lower exhaust chambers. The connection between the low pressure exhaust port and the exhaust pipe is through the ends of the valve, but this cannot be shown clearly in the engravings. The method of driving the valves is such that each valve can automatically take up wear like an ordinary slide valve. The high pressure valve wears upward and the low pressure downward. The function of the upper part of the low pressure valve is simply to isolate water, which may lodge in the valve cavity from the high pressure steam; its removal would not appreciably affect the steam consumption.

The ports communicating through the low pressure valve between the receiver and the low pressure cylinder are seen at a a, Fig. 4; the section (Fig. 2) being on the center line does not show them. The valves are worked by ordinary eccentrics, one of which is controlled by the shaft governor.

When triple expansion engines are made on this system the high and intermediate form one pair of tandem cylinders over one crank, and two low pressure cylinders are used over a second crank. Quadruple expansion engines are similar to a duplicate of the compound engine illustrated.

When working on full load, non-condensing, the steam consumption, taking the full load diagrams, averaged 19.8 lb., and with two-thirds load 20.1 lb. Unless, therefore, it is conceivable that this result may be lessened, it would appear that the method of jacketing the high pressure cylinder with low pressure steam is an economical one, and any loss that may accrue in the high pressure is more than compensated for by the gain on the low pressure cylinder. The figures we have given were obtained by some observers during a recent visit by a party interested in steam engine performance, arrangements being made by the Brush company for the purpose. The dimensions of the engine are: high pressure cylinder, 9.81; low pressure, 14.5; and stroke, 6 in.

The main bearings and method of setting them up are shown by Fig. 10, and the arrangement of the brasses in the end of the eccentric rods and spherical end to the valve rod arms are shown by Fig. 11. The main connecting rod is shown in Fig. 12. This rod answers well in practice. It consists of two main parts, an external frame taking the upward pull, and consisting of two rods fixed in the caps of the big and little ends, and a central strut taking the downward thrust of the low pressure piston. The central part is in two parts, connected by a large screw gripped by the split bosses with bolts and nuts to either part. With this arrangement, adjustment is so easy that it may be expected always to be done. The arrangement of the low pressure gland is shown in Fig. 13, and of the packing between the two cylinders in Fig. 14.

For obtaining an automatic graphic representation of the velocity of the crank shaft throughout a revolution, Mr. Raworth employs a very ingenious apparatus, which he has named the velograph, by means of which the exact cause and extent of irregularity in the turning of an engine can be ascertained in a few minutes, and usually a cure can be effected in the course of a few hours.

For our illustrations and the accompanying details we are indebted to the Engineer.

P. VILLARD describes, in the Comptes Rendus, a crystallized hydrate of argon with water. Argon is compressed to 150 atmospheres in the presence of water cooled to nearly zero. On chilling the tube at a small point, crystallization begins, proceeding out from the point cooled. Or crystallization may be induced by introducing a crystal of the hydrate previously formed. Crystallization does not take place, however, by merely compressing argon in the presence of cold water. The crystals are colorless and small, though easily visible with a lens. The tension of dissociation at 0° is about 105 atmospheres; at +8° C., 210 atmospheres.

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NOTES ON THE HYDROMETALLURGY OF GOLD AND SILVER.

By W. GEORGE WARING.

THE wet methods for extracting gold and silver have gradually attained an importance that is undeniable, though exaggerated by political writers, who, through ignorance of the real facts of mining and metallurgy, fear an excessive production of these metals. The actual advances of the present day do not consist in the discovery of new processes, promising to extract more than the assay value, or to cheapen the cost to less than the expense of crushing the ore; but they do consist of improvements in manipulation of the old and well founded methods so as to gain a certain economy, if it be only of the value of a few cents per ton of ore.

As the limit of economical extraction is thus gradually approximated, however, the field for further improvements grows wider, deeper research is required, more minute problems are to be attacked, and the success of establishments employing the highest business ability and technical skill encourages other works that have hitherto been satisfied with less economical results.

I have in mind a particular plant situated in one of the most prosperous silver mining regions in Mexico,* which plant has grown up from a small beginning ten years ago as a custom mill, until it is now reducing about 100 tons daily of ores, mostly purchased, and in competition with the large central smelting works at Monterey, El Paso and San Luis Potosi. The freight rates being merely nominal, this leaching establishment is profitably handling all ores offered, at a charge for treatment not exceeding \$8 gold per ton. Yet this same enterprise started with a mill that had been previously a complete failure, and in a camp filled with wrecks of other failures in the same line; among them several extensive leaching plants, with Stetefeldt and mechanical furnaces, besides a number of "patent process" establishments. Of that earlier era nothing survived except one or two large amalgamation patios, and a few small smelters, which lingered until a year or so ago.

A recent chemical investigation at these works, having for its object to determine the influence of minute traces of rare elements in the ores upon the roasting and leaching processes, served to emphasize the idea of my first paragraph, and at the same time to show how little is generally known about some facts in hydrometallurgy that ought to be better understood.

The so-called "going back" of the chlorination of chloridized ores is one of these facts. A proper understanding of the causes of this phenomenon throws much light upon many of the mysteries of leaching, and helps to explain many perplexing little irregularities that so often occur, as well as to remedy them most effectually. Some of the most valuable contributions to hydrometallurgy of recent years, such as the Russell process, and the use of hypochlorites and cyanides in gold extraction, would doubtless find more extended application were the chemistry of leaching roasted ores better understood.

Consider the complex conditions which accompany the preliminary preparation of a simple silver ore for leaching with "hypo." An ore containing only such common elements as silica, lime, iron or manganese, lead, zinc, sulphur and perhaps antimony, which has been roasted with say 10 per cent. of salt.

When charged into the leaching vats it may be quite warm or even hot. It may contain from 2 to 8 per cent. of undecomposed NaCl, along with other soluble chlorides such as CaCl₂, also MnCl₂, anhydrous ferric salts (rarely ferrous salts, though such may result during leaching by mutual decomposition); undecomposed ZnS, Sb₂S₃, etc., may be present in small amount, or in considerable quantity if the ore is liable to ball up or agglomerate in roasting so as to prevent thorough oxidation, CaO may also be present, as well as various sulphates, etc.

When water is admitted into a vat full of chloridized ore, the alkaline chlorides begin at once to dissolve, making a brine which increases in density and temperature as it passes through the ore, and at the same time increases in capacity to dissolve AgCl, PbSO₄, etc.

That AgCl in solution is readily decomposed by ZnS, Sb₂S₃ and many other sulphides is well known; and under the conditions stated some AgCl must inevitably be precipitated as Ag₂S, and so lost. Reducing agents, such as FeSO₄, Na₂SO₃, and others that reduce silver sulphate, fluoride, etc., are quite without action upon AgCl in briny solution—a fact that is not well known, but minor reactions can and do take place between some reducing agents and ferric and perhaps other metallic salts, and between the CaO and the reduced metallic salts that cause eventual reduction of AgCl. Thus ferrous or manganous hydrate may be produced, both of which decompose AgCl, the former very energetically, resulting in ferric hydrate and chloride, and metallic silver. Manganous hydrate, which is of very common occurrence in leaching, acts more slowly, an hour or even more of contact with a hot saturated saline solution of AgCl being required to completely precipitate all the silver as Ag.

These important reactions are very evidently not generally known, and I doubt if they have ever been mentioned in the literature of metallurgy, although frequent references have been made to the injurious effects of alkaline solutions in leaching. Of course, the last named reactions can take place only in neutral or alkaline solutions. They can be very easily demonstrated by heating strong solution of common salt containing AgCl with the hydroxides named. The action of mineral sulphides, even in coarse grains, can be similarly exhibited.

It is evident, therefore, that a silver ore may have been roasted with salt in such a way that 95 per cent. or more of the silver may have been converted into AgCl, and yet yield only 80 per cent., or even as low as 30 per cent. to treatment with hypo. The laboratory chlorination test therefore may fail to exhibit the actual degree of chlorination obtained. This may be demonstrated in particular instances by digesting the assay sample with a considerable amount of water (so as to avoid the production of a brine capable of dissolving traces of the AgCl) with a very little of some ferric salt, so as to neutralize the CaO, and filtering off the solution before treating with hypo. The aqueous solution

may be neutral, or it may be slightly acidulated, and hot, and contain a little free chlorine, as will be the case if the ferric salt has been prepared with copperas and calcium hypochlorite. The results will frequently, and especially upon calcareous ores, considerably exceed the highest extraction possible with hypo or cupreous hyposulphite, thus showing that some of the advantages attributed to the action of the latter salt may be due to reactions quite different from those claimed for it.

My attention was first called to the injurious reactions caused by the presence of alkali in wash water leaching in 1886, when it was discovered quite accidentally at Lake Valley, New Mexico, during a test of the Russell process, that a preliminary washing of the roasted ore with water containing copper sulphate gave better final results than did the use of cupreous hyposulphite in the hypo leaching, and I believe that such use of copper salts was incorporated in Mr. Russell's additional patent applications.

In the same year, at Silver City, with a similar ore. I observed that ferric salts yielded similar results. The ores carried considerable manganese and lime, and the increased extraction was due to simple neutralization of alkali, preventing the formation of manganous hydrate.

Ferric sulphate or chloride is more efficacious than cupric sulphate in such a case, because the latter salt often contains ferrous sulphate, giving rise to the very dangerous ferrous hydrate, the most deleterious substance that has been met with, to my knowledge, in silver leaching, next to some raw minerals unoxidized by roasting. Fortunately, however, the finely divided precipitated metallic silver can be rechloridized readily in the ore by a weak solution of clear hypochlorite of lime.

The sulphide of silver thrown down in the wash water leaching does not yield so readily. It is here that the Russell process offers a partial remedy. But it seems to be only partial. Is part of the sulphide converted into an insoluble allotropic modification, that it fails to dissolve completely, or is its composition changed into an insoluble sulpho salt? The most perfect remedy yet discovered for injurious sulphide reactions is to perfect the roasting, to which I shall refer further on.

The use of ferric salts in neutralizing wash water has the advantage of not introducing copper into the sulphides, and thus making them difficult to refine. Where the use of cupreous hyposulphite is necessary in the final leaching, I imagine that much of the difficulty arising from the presence of so much copper in the sulphide product might be obviated by a judicious employment of ferric chloride in connection with the cupreous salt. The solution is easily made from copperas by adding to it the requisite amount of sulphuric acid and then running in clear bleaching powder solution to slight excess. It can only be successfully applied by sprinkling on the cooling floor before the ore is charged into the vats. If applied upon the surface of the ore in the vats, the advancing portions of the fluid will have been deprived of the salt before it is sufficiently saline to take up much AgCl.

The procedure will vary, of course, with circumstances. In one instance in which this method had only about two months' trial in New Mexico, having been interrupted by the rapid fall in the price of silver, remarkable economical results were obtained by using the strongly saline wash water repeatedly, after precipitation and oxidation,* to wet down the roasted ore upon the cooling floor. The completely saturated portions were led into evaporating basins to recover the salts, which were considered to be more effective for chloridizing purposes than ordinary NaCl, on account of containing much Na₂SO₄ and ZnSO₄. The ores contained a notable amount of gold, all of which, with much the greater part of the silver, was recovered from the first wash water, the remaining silver being extracted with hypo.

The refining of wash water sulphides often presents difficulties on account of the presence of an excess of copper. This embarrassment has been overcome in various ways. One case in particular is interesting, not because of any particular trouble in refining, but because of the collateral object in view, which was to economize the hypo, expensive because of the remote locality, in the Sierra Madre de Sonora. The ore contained about 0.5 per cent. only of copper. I recommended the following plan:

The first outflow of wash water, containing all the soluble copper and all the silver dissolved by the brine, is conducted into a special tank, about half filling it. When the hypo solution first appears, the first dilute portions are also conducted into the same tank, also the dilute tail hypo from a finished leaching vat, that is, the portion that usually goes to waste after the main part of the stock solution in the tailings has been displaced by the final wash water.

The amount is regulated so as not to completely precipitate the copper. The silver and copper are thus thrown down from the wash water as insoluble hyposulphites, and the precipitate after draining is thrown upon the surface of an ore vat, in which the hypo leaching is nearly finished. Additional hypo dissolves the silver and copper, the former going through the ore to be precipitated with the regular sulphides, while the copper is reprecipitated upon the surface of the ore as sulphide by the action of the finely divided sulphides that usually coat the surface during the hypo leaching.

The results in this instance are that there is no waste of hypo, the sulphide product is extremely pure, never assaying less than 60 per cent. silver, and consequently refined without roasting, by simple fusion upon a lead base, with just enough litharge to oxidize the sulphur. The operation is extremely simple and easy. Incidentally also the tailings are remarkably clean, in fact it would seem that the essential reaction of the Russell process may occur, although procedure is quite different, and the object sought being quite the reverse of that actually obtained in the Russell procedure, namely, the production of pure sulphides free from copper.

With regard to roasting furnaces, I have already mentioned the necessity for perfect roasting, and to obtain this the furnace must be adapted to the ore. There is no ore that cannot be successfully roasted or chlorid-

* The Hidalgo Works, of Minas Nuevas, near Parral, Chib.

* In this case the copper was thrown down by scrap iron, and the solution oxidized by bleaching powder solution.

ized in one or another of the several types of furnace in use, that is, the gravity type, the revolving cylindrical type, the hand or mechanical reverberatories, or the muffle type.

But the solution of the important question of what type to use should in every case be made by a thoroughly experienced metallurgist, instead of being left, as is usually the case, to be settled by the simple advice of an advocate of some particular style of furnace. The arguments generally adduced to prove the advantages of certain mechanical conditions peculiar to any furnace cut no figure whatever in comparison with the importance of the chemical conditions required in the roasted ore. No one who does not understand the nature and importance of these conditions, and how they are produced, is competent to advise in so important a matter.

It would seem almost superfluous to write so insistently upon this subject, in view of the many standing monuments of folly to be seen in every large mining district in the shape of furnaces of almost every type that have failed to accomplish what they were built for. They speak volumes more than I could write. Readers of the Engineering and Mining Journal are familiar with instances that have been cited in its pages of vast losses and expenditures and experiments with the right kind of furnaces in the wrong places.

Ores balling up in revolving furnaces and inclosing undecomposed sulphide of zinc, etc., in fusible CaCl or CaF , leady ores matting in gravity furnaces, and in other types undesirable chemical combinations being produced like oxychloride of zinc, which sets or cements the roasted ore into solid rock the minute water touches it, are familiar examples, yet none of these or any other horrible disasters need occur if the proper method of roasting be adopted.

Muffle furnaces, of proper construction, using the regenerative principle, are admirably adapted to use in many cases where ores containing gold and silver along with copper or zinc, and perhaps other metals, are to be leached for the extraction of both gold and silver and one or more of the other metals after a single roasting. I only refer specially to the muffle type because it is so little known in this country and because an erroneous idea as to the fuel economy of this type has been current in metallurgical literature. The muffle furnace cannot take the place of the revolving cylinder for many purposes, and it lacks as yet one very desirable feature, a mechanical finishing hearth, or, at least, some system of mechanical rabbling, to make it very generally useful. But it is a mistaken notion that the regenerative muffle furnace is more expensive to fire than other furnaces. My experience has been quite the reverse. Such a furnace built at Silver City, New Mexico, with a hearth area of 16×40 ft., roasted from 12 to 25 tons daily in 1879 of ores and concentrates containing 10 to 30 per cent. sulphur, the hearth being almost uniformly at about 500°C ., while the escaping products of combustion rarely reached above the temperature of boiling water. The volatile products from the muffle hearth were condensed in coke towers, after passing through a long flue, and the acid liquors used to leach out copper, etc., from the roasted ore.

A matter of importance connected with roasting is the degree of resistance afforded by various sized quartzose particles to the disintegrating influences at work in the roasting process. This question has an important bearing upon volatilization, as the following test will show:

A silver ore in Northern Sonora—antimonial sulphide, free from copper, in quartz gangue—when reduced to the size usually called "16 mesh," and roasted with 10 per cent. of salt, showed no considerable loss by volatilization, the leaching extraction being 96.4 per cent., and 3.4 per cent. remaining in the tailings. When reduced to 30 mesh size, however, with the same treatment the volatilization loss was 11 per cent., the extraction being 86.3 per cent., with 2.7 per cent. left in the tailings. At 45 mesh the volatilization loss had increased to 42 per cent., the amount remaining in the tailings being constant at 2.7 per cent.

The limit of resistance to disintegration should be ascertained by experimental roasting and treatment with strong acids and other solvents, and then the furnace work should be brought up to the highest percentage that can be extracted by such tests, instead of allowing poor furnace work to set the limit of efficiency in gold and silver extraction, or to determine the crushing size of the ore.

Much is yet to be learned about roasting methods, through analyses of furnace fumes and gases, and the time has come when leaching and chlorination works should find out what is going out in smoke. The importance of such investigations was long ago recognized in the iron industry, and they are of relatively greater importance in the metallurgy of the precious metals, as Eggleston and others have suggested.—Engineering and Mining Journal.

OYSTER CULTURE IN RELATION TO DISEASE.

By T. E. THORPE, in Nature.

UNDER the above title the medical officer of the local government board has just issued a supplement to his report for 1894-95 dealing with reports and papers on the cultivation and storage of oysters and certain other edible mollusks in relation to the occurrence of disease in man. An inquiry on this subject was bound to be instituted sooner or later. There has been an uneasy feeling for many years past that the infection of enteric or typhoid fever is at times due to the consumption of uncooked oysters; and in his report on cholera in England, in 1893, Dr. Thorne Thorne expressed his conviction that the distribution of shell fish from Cleethorpes and Grimsby, as a center, had been concerned in the diffusion of scattered cases of cholera over a somewhat wide area of England, owing to the fact that oysters and other mollusks at these ports were so deposited and stored as to be almost necessarily bathed each tide with the effluent of sewers at that time receiving cholera discharges. In the early part of 1895 Sir William Broadbent also publicly announced his conviction that oysters were occasionally capable of transmitting the infection of typhoid fever, and the fact received startling confirmation from a report to the State Board of Health of Connecticut, U. S. A., by Prof. Conn, on an oyster epi-

demic of typhoid at Wesleyan University, Middletown, Conn., in which some twenty-six cases of that disease were indisputably traced to the consumption of raw oysters which had the opportunity of becoming specifically contaminated by sewage delivered at the time the discharges of typhoid patients. A similar outbreak of Saint-André de Sangoin, in the Mediterranean department of Hérault, was investigated by Dr. Chante-messe, and traced to oysters received from Certe, on the coast of the same department, where, according to a commission subsequently appointed, the oysters had been stored in waters highly contaminated with sewage.

Under these circumstances, the local government board determined to institute a searching inquiry into the conditions of oyster cultivation and storage along the coasts of England and Wales, and to cause bacteriological investigations to be made as to the power of the oyster to absorb, retain and transmit the typhoid bacillus and the cholera vibrio. The first part of the inquiry was intrusted to Dr. Timbrell Bulstrode and the second portion to Dr. Klein. Their reports, which are suitably illustrated with photographs and maps, constitute the material on which Dr. Thorne Thorne bases his introductory remarks. In the appendix are given a copy of Prof. Conn's report already alluded to, and an extract from the Proceedings of the Académie de Médecine, in Paris, relating to the spread of disease through the agency of oysters.

The value and extent of the oyster trade in this country may be gleaned from the following figures, furnished by Dr. Bulstrode. In 1894 there were landed on the English and Welsh coasts by English dredgers 27,747,000 oysters, valued at £84,271, the average price being per 100, 6s. 1d., and per 1,000, £3 0s. 10d. These were delivered on the several coasts as follows:

	Oysters.	Value.
East coast	16,833,000	£58,300
South coast	4,251,000	11,186
West coast	6,663,000	14,785
	27,747,000	£84,271

These figures relate only to oysters landed by English boats employed in the home industry; in addition enormous quantities are imported from abroad, partly for relaying and partly for more or less immediate consumption. American oysters, known as "Blue Points," "East Rivers" and "Sounds," are mainly received at Liverpool and Southampton, while the Dutch and Belgian oysters chiefly come to Grimsby and Brightlingsea. A considerable number also are received from Scotch and Irish beds.

It is generally assumed, at all events, by the more educated lovers of the bivalve, that oysters are "out of season" during such months as have not the letter "r" in their names, and, as a matter of fact, the "close time" for oysters born and bred in this country extends from May 14 to August 4, that is, during the spawning season. But that portion of the community which is referred to in the report as "the less fastidious class," and which is "addicted to the practice of seaside trips of brief duration," is addicted also to the practice of eating the oyster at any time of the year it can be got, and in the summer months, therefore, has to content itself with the imported varieties, the restriction as to "close time" not applying to oysters taken in the waters of a foreign state.

It would appear from the returns that the largest number of oysters is consumed in September; but, although the number eaten diminishes as the year draws to a close, their value steadily increases up to December, when it gradually diminishes month after month, until it reaches a minimum in June or July.

As the result of Dr. Bulstrode's inquiries and observations, it is distinctly disquieting to be told that only a few of the oyster layings, fattening beds, or storage ponds round the English and Welsh coasts can be regarded as theoretically free from every possible chance of sewage pollution. At the same time, in the case of the majority of them, the polluting matter is mixed with so vast a bulk of water that there is little substantial risk of deleterious influence. The possible mischief is due to the circumstance that the cultivation of the oyster is mainly carried on at points on the coast which are readily accessible, and where labor can be easily obtained, or, in other words, in tidal estuaries in the neighborhood of more or less populous places, into which, therefore, the sewage of such places is apt to be delivered. In the report, three such localities are singled out for special condemnation: viz., Southend, where, as regards one laying, "the sea bottom and the matters floating on the surface afford the most obvious proof that the conditions are filthy in the extreme;" at Cleethorpes, where the layings are exposed to the influence of sewer outfalls, serving (counting that of Grimsby) populations of about 67,000; and the Medina, in the Isle of Wight, of which it is stated that "it seems almost beyond comprehension how any one could venture to 'fatten' oysters for human consumption in a river estuary such as this, which is fouled above the layings by the crude sewage of Newport, with its 10,000 inhabitants, by the effluent from the neighboring prison and barracks, and by the overflow from the workhouse cesspool; and which receives into it immediately below the layings the contents of eight other sewer and drain outfalls from East Cowes and West Cowes." It is further pointed out that "the layings in the Penryn River, Cornwall, and those in Brightlingsea Creek, in Essex, also call for especial notice in connection with the obvious risk of sewage pollution. At Brightlingsea this risk has more than once been drawn attention to by the local health officer. The layings in the South Channel, off Southwick, near Shoreham, are similarly exposed to sewage; and in a minor degree, on account of the great bulk of water there in question, such layings as those in the Menai Straits come under suspicion. From most, if not all, of these layings, oysters are dispatched direct to market."

On the other hand, some of the most celebrated layings on the coast of Essex and Kent—as in the Crouch, Roach and Blackwater, and off the Swale—are practically free from risk, although the layings in the bed of the Colne which presumably furnish the supplies for the time-honored "Colchester feast," are subjected to the comparatively concentrated effluent of Colchester sewage at low water, and to the additional pollution to which the river is subjected at Wivenhoe and Row-hedge.

The conditions under which the oysters are stored in beds, ponds, or pits, pending dispatch to market, naturally received close attention. The layings or "fattening" places might be everything that could be desired, but the oysters, when lifted, might still be stored in a most objectionable manner. The boxes off Southend Pier, for example, float in what is practically dilute sewage. A set of storage pits at the mouth of the Blackwater was found to be within forty-three yards of the point at which the drainage of twenty houses is discharged. At Wivenhoe "it is impossible to see how the oysters there, stored in pits, can escape contamination by sewage." The means for the storage of oysters in the Fish Dock at Grimsby are stated to be particularly offensive and dangerous. "It would be difficult to find much worse conditions than those under which certain storage pits are placed at Poole." . . . "At Warsash, above the junction of the Hamble River with Southampton Water, a sewer was found opening out just between two oyster ponds. Again at Emsworth, near Havant, a sewer and certain drain outfalls have been conveyed into the middle of a group of oyster pits, and matters are little better at Bosham."

On the other hand, the methods of storage on the Crouch and Roach, and for the most part also of the Blackwater, leave little to be desired, and the same may be said of the layings and means of storage in the Helford River, in Cornwall, and at Newtown Estuary, in the Isle of Wight.

To judge, however, from the frequency of instances to the contrary, it would almost seem that the cultivators were under the belief that the oyster actually enjoys himself and waxes fat in insanitary surroundings. Precisely the opposite is the case. No one enjoys the confidence of the oyster to a greater extent than Prof. Herdman, or is better able to appreciate his innermost sentiments; and we gather from Prof. Herdman's recent work that the oyster—especially the British born and bred oyster—is, in reality, a cleanly, self-respecting mollusk, with an appetite not less dainty or fastidious than that of the epicure for whose gustatory pleasure he is supposed to live. Indeed, if oysters in general had only the locomotive powers of their brethren in the classical legend of the Walrus and the Carpenter, there is very little doubt that, in many cases, they would quickly move off in search of quarters more salubrious than those in which they are often compelled to exist.

It is not easy to indicate how the present condition of things may best be remedied. Oysters, of course, are not a necessity, unless to the hardly driven brain worker, to persons of feeble digestion, or to convalescents. Unless something is done, therefore, to reassure the public mind—either by the collective action of the oyster breeders themselves, or by systematic inspection on the part of the state—the future of the industry will be seriously jeopardized. As it is, the "scare" has done very great damage to the trade, and the good and the bad alike have indiscriminately suffered. To the statesman who is concerned with the welfare of a littoral population from which the personnel of our navy and coast defenses is largely recruited, the problem has even a wider and deeper significance. On every ground, therefore, the question calls for prompt remedial action.

At the conclusion of his report Dr. Bulstrode makes some reference to "green bearded" or "green finned" oysters. These oysters find but little favor in this country, although, as is well known, they are much appreciated in France, and the "huîtres vertes" or "huîtres de Marennes" obtain a far higher price in the Paris market than the "huîtres blanches." This green color, which is met with to a small extent in certain Essex oysters, has been the subject of repeated investigation during the last seventy years, notably by Gail-lon (1820), Valenciennes (1841), and Puséur and Decaisne (1877). The last named observers found that the green tint was due to the inclusion of a diatom, *Navicula ostrearia*, or, as it is now called, *N. fusiformis*, taken up from the "claires" in which the oysters are confined. These observations were confirmed and extended, in 1885, by Prof. Ray Lankester, who showed that a blue pigment, which he termed "marennin" occurs in the *Navicula*, and is either "uniformly diffused throughout the cell protoplasm," or "confined to the ends of the elongated cell body" (Bulstrode). In the oyster the green coloring matter is localized on the surface of the gills and labial palps in "certain peculiar cells of the superficial epithelium." It is the deposition of this blue pigment (marennin) in the yellowish brown gills which, according to Prof. Lankester, gives rise to the green appearance of the "huîtres de Marennes."

It has been often alleged that this greenness is due to copper, and as a matter of fact copper has frequently been detected in oysters since Bizio, in 1835, first discovered it in the organic substance of the mollusk. Dr. Bulstrode, from time to time, sent the writer of this notice oysters from different localities, and copper was uniformly found in them, although in the Marennes oysters it was present in minute amount only—far less, indeed, than in certain oysters of a normal color. But there is no question that the greenness of certain oysters, especially of those found in Falmouth and Truro waters, is due to copper. The color, both in character and distribution, is, however, quite different from that of the Marennes oyster. The green Cornish oyster is unsalable in this country—at least for immediate consumption—as it leaves a distinct metallic taste in the mouth, similar, it is said, to that due to "sucking a penny." Dr. Bulstrode caused a number of such oysters to be sent to me at different times. On incineration under conditions which precluded the possibility of the introduction of copper, there was no difficulty in detecting the presence of that metal in the ash. Indeed, here and there in the ash were particles of Alexandrine or Egyptian blue, which, as Davy found long ago, is a frit, made by heating together soda, lime, sand and copper. The amount of copper, on the average, was not more than about 0.02 grain per oyster, but as it is obviously caused by the mechanical retention of cupriferos particles, individual oysters might, and indeed did, contain large quantities. On examining the mud of the locality in which such green oysters occur, it was found to contain 0.148 per cent. of copper. On relaying, the green Cornish oyster gradually loses its color and also its metallic taste; specimens of such relaid oysters were found to contain only