

other contains not a trace. The ocean is an inexhaustible treasury of varied wealth, but its riches are stored in so attenuated a form that we are powerless to gather them without the aid of natural processes that go on continually. Marine plants include annually certain portions of this wealth, and offer it for our acceptance like dividends due; should we refuse, it is returned to the treasury, and as time advances offered us again and again.

Nevertheless, the old proverb "*vilior alga*" still holds good; our marine crop is despised and rarely harvested; in speaking of the vegetable growths of the sea the term "weed" is universal. A weed, according to the best definition ever given, is a plant whose virtues yet remain undiscovered. It is fitting, then, that the more prominent members of the numerous genera and species of these plants be studied, and their hidden virtues brought to light.

Assuming it to be not impossible—though by no means probable—that a marine plant may be found sufficiently complacent to have included and stored up gold in its tissues; that such a plant would be widely sought and cultivated there is little doubt. But products of more substantial value to us than gold, by processes that we cannot imitate, are being prepared and stored for us yearly by plants that we at present despise. They draw these products from a source unquestionably inexhaustible. This term is often loosely applied to sources that by no means deserve it; we observe the vast gold reefs of the Rand, and say here is an inexhaustible field for exploitation; we consider the extensive saline deposits of Germany, and repeat the remark; a generation ago we were saying the same of the nitre beds of Chile; that no terrestrial deposit of value can escape depletion the fate of the latter proves.

But with the saline contents of the ocean it is different. They are not only as now existent inexhaustible, but are being constantly augmented, for as long as rain falls on disintegrated rock and its surplus flows into the sea the mineral contents of the ocean will increase.

Every economist views with disfavor the extravagant—in fact criminal—wastefulness of cities great and small, through whose sewers the fertility of a million acres is poured yearly into the sea. The phosphoric and nitrogenous constituents of this waste seem hopelessly lost; but potassium, one of the most important, we can easily recover, for along our coasts are growing with the rapidity

and vigor of the bamboo countless millions of marine plants, each one of which may store up during its short life from one to two pounds of chloride and sulphate of potassium.

We are dependent for our food supply on the fertility of our soils; in order that they may remain productive the constituents that make them so—removed with each annual crop to distant localities—must be supplied from other sources. The chief of these are phosphates, combined nitrogen, and potassa. The first is supplied by animal waste, and by mineral deposits fairly abundant; the atmosphere is a vast reservoir of nitrogen and oxygen uncombined, which we are rapidly learning how to economically combine to produce the products we need; that we can economically win from a similarly inexhaustible source the third element we require, I have endeavored to make plain in the preceding pages.

This paper will be followed by a second on the chemistry of the more important littoral algae, many of which are of interest, and on some other results of the study of marine growths.

I take this opportunity to express my obligation to the courtesy of Prof. Setchell, of the University of California, and to Prof. Frye, of Washington, for valuable information on the nomenclature and habits of these plants.

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NITRATES IN BOILER-WATERS.

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The determination of nitrates in the analysis of waters to be used for boiler purposes does not appear to be customary, and, indeed, such determinations may be considered unnecessary in cases where potable waters containing only traces of nitrates are under consideration. However, it sometimes happens that manufacturers, in order to save the cost of city water, employ for this purpose ground waters from densely inhabited districts, and in such cases, where nitrates may be comparatively abundant, their determination is believed to be important.

For the last five years the writer has made it a practice to determine nitrates in boiler waters by means of the well-known colorimetric method used in sanitary examinations. Several ground waters have been analyzed which caused severe corrosion as well as a heavy scale in the boilers, and the conclusion was reached that the nitrates were largely

responsible for the corrosion, on account of their oxidizing action at the high temperature reached by the metal in the presence of heavy scale.

A particular instance of a water from a driven well in the city of New Haven may be mentioned. After this water had been used for a short time the boiler tubes were filled with small holes, and were coated with a very thick and hard irregular scale. The water gave the following analysis:

	Parts per million.
Sodium chloride.....	83.7
Sodium nitrate.....	26.8
Potassium nitrate.....	28.1
Magnesium nitrate.....	99.6
Calcium nitrate.....	83.0
Calcium sulphate.....	117.0
Calcium carbonate.....	25.0
Iron carbonate.....	9.5
Silica.....	20.0

The quantity of nitrates (182.9 parts per million of NO_3) in this water is very great and although nitrates are very soluble in water, they would not fail to be deposited in the hot scale wherever the water penetrated into it. In fact, small quantities of nitrates were found in the scale itself of this boiler, although they must have been destroyed by heat in the parts of the scale next to the metal.

Another well water from a different locality in New Haven was found to contain 39.85 parts per million of NO_3 , besides large amounts of carbonates and sulphates. This was not recommended for boiler purposes. Both of these well waters were characterized by being very free from organic matter and were neutral in reaction after the carbon dioxide had been boiled off.

No.	Parts per million.		
	Total solids.	Chlorine.	Nitrate NO_3 .
1.....	331.00	25.00	55.35
2.....	346.00	22.00	44.30
3.....	85.00	9.00	20.68
4.....	266.00	23.00	54.47
5.....	185.00	9.00	20.37
6.....	243.00	26.00	31.62
7.....	301.00	23.50	68.20
8.....	434.00	58.00	59.78
9.....	106.00	11.00	8.85
10.....	345.00	25.20	56.07
11.....	172.00	7.25	39.85
12.....	261.00	22.00	44.30
13.....	81.00	9.00	17.71
14.....	119.00	12.75	17.71
15.....	220.00	20.00	66.44
16.....	95.00	6.00	15.58
17.....	257.00	12.00	17.71
18.....	164.00	14.00	44.30
19.....	170.00	11.00	22.14
20.....	275.69	11.42	13.00

Further investigations are needed to reach a decision in regard to the amount of nitrates that may be permissible in a boiler water, and also in

respect to the protective effect of other constituents.

The table of analyses given above comprises twenty waters from Connecticut, and serves to show the abundance of nitrates in them.

As a comparison with the large quantities of nitrates shown in this table, it may be observed that the average amount of NO_3 in the water supplies of Connecticut cities is only about 1 to 3 parts of NO_3 per million.

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CRUDE PETROLEUM AS A REDUCING AGENT FOR ZINC ORES.

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The process generally in use for zinc reduction is exceedingly cumbersome, slow and far from satisfactory. Comparatively small quantities of the roasted ore are mixed with coke and coal and heated in clay retorts which must necessarily be of considerable thickness, the zinc distilling over. The time required is about twenty hours and the expense for heat large. In the best of coals there is quite an amount of matter which does not act as a reducing agent. Some of this is not only not helpful to the process but really injurious, as oxygen is furnished which hinders the reduction. These impurities also occupy space in the retort and consume heat the same as ore.

The high percentage of carbon and of hydrogen in crude oil and its resulting reducing power suggest it as a possible reducing agent. Its extreme cheapness makes it all the more desirable. An objection to its use arises at once in the fact that a temperature of at least 1200°C . is required to practically reduce zinc oxide to metallic zinc and before such a temperature could be reached in the usual furnace all the oil would be volatilized, leaving an insufficient amount of carbon to carry on the reduction. Evidently, then, if crude oil can be used economically for zinc ore reduction it must be in a continuous process by which the furnace can be heated to a sufficiently high temperature and the mixture of oxide and oil fed into it. It would seem that under such conditions reduction should take place before any quantity of the oil can escape. To test this assumption a series of experiments was carried out in this laboratory.

An ordinary gas pipe, $\frac{3}{4}$ inch in diameter, was connected at right angles with a cup from which