists through some years past on this subject, Mr. Williams's full and clear summary of the facts and theories as to the whence and the how of this unique store of precious gems, will possess great interest. It may cause surprise, however, and disappointment to find that his closing word is practically that we do not know! He finds in the several theories advanced many points of striking suggestion and some of strong probability, but nothing yet that fully meets and explains the various facts encountered.

Some points are well established; others are eliminated; others still are awaiting further study. The 'necks' are in some sense volcanic chimneys, but their filling has taken place at no very high temperatures—more after the manner of mud-volcanoes than of true volcanoes; the 'blue-ground' is a breccia of fragments, and not a decomposed lava; the diamonds were not found in it, but carried up with it from below. In these conclusions Mr. Williams agrees more with the English scientists, Bonney and Crookes. On the other hand, he does not agree with Sir William Crookes in attributing to the diamonds an origin similar to the artificial diamonds of Moissan, formed from carbon in melted iron under enormous pressure and heat. Here Mr. Williams gives some facts of his own, opposed to Crookes' theory. The latter, arguing for a crystallization at great depths from molten iron, at very high temperature, had cited the explosion, or violent rupture, of African diamonds, said to occur not infrequently, as an evidence of the strain and pressure under which they had been formed. Mr. Williams states that this spontaneous breakage is exceedingly rare, and that in fact he had hardly ever met with it. He then describes some original experiments as to the presence of iron or its oxides as the coloring matter of the yellow and brown diamonds, which Crookes had cited as an evidence of their origin from fused iron far down in the earth's crust. 'These experiments were made upon a magnetic separating machine, the field magnets of which attracted any mineral which

contained iron in a metallic or oxidized state'; but no slightest response was shown under the most powerful action of the machine, and with diamonds of the most marked yellow and dark tints. If they contain iron at all, its amount must be infinitesimal.

That the 'blue-ground' is not a decomposed lava, and has not been greatly heated since the diamonds have been in it, is shown by experiments of Herr Luzi, at Leipsic (*Ber. d. Deutschen Chem. Gesell.,* 1892), which are here described, but which have not attracted the attention that they deserve. He fused some of the 'blue-ground' in a graphite crucible at 1770° R. (4014° F.) and then introduced a diamond crystal, and closed and reheated the crucible. The diamond, previously smooth and brilliant, was found to have been corroded and etched, *i. e.,* partially dissolved, by the fused silicate mixture, in which it had been originally embedded. Mr. Williams then asks, How is it possible that most of the crystals found are bright and polished, with no trace of such corrosion, if the blue-ground has ever been in any condition of fusion from heat, like a lava.

The latest reference of the diamonds to an origin in an eclogite rock at very great depths, suggested by Professor Bonney, in consequence of some having been found enclosed in boulders of that rock in the blue-ground of the Newland's mine, is duly considered, and some questions raised in regard to it by Professor Bonney himself are stated. Mr. Williams expresses no positive opinion as to this view, the facts observed at the Newland's mine not having come under his notice at De Beers or Kimberley; and, as before stated, his latest word is non-committal.

The next two chapters, on 'The Diamond Market' and 'Cutting and Polishing,' are abundantly interesting, but can not be enlarged upon in this sketch. Suffice it to say that they are full and accurate accounts, freely illustrated, of all the methods of assorting and valuing the diamond-product, together with notes on the other diamond regions of the world and on the sale and distribution of the stones in commerce; and in the eighteenth chapter, of the history and development of the art of cutting, and of the present methods and principal seats of the industry.

The closing chapter, 'An Uplifting Power,' is a remarkable presentation, from the Rhodes-De Beers standpoint, of the influence of the great diamond fields on the development, progress and civilization of the Dark Continent. The opening of mines; the building of cities; the laying out of railroads; the conversion of an arid wilderness into a populous and progressive land of civilized institutions; the repression of bloody tribal warfare; and the extension of British control and influence far toward the equator, and ultimately, in vision, 'from the Cape to Cairo'—all these have resulted largely from the Kimberley discoveries. They were the dream and the ambition of Mr. Rhodes, who bent all his truly wonderful energies toward their accomplishment, seeking wealth and power, as Mr. Williams emphatically contends, not as ends in themselves, but as means to the realization of a grand historical idea. The account is both impressive and inspiring, and evidently contains a large amount of truth. Of the other and darker side, nothing is said; the 'Jameson raid' is not mentioned and the recent war is but slightly alluded to, save in the account of the siege, in the appendix, and then only in its local incidents. It is but just to Mr. Williams, however, to recall that he is writing about the De Beers mines, and not about the history of South Africa in general, though the two are closely connected, as he himself has shown. His estimate of Mr. Rhodes is exceedingly high and his sympathy with him is profound, but he writes in a spirit of great breadth and fairness that impresses the reader very favorably.

The volume closes with an appendix, of which the first part is a history of the siege of Kimberley. This is a most vivid and even thrilling account of the four months' investment; the conversion of the mine-workers into a garrison, and of the tailing-heaps into redoubts; of the turning of all the machinery and resources of the great mining plant into one and another means of defense; of the ever-ready energy of Mr. Rhodes to meet new

emergencies as they arose, which were often beyond any means of military or official solution.

The remaining parts of the appendix give detailed statements about the winding engines, pumping plant and the relative value and efficiency of various coals, African and English; and the last section gives a tabular statement of the yield of the mines, year by year, since the consolidation in 1888. This is a most remarkable body of statistics, well worthy of careful examination.

The report volume would be much more valuable if a single good map of the region dealt with so extensively in all the historical chapters accompanied it. Two or three little maps of special localities, and one of the railroad systems, in part, are all that are given. The book has a good index, but is wholly lacking in a table of contents, either at the beginning of the volume or at the head of each chapter. This again is a great defect.

Mr. Williams has written a great book that reads like a romance; and the tale of Sinbad the Sailor and his valley of diamonds is as nothing compared with the story of the discovery of mines which up to the present have produced more than $500,000,000 worth of uncut diamonds—with little diminution of the output in sight to-day; of the building of cities and railroads in the wilderness; of mines equipped with machinery made in Chicago and London—machinery that is almost human in its accuracy. The literature quoted in the volume is an admirable exposition not only of the history of the mines, but of the entire South African region. From the finding of the diamond by the children of Samuel Jacobs, the handing of the crystals by van Niekerk to a traveling trader, John O'Reilly, and the identification of it by Lorenzo Boyes, to the working of a shaft to a depth of 1,400 feet, is a story without parallel. The wonderful finding of the diamond on the Vaal River on the Gong Gong, and discovery at Kimberley only a few years later, are described so vividly as to have an interest such as few works on travel afford us. Here we have also the story of the thousands of claims that seventeen years later were consolidated into a great corporation through the genius and organizing powers of Cecil J. Rhodes.

The discovery of diamonds in South Africa has done more to open up that country than all other industries together, for it was the encouragement from the sale of diamonds that precipitated the Matabele war which led to the discovery of gold in the Transvaal, in value many times exceeding that of the diamond fields of the region. The change from a multitude of individual claims, that gave the district the appearance of gigantic ruins, to the working by the shaft system was organized under Mr. Williams's administration. The employment of contract and native labor, the latter often obtained more than 1,000 miles from the mines, and the utilization of the most approved mining machines, replacing the old wheelbarrows and cradles of the earlier days, meant that the cost of mining diamonds was reduced to a fraction of what it was before, and that there was nothing to be feared from the lowering of the price by dealers who purchased stolen material. When we realize that South Africa has recently produced in one decade more than ten times the value of all the diamonds ever found in Brazil, and that this immense production dates from the discoveries begun in 1867, we may realize in a slight degree how great a change has taken place in the world's diamond production within the lifetime of a single generation.

GEORGE F. KUNZ.

Vergleichende chemische Physiologie der niederen Thiere. Von Dr. OTTO VON FÜRTH, Privatdocent und Assistent am physiologisch-chemischen Institut der Universität Strassburg. Jena, Gustav Fischer. 1903.

The progress which recent years have contributed in the study of the comparative morphology and physiology of animals has largely been emphasized along non-chemical lines. This is due not so much to an absence of chemical data which are of interest and importance in animal biology as to the difficulty which the student has experienced in collecting and correlating what has already been ascertained in this direction. There is no