

way with thermocouples and a ballistic galvanometer. These experiments were performed on monkeys (*Macacus rhesus*) under sterile conditions; the animals were killed after one or two weeks and the changes in the cerebral cortex studied by the Nissl method.¹

The lesions are found to be strictly localized to the heated area. It shows as an encapsulated area, sharply marked off from the surrounding normal cortex by a wall of proliferated connective tissue and blood-vessels. The nerve cells within this area have all disappeared; those immediately outside this wall of connective tissue show a normal Nissl picture. Of great interest is the fact that the neuroglia inside the damaged area is not killed, but is found to have reacted to the heating by proliferation. Even a temperature of 130° C. applied for ten seconds does not kill the cortical neuroglia.

This method of laminar thermo-coagulation of the cerebral cortex, as it might be called, results, therefore, within a wide range of temperatures, in a sharply localized, selective destruction of the nervous elements. By selecting a suitable temperature and a suitable period of application of the heat it is possible to destroy, at one's discretion, the nervous elements, the nerve cells and their processes, in consecutive layers of the cortex.

Details can not be given in this preliminary paper; suffice it to point out that this method permits a new attack upon many important problems in the fields of physiology, anatomy and experimental pathology of the cerebral cortex.

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LITHIUM IN SEA WATER

COMPARATIVELY little is known concerning the distribution of the rarer alkali metals in nature in spite of the intrinsic interest of the subject. Beyond the fact that the order of occurrence is probably Na, K, Li, Rb, Cs, Va, no quantitative data are available to enable us to assign numerical ratios to this series. Even in the case of sea water, which has been extensively studied by so many investigators since the beginnings of chemistry, quantitative determinations of the alkalis, lithium, rubidium and caesium are practically non-existent, and virginium has only recently been discovered. Analyses by Schmidt,¹ frequently quoted in works on oceanography and geochemistry, give values as high as 0.04 per cent. of rubidium in sea salt, but examination of Schmidt's original paper shows that his results are based upon indirect analysis with a very high probable error. Grandeau,² who found rubidium in beet root, failed to detect the

¹ I am greatly indebted to Dr. Harry M. Zimmerman, of the department of pathology, for the preparation and help in interpretation of this histological material.

² Schmidt, *Bull. Acad. St. Petersburg*, 24: 231, 1878.

³ Grandeau, *Comp. Rend.*, 53: 1100, 1861.

element in sea water and also mentions Bunsen's failure to find it.

So far as the authors know there is no published account of even the detection of caesium in sea water. In some works on oceanography its identification is attributed to Sonstadt, but in every such case the writer has overlooked Sonstadt's³ admission that the spectrum lines he thought were due to caesium were actually given by strontium.

As far as is known, the authors report in this paper the first quantitative determination of lithium in sea water. In this procedure a liter sample is used. The calcium and magnesium are removed by precipitation with sodium carbonate. This precipitate is dissolved and reprecipitated in order to avoid the possibility of loss of some of the lithium with the carbonates.

The filtrates from the two precipitations are combined and evaporated, the magnesium carbonate which continues to precipitate as the solution evaporates being removed by filtration from time to time. When the volume is about 100 ml the solution is filtered and acidified with hydrochloric acid. The evaporation is then continued in the acid solution.

When sodium chloride begins to separate the solution is cooled, and an equal volume of ethyl alcohol is added, which precipitates much of the sodium chloride. This is filtered off, washed with a little 50 per cent. alcohol and evaporation of the filtrate continued. The sodium chloride is reserved for subsequent treatment.

When sodium chloride again begins to crystallize from the solution, the above procedure is repeated, and this is continued until the volume is about 10 ml. The precipitation may also be accomplished with hydrogen chloride gas.

At this point all the sodium chloride which has been removed is dissolved in water and reprecipitated by the same process of alternate evaporation and addition of alcohol until the volume of solution remaining is about 5 ml. This is added to the 10 ml of filtrate from the first procedure. Reprecipitation of the sodium chloride is necessary to avoid loss of some of the lithium with the sodium chloride.

An equal volume of alcohol is added to the combined filtrates and the solution is saturated with dry hydrogen chloride. The greater part of the remaining sodium chloride and sulfate and some potassium is removed by this operation, and the solution is evaporated to dryness.

It is now necessary to remove the remainder of the magnesium. The residue from evaporation is dissolved in 20 ml of 50 per cent alcohol, 2 ml of normal sodium carbonate solution is added, and the solution is boiled. The precipitate is filtered off, dissolved and reprecipitated to avoid any possible loss of lithium. The combined filtrates from the two pre-

³ Sonstadt, *Chem. News*, 22: 25, 1870; *ibid.*, 22: 44, 1870.

cipitations are acidified with hydrochloric acid and evaporated to dryness. The residue is dissolved in a minimum amount of water, alcohol is added until the volume is 10 ml and the solution saturated with dry hydrogen chloride, filtered and the sodium chloride washed with absolute alcohol. The filtrate and washings are evaporated to dryness.

The residue, weighing a few milligrams, consists largely of potassium chloride and sulfate, some sodium and magnesium chlorides, and contains the lithium.

Complete separation of the lithium and its direct determination is impracticable, but it may be estimated by use of the spectroscope with comparative ease. The authors use an atomizer (zerstäuber) especially designed to spray a solution into the air inlet of a blast lamp so that the spectrum may be observed continuously.

The solution rises by capillary action in the tube A (Fig. 1) which is open at the point B and sealed off

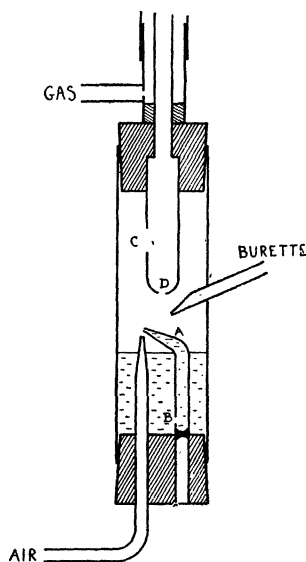


FIG. 1. Apparatus used in the quantitative spectrum analysis for lithium.

just below this point. The air blast produces a fine spray, and a small quantity of this is carried up through C into the burner. The opening at D permits any excess to drain back without interfering with the passage of the spray into the tube. The tube sealed into the side allows solutions to be added during the course of the analysis. The lower part of the apparatus is made of glass, but the burner proper is of brass.

The residue containing the lithium is moistened with a drop of hydrochloric acid, dissolved in two milliliters of water and washed into the reservoir of the atomizer with an additional two milliliters of

water. Then, while the spectrum is being observed, a 3 N solution of potassium chloride is added until the red potassium line at 7666 Å is of sensibly the same intensity as the red lithium line 6708 Å. This requires some skill and judgment, since the lines are of somewhat different color. With practise, however, results with known quantities of lithium can be duplicated with an accuracy comparable with other methods of quantitative spectrum analysis.

This method is also useful for estimating small quantities of strontium in the presence of much calcium, using the blue lines of the two elements.

The solution is removed quantitatively from the atomizer (the quantity which was used in the burner is negligible), evaporated, and the residue weighed as potassium chloride.

This entire procedure is duplicated with a synthetic sea water containing a known quantity of lithium and a ratio established between the lithium and potassium, which will give equal intensity to the two lines. This ratio will depend upon the apparatus and to some extent upon the experimenter. The authors found a value of 2:10,000. Since the quantity of potassium chloride actually weighed is relatively large, the results are unaffected by the small amounts of sodium and magnesium which may be present.

In this way the lithium in sea water of ordinary concentration (chlorinity = 19 ‰) has been determined to be 0.1 mg per liter.

The importance of lithium in the economy of the sea is not known. No quantitative estimations of the element in the various organisms have been made, although it has been reported qualitatively by many. Possible variations in the quantity of lithium present in sea water, due to marked growth of plankton, are also unknown. The accuracy of the method does not permit, nor does its tediousness encourage, the determination of such fluctuations.

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