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REPORT

ON

THE MANUFACTURE OF SALT

IN THE

MADRAS PRESIDENCY,

1872.

BY

J. J. L. RATTON, M.D.,

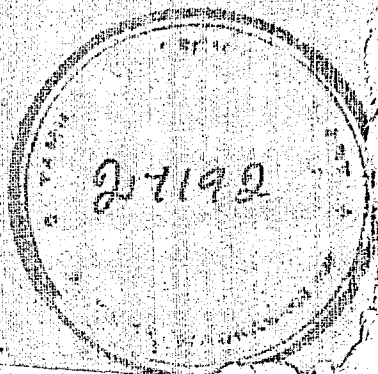
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MADRAS.

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REPORT ON SALT MANUFACTURE

From J. J. L. RATTON, Esq., M.D.,
Assistant Surgeon,
To H. E. STOKES, Esq.,
Ag. Sub-Secretary, Board of Revenue.

SIR,—I have the honor to inform you that, in accordance with instructions received in January last, I have visited the salt works in the following districts:—Ganjam, Vizagapatam, Godavery, Kistna, Nellore, and Chingleput; commencing with Ganjam in the North on February 7th, working down the coast and finishing with Cheyvor, June 28th, 1872.

2. As the terms of the investigation with which the Board of Revenue have been good enough to entrust me admit of some latitude of interpretation (*vide* Proceedings, No. 353, dated February 22nd, 1872, as follows:—"The object aimed at is simply to effect some improvement in the manufacture of salt * * * * * by careful scientific inquiry"), I have endeavoured in these pages to carry out the wishes of the Board, by careful inquiry into all the various details of the manufacture, with the object of improving it by cheapening it, by raising the standard of physical quality and of purity, and by diminishing loss, whether from natural wastage or from other causes.

3. In the first instance, no scientific information having been hitherto furnished to those in whose hands the manufacture practically rests, and upon whom the work of its reform will devolve, I purpose glancing briefly at the prime factors of salt culture and the natural laws which affect them; afterwards developing from these laws a method of manufacture in accordance with them, and finally comparing with it the existing works, whereby their shortcomings and the means at our disposal for remedying them will be better understood.

4. The following fragmentary extract from a minute by Mr. Robinson, Second Member of the Board (furnished to me with other papers), has, in a great measure, influenced me in this arrangement, which gives prominence, but not unduly, to the theory of salt manufacture.

5. He says:—"Salt too has to be produced under an infinite variety of circumstances of soil, climate, etc.; and a sound knowledge of the laws

which govern the whole, alone can enable a man to see the effect, and how to counteract it, of these varying conditions at different factories."

6. Sea or salt water has ordinarily a specific gravity of 1.025°, but the precise degree is not constant. It will serve our purpose best to know that it marks from 2.50° to 3° on Beaumé's Hydrometer; the reading varies with the season, and at different points of the coast—a few decimals, according as it is influenced to a greater or less extent by local causes, the mouths of rivers, etc.; but these figures represent the extremes of variation, and correspond respectively with December and June. We may take the mean 2.75°, and assume it to be the normal density for the sake of having a standard of comparison.

7. It is, as will be seen from the analysis appended, a complex solution containing, in addition to Chloride of Sodium or common salt, many other salts which have characteristics and actions peculiar to themselves, and which form together more than one-fifth of its contained solids.

8. Of these, Chloride of Magnesium, Sulphate of Magnesium, or Epsom Salts, and Sulphate of Calcium are, in the order of their enumeration, the chief impurities to which salt is liable.

9. These, though contained in relatively small quantities, are, as well as common salt, and in fact, by an extension of the same process, largely and profitably manufactured from sea-water on the Mediterranean Coast.

10. The precise composition of the sea as its density varies with locality and season. For the following analysis I am indebted to Dr. King, Professor of Chemistry at the Medical College:—

	Parts per 1,000.	Sp. Gr. 1025°.
Chloride of Sodium ...	26.053	26.053
Chloride of Magnesium ...	2.811	7.199
Sulphate of Magnesium ...	1.823	
Sulphate of Calcium ...	1.360	
Chloride of Potassium ...	1.205	
Water ...	966.74	
	1000.000	33.252

11. This analysis gives only the chief constituents; sea-water contains besides, a little Bromide of Magnesium, traces of Iodides, and some organic matter.

12. The water analysed was taken from the Bay of Bengal on the 15th March 1872, rather early in the year. The mean per-centage of common salt would be somewhat higher than that here found, and may be taken for the purposes of calculation at 27 per 1,000; that such is the case is clear from the increased specific gravity, which I found to be 1.02619 in July, and Major de Havilland estimated at 1.0268 mean annual sp. gr.

13. Beaumé's Hydrometer, to which reference has been made, requires some explanation. There is a variety of these hydrometers, graduated for solutions heavier and lighter than water. The instrument alluded to is specially adapted for such strong solutions as saturated brine and is in general use throughout the salt manufactories of Europe.

14. It is graduated from 0 zero to 40.

15. It sinks in distilled water till the zero marked on the stem is on a level with the surface of the liquid, rises in solutions marking a degree corresponding to their density, and would stand at 40° in a saturated solution of a very soluble salt.

16. Its graduation is conventional, not expressing the specific gravity of the fluid nor the amount of solids in solution, though these can be arrived at obliquely, taking its reading in connexion with other known facts.

17. A number of these hydrometers, which are indispensable, have been indented for from Europe, and will, no doubt, be supplied to the works. These remarks with what follows will, it is hoped, sufficiently explain their use.

18. Common salt or Chloride of Sodium, which, for the sake of brevity, may be sometimes denoted by its symbol NaCl, is said to be when pure a transparent crystalline solid; but these, though so far an index of absolute purity, are by no means its necessary characteristics; transparency when present, as at Nishapore in Persia, results from the slow evaporation of inland lakes, a process probably extending over many years and not comparable with any ordinary method of manufacture.

19. It is very soluble; 100 parts of water dissolve 37 parts of the salt, the exact amount is a little, but very little, affected by temperature.

20. Its solubility diminishes in the presence of MgCl₂; water containing 27.4 parts of the latter can only dissolve two parts of common salt.

21. It decrepitates and melts at red heat, and may be volatilized at a higher temperature.

22. It is relatively twice as heavy as water as denoted by its specific gravity 2.011.

23. Its taste is well known—saline peculiar.

24. It crystallizes when procured from its solutions by gentle evaporation in the regular or cubic system, but salt in the abstract has no definite shape; its appearance and other physical qualities will be considered in connexion with evaporation and the laws of crystallization.

25. Common salt, properly so called, is not seldom altered in physical properties by the presence of other salts as chloride of magnesium MgCl₂, which, it has been seen, is largely contained in sea-water.

26. Its presence in common salt is indicated from the first by an intensely bitter saline taste, ultimately, if suffered to remain, by the

deliquescence or moisture of ordinary table salt and the wastage of salt in store.

27. Pure Chloride of Sodium does not deliquesce; it is, however, slightly hygroscopic and moistens in a humid atmosphere.

28. Epsom Salts, Sulphate of Calcium, Sulphate of Sodium and sand are also common impurities in this country as will be seen hereafter.

29. Having ascertained the number and extent of salts existing in sea-water, some of which constitute prominent impurities in the manufacture of Chloride of Sodium, the next point is to consider how they may be severally separated from it, so as to admit of pure salt being obtained, and this depends practically on their behaviour in solutions, their solubility, or the degree at which they form saturated solutions.

30. Any number of soluble salts which do not mutually decompose each other may exist coincidently in a given bulk of water if there be a sufficiency of water to dissolve them all; but, as we diminish the quantity of water, the salts will separate the less soluble first, and the others according to their degree, until a point is reached (complete saturation,) when many or all are thrown down together.

31. This point in salt water and the stages of concentration leading to it are under our control.

32. Of the salts contained in sea-water CaSO_4 Sulphate of Calcium, called also Sulphate of Lime Gypsum or Plaster of Paris, when dehydrated is the least soluble; it requires 400 times its bulk of water to dissolve it; water containing 22.1 to 23.3 per cent. of NaCl and MgCl_2 respectively cannot retain any of it in solution; it is hence thrown down first, and resigns as it were in favor of the other salts which are more soluble.

33. It is found that the point at which CaSO_4 begins to separate corresponds to 17° Beaumé, equal to specific gravity 1.148, and that, when the specific gravity reaches 1.210 or 25° B., the water holds but a trace of it in solution.

34. It falls in the form of a fine white crystalline powder of the 5th system insignificant in amount from a commercial point of view, and, to all intents and purposes, therapeutically inert.

35. Here it is important to note that sea-water, the ordinary density of which is 2.75° B., loses five-sixths of its volume in passing on to 17° B., and nine-tenths of its bulk if the evaporation is continued to 25° B., the point at which CaSO_4 ceases to be soluble and NaCl approaches saturation.

36. Chloride of Sodium is the next salt to separate, bearing in mind its original amount 2.70 p. ct., and that the water containing it has been diminished by evaporation to one-tenth of its former bulk; it will now occupy 27 per cent. of the remaining brine; as it requires only twice and a half its

own bulk of water; so that, to dissolve it, it would still remain in, were it not that the other more soluble salts render the brine a saturated solution as far as it is concerned.

37. It begins to separate then between 25° and 26° Beaumé and is deposited almost pure, more and more as the evaporation continues until the water reaches a specific gravity denoted by 28.50° Beaumé, when 20.807 parts of the 27 contained will have separated.

38. The evaporation may be continued to 32° Beaumé, at which point Sulphate of Magnesium or Epsom Salts begins to separate and we can no longer get NaCl pure.

39. In this way we can obtain 25 parts of the whole 27 contained, or 92 per cent.; the remaining eight per cent. must be sacrificed to purity, as we cannot obtain more without the magnesium sulphate which now descending mixes with the salt.

40. This salt though nearly pure, so much so that on the continent it goes into the market without any further preparation, still contains some traces of MgCl_2 , which, as a fertile source of wastage, must be removed by after treatment.

41. From 32° to 35° Beaumé, that is, from 1.286 to 1.321 degrees of specific gravity, NaCl and MgSO_4 are deposited in almost equal proportions, and the MgSO_4 , carrying with it seven equivalents of water of crystallization, rapidly diminishes the remaining brine.

42. The brine or bitters, as it is sometimes called, left in after 35° Beaumé is a saturated solution of such soluble salts as MgCl_2 , the Iodides, and Bromides of the Alkalies when present, with scarcely a trace of NaCl, these all separate if the evaporation be continued; the iodides, etc., the most soluble, remaining till the last.

43. The manufacture of common salt ceasing when the brine marks 32° Beaumé, the concentrated refuse brine from which it has separated is called at that point its mother liquor or mother; the Germans call it "Bitterns."

44. It will be seen from the foregoing description of the separation of salts from sea-water, that where the process is continued to dryness, as is the case in natural salt lakes, salt swamps, etc., the salts deposited will form layers corresponding to their degree of solubility, the less underneath, the more soluble at the surface, because they are deposited last, and it is evident that the amount of these salts will be proportionate to the depth and volume of the water, sometimes there is a considerable bulk of surface salt made up of MgSO_4 , MgCl_2 , KCl, in cold climates $\text{Na}_2\text{SO}_4 + 10\text{H}_2\text{O}$ or Glauber's Salts, and the Iodides and Bromides on top of all.

45. The therapeutical effects of these salts forming about one-fifth of the thickness of the whole deposit, to use the analysis already given, which would not be in excess of the amount procurable from an inland

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sea, but rather the reverse, may here be mentioned. $MgSO_4$ and Na_2SO_4 + respectively seven and ten equivalents of water are called Epsom's, and Glauber's Salts, and are well known purgatives; the Chlorides, Bromides, and Iodides act chiefly on the skin, producing often, more especially in people of peculiar idiosyncrasies, a very irritable kind of rash accompanied by some fever.

46. It is well known to salt officials, and mentioned also by Lieutenant Burke, who first brought the salt plains of Scinde to public notice, that the people living in the vicinity of these beds of spontaneous salt have a great repugnance to their use, and complain that swamp salt gives them diarrhoea, and the itch as they call it.

47. Strange as this has hitherto appeared, it seems now, read in the light of these facts, intelligible enough, for there is no doubt they helped themselves from the surface of the salt deposit, and so probably missed the Chloride of Sodium altogether.

48. We can get a practically unlimited amount of pure salt from the sea, extracting its water by the process of solar evaporation—a very powerful one in this country—and collecting the deposit between 25° and 32° Beaumé, it follows, the more rapidly we can do this the more salt we shall obtain in the season, but here another element steps in, the commercial one.

49. In England, where salt manufacture is regulated by the thermometer, as well as by the hydrometer, where huge furnaces evaporate by slow or rapid boiling, enormous caldrons of brine, the public taste and necessity are catered for in the production of salts differing in grain and general appearance, and known as stoved or lump, common, large-grained, flaky, and fishery salt.

50. In our natural salt works the first two varieties which require brine raised to the boiling point are not attainable, but the latter or larger are ordinary forms produced.

51. The physical properties of salt, its size, shape, weight, etc., vary with the method of its production, obeying the laws of crystallization procured by boiling however it is apparently amorphous or without shape, as there is no time for crystal formation.

52. To put it briefly crystals formed from their solutions by evaporation are large or small according as the evaporation is slow or rapid, well or ill formed according as they are maintained at rest or agitated during their formation.

53. Their size can consequently, under ordinary conditions of rest, be modified at pleasure, by regulating the rapidity of evaporation.

54. I have found by actual experiment that a period of seven days elapsing, from the point of saturation till 32° Beaumé is reached and the process terminates, affords ample time for the formation of good crystals.

55. The process of crystallization can be always so regulated as to occupy seven days, the changing temperature and season notwithstanding, by regulating the extent of surface of a given bulk of water exposed to the sun, the work to the power.

56. As the surface contracts or expands the depth increases or diminishes, knowing the correlation that exists; it saves time to speak of one movement only as the depth.

57. A perfect crystal is white or translucent, hard, not easily broken, heavy, and of regular cubic shape.

58. The cubes of salt have a tendency to arrange themselves in pyramids or funnels, and as each cube is built up of a number of others smaller than itself, sharing the same tendency, one or more sides are usually irregular.

59. Regnault explains this as follows:—Evaporation takes place at the surface, and consequently crystal formation. The minute crystals when first formed are retained at the surface by capillary attraction, other crystals deposit on their upper free edges, and on these again others in the same way, and so on, forming a hollow pyramid reversed, the apex pointing down, until such weight is attained that capillary attraction and inertia are overcome, and the crystal falls to the bottom.

60. I think also that as salt crystals vary in weight with the amount of water they contain of crystallization, and of decrepitation also, enclosed between their lamellæ, and seldom approach the specific gravity of pure $NaCl$ 2.011°, or about twice that of distilled water, were it not that they are assisted to sink by the penetration of the apex of the pyramid, which gives greater effect to the slight difference of specific weight, the minute cubes of salt would remain at the surface of the dense brine (specific gravity 1.210° to 1.321°) like a sheet of rough ice; such a pellicle, as is seen every day at the salt works, preventing evaporation, practically sealing the waters underneath, and interfering with the necessary interchange of moisture between the surface waters and the air.

61. Only the smallest crystals are perfect cubes, the most regular of those which turn their geometrically-squared upper faces towards us from the salt-beds exhibit a tendency to point underneath, more or less marked to one side or the other according as it has been faced up or down in the settling of the crystal.

62. It is sought at present at all the divisions examined by me to obtain large symmetrical cubes of salt. Within the Presidency, and to the northward of Ganjam, on the score of profit, the merchants like them, and have got to look upon the size of the crystal as an indication of the purity of the salt, because large crystals carried about in carts, boats, etc., are said to suffer less from wastage; but especially because merchants

buying by weight from Government, and selling by measure to the consumers, finding large salt by much the most profitable, seek it out, and buy it in quantities proportionate to the magnitude of the crystal.

63. Before passing on to the external agencies, such as the atmosphere, which affect chiefly crystallization, it would be well to consider the policy of urging on the manufacturers the production of large geometrical cubes of salt.

64. The chief argument in its favor, as mentioned, is that those who buy by weight, and who, from their near neighbourhood to the pans, or by the facilities of traffic, railways, etc., can sell by measure in their own market the same salt physically unchanged, reap a double profit from its size, charging an increased price of course, but giving a less quantity also; for if a certain measure equals a given weight of solid salt, the same will hold a less weight of it powdered, and less again if it be in fragments, not that its specific weight can differ, but that its packing does; the absolute profit equals 42 per cent., as will be shown hereafter.

65. In illustration. Iskapilly, April 18th. Weighed a maund of medium sized salt; it just filled the cup and measured 26 pads; heaped it, broke up the crystals, and re-weighed it in the cup scale. Weight the same, but it measures only 20 pads, and the cup is but three-quarters full; the small salt shows a gain of six pads in one maund to the consumers, or 23 per cent.

66. Again, Nowpada, February 25th. Weighed and heaped a garco of new moist salt; 20 days scraped; large crystals; the heap measured 140 cubic feet.

67. Weighed and heaped a garco of old dry salt, three years in store; small crystals; the heap measured 125.5 cubic feet, showing 15.5 cubic feet in favor of the large salt, which, *ceteris paribus*, would, from its moisture, weigh heavier and measure less.

68. Of the purchasers of these two heaps the one who takes the large salt will sell 15.5 cubic feet over and above the other, but the retailers who buy from him will get less salt in their measure.

69. The argument is summed up in saying that the merchant benefits and the people suffer in proportion to the magnitude of the crystal.

70. It is evident that as Government buys by weight and sells by weight it is unaffected, but that the smaller the salt the closer it packs, and the more the people get for their measure.

71. As the object of this inquiry, its ultimate object at least, is to promote the interest of the public in the matter of salt, the close relation existing between size and quantity cannot well be lost sight of; it rests on the universal custom of selling salt by measure which is bought from Government by weight.

72. There is no relation between its size, symmetry, etc., and purity; it

exists as pure in the fine white powder of our dinner tables as in the large transparent blocks of Nishapore, through two inches thickness of which one can read.

73. The whiteness in the one instance is due to the reflected light from an innumerable host of minute and broken crystals, the transparency in the other to the perfection of crystallization; they mark the extremes of what it is possible to obtain, the one rapidly, the other by a slow and guarded process, difficult to carry out.

74. The manufacture of large salt involves extra time, labour, and expense; the manufacturer loses by it; the consumer gains nothing; he has the slight trouble of breaking it up before use; the revenue appears to be untouched by it. But it already threatens to be a question whether it will not be necessary for the revenue to assist the manufacturer in its production, by increasing the Kudivaram or contract price.

75. The ryots have struggled for some time to produce large, well crystallized salt; their traditional system of manufacture, than which they know none other, is quite opposed to it, the surrounding circumstances are unfavorable, and yet large salt has of late been demanded from them with some severity.

76. I have seen many maunds of excellent salt destroyed simply because it did not come up to an arbitrary standard of size, which differs at most places.

77. Statistics show that in the six divisions examined 120,000 maunds of salt are annually destroyed, systematically cast into the reservoirs, or trampled into the mud, and the ryot who labours hard in its production, and can ill afford it, bears the whole loss.

78. I would advocate the manufacture of salt without such marked reference to the size of the crystal, if the Board would be content with a pure, clean salt of moderate size; they can have it by an altered system, at diminished cost, and secure its uniform production.

79. At any rate the ryots left to their own devices produce a salt equivalent to the large grained or fishery salt at home, which, in a less degree, would still give a fair profit to buyers by weight and sellers by measure. See Nowpada's worst salt, No. 3.

80. The demand for salt exists in India as elsewhere independent of the size or shape of the article. Merchants are controlled by this demand. Those of the Central Provinces, etc., who take their supply from the Northern Divisions, would benefit by the change.

81. It is commonly attributed to Lambadies and Brinjaries that they prefer large crystals; but this is seldom the case; they are pretty unanimous in demanding a small, hard, dirty crystal; they buy at present the smallest and the dirtiest salt manufactured, to which they generally add sand till their bags are well and compactly filled.

82. In this way they calculate that at their journey's end their bags

of salt, which are slung on bullocks' backs, and frequently changed, will still be full, and they probably are so; but this end can be attained with greater advantage to the community by providing them at starting with a fine description of salt, which will pack their bags full, and keep them full throughout the journey without the intervention of sand and dirt, which, put in originally no doubt to prevent wasted space in the bag from broken crystals settling down, have now come to be looked upon as a legitimate item of profit to the trader, and, I am told, also of so-called goodness by their customers.

83. The finer the description of salt the better suited it is to sack carriage, but it is in rough transport, as from the stores to boats, shipping, carts, etc., and from these again to railway waggons, or *vice versa*, where the salt is unconfined, that loss is sustained from its fine mobile particles sifting out through every crevice.

84. To meet this difficulty the Cheshire brick has been manufactured; the salt when scraped is placed at once in a wooden box or mould and subjected to pressure from above; holes drilled in the bottom give exit to the brine, the moulded salt is then turned out upon the bank, and dries in the sun to a firm compact brick which bears carriage and ordinary rough usage well.

85. The whole process is manual, simple, and cheap, and has the double advantage of rapidly drying the salt and giving it shape and consistency, which enable one to store it conveniently and keep it or transport it without loss.

86. For the successful manufacture of these bricks two things are necessary, fine salt and concentrated brine at about 32° Beaumé, elements seldom found at the existing salt works, but easily created.

87. Accompanying this report is a brick of salt from the Pulidivak pans, together with the apparatus used in its production. The ordinary salt taken from the pans was broken up in a mortar before being moulded.

88. I had hoped at Pulidivak to cultivate a salt, specially with a view to brick-making, but was obliged to push on to the southern pans owing to signs of the season's work ending.

89. There is more to be said on the question of the kinds of salt it is advisable to manufacture than can well be said within these limits.

90. In preparing this report, I have proceeded on the hypothesis that a medium-sized crystal, smaller than that of Ganjam and larger than that of Madras, fulfils every requisite, and I have been led to this conclusion from a personal examination of the system of transport by sea and land, and from conversing with the largest dealers in the inland and export trade of salt.

91. Accompanying the report are specimens of salt of all sizes taken

from different districts, which illustrate the terms large and small. Its production is influenced by a variety of causes which must be examined as far as possible separately; such are—

92. The state of the atmosphere as to temperature, moisture and wind, and, since these are more or less the expression of latitude and season, the latter need hardly be separately discussed.

93. The distance of the works from the sea, or the amount and character of the water-supply, their levels, general construction and relative areas, and

94. The method of conducting the process. In considering these subjects, it is well to keep the following axioms in view:—

95. The quality of crystal depends on the conditions of evaporation as to time and rest.

96. The purity of the salt on its reception between 25° and 32° Beaumé, and its colour on the floor of the salt bed, or the method of collecting it.

97. Evaporation or the slow production of vapour at the surface of a volatile liquid is the result of heat, any increase of which accelerates the formation of vapour by increasing its elastic force, presuming always that the pressure remains constant.

98. This increase of temperature may be looked upon as taking place steadily throughout the manufacturing season, though by uncertain increments, owing to atmospheric changes.

99. From experiments made in each district on the line of march, I found that the rate of evaporation increased uniformly from February till June, an inch of brine evaporating in five days in February, in one day in June when the land wind was blowing not otherwise, and I have taken the rate in April three days to the inch as the mean, and based my calculations at that rate.

100. Major de Havilland and Mr. Angelo estimated the mean rate at one-third of an inch per diem also, and others again estimate it at half an inch, but all experiments carried out in the salt works are liable to an error, loss from leakage, which can not, unless very manifest, be detected without the aid of the hydrometer.

101. When sea water is diminished in bulk without a corresponding rise in density, it is quite certain that the loss is not all due to evaporation.

102. I found some leakage in nearly every bed examined, for which error I allowed; but then also the earlier experiments were made in the north, those later in the centre of the presidency, a difference of eight degrees of latitude separating the first and the last; still three days to the inch, the mean of my observations carefully made and less than the mean of some observers, I am certain, is not an exaggerated estimate if it be below the mark, then also my calculations will be surpassed.

103. If a uniform crystal is desired, depending upon a given rule of time, this accelerated formation must be met, and this can be done as stated by increasing the depth of brine from which salt is formed, which amounts to retarding the evaporation.

104. A single day would scarcely affect salt crystals, but when, on the other hand as often happens, many days together are cloudy, and the wind is from the sea, a moist state of the atmosphere is indicated, and evaporation is retarded, for besides, its rapidity varies as the surrounding air is more or less charged with moisture; if it were already saturated with moisture, no evaporation could take place from the pans, and the degree of moisture as indicated by the hygrometer, other things being the same, is an index, and a practically useful one, of the amount of retardation, and consequently of the extent to which it will be necessary to diminish the depth and increase the area to maintain a uniform rate of evaporation.

105. Other things that retard are clouds, by obstructing and absorbing the direct rays of the sun, and the absence of wind; calm still days are unfavourable to evaporation, because the stratum of air surrounding the pans gets saturated with moisture, which is but slowly removed and the evaporation is *pro tanto* retarded.

106. Of the winds so great are the distances which separate the pans, so different their topographical relations, that it is impossible to speak very specifically; certain it is that sea breezes being moist moderately retard the process, and that hot and dry land winds accelerate it, and do so in proportion to their violence, removing the moist air from the pans, and substituting a hot rarified stratum, which assists the formation of vapour.

107. Winds have, in addition, a mechanical action which is altogether adverse to salt-making, besides carrying dust into the pans, which they often do to a very damaging extent; they agitate the brine, preventing crystal formation in so far, that the crystals are irregularly formed and contain water of decrepitation.

108. Impurities in the reservoirs are retained in suspension, and those already deposited are often rippled up, giving the brine a coffee colored tinge.

109. In the salt-beds, the minute crystals which gather at the surface previous to their subsidence, are swept into a corner and there form flakes, which deposit without further growth; such salt, forming one-third or one-fourth of the entire crop, is invariably condemned.

110. The means, such as they are, of guarding against wind and rain will be considered under the head of construction.

111. None of the foregoing meteorological agencies can as a rule be disassociated from one another in a consideration of their value, as factors in salt formation; temperature, moisture and wind combine variously

from day to day, giving rise to changes of weather and season; at present one can only theorize as to their effects, but a truly practical salt manufacture should include amongst its essential requisites, at least a thermometer and a hygrometer, and there can be little doubt that a well kept meteorological chart in connexion with the salt works, would in a short time lead to the establishment of rules and modifications very profitable to the manufacturer.

112. The works require a constant unlimited supply of pure brine, and, at a uniform degree of concentration, the sea alone fulfils these requisites.

113. Backwaters, though in general use, have many and grave disadvantages, draining as a rule large tracts of land, dissolving out the soluble salts from the loose clayey soil through which they pass, and holding abundant impurities, organic and inorganic, in suspension, as is manifest from their very turbid opaque condition. They are, notwithstanding, less condensed than the bulk of water behind them; in the earlier months of the season especially, they are often little better than half the density of sea water, and liable at times to become less dense from the occurrence of rains, freshes, etc.; not uncommonly, they are altogether obliterated or they degenerate to little better than fresh water pools as at Kupili and Vadasemijari, from the formation of bars at their junction with the sea.

114. Estimating the loss in salt manufacture at 3 per cent. of the whole contained, the available salt in sea water will be about 2.5 per cent. of its weight, and small as this per-centage is, it is considerably in excess of that procurable from the general run of backwaters.

115. Major de Havilland, in a portion of water he experimented with, found that salt was contained to the extent of 2.75 per cent.; estimating the whole of which as procurable, he goes on to point the moral that with such a small per-centage the water used should be of the strongest.

116. It is easy to endorse his statement that this is of the utmost importance, the more so as it appears to have been very generally lost sight of.

117. Brine pits or wells exhibit the opposite extreme; a scant interrupted supply of tolerably strong brine.

118. Owing, I think, to the pressure of the sea on its loose shores, a considerable volume of water is forced to percolate inland, filtering through soil more or less rich in the deposit of NaCl ; it increases in density with the distance traversed, but falls away from the surface in like proportion, obeying in this respect the law of projectiles, and moving in the curve of a parabola as the force of gravity dominates the *vis a tergo*.

119. It follows that the depth at which brine is struck, its quantity

and density, the conditions of soil being the same, will vary with the surface level, and the distance from the sea, the further inland, the denser, the scantier, and the deeper down, and in practice this is found to be the case, though the density, depending on the character of the soil, does not follow the rule very closely.

120. The soil drainage which accumulates in the skirts of the shore after the rains, is here left out of the question, for by the time pits come into use, it will have been assimilated to, and follow the same laws of pressure as the waters of the sea.

121. From a scientific point of view pits are even more objectionable than backwaters; they have but one advantage, increased density of brine, but as the density is directly as the depth and interval, and inversely as the quantity, this is of necessity counterbalanced by overwhelming disadvantages.

122. A pit yields so many cubic feet of opaque brine, concentrated from 5° to 15° Beaumé, the amount differs so much with the size, depth, distance from the sea, and period of the season, that it is impossible to be exact; as a rule they are said to be capable of filling two salt beds, or about one-twentieth of the area under salt cultivation which they are trusted to supply.

123. The interval then alluded to is the time the pits take to re-fill to their previous level; it is never less than 24 hours, generally much longer.

124. The benefit, if it can be so termed under the circumstances, of increased density, has associated with it, and proportionately to the density, the disadvantages of scant supply, found at a great depth, and renewed only after a considerable interval.

125. These differences are intensified in the hot weather; as the season advances, the brine gets scantier, and more condensed, and the ryot must dig deeper from day to day to keep pace with the evaporation from the surface, and capillary attraction or absorption by the surrounding parched soil, which combine to dissipate the amount of brine pressed from the sea.

126. Deficiency of water-supply is a fertile source of irregularities at the pans.

127. Of the divisions examined by me, two only, Mangenapudi and Tummalapenta, are supplied exclusively by pits; they are, as will be seen hereafter, within a few yards of the sea and at a lower level; hence they are sufficiently supplied.

128. The importance of the level in choosing the site of a salt-pan does not appear to have been hitherto appreciated; low levels have been avoided, perhaps owing to their liability to inundation.

129. At the points of the coast at which it would be profitable to establish salt-pans, the sea itself has silted up a barrier of sand some hundred yards in diameter, and piled it to a height of several feet

above the limit of spring tides. The lands within this barrier, though below sea level are absolutely protected from danger in that quarter and are as little pressed by the rains as the higher grounds at present used; the water is absorbed, drained off, evaporated before the manufacturing season begins.

130. To a higher level than that of high water mark there are many objections, the cost of labour, and of mechanical appliances in raising water to the pans, the chief item in the expense of manufacture, and wastage from soil drainage, the natural percolation towards the cuttings felt more or less throughout the works, but markedly so in the reservoirs, which, flanking the supply canals, have not their floors prepared in any way.

131. To this cause also is attributable the scarcity of brine felt at many places, as at Soorla and Nowpada, to the extent that high levels require deep cuttings to attract their water-supply, which are again rapidly filled up by the soil drainage they receive.

132. The works supplied by brine pits suffer more than others for their elevation, and are to some extent starved for want of brine.

133. How these defects react upon the manufacture will be explained in connection with its details. It is not too much to say here, that the site of the salt pans with reference to their level, and water-supply is the key to their productiveness and the cost of the product.

134. A level, perhaps a foot below the point reached by the sea at ordinary flood tide, would appear to answer best.

It affords facilities for obtaining a constant abundant supply of pure sea water, and for irrigating the works, at a very great reduction of labour and expense; to these advantages I will recur.

135. It also impresses favourably the character of the soil. Any place above high-water mark in the vicinity of the sea, the surface of the plain is covered with loose unadhesive sand, which is shaped into salt beds with difficulty, and can seldom be rendered impervious, but which is readily blown about by every wind, spoiling the purity and color of the salt, as at Kurasa, Padarti, and other places, which, as will be seen on reference to their levels approximately made out, are much above the sea.

136. At the level advocated the soil is firm, adapted to the formation of salt works, and the sub-soil being moist and more or less saturated with brine, tends greatly to diminish, probably altogether prevents wastage by percolation from the beds.

137. A valid objection to low levels that I have not seen elsewhere stated, is their liability to loss from the upward pressure of the tidal wave.

138. Surfaces which are below the sea level, and at the same time near enough to feel its pressure, are liable to be covered by a stratum of brine, rising and falling synchronously with the tide.

139. This I conceive where the disproportion of level is not great, as at Iskapilly, must arise from the effused brine, meeting with impermeable strata which stop its downward course, and enable it to seek its own level.

140. At Iskapilly the salt pans, which had not been prepared or worked for three years, presented the spectacle of a series of shallow pools ebbing and flowing with the sea, but they were not many of them a dozen yards from the backwater which supplied them, a large creek some two hundred yards in width, too deep to ford, maintaining a free connexion with the sea, at its broad mouth, a quarter of a mile away, and in fact exerting the same tidal influence on its shores as the sea itself.

141. What the effect of this would be on salt production is easily foretold; brine submitted to evaporation in beds of this description would never concentrate, however carefully their floors were made; the water which at Iskapilly marked 3° Beaumé, percolating upwards, would mix directly with the concentrated brine, of which the more concentrated or heavier stratum is at the bottom, and there having robbed it of its strength, would sink again with the receding wave, weakening it from day to day, and preventing it from ever passing on to saturation.

142. Within the last ten years, salt has been manufactured three times at Iskapilly, and with success; this will be explained in the detailed report of that division.

143. This exceptional instance, due to special causes, does not in the least affect the general advisability of choosing the level advocated, which is not open to this danger, and moreover in proof that the opposition to low levels rests on a theoretical, and hardly correct basis, it may be stated, that on the shores of the Mediterranean, the salt gardens which supply the greater part of France with common salt, sulphate of sodium, and chloride of potassium, are laid out at a foot below the level of the adjoining tideless sea.

144. In planning or laying out the salt pans, as will be seen from the sketches attached to the Divisional Reports, it is possible to have an immense variety of detail; the parts of the work should however correspond to the stages of the process in position, area, level and, as far as possible, in number.

145. The stages of the process are two; the first in which water is collected, exposed to evaporation, purified of suspended matters, and of sulphate of lime; it terminates when the brine marks 25° Beaumé, at which point as already stated NaCl begins to deposit.

146. The second stage or that of crystallization takes the brine from 25° to 32° B.

147. This scheme leaves the other salts, such as CaSO_4 , and MgSO_4 , out of the question altogether, but if we wish to get them, we can

do so, and then manufacture will add a third and fourth stage to the process.

148. For the first stage as large an evaporating surface as possible is required; there is no question of storage here; in fact the title Reservoir is a misnomer; the sections of the work are divisible naturally into evaporating and crystallizing, and, for the sake of economy and simplicity also, the fewer the parts the better.

149. There is a prevalent notion that the office of the evaporating pan or reservoir as it is called, is to hold as much water as is wanted for the use of the season; this had better be questioned *in limine*, for it is

neither sound in theory, nor capable of being carried out in practice, it has its origin in the wish to provide a constant supply of strong brine; its results are seen in the use of brine varying from 5° to 15° B. The density of the sea has been shown to be 2.75° B., that necessary for the salt beds 25° B.; a reservoir capable of holding anything like water enough for the use of the season would take months in raising its contents to 25° B., and would never do so as at present managed, where its capacity is made to depend upon its depth.

150. Moreover this arrangement is open to the following objections: that the prolonged system of manufacture involved, places the salt crop at the mercy of the elements; that it is necessary either to raise the reservoir above the ground level, as at the experimental beds of Tumulapenta, or sink the other parts proportionately below it, and that a large number of beds is required to relieve the reservoir when the point of saturation is reached.

151. One must distinguish carefully here between the reservoirs, which are part and parcel of each set of pans, the use of which is now considered, and the large collecting tank of the Mediterranean the analogue of our banded backwater, the use of which is to hold and help to concentrate the water required for the works; the latter has its advantages and something of the kind had been probably aimed at, but was miscarried in fixing on the reservoirs.

152. In practice it is true, as things now stand, that it is impossible in Ganjam and Vizagapatam to get enough water; the sites are so chosen, and the cuttings are so small, that the ryots can only obtain it at the bi-monthly high tides and with difficulty store sufficient to last them in the interval.

153. There are three ways in which this may be remedied: by excavating a sufficiently large collecting tank and filling it from the sea, as is done at the Mediterranean salt gardens, that the water may condense a little, and so lessen the work of the after stages; by increasing the depth and capacity of the supply canals, so that water may gravitate naturally towards the works instead of draining away

with the receding tide as at present; or by availing ourselves of natural excavations, water courses, &c., at hand and adapting them to our purpose.

154. The latter promises best where natural hollows exist, or slopes can be converted into tanks by running an embankment or bund along their lower margin, or backwaters can be adapted without interfering with traffic, but of this more hereafter in connection with the localities themselves.

155. The first reservoir or evaporating pan should supply clean brine, at 23° B. to the second set, as often as possible throughout the season; here superficial area is everything, for the time occupied in evaporating a given bulk of water is directly as the depth, and inversely as the area; hence area is rapidity, and the depth should be only such that nine-tenths of it being lost, sufficient brine will remain for the second stage, bearing in mind the size of the salt bed, the depth necessary for the formation of large crystals, and the amount of mother liquor, which must be left in to retain in solution salts which separate after 32° B.

156. For the second or crystallizing stage a certain number of salt beds is required, varying with the size of the reservoir; they should be at least one-twentieth less in area, that the brine diminished to one-tenth of its original bulk may here stand at twice its original depth, for here slowness of evaporation rather than rapidity is courted.

157. The absolute areas of these two essential parts of a salt work will of course vary with the surface available for construction, or the size of individual holdings, but one reservoir and as few salt beds as can be worked efficiently, of at least the relative proportions indicated, is all that is required in theory.

158. The floors throughout should be made with care as nearly impermeable as possible; in earthworks there is generally some loss, but the amount varies greatly with the level and character of the soil.

159. Old pans are found to produce the most salt, for they have gained in staunchness by repeated dressing; some of them have been prepared annually for more than one hundred years; new pans on the other hand, from recent and careless formation, and sometimes from the action of annelides and arthropods, the marine order of the class Annulosa, prominently a worm called in Hindustani Ramdulla, which tunnels into and under new pans, lose a constant proportion of the brine which passes through them.

160. The loss is often very great from either or both of these causes, making salt manufacture a very hard struggle.

161. Spots, where these Annulosa exist, must be avoided. Species of them abound along the coast, burrowing in the sand at the meeting of the dry and swamp lands.

162. It is said that pans, which are worked on in spite of them for three years, destroy or drive them away, but most men abandon the works directly they appear, believing manufacture under the circumstances much too costly an enterprise.

163. In one or two of the Banore Divisions they have had recourse to an ingenious way of getting over this difficulty. When the orifice of an arthropod or other intruder appears in the floor of the salt bed, they build round it, at a few inches distance, a separate bund, so as to make for him a distinct bed within, but not communicating with the rest of the salt bed in which he purposes establishing himself; this precaution is not practically of much use.

164. To obtain an impermeable floor, the natural soil, alluvial, with a preponderance of sand, should be well mixed with tenacious black clay, found from three to four feet beneath the surface at most pans, and with the cast fibres of the palmyra tree, which can be had plentifully; in fact, picked up about the works, as at present they are of no value.

165. These fibres are strong, tough, and durable, about a foot in length, and naturally interlaced; they bind the soil together, preventing cracks, and rendering the floor firm and compact; they are as well adapted to the purpose I think as hair which is used for the same end in Europe.

166. From the experience of two salt beds prepared in this way at Palidwak, it seems probable that the addition of these fibres will lessen the labor afterwards required in stamping.

167. The fibres pulled out should be well mixed with the soil, and clay; in the dry state, wetted, trodden to the proper consistency by coolies, sprinkled with sand and beaten with the "Dimnice," or rolled with a heavy roller.

168. In this way an excellent floor can be made for the reservoir, but the salt beds require a smooth, hard, clean, impermeable floor; otherwise the purest and best of crystals will be soiled and damaged in the act of scraping.

169. The character of the soil, more than anything else, is supposed to affect the quality of the salt. At some divisions the crops are bad, at others dirty, at others ill-formed, and everywhere the soil is at fault.

170. It is so only in a restricted sense, because it has not been properly handled. Where there is leakage, the crops will be poor both in quality and quantity.

171. At Ganjam two adjoining beds of precisely the same area, and worked for the same period, produced in July 1872, 5,065 and 3,933 maunds of salt respectively, showing a difference of 1,132 maunds produced in one season.

172. This also was attributed to the soil, but there can be no question that it arose from the difference of care in preparing it.

173. In the same way the color of the salt, which ranges through tints from white to deep brown or red, though dependent in a sense on the soil, arises directly from the negligence of the scrapers.

174. Although without doubt it is possible by careful preparation to equalize the manufacture throughout and, by simple arrangements which will be described, to obtain salt perfectly white, it may be still a question whether it would not be in the end cheaper, and better to construct permanent beds of a suitable material; those made as at present are annually obliterated or nearly so by the rains; they require to be re-made at the beginning of each year at some outlay and the loss of about six weeks of the dry or manufacturing season, and to be re-made after every third or fourth scraping, as in the interval the brine acts on the mud floor, softening it and rendering it quite unfit as a recipient for salt crystals.

175. There is also some loss from leakage, as I had an opportunity of verifying with the hydrometer at Pulidiwak, and this loss is, I believe, inseparable from earth works.

176. It is not supposed that the ryot can afford, or that Government will be willing to construct beds of permanent materials, such as Val de Travers and the numerous other bituminous rock cements or concrete, the familiar chunam or boards which have been long in use at the New York salt works, Lake Onondaga, which is said to produce some of the finest salt in the world, even but as an experiment.

177. Few such openings for commercial enterprise exist as a contract for salt at Rupees 12 the garce unlimited in amount, such as the ryots of the five divisions from Vellur to Kattur enjoy, salt which I hope to show can under present circumstances be produced for less than Rupee 1 the garce, and with mechanical improvements probably for even half that.

178. The salt beds should be placed to leeward of the reservoir, and at a lower level sunk in the soil to the depth at which it is intended to maintain the brine during crystallization; this need never be more than six inches.

179. The object of putting them on the leeward side is to facilitate the transmission of brine; only one-tenth of the original quantity remains in the reservoir, now valuable saturated brine, which does not flow very readily over its rough unequal bed, unless assisted by the wind.

180. This point is of some practical importance; it is too the only compensation at present afforded by the wind, whose mechanical action is in all else injurious to crystallization. It should, however, I think by some modification of the wind-mill be made to elevate water to the works.

181. Nothing has hitherto been done with a view to protect the crystallizing beds from the wind; they are the vital point; if they be

protected all is well, if not it matters little what protection is afforded to the works generally.

182. Hitherto, as these beds have been coextensive almost with the area under salt cultivation (see diagrams), it has been impossible to attempt anything of the kind.

183. Now that they may be diminished in area and number, and made to occupy a definite position, some thing may be done.

184. The points to be guarded against are east and south. The west or land wind is much too valuable an agent to be excluded from the works. Under its influence evaporation goes on at the rate of half an inch a day.

185. The beds might be separated a little from the reservoir, maintaining their connexion by means of a channel, and protected to windward by a natural or artificial screen.

186. A mound or other obstruction might be erected, or such plants as the Thedarah Madha, Mangrove, Cacti, Palms, &c., with the botanical names of all of which I am not acquainted, but which I have seen in the neighbourhood of most pans, might be trained to form an efficient screen.

187. The obstruction, whatever it may be, must be low-sized and removed to a little distance, otherwise a good deal of sunshine will be intercepted.

188. Additional protection will be obtained by making the beds oblong in shape, something like a channel, and set at right-angles to the prevailing wind south-east, the bank to the windward side well raised and cut with an upward slope or facet along its outer border, that the wind striking it may be thrown up and pass over the bed below.

189. To avoid the dust, the surrounding land should be inundated occasionally with half an inch of water. This is done by the ryots, at some divisions especially in the north, but it is not generally attended to.

190. It ought to be insisted on at the time the salt heaps or cumuli are drying, for they are then exposed to the air, covered with viscons brine, which attaches every particle of dust that comes in contact with it; and, as the salt is taken from this stage and heaped or stored for use, no further purification is possible.

191. It is scarcely worth while making provision against rain at the works, as its occurrence during the manufacturing season is a very exceptional thing.

192. In the reservoirs rain can at most spoil a few days' work, restoring an inch or two of water recondensed, which will have to be again evaporated; but in the salt beds it is injurious enough, rendering nugatory the work of a longer period, and altering the conditions as to crystallization.

193. This too is an exaggerated picture of its ordinary effects, and it

is obvious that in the event of such cyclones as that of May last, no protection would be of any use.

194. At the New York salt works before mentioned, the beds are provided with a movable covering which rests on rollers, can be pushed on, or drawn off with great ease, and the arrangement is productive of economy, but then the climate of the United States is much moister than ours.

195. At present the slight showers which fall during the season are much liked by the manufacturers, who find their salt in consequence larger and better formed.

196. This arises from their system, and this system is common to all the divisions examined by me, though obscured here and there by differences of detail.

197. In connection with the method of conducting the process which I am about to describe, it will be well to consider the system at present in use.

198. At first sight it would appear that the chief point aimed at by the ryot is to get at the salt itself anyhow, to enter into possession with as little delay as possible, without any regard to the quality of the article, and there is no doubt that this is partly the case, but the ryot is, though not blameless, not so much in fault perhaps as the machinery with which he has to work.

199. The plan of construction of the works conveys the expression of a principle with which the system, however otherwise controlled, invariably tends to harmonize. With this plan the ryot has very little to do. It is drawn out in accordance with the immemorial traditions of the locality, and has the sanction of the authorities.

200. It consists in every place, either of reservoirs and beds in equal proportions, or, and far more often, of beds occupying a much larger area than the reservoirs.

201. The reservoirs are made deep to hold water and the crystallizing beds are made shallow to evaporate it.

202. This construction implies a system, the reverse of that which has been shown to flow from the natural laws which affect the subject. In the first stage, or that of preparation, water is maintained at a depth which prevents concentration from six to twenty-four inches. In the second stage a little weak brine is rapidly evaporated.

203. The following are the essential details of practice.

204. The ryot obtains water for the service of his salt or crystallizing bed from the last reservoir if there be more than one; the mean strength of it is in any case about 10° Beaumé. There are general instructions to admit only strong brine to the salt beds, but these lose much

of their value for want of a definition or standard, or some instrument to indicate the state of his brine and check his progress.

205. Certain dodges, so to speak, are known at different pans, whereby a relative idea of the strength of the brine can be arrived at. Tested with the hydrometer, they gave the following results:—

Brine. Froths well and continues frothy for some time, poured out at 12° Beaumé.

„ A moist thread floats on it at 14° Beaumé.

„ Forms grit on the finger, moistened and exposed at 15° Beaumé.

„ Boiled rice floats at 16° Beaumé.

206. These tests are merely noticed, inasmuch as it is of interest to know what guides have hitherto been at the disposal of the ryot, and supplied the place to him of scientific instruments, but it would be a mistake to imagine that they are in constant use at the works; on the contrary their existence has been elicited by patient inquiry and they are never by any chance used in practice.

207. In practice one thing only guides the ryot, a vacant bed; there are on the average fifty to each set, and none of them are suffered to lie idle.

208. The salt bed is filled to a depth of from a half inch to three inches according to season, and single or plural irrigation methods; the latter is a modification of the former, and will be fully described with Mangenapudi, the division in which I first noticed it.

209. The salt bed is converted for the time into a reservoir of the first or preparatory stage, the brine goes on condensing until it reaches saturation, when the proper office of the bed begins. Brine evaporated from 10° to 25° Beaumé will be reduced quite three-fourths in bulk; of the two inches originally admitted there will now remain but half an inch.

210. This amounts to the same thing as exposing half an inch of properly condensed brine from the first; it rapidly evaporates, and salt is forced out too quickly to form proper crystals.

211. The crystallizing stage proper occupies about three days, at the end of which time the salt deposit is covered with only a thin film of mother liquor.

212. The ryot must now scrape; as the rule of scraping moist, that is under water, is everywhere well enforced, its object is to cleanse the salt from adherent mud in its passage from the bed.

213. The amount of mother or brine left in, however, scarcely suffices for the purpose; it marks from 26° to 27° Beaumé.

214. At 27° Beaumé, not quite one-half of the M. Uiglin's table C. A. salt procurable has been separated from the brine.

215. The crop realized amounts to about half a maund per bed of 360 square feet, the result of at least a fortnight's work.

216. This slender crop, a great grievance of the manufacturers, is the result of several inches of weak brine in the condensers, one or two inches of the same distributed over a multitude of salt beds.

217. The later crops are larger, but they are so at the expense of purity.

218. To this mother at 27° B. fresh brine is added and evaporated as before, the crop is scraped, it is larger than the first, the bitters left in are also denser, and they mark about 30° Beaumé.

219. The following is an analysis of the brine of common sea water at 30° Beaumé prepared by M. Usiglio from the Mediterranean per 1,000.

MgSO ₄	...	...	...	...	78.76	} 213.40
MgCl ₂	...	...	...	...	101.60	
KCl	...	...	...	...	18.32	
NaBr	...	...	...	...	14.72	
NaCl	...	...	...	...	212.80	212.80

220. Comparing the analyses of sea water from the Mediterranean, and Bay of Bengal we find the latter much stronger in magnesium salts, though less strong in NaCl, so that the proportion of 213.40 chiefly magnesium salts to 212.80 common salt, does not represent the preponderance of the former here.

221. I regret that through breakages sustained in the cyclone of May last, I am unable to verify this analysis; it is without doubt correct.

222. But this ryot's brine which now marks 30° Beaumé is the mother of the second crop; it has received two increments of magnesium salts, which are, therefore, doubled, and NaCl on the other hand has been twice removed, scarcely a trace remains.

223. Brine containing 27 pr. ct. of MgCl₂ can hold in solution only 2 pr. ct. of NaCl, the solubility of which is further diminished by the presence of KCl; we may conclude that all or nearly all has been forced out with the second crop, leaving only the magnesium and other salts.

224. Again to this second mother two inches of brine are added from the reservoirs as before; this on admission increases in density and proportionately to the amount of mother left in; the rise averages about 5° Beaumé, brine let on at 10° marks at once 15° Beaumé.

225. The condensation is due evidently to the presence of magnesium salts.

226. This brine differs a good deal from ordinary sea water, with the exception of CaSO₄, which has been gathered with the salt; it holds three times the usual amount of residual salts with but a small increase of NaCl.

227. Its behaviour too is altered, whereas pure salt separates from its own solutions at 57° F., when the density reaches 26.995°, and from

sea water at about 25.5, it separates earlier at 24.5 from this third irrigation, and can be had pure for a less interval.

228. Sulphate of Magnesium forms a saturated solution, and begins to crystallize out from 27° to 28° Beaumé; the other salts in like manner being trebled in quantity, separate earlier from the brine.

229. As the evaporation is pushed in all cases until the scant brine warns the ryot to scrape salt before it is too late to do so moist, the third crop is generally adulterated with a good sprinkling of magnesium crystals.

230. Leakage, however, sometimes interferes and removes the brine so rapidly that the ryot scrapes at 26° Beaumé, in which case he avoids the residual salts, but also loses much of his NaCl.

231. The bitters or mother left, is from the third batch, as from the following ones, is a concentrated solution of residual salts, or salts foreign to the manufacture, which will be obtained in increasing quantities at every succeeding crop.

232. How long this accumulation continues it is difficult to determine exactly, but I have reason to believe that the manufacture is one of mixed salts from this point to the end of the season.

233. Owing probably to Major de Havilland's report in 1822, in which the ryots are told to clear away the slime after each scraping, there is a general rule in the north requiring the removal of the bitters every third time, but

234. There is not sufficient supervision in this matter; its importance is not understood; in the north the ryot retains the mother a fourth or a fifth time, and curiously then proceeds to get rid of it either by throwing it into the last reservoir or side channel as in Vizagapatam, whence it is immediately re-admitted to the bed, or by evaporating it to dryness and stamping it into the floor of the bed, whence it is re-dissolved by the first admission of brine.

235. In the south this matter is not attended to at all; the same routine is followed until the manufacturer is brought up sharp by the production of genuine crystals of MgSO₄ in large amounts.

236. Epsom salts, manufactured as described, occurs in large four or six sided colorless prisms about half an inch long and two or three lines in diameter, known in the north as moulaka or growing salt, in the south as "wooshee oupoo."

237. It appears in the beds about the end of April, the fourth or fifth scraping, often coincidently with the arrival of the hot land winds, which are said consequently to produce it by "over boiling the brine."

238. Its appearance is the signal for scraping away the slime and re-making the beds.

The manufacture is arrested for several days, strong brine is looked

upon with the greatest apprehension and thenceforth sea water admitted to the crystallizing pans without any preparation whatever.

239. Where pits are used, the brine is diluted in equal parts, or more with backwater before admission to the pans, and at this time especially rain is looked upon as a blessing.

240. The appearance of $MgSO_4$ in the beds is so far useful that it leads to the removal of the mother saturated with foreign salts, and, for a time, to the chances of its reproduction; but its ill-effects remain in the altered system adopted in its regard, for the brine now exposed averages about 5° Beaume in density, which when raised to saturation has lost so much in bulk that the salt formation is by this cause, in conjunction with the increased heat of the season, urged on more rapidly than ever, and the salt crystals are both smaller and less regular than in the early part of the season.

241. But the complete and manifest production of sulphate of magnesium is preceded for some time both in the beds in which it is produced largely and in those in which it is insignificant in amount, or altogether overlooked by a considerable sprinkling of the fine needles or acicular crystals of the pharmacopœia, which escape detection and pass into commerce together with the salt.

242. These were first noticed by me early in March, and I met with very few crops after that date (until the cyclone cleared the beds) in which they were not present to a greater or less extent.

243. It is difficult to avoid the conclusion, looking to this method of production, that all the salts contained in sea water are procured as common salt, and though from the manner of its use this may be of little consequence to the consumer, when we come to consider the production of large quantities of salt, say four thousand maunds, a proportion of nearly one-fourth or 865.9 maunds of mixed magnesium and other salts may be justly deemed an excessive proportion of impurity; moreover the successive crops are in this respect unequal and it must happen that a very impure article, unfit for use, is sometimes made.

244. I think, however, that the normally porous or leaky condition of the beds supplies, to some extent, a condition of safety not to be found in the arrangements proper of the system, and that the magnesium salts are not gathered to anything like the extent that might be expected.

245. This opinion receives confirmation from a statement of the Deputy Collector, Salt Department, Kistna, who says "that moulaka salt appears only in beds sunk lowest in the swamp lands," where, as I have endeavored to show, there is the least tendency to leakage, and from that of the Salt Superintendent, Voyalur, who says it appears only in the Voyalur old pans, which are the staunchest and the most productive in his division.

246. If it be not the case that a great part of it is removed by leakage, it is not easy to see how else it is removed; for I find on inquiry that the aggregate quantity of it destroyed in the six divisions examined, amounts to less than 500 maunds in the season, and in some districts it is altogether ignored.

247. So far for the system, as typified in the planning of the works and carried out in practice.

248. In the construction of the works also, mechanical defects appear which react unfavorably on the manufacture.

249. The pans are constructed for the most part on a flat surface, swamp after the rains dried, and well baked later in the season. This is divided out into reservoirs and beds, according to the pattern of the locality, by throwing up embankments. The natural inclinations of the ground, where any exist, are taken advantage of, but there is little if any excavation further than that necessary for making the bunds.

250. As the entire set of pans is at nearly a uniform level, it is impossible to get two or three inches of brine into the distant salt beds; unless there be a pressure of water in the reservoirs, such that when the beds are filled, and equilibrium results, i.e., when the surface of the unbroken mass of liquid is in one horizontal straight line, there shall be as many inches in the reservoir as are required to be sustained in the salt beds. Hence, allowing for the loss of bulk due to evaporation, the loss in filling a number of salt pans, whose united area is greater than that of the reservoir, the loss from leakage, and the depth of brine required still to support that in the salt beds; it is evident a considerable initial depth in the reservoir is absolutely necessary. In point of fact the depth varies from nine to thirty inches; where the depth is little, the plan followed is to fill a few beds at a time, but, still and of necessity, with shallow irrigation of weak brine.

251. If the water in the reservoir could be exposed continuously to evaporation unaffected by other agencies, the brine, notwithstanding the disproportion of bulk to surface, would concentrate slowly, as do the spread waters about the Eastern Coast Canal, making progress from month to month; but this, too, cannot be, owing to another mechanical defect.

252. The reservoirs are not water-tight; they leak through their floors and the embankment which confines them; some of them retain brine long enough to raise a portion of it to 15° or 20° Beaume though here with heavy loss, but few of them as far as saturation; though I have seen many reservoirs disused permitted to evaporate to dryness, I have never seen spontaneous salt, as it is then called, formed further than a little in the hollows here and there.

253. Owing to this, as much nearly as to replace the legitimate drain caused by the manufacture, the ryot is obliged to replenish his

reservoir daily by bailing into it from the creek a fresh supply of sea water which dilutes the whole mass and counterbalances the good effects of solar evaporation.

254. These are grave defects, having both the same tendency as regards the manufacture; the latter by permitting the escape of so much valuable brine from the works, must also add enormously to the cost of the salt.

255. I will describe here what I conceive to be a scientific arrangement of the salt pans and system of manufacture, remedying, as far as possible, the faults adverted to; and, though the alterations suggested are somewhat radical, they are not by any means expensive, and the trifling cost of improvement will, I believe, be amply repaid by the savings effected in after-labor and by the increased crops of salt.

256. The ordinary ullum held singly is about half a cawoy or 28,800 square feet; this I have taken as an illustration to facilitate conversion, though I do not at all approve of such small works.

257. On the opposite page are sketched two forms of ullum, the construction and working of which I shall endeavour to explain in detail.

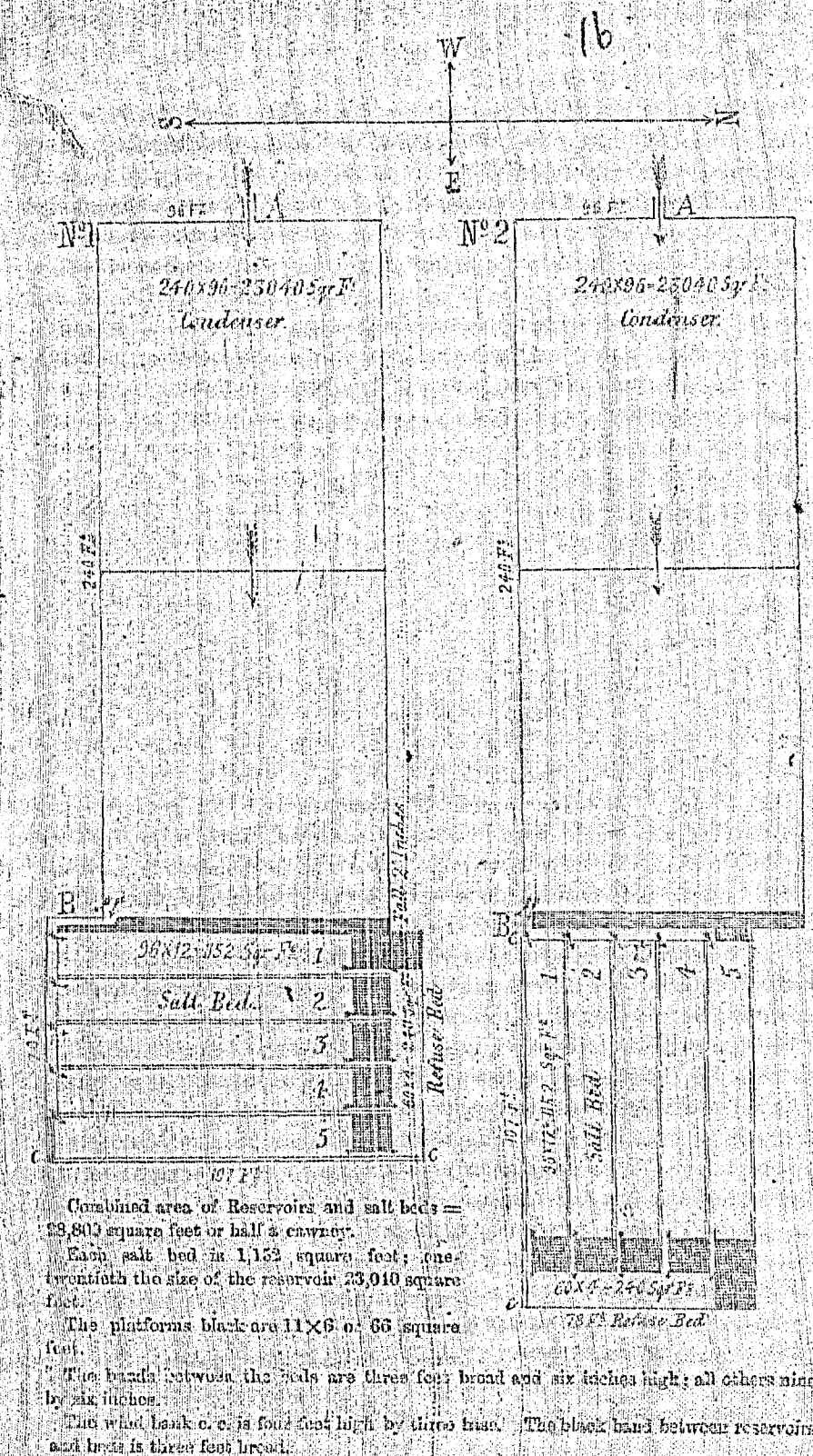
258. The ullum is divided into three parts, the evaporating, preparing or so-called reservoir, the salt or crystallizing beds and the waste or refuse bed. The salt beds collectively occupy a space equal to one-fourth of the area of the preparing pan or condenser; taken separately they are equal to one-twentieth.

259. Water follows the course of the arrows from A., beyond which is the reservoir, channel, or brine-pit, from which water is obtained for the refuse bed. The beds run east and west; the condenser is consequently turned away from the sea, its presumed source of supply. This has been done to accommodate the plan to that at present commonly in use. The pans are nowhere supplied directly from the sea; and, as the slope of the ground is generally towards it, the beds are at the east end to help the flow of water. It were well also, when the hot land winds are blowing, that the condenser should get the full benefit of them, and that the wind, having obtained moisture from that source, should be unable to accelerate unduly the work in the crystallizing beds.

260. I do not attach much importance to the exact shape of the set of pans; attached to the divisional reports will be found a whimsical variety of outline, but I believe the two great objects have been attended to in the pans sketched: to reduce, as far as possible, the injurious effects of the wind and to cover the ground with salt pans with as little waste of space as possible.

These will be arranged, like the Ennore pans, in parallel rows, without any loss to the proprietors.

261. The two forms sketched differ only as to the position of the beds which are situated so as to oppose their sides to the east and the south



winds respectively, according as either may be judged by experience to injure more the works in particular localities.

At Tootanlapenta, and the northern divisions of the Chingleput District as at Attiput and Pulidiwak, which are screened off from the sea in front by a thick belt of plantation. The second form, which presents the raised bank marked C. C. to the south wind, will probably be preferred.

262. The condenser and crystallizing beds must be water-tight, otherwise all calculations as to time and crop of salt will prove fallacious; for this, they should be excavated from first to last, not built up as at present; the excavation will be at any rate necessary for the salt and refuse beds, which are at a level of six and twelve inches respectively below the condenser. The operation will not entail any extra expense on the ryot, as it is the custom now in constructing beds to dig up six inches of earth and beat it in again to form a floor every five years, and the beds so treated are sometimes coextensive with the whole area of the ullum as at Iskapalli and Tada in the Nellore District.

263. The other steps necessary to make an impermeable floor have been already detailed.—(See paragraphs 164 to 167.)

264. It cannot be too strongly dwelt on, that the greater the care and attention bestowed on this part of the preparation of both the condenser and the salt beds, the greater will be the yield of salt and the finer its quality. It would be a mistake to suppose that the ryots are not able to afford the necessary expense; they *can*, but *will not*, through false economy; if they but knew for certain the compound interest they would receive for an extra five rupees spent at this period, they would never hesitate about it. As it is in the north, where the beds are tamped with clay and otherwise made with care, the ryots manufacture the salt at a cost of Rupees 2-5-0, for which they receive Rupees 9 the garce; whereas in the south, the ryots who grudgingly spend Rupees 5 on the preparation of their pans, with difficulty turn out salt at Rupees 10 the garce, for which they receive Rupees 12.

265. Painfully slow as is the method of preparing the ground by a string of coolies kneading it under foot, it is, I have been convinced by actual experiment at Pulidiwak, essential to its due preparation; there is, I fear, no short cut to impermeability at the pans without having recourse to other materials.

266. In addition to being impermeable, the floors of the condenser and beds must be as nearly level as possible, allowing only a slight fall for water, free from all irregularities of surface, lumps or pits, which both interfere with the flow of brine and upset all calculations as to period of saturation.

267. An incline of one in ten thousand is all that is required for a flow

of water in irrigation canals; one in three thousand should in that case suffice for salt works properly smoothed.

268. Where as in the sketch the condensers exceed one thousand inches in length, they should be, according to their extent, divided into sections of not more than one thousand inches each. For the system which I propose consists essentially of frequent rapid shallow evaporations in the condenser of brine to be afterwards dealt with in the crystallizing beds, under altered circumstances of time and quantity, as the shifting seasons demand.

These irrigations are regulated and timed by the knowledge we possess of the rate of evaporation, the depth of brine, its degree of density, and the loss of bulk it will sustain before reaching saturation. If the depth be not uniform as in a condenser of six thousand inches length, in which two inches fall are allowed for the flow of brine, not only does the calculation become too difficult for a Salt Superintendent, but the period of saturation is delayed, and time and space are absolutely wasted.

269. The most economic way of treating such a condensing area would be, as stated, to divide it into six equal and communicating sections, having each a fall of one-third of an inch; these would be worked together, and would deviate in little more than constriction from that unity and simplicity which is desirable in the parts of an ullum and in theory there would be still but one condenser and one irrigation.

270. The reservoirs at present in use are very irregular, full of pits covered with at least twelve inches of soft mud, with sea-weed, confervoid growth and whatever else may have been floating in the backwater.

271. Also a certain proportion of lime-matters in suspension, the debris of animalculæ, &c., must necessarily form a part of the normal contents of the condenser as it is its office to separate them from the brine, and these will, as at present, work their way into the salt beds with the irrigations unless prevented by some mechanical contrivance.

272. The object of the neck B. (see sketch) is to subject the brine to some rough method of filtration on its way to the salt beds. I found from experiments at Pulidiwak, that a grating of cane fibres interlaced like the back or seat of a cane chair, confining with a few wattles a bundle of Palmyra fibres washed and loosely drawn out, answered the purpose admirably well, preventing all coarse impurities from passing from the condenser to the beds.

273. All the openings of ingress and egress, marked by the arrows, are at the pans mud tunnels stopped with mud which disintegrates and is carried copiously with the stream of brine into the crystallizing beds.

274. The upper openings which the arrows show to admit brine to the salt beds (see sketch) should be made of firmer material. Major Plowden, speaking of the Nerainpore and Goordah salt works, says that communication between the beds was made by means of a wooden sluice gate; I tried a piece of bamboo stopped with a wooden plug; either of these would answer and both deserve trial.

275. Any one who has been much about the salt works must have noticed an extremely offensive odour, which pervades certain quarters now and then, emanating often from well-filled reservoirs, coming on and passing off again without apparent cause; it is also an unpleasant result of the mechanical defects which necessitate a reservoir full of weak brine.

276. The water used at the works, especially creek water, is crowded with living organisms, animal and vegetable, which in the reservoirs at rest at a high temperature, and at a low degree of density multiply out of all calculation. Towards the middle of April, many reservoirs, those called first reservoirs in which the density never rises above 4° Beaumé, swarm with minute life, with varieties of Arthropods, and even fish, whilst above everything, jungles of weeds and confervoid growths obscure the view. As these after prolonged rest at about 4° Beaumé, owing to the suspicion of "over-boiling," are one by one abandoned, and no longer receive that daily increment of fresh brine which kept their density uniformly low or from other causes are permitted to gain a rise of a few degrees in condensation, the myriad organisms which are unable to support life beyond 7° or 8° Beaumé die, putrefy, rise to the surface, evolve gases, and finally sink, depositing their inorganic constituents in the mud.

277. This takes place generally at 8° or 9° Beaumé. Whilst there is still abundance of water in the tank it may pass off if the reservoir has been simply neglected and the ryot or cooly returns to his duties and fills it to the old mark again; but if allowed to evaporate to dryness the stench is unbearable, widespread and prolonged.

278. This stench of putrefaction, which is unhealthy in proportion as it is offensive and persistent, is by no means a necessary concomitant of salt manufacture, where ordinary backwater, seawater or pit-water are exposed in shallow irrigations and raised rapidly to saturation; there is no smell, nor is there any advantage gained by keeping reservoirs or tanks throughout the season at such a low degree of density that animal life can develop in them without limit.

279. The ullum sketched is worked as follows:

Brine is bailed into the condenser at A.; it is filled to a depth of four inches; it evaporates at the mean rate (three days to the inch) in a little over ten days to a little less than half an inch, one-tenth of its original amount presuming that it entered with a density of 3° Beaumé;

this now marks 25° Beaumé, it is saturated brine, and is let off by the neck B., where it is roughly filtered along the arrow into the first four beds.

280. As these are one-twentieth of the condensing area, the brine will stand in them to a depth of two inches, quite deep enough for the middle of the season.

281. Brine loses about four-fifths of its bulk in passing from 25° to 32° Beaumé; rather more than an inch and a half must, therefore, evaporate. This should take 4½ days at the mean rate, but in practice it is found to take eight days more or less.

282. From this it appears that three-and-a-half inches of brine below 25° Beaumé evaporate in little more than ten days, or in half the time proportionately taken by the same brine to evaporate above 25° Beaumé. If such is the case the evaporation of saturated brine is retarded about 50 per cent.

283. This has been already noticed. Major de Havilland and others have observed a marked retardation in the rate of evaporation when the surface of the water approaches the surface of the salt.

The retardation increases with the density, and would consequently become more evident as the brine diminished.

284. Salt water is diatherminous, and it is but natural to suppose that this property increases with its saturation; as rock salt, which separates from it under favorable conditions of crystallization is the most diatherminous of all known bodies. It transmits, therefore, unaltered, an increasing proportion of the heat rays which impinge upon it as it progresses towards saturation; these at first, striking the mud flooring, are absorbed and a part of them given back again by conduction and convection increase the temperature of the liquid, and assist evaporation; but, after crystallization has commenced, the floor is covered with a layer of salt, and is converted from a dark absorbent into a white reflecting surface, whereby the rays are reflected back into the air through the shallow bittens and are less potent to help evaporation.

285. This diatherminous property of salt water is directly as its density and inversely as its depth; it must fall heavily, therefore, on evaporation at natural works; with it is associated another cause of retardation first noticed in connection with artificial works. Karsten has shown that the boiling point rises 11.6° Fahrenheit, as the concentration passes from 1 to 26 per cent. of chloride of sodium; that is, that the adhesion between the particles of water becomes greater. It follows that the temperature of evaporation must also rise; since it is but a different manifestation of the same phenomenon, the volatility of water due to the degree and mode of application of heat and the adhesion should be the same in both.

286. Evaporation hence commences later, and leaves off earlier in the day in the salt beds than in the condenser, and the retardation from the combined causes, experiments made at Pulidivak led me to conclude, nearly equals 50 per cent.

287. As at present managed, a further delay has been engrafted on the manufacture in this stage, which, although the result of neglect or ignorance, has been on the whole beneficial in its action.

288. The salt crystals, when first formed, Regnault has shown, are retained at the surface by capillary attraction until that force is overcome by the pyramidal superstruction which they afterwards gain.

This superstruction, which is essentially a process of crystallization, is often interfered with or prevented in natural salt works by the violent action of the wind.

289. The lesser crystals formed from brine in a state of agitation contain much of the mother liquor, enclosed between their lamellae. This in the first instance at 25° Beaumé is of specific gravity 1.210 floating; they coalesce, form flakes, and are driven into a corner by the wind.

They attach themselves to the corner and adhere to one another, forming a thin crust of salt, which extends at its free margin over a quarter, sometimes half, the surface of the brine, completely extinguishing evaporation from all that portion which it covers.

290. This crust is not, as a rule, interfered with by the ryots; it is generally present; I have never seen it removed; it diminishes evaporation a quarter or a third, according to its extent, and has hitherto unnoticed worked well by affording time for the production of good crystals.

291. As its action in the future would be to upset calculations based on the depth and density of brine, the temperature, &c., which are known and ought to be accurate in their results, it must be removed.

It should be scraped off and thrown into the nearest empty bed as often as it forms, to be re-dissolved by brine admitted for that purpose before complete saturation is attained.

292. Such salt from its shape and density sinks with difficulty in its own bed, in which the "Bitterns" have gained in specific gravity; it cannot re-crystallize there, and much of it is scraped with the better salt, spoiling the character of the whole crop.

293. This opportunity should be taken to get rid of the hydrated sesquioxide of iron, which gathers at the corners of the salt beds at most divisions, at about the time the brine reaches saturation, forming a red, semi-circular floating film, attached to, but separable from, the great bulk of the wind salt.

294. This substance does not appear in the analysis of water taken from the Bay of Bengal; no iron is, as a rule, found in sea water, neither

does it appear in the enumeration of the impurities to which salt is liable; it is, however, a very common, though harmless, impurity; iron exists more or less in the soil of every division examined by me, perhaps more in the Vizagapatnam District than elsewhere.

295. Regnault says of it that it is taken up from the earthworks in the form of peroxide, which causes the yellowness of the early deposit; that this quickly becomes protoxide by the putrefactive action of the organisms contained in the brine; this again is converted into carbonate of the protoxide, which dissolves owing to excess of carbonic acid, and is in its turn converted into hydrated sesquioxide on exposure to air.

296. As at present there is no question of its use or preservation, it had better be scraped off and thrown into the refuse bed when removing the wind salt.

297. Two inches of brine at 25° Beaumé will, towards the middle of season, afford sufficient time for the formation of good crystals owing to the slow rate of evaporation induced by its saturation; earlier the depth need not be so great, and all the beds can be utilized together.

298. As the season advances and salt is formed in obedience to natural laws at an increased rate, the salt crystals must be protected by diminishing the number of beds, i. e., the area of evaporation if a uniform manufacture is desired.

299. If it were a question of the size of the crystals only, they might equally be protected by keeping the density of the mother constantly low at about 27° Beaumé, by fresh admissions of unsaturated brine; as the NaCl, separating slowly from 25° to 27° or 28° Beaumé separates by increasing the crystals in size rather than in number, whereas, as the density progresses and the influence of MgCl₂ becomes more and more felt, it separates rapidly, and consequently in smaller crystals; but this arrangement would lead to an accumulation of residual salts in the mother, which would presently react injuriously both on the crystal and on the purity of the salt.

300. For the reason that this re-action has not as yet been fully investigated, I have not availed myself in the system which I describe of the forcing action of the residual salts, which, taking precautions against their ill-effects, might be allowed to accumulate to the extent of compelling NaCl to part company with the brine much earlier than in ordinary sea water; this would save time and turn the presence of these salts to some account in the manufacture itself, but in the first instance our knowledge requires to be extended in this direction.

301. In June it would be advisable to expose six inches in the condenser, which would reach saturation (three-fifths of an inch) in about eleven days; supposing the high rate of evaporation mentioned (half an inch a day) to be continuous, this run-off would just fill four

salt beds to a depth of three inches, which in their turn would reach 32° Beaumé in less than ten days.

302. Five beds would appear to be ample under any circumstances that can be foreseen, but this, like everything else, requires to be tested practically; it would certainly add to the symmetry of sketch No. 2 if a sixth bed were attached to it, but it might also add unnecessarily to the cost.

303. At the end of the season or at any time that there is reason to fear the loss of the crop from rain, if the brine is ready, or somewhat advanced in condensation, it can be run into all the available beds at once, where it will suffer much less dilution than in the large condensing area; such salt as is already formed should be scraped and protected; if the rains occur during the season, the fresh water in the condenser can be let off by an opening through which the arrow passes at B, the top half inch or so, of, according to the rainfall, weak and specifically light brine, drawn off the salt beds by means of a syphon, and the manufacture continued as usual.

304. In this way in the early part of the year, the condenser and beds will be employed in one continuous round of work, the irrigations in the latter passing off and yielding salt in the time required to prepare each fresh batch of brine; later the beds employed will be fewer in number, but there will be no interruption; as fast as saturated brine can be prepared in the condenser the work goes on; the amount of salt turned out increasing rapidly with the season and its physical standard being maintained by the altered arrangement in the crystallizing beds.

305. Salt will be scraped under the mother liquor in the direction of the arrows towards the platforms shaded black by men walking on the bunds which divide the beds, or in the beds themselves as at present.

306. The object as before stated of gathering the salt under its mother liquor is to obtain it clean washed of its adherent mud, and for this purpose the more mother there is the better.

307. Where the sandy element predominates in the soil, I have invariably found the salt nearly white if scraped with ordinary care; where alluvium predominates seldom white, and where laterite is present, as at Womeravilly and some of the Vizagapatnam Divisions, always tinged with red.

308. Alluvial earth and laterite dust are in a much finer state of division than sand; when, as a preliminary to the removal of the salt from the beds, the coolies tramp on the formation or break it up with their rakes, the subjacent soil is disturbed, detached particles arise and cloud the mother liquor, giving it their peculiar tinge; laterite and alluvial earths are retained for a long time suspended in the dense mother, through which the salt is scraped; and the heaps and separate

crystals are consequently covered with a thin film of these earths left by the dripping brine.

309. Sand, on the other hand, being larger grained and specifically heavier, is not so easily disturbed and settles down again more rapidly; its color, too, at the pans approaches so near to that of salt that what little of it may be scraped is unnoticed save on close inspection; this should be taken advantage of by the manufacturers, who, by giving their beds a top-dressing of sand, will greatly facilitate both the scraping and the cleansing of the salt; they should be on their guard however against mixing sand too largely with the material of the bed-floor itself; naturally it forms 50 per cent. of the whole in some places, and at others is added or worked in to that extent; this I believe to be a cause of leakage, and I doubt if an impermeable floor can be had, in which there is more than 30 per cent. of sand.

310. The mother in the system sketched will vary in amount from half an inch at first to about three quarters at the end of the season; this, though enough, with ordinary care might be increased with advantage by giving the floor of the bed a gentle slope in the direction of the platform a fall of half an inch. A double advantage will be gained, the mother will flow quickly and completely out at the corner along the arrow into the refuse bed, when it is desired to remove it, and previously will accumulate and stand deeper at the platform end, whereby the salt will be better cleansed in scraping.

311. But this, too, may not be always enough to remove dirt and discoloration, as it certainly will not avail to remove magnesium crystals, especially the magnesium chloride.

For this purpose the salt when removed must be well washed with its mother liquor; somewhat diluted, it will be incapable of dissolving any of the salt, but brine at 26° Beaumé will dissolve away the $MgCl_2$ of which there is always a certain though a slight percentage.

312. It may be washed in baskets; or, simpler still, in the brine poured over it as it lies on the platform. The platforms slope up from the bed at an angle of 15 degrees, so that the mother will flow back again, and the operation can be repeated four or five times to ensure the perfect cleanliness of the salt.

313. These are very important points to attend to both for the sake of the manufacturer and the public revenue; the former suffers severely from producing dirty salt, which is recognized now as the result of carelessness and destroyed without mercy.

314. The total quantity of salt destroyed under this head during the season amounts in the six districts examined to 30,000 maunds. It is, as in the case of small or ill-formed salt, for the most part destroyed in the strict sense of the word; a portion of it, which is thrown into

the reservoirs, helps to concentrate and increases the bulk of the following crop, but this method of destruction is rather the exception than the rule.

315. Combining the amount of salt destroyed under this head with that under the head of badly-formed, we get a sum total of 200,000 maunds of salt destroyed during the season in the six districts examined alone; and as these are not supposed to be inferior to the southern districts, but, if anything, the reverse, it is but fair to conclude that a like proportion is destroyed in the south, which gives a gross total of about 334,000 maunds destroyed in the Eastern Coast manufacturingries from eminently preventable causes.

316. This destruction is a matter of discipline at the pans; it is borne altogether by the manufacturer; it does not appear in the revenue returns as they are unaffected by it, but they are concerned in the presence of the $MgCl_2$ in another way.

317. The salt, when received by the Superintendents, is stored on the platform in ten-garce heaps. Covered up and after a time sold either in detail or "on bloc;" in either case, wastage is found to have taken place, which is calculated for convenience at five per cent.

318. The wastage, I am informed, oftener exceeds than falls below that figure; where the heap is retailed, the loss is borne by the revenue, which pays for the salt, and pays for it before it is heaped on the Government platform; where the heap or several heaps are themselves sold, the revenue still loses five per cent., but any excess of wastage is borne by the purchaser.

319. In the salt season 1870-71, of which the returns are published, the wastage amounted to 20,623,331 Indian maunds, of which the prime cost to Government was Rupees 27,925-14-4 and the loss valued at the monopoly price Rupees 4,08,607-5-9 or about £40,860-14-6.

320. It is of the greatest importance then to use every precaution to get rid of $MgCl_2$ whilst the salt is still in the hands of the ryot, and this can be done by careful manufacture as described by washing and by free exposure.

321. The salt when scraped had best be heaped in cones or cumuli and allowed to drain for a day or two, freely exposed to the sun and air. As many heaps should be made as the platform surface will allow of sixty-six square feet, the broad bunds being used also if necessary so as to expose as large a surface of the salt as possible to the air.

322. It is a bad practice that is in vogue at the northern pans of carrying away the fresh scraped wet salt, and plastering it over the heap on the ryots' platform; the moisture percolates the mass, and keeps it damp, whilst, perhaps, half an inch at the surface dries, and in addition whatever $MgCl_2$ there may be is retained.

323. This salt when sold to Government weighs heavier and wastes

more than that, in the south; the $MgCl_2$ in the wet weather attracts moisture and dissolves away, carrying with it partly mechanically, partly in solution, a large quantity of salt, breaking up and diminishing the size of the crystal for the outer lamellae of a crystal dissolving, liberates $MgCl_2$ contained in its water of decrepitation which in its turn absorbs moisture from the atmosphere and helps on the loss; so that the surface moisture separating destroys the integrity of the whole.

324. The wastage occurs chiefly in the first year as might be expected from the foregoing explanation. After salt has been in store two years it may be kept properly covered an indefinite time without further loss.

325. The *cumali* after three or four days exposure, according to circumstances, may be transferred to the ryot's heap. Thorough dryness of surface is perhaps the best test of the elimination of $MgCl_2$.

326. The salt often remains heaped on the ryot's platform a considerable time before being handed over to Government.

327. The Government *ten-garce* salt heaps are carefully covered with straw or leaf thatching, not so the heaps which they are about to purchase; the latter, speaking generally, are exposed from first to last without any protection whatever. Along the great Eastern Canal the pyramids of salt which await deportation to the Madras Kotar are scarcely distinguishable in color from the alluvial soil from which they spring, yet from their situation they are less exposed to dust than at most other places.

328. The dirt which gathers on the surface is as a rule scraped off by the ryots, who prefer destroying a portion to protecting the whole; but, as each heap is made up of successive layers as crops come in, dirt accumulates in the interval and is overlaid. Specimen No. 4 is surface salt taken from a ryot's heap; the heaps should be protected everywhere from dust, dew, etc.

329. It is undoubtedly to the ryot's interest to protect them; their loss in one wet season sometimes equals the charge of several years' covering; between the 21st of June and the 5th July last, 25,000 maunds of salt perished in Ganjam alone through want of proper protection.

330. This is not, however, exclusively the ryot's affair; the salt does absolutely deteriorate from exposure, and the department should either take it off their hands at once as soon as manufactured, or else leave them no option in the matter of protecting it, for it is inconsistent, having procured the manufacture of pure clean salt, to permit it to be neglected immediately thereafter, heaped in exposed places and unprotected from the weather.

331. It is with diffidence I suggest that there may be some doubt as to the value of the protection afforded by straw and leaf thatching; having examined one or two heaps in store at 30 divisions, the impres-

sion left on my mind is that these coverings are not very effective. I found almost invariably on the surface of the salt a number of deep channels scored by the leakage from the thatch.

332. It may be even a question whether a good deal of the wastage, which occurred last year, of which the estimated money value was over £40,000, was not due to this cause?

333. Though these coverings can, I believe, be made water-tight by careful manipulation, the coolies who do the work are not noted, to say the least, either for their care or conscientiousness. The thatch costs at Madras Rupees 18 per heap; it has to be renewed annually, and might perhaps be economically replaced by a tarpaulin or other covering.

334. At Hidgee and Sullakeh in Calcutta, salt is or has been kept in warehouses. Here it is not so; but, considering its perishable nature, the length of time it remains in store, its monopoly value, its known wastage,* the nature of our climate and the universal custom of storing it under cover, it seems strange that there is not a single plank above the salt in store here at Madras or at any of the divisions examined.

335. The mother liquor left from the first scraping contains at 32° Beaumé but 2 parts per 1,000 of the 27 originally contained; this cannot be got out without a large admixture of the residual salts; it is, therefore, sacrificed to purity, and the bitters containing it run off into the refuse bed with which salt manufacture has no further concern.

336. The bitters evaporated to dryness in the refuse bed yield an abundant precipitate in which the crystals of sulphate of magnesium predominate; these are sometimes, when the evaporation is not too rapid, of large size, hence called growing salt by the natives; they might be separated from the finer crystals by rough sifting, but Epsom salts is of no great commercial value in this country, little used in medicine, and would hardly repay the trouble of separation and storage.

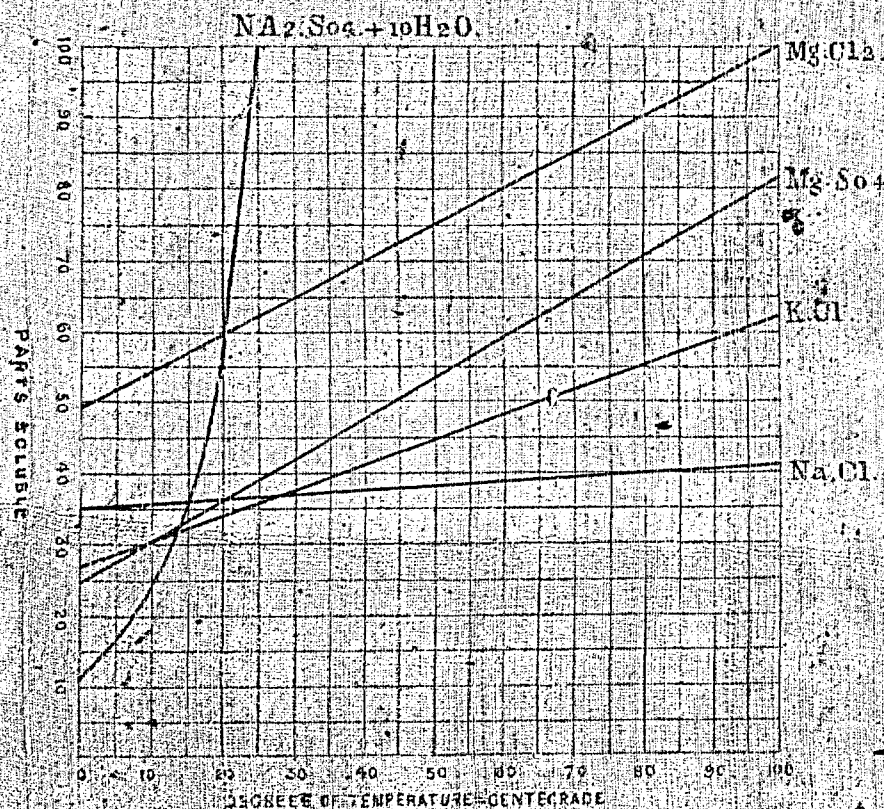
337. The manufacture of salts from sea-water especially of Na_2SO_4 , $MgSO_4$ and KCl is carried on in France. After this point, till in fact the brine is thoroughly exhausted, there is no waste.

338. If the evaporation be continued to dryness, the bitters deposit as follows: from 32° to 34° Beaumé, a mixture of common and Epsom salts; from 34° to 36° Beaumé, the double sulphate of potash and magnesium ($KMgSO_4 + 6H_2O$) and from 36° to 40° Beaumé a double chloride of the same ($KMgCl$); but as the salts so obtained are profitless, the bitters are not only not evaporated to dryness in France, but they are run into underground receptacles in which they are protected from further loss during the hot weather.

* Six heaps of salt (12 months in store), which contained originally 15,169 maunds of salt, were sold at Platform No. 2, Madras Salt Kotar, October 1872. Their out-turn was 13,584, their loss 1,585 maunds, which equals 10.4 per cent; the monopoly value of the salt wasted, Rupees 3,179; its prime cost to Government, about Rupees 156.

339. In the winter the bitterns are pumped up and again exposed for the sake of the double decomposition which then ensues. At low temperatures, commencing at about 45° Fahrenheit, the sulphate of magnesium and chloride of sodium break up and reform as sulphate of sodium and chloride of magnesium; the equation is $\text{MgSO}_4 + 2 \text{NaCl} = \text{MgCl}_2 + \text{Na}_2\text{SO}_4$. This re-grouping of the elements contained in the mother liquor increases as the temperature falls, and is complete at about the freezing point of water 32° Fahrenheit.

340. The further processes depend upon the relation of solubility to temperature, and can best be explained by a diagram showing the curves of solubility of the salts concerned. The curve of MgCl_2 in the following diagram is not the result of direct experiment, but it is correct relatively and for purposes of illustration, though it may not be so absolutely:—



341. The sketch shows three salts that are more soluble than common salt at high temperatures, and less soluble at low; they fall below it at temperatures varying from 15° to 30° C. The curve of NaCl is nearly a horizontal line; it is very slightly affected by temperature. It will be seen from its curve that MgCl_2 is more soluble at all temperatures, and that the solubility of sulphate of sodium is extremely sensitive to temperature, differing widely in this respect from the other salts; its curve is nearly vertical.

342. Two hundred and ten decimal twenty parts of sulphate of sodium dissolve at 217.7° Fahrenheit, 100 parts at 77° F. and 35 parts at 59° F. If then brine saturated with Na_2SO_4 at 217.7° Fahrenheit be reduced in temperature to 59° Fahrenheit, the absciss of its curve with NaCl , it will part with 175.20 parts of the salt, which crystallizes out and can be gathered pure.

343. Such, in brief, is the rationale of the process whereby Na_2SO_4 is obtained; this rough sketch is intended only to show that the manufacture is a natural one, and could, with equal facility, be carried out in India if the range of temperature were great enough.

344. There are not sufficient data at present to enable one to determine whether or not this is the case.

I am inclined to think, judging from my own sensations in Ganjam and Vizagapatam, that the night temperature is cold enough in January and February; but, to ascertain this practically, it would be necessary to expose an ordinary grass minimum thermometer during the nights of the cold weather months on the ground at the salt-pans themselves, where terrestrial radiation is unimpeded and the degree of cold much greater than at station observatories.

345. Sulphate of sodium, manufactured as described, realizes in France 32 shillings a ton, or as nearly as possible Rupees 70 a garco.

346. A very practical conclusion to be drawn from an inspection of the curves of solubility is to scrape salt in the afternoon at 3 P.M., when the brine is hottest; for, by so doing, we diminish greatly the chances of procuring the magnesian and other salts with the NaCl .

347. The present custom is to scrape either in the morning or in the evening; in either case there is danger of adulteration; but the morning is by far the worst time to scrape, as salts, which are nearly saturated at the mid-day temperature, will certainly deposit largely in the night.

I have myself seen a considerable mixture of magnesium crystals, scraped with the morning salt, which would have been re-dissolved if left in until the sun had well raised the temperature of the brine later in the day.

348. The expenses of working a set of pans such as I here describe will be supplying with water, scraping, heaping and portage of salt.

349. I have ascertained by direct experiment at Puldiwak that three

men working with the common scooped Palmyra tree "picotah" can raise 3,000 cubic feet of water, a height somewhat over two feet, to the condenser in three hours. They would raise 7,680 cubic feet, the amount required to fill the condenser, to a depth of four inches in less than eight hours, but it would be more economic to employ two such "picotahs" and complete the work in less than four hours.

350. This operation would have to be repeated at the mean rate of evaporation every eleventh day, or about 17 times in the working season of six months, which, at two annas a day cooly-hire, would amount to Rupees 6-8-0 at the end of the season.

351. The salt beds at Pulidiwak average 360 square feet in superficial area; one cooly scrapes from 12 to 24 of these beds in a day according as the crop is heavy or light. At the lowest estimate then a cooly can scrape a good crop of salt from 4,320 square feet by an ordinary day's work.

352. Calculating that there will be four beds to scrape, as in the height of the season we get 4,608 square feet, or about the ordinary surface scraped by one cooly, two coolies then will be able to attend to this matter, the letting in of fresh brine, heaping the salt, and letting off the mothers every second scraping.

353. These operations will recur also 17 times during the season, and the cooly-hire calculated in the same way will amount to Rupees 4-4-0.

354. Lastly, there is the carriage of salt to the platform, a variable distance beside the pans in Madras, some two or three hundred yards away on the north. Assuming the distance to be 100 yards, and it is about that on the average, and the yield of salt to be at the rate of two and a half per cent., we get 192 cubic feet to be transported 100 yards, or two cubic feet 9,600 yards, about five and a half miles, not too much for a cooly, but the return journey with the empty baskets doubles the distance; hence allow two coolies.

355. A cooly carries, as a rule, two cubic feet of salt suspended in baskets from a pole across his shoulders one at either end; two would take 192 cubic feet of salt 100 yards in 48 trips, doing 4,800 yards loaded, or less than two and three quarter miles, the same distance empty each. This amounts, at the rate above worked, to Rupees 4-4-0 at the end of the season.

356. The total expense of working the manufacture for six months, in which time 17 crops of 192 c. c., or 3,264 cubic feet of salt, have been produced, purified and heaped on the platform, amounts to Rupees 14-4-0.

357. The relation between cubic feet and maunds is very variable; it depends naturally on the size, shape, weight, percentage of mixture, &c., of the salt; with such a variety of salt as I have seen turned

out of the pans (specimens are herewith forwarded), there can be no fixed relation whatever between weight and measure; but, as Government has authorized (January 8th, 1850) 2,761.1 cubic inches to be taken as the equivalent of an Indian maund, I shall use those figures in computing the number of garce obtained.

358. It must be remembered that the 3,264 cubic feet of salt obtained by me on paper are solid cubes, and that the same gathered as crystals from the pans would probably measure 4,600 cubic feet. Also, that the salt experimented on in fixing the Government equivalent of 2,761.1 cubic inches to the maund appears to have been an average specimen of ordinary salt in the rough state, intended to apply to the conversion of salt weights and measures throughout the Presidency.

359. There is no evidence that the salts used had been pounded to a common physical standard and heated to dryness before being weighed; but, if anything, the reverse. Therefore to be accurate, or rather to avoid extreme inaccuracy, I must take my salt in the loose crystalline state, the condition of the 2,761.1 cubic inches of salt with which I wish to compare it, and this will add more than a fourth to its bulk as is shown conclusively by the following experiment.

360. Having taken 200 cubic centimetres of Pakala salt, an average description, I reduced it to a fine dry powder, and re-measured it, it measured 116 c. c. less 84 c. c. equal to 42 per cent.

361. This experiment, carefully performed in the chemical laboratory, proves clearly that about 42 per cent. of an ordinary measure of salt is, strictly speaking, imaginary, and that to put the solid cubes on the same level as ordinary loose salt I should add 42 per cent. to their bulk, which gives a produce of ordinary salt for the six months equal to 4,814 cubic feet, which, at the equivalent 2,761.1 cubic inches to the maund, amounts to 2,837.6 maunds or 24.06 garce for Rupees 14-4-0, or at the rate of nine annas and six pies per garce.

362. In making this calculation I have erred, if at all, on the side of caution. Sir A. Cotton bases his calculations on water yielding three per cent. of salt; mine are based on a lower yield by one-sixth.

363. The exact amount of salt obtained can be worked out with greater certitude in another way, which may be explained here as it strengthens the conclusions arrived at.

364. Each time the condenser is filled, 7,680 cubic feet of salt water are exposed to evaporation. A cubic foot of distilled water at 60° Fahrenheit weighs one thousand ounces. A cubic foot of our salt water, specific gravity 1.026, will weigh at the same temperature and pressure one thousand and twenty-six ounces.

Therefore 7,680, the number of cubic feet raised, multiplied by 1,026,

the number of ounces in each, gives the ounces of salt water raised, 7,859,680 ozs.

365. The yield of salt is 2.5 per cent by weight, or 25 per thousand; hence 7,859,680 multiplied by 25 equals the yield of salt in ounces, or 196,492 ounces salt.

Memo. Salt, page 117, paragraph 7. 366. A garco of salt equals 9,8743 lbs., or 157,988 ounces.

Then 196,492 ounces of salt divided by 157,988 oz., or a garco, gives the amount obtained in garco 1.24, garco; this multiplied by 17 gives the season's crop, 21.08 garco, which, at Rupees 14-4-0, amounts to Annas 10-9 per garco.

367. The cooly-hire, though apparently small, is above the average hire, which varies amongst the salt divisions from Rupees 4 to Rupees 2 a month. Rupees 3 a month is perhaps the ordinary hire of a salt cooly, but more has been allowed for him in this calculation.

368. At the Government salt pans, Merkanum, which have been closed quite lately, only two coolies were employed to attend to a set of pans measuring $\frac{1}{4}$ of a cawny, or once and a half the size of those we are now considering; these men received Rupees 4 a month, or at the rate of two annas a day.

They produced 42 garco, 71 $\frac{1}{2}$ mannds at a total cost of Rs. 101-14-9; or at the rate of Rupees 2-6-4 per garco; in Ganjam also, at the other extremity of the tract examined by me, salt is made at Rupees 2-5-0 the garco. With such results from a rude untutored system, there is nothing surprising in the estimate I have arrived at from the analysis of a much more economic method of manufacture.

369. I cannot but think that the cost of a garco of salt, even at the low figure here obtained, is in excess of what its normal cost should be in India. The manufacture here enjoys exceptional advantages: dry season lasting uninterruptedly for more than eight months, a high degree of temperature, combined with hot land winds for a season which have been known to procure the evaporation of two inches of water in twenty-four hours, labor exceedingly cheap and soil well adapted to salt works, granted free and untaxed.

370. To reap the full benefit of these advantages one should manufacture on a larger scale than at present. Sir A. Cotton says: "The native mode of manufacture is open to the same objections as their other operations, viz., that of carrying it on upon too confined a scale and without capital."

371. The relatively enormous cost of salt production at present arises in some measure from the excessive and unnecessary multiplication of the machinery used in its manufacture, both men and pans. On an average there are about 300 pans at every salt station.

* The average cost of manufacture is about Rupees 8-8-0 the garco.

along the coast, each made up of about 50 beds, besides side beds, channels, and several reservoirs; these are attended to by from two to eight men, or about 1,500 in all, living on salt culture at each division, who, though ill-paid, weigh heavily on its cost.

372. The salt works sketched facing page 23 dispense with, it is difficult to say precisely, how many hundred yards of embankment; but an extension of the works ten diameters would improve away miles of useless bunds, and at the same time afford opportunity for the economic use of machinery and retrenchment in the number of men employed. The salt beds would be multiplied in number, not in individual area, which would add much to the difficulty of tending them.

373. That a salt work ten times the size of the standard ullam, or 288,000 square feet, would not be unmanageable is, I think, shown by the successful working at Penuguduru in the Godavary District of ullams averaging 214,164 square feet.

374. An ullam of 288,000 square feet would require 76,800 cubic feet of brine for each irrigation, and it is here precisely that machinery might be substituted for hand labor with great advantage.

375. Of the total cost of salt just estimated at Rupees 14-4-0, Rupees 6-6-0, or 44.7 per cent, was expended in raising water to the works; this item we may hope to reduce considerably.

376. At Hayling Island near Portsmouth, where salt has been manufactured from times previous to the Conquest, water is pumped to the works by means of windmills; and, if these have been found to work well in the summer months, and hold their own in practical and economic England, how much better may they not be expected to work on the salt plains of India, where the winds blow strongly and steadily throughout the season, a great unused source of mechanical power, which is noticed only in the injury done to crystallization.

377. It may be objected that windmills have been already tried with this very object in Madras and found wanting; true, but the failure has arisen from insufficient wind. The circumstances at the salt works are quite altered: a reference to any of the Deputy Collectors of the districts reported on will show that there are many divisions in which, owing to special causes, the wind blows steadily and with considerable violence during some part of the day throughout the manufacturing season.

378. Again, why not lay out the works at once at the proper level, and so do away with this source of expense altogether? It is much more natural, and to be expected in works of a simple type, that water should gravitate into the pans than that it should be elevated at great expense. It is perfectly feasible and at many places would not cost much; at Mangensoodi and Toomlepenta, were it not for the intervening high beach, the sea would flood the works at full tide, and all that seems to be required is a pipe or channel properly guarded.

by a flood-gate, to bring an unlimited supply of clear salt water right into the condensers as often as wanted.

Nor is this facility confined to a few places only; there are miles of such low-lying land along the coast separated and protected from the sea by raised beaches.

379. Independent of these considerations an extended method of manufacture would cheapen construction, afford opportunity for the economic use of mechanical appliances at all points, and give the ryots an increased profit on their salt.

380. The tabular statement at the end of the report shows that the cost of salt manufacture ranges at present as high as Rupees 13-14-0 the garce; the average cost is about Rupees 8-3-0.

Doubling the area of the experimental pans, doubling the produce, and employing two men at a monthly charge of Rupees 4 each, which would be more convenient, we get salt a trifle over one Rupee the garce, Rupee 1-2-3, and this salt, unlike that with which it is compared, is pure chloride of sodium only.

381. As all these statements of produce, cost, etc., have been worked out on paper simply, they require to be submitted to the test of actual friction at the pans before being adopted; one season experience of working a set of pans like these scientifically arranged should teach us how to handle them most economically and set at rest every question concerning them.

382. Having now traced out a plan of works and a method of salt manufacture, which are based on the theoretical knowledge we possess, and which, in the absence of test works, appear to be well adapted to existing circumstances, and having guarded against loss and deterioration of salt from all causes as carefully as possible, something still remains to be said.

A great deal of the success of the present enterprise depends upon the character and completeness of the supervision exercised; the Officers of the Salt Department are recruited usually from other branches of the public service without reference to their special knowledge of salt culture; here I hope I may be pardoned for again extracting from a minute by Mr. Robinson, 2nd Member of the Board of Revenue:—

383. "The correspondence shows how little is really understood of the matter by those in whose hands the manufacture of salt is.

384. "A Deputy Collector, who perhaps has been a Sheristadar, Tahsildar, or other man of all works, is appointed to the salt; he is energetic possibly, but what does he know of the natural laws of crystallization, etc., and what in the world is the use of experiments by men who are in the main devoid of acquaintance with the first principles of the process. They go to the salt works as administrators only, and for this they are good enough. But for any real practical or

scientific acquaintance with the subject they must depend on the salt manufacturers and lower servants, who know little beyond the ancestral rule of thumb, and what observation has taught them."

385. So much for the character of the supervision; now as to its completeness. The Deputy Collector has under him several salt divisions scattered along the coast at intervals of 10 to 40 miles; at Nellore 120 miles separate the first and the last; the Deputy Collector cannot do more than visit each for a brief while two or three times in the season.

386. The practical supervision of the manufacture may be said then to rest with the Salt Superintendents; there is one Superintendent with either one or two assistants to each division. A division consists of 200 or 300 separate ullums or manufactories covering an area several miles in circumference; these, except at Madras, have to attend to the purchase and sale of salt, its storage, and all matters connected therewith, as well as look after the manufacture.

387. The panowners are consequently left much to themselves; they are often well-to-do men employed in the village or in agriculture; they commit the details of manufacture to the hands of their coolies, hereditary salt scrapers of an ignorant and a bigoted type, who live improvidently on advances, mortgage their services from year to year, and are virtually the bond-slaves of their masters; these are the real manufacturers, the men to be supervised.

388. Large employers wield enormous influence; they derive their opinions from their operatives; and, as the latter as a matter of course cling tenaciously in everything to the old "mamool" or custom, they are frequently at issue with the Superintendent on questions of improvement; in such case, the result is doubtful, for, again, the Superintendent is himself powerless, and, measured by the standard of income as men are, he is often neither feared nor respected, less influential in his own domain than the ryots whom he is charged to superintend.

389. Such, in brief, is the state of affairs at many or at most of the salt pans provided with hydrometers: can it be possible for one or two assistants to test the operations of so many ullums carried on simultaneously at points so far apart? or can they overcome the difficulties which await reform in any branch of salt culture?

390. It seems unlikely unless vested interests be interfered with to the extent of doubling up adjacent works, and laying them out in accordance with the plan suggested, which, by diminishing the number of salt pans, placing them in line, and procuring salt crops at regular intervals, will facilitate the work of the Assistants and that of Police inspection. And, unless also the hands of the Superintendents and others with whom the supervision rests be strengthened by adding somehow to their local power; the knowledge which they may in the future be expected to possess will, no doubt, increase their moral

influence, but something more tangible than this, is I think required, at all events whilst the works are in a transition stage.

391. An analysis of the value of the suggestions contained in this report shows a balance of profit much in favor of the ryots, whose expenses will be reduced according to their own showing as much as 80 per cent.; if the report be adopted, and its conclusions verified, would it be too much to expect contractors, who are paid 10, 12, 15, and 21 times the estimated value of the article contracted for, to contribute something towards that instructive and intelligent supervision, which is to result so greatly to their advantage?

392. In taking up the manufactories themselves, it will facilitate matters to describe them under certain aspects, such as topography, level, etc., fully in the case of Ganjam, the first division examined; noting in the case of the others which follow only their special features and points of divergence from it.

393. The following is the scheme of examination practised by me at the salt works and adopted in this report.

394. Division N———. Topography, level, number of pans, area of pans, distance from the sea, source and character of water-supply, mechanism of supply, construction of ullum, number of parts, relative area of parts, depth of parts, density of brine in parts, system as to depth and density of irrigations exposed, prevailing rate of evaporation, disposal of bitters, their action on the manufacture, character of salt crop, quantity, quality, after-treatment of salt, prevalent wind, protection, dates of manufacture, number and influence of pan-owners, produce compared to area, cost of working kadevaram, profit or loss, sales, improvements required, etc., etc.

395. The improvements called for at the divisions are not often specified inasmuch as they present great uniformity, and are such as have been already fully described in the report, and because the information furnished under the preceding heads, read in the light of scientific salt cultures, render the improvements necessary at once obvious.

GANJAM DISTRICT.

1. 1st Division commencing from the North Ganjam. Arrived February 8th, departed February 10th, 1872.

2. The Ganjam salt pans, less than a mile from the sea in a straight line, are scattered along and parallel to the line of coast for about two miles on low swampy ground, which rises gradually on the land side, extending into a large plain studded here and there with hills. They are about five feet above the sea level, laid out on grey soil, a mixture of alluvial earth and sand, which rests on an impermeable stratum of black clay.

3. The water used at the works is obtained at about two miles from the sea from a small creek sixteen yards wide, well filled with opaque turbid brine at the new and full moon tides; but generally dry at the ordinary ebb.

4. A quarter of a mile from the nearest part of the pans a bund constructed of stakes and sods, which serves also as a bridge, is placed across the creek; it divides it into an inner and an outer portion. At either end of the bund is a gap loosely filled with sods which are removed at high tides to give entrance to the enclosed section, and then replaced to prevent the escape of brine.

5. The volume of water thus obtained is supplied to the works by means of canals radiating from the near or terminal end of the creek. It is assumed to be sufficient for fourteen days' consumption.

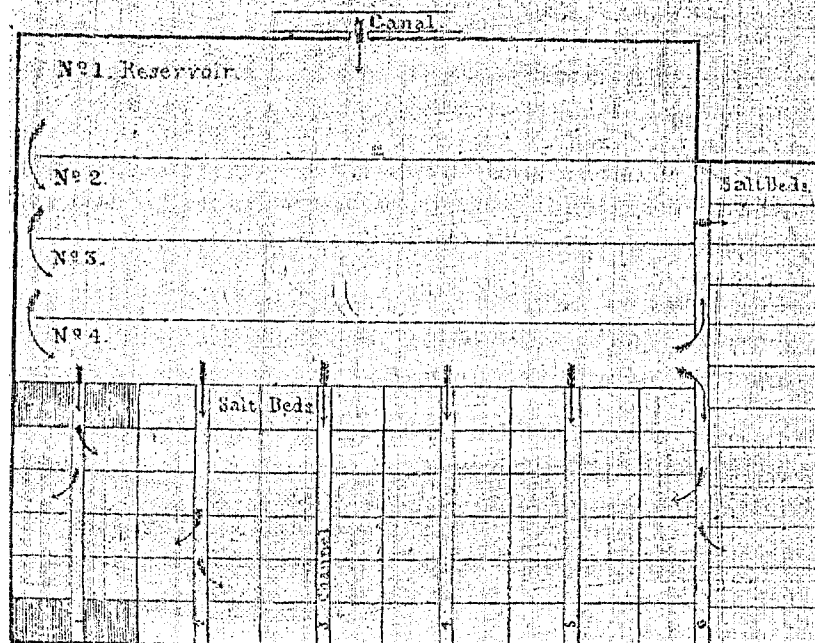
6. There is great scarcity of brine at these pans; the creek is small; it is tapped too far from the sea, at too high a level; the canals are seldom full; they rise towards the works; and, as the water is used, and its bulk diminished, it gravitates back to the bund, which is inefficient and permits escape.

7. Water both within and without the bund marked but 2° Beaumé, this reading compared with that of sea water at the neighbouring beach 2.75° Beaumé indicates a less amount of salts in solution by nearly 30 per cent., and there can be little doubt that this arises from the two miles of drainage received by the creek.

8. Coolies raise water to the works by means of slung baskets, by which they lift it from the canal and discharge it into the reservoir, with a swinging motion and machine-like regularity; a wicker screen receives the first shock and protects the mud floor. From six to eight men are employed daily at this work, to maintain the first reservoir at a constant depth of about eighteen inches.

9. I did not examine the volume of water raised, nor its rate of discharge; but from observations made at Vadasaminjari, where the same method is pursued, I have reason to believe that two men with the common "picotah" would raise water to the works more economically, though not perhaps with the same rapidity.

10. There are in all 15,811 pans at Ganjam, which, though differing slightly in detail, resemble each other in all important respects. The ullums average 101,277 square feet in superficial area, the reservoirs, four in number, and the salt beds about seventy, dividing the area equally between them; they are laid out as shown in the sketch heading the following page, and the arrows indicate the flow of brine.



11. The reservoirs diminish in superficial area, and in depth as they approach the salt beds, No. 1 is filled to 18 inches, No. 4 to six inches depth of brine; the whole being at nearly a uniform level, the flow of brine from one part to the other is accomplished with difficulty.

12. The method of constructing or preparing the ullum is, I am informed by the Deputy Collector, still almost precisely the same as that described by Mr. Angelo, in Record No. XVI, Memo. on Salt, page 18. The floors of the reservoirs and channels had not been prepared at all; those of the salt beds had been done quite lately and with care; they were as firm as clay and sand can be made.

13. The beds are constructed to hold three inches depth of brine; they are not filled to that depth as will be seen, nor are they irrigated simultaneously even for a given ullum; they are worked in batches, each on its own merits; one is scraped to-day and another to-morrow; neighbouring pans, in fact, pans all over the division (381 acres), are in different stages of the manufacture, so that the Superintendents cannot attend to all, and the Police work is greater than it need be.

14. The beds are irrigated with brine from the last reservoir which is the strongest; that in the first averages about 4° Beaumé, that in the last about 10° Beaumé in density. There is no guide to the admission of brine to the beds, nor is there any concern about its strength; it is let on to them as often as they are ready to receive it. It is passed

from part to part by breaching the mud partitions, which are at the opening more or less broken down and carried with the flow of brine.

15. To illustrate the system as to the probable composition of the brine exposed, its depth and density, the most important part of the manufacture, I examined in each division three or four beds taken at random, and give the result in line of column as follows:—

A.—The amount and strength of brine taken from the last reservoir wherewith to irrigate the beds, called for convenience "Fresh brine." It is an index of the work done in the condensers.

B.—The depth and strength of bitterns left in from the previous scraping called "Mother."

C.—The depth and strength of the resulting mixture of fresh and mother, which constitutes the prepared brine, exposed for a fresh crop of salt, this I have called "Prepared." The amount of mother joined to it gives an idea of its purity, the depth and density taken in connexion with the prevailing rate of evaporation, a fair idea of the size and symmetry of the crystals which will be formed.

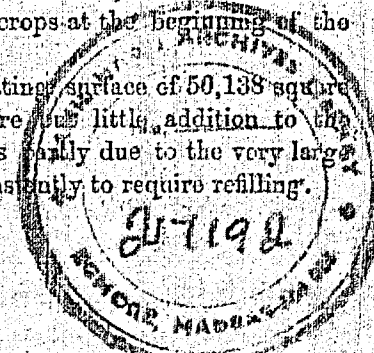
16.	A. Fresh.		B. Mother.		C. Prepared.	
Beds.	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1	9° B.	1	27° B.	1	13° B.
II. ...	2	10° „	1	27° „	1	13° „
III. ...	1	12° „	1	28° „	1½	14° „

Rate of evaporation, an inch in five days.

17. Column C. then shows the irrigation in the early part of February to be an inch of impure brine at 13° Beaumé, which, evaporating to saturation, loses a half inch in two and a half days, and a further quarter inch in two and a half days more, which second period is allotted for crystallization; the remaining quarter will be at 27° Beaumé—(M. Usiglio's tables). It is probable that this brine at 27° Beaumé will, owing to the pressure, so to speak, of the accumulated magnesium salts, have parted with all or nearly all the NaCl it contained in the space of two and a half or three days, too quickly to allow of its crystallizing out in large or regular forms.

18. The manufacturers say that they increase the depth of the irrigations as the weather gets hotter; if this were done in an equal ratio, the facts would remain unaltered; but, judging from the tabular statement at the end of the report, the matter is overlooked, a conclusion further confirmed by the Superintendents and Merchants, who state that the best crystals are obtained in the poorer crops at the beginning of the season.

19. Column A. shows that an evaporating surface of 50,138 square feet has been so managed as to procure but little addition to the density of the backwater, though this is partly due to the very large number of beds which are so used as constantly to require refilling.



20. The salt is scraped by means of a board set transversely at the end of a long bamboo, an instrument very like that used by sailors to scrape water off the decks; it is first broken up by a few blows from the back of the board, or later in the season, when the deposit is thicker, by men treading it in the bed, it is then scraped into little heaps at the edge and sluiced with the mother liquor, afterwards heaped to drain on the bed side for an hour or two and then carried still dripping to be added to the ryots' heap.

21. The heaps when examined were not protected in any way, except that they were placed in a drained and fenced enclosure, which coolies sprinkled with water now and then.

22. The salt scraped and in store was clean, tolerably regular, and fair sized, without any admixture of magnesium crystals that I could detect, but then it was only the first or second scraping and for the same reason the crops were small.

23. The mother liquor every fourth scraping is thrown back into the last reservoir, or evaporated to dryness in the bed and the resulting salts stamped into its floor; in the latter case nothing has been done, in the former the period of saturation for NaCl is again for a time accelerated without any immediate prospect of a deposit of magnesium salts.

24. An ordinary ullum as sketched, measuring 101,277 square feet, worked by from eight to twelve men, produced on the average of nine years four garce of salt a month, only sixty maunds more than I have calculated on getting from an area one-fourth of its size. It is said that comparisons of this kind are vitiated by the fact that the amount of salt worked from the pans is controlled by the "dittum" or contract given to each, but the relation of produce to area in a given time is quite irrespective of the whole amount; the dates are given, and we know it is to the ryot's interest to get through the contract as quickly as possible, as the cooly-hire is eating into his profits, and here if anywhere time is money, so that we may conclude he takes as much a month out of his ullum as he can.

25. The sea breeze from the south-east blow violently over these pans at the time of my visit.

26. The 15,811 pans, which constitute the Ganjam Division, are in the hands of 194 ryots; they live chiefly on salt culture, and for the most part work the pans themselves or by the aid of their relatives; they are docile in disposition, and would willingly adopt any measures which they understood to be for their own advantage.

27. The ordinary season "dittum" is about 15 garce per ullum. The season commences early in February or March; it is preceded by a period of preparation, which lasts about six weeks; it terminates not with the weather, but with the completion of the contract in May or June.

28. The contract price of salt or "kudivaram" is Rupees 9 the garce; its cost of manufacture, storage, &c., Rupees 2-5-0; and the profit to the ryots about Rupees 6-11-0 per garce; but, as labor in some form or other is charged with 91 per cent. of the total cost, which is not all strictly paid labor, the money return per garce is greater than here shown.

29. The trade flows north and into the interior; the salt is carried in sacks on bullocks, or in bandies; it is for the most part good salt, but sometimes dirty from exposure; it bears carriage well, and is liked by the natives.

30. The system of water-supply requires to be attended to here, exclusive of alterations which more immediately affect the allum and mode of working it. The canal bund should be provided with a sluice gate and coarse filter or sieve to prevent the admission of weeds and all other floating debris to the inner section of the creek from whence the works are irrigated and the canals should be enlarged and deepened to the extent of conveying all the brine obtained to the pans.

31. Both the manufacturers and Superintendents are prone to attribute, whether correctly or not, their deficiencies of system, such as shallow irrigation, &c. to a want of water; looking however to the area to be supplied, the number of pans, &c., they cannot well expect much improvement under existing circumstances.

32. To point out and correct all other faults at this and the following divisions would lead to endless repetition; their improvement could best be managed by drawing up a set of rules for the guidance of the manufacturers which it would be premature to do, pending the resolutions of the Board on the subject of this report.

2nd Division, Itchapur.—1. A march of 32 miles along good roads through Berhampore leads to Itchapur, the next division south of Ganjam, commonly called Suria in the neighbourhood. The works are on the coast, about two and a half miles from the beach, situated on low swampy ground, between an extensive backwater and a range of mountains, the Eastern Ghats, which here approach the sea.

2. The soil is much the same as at Ganjam, a mixture of sand and alluvial earth; the beds are, however, softer; they are longer submerged and later reclaimed from the swamp, owing in part to the action of the neighbouring water-sheds, and in part to their lower level about two feet above that of the sea.

3. A canal, a quarter of a mile in length, conducts water to the works; it is filled from the backwater at the new and full moon tides, and then banded with loose sods; there is no permanent bund as at Ganjam. A scarcity of water is felt here periodically, as that in the canal is used up before each high tide.

4. The canal is not large enough, and the bund again is quite porous,

permitting the outflow of brine at low tide, and the mixture of the inner and outer waters at full tide. Owing to these causes the water which is taken at a point of the creek about two miles from the sea, and marks originally 2.50° Beaumé, seldom attains a higher density than 3.50° or 4° Beaumé in the canal.

5. The Itchapar pans cover 323 acres, 19 coontals. The ullams are larger here than at any other division in the district; they measure about 152,460 square feet; they are planned as at Ganjam (see sketch), and made up of three or four reservoirs, and from 25 to 30 beds; the latter, however, occupy more than half the whole area, taking 82,460 square feet as against 70,000 allotted to the reservoirs.

6. Water is raised to the works by hand labor with slung baskets as at Ganjam; about the same number of men are employed every morning; they keep from eight to twelve inches of brine constantly in the reservoirs, that in the first marked 4.50° Beaumé.

7. The reservoir floors were untouched; the beds carefully prepared; they are irrigated to a depth of two inches with fresh brine, averaging 10° Beaumé in density. The brine was said to have been evaporating for 15 or 16 days previous to its admission to the beds. These statements, as to the time taken to prepare the brine, I have not any where reproduced; they must be incorrect; water is withdrawn from the reservoir every evening for some four or five of the thirty salt beds, day and night there is leakage and in the morning loss from all causes is made good by re-filling to the set level, so that it is impossible to ascribe a definite period to any given bulk of brine after the first irrigation; besides strength, not time, indicates its state of preparation.

8. The following observations with the hydrometer and inch measure were made at different Ullams:—

Beds.	A. "Fresh."		B. "Mother."		C. "Prepared."	
	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1½	12°	1½	28°	2	16°
II. ...	1½	7°	1½	28°	1½	10°
III. ...	1½	10°	1½	28.5°	2½	14°

9. Column A. shows that the brine, although exposed in reservoirs with an evaporating surface, nearly 20,000 square feet greater than at Ganjam, has but the same density, but that the irrigations are larger. B. shows the mother liquors getting denser, but still too weak to be of any injury; they are said to be evaporated to dryness, and beaten into the bed-floor every fourth or fifth scraping.

10. C. shows a better arrangement for crystal formation than at Ganjam; the irrigations are deeper, and somewhat stronger, owing chiefly to the amount and strength of mother; taking two inches at 13° Beaumé as about the mean, we find that, as brine at 13° Beaumé must lose about 61 per cent. of its bulk before reaching saturation,

there will remain about 9½ lines of saturated brine; this loses a further 77.8 per cent. in passing on to 32° Beaumé, which reduces it to 2½ lines, 7.8 lines having evaporated at the then rate (five days to the inch) in six days; but, in practice, we know the brine will not be evaporated to 32° Beaumé, as 2½ lines remaining are not sufficient to cleanse the salt in scraping; this is well also, as this brine evaporated to 32° Beaumé, would deposit magnesian crystals; it will be evaporated probably to 28.50° Beaumé, losing 65 per cent. of its bulk, or 6½ lines in less than three days, which may be taken as the period of crystallization.

11. M. Usiglio taking a litre of Mediterranean sea water at 3.50° Beaumé as equal to 1.000, evaporated it to 35° Beaumé, and constructed a table showing the volume of water at different degrees of density; he shows that at 25° Beaumé, the volume is reduced to 0.112, and at 32.40° Beaumé to 0.023. By this, in connection with the rate of evaporation, I have formed an opinion of the value of the irrigations at the pans as regards crystal formation.

12. The salt is scraped here as at Ganjam; the crops were poor in quantity, but of good quality; the crystals fair-sized and well formed, but somewhat discolored and mixed with sand.

13. The salt scraped, generally in the evening, drains at the pans for perhaps an hour; it is then heaped moist, and left without a covering. It receives a coating of fine white sand taken up by the sea breeze and carried all over the division; the wind is from the east, a point north stronger than usual, owing to the aspiration caused by the heated ghauts. There is no protection afforded, though trees and shrubs of a description common to the whole coast grow plentifully about, and are available for fencing round the platforms.

14. An ullam measuring 152,460 square feet produces on an average 4 garce 16 maunds a month, nothing like as good a yield as that of Ganjam, which produces only an ordinary crop in relation to its area. Having compared the yield of the experimental ullam with that of Ganjam, it is but fair to note that, as the impermeability of the former is assumed, it would be useless to pursue the comparison further; the differences of yield at the divisions appearing to be the measure of their leakage.

15. The cost of salt manufacture is Rupees 2-5-0 the garce as at Ganjam, according to a return received from that District, but I think it ought to be somewhat less, as the number of hands employed is the same, and the yield per month 13 maunds greater. The "kudivaram" is still Rupees 0 the garce.

16. The greater part of the salt is taken into the hill countries and Central Provinces on bullocks; a portion goes north in common carts; and the remainder is disposed of in the locality.

17. The improvements required here are precisely those noted at

1, providing the canal with a sluice gate taking measures to regulate the supply of brine and re-casting the system of manufacture. At these northern divisions especially, but elsewhere also to a extent, supernatural agencies share with natural laws the respect of the manufacturers; the skulls of oxen and other animals are placed on poles at the corners of the salt beds, to avert the evil-d propitiatory offerings of salt are made on mud altars, or at the stone, to ensure the production of large crops of salt; such at the explanation I received of the things I saw. I do not mean in any spirit of ridicule, but simply because it tends to throw in the knowledge of the manufacturers and the bent of their

2. *Division, Nowpada.*—1. Here, by the road 50 miles south from Ganjam, are the most extensive and by repute the best salt works in Ganjam District; they occupy a long and swampy tract about five miles from the sea at the extreme end of the backwater which supplies the land between it and a distant range of the Eastern Ghats.

The united area of the ullums amounts to 758 acres and 15 bighas, double the area at the Ganjam and more than double that of Itchapore pans.

The soil is a mixture of alluvial earth sand and salt dust, underlain by a thick belt of black clay, which, though the works are nearly 10 miles above the sea level, approaches nearer to the surface here than at Ganjam or Itchapore, and there is consequently less leakage.

Water is obtained from the backwater by means of a number of canals, which run in almost parallel lines, striking the works at various points; they are as usual supposed to be filled and banded at monthly high tides.

The supply is very deficient, the works are far inland, the backwater at the point from whence brine is taken is at a high level, very shallow, its bar is rapidly silting up, the canals are small, and not cut deep enough to drain towards the pans. At the time visited the bunds were all open to allow the entrance of a little water at the ordinary tide.

The creek water obtained in this way is very opaque; it marked 10° Beaumé; three miles off nearer the sea it marked 3° Beaumé, which shows that it receives a good deal of drainage in the interval.

The ullums are planned as at Ganjam; they are large-sized comparatively of reservoirs and beds, the former four or five in number, the latter from 30 to 40, together they make up 117,612 square

The salt beds were very firm, they appeared to be made with more care than usual. The reservoirs are of the ordinary kind, the

first is filled to a depth of 12 inches, the depth diminishes in the others, in the fifth or last, which supplies the salt beds, there is but 4 inches. The depth is maintained constantly the same by the labor of eight men who bail every morning a fresh supply of brine into the reservoirs by means of slung baskets as at Ganjam.

Water in the first reservoir averaged 4° Beaumé, in the last 10° Beaumé.

3. The beds were irrigated as follows:—

Beds.	A. Fresh.		B. Mother.		C. Prepared.	
	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1½	10°	1	28°	2	13°
II. ...	1½	11°	1	29°	1½	16°
III. ...	1½	10°	1	28.5°	2	13.5°

10. The strength of the fresh brine is precisely the same as at Ganjam and Itchapore, 10° Beaumé for an evaporating surface of 78,806 square feet. The mothers are a little stronger, and the prepared brine one degree stronger; we may take 2 inches at 14° Beaumé as the condition of the prepared brine rather more favorable to crystallization than at Itchapore. The rate of evaporation at the time was about five days to the inch.

11. The salt crops are very good, and the crystals as a rule larger and cleaner than at other divisions. I could detect no magnesia crystals amongst the salt, but the season was still young.

12. All the further details of manufacture, disposal of bitterns, scraping, and after-treatment of salt, etc., are such as have been already described.

13. The wind blows steadily from the sea (south-east) throughout the greater part of the day; there is very little vegetation about the pans, the soil is too richly impregnated with salt, the impermeable clay stratum keeps the weak brine, which overflows the backwater after the monsoon, from sinking away; later it is drawn up and evaporated, leaving an efflorescence of salt at the surface, this the natives, when they can, scrape mixed with earth, smuggle it off to their own homes, and there filter and boil it for use. It is used for washing clothes as well as for cooking.

14. An ullum of the dimensions given, 117,612 square feet, produces on an average five garce thirty-three maunds of salt per mensem; these figures compare very favorably with those of Itchapur, four garce sixteen maunds from 152,460 square feet. The contract price is the same, Rupees 9 the garce; the cost of manufacture has not been furnished, but it must be considerably less comparing the labor

* T. Clarke, Esq., reporting April 1861, puts the cost of manufacture at Rupees 5.3-0 the garce.

and the return; the difference is probably due to the greater age of the pans here, the greater care in preparing them, and the proximity of the clay beneath them. The proportionately larger evaporating surface allowed should also be in favor of Nowpadah, but column A. shows this is not the case.

15. The salt made here has the reputation of being the largest-grained in the northern districts; the sales are hence very large, and salt is taken north and south and into the interior; the value of the sales last season (April 1871) was Rupees 4,32,476-8-0; it is carried for the most part on bullocks in sacks.

16. The salt made here, though better than that of any other of the northern divisions, except perhaps Itchapur from which it is not easily distinguishable, has not improved of late years; the scarcity of brine induces the people to vie with each other in storing it deeply, lest they should run short of it, and the irrigations are for this reason made shallower than they would otherwise wish.

17. It is evident from the present strength of the backwater that, should its mouth be further silted up, the water would become too weak to work with. The bar wants clearing out, and the whole system of supply to the works enlarged and deepened.

18. The ryots are a docile set of men, and anxious to improve their method of salt manufacture.

4th Division—Womeravilly, arrived February 28th, departed 29th, 1872.

1. The Womeravilly salt pans are about 27 miles south of Nowpadah; beside the town of Calingapatam they occupy the dip of the plane, as it sinks towards the shore half a mile from the sea and separated from it by a low barrier of sand drift.

2. The works are about three feet above the sea level laid out on soil tinged red by the admixture of laterite with earth and sand, a mixture which does not appear to be well adapted to the formation of impermeable beds.

3. The water-supply is obtained directly from the sea by an artificial canal cut from the beach to the works; it is not a good supply; the canal is small and with difficulty kept open; the brine marked 2-75° Beaumé.

The backwater on which the works had hitherto depended had been for some time dry being closed by the action of the tides.

4. The reservoirs and salt beds are irregularly planned; they vary in number and relative areas; one man has three reservoirs and

twenty-eight salt beds, his neighbour three and forty-two, and so on; the beds were badly made, both soft and porous, but this may be in a measure due to the description of soil.

5. The reservoirs were uniformly filled to a depth of six inches, that in the first marked 3°

6. System.	A. 1.	B. Mother.	C. Prepared.
Beds.	Inches.	Degrees.	Inches. Degrees.
I. ...	1	28-5° B.	1 12° B.
II. ...	1	30° "	1 12° "
III. ...	1 3° "	30° "	1 12° "

The irrigations of fresh brine given by column A. are both weak and shallow; and, notwithstanding, the mothers are getting stronger as the season advances, the prepared brine is also very weak; 1 12° Beaumé, of which four degrees of strength are due to the presence of magnesium salts; the rate of evaporation having increased to an inch less than five days, not much in the way of crystallization can be expected.

7. The salt crops were poor, and the salt crystals much smaller and dirtier than elsewhere in Ganjam, a quarter of an inch of mother being insufficient to more than dilute the amount of bed-floor scraped up with the salt.

8. All the other manufacturing operations, storage, etc., are precisely such as have been already described. The salt made here is disposed of in the locality and in the home districts; it is conveyed chiefly in bundles.

9. Wind; strong sea breeze from the south-east. The Kudivaram is Rupees 9 the gura. The produce to area I have not been furnished with, neither have I learned the cost of manufacture; but, judging from the foregoing, the cost must be much higher than at any of the previous divisions. A too close inquiry into these matters was deprecated at Womeravilly, as the officials attribute the inferiority of the manufacture to the scarcity of brine due to exceptional circumstances over which they had no control.

10. The water-supply, if salt culture is to be continued here, should be thoroughly looked into; the backwater frequently closes and dries up as at the time visited, and the expedient of cutting a small canal or rather channel in sand driven about by wind and tide is both expensive and unsatisfactory.

11. The Womeravilly pans are favorably situated as regards export; ships anchor in front of the works which are close to the sea and flanked by an excellent metalled road which leads to the beach; they have the advantage of being the nearest salt works to Calcutta in point of acces-

sibility; and the Kudivaram, Rupees 9 the garce, is the lowest rate procurable, but the description of salt at present made would not find favor in the Calcutta market; a good deal in the way of improvement has yet to be done here.

12. Speaking generally, the Ganjam salt manufacturers excel those of other districts in the quantity and quality of their salt output, and this I think arises more from greater care in manufacture than from any natural advantages which they possess. Their water-supply is everywhere weak, scant, and turbid, and their soil and system, are much the same. At the latter a Nowpada ryot exposing in February two inches at 14° Beaumé, the rate of evaporation being an inch in five days, exhibits a greater knowledge of the fitness of things than a Vullur ryot, exposing 1½ inches at 14° Beaumé in June, evaporation being sometimes at the rate of half an inch a day.

13. The Ganjam men are most careful in the construction of their salt beds which are re-made every fifth scraping; they are active and docile, and their intelligence, if not greater, appears to be more in their work than that of their southern brethren. I think that the impermeability of their beds has secured to them more salt, better salt, and cheaper salt than can be had elsewhere; cheapness, of course, depends in a great measure on the price of labor; but starting with the idea that the cost of labor was all in favor of Ganjam, I find myself unable to think so now; as far as I can ascertain the hire of a salt cooly nowhere exceeds Rupees 4 a month. I was told by an intelligent Superintendent that even in Madras, where labor is dearest, salt coolies, owing to the grinding system of advances, are sometimes worked at Rupees 3 a month, and if this be so, the difference cannot be great; but admitting that the pay is less in Ganjam, from six to ten men, owing to the want of such common machinery as the "Picotah," are employed daily at a set of pans, which would be worked by half the number of men in the south, and the cost is in consequence much the same.

14. Another view of the case is that in the north the ryots are poor men who support themselves through their pans, working them themselves with their relatives, male and female, who are as often as not paid in kind, whereas in the south one rich Bannia owns many pans, which he works through coolies, whom he has not time to superintend; these men though badly paid, perhaps because badly paid are expensive agents, since having no pecuniary interest in the produce of the pans, they are careless and perfunctory in the discharge of their duties.

15. At the Nowpada salt works Mr. Thompson, Acting Deputy Collector, constructed at my request a small salt bed, floored experimentally with boards; it answered very well as far as it went; there

was no leakage, the salt was well formed, perfectly clean, and the crop larger than usual. I received every assistance whilst in the Ganjam District from Mr. C. G. Master, Acting Collector, to whom my best thanks are due here, as also to Mr. Thompson, Acting Deputy Collector, who accompanied me to each division facilitating my progress and giving me all the explanation in his power.

VIZAGAPATAM DISTRICT.

1st Division—Kuppili, arrived March 2nd, departed March 3rd, 1872.

1. The Kuppili salt pans, opened in 1865, are rather isolated in position, owing to the absence of good roads; they are situated near the beach at the north extremity of the Vizagapatam Coast line, and approached from Chicacole in the Ganjam District by a jungle tract in strong contrast with the road which leads from Womeravilly to the same place.

2. The works are less than half a mile from the sea, laid out on the north bank of a small backwater on very sandy soil at about five feet above the sea level, from whence the ground rises rapidly towards the beach, forming an irregular barrier of sand hills.

3. The ullums, 292 in number, are supplied from the backwater by means of a channel, which would be flushed and banded in the usual way if the tides could reach it, but which was neither flushed nor banded at the time of my visit, but on the contrary nearly dry, for the sea had silted up the mouth of the backwater (if the point of exit of a monsoon river can be so called) in the previous November, and the river alone, brackish from past admixture with tidal water, supplied the works. As the river, though reduced in March to scant proportions, had been cut off from tidal influence for three months, the water supplied was very weak in density, marking only one degree of Beaumé.

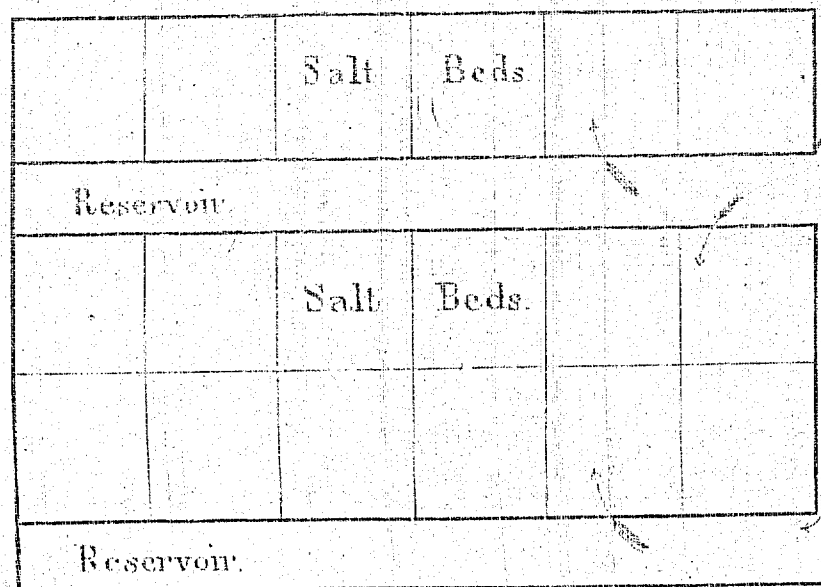
4. Perhaps on this account, though most unreasonably, the ullums are planned differently from those of Ganjam; as a rule there are no reservoirs; water is let on to the salt beds directly from the creek, and where reservoirs exist they are, as shown in the sketch, narrow strips with half the area of the beds.

5. Those ryots who have reservoirs treat them merely as holding brine until a salt bed is ready; they are kept constantly filled to six inches depth by daily additions of fresh water, elevated with slung baskets as in Ganjam, so that the condensation of the "fresh brine" is very insignificant.

6. The reservoirs and beds must leak a great deal. I felt so certain of it from their elevation, the character of the soil, and the carelessness of construction in every part of the ullum that I did not delay

three or four days to test the matter practically with the hydrometer.

7. The following sketch furnished by the Deputy Collector is not very correct; the beds at Kuppili are small and very numerous; they are usually from 50 to 70 in number:—



E. System. Beds.	A. Fresh.		B. Mother.	B.	C. Prepared.	
	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1½	5°	1	26°	1½	7°
II. ...	1½	4°	1	26°	1½	8°
III. ...	1½	5°	1	26°	1½	9°

These observations refer to an allum of the better class having a reservoir area of 7,839 square feet to a total area of 18,153 square feet; there are four or five such in the division.

9. The irrigations of prepared brine, considering the rate of evaporation, about 4½ days to the inch, are much too weak and scant to allow of the formation of good crystals. The salt crops were poor, the salt itself fine-grained, badly-formed, friable, and dirty. I find in a note that the salt heaps had the appearance of heaps of "kunkur."

10. The mother liquor every third or fourth scraping is pushed or rather dashed over into the adjoining reservoir by reversing the action

of the scraping board, the usual method of removal at other divisions.

11. The arrangements of heaping and storing the salt, &c., are as at Ganjam.

12. The salt sales here are not great owing to the character of the salt and the want of roads. I have no reliable statistics, but the Acting Deputy Collector of Ganjam, Mr. Thompson, informs me that merchants from the south pass by Kuppili, preferring to get salt from Womeravilly, which is in a straight line about 14 miles further on.

13. The following profit and loss accounts furnished by the Deputy Collector refer probably to the best and to the worst pans at Kuppili:—

Ryot "A. B." manufactured last season 1,030 maunds of salt, for which he received Rupees 77-4-0, being at the rate of Rupees 9 the garce, employing four servants for seven months at Rupees 2-8-0 each he expended Rupees 70, and for extra baskets, etc., Annas 8. His profits on the season amounted to Rupees 6-12-0. Ryot "C. D." manufactured 110 maunds, for which he received Rupees 8-4-0 at the same rate of Kudivaram, employing one man for six months at Rupees 2-8-0 he expended Rupees 15, and extras Annas 4. He lost 7 Rupees on his season's work. It cost "A. B." Rs. 8-3-0 to make a garce of salt, and it cost "C. D." rather more than Rupees 16. C. D. moreover was employed for six months in making it. These statements, though deriving a certain amount of confirmation from the known defective state of the manufacturing arrangements at Kuppili, are given as they were received and for what they are worth.

14. The extreme dates of manufacture for the last six years have been the 17th January and the 17th June respectively, the average period of work in the salt beds has been four months; now, whether we take four or six months, it will be found that Ryot "A. B." has turned out of his pans a larger quantity of salt than the average Now-padañ ryot, which is, to say the least of it, unlikely.

15. In another return the Deputy Collector states that the average produce of an ordinary allum, measuring 18,152 square feet, is 111 maunds 46½ seers a month, a produce so much greater than that of Ichapur, as compared with area, that, if correct, it would go far to prove that produce bears no relation to the impermeability of the pans and the amount and strength of their water-supply, an absurd proposition.

16. It will be noted that the Kuppili salt coolies are paid at the rate of one anna and three pies a day. The pans are in patches of four or

five ullums, separated by broken ground, not easily guarded against smugglers; they are owned by 128 ryots, many of them of the money-lending class; these men appear to care little for salt culture; if the profit and loss return be at all correct, many of them have suffered through their connection with it. The Deputy Collector informs me that the coolies mutiny and desert the works, whenever he attempts to introduce improvements.

17. It is difficult to conceive arrangements for salt manufacture worse than those existing at Kuppili; they are badly situated both as regards soil and water-supply, badly planned and carelessly constructed, the system adopted of the most primitive kind, open to every objection dwelt on in the earlier part of this report. I do not think under the circumstances that it is worthwhile attempting improvements in this division. To obtain good salt would be both a difficult and a costly matter, and considering its isolated position, the indifference of the manufactures, the proximity of Womeravilly on the north and of the new salt division, Conada, on the south, its abandonment would not be a loss to any one.

2nd Division—Bimlipatam, arrived March 5th, departed March 7th, 1872.

1. The salt works are situated on the north side of, and close to, the town and harbour of Bimlipatam; they are consequently approached to within a short distance by excellent roads.

2. The pans, few in number, are laid out on an island which rises from the backwater to an elevation of five feet; the soil is chiefly alluvial earth brought down by a river, which in the monsoon season washes the skirts of the island and makes its exit at the bar a quarter of a mile further off.

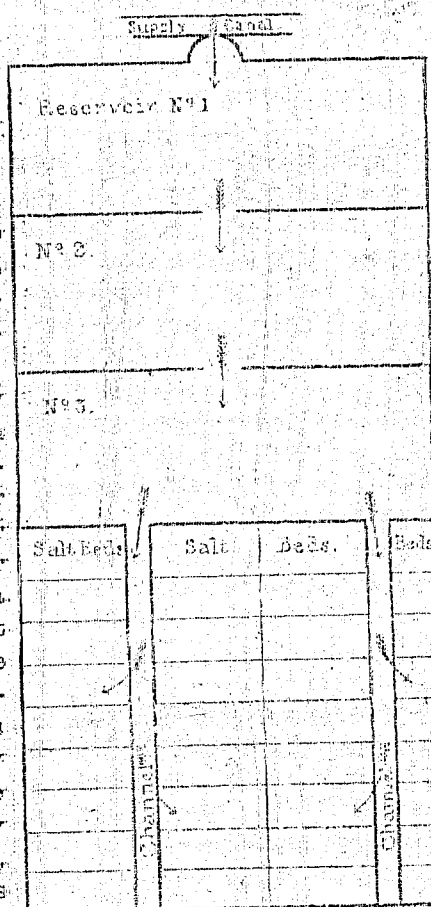
3. The backwater is shallow, easily forded at low tide; it marked 4° Beaumé, showing it to be unaffected by the river, but very effectively disposed for condensation; it is conducted to the works by means of canals which pierce the island at three or four points, and then break up into branches which ramify amongst the pans; the main canal is provided with a masonry bridge and sluice gates, which are intended to admit brine at high tides, and retain it for use when the canal arrangements are complete.

4. The works are, many of them, new; there are but 40 pans; and so far, notwithstanding great natural advantages, they have suffered in the midst of plenty from want of brine, as the canals are cut at a level seldom covered throughout at ordinary tides.

5. The ullums are better planned than usual; 76,650 square feet are allotted to the condensers out of a total area of 110,043 square feet, the beds are from 24 to 45 in number, as a rule well made, but sometimes as soft as possible; the latter were said to have been new pans; the reservoirs and channels were unprepared.

6. The following sketch will serve to illustrate the mode of manufacture here and at the remaining divisions in this district. Water follows the course of the arrows from the supply canal through the first, second, and third reservoirs to the salt beds. It is exposed a certain time in each, and increases in density as it approaches the beds. It is finally exposed for a day or two in the channel, and admitted to the salt beds with a density of from 15° to 20° Beaumé.

7. The chief feature or speciality of the ullums in the Vizagapatam District is the channel which conducts brine from the last reservoir to the salt beds; it is made after the idea of the Deputy Collector more as a condenser than as a channel, and is usually 12 feet wide. It is utilized much in the same way that I proposed utilizing the condensers themselves by exposing in it frequent shallow batches of brine taken from the last reservoir, which are rapidly condensed enough for irrigation, and passed into two or three beds at a time.



8. The water in the last reservoir averages 13° Beaumé, it is exposed for one or two days in the channel an inch in depth, and gains perhaps 5 or 7 degrees of density. This is without doubt an excellent plan, but it has its drawbacks; the channel floor is unprepared; to a depth of 6 or 8 inches, it is, by reason of its being constantly acted upon by strong brine, a mass of liquid mud, which is carried into the salt bed and scraped with the salt; the channel is moreover used as a receptacle for the "bitterns" which are thrown into it every third or fourth scraping. So that it is hard to say what amount of rise in condensation is due to their action and what to the action of the sun:—

9. system.	A. Fresh.	B. Mother.	C. Prepared.
	Inches. Degrees.	Inches. Degrees.	Inches. Degrees.
I. ...	1 17° B.	4 28° B.	2 20°
II. ...	1 19° „	4 30° „	2 22°
III. ...	2 19° „	4 30° „	2 21.5°

The fresh brine is from the combined action of sun and bitterns in the condensing channel nearly twice as strong as usual. The prepared brine is, considering the rate of evaporation, an inch in $4\frac{1}{2}$ days, quite deep and strong enough to obtain very good crystals.

10. Taking the prepared brine as two inches at 21° Beaumé we find it must lose 20 per cent. of its bulk, or 4.8 lines before reaching saturation, and that the remaining 19.2 lines at 25° Beaumé, must lose 77.6 per cent., or 14.8 lines, before reaching 32° Beaumé; this it will do in eleven days at the prevailing rate of evaporation, affording ample time for crystal formation and leaving 4.4 lines of mother liquor.

11. The salt broken up and scraped in the usual way was good-sized, well-crystallized salt, but for the most part extremely dirty, it contained a slight sprinkling of magnesium crystals. Many of the pans were opened in 1864, and are not as well made as they will be perhaps when time consolidates their floor, but this is no excuse for the dirt and discoloration of the salt; the bed floors are themselves badly prepared and covered with mud from the side channel; the mother liquor is insufficient and the salt scrapers are careless to a degree.

12. The pan-owners are, some of them, in their way, rich and haughty people, who brook very little interference with their work or what they are pleased to consider established customs, and the scraping of dirty salt is with them an ancient custom and a privilege. Mr. Clarke, Member of the Board of Revenue, who examined the Vizagapatam Divisions last, treating of them collectively writes as follows under

date 24th April 1864:—"These servants offer for sale an ingredient more resembling sand and mud than salt, of which the Bengal officials write that no one in the more civilized part of the Presidency 'would look at it.'"

13. Now, though the salt remains much as it was in 1864, I think that this is due more to the character of the soil in this district, the carelessness in constructing and scraping the beds, and to the present use of the condensing channel, than to inaction on the part of the Superintendents, whose power I have already shown to be limited.

14. Whilst staying at Bimlipatam, an old and intelligent Brahmin who owned many pans, took occasion, notwithstanding my presence and that of the Deputy Collector, to show us, in consequence of what he considered extreme oppression, what power and influence he wielded at the pans and what pressure could be brought to bear on the Superintendent in our absence.

The Deputy Collector, Mahomed Ali, had, on the day of our arrival, issued instructions to the Superintendents to refuse all dirty salt at the platform; that evening, therefore, as the salt arrived, I think at least seven-tenths of it must have been rejected and with good reason. The old man harangued the ryots who quickly assembled and would have succeeded were it not for our presence in getting up a strike; as it was

he walked away with all his following, a great crowd threatening Mahomed Ali with the law and promising at the least a failure of the dittum.

15. The dittum is the amount of salt in garce allotted to each division for manufacture; it is regulated by the central authority according to the requirements of trade at each place, and its failure would cause some inconvenience to the department; for this reason Superintendents are solicitous about it and fear to press too heavily on the ryots lest, abandoning the pans, they should cause its failure and involve them in disgrace.

16. In the present instance the old man returned to work on the second or third day as we were leaving the division, and I suspect supplied salt much as before, but the fact remains that he had no hesitation in threatening the Deputy Collector, the chief salt official in the district, which shows plainly enough in what estimation he would hold the unsupported authority of the Superintendent. It is a mistake I think, to allow a single individual of the old salt customs, conservative type at all events, to become possessed of such a number of ulum that he can in any way exercise pressure on the Superintendent.

17. The mode of rejecting the salt at this and other division deserves a word of comment. About sun down a variable number of coolies from 20 to 100 or more come tripping to the platforms; some times one platform, sometimes at large stations half a dozen, laden with fresh scraped salt which they are about to add to their heaps; now, as the Superintendent can only be in one place at a time; at large stations he is obliged to appoint assistants or peons, more often the latter, to examine the salt; but even at small stations, such as at Bimlipatam, his other duties, involving money transactions, often require his presence elsewhere than at the platform gate, and peons supply his place; these men may be honest and of the best intentions, but they have the power for the time being, of rejecting or passing each basket of salt that is brought to the gate, and this further according to their own unaided appreciation of it, for unlike most contracts, that for salt is regulated by no standard either of size, color, or purity. This power is, I suppose exercised with discrimination; but, as the temptation to receive, if not to exact, presents on the face of it exists, I would suggest that sample of salt in sealed bottles be issued to the platforms as a standard with which to compare and by which to receive or reject newly-made salt.

18. The salt destroyed at Bimlipatam and in the Vizagapatam District generally is thrown into the reservoir where it quickly dissolves, and a great part of it is lost through leakage. When it is too small, it should be dissolved and re-crystallized in the beds; when dirty, washed with its mother liquor, or with brine at 26° Beaumé.

19. The other arrangements of the manufacturers are as at Ganjam.

20. The wind here is from the sea nearly south; the pans are more or less sheltered on all sides by the hill of Bimlipatam on the south, large sand hills on the east, and a thick belt of trees stretching round and uniting the town with the coast on the west and north.

21. An ordinary plim, measuring 110,043 square feet, produced on an average of eight years 4 garce 20 maunds of salt per mensem, a surprisingly large yield, the largest yet noted, due probably to the strength of the water-supply which is four times as strong as that of Kuppili and twice as strong as that of Nowpada.

22. The following is taken from a statement showing the receipts and charges of a pan-holder at Bimlipatam:—

Ryot "A. B." manufactured in Fasli 1279 2,180 maunds of salt for which he received, at contract rate Rupees 9 the garce, Rs. 163-8-0. He expended Rupees 123 on servants, employing seven for six months at Rupees 2-8-0 each, and one cooly maistry at Rupees 3; further charges are shown as nine scraping boards, 36 baskets, etc., amounting in all to Rupees 8-14-7; these are not annual charges, and are not therefore included in the calculation, which gives about Rupees 6-13-0 as the cost of manufacture and Rupees 2-3-0 as the profit per garce.

23. Rupees 6-13-0, the cost per garce, though a great improvement on Kuppili, contrasts most unfavorably with the cost of manufacture in Ganjam, and this is all the more deplorable as the arrangements, with the exception of those which relate to cleanliness and impermeability, are better, and the produce to area is decidedly greater; the difference must arise from the manner of employing coolies as the hire at the rate of one anna and three pies a day is the same at both places. Judging from the elevation of the Bimlipatam pans, the absence of the impermeable clay strata, the excellence of the drainage, and the want of care in preparing the works, it seems probable that they leak a good deal, and that the labor of filling the reservoirs with slung baskets and keeping them full is greater and more expensive than at Ganjam.

24. I fear I have not a very reliable statement on the salt trade of Bimlipatam; the total sales are put at 23,512 maunds, of which 7,128 are taken north, and precisely the same amount west, south, and east; the latter seems especially unlikely, as the pans are close to the beach on the eastern coast, and there is no export.

25. Their owners apart, these pans deserve to be extended and converted into an export station for salt; they are well laid out, sheltered from the wind, easily guarded and superintended, and plentifully supplied with unusually strong brine; these advantages, no doubt, result from their having been originally chosen by, and constructed at the expense of Government, as I gather from Mr. Clarke's report, who says, also that manufacturers were obtained with great difficulty at first.

26. Close to a commercial town and harbour with which they are in

direct water-communication these pans present uncommon facilities for the export trade of salt.

At Covelong, which is the chief and rapidly becoming the only place of export in the Presidency, salt has to be taken some distance in boats and then by land, part of the way through heavy sands, before it reaches the export platform, situated itself about 500 yards from the beach which again is beaten by a triple line of surf.

27. Shippers at Covelong have to defray the contract charge, Rupees 13-8-0 plus all other expenses; they get the salt at the platform for Rupees 16-8-0, and it costs them roughly Rupees 20 a garce to get it on board. At Bimlipatam their expenses would be contract charge Rupees 9, conveyance, etc., to the ship, perhaps Rupees 4, or in all Rupees 13 per garce, showing a difference of Rupees 7 per garce in their favor, which would add enormously to their profits.

28. At the present time there are not, I think, any ships engaged exclusively in the salt trade; the margin of profit is so small that it is not thought worthwhile; ships in ballast, working round to Calcutta from Bombay and the Persian Gulf, stop at Covelong for a cargo of salt, but with such opportunities as Bimlipatam affords the salt trade of itself should pay well.

29. The question of profit and loss is one that concerns the shippers only; the Madras Government would gain nothing more by the export trade than the increased wealth and commercial importance of the export town, as the salt is parted with at cost price; but on the other hand the Imperial Revenue benefits, the duty levied at Calcutta on imported salt, being, as I am informed, Rupees 350 per 100 maunds. The bulk of the salt which pays duty at Calcutta now comes from Kurrachee, the Persian Gulf, and even from England.

30. Another advantage at Bimlipatam is the facility of obtaining provisions, port clearances, and other necessities on the spot, which cannot be had at Covelong, nearer than Madras, distant 20 miles, a circumstance which frequently gives rise to vexatious, because costly, delays.

31. As shippers are themselves obliged to deduct from the profit or gain on their cargo, the cost of conveyance, which is reckoned by time, their net profit, other things being the same, is evidently inversely as the distance, so that trading from a place like Bimlipatam, comparatively near to Calcutta, should be much more profitable than taking salt at Muscat, Kurrachee, or even Covelong, not to speak of England, though the prime cost of salt at the latter places with the exception of Covelong is less.

32. The improvements required at Bimlipatam are deepening and enlarging the supply canals, and those which have relation to leakage, the exclusion of dirt and residual salt from the manufacture, and the prevention of wastage in the stored salt.

33. To adapt this division to the export trade would be a work of two or three years at least, as the number of ullums at present in use is not more than required by existing wants; it would be necessary first to extend the area under salt cultivation, and manufacture and store a supply at all events equal to the prospective demand.

3rd Division—Kurasu, arrived March 11th, departed March 12th, 1872.

1. The Kurasu salt pans are about three miles from the sea and about the same distance south of the town of Vizagapatnam, in a small valley girt round about by lofty and abrupt hills, which separate it from the sea except where the backwater enters, or perhaps more accurately a river makes its way out from the surrounding water-sheds in the flood season.

2. The works four feet above the sea level are supplied from the backwater by means of a canal half a mile in length, which is filled at high tide, and provided with the usual defective dam of stakes and sods to prevent outflow; the dams in this division and at Pentacottah are, however, better made than usual.

3. At the time examined, the canal had been lately filled, the brine within and without the bund marked 3° Beaumé, this a fair strength to start with, shows that the backwater is unaffected by the stream, which is, as a rule, dry throughout the salt season though liable to freshes.

4. The soil is of the usual character with an increased proportion of laterite, which interferes with the hardening of the beds and gives the salt a red tinge unless great care be taken in scraping it.

5. There are 56 pans in this division, averaging 77,760 square feet in superficial area, of which the reservoirs, 4 in number, take two-thirds, the salt beds from 25 to 30 one-third or 25,920 square feet; they are laid out on a plan very similar to that shown in the sketch of a Bimlipatam ullum, having a condensing side channel of the same dimensions.

6. The floors of the beds had been carelessly prepared; they were soft and covered with a layer of soft red mud, which is carried in from the condensing side channel and loosely deposited, thus rendering the action of this channel practically injurious.

7. The depth of water bailed into the reservoirs in the usual way varies from two feet in the first, which marked 4° Beaumé, to six inches in the fourth and last, which averaged 12° Beaumé.

8. System.	A. Fresh.		B. Mother.		C. Prepared.	
Beds.	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1½	16°B.	¼	30°B.	2	19°B.
II. ...	1½	12°,,	½	29°,,	2½	17°,,
III. ...	1½	7°,,	¾	30°,,	1½	20°,,

9. A. shows that the water which is taken from the last reservoir at about 12° Beaumé gains four or five degrees in the condensing channel; how much of this may be due to the action of the bitters and how much to solar evaporation is uncertain. C. shows that it gains a further 3 or 4 degrees Beaumé from admixture with the mother in the bed, so that the reservoir brine gains altogether some seven or eight degrees in 24 hours, the time which generally elapses from its admission to the channel to its exposure in the bed; as the rate of evaporation was one inch in 4½ days it is evident that but a fraction of the increased condensation can be attributed to this cause.

10. The salt crops were good, the crystals large and well-formed, but of a pinkish tinge, owing to the laterite and the want of washing; a large number of fine magnesium crystals were sprinkled through the salt, these had separated from the mother liquors shown in column B. The bitters, therefore, at 29° and 30° Beaumé were not only saturated solutions of common salt, but also of the more soluble magnesium sulphate and chloride, which will separate largely if the prepared brine is evaporated again to the same density as it probably will be. This peculiarity of the manufacture has been already explained; its occurrence so soon as the beginning of March results from the earlier date of commencement of manufacture at Kurasu; it began in December, and had already reached the 4th or 5th scraping.

11. A strong wind from the south-east swept through the valley during my visit; it is a constant source of trouble to the ryots, who at the same time employ from eight to ten men to raise brine to their reservoirs.

12. An ullum measuring 77,760 square feet, taking the average of the past three years, produced three garce and a half a month, a very satisfactory yield, but it must be remembered that the yield here and at the other pans includes the residual salts, even sulphate of calcium, which is deposited from 17° to 25° Beaumé, and that these salts form 21·7 per cent. of the saline constituents of sea water.

13. The following statement as to the cost of manufacture is supplied by the Deputy Collector:—

A middle-class ryot received last season as Kadivarata for salt made Rupees 275-4-0, and he expended Rupees 285-12-4 on its manufacture, or at the rate of Rupees 7-12-0 a garce, as follows:—Nine servants for six months at Rupees 3 per mensem = Rupees 162; conveyance of salt to the platform, Rupees 60; sundries, Rupees 12-8-4, of which Rupees 6 is entered as interest for money borrowed.

14. Excluding the Rupees 6 and the sundries generally, as they are not annual charges, the cost of manufacture is still very great; of the remaining charges that for carriage of salt to the platform is one that I do not understand in the account of a ryot employing nine men at a

The fresh brine is here, notwithstanding the use of the condensing side channel, very weak, on a par with Womerally and Kuppili, and the prepared brine, which owes much of its strength to the residual salts, is both weak and scant, considering the accelerated rate of evaporation, now four days to the inch. Besides the beds here given, I examined several others in which the irrigations had been two or three days evaporating for salt, and found the brine varying in density from 12° to 15° Beaumé.

The salt crops were poor, the salt friable and small in crystal, but tolerably clean; it contained, however, a good sprinkling of magnesian crystals, as the bitterns are not removed in any practical sense, but thrown into the side channel and re-admitted to the bed about every fifth scraping.

11. The fact is that the ryots here are new to their work and apparently ignorant of its first principles; some of them came to me and complained that they were told to make good salt without knowing how, or being instructed how to do it. The Superintendent cannot instruct them; they have no special knowledge; they fall back on these occasions on Major Plowdon's report, which is in the hands of the Deputy Collector, as a book of reference. The report, though replete with valuable information, does not serve as a teaching manual; it treats in fact much less of salt culture than of the statistical and other details connected with the department.

Some rules to work with are badly wanted at the pans. I was struck by the desire of these people, to increase their knowledge, to accept and adopt any suggestions that might be made for the improvement of their manufacture.

12. The salt made here has a bad reputation; it is said to gripe and cause irritable cutaneous eruptions, with what truth I am unable to say. The statement furnished as to its sales and the part of the country to which it is taken for consumption being, northward 610 maunds, southward, westward, and eastward 610 maunds each; total 2,440 maunds.

13. Although these ullums are 60 miles from Balycherry, the nearest salt station on the north, and 45 miles from Penugudur, the nearest on the south, and cannot therefore suffer much by competition, the sales are less by 26,072 maunds than at any other division in the district, or taking the average sale all round by 82 per cent.

14. The following profit and loss account has been sent me by the Deputy Collector:—

"A. B.," a pan owner, made $7\frac{1}{2}$ garce of salt, for which, at Rupees 67-8-0 the garce, he received Rupees 67-8-0; his expenses were servants' wages Rupees 67-1-0; other charges Rupees 7; total Rupees 67-8-0; profit or the season's work nil; cost of manufacture per garce Rupees 9.

15. This seems to me a doubtful statement, because, if for no other reason, Ryot "A. B." would probably abandon the manufacture

seek a better investment for his labor and capital before finishing the $7\frac{1}{2}$ garce, which were made, not only without profit, but at a considerable loss of time.

16. Another ryot, "C. D.," manufactured 20 garce and 27 maunds, for which he received Rupees 132 at the same rate; his expenses were servants' wages Rupees 128-15-0, other charges 15 annas; profit Rupees 52-15-0; cost per garce Rupees 6-8-0.

17. The produce of the pans in garce per area per annum is not given, as the pans have only been worked for two years, and the returns of the first year, generally a bad one, are alone available.

18. We have seen that in the Vizagapatam District generally the cost of salt manufacture is greater than in Ganjam, and that the article turned out is inferior in many respects to that made at the northern pans; this cannot be, owing to the water-supply which is, as a rule, stronger and more abundant here, nor to the system of manufacture which is, except in the matter of the floor of the condensing channel, as a rule better, nor yet to the cost of labor, which is here 1 anna and 3 pies a day; that part of the increased cost which is not an exaggeration is owing I believe to the porous character of the soil and the negligence of the ryots in preparing it. At Pentacottah, however, what difference there is, is due to neglect or ignorance as the surface soil is precisely the same as that of Ganjam.

19. At Pentacottah I noticed for the first time "Picotahs" at the salt pans; they were of the commonest variety, a long-armed lever of the first order; its fulcrum the top of a palmyra stump, 15 feet from the ground; the power, a cooly walking up and down the arms; and the resistance a vessel of water.

20. Judging from Mr. Clarke's report in 1864, I think the quality of the salt made in this district has improved a good deal of late, especially at Kurasa, that is, in the size and color of the crystal, not in purity; the wastage he spoke of must, owing to the presence of magnesium chloride, continue as great as ever.

21. Speaking of sulphate of magnesium, the Deputy Collector says, "Mulluvayon, as it is called in this district, is produced in the hottest weather, and at the close of the manufacturing season it is produced about half a maund at a time; when this salt is produced, the beds are cleaned and weak water is let into them to get rid of it."

22. No regular account of the amount of salt destroyed is kept here or at other districts, even where it is the custom to hire labor of some sort for the purpose of destroying it; but, estimating it by guesswork as near the mark as possible, the Deputy Collector states that 47,877 maunds, or one-eighth of the total quantity made in the season, is destroyed for being too dirty for use; 13,935 maunds, or one-sixteenth, for being too small and friable; and 38 maunds owing to the presence

of magnesian salts; this, though giving a total destruction of 61,850 maunds, a larger amount than is manufactured at any single division in the district, was, I presume, necessary to keep the manufacturers up to the mark, as to receive bad salt once is to ensure its production for a long time; but, although we may reasonably expect by an improved system to obviate the necessity for the greater part of this destruction in the future, still, in the face of these figures and the knowledge we possess of the men to whom the power of destruction is delegated, there ought to be, in the interests of all concerned, a hard and fast line of demarcation between good and bad salt drawn, known alike to the ryot and to the Superintendent for the guidance of both.

I have much pleasure in here thanking Mahommed Ali, Deputy Collector, Salt Department, who met me at Kuppili, and accompanied me through the district, for the assistance he afforded me in obtaining information at the different salt stations we together visited.

GODAVERY DISTRICT.

Pennuguluru, the only division in this district, was visited on the 20th and 21st March 1872.

1. The salt pans are about five miles south of Cocanada on a wide open plain which falls gradually to the sea. They are, at their commencement, a mile and a half from the beach, from which they stretch away at right angles in a broad irregular line which terminates two miles further inland.

2. Their mean level is about four feet above that of the sea. The soil is dark, somewhat loamy in appearance, consisting of alluvial earth with a less admixture of sand than at most places; it is well adapted to the formation of salt works, and a thick belt of clay which underlies the pans, at a depth of two feet, adds much to their impermeability.

3. At the time examined, March 21st, the works were still in course of preparation; salt manufacture had not yet commenced. The Deputy Collector gave reasons for this strange delay as follows:—The manufacture never commences till the end of March or beginning of April, as high spring tides are required to supply the works.

Better salt is obtained in the late months of the season owing to the greater power of the sun. As the work is done by contract, and the ryots are able to supply the required amount of salt in two or three months, beginning early is of no consequence.

4. The last reason of these three is probably that which has most weight in regulating the time for commencing operations; looking to the area under salt cultivation, and the probable "dittum," there need be no apprehension as to its fulfilment within a limited period, and the ryots are suffered to choose their own season; they naturally choose the hottest weather for their work, not, as might be supposed, from the second reason

given, because the salt is better; for, with their system of weak and shallow irrigations, the crystals must be worse, but because they can get through the contract in a shorter time and make a greater profit out of it.

5. However this may be, there are, or have been, other reasons for delaying manufacturing operations to a late month in the year which the Deputy Collector did not notice. Major Stoddard says: "The water in the Bay, from which that used in the manufacture of salt is derived (the Bay itself being the receptacle of the contents of the Godavery and of the surplus water of a great number of canals and drainages), is quite fresh and sweet for six or seven months, and for the rest of the year is never so briny as the sea water higher up the coast is." He thinks for this and other reasons that "it is not possible to begin the manufacture of salt till the season is considerably advanced, thereby running the risk of having the salt destroyed in the pans by the mango showers."

6. Mr. Clarke remarks in the letter quoted (paragraph 23): "The water in the creek was, the Deputy Collector thinks, in February, of the usual density of salt water. It may, however, be necessary, from the large precipitation of fresh water into the Bay during the monsoon, to defer the date of commencing the operations of the season till the end of February or the beginning of March, but this is not too late a date to make the quantity of salt required in this division."

7. With the present system of manufacture, the period of commencing operations has, owing to the rate of evaporation, much to do with the size and appearance of the crystal. Superintendents are agreed that the first salt formed is the largest and, in other respects, the finest; but even supposing a new method be adopted, which fixes the period of crystallization at so many days irrespective of the season; still, this question has something more than a retrospective value; for such a system would, if started in March, extend the manufacturing operations to a dangerously late period of the year, and besides the delay is after all hardly necessary and to a certain extent injurious.

8. I found that sea water taken from the Bay at the mouth of the creek, which supplies the works, marked 3° Beaumé, an increase of 25 of a degree, or more than nine per cent. of salinity, on the reading obtained at Pentacottah five days previously and from water unaffected by the Godavery.

9. This may be explained by the disposition of the water in the Bay, more especially where it skirts and supplies the salt works. Owing to the quantity of silt and other deposits brought down by the Godavery and the action of the tides upon them, the foreshore is rapidly extending, and the Bay is shoaling for a long way out, so much so that ships have been

obliged to shift their anchorage several miles to the north. The result is that a vast expanse of sea water is spread out in a thin sheet under circumstances most favorable to evaporation; it is heated much more rapidly than the deeper waters without, and then from its shallowness, every inch taken from the surface materially affects its bulk and consequently, its density or degree of saturation, so that, were it not for the constant action of wind and tide, it would soon acquire a high degree of density. Three degrees Beaumé is about the maximum density of sea water, and, with such a reading in the middle of March, it is highly probable that the brine here is as strong in February as sea water elsewhere, or perhaps equal to its mean density, 2.75° Beaumé. At any rate, as Ganjam and Nowpada are both supplied with backwater at 2° Beaumé and they rank high as to the amount and quality of the produce of their pans, we may conclude that, as far as the strength of the brine is concerned, the manufacture might commence here at as early a date and under equally favorable circumstances.

10. But to return to the first reason given by the Deputy Collector, that high spring tides are required for the works; I found that here, to the same extent as elsewhere, they were of great use in filling the supply canals to a high level, but they are not required to the extent of being essential or anything of the kind.

11. Water is obtained from a small creek by means of a canal which taps it close to the sea, and conducts the brine to the works. The mouth of the creek is silting up. At the time of my visit a bar had formed, which extended far into the Bay, and was covered with but two feet of water at high tide.

12. Earlier in the season the bar is less pronounced, water gets in more abundantly, and the work of construction begins in January and progresses without difficulty or interruption. This should be an inducement to commence early rather than the reverse—to use in December in the construction of the works the abundant, though perhaps weak brine, at a time when its density is a matter of indifference, and later for the manufacturing operations proper the condensed brine which will be found as plentifully as it is now for construction.

13. Moreover there is generally an appropriate time for making bunds, which is seized on for that purpose by the ryots at other divisions, that is, when the ground is still moist, neither too wet nor too dry; in that condition to which it must be brought by artificial means at Penuguduru; the times varies a little in different localities with their level and drainage, but it is generally some time in December after the "monsoon."

14. The water which flows up the canal twice a day at high tides might be altogether, and is to a great extent, prevented from flowing back with the ebb by a wooden sluice gate, which spans the canal and commands the entrance to the works; but this sluice gate is provided for

another purpose than for the supply of the pans, though one which embraces that effect in theory; the canal is navigable but at high tide only, boats then pass into it to take salt from the platforms, and the sluice is closed to keep them afloat, but in practice the boats in their passage to and fro cause delays through which much of the water escapes; besides, anything like condensation in the canal water itself is altogether prevented.

15. The canal was at the time of my visit sufficiently filled at high tide as far as salt manufacture was concerned, but I believe, owing to the depth being insufficient for navigation, it was under consideration to cut another canal from a small creek nearer to Cocanada, from whence it was hoped to obtain a larger volume of water; if this be done, it would be well, if possible, to keep the two distinct, and let one retain brine for condensation.

16. The ullums here are larger than at any of the other divisions I examined; they average 214.164 square feet in superficial area, well planned in one respect, the condensing being to the crystallizing area as two to one, but so complicated in arrangement that a diagram would be a perfect puzzle. There are large reservoirs of the first stage, small ones of the second, still smaller of the third called Coplavas (in shape something like the Vizagapatam condensing channel), and smallest of all Yidalooos and Yidamadis, condensers of the fourth and fifth stage. These reservoirs and condensers are altogether 41 in number; they are of all sizes, irregularly arranged, at various angles to each other, as are also the 50 odd salt beds which they supply.

17. Having had here for the first time an opportunity of witnessing the work of construction, I am led to a few remarks on the subject.

18. As the work of preparation occupies from five to six weeks, and the condition of the soil is altering from day to day, it is the custom here, though not so much so as elsewhere, to proceed with all the bunds first, then to fill the reservoirs, and with water taken from them to puddle and stamp the floors of the salt-beds to a proper consistency.

19. This is not in accordance with Major DeHavilland's recommendations issued to the Superintendents, which are in several paragraphs to the following effect:—First, make and fill the reservoirs, afterwards go on with the construction of the other parts of the ullum with water taken from a different source, that when the beds are ready the water in the reservoirs shall be far advanced on the road to saturation.

20. The difficulty in the way of carrying out his views in their entirety is that the beds are several times irrigated and puddled in course of construction, and the reservoirs intervening between the beds and the source from whence water is obtained form the most convenient, and sometimes as at Penuguduru without very special arrangements, the only practicable source of supply.

21. This might be obviated if the advantages to result were as great as he supposes, but to take his second reservoir, which gives the mean depth of the other two, viz., two feet of water, and to assume its impermeability, we find that, according to M. Usiglio's observations, it would not, at the end of the period of construction (six weeks) have reached a higher degree of density than 5° Beaumé; for M. Usiglio shows that water in passing from 3.50° to 7.10° Beaumé loses 46.7 per cent. of its bulk, and that the loss of bulk requisite to procure an increase of one degree in density, is, as far as saturation, inversely as the specific gravity, hence the two feet of water in the reservoir in December, probably at 2.50° Beaumé, would lose quite 40 per cent. of its bulk, or 0.6 inches from the surface in gaining 2.50 degrees of Beaumé, while judging from the rate of evaporation in February, five days to the inch, would take considerably over six weeks.

22. It is to be feared also that water left in the reservoirs as at present prepared would in six weeks be greatly diminished by leakage. Here the floors are not properly attended to; that of the Yedunadi, like the Vizagapatam channel, though to a less extent (owing to the character of the soil, yields mud with the brine irrigations, so that, were it not for their impermeability, the bed floors might as well themselves be neglected.

23. In making the bed floors the ryots do not avail themselves of the clay which underlies the pans, neither do they use any binder, as hair; the bed is simply wetted and trodden underfoot until it is worked to a smooth and solid surface; this takes a variable time according to the number of coolies employed: one cooly for fifteen days is the basis of the calculation; here five were employed, I presume, for three days; sand is constantly sprinkled under foot whilst the kneading is going on, to prevent the wet earth from getting too sticky.

24. Water is bailed from the canal to the reservoirs by the tank or scooped palmyra trunk picotah; three men accomplish with it as much work as eight can do in the north with slang baskets.

25. Though I have not witnessed the manufacture, I have no doubt it is, in its main features, the same as that I have already described. The Deputy Collector has sent me a description of it, which I re-produce here, because it is a fair sample of the tests which are applied and the style of investigation to which the system is subjected here and in other districts:—"First, water is bailed by picotahs from the canal into the channels, and is conveyed to the reservoir called 'Usligoondam,' in which it is kept for three days. It is then put into the second reservoir called 'Vedigoondam,' and is kept there for two days, after which it is put into the third reservoir called 'Coolava,' from thence it is taken into the long beds called Yida, and then into the beds called Yadamadi, from which it is taken to the salt-yielding pans. The space of time for which water is kept in the reservoirs Nos. 2, 3, and 4 is one day in each; salt

is scraped from the pans in four to eight days after they are filled with brine."

26. If this were all correct, without a knowledge of the depth and density of the brine and the rate of evaporation, it would still be useless information; but, in fact, the reservoirs, so far from each receiving and retaining for a certain period a given batch of brine, which is then passed on to the next in order as this and similar statements would lead one to suppose, they are all filled together and to a constant level, so that one can form no idea of the time brine has been in each except from its density.

27. Mr. Clarke says: "The water used is very little denser than sea water, and is never renewed in the beds, but is allowed to remain in them five or six days, and is then scraped up. The product is a poor friable stuff not adapted for carriage."

28. The salt in store was clean, but very poor in crystal; its appearance leads to the conclusion that very little improvement has taken place since 1864 in the usages described by Mr. Clarke; this may be, perhaps, owing to that lack of influence in the officials which I have elsewhere drawn attention to, and which Mr. Clarke notices more than once. Speaking of Penugoura, he says: "At some villages the manufacturers have not only refused to destroy salt rejected by the Deputy Collector, but have also resolutely opposed the coolies employed for this purpose."

29. The mother liquors are seldom, if ever, removed from these salt beds; their influence on the manufacture is not understood. The Deputy Collector states that moulaka, or growing salt ($Mg. SO_4$), appears two or three times towards the close of the season to the extent of about 100 maunds in all; it is thrown into the water whenever found, what water is not stated.

30. The quantity of salt destroyed at this division during the whole season is estimated at 5,000 maunds as follows:—

	Maunds
Destroyed for being too dirty for use	3,900
Do. do. too small or badly formed	1,000
Do. do. moulaka	100
Total	5,000

31. Its destruction is effected by throwing it into water, but again into what water is not stated, nor is any distinction made between the three classes; if all are destroyed together, whether in the canal or reservoirs, evil results, in the first case from wastage of good salt; in the second, from the re-admission of impurities.

32. A set of pans, measuring 214,164 square feet, produce on the average five and a half garce of salt a month; a yield which, in relation to area, compares badly with that of most of the previous divisions.

Ryot A. B. manufactured 25 garce of salt in four months, for which he received at contract rates—Rupees 10 the garce—Rupees 250; employing seven workmen for four months at Rupees 5-8-0 a month each he spent Rupees 154, and for plant and sundries Rupees 11 extra; total Rs. 165; cost of manufacture per garce Rupees 6-9-7; profit per garce Rs. 3-6-5.

33. With reference to this statement furnished by the Deputy Collector, it will be noted that the contract rate which was Rupees 9 at Pentadettah, 40 miles to the north, is here raised to Rupees 10 the garce, and that the cooly-hire, which has hitherto been about Rupees 2-8-0 a month, is now Rupees 5-8-0, an abrupt increase of more than 50 per cent. on the average hire, and a higher rate of wages than the lower-class of Indian coolies generally receive. The salt coolies are of the lowest class, and those that I saw at Penuguduru are as poor and hungry-looking, and, notwithstanding their higher pay, quite as naked as their brethren elsewhere.

34. The annual sales amount here to 280,000 maunds, of which 13,000 are taken inland, chiefly to Nargore, and the remainder sold for home consumption. There is no export now, though there appears to have been previous to 1864: the loss of export trade may be due either to the shoaling of the Bay or to the character of the salt in store, which is very inferior to that brought from Bombay, the Persian Gulf, and England.

35. There is no reason why the Penuguduru division should not make as good salt as any other, granting that the amount of brine supplied to the work does not fall much below the point at which I found it in March last. It possesses natural advantages of soil, a clay substratum, and sea water above the mean density, and I think an improved system and earlier date of manufacture should alter both the cost and quality of the salt.

36. Mr. L. Venkatappayya, Deputy Collector, Salt Department, visited Penuguduru with me, and gave me all the assistance in his power.

KISTNA DISTRICT.

Mangenapudi, arrived April 1st, departed April 2nd, 1872.

1. Owing to the number of swamps and backwaters formed by the outfall of the Godavery, travellers are unable, except at an advanced period of the dry season, to march direct from Penuguduru to Mangenapudi.

2. I was, therefore, obliged for the first time to leave the coast, and proceed from Cocanada to Bunder by an inland route *via* Rajahmundry and Ellore; from Masulipatam I turned north again, and a ride of five

miles brought me to Mangenapudi. In this way I missed the salt swamp of Pandraka, which lies to the north of the Kistna District.

3. As Pandraka is not a manufacturing division in the usual sense of the word, but a place where natural salt is gathered and stored, I did not think it worth while to retrace the coast further for the sake of seeing it.

4. I examined several specimens of swamp salt from the Pandraka stores, which were sent for by the Deputy Collector. The salts in irregular lumps of various sizes, from which small crystals project at many angles; it resembles a good deal the salt made at Cheyur, but it is better and not so easily broken up, for the crystals are formed in hollows of the swamp into which the receding waters gather as they evaporate, so that the increased density of the brine and the greater temperature are to a certain extent counterbalanced by the diminished evaporating surface presented to the sun, and crystallization is by the operation of natural laws protected from influences which would unduly hurry it.

5. There were some magnesium crystals mixed with the salt, but not many, nor were they present to a deleterious extent. Owing to the custom of gathering swamp salt under water, the object of which I believe is to procure it clean, the greater part of the residual salts are avoided; they are left still in solution; nevertheless swamp salt is disliked. Mr. Clarke, remarking on the preference shown by the inhabitants of the southern part of the Godavery District for an inferior description of manufactured salt, says that they have a mistaken prejudice that swamp salt is unwholesome. This prejudice must, I think, originate with the contraband dealers or rather with their customers.

6. When the Pandraka salt is gathered and stored, and I suspect, from the mere fact that magnesium crystals are to a slight extent present, that this is done a little too late; (after the brine has passed 32° Beaumé), there is yet some salt forming in the swamp, and other fine grained and unfit for storage is thrown back into it; thus the smuggler keeps his eye on, and later, when the mother liquors have further evaporated, and the deposit is quite impure, in the night, a dark night generally, he scrapes it all up, and hurries off with it.

7. It is quite certain that such salt formed from the abandoned "bitterns" would, if taken internally to any extent, produce speedy effects characteristic of its magnesium compounds, and, though from its intensely bitter saline taste, it would probably be used with economy, still its prolonged use would give rise to diuresis and, I think, diarrhoea also.

8. It is very credible that having once experienced the effects of these salts, proximate or remote, the ignorant villagers would suspect the whole produce of the swamp, but, provided with the hydrometer, the Superintendents will be able to obtain an absolutely pure article, and, perhaps, when the matter is better understood, the prejudice against swamp salt will disappear.

9. The Mungenapudi salt works, about a mile in length, are very well situated in a hollow bordering on the sea at a distance of 500 yards, and separated from it by a long low range of sand drift, over which at one point the waves sometimes break at spring tides and inundate the pans.

10. The level of the works is about two feet below that of the sea; their water-supply is not, as might be supposed from their proximity, carried directly from it, but exclusively from pits dug in connexion with each ullum; there is no backwater, nor is there any supply canal.

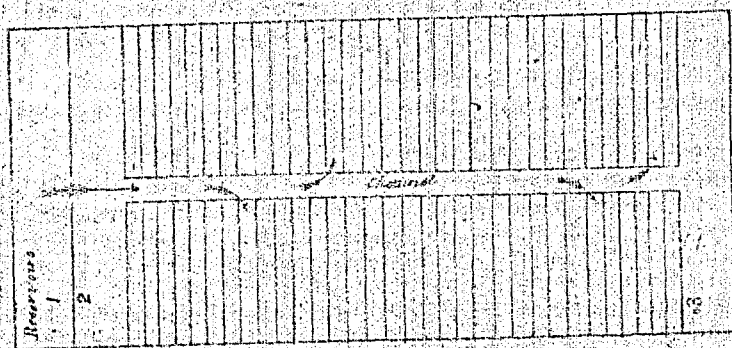
11. At the time visited the surface of the pit water was about nine feet below the surface of the soil; the amount of water supplied appeared scant, but was said to be sufficient; it averaged 12° Beaumé in density. As the season advances the pit water gets scarce, and it is obtained with difficulty by digging deeper; the labor is great and the brine insufficient; there is a fair opportunity here of making the experiment at a small cost of laying on sea water directly from the sea.

12. Brine is raised from the pits to the reservoirs by means of the well "picotah" worked by two men; this form can alone be used with deep pits, as the tank "picotah," though more efficient, has not sufficient dip.

13. There are 240 ullums well and regularly laid out. An ullum measures 46,692 square feet; it consists of beds and reservoirs in the numerical proportion of two of the former to 64 or 104 of the latter; the beds separately are smaller than usual, but taken together they occupy nearly four times the area allotted to the reservoirs.

14. The beds are made with care, but the earth composing their floors is largely mixed with sand; neither clay nor any other material is added from without, so that salt is scraped clean with but little trouble; but on the other hand, were it not that the works are below sea level, considerable loss from leakage might be expected.

15. An ullum is planned as shown in the following sketch:—



16. The most notable feature in this sketch is the comparatively small space allotted to the reservoirs; they are made to play a very subordinate part in the manufacture; in fact, owing to the strength of the pit water, 12° Beaumé, a degree of density which is elsewhere considered sufficient for the crystallizing beds, they are filled only to please the Deputy Collector, deemed unnecessary by the ryots, and altogether dispensed with later in the season. At the time of my visit several had been already abandoned, and the stretch they omitted was quite overpowering.

17. The method of salt manufacture here differs from that which has been hitherto described. Two or three inches of brine at about 14° Beaumé are let into the salt beds, and evaporated until salt forms; then, at the time they would scrape salt in Ganjam, two additional inches of brine are let in, also at 14° Beaumé; this dissolves the greater part of the salt already formed, and is soon raised to 25° Beaumé; salt is again deposited, and for the third time the bed is similarly irrigated; thus twice partially dissolving instead of scraping the formed salt; now the bed is let alone, and salt crystals begin to form, and are deposited from an inch to an inch and a half of saturated brine. The whole operation takes about three weeks.

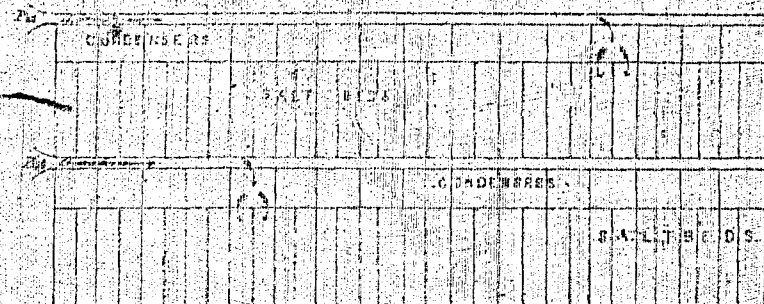
18. The following observations relate to the third or last irrigation:—

System.	A. Fresh.		B. Mother.		C. Prepared.	
	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1½	14° B.	¼	31° B.	1½	19° B.
II. ...	1½	12° „	¼	30° „	2	18° „
III. ...	1½	14° „	¼	30° „	1½	19° „

19. The increased density acquired by the fresh brine on admission to the beds, here shown to be 5° Beaumé, was noted within a few minutes from the completion of the prepared brine, and is due altogether to the action of the mother liquor; later in some hours, when the salt in part dissolves, the density rises rapidly and attains to saturation in from 24 to 48 hours.

20. The second salt formed is thus not altogether dissolved by the third irrigation; the magnesium salts, if any have deposited, are at once taken up, but the chloride of sodium which forms a compact layer flooring the bed, is after a time but little affected in contact with a solution at 19° Beaumé, at rest, rapidly evaporating to a higher density, and containing a good quantity of $MgCl_2$ which diminishes its solubility. It happens then, as the third brine reaches saturation before dissolving all the salt, that two layers of inferior crystals are deposited which dove-tail into each other, and when broken up form lumps, not unlike spontaneous salt, but lacking its cohesion.

8. The following sketch furnished by the Deputy Collector shows the plan of ullum:—



9. There are two brine pits, one for each row of condensers; the arrows mark the flow of brine as it passes from the channel into the condensers, and from thence gravitates into the salt beds, which are sunk to a slightly lower level.

10. The system of working differs from that of Mangenapudi, in so far, that there are here only two irrigations; salt is scraped after the second. The following observations relate to the first irrigation:—

System.		A. Fresh.		B. Mother.		C. Prepared.	
Beds.		Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I.	...	2	11° B.	1	30° B.	2 1/2	15° B.
II.	...	1 1/2	10° „	1	30° „	2	14° „
III.	...	2	10° „	1 1/2	30° „	2 1/2	16° „

11. The value of column A. as an index of the work done in the reservoirs, has been altogether changed in this and the preceding division, for, whereas hitherto it represented the increased density acquired by sea water at 275° B. or backwater often weaker, here it is pit water that has been evaporated, the initial strength of which must be borne in mind; in the present instance, the beds examined were far from the lagoon, and supplied by a pit yielding brine at 8° Beaumé. Column A., therefore, shows that the condensers have not been of much service in preparing the brine.

12. The sketch shows that the whole area of the condensers is exactly half the combined area of the salt beds to which they supply brine. Column C. shows that the amount of brine required for the next crop is two inches for each bed; hence there must remain four inches in the condensers, or rather more, as the levels are not good, after evaporation has

passed, and the brine is prepared sufficiently for the salt beds. The condensers must then, allowing for all this and leakage besides, be filled originally to a depth of six or seven inches, which in fact they are, and naturally the resulting condensation is shown by Column A. to be so unimportant as scarcely to compensate for the trouble of making the condensers, or the value of the ground they cover.

13. Hitherto the plan of ullum has been such that each bed communicates freely with a large reservoir or system of reservoirs, and although the gain in strength to the fresh brine has not been great, it might be made so with stauncher reservoirs and a better system; but here a number of isolated beds and condensers are so strung together that preparation, in the true sense of the word, is next to impossible; take for instance an ullum nearer to the creek supplied with pit brine at 3° Beaumé; this brine loses nine-tenths of its bulk before reaching saturation, but, having lost so much, four inches must still remain for the use of the beds, therefore the original depth should be 40 inches, which, even at the mean rate of evaporation for the season, three days to the inch, would take 108 days in reaching 25° Beaumé.

14. This division is an important one, possessing first-rate natural advantages which are neutralized by a plan of ullum intrinsically bad and incapable of being worked on scientific principles.

15. The salt deposited from the second irrigation forms a cake, perhaps a quarter of an inch in thickness, which is first broken up, and then scraped and heaped for two or three days on the pathway beside the bed, from whence it is removed to the ryot's heap on the platform. It is in fair-sized lumps of aggregated crystals, but little inferior to those made at Mangenapudi, but it is dirty salt scraped nearly dry from a soft floor, and heaped without washing.

16. At the time visited the heaps in store were without protection, though the nocturnal dews were heavy; this, considering that each had been already exposed in crops at the pan side, to drain and to dry, and to get rid of $MgCl_2$, is a bad preparation for salt about to be purchased and stored under thatch by Government.

17. An ullum, measuring 13,000 square feet, produces 1 garce 92 maunds of salt a month, a larger produce in proportion to area than at any other division as yet examined; this may be due to the low level and absence of leakage, but perhaps the Deputy Collector has chosen the material for this statement from an ullum supplied by a pit yielding brine more abundantly and of greater strength than usual.

18. The cost of manufacture is as follows: two coolies for six months at Ruppees 4 a month = Rupees 48; extras, plant, etc., Rupees 3; produce in five months as per foregoing statement, 8 garce 100 maunds, which bring in at the contract price Rupees 10 the garce, or Rupees 88-7-0; cost per garce, a fraction under Rupees 6.

19. The alterations required here have been already suggested; they relate to the water-supply, the plan and construction of the ullum, and the system of manufacture.

20. The 247 pans which make up this division are in the hands of 120 ryots; they are for the most part Mahomedans, and are said to be most insubordinate to the Deputy Collector. As to that I may state, as a matter of fact which has fallen under my observation more than once in this and the Vizagapatam Districts, that the presence of a Hindu official over Mahomedans ryots and *vice versa* does not tend to reciprocal good feeling between the manufacturers and their superiors, or to the smooth working of the machinery of supervision and control.

21. The pans are valued at different rates according to their produce, some at Rupees 100, others as low as Rupees 30; here they are bought and sold or mortgaged as real estate, and such too, is the custom in the remaining divisions as far as Cheyur. In the last district (Godavery) they are said to be valued indiscriminately at Rupees 100 the acre. In the Vizagapatam District, the pans at Bimlipatam alone are valued at from Rupees 15 to Rupees 80; at the other divisions, they are said to be of no value; and in Ganjam, where the profit is greatest, they are sometimes privately bartered at prices varying from Rupees 10 to Rupees 20 only.

22. Mahommed Ali, writing from Vizagapatam, seems to suggest that the pans are without value, inasmuch as they are given gratis to the manufacturers; but this cannot be, since everywhere that Government has opened or extended salt works the land has been a gift to the ryot; generally speaking, palmyra trees for picotahs are also furnished gratis.

23. As far as I can learn, the cost of preparing the land for salt culture does not exceed Rupees 12 the first year, and diminishes with each succeeding year, until it remains constant at about Rupees 5; in the meanwhile, the value of the ullum is progressively on the increase with its age.

China Ganjam, arrived April 10th, departed April 12th, 1872.

1. This is the largest and most important salt division in the Kistna District.

2. The ullums, 374 in number, are laid out on an extensive alluvial flat or plain, at about the level of spring tides four or five feet above the mean sea level; they are protected from inundation by long embankments. They commence at a point about a mile from the sea, from whence they stretch away at an oblique angle, forming an irregular line of works nearly two miles in length.

3. The soil is much the same as at Nizampatam, alluvial earth with a large admixture of sand cleanly to work with, but not easily made impermeable.

4. Water is procured exclusively from pits sunk at the time visited to a depth of 9 feet, and yielding brine, which, from different parts, averaged 9° Beaumé in density; it is said to be sufficient in quantity.

5. The reservoirs and beds were much firmer and better made than at the previous division; they are arranged as at Nizampatam except that there are two additional terminal reservoirs as at Mangenapudi, in which water for a time evaporates before being admitted to the smaller system of condensers, called warming beds. The beds collectively occupy four times the area taken by the reservoirs and condensers, of which latter there are 34; the area of the whole ullum is 30,240 square feet.

6. The triple system of irrigations, as described at Mangenapudi, is used here: the following observations relate to the third irrigation:—

System.	A. Fresh.		B. Mother.		C. Prepared.	
Beds.	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1½	15° B.	1	22° B.	2½	20° B.
II. ...	1	14° „	1	28° „	2	20° „
III. ...	1½	15° „	½	30° „	2	19° „

7. If these observations related to pure sea water, column C. would show an excellent prepared brine, but we are dealing with pit water of the initial density of 9° Beaumé, to which the mother liquors have added 5 degrees of strength, and the whole amount of condensation due to evaporation is 53 degrees only.

8. The bitters are always retained, the salt is broken, scraped, heaped, and afterwards stored as at Mangenapudi.

9. The salt is in cakes or lumps; the lumps are called large crystals; there are some very good crystals amongst them, but the lumps themselves do not bear carriage well; they are friable, and soon break up into the smaller crystals which compose them; they are clean, brilliantly white, and with scarcely a trace of magnesium crystals, owing to the custom here of scraping salt from under, about three-fourths of an inch of bitters.

10. An ullum, measuring 30,240 square feet, turns out 1 garce 105 manūs a month, a slightly better yield than at Mangenapudi.

11. The cost of manufacture is Rupees 6 the garce. The contract price Rupees 10. The Deputy Collector forwards the following statement of expenditure on pans yielding during the season 10 garce of salt valued at Rupees 100:—

	RS.	A.	P.
Three coolies for mud-work for one month, at Rupees 4 each	12	0	0
Two coolies for three months for picotah- work and irrigating beds	24	0	0
Cooly-hire for bringing ten garce to platform, at Rupees 1-8-0 the garce	15	0	0
Value of picotahs, scrapers, mornaties, bas- kets, etc.	7	2	0
Extra cooly-hire	1	14	0
Total	60	0	0

12. Leaving out the value of plant, etc., we find that picotah-work is charged with 49 per cent., and, combined with mud-work, with 70·6 per cent. of the whole cost of manufacture.

13. The salt season commences here in January and terminates in June; the manufacture ceases as soon as the alittum is completed; the date of ending is a matter of chance; it depends on the past and probable demands for salt, and the amount in store; being rather larger and much cleaner than at most places, the *Chilla Ganjam* salt is very well liked by home merchants, for the same reason, it is rather obnoxious to the Lumbadies from the interior; 404,582 maunds are sold in the home districts, against 245,969 maunds going to Hyderabad, etc., and against 305,413 maunds and 278,249 maunds going into the interior from the much smaller divisions, Mangenapudi and Nizampatam, which have, however, a better inland communication through roads and canals.

14. The 374 ullams here, of which 100 are mortgaged, are said to belong to 50 individuals; they are highly valued and range in price from Rupees 100 to Rupees 400; it is not easy to see why they are so much more valued than those of Mangenapudi, which are larger by 16,446 square feet; but, in considering the value attached to ullams, many things besides their size and produce must be taken into account, such as their past reputation, the wealth, population, attractions, religious, and otherwise of the neighbouring salt ryots' village, and more important still whether the pan owners live exclusively or chiefly on salt culture, or, having fertile lands in the vicinity, are independent agriculturists, who make salt manufacture the second iron in their life.

15. It is doubtful whether the system of multiple irrigations possesses any advantages over the northern plan; as practised here, it is much the same; in theory, it is a round-about way of procuring two inches of saturated brine as carried out to the fullest extent at Chayur; it exposes the salt crop to the chances of storms, floods, freshes, etc., from the end of the season to the other; the cost of manufacture, Rupees 6 the garce, does not compare very favorably with that in the north, although the cooly-hire, Annas 2 a day, is but an ordinary rate; and the quantity of

salt destroyed during the season for being dirty too small, or badly formed is rather high, 20 to 30 garce at each division, or say 90,000 maunds in all. On the other hand, the salt of the Kistna, such as I saw it, is superior to that of the two preceding districts; whether from the system or from the initial density of the pit water, which both combine to the production of a deeper and a denser brine than usual, the crystals are better; and the system of gathering them from under a good depth of mother liquor both cleanses them well and, to a certain extent, guarantees their purity.

16. There are salt swamps in the Kistna and other districts, which are not used for the manufacture or storage of salt; they are undulating or sloping low-lands, flooded by the sea at certain seasons; the salt water evaporating leaves at the lowest points a thick deposit of salt, much prized by the contraband dealer, and consequently an object of solicitude to the Salt and Police Departments.

17. The Deputy Collector, Mr. P. Venkatanarasimha Row, on this subject writes that. "When swamp salt forms in small quantities, it is generally destroyed by being trodden into the mud by coolies or cattle; when in large quantities as in Kona swamp, which is half a mile in length by a quarter mile in breadth, it cannot be destroyed owing to the want of sufficient labor procurable in the vicinity and other causes, and is therefore guarded until destroyed by the rains."

18. I believe that the formation of spontaneous salt can be prevented altogether, and that it is a question of cost, about which I have no information whether it would be better to trample it into the mud, guard it till the rains, or prevent its formation.

19. Bearing in mind that the swamp forms a lake or series of shallow lakes, at first much less dense than sea water from admixture with freshes, and that it must lose, according to its density, nine-tenths or more of its bulk before any salt can form; a pit, one or more according to circumstances, roughly excavated at the fall of natural slopes, would gather together the lessening brine, rapidly contracting its evaporating surface, and, I think, preventing salt formation altogether; however, it would certainly retard it, so that, considering the diminished rate of evaporation ensuing on saturation, the small surface exposed, compared to the bulk of brine, but very little salt could form, and that in an almost inaccessible situation at the bottom of the pit.

20. My best thanks are due to Mr. Leman, Acting Collector, for his kind assistance to me, whilst in his district, and to Mr. Venkatanarasimha Row, the energetic Salt Deputy Collector, who accompanied me.

NELLORE DISTRICT.

1st Division, Kanuparti, arrived April 12th, departed April 13th, 1872.

1. The Kanuparti salt pans are situated on a great sand plain, about a mile from the sea and five feet above its level; they are a good deal

scattered: their platforms, four in number, are half a mile apart, and grouped about each a collection of ullums.

2. The soil as at China Ganjam is a mixture of alluvial earth and sand, in which the latter seems to be in excess; it is clean to work with not easily scirred into mud, but scarcely as impermeable as might be desired.

3. The water-supply is derived almost exclusively from pits about ten feet deep, which are said to yield a sufficiency of brine. Its density varied a good deal, but the mean strength of a dozen pits examined was 6° Beaumé.

4. An ullum measures 20,925 square feet, a smaller area than the standard half cawny; it is made up of a number of beds and condensers, arranged in parallel rows as at Nizampatam; the former are at a somewhat lower level than the latter, and take 11,178 square feet, as against 7,884 allotted to the condensers, both had been well and carefully prepared.

5. The system is in theory precisely the same as at China Ganjam; practically the irrigations are much weaker as the pits are weaker, and there are no reservoirs. The following observations relate to the third batch of brine, from which salt will be scraped. Rate of evaporation 3½ days to the inch:—

System.	A. Fresh.		B. Mother.		C. Prepared.	
Beds.	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1½	9° B.	1	29° B.	2½	15° B.
II. ...	1	10° „	1	30° „	2	17° „
III. ...	1½	9° „	½	30° „	2	14° „

6. It is noticeable here that, although the bitters are never removed the custom of retaining an inch of mother liquor on rather a porous soil greatly diminishes the chance of the residual salts forming a saturated solution and crystallizing out in large quantities; few magnesium crystals were present in the crops examined, and those of the smallest or acicular variety, the crops were otherwise clean and lumpy, the lumps consisting of a number of small poor crystals rather loosely joined together.

7. The operations of scraping, heaping, etc., are conducted simultaneously throughout this division or kottar as it is called here, and at the remaining kottars of this district; they are such as have been already described. The salt is without a covering, but it is heaped on a raised platform neatly kept, and the ground is watered from time to time by coolies.

8. The time for which the salt remains heaped at the pan's side before being stored varies a day or two at these kottars; it depends a good deal on the extent of ground covered by the works and the force available for guarding the salt at night.

9. The wind is very strong, from the south-east; there is no protection from it; nothing but the prickly-pear will grow on the plains; the manufacturers consequently suffer a good deal, as one-eighth of each crop formed is wind salt, and has to be rejected.

10. The ullums are divided into three classes according to their produce; an ordinary ullum is said to yield 1 garce 9 maunds of salt a month, a large amount in relation to its area, and the cost of manufacture is put at Rupees 9 the garce; the second and third class ullums are, if the statement be correct, working at a tremendous loss, making salt at Rupees 12 and Rupees 18 the garce, for which a kullivaram of Rupees 10 is received. But here it must be remarked that the pan-owner and his people work the pans themselves, and the salt is charged with their labor at the cooly-rate of Rupees 4 a month, a rupee of which is not expended on the works, though it may be on their support; their position accordingly is that of men working for Government for six months without pay, and then presenting a certificate of the work done in the shape of salt, receiving pay for the whole period, the better class at Rupees 3-9-4 a month, for they make 6 garce 54 maunds of salt in six months, for which they receive Rupees 64-8-0, which amount divided amongst them gives each a cooly-hire of Rupees 3-9-4.

11. It is apparent from all this that salt manufacture is not a profitable concern at Kanuparti, nor, I think, can it be as long as the ullums measure only 20,925 square feet. The labor of salt culture is such that at least two men are required to attend to each ullum, even though they be as at Tammalapenta, but 16,020 square feet in area, but, on the other hand, as far as my experience goes, the ullum may be very considerably extended and yet lie within the scope of the exertions of two coolies or three at the outside, so that the ullum here, where three men are employed, might be trebled in extent and, consequently, in yield, and yet be debited with the same amount of cooly-hire, thus bringing in a profit of Rupees 121-8-0 instead of a loss of Rupees 7-8-0 on the season's work.

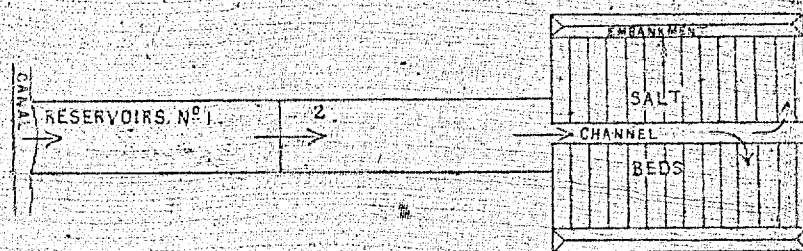
2nd Division, Padarti, arrived April 13th, departed April 14th, 1872.

1. The salt pans are situated on a very similar sandy waste to that of Kanuparti about eight miles further south; they extend irregularly for about two miles, and have four platforms around which the beds are gathered.

2. They are supplied by a backwater half a mile distant, from whence a canal conducts brine to the works; the canal is not banded, it is a mere conducting channel, too small to retain a supply of brine for any length of time, and unfortunately, too, at such a level that but one foot of water enters it at the diurnal high tides. The manufacturers were loud in their denunciations of the whole arrangement for water-supply.

3. The works are well inland, three miles from the beach, and on rather high ground about five feet above the mean sea level; the water supply is, though scanty, fairly condensed; it marked 3° Beaumé; it is raised to the reservoirs by means of the well picotah.

4. The ullums are very curiously laid out as shown by the following sketch, which somewhat resembles a grid iron, the reservoirs forming the handle, the bunds between the beds, the bars. The pans are arranged in parallel rows running east and west, and the salt beds of adjoining ullums are separated from each other by mud-walls or embankments about five feet high:—



5. The embankments which separate the salt ranges were intended originally to protect the works from wind and dust, but they serve rather to increase these evils, and are, in addition, a great impediment to free locomotion about the kotar; running, as they do, east and west they focalize and concentrate the sea breeze and land winds upon the salt beds, interfering with crystallization; moreover, dry mud and sand, the materials of which the partitions themselves are composed, scale away in the wind and fall in showers on the salt.

6. The area of the whole ullum is 52,137 square feet. That of the reservoirs, 28,800 square feet, and that of the salt beds, usually sixty to eighty in number, is 16,029 square feet. The reservoirs were as usual unprepared; the floors of the salt beds were quite soft; they evidently required some hard clay to be mixed with their too sandy substance.

7. System.	A. Fresh.		B. Mother.		C. Prepared.	
	Beds.	Inches. Degrees.	Inches. Degrees.	Inches. Degrees.	Inches. Degrees.	Inches. Degrees.
I. ...	13	14°B.	1	30°B.	2½	19°B.
II. ...	1½	14° „	1	30° „	2	20° „
III. ...	1½	12° „	1	29° „	2½	16° „

Column A., owing, no doubt, to the greater reservoir area as compared to that of the beds, shows brine better prepared than usual, that is, raised from 3° Beaumé to 14° Beaumé, a gain of 11-degrees, and, judging from

column C., although the rate of evaporation was an inch in three days, one might expect to get good salt, but the yield was scant, and the salt itself small, irregular, poor stuff loaded with sand.

8. The nature of the soil, the position of the embankments, and the violent winds, which both here and at Kanuparti, accompanied by blinding sand storms, almost daily visit the works are accountable for these defects.

9. Owing to the dust storms and reflected heat from the sands, business is at a standstill here for several hours a day in the hot weather. The coolies will neither work, nor will the salt merchants buy and heat and wind and dust have possession of the whole kotar in the midst of an oppressive silence. There are no plants about the pans; there is very little vegetation even in the neighbouring village; fresh water for drinking has to be brought from a distance of three miles, and altogether the manufactory is most unpleasantly situated.

10. An average ullum measuring 47,133 square feet produces 1 garce 13 maunds of salt a month, the smallest yield in proportion to area yet recorded; this may be in part due to scarcity of brine, but I think chiefly to leakage, which must be great in beds carelessly constructed on sandy soil at about five feet above the sea level.

11. Notwithstanding that the salt both here and at Kanuparti is poor, irregularly crystallized stuff—here, moreover, loaded with sand—it is largely bought by the Lumbadies, who take as much as two lakhs of maunds annually to the southern and western districts of Hyderabad.

12. There are 261 ullums in the Padarti Kotar, owned by 204 ryots, a fact in itself significant of their class and means. They are very poor; two or more enter into partnership in a single ullum, taking a row of beds or part of a row each and having the reservoirs in common; they distrust and watch each other jealously; each being limited, owing to its scarcity, to a certain quantum of brine, and the result is that the manufacture is conducted irregularly by stealth and artful shifts, rather than in the ordinary way.

13. The cost of salt manufacture is returned as ranging, as at Kanuparti, from Rupees 9 to Rupees 16 the garce. The kudivaram is Rupees 10 the garce.

3rd Division, Pakola, arrived April 14th, departed April 15th, 1872.

1. The salt works are 23 miles south of Padarti, laid out on a fine sandy and alluvial flat four feet above the sea level and about a quarter of a mile from the beach.

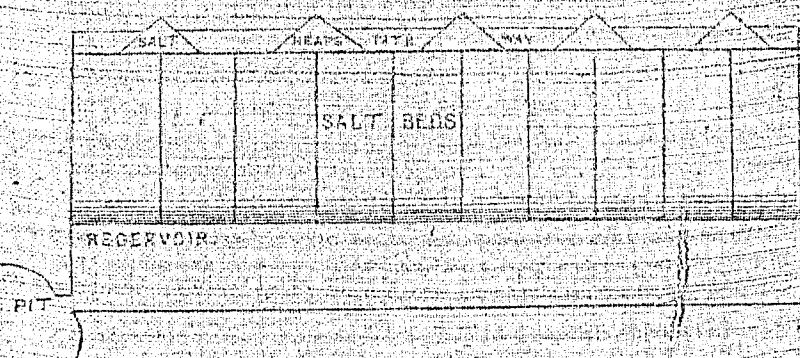
2. The soil is clean, firm, and well adapted for salt works.

3. The pans are supplied with water exclusively from pits dug by

Note.—About a mile to the north of the village of Kanuparti there lies buried in the sand the half figure of a Mahimna Datt, sculptured in black granite, apparently a fine specimen of ancient Hindu art.

the ryot in the neighbourhood of his holding; the average strength of the brine is 5° Beaumé, and its distance from the surface nine feet; it is insufficient in quantity, but the ryots manage to work with it, though not without grumbling. The distance of the works from the sea is not so great as to preclude the possibility of their deriving an additional supply from it if necessary.

4. There are 474 ullums in the kotar, averaging 21,159 square feet in area. An ullum consists of one or more reservoirs, and 34 salt beds arranged as shown in the sketch; the bed area is to the reservoir area very nearly as three is to two: the beds were firm and well made.



5. The system in use is that of two irrigations to each scraping; the following observations relate to the second irrigation:—

System.	A. Fresh.		B. Mother.		C. Prepared.	
Beds.	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1½	16° B.	¾	30° B.	2	21° B.
II. ...	1	15° „	1	20° „	2	20° „
III. ...	1	16° „	¾	30° „	1½	20° „

6. The fresh and prepared brines are stronger than at the previous divisions, and in quantities sufficient or nearly so, considering the rate of evaporation at the time, an inch in three days; but the salt formed, though with few exceptions clean, was small and badly crystallized, owing to the agitation of the brine by the south-east wind, which blows strongly on the unprotected pans for some hours every day at this season of the year.

7. The scraping and after-treatment of salt, etc., bitterns are as have been described. A few acicular magnesium crystals were mixed with the salt.

8. An ullum of the usual size, 21,159 square feet, produces 1 garco 30 maunds of salt a month, a very large produce, 17 maunds greater than that of Padarti, which is more than twice its area. The cost of manufacture is consequently less; it is returned as Rupees 6-12-0 per garco in all three classes of ullums, but the items of expenditure have not been furnished.

9. As the cost of manufacture is the same in all, the ullums are

divided into classes according as sand or clay predominates in the soil: those on sandy soil are valued most; those on clayey soil, really the most valuable, are somehow valued least.

4th Division, Tummalapenta, arrived April 16th, departed April 17th, 1872.

1. The site of these salt works is, in some respects, well chosen; they are scattered over about half a mile of low-lying ground, parallel to, and not more than a hundred yards in rear of the raised beach which separates them from the sea, and which, together with a thick belt of full-grown mangroves, shields the beds from the violence of the south-east or sea breeze.

2. The soil, a mixture of white sand, and earth in which the sand predominates, forms a hard, clean floor for the beds; it is seldom raised in dust storms, as being at the mean sea level, and for another reason presently to be noticed it is moist even at the surface.

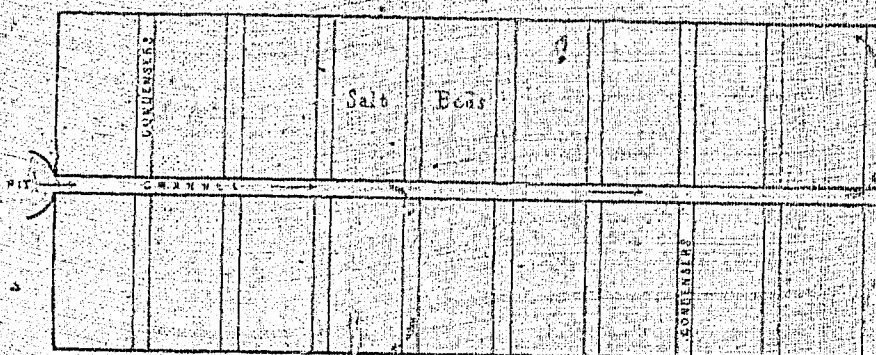
3. An abundant supply of brine is obtained from shallow pits dug to a depth of two or three feet; it averages 5° Beaumé in density; nevertheless the manufacturers are dissatisfied with it and complain of the want of water, overlooking the circumstance that here one well is made to do duty for five or six ullums; if each had a separate pit, as is usual at other kotars, the supply would be ample.

4. The construction of additional wells is shown by Column A. to be urgently needed, since the scarcity of brine now felt leads to shallow irrigations, the same almost, as to depth and density, as the Nowpadah fresh brine in February, when the rate of evaporation was much less than at the time of my visit to Tummalapenta.

5. Having said something in favor of this kotar, other points to its disadvantage remain to be noticed: first, the beds though firm and clean, are also, I suspect, porous, as there is a total absence of that thick plastic clay, which characterises the northern pans and adds so much to their impermeability, and again, a large fresh water stream runs over the sands in close proximity to the beds between them and the sea.

6. This stream at the time of my visit had dried up to a series of disconnected pools, about twelve yards broad and from one to two feet deep, which had been looked upon as salt-water pools, and in fact tasted somewhat brackish; but, tested with the hydrometer, the water marked 0° Beaumé, showing it to be almost fresh. Now the presence of these large sheets of water lying on the sands beside the works, supported by the denser sea water underneath, accounts for the abundance of brine which here almost enables one pit to provide for the wants of five or six ullums. It also accounts for the abundant vegetation which surrounds the salt works and more or less shelters them from the wind; but I think it has an injurious influence as well, penetrating the permeable soil mixing with the brine in the pits, and reducing its density uniformly to about 5° Beaumé.

7. The ullums measure 16,020 square feet; they are the smallest I have met with. There are no reservoirs, only beds and condensers laid out as shown in the sketch, alternating with each other in parallel rows. The condensing area is 5,760 square feet, the remaining 10,260 square feet is taken up by salt beds, ridges, etc. It is curious to observe that no matter what diversities of form the ullums in different districts present, the same mistake runs through all, namely, that of throwing nearly the whole work of preparation, etc., as well as crystallization, on the salt beds:



8. Water is raised from the pit to the channel by means of the common "picottah," the channel and condensers are at the same level; the salt beds are two inches lower, and are filled from the condensers by gravitation.

9. System.	A. Fresh.		B. Mother.		C. Prepared.	
Beds.	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. } ...	1 $\frac{3}{4}$	13°B.	1	30°B.	1 $\frac{1}{2}$	17°B.
II. } ...	1 $\frac{1}{2}$	12°,,	1	29°,,	2	17°,,
III. } ...	1 $\frac{1}{4}$	13°,,	1	31°,,	1 $\frac{1}{2}$	17°,,

10. There are two irrigations for each crop; these observations relate to the first irrigation; the second, from whence the crop is taken, will be probably of the same depth, but stronger.

11. The salt crops were drawn from the beds brilliantly white in color without any admixture of the fibring material; the crystals were well-formed owing to the protection from the wind, but they were small-sized and had evidently been formed in too great a hurry. There were no acicular magnesium crystals present, although the bitters are seldom removed and then thrown over into the condenser.

12. The yield as compared to area appeared at the time but scant, and, from returns since received, I find that the ullum, measuring 16,020 square feet, produces 62 maunds, a little over half a garce a month. Knowing the porous character of the soil, one would be inclined to attribute this to leakage, but the subsoil is already saturated with moisture, and it is more likely that a rather free interchange takes place

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between the condensed water in the beds and the feebler brine beneath them in the nature of an endos and exosmosis, which must reduce to a certain extent the total salts obtained and prolong the period of manufacture; and, consulting the return for the last four years, I find, in fact, the average produce to have been 2 garce 38 maunds in 6 months 4 1/2 days. This conclusion is further strengthened by the absence of magnesium crystals from the crop.

13. The cost of salt manufacture here is set down at Rupees 8-3-8 the garce, which is not surprising if the foregoing statement be correct. The items of expenditure have not been furnished, but the rate of cooly-hire for the district is Rupees 4 a month; if then but one cooly had been employed for 6 months 4 1/2 days on the set of pans whose average produce during the last four years was 2 garce 38 maunds, his hire would be Rupees 24-9-9 as a set-off against the kudivaram, Rupees 22-2-8; but, as the majority of the pan-owners here are poor and work the pans themselves, the cost has been arrived at in some other way.

14. All that these pans require to make them as productive as the best divisions in the north and to reduce the cost of manufacture to their standard, is to make the beds impermeable, which can be done as I have already described; impermeable clay will be found at some depth beneath the pans, as a clay stratum approaches the surface all along the coast and, I believe, reaches the surface and forms the bed of the sea a few furlongs from the beach.

15. Some new pans were opened during my stay. The ryot who constructed them, mapped out his ullum by drawing lines in the sandy soil which were quickly replaced by mud partitions made by working up the surface scrapings with water; there I left him, having ascertained that he had no intention of improving upon the existing materials for his pans.

5th Division, Iskapilli, arrived April 17th, departed April 19th, 1872.

1. The salt pans are laid out on low marshy ground close to the edge of a large backwater. They bear the appearance of having been excavated rather than built up as is the custom elsewhere. They are surrounded by bulwarks of debris which conceal them at first from view; upon entering within the debris, the pans are found to be about two feet below the level of the soil and one below the mean sea level. Their construction is simple in the extreme; there are no reservoirs or condensers, nothing but large salt beds connected by channels with the backwater.

2. At the time visited there had been no manufacture for three years; the channels were silted up and the beds cut off apparently from communication with the backwater; they nevertheless presented a very distinct tidal trace along their margins, and many of them were half-filled with brine at 6° Beaumé, which rose and fell with the movements of the backwater.

3. Further observation showed conclusively that the beds communicated with the creek through their floors; that they were in fact shallow brine pits, in which it would be extremely difficult to make salt.

4. Three times within the past ten years salt has been manufactured at these pans, but it so happened that on each occasion, and as far as I can learn by a fortunate coincidence only, the bar of the backwater had closed, its water level had fallen, and there was even some scarcity of brine, so that a condition of things, which would elsewhere be considered unfortunate, arrived here most opportunely to make salt manufacture practicable.

5. The salt, of which there was a large quantity in store, was clean, but very small and poor in crystal, with a more than usual sprinkling of magnesium impurities.

6. Of the system of manufacture, the disposal of bitterns, and the treatment of salt, etc., I cannot say anything from personal observation; but, judging from the indications visible and the information furnished by the ryots, they appear to have been with points of departure not in their favor, similar to those already described.

7. This was once a famous place of export for salt, and the inland trade was also large, but now it seems that ships have forgotten Iskappili, and the salt is long in store and difficult to get rid of; it may be that other places, as Covelong, possess greater facilities for shippers, but it is more probable that it has been beaten in the quality of its manufacture, seeing that its system and arrangements, as at present visible, are of the most primitive kind it is possible to imagine.

8. Great care in the preparation of the ullum is necessary here; an impermeable floor throughout the condensers and beds is the one thing required; were the floors impermeable, an abundant brine almost at the required level is at hand, and the salt manufactured should be both good in quality and cheap.

6th Division, Kristnapatam, arrived April 22nd, departed April 24th, 1872.

1. The pans are situated on some irregular ground in the middle of a salt swamp, laid out in two lines, each about half a mile in length, which meet at a right angle directed towards the sea; they are more than a mile from the sea, but only 400 yards from the backwater, a large and deep inlet which is navigable by country craft of 50 tons burden.

2. The works are at about high tide level, excavated, not banked up, and supplied hitherto exclusively from pits from which scant brine varying in density from 11° to 15° Beaumé oozes at a depth of four feet. There is one pit to each ullum, yet the supply of brine is insufficient; the Deputy Collector is cutting a canal from the backwater to supplement it.

3. There are 90 ullums; an ullum here measures 45,162 square feet

as follows:—reservoirs 3,900 square feet, salt beds, etc., 35,262 square feet. The reservoirs at the time of my visit were not in use, that is to say, a slice of the ullum measuring 9,900 square feet was for the purposes of manufacture, a profitless waste.

4. The Superintendent states: "As the season advances and the sun becomes hotter, the water in the wells is found to be so over-boiled as it were that further preparation of it is dispensed with, and it is taken direct from the well to the evaporating or salt-producing beds."

5. The explanation of this is that in the hot weather, or about the middle of the season, sulphate of magnesium which has accumulated in the mother liquors, and which is looked upon by the ryots as common salt pushed to an advanced stage of development by the increased temperature of the season acting on brine already too condensed or "over-boiled" as they express it, begins to deposit largely in the beds.

6. To counteract this abnormal state of the beds and brine, the manufacture is suspended for three or four days whilst the pans are cleaned out and their floors re-made, afterwards and for the remainder of the season, the brine used for the salt-producing beds, even where it is creek water, is not previously exposed in the reservoirs or condensers: moreover, pit water, which varies in density from 5° to 15° Beaumé is largely diluted with backwater before use. Heavy showers at this period of the manufacture are considered to have a very beneficial effect.

7. As it will be quite impossible for sulphate of magnesium to form in the beds if the suggestions contained in this report be acted upon, it seems unnecessary to point out the speediest and most effectual means of removing it; but, should the occasion arise, it can be entirely removed in four or five hours at most by treading and washing out the pans several times at mid-day with either backwater or pitwater of the ordinary density, which will take up and carry away the very soluble magnesium salts.

8. No sketch is required to illustrate the plan of works; an ullum, as worked for the greater part of the season, consists of about 30 salt beds firm and well-made connected by a channel with a brine pit.

System.	A. Fresh.		B. Mother.		C. Prepared.	
	Beds.	Inches.	Degrees.	Inches.	Degrees.	Inches.
I.	...	24	13°B.	4	31°B.	24
II.	...	2	13°	4	31°	24
III.	...	2	13°	4	31°	24

Rate of evaporation, three days to the inch.

10. There is but one irrigation to each scraping of salt. Column C. shows a mixture of pit brine and mother liquor 24 inches in depth, averaging 17° Beaumé in density; it will lose 35 per cent. of its bulk, or 10.5 lines from its surface, in passing on to saturation; this it will reach in about three days, leaving 19.5 lines at 25° Beaumé to be evaporated to 30° Beaumé. A further loss of 70 per cent. takes

place in brine, passing from 25° to 30° Beaumé, in this instance the loss will amount to 13.5 lines, which will evaporate in six days more, which would be taken as the period of crystallization in ordinary sea water; but here, the bitterns left in will have forced out all the NaCl before the completion of the fifth day and for that matter, almost to a certainty some magnesium crystals with it.

11. The salt crops were large, the crystals clean, but small and very irregularly formed; they contained a large sprinkling of acicular magnesium crystals. The salt scraped in the usual way is first made into little cones and left in the bed to drain; it is afterwards heaped on the bank a further period and then carried off and stored.

12. It is the custom here and at some of the following kotars to sift the salt heaps before they leave the pans through a coarse wicker sieve, rejecting all that pass through; the rejected salt is either trodden into the pathways or carried off and destroyed at some distance; this is an effective, but scarcely economic way of getting good salt.

13. An ullum, measuring 45,162 square feet, produces on the average 1 garce 68 maunds of salt a month, a fair yield. The cost of manufacture is said to vary from Rupees 7-8-0 to Rupees 8-9-0 the garce, but particulars have not been furnished.

14. These pans are in many respects well situated and should with an improved system prosper on salt manufacture; the soil is good, and the water-supply will, when the canal is completed, be both good and abundant; there is an excellent road from Nellore, and the backwater close by is navigable out to the sea; there is but one platform to which all the salt is brought; it is centrally situated, surrounded by a moat and crowned by a watch tower and all its arrangements, the heaps, their covering, etc., are in perfect order.

7th Division, Dugarazupatnam, arrived April 26th, departed April 28th, 1872.

1. These pans are not extensive; there are but thirty-four ullums situated at the very edge of a backwater, the northern outlet of the Pulicat Lake, which separates them from a vast salt plain some twenty-five miles in length, whence the prevalent winds, south and south-east, frequently bring clouds of dust over the works.

2. The beds are about two feet above the level of the arm of the lake which supplies them, laid out on alluvial soil largely mixed with sand ill-adapted for their purpose.

3. The manufacturers complained loudly of the weakness of their water-supply, on examination it proved to be 3° Beaumé, a trifle less dense than sea water, which marked at this time $3-15^{\circ}$ Beaumé, beyond the bar, four miles to the north of Dugarazupatnam.

4. What may be the density of the Pulicat Lake just here, earlier in the season, I know not; but, judging from its strength at the end of April, after four months of uninterruptedly dry weather, it is possibly

very weak, as the lake is flanked by a range of the Eastern Ghauts and drains some forty miles of border lands between Dugarazupatnam and Pulicat, the nearest point to the south at which it communicates freely with the sea.

5. The ullums measure 59,049 square feet. The area set apart for preparing the brine is larger than usual, being to the crystallizing area nearly as 3 is to 2; this, however, is a matter of little practical importance, inasmuch as the ryots, notwithstanding their complaint of the weakness of the brine, seldom use their reservoirs; they were nearly all dry at the time examined, and those that contained water had evidently been filled the day previously in anticipation of my visit.

6. The works are irregularly laid out; no two ullums are absolutely alike; they consist of a large number of reservoirs, side beds, or condensers and salt beds, curiously arranged as at Penugudur, and apparently without method. The crystallizing beds were badly made; a good-sized walking stick could be introduced without effort at least two feet down through most of their floors.

7. Water is bailed from the creek by picottah work and passed on direct to the condensers, from whence it gravitates into the salt beds; there is but one irrigation for each crop. At the time of my visit all the ryots were occupied in the same stage of manufacture; none of the beds were ready for scraping; I am unable therefore, to give details as to the fresh brine and mother liquor, but the prepared brine as it stood in the beds, averaged an inch and a quarter at 25.5° Beaumé, and the rate of evaporation was something over an inch in three days.

8. The salt in store was inferior in size and crystallization to any that I had previously seen; when first scraped, it is clean, coming from a sandy floor, but the heaps were unprotected and consequently covered with dust from the salt swamp, which gave them a rich brown color.

9. An ullum of the measurement given produces 1 garce 70 maunds of salt a month, a yield which compares very badly with that of the northern divisions, but is about up to the average of the Nellore and Chingleput Districts. The cost of manufacture varies from Rupees 6-5-0 to Rupees 9-3-0 the garce according to the amount expended on preparation; none of the pans bore evidences of preparation in any way corresponding to the supposed outlay.

10. As at present managed Dugarazupatnam is in a bad way, both as to its ullum, system, produce and cost of product. A Superintendent had been lately appointed, who was quite new to salt manufacture and understood very little about it, and the salt ryots are described as being very ignorant and intractable; notwithstanding these drawbacks, if the bed-floors can be made impermeable, there is no reason why a better system should not be introduced here and the salt manufacture in every respect improved.

Tada, 8th Division, arrived April 29th, departed April 30th, 1872.

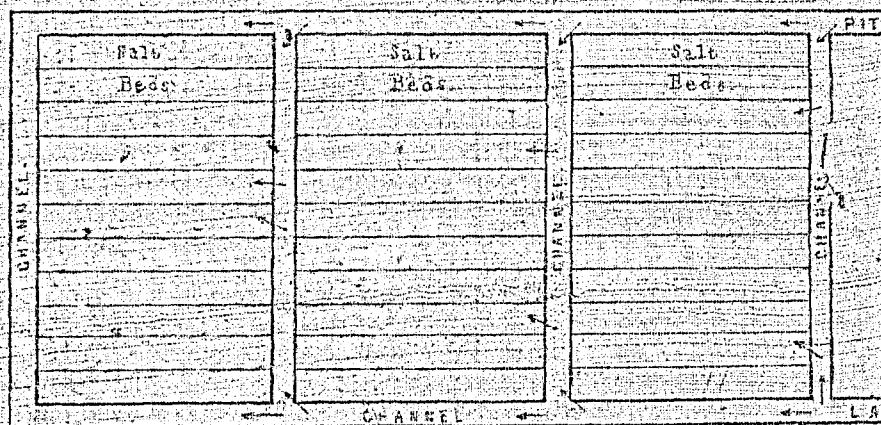
1. The salt pans are laid out for about three quarters of a mile on a low-lying stretch of swampy ground, composed chiefly of alluvial earth and sand mixed with yellow clay, which forms a part of the western shore of the Pulicat Lake, so low, that a bund is necessary to keep the feeble lake tides from overflowing the works.

2. The pans are supplied until the end of March almost entirely from pits dug beside the ullams. In April, the pit brine is said to be over-heated and lake water as at the time visited, is added to it, or substituted for it in irrigating the beds. The pits alter in the amount of brine they yield, its density and distance from the surface, according as they are at the edge of the lake or further inland; the difference in density is not great, it varies from 9° to 12° Beaumé.

3. The lake bordering on the pans is very shallow, perhaps at full tide a foot and a half in depth, at the ebb, there is no water but a belt of soft mud, a quarter of a mile in breadth, flanks the pans; this affords a good opportunity for constructing a collecting reservoir on the Mediterranean principle; a bund provided with a sluice gate, thrown along the distant margin of the belt of ooze exposed at low tide, would retain the brine and convert the marsh into just such a shallow condensing tank as is required for works like these.

4. An ullum measures 95,418 square feet; there are no reservoirs or condensers; the whole area is occupied by salt beds connected with and capable of being filled indifferently from the lake or the pit or both together. The beds are well-made and deep, so as to hold more water than usual.

5. The following sketch shows the plan of ullum:—



6. System.	Beds.	A. Fresh.		B. Mother.		C. Prepared.	
		Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I.	2	7°	B.	1	30°	3	11°
II.	2	4°	"	1	31°	3	7°
III.	2	3°	"	1	31°	3	6°

7. The fresh brine admitted to bed No. I. is a mixture of pit and lake water; that in Nos. II. and III. lake water only. It will be seen that the depth of mother liquor and consequently of prepared brine is greater than at previous divisions; but, as if to compensate for this advantage, the brine is also weaker, so that considering the loss of bulk which No. II. will sustain, 79 per cent and the rate of evaporation, crystal formation will be unduly accelerated. On the other hand, the custom of retaining an inch of mother liquor postpones and diminishes the chance of obtaining magnesium crystals with the salt.

8. The salt was clean and well-formed, but small. It must contain, though not to any noticeable extent, the hydrated sulphate of lime, the suspended matters, and the debris of the organisms contained in the lake water; as there is no provision for eliminating any of them from the manufacture.

9. Owing to the violence of the south-east wind, a great deal of creamy salt is formed to leeward of the beds, which is either thrown into the lake or trodden into the mud which might with advantage be left in, dissolved and allowed to crystallize again with the next crop.

10. The ullums here produce on the average 1 garce 90 maunds of salt a month, certainly a poor out-turn, and the cost of manufacture is rated at Rupees 8-10-3 the garce; the increased cost depends in some measure on the difficulty of excavating the pits, which have to be worked through a harder subsoil than at most divisions and also on the necessity for preparing carefully the whole area of the ullum for bed-floors.

11. I think that this division is well chosen for salt manufacture and that it would with altered arrangements yield abundant crops of salt.

Sunnagunta, 9th Division, arrived April 30th, departed May 1st, 1872.

The ullums, 77 in number, are on the southern border of the Pulicat Lake on a narrow strip of similar low-lying shore to that of Tada, enclosed between the lake and the bed of a broad stream, which yields abundant fresh water at a depth of three feet from the surface.

2. It rained the previous night and rained heavily during my visit; it was useless, therefore, taking readings with the hydrometer in beds half-filled with rain, but observation and inquiry made it clear that the system of manufacture pursued differs from that of Tada only in

* The 1st of May, remarkable for being only somewhat less stormy than the 2nd, cost me the destruction of most of the specimens of pit brine and manufactured salt which I had intended to analyze or exhibit to the Board. They were broken or swamped in the top boat whilst crossing the Pulicat Lake from Sunnagunta to Pulicat.

this, that the depth of lake water evaporated in the beds is less by nearly an inch.

3. The ullums are irregularly and badly arranged; there is but one small condenser attached to every three salt beds, and the floors are throughout soft and carelessly made.

4. The salt in store was small in crystal, dirty and badly formed; it would not have been received at any other division.

5. Without going further into details, I may say that Sunnapagunta has, irrespective of level, all the faults that I have elsewhere described, and is in every respect one of the worst divisions I have examined.

6. It is in the Chingleput District to the extreme north just short of the southern confines of the Nellore District, isolated in position and far removed from the centres of observation; and, though the distance from Nellore is twice that which separates it from Madras, and offences committed at the pans must be tried in the Chingleput Courts; it is attached to the already over-grown Nellore Salt Collectorate for the purposes of control.

7. This, I think, throws light on the degenerate state in which I found it, for it will be observed that, in those districts, as in Ganjam and Masulipatam, in which the divisions are few and capable of being frequently inspected, salt manufacture rises in all respects to a higher level of efficiency than in others, as Nellore and Chingleput, in which the divisions are numerous and scattered beyond the possibility of receiving constant supervision from any single individual.

8. The kotars throughout the Nellore District bore ample evidence of having been carefully supervised by the Deputy Collector; the platforms were exceptionally well-made, clean, and orderly, and experiments with Major deHavilland's system of salt manufacture, which I had not an opportunity of witnessing in other districts, were being carried out at various points.

9. The foregoing remarks are not therefore intended in the slightest degree as a reflection on Mr. Plunkett, the Deputy Collector, to whose careful work I can testify; but the points of likeness between Sunnapagunta and Kuppili, which is also at the extreme end of its district, are so many, that the resemblance is not easily lost sight of and leads to the conclusion that both have suffered from the same cause and necessarily from their situation.

10. The ryots also are described here as being independent, unruly, and abandoning the works if their salt is rejected or any attempt is made to alter their system of manufacture.

11. I received every assistance whilst in the Nellore District and a great deal of useful information from Mr. Plunkett, the Deputy Collector, who accompanied me, and to whom my best thanks are due, as also to Mr. Hughesdon, Acting Collector of the District, who kindly gave me all the assistance that I required.

CHINGLEPUT DISTRICT.

4th Division, Attiput, examined May 24th and 25th, 1872.

1. Between Sunnapagunta and Madras, along the west bank of Cochrane's or the Eastern Coast Canal, are situated the five northern divisions of the Chingleput District, which, as they are not placed on the salt chart, I may state occur in the following order from north to south:—Kattur, Voyalore, Palidivak, Attiput, and Vullur.

2. All of these, together with the southern divisions and many of those in South Arcot, were submerged by the floods which arose during the cyclone. I was unable, therefore, for some time, to proceed with the examination of the salt pans, but occupied myself with those experimental matters which have been from time to time referred to in the report. Afterwards, as the divisions one by one emerged from the flood and recovered from its effects, I visited them, and will report on them in the order in which they were examined.

3. Attiput was the first to resume work. It is the second largest of the northern divisions, situated above 12 miles north of Madras on the low-lying sandy and alluvial flat, which flanks the Eastern Coast Canal rising to 15 inches above its mean level.

4. The ullams, 1,400 in number, are supplied with brine exclusively from the Canal, which sends branches into the interior of the division, splitting it up into seven sections. The brine which had marked 4° Beaumé at Sunnapagunta just before the cyclone, and but 2° Beaumé at Attiput the day after it, now marked 2.75° Beaumé; it is raised to the works by means of the tank "picottah."

5. An ullam measures 44,154 square feet, of which the reservoirs take 22,077 square feet, the condensers and salt-beds, 60 in number, the remainder. The reservoirs contained six inches of brine at from 3° to 5° Beaumé; the condensers held three inches at 9° Beaumé resting on four inches of soft mud; the bed floors were also soft, attributed to the action of the flood.

6. The ullams are laid out as shown in the Nizampatam sketch, except that there is additional reservoir area attached to one end, if that fact alone can constitute a distinction, when the reservoir brine averages only 4° Beaumé in density. The reservoirs and condensers are at a uniform level, but the salt-beds are lower by two inches.

7. System.	A. Fresh.		B. Mother.		C. Prepared.	
	Beds.	Inches. Degrees.	Inches. Degrees.	Inches. Degrees.	Inches. Degrees.	Inches. Degrees.
I. ...	1½	9° B.	½	30° B.	2	12° B.
II. ...	1½	8° "	½	29° "	2	11° "
III. ...	1½	10° "	½	29° "	1½	12° "

Rate of evaporation, one inch in 2½ days.

8. The double irrigation system is employed here during the greater

part of the season. At the time examined owing to the absence of mother liquor, leakage, etc., as many as five or six irrigations were required to procure a fair crop of salt.

9. Column C expresses a very unpromising system of manufacture considering the prevailing rate of evaporation; it is, however, but the first irrigation, and it was urged by the Superintendent that the state of the pans examined was equivalent to their condition at the commencement of the season, as the floods had washed away, not only the accumulated bitters, but also a certain proportion of salt which gathers at the edges, adheres to the mud-flooring, or is left in as wind salt and adds considerably to the value of later scrapings.

10. The crystals were small, but clean and well-formed. The salt is allowed to dry for two or three days on the margin of the bed where scraped; it is then carried to the banks of the canal for the convenience of the boatmen and heaped on raised platforms of sand, awaiting, at the ryot's risk and unprotected, its transmission to the Government Stores at Madras.

11. A fleet of large canal boats conveys salt to the stores from the divisions, taking each in turn, whereby the pans are relieved of their salt once in every two or three months; in the meanwhile the heaps are quite exposed, dwindling with every shower or gathering dust from the land winds, liable at any time to be attacked at their bases and dissolved away by subsidence into the freshes which may rise to the platform level.

12. The boats are cumbrous and though able to sail from Madras to the pans, have to work their way back with a full cargo, against a strong headwind, poled by two men, who take three or four days to propel them 25 miles; these tedious journeys necessitating the intervals of two months are answerable for the deterioration through prolonged exposure of the salt, which should however, be heaped on platforms raised above flood level and provided with a covering.

13. The manufacture commences in January and terminates in July or August with the dry weather; there is no dittum here or at any of these Ennore divisions; the demand for salt is so great at Madras that the manufacturers are encouraged to make as much as they can during the season.

14. An average sort of ullum, measuring 44,154 square feet, produces one garce thirty maunds of salt a month, a fair yield; but there are other ullums which are said to produce much less, hence the pans are divided as in the Nellore District into classes with reference to their produce and the cost of the product; it costs in the first class Rupees 7 to manufacture a garce of salt, and in the third class Rupees 11. We find that the contract price allowed for salt rises from Rupees 10 at Sunnapagunta to Rupees 12 at these divisions, the first of which,

Kattur, is in the same district as, and distant from, Sunnapagunta about 12 miles.

15. The cost of manufacture of a garce of salt varies solely with the season's outturn from each class, for the ullums are of equal area and the cost of working them is throughout almost the same:—

		RS.	A.	P.
Items as follows:—				
Repairs, covering, and loading ...	...	17	8	0
One cooly for 6 months, at Rupees 4 a month ...	...	24	0	0
Total ...		41	8	0

The cost of working the third class is understood, however, to be less by Rupees 2-8-0, which saving is effected in the items of covering and loading salt; for the third class making only three garce as against six made by the first has neither so much salt to cover nor so much to load.

16. This dissimilar produce of neighbouring ullums, if it in reality exists to the extent depicted (which, I confess, I doubt) must depend on radical differences of site, for in all visible matters, soil, level, supply, plan and system, the ullums are on a par and all are worked by salt scrapers of the usual type, ignorant of any but the traditional method of manufacture.

17. A careful examination of the pans at many divisions has revealed nothing at the surface to account for the discrepancies which were spoken of, apart from that negligence of construction to which I have frequently drawn attention. It is true that a vertical section of several ullums might show impermeable clay strata underlying some and loose sand under others, and that some such differences do exist between the ullums of different divisions separated by miles of coast I have endeavoured to show; but, where adjoining ullums laid out on precisely similar soil, the substrata of which are visible in the walls of the deep canals which ramify and intersect each other among the pans, differ so widely in point of produce, one is forced to conclude that the first, second, and third class, if they exist, are terms which might be applied with greater truth to the ryots than to their ullums, to denote the careful, the careless, and the very careless, respectively.

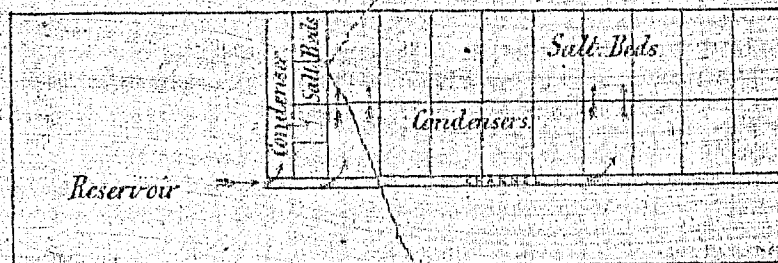
18. We see the same difference between careful and careless cultivation in arboriculture planting generally and other industries, and need scarcely doubt or dig beneath the surface to find another cause. The ullums, 1,400 in number, are owned by 337 ryots, many of whom are unable to superintend personally the work of manufacture, which receives, at the hands of their coolies, just that amount of attention which is necessary to save appearances.

19. The so-called first class ullum, probably truthfully represents the produce and its cost; and, though the latter is greater than it need be in the future, it is less even now than is said to be, as it is burthened with such items as repairs, implements, and coverings; of which the first, Rupees 10, is exaggerated; the second, Rupees 3, is not an annual charge; and the 3rd, Rupees 2, had not been expended at the late period at which the heaps were examined by me.

3rd Division, Pulidivak, examined May 28th and 30th, 1872.

1. This division is about five miles north of Attiput, laid out on rather higher ground, but on the same description of soil; it is split up into six minor sections by branches of the eastern coast canal, from which, as at Attiput, its water supply is derived.

2. There are 859 ullums laid out as shown in the sketch on a plan which differs from that of Attiput in the greater area and peculiarity of shape of the reservoir, which, together with the condensers, takes 16,892 square feet of the whole area, or 26,253 square feet.



3. The small condenser, with its attached salt beds towards the centre of the ullum, appears to be a meaningless complication. The reservoir and condensers are at a uniform level; the former was filled to a depth of six inches with brine marking 5° Beaumé; the latter held 3 inches at 12° Beaumé; the condenser floors were fluid mud; the bed floors, which are sunk an inch lower in level than the rest of the ullum, were badly prepared.

4. System.	A. Fresh.		B. Mother.		C. Prepared.	
Beds.	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	$\frac{3}{4}$	12° B.	$\frac{1}{4}$	28° B.	$1\frac{1}{4}$	15° B.
II. ...	1	12° „	$\frac{1}{4}$	27° „	$1\frac{1}{4}$	14° „
III. ...	1	10° „	$\frac{1}{4}$	26° „	$1\frac{1}{4}$	13° „

Rate of evaporation, less than three days to the inch.

5. The salt crops were poor, the salt itself small in crystal and mixed with sand. An average ullum, measuring 26,258 square feet, produces about 100 maunds of salt a month; the manufacturing charges amounting to Rupees 41 at the end of the season are in all details the same as at Attiput; the produce in each class is less owing to the

smaller area of the ullum; the cost per garca is consequently greater, and this illustrates the relation between area and cost of manufacture to which I have before alluded.

6. It is reported from Pulidivak that a third-class ullum working for six months at a cost of Rupees 39, produces 21 garca of salt, for which at contract price Rupees 30 is received, whereby the proprietor is Rupees 9 out of pocket on the season's work; but, independent of the improbability of this statement, it is scarcely credible that an ullum measuring 26,253 square feet would yield less than three garca in six months, where I have shown that the standard ullum, measuring 23,800 square feet, is capable of yielding, after the elimination of foreign salts, 21.08 garca in the same period.

7. The canals which enter the salt divisions are intended chiefly for the passage of boats, which remove the salt heaps as they go along. The large boats which convey the salt to Madras can seldom enter the branch canals until they have been deepened for their reception, a process which costs a good deal of money; the whole arrangement besides prevents brine in the canals from being enclosed for condensation.

8. The branch canals as they are not thoroughfares, might be provided with sluice gates where they enter the divisions; the water within them would then go on condensing during the long intervals of rest afforded to them by the salt boats; it is even worth considering whether it would not be well to draw the large boats up at the barrier and fill them from smaller ones within, which, having a less draught of water, would not require such deep and expensive cuttings.

9. Many of the pans which are encircled and formed into a sort of island by canals are liable to a curious accident in connexion with the dredging operations. The dredgers passing round, clearing out the canals, heap the mud along their banks, forming the island into a large tank, which retains the rainfall. After the cyclone a section, comprising 30 ullums well above the canal level, was for a time, until the cause was discovered and the embankment broken, completely submerged by rain water.

10. About 1,390 maunds of salt are annually destroyed at this division for being small or dirty. Moulaka salt, the Superintendent informs me, is seldom seen, and then only in a few beds towards the close of the season.

2nd Division, Vayalore, examined June 4th, 1872.

1. The Vayalore pans, 1,237 in number, extend along the border of Cochran's Canal about four miles stretching inland at one point, where are the Vayalore "old pans" for rather more than a mile.

2. The works nearest to the canal banks are but six inches above high tide level, laid out on moist alluvial soil and irrigated at spring tides

without mechanical aid; these further inland are on sandy soil and comparatively high ground; they get their water supply from an arm of the canal which bends in behind the pans and forms a large spread water.

3. The water in the canals which supply the greater part of the works marked 2-75° Beaumé; that in the spread water from whence the "old pans," the most productive in the division are supplied, marked 4° Beaumé. The ullums are planned as at Nizampatam, having in addition a good-sized reservoir at one extremity of the line of beds and condensers, which makes the preparing, double the area of the crystallizing surface.

4. The reservoirs held eight inches of brine at 5° Beaumé; the condensers which are at the same level, three inches at 14° Beaumé; the salt beds, sunk about an inch below the general level, were irrigated as follows:—

5. System Beds.	A. Fresh.		B. Mother.		C. Prepared.	
	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1	14° B.	½	28° B.	1½	16° B.
II. ...	1	14° „	½	27° „	1½	16° „
III. ...	1½	13° „	½	27° „	1½	14° „

The rate of evaporation varied with the direction of the wind from 2½ to 3 days to the inch.

6. Two irrigations are practised here; otherwise the salt formed under the conditions shown above would be exceptionally miserable; as it is, the crops are poor, and the crystals small and friable. The inferior salt destroyed amounts to 4,825 maunds at the end of the season.

7. The salt heaps on the banks of the canal were covered with straw, but in all other respects this division resembles the preceding one.

8. A first-class ullam is returned as making seven garce of salt in six months at a cost of Rupees 41-8-0. The items of expenditure are precisely the same in nature and amount as those given under the heading of Attiput (paragraph 15). The amount realized at kudivaram rates is Rupees 84. The cost per garce, Rupees 5-15-5.

9. Seven garce in six months, or one garce twenty maunds a month is a fair yield from ullums which measure 30,330 square feet, but it is the produce of the best only, the majority produce less, and the third class is said to make only 3½ garce in the same period at a cost of Rupees 11-2-0 per garce.

1st Division, Kattur, examined June 6th, 1872.

1. These salt pans are situated not far from the Pulicat Lake, about a mile to the west of the Eastern Coast Canal, which gives off a special branch for their supply.

2. This branch passes through the works, dividing them into two sets, a northern and a southern; on the north bank there are 300 ullums, on the south 316; they are laid out on the usual description of soil, with a slight excess of sand, at about two feet above the canal level.

3. At the commencement of the division the canal gives off two channels, which branch right and left and surround the pans, conducting brine into the interior for their supply. The entrances to these channels (which are not navigable) are guarded by sluice-gates, one on either side of the main canal, which are opened at high tide and closed before the ebb to prevent outfall.

4. The channels are not capacious enough to permit of the brine being retained for condensation; as much as they can hold is used up in one or two days' work, but they keep the water at a high level, and there is little trouble in filling the reservoirs.

5. The bed of the southern channel is a few inches above the mean level of the canal water, so that it is covered with scarcely six inches of brine at high tide, as the tidal influence is little felt here. It would add much to the value of both if they were made deeper.

6. The ullums measure 29,394 square feet; they appear to be throughout their parts at a dead level; and are laid out on a plan similar to that of Voyalore. The bed-floors were better made than usual.

7. System Beds.	A. Fresh.		B. Mother.		C. Prepared.	
	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1	12° B.	1	26° B.	2	15° B.
II. ...	1½	10° „	½	27° „	2	12° „
III. ...	1	12° „	1	26° „	2½	15° „

Rate of evaporation, an inch and a quarter in three days.

8. The mother liquors in column B are weaker and more plentiful than usual, as the previous crop had been raised by multiple irrigations, of which the last had not been fully evaporated. The salt scraped was fair-sized, well-formed, clean salt; it is heaped and treated as at Attiput.

9. An ullam, measuring 29,394 square feet, produces 80 maunds of salt a month, or four garce at the end of the six months' season, which brings in at contract rates Rupees 48; from this deduct the cost of manufacture, which is, as at Attiput, Rupees 41-8-0, and the season's profit will be Rupees 6-8-0, and the cost per garce Rupees 10-6-0.

10. Though the manufacture has to contend with leakage, and other difficulties to which I have elsewhere drawn attention, still I think that many of these statements of its cost, which are worked out from returns furnished to me, are unreliable, as the returns are often at variance with scientific inferences or the known probabilities of the case.

5th Division, Vallur, examined June 11th, 1872.

1. These pans, the nearest to Madras and the largest in the district, are situated on the west bank of Cochrane's Canal along which they extend for about two miles. They are entered at a point nearly opposite Ennore by a special canal, from which thirteen branches spread out to supply the works with brine. The brine marked 8° Beaumé.

2. The works are nearly seven miles in circumference. There are 1,483 ullums laid out on soil richer than usual in alluvial constituents, but at a high level about two feet above that of ordinary high tide.

3. The pans are submerged in 'the rains' by the overflow of an adjoining river which is supposed to tell on their productiveness by washing away the saline constituents of the soil, but this should make no difference, as salinity of soil should not enter into the calculations of the manufacturer.

4. The ullums, measuring 32,157 square feet, are laid out on the same plan as at Attiput, a greater area being allowed for reservoirs and condensers, which together take 18,000 square feet.

5. The reservoirs held 6 inches of brine at 5° Beaumé, and were in many places choked with weeds. The condensers held an inch or less of brine at 10° Beaumé; they were uniform in level with the reservoirs. The beds are at the lowest level and carefully made.

6.	System.	A. Fresh.		B. Mother.		C. Prepared.	
		Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...		$\frac{1}{2}$	11° B.	1	27° B.	$1\frac{1}{2}$	14° B.
II. ...		$\frac{3}{4}$	10° „	1	28° „	$1\frac{1}{2}$	14° „
III. ...		1	10° „	$\frac{1}{2}$	29° „	$1\frac{1}{2}$	13° „

7. Double irrigations are used here, but at the time examined, in consequence of the cyclone it was said, many irrigations were required to get a good crop of salt. The character of the irrigations explains this necessity perhaps better than the cyclone. Column C. would, if evaporated at the then prevailing rate, produce salt resembling saw dust.

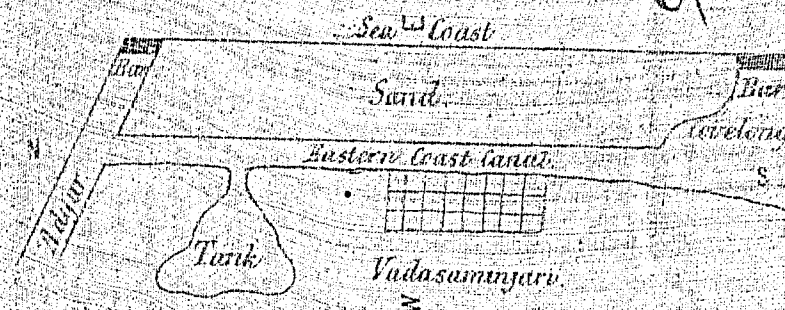
8. A first-class ullum of 32,157 square feet produces 6 garce of salt in six months; contract price Rupees 72; cost of manufacture as before Rupees 41-8-0; cost per garce Rupees 6-14-6. A third-class ullum is said to produce only 3½ garce in the same period at a cost of Rupees 11-2-0 per garce. Seven thousand six hundred and seventy maunds of salt are destroyed during the season for being either badly formed, or dirty; it is thrown for the most part into the canal, i.e., wasted.

6th Division, Vadasaminjari, June 18th, 1872.

1. These are the nearest salt works to the south of Madras; they occupy a narrow strip of land about one and a half miles long on the west bank of the Eastern Coast Canal.

2. The pans are about two miles from the sea in a straight line, laid out on very sandy soil about two feet above the level of the canal, from whence their water-supply was in great part derived at the time of my visit; though earlier in the season it is taken chiefly from pits which yield at a depth of six feet scant brine at 8° Beaumé.

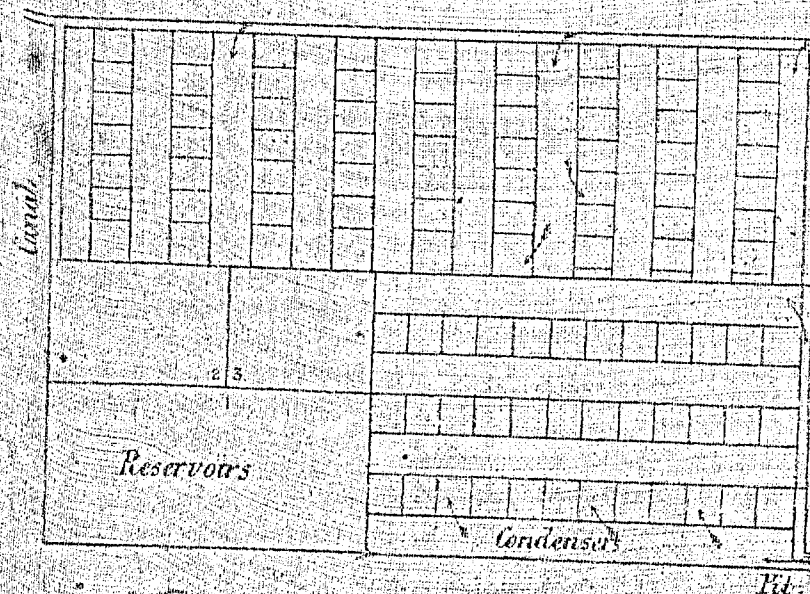
3. The following sketch will give some idea of the water-supply of Vadasaminjari:—



It will be seen that owing to the bar at the mouth of the Adyar river its waters are diverted into the canal, which also receives on the north the surplus waters of a large tank, whilst on the south it is cut off from the sea by the bar at Covelong, which is topped by the waves only at spring tides. It follows that the canal water is very weak, scarcely adapted for the large share which it takes in the manufacture of salt. It marked only 1.25° Beaumé as against 3.25° marked by sea water at the beach, Covelong.

4. Water is bailed into the pans by means of baskets as at Ganjam; six men working at a time discharge 2,040 cubic feet per hour.

5. The ullums are large-sized, measuring 73,692 square feet each; they consist of two or three reservoirs and 150 salt beds with one long condenser attached to each row of beds as shown in the sketch.



6. The reservoirs leak so much that they are never used; the condensers also leak and I believe are seldom used; they were empty at the time of my visit, and the salt beds were carelessly made.

7. Two irrigations are employed for each scraping: the following observations relate to the first:—

System.	A. Fresh.		B. Mother.		C. Prepared.	
Beds.	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1½	7° B.	¾	31° B.	1½	10° B.
II. ...	1	5° ..	¾	29° ..	1½	7° ..
III. ...	1	5° ..	¾	29° ..	1½	7° ..

8. Column C. shows prepared brine both excessively weak and scant considering the rate of evaporation prevailing at this season—sometimes, when the land wind blows, an inch in two days. The salt was small, badly-formed, and mixed with sand. It is not, however, disliked by the merchants, as it is light and gives a good bulk when weighed.

9. An ordinary ullum of the measurement given produces 1 garco 86 maunds a month, a very small out-turn in relation to its area, but just what might be expected from an ullum laid out on sandy soil and badly supplied with brine.

10. The cost of manufacture rises here to Rupees 10 the garco, the season's outlay to Rupees 120 as against Rupees 41-8-0 in the divisions around Ennore; the increase is due to the number of men employed in lifting brine with baskets, six men at Rupees 3-8-0 each; their pay amounts to Rupees 105, leaving Rupees 15 for all other expenses.

11. It would seem from this that the substitution of the picotah for hand-labor would diminish considerably the cost of manufacture, which is not, however, I think, as great as it is stated to be; for, when at Vadas-minjari, I was informed by the coolies themselves that one only, viz., the cooly maistry, received Rupees 3-8-0, the others getting but Rupees 3 a month.

12. These pans are very badly situated as to soil and water-supply, and it would be a difficult matter to improve the manufacture where it stands; further down the canal near Covelong the brine is much stronger and the soil is better; a change of site South would do much for the manufacture, and should, I think, precede minor attempts at its improvement.

7th Division, Covelong, arrived June 18th, departed June 27th, 1872.

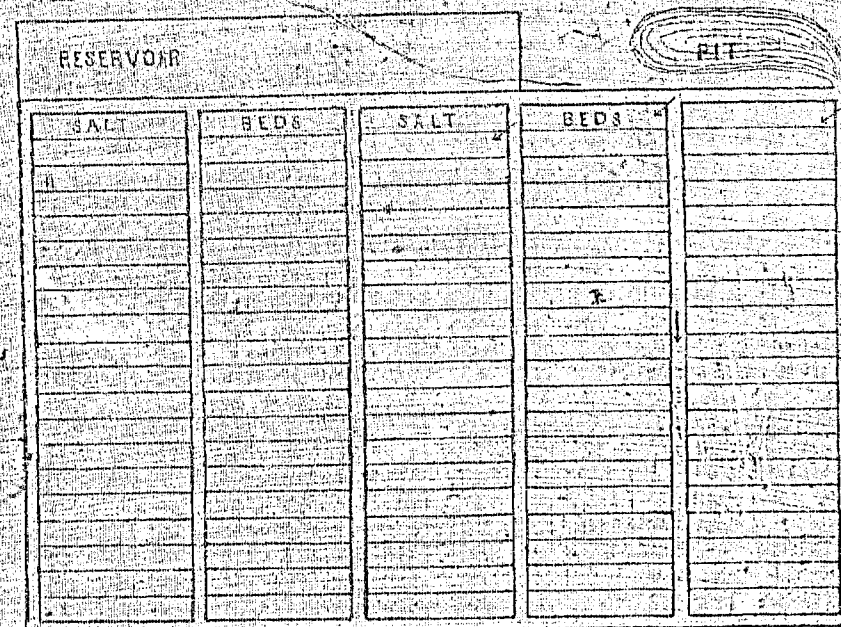
1. The works at Covelong suffered so severely from the cyclone that although present there from the 18th, it was not till the 25th of June that salt scraping commenced, and I was enabled thoroughly to

examine the system and manufacturing arrangements of this important division.

2. The works are divided by the Eastern Coast Canal into two sets, which extend for about a mile and three quarters along either bank. There are in all 374 ullams, laid out on low swampy soil, largely mixed with sand: supplied with brine chiefly from pits, which at a depth of six feet, yield a moderate quantity at 10° Beaumé: partly from the canal which here marks 3° Beaumé, and at one place alone close to the bar, from a shallow backwater in which the brine marked 6° Beaumé.

3. The latter pans and those which lie nearest to the canal bank are inundated at high tide two or three times during the season. The swamp on which the pans are now laid out, was at one time constantly under water; the canal cut through its centre re-claimed it, but it is still so liable to be submerged that the works should, I think, be protected by an embankment.

4. The ullams, measuring 66,924 square feet, consist almost entirely of salt beds; there is a small reservoir attached to each as shown in the sketch, but it is very seldom used. The salt beds are firm and well made.



D. System. Beds.	A. Fresh.		B. Mother.		C. Prepared.	
	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I. ...	1½	10° B.	1½	28° B.	1½	13° B.
II. ...	1	10° „	1	28° „	1	12° „
III. ...	1	10° „	1	28° „	1	12° „

Rate of evaporation, from two to three days to the inch, according to the wind.

6. The beds are twice filled with fresh brine for each crop of salt; the above observations relate to the first irrigation, the second prepared brine from which salt is scraped will be somewhat deeper and stronger, but nothing like what it should be at this period of the season, and the resulting crop of salt will be similar to that just scraped, small in quantity and made up of small, poor, ill-shaped, friable crystals.

7. The salt made here is disposed of in two directions, a part amounting in the last three years to 56,740 maunds is heaped on the canal bank and after a time taken in boats to Home's Gardens, Madras, where it is sold; but the great bulk, amounting in the same period to 687,160 maunds, is stored at the export platform close to Covelong beach, from whence it is removed by shippers and sold at Calcutta.

8. The quantity of salt exported depends on the amount supplied, for the shippers contract to take all that can be stored annually on the export platform.

9. It is perhaps owing to the extent of the demand which necessitates a corresponding exertion on the part of the manufacturers that merchants have reason to complain that the salt is deteriorating in quality of late years. As far as I can gather from previous reports, Covelong salt was thought superior to that of any other division manufacturing in the same way, but that which I saw made and examined at the export platform and at the stores, Home's Gardens, was quite on a par with the produce of Vadasaminjari, so much so that I could scarcely tell one from the other, as I suspected would be the case, when examining the prepared brine in column C.

10. The Covelong shippers are deserving of some consideration, if it is at all desirable to extend the export trade. They complain that the salt which is made for Rupees 12-7-0 at contract price, costs them with carriage to the export platform, Rupees 16-8-0, owing to a want of smoothness of communication, and Rupees 20 a garce when it arrives on board owing to the dilatoriness of the boatmen, who appear to be under no supervision, obey no authority, and see in the approach of a large ship an opportunity for extortion.

11. The boatmen are, in fact, a great source of loss and annoyance, as they absent themselves until bribed with rice and brandy, etc., in addition to their usual hire, and then commence and leave off work at

any hour that suits them; it would be well, if possible, to bring them under the control of the Salt Superintendent.

12. The ullums here, averaging as stated 66,924 square feet, are returned as producing 2, 1½, and 1½ garce a month, respectively, according as they are first, second, or third class. Of this division into classes I have already spoken. Assuming the produce of the first class to be a fair criterion of the amount which the pans are capable of yielding, one would be obliged to rank Covelong with the worst divisions examined elsewhere.

13. The cost of working for five months, in which time ten garce, valued at Rupees 131-14-0 at contract rates, has been produced, is as follows:—Five men at Rupees 3-8-0 a month = Rupees 87-8-0; material and conveying charges, Rupees 13. Total Rupees 100-8-0. Cost per garce, Rupees 10-12-9. This statement of produce and expenditure appears to me of doubtful authenticity, more especially as the proprietor of the third-class ullum is returned as losing Rupees 18 on each season's work, which seems to be a *reductio ad absurdum*.

14. The Covelong salt works, instead of being as I had supposed, something nearly perfect, are, though well situated as to soil and water supply, in all other respects as much in need of improvement as less-favored divisions. It may be that the effort to keep the export platform well supplied, leads to the acceptance of poor salt and a hurried system of manufacture, but the pans are capable of increase, and the Vadasammijari ryots would, no doubt, gladly exchange their barren soil for the more productive tracts bordering the canal in the neighbourhood of Covelong backwater.

8th Division, Cheyur, examined June 29th, 1872.

1. The Cheyur salt pans, 117 in number, extend for five miles along the west bank of a broad but shallow backwater, which makes a bend at the village of Multicand, some way to the north of the division, and thence courses in a southerly direction past the pans.

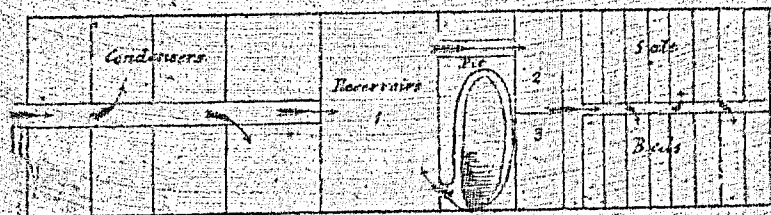
2. The ullums are laid out on alluvial soil mixed with sand at about one foot above the level of the backwater, from which their water supply is chiefly derived; there are pits also in connexion with each ullum, but these are used only in the early part of the season and they were filled with rain water at the time of my visit.

3. The bar of the backwater silts up early in the year about January, and, as the brine thus separated from its source evaporates to scant proportions in March or April, it recedes from the salt works and collects about the bend near the village of Multicand before mentioned, from whence a canal called Madlean's Channel, conducts it back to the works.

4. This channel is of important service to the works, without it the manufacture would be arrested for want of brine, as all attempts to

keep the bar open (five of which were made last season) speedily prove abortive; the channel, it is thought has silted up, as brine has become very scarce of late; its utility, at all events, would be much increased by adding to its capacity.

5. The nullams average 203,580 square feet in superficial area, a little less than at Penuguduru; all are not absolutely alike in plan, but the following sketch furnished by the Deputy Collectors represents the commonest form:—



6. Before describing the system of manufacture, which is special to Cheyur, I must premise that owing to the cyclone, the pans had been abandoned some time previous to my visit, so that it is impossible to be accurate in detail: but from the indications visible and the account furnished by the Superintendent (in the absence of the Deputy Collector, who was prevented by change of office from assisting me at any of these divisions,) the system pursued is, I think, as follows.

7. Brine is pumped from the backwater into the condensers and there exposed until it is thought to have attained a high degree of concentration; it is then passed on to the first reservoir, where it can, if necessary, be supplemented with pit water; from here, after some further exposure, it is passed into the second and third reservoirs, in which it is retained, the Superintendent says, until salt crystals begin to form (1) it is then run into the salt beds and evaporated in shallow strata, and this is repeated every four or five days throughout the season, one layer of salt forming on top of another until the dittum is accomplished, generally about June. The salt which now forms a cake three inches thick in the beds is broken up under about one-eighth of an inch of mother liquor, heaped for, eight or ten days at the pan side, and then removed to the Government platform, where it is weighed and stored under thatch pending its sale.

8. The reservoirs 1, 2, and 3 are six inches in depth; they are always filled to the top with brine from the condensers, which are in their turn replenished daily from the backwater; it is more likely there-

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fore, that so far from salt forming in the reservoirs, the irrigations are not much denser than those we have been hitherto accustomed to notice in column C., in which case the individual crystals would also be the same.

9. I examined the heaps in store, and found with difficulty in the midst of a vast bulk of small, ill-shaped and sandy salt, some lumps made up of crystals which appeared to have been deposited at different times from successive evaporations and under different circumstances of wind, temperature, &c., as they were, in many respects, dissimilar, over-laid each other at various angles, and fell asunder on rough pressure.

10. This cannot be the result aimed at, nor would it justify the arrangement which takes the unforeseen so much on trust as to place the whole season's work at the mercy of the elements, exposed from January till June in salt beds about a foot above the level of the adjoining backwater in a latitude not unliable to storms, freshes, and high tides.

11. The remarks made on the triple irrigation system of Mangenapudi apply with still greater force here, as, not only is it impossible to get a homogeneous lump of salt from shallow irrigations successively evaporated to dryness, but also the effect of a white reflecting floor of salt crystals in retarding evaporation throughout the season must be taken into account.

12. The amount of sand mixed with the salt obviously results from prolonged manufacture on common earthworks; the bed floors, though in rough material as well adapted to salt culture as at other places, are covered with brine and necessarily untouched throughout the season, so that, when scraping time arrives, they are soft and pulpy and dragged up largely with the salt. I pushed a good-sized walking stick with ease two feet through most of the beds.

13. If the system could point to its results in the past to the superiority of the salt and the extent of its sales, it might, perhaps, be worthwhile risking an occasional loss such as occurred this year, when the whole crop, 98,280 maunds, was destroyed in the beds; but such is not the case; the salt in store, the only evidence of the value of the system we possess, is so inferior in crystal and so dirty that 53,600 maunds* of it, which had been three years on the platform, was condemned just previous to my visit at the urgent request of the manufacturers themselves, as it was thought to be unsaleable.

14. Cheyur possesses a reputation and some natural advantages, notably backwater of a high degree of density (it marked 6° Beaumé at the time of my visit), but its system is not one that can well be advocated, and should, I think, give place to a more economic and a better method of manufacture.

* 48, ten garco salt heap.

15. The ullums, measuring 203,580 square feet, are returned as producing the allotted dittum, 7 garce of salt, at an expenditure of Rs. 97-2-0, or Rs. 13-14-0 per garce. This I believe to be an exaggeration, and I would draw attention to the fact, brought out in the tabular statement at the end of the report that the cost of manufacture increases progressively with the kudiyaram as if a ratio necessarily subsisted between them, which is not the case; at Cheyur for instance, the kudiyaram is regulated by Inam considerations.

16. From inquiries made at Merkanum from Mr. Freer, Deputy Collector of South Arcot, and Mr. Thompson, Superintendent of that Division, it appears that the Cheyur salt manufacturers manufacture also at Merkanum; that the system and its surroundings are the same; and that the cost of manufacture, so far from being Rupees 13-14-0 the garce, could not well exceed Rupees 3 the garce, the outside cost of salt made in the Merkanum "Sirkar" pans.

17. Moreover it was upon the persistent and urgent representations of the manufacturers themselves that the 53,600 maunds of salt in store had been condemned to destruction,* they promising to replace the whole amount with a better quality of salt free of all charge; now, although the salt was such that traders were gradually deserting Cheyur for Merkanum, although working the pans keeps them from deteriorating and gives occupation to dependents, and, although the contract rates are high; still, I think it unlikely that the ryots would be anxious to replace so much salt gratuitously, and at a cost to themselves of Rupees 13-14-0 per garce, or Rupees 6,660 in all.

18. The kudiyaram is curiously arranged;† there are 40 ullums which get Rupees 3-5-0 per garce plus 2½ cawnies of paddy land held by their proprietors in perpetuo; six and a half ullums get Rupees 15-7-0 per garce; 68½ ullums get Rupees 22-5-0 per garce, one gets Rupees 22-6-0 and 1½ get Rupees 26-12-0 per garce. As in the normal condition of things one season's crop places as much salt in store as will supply the trade for three years, the ryots who hold the 2½ cawnies of land have much the best of it, as it is good land and under cultivation, and yields kudiyaram in the shape of crops whether salt be made or not.

19. Next year, when it becomes a question of destroying the inferior salt at Cheyur, it would be well to depart from the present mode of destruction as described by the Acting Deputy Collector, who says:—

"Salt is destroyed in this district by throwing it into the canal water and mixing it up with the silt, and thereby rendering any theft of it

* In consequence of the failure of this year's crop, the salt was not destroyed; it will remain on sale until replaced by a better article at the end of next season, when it will be destroyed.

† An Inam pan at Corolong which is allowed Rupees 22-6-0 a garce for salt, has been under water for several years.

impossible." A better plan would be to throw the salt into the reservoirs, which would destroy its crystallization, remove its impurities, make theft equally impossible, and yet leave the chloride of sodium in solution ready to be re-crystallized out in better form. This remark applies equally to the other divisions in this district, in which the total quantity of salt destroyed during the past season amounted to 29,645 maunds.

20. Amongst the alterations required at Cheyur to improve the manufacture, enlarging "Maclean's Channel" rank first, as the supply of brine is at present insufficient; it should be made, if possible, wider rather than deeper, that the brine, having a large evaporating surface, may condense a little before entering the works. For the rest I think the present system cannot stand, looking to its results in destroyed crops and unsaleable salt made at a cost of Rupees 13-14-0 the garce.

21. From Cheyur I proceeded to Merkanum with a view to ascertain the cause, if any legitimate cause existed, of a petition for increased kudiyaram, which was said to have been sent in from that division. I found, however, that no petition had been made, nor was there any in contemplation, for which reason, as salt manufacture had ceased, I remained there only one day, getting up information as to Cheyur by comparing notes with the Deputy Collector, who, from having Cheyur ryots at Merkanum, was well acquainted with them and their method of manufacture.

22. It was the beginning of July, salt manufacture had been abandoned at Merkanum and at many of the southern divisions, and was drawing to a close at the rest. It would have been waste of time to go farther south, and, as much time was still required, I returned to Madras and have since occupied myself in the preparation of this report; which is intended to show the actual condition of salt manufacture on the coast visited, and to improve it, by placing it in juxtaposition with scientific salt culture.

23. In conclusion, I have to thank Mr. Freer, Salt Deputy Collector of South Arcot, who met me at Merkanum and gave me a great deal of useful information relative to the southern part of the Chingleput District, which I might not otherwise have obtained.

MADRAS,

25th November 1872.

DIVISIONS.	Superficial Areas in Square Feet of		
	The Whole Ullam.	The Evaporating or preparing pans.	The Crystallizing pans.
	Sq. Feet.	Sq. Feet.	Sq. Feet.
Ganjam	161,277	50,135	59,133
Itchapur	152,460	70,000	32,480
Nowparlah	117,612	59,806	58,266
Keppili	18,153	—	18,153
Bimlipatam	110,043	73,050	34,993
Kurasa	77,760	51,840	25,920
Pentacottah	121,500	60,750	60,750
Penugadura	214,164	101,032	113,132
Mangonapudi	46,692	10,692	36,000
Nizampatam	18,090	5,770	12,420
Ohina Ganjam	30,240	6,300	23,940
Ramparti	20,925	7,584	11,173
Pardarti	52,137	23,800	16,929
Pakala	21,119	8,982	12,177
Tunmalapenta	16,620	5,700	9,000
Kristnapatam	45,162	9,900	33,392
Dugarazupatam	59,049	24,866	24,183
Tada	95,418	—	70,784
Attipat	44,154	22,077	15,273
Pulidivak	20,253	16,692	9,301
Voyalore	30,330	20,132	10,197
Kattur	29,394	15,039	13,455
Vullur	22,157	18,000	14,157
Yadaraminjari	73,692	36,059	37,633
Covelong	60,924	31,283	33,641
Cheyur	208,580	125,720	67,860

REMARKS.—The ullams, with a few exceptions, diminish in superficial area from crystallizing as far as Attipat. The produce in relation to area as a rule falls off rapidly, diminish in depth and strength as the season advances, and the rate of evaporation is of manufacture increases, not uniformly, but still more or less progressively with the abruptly defined by their limits.

Strength of Water supply in Degrees Beaume.	Monthly Produce in Garca and Mounds.	Irrigations of Brine.		Rate of Evaporation, days to inch.	Quality of Crystal formed.	Cost of Manufacture per Garca.	Kudvaram or Contract Price.
		Depth in Inches.	Strength in Degrees Beaume.				
Beaume 2°	4 0	1	13.5°	5	Good	Rs. A. P. Rs. A. P.	2 5 0 9 0 0
2.5°	4 16	2	13°	...	Very Good.	2 5 0 9 0 0	2 5 0 9 0 0
3°	5 33	2	14°	...	Very Good.	2 5 0 9 0 0	2 5 0 9 0 0
1°	0 111	14	8°	41	Very Bad.	8 4 0 9 0 0	8 4 0 9 0 0
4°	4 20	9	21°	41	Good.	6 13 0 9 0 0	6 13 0 9 0 0
3°	3 30	2	16°	41	Good.	7 12 0 9 0 0	7 12 0 9 0 0
2.75°	—	2	13°	4	Middling.	6 8 0 9 0 0	6 8 0 9 0 0
3°	5 60	—	—	4	Very Middling.	6 9 7 10 0 0	6 9 7 10 0 0
12°	1 114	2	19°	4	Good.	6 0 0 10 0 0	6 0 0 10 0 0
5°	1 92	22	15°	4	Good.	6 0 0 10 0 0	6 0 0 10 0 0
2°	1 105	21	23°	4	Very Good.	6 0 0 10 0 0	6 0 0 10 0 0
6°	1 9	24	15°	31	Good.	9 0 0 10 0 0	9 0 0 10 0 0
3°	1 13	24	13°	31	Middling.	9 0 0 10 0 0	9 0 0 10 0 0
4°	1 30	2	19°	31	Middling.	6 13 0 10 0 0	6 13 0 10 0 0
5°	0 62	11	17°	31	Middling.	8 3 8 10 0 0	8 3 8 10 0 0
1.1°	1 63	21	17°	3	Middling.	7 6 0 10 0 0	7 6 0 10 0 0
3°	1 70	14	25.5°	3	Bad.	6 15 0 10 0 0	6 15 0 10 0 0
14°	1 90	3	0°	3	Good.	8 10 3 10 0 0	8 10 3 10 0 0
2.75°	1 30	2	11°	21	Middling.	2 0 0 12 0 0	2 0 0 12 0 0
2.75°	0 100	14	14°	21	Bad.	8 8 0 12 0 0	8 8 0 12 0 0
2.75°	1 26	11	15°	21	Middling.	8 8 0 12 0 0	8 8 0 12 0 0
2.75°	0 80	2	13.5°	21	Good.	10 6 0 12 0 0	10 6 0 12 0 0
8°	1 0°	14	14°	2	Middling.	8 11 3 12 0 0	8 11 3 12 0 0
1.25°	1 86	14	0°	2	Very Middling.	10 0 0 12 0 0	10 0 0 12 0 0
5°	2 0	1	12°	1	Middling.	10 1 0 12 0 0	10 1 0 12 0 0
6°	1 46	...	...	2	Very Middling.	13 14 0 12 0 0	13 14 0 12 0 0

Ganjam down. The preparatory surface, in like manner, contracts in favor of the though the brine increases in strength. The irrigations remain the same or even accelerated; the salt consequently deteriorates both in crystal and in purity. The contract price, which is regulated by salt collector's rates, or at all events (Cheyur excepted).

