REPORT

ON

THE MANUFACTURE OF SALT

IN THE

SOUTH ARCOT, TANJORE, MADURA, AND TINNEVELLY DISTRICTS,

1873.

BY

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SURGEON.

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1873.

REPORT ON SALT MANUFACTURE.

From J. J. L. RATTON, Esq., M.D. & M.C.,

Surgeon on Special Duty,

To H. E. STOKES, Esq.,

Acting Sub-Secretary to the Board of Revenue.

SIR,—I have now the honor to forward you my Report on the Salt Stations in South Arcot, Tanjore, Madura, and Tinnevelly, exclusive of Merkanum, which has been reported upon separately. See Letter dated August 21, 1873, Tuticorin.

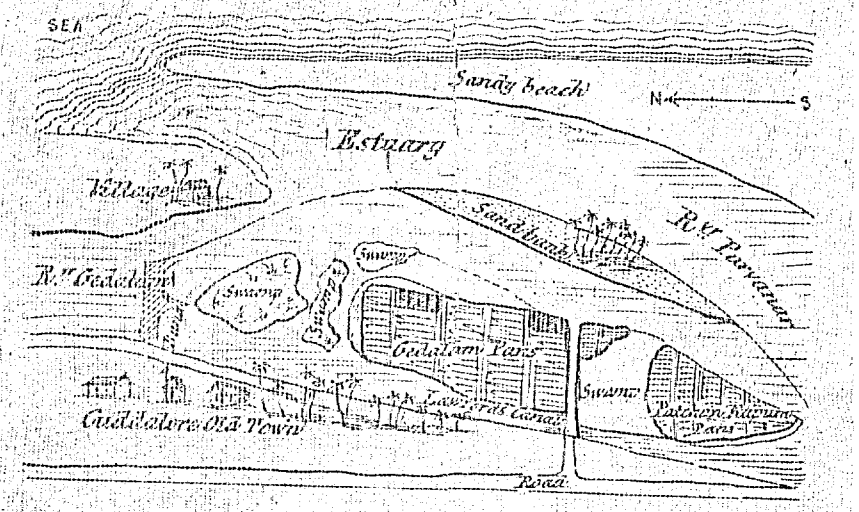
2. Before entering into station details, I will make what follows a little clearer perhaps, and avoid some repetition, by briefly answering a question, which has been frequently put to me of late, viz.:—What are the natural requisites of soil, &c., for a good and productive set of salt pans?

3. They are, 1st, an easily drained site, protected from inundation; 2nd, an impermeable surface stratum of some description of plastic clay, which should not be much less than 12 inches in thickness,—this, if the site be in other respects a good one, may be made artificially—and 3rd, an abundant and convenient supply of common salt-water, not less than 3° Beaumé in density. Convenient here refers to both level and distance. To these may be added, with advantage, a sub-soil brine, richly impregnated with sodic chloride. We will see at the salt-stations themselves to what extent the presence or absence of these primary requisites affects salt manufacture.

4. *South Arcot, 2nd Division.*—Gundalum—arrived February 4, departed February 11, 1873. This division consists of five stations, two of which, Gundalum proper and Patchankupam, are quite close to the Old Town of Cuddalore, and the rest, Kudikadu, Manavary, and Kamblimodu, are far outlying at different distances up the tidal river Paravenar.

5. The salt pans at Gundalum and Patchankupum are laid out on a low sand bank, to the west of the estuary formed by the rivers Gudalum and Paravenar. The bank is separated a few yards from the mainland by Lawford's Canal, but united to it by a bridge, which spans the canal nearly opposite the centre of the works and by a narrow causeway or bund on the north, as shown in the following sketch.

SKETCH No I.



6. The pans are at a low level, not more than six inches above that reached by the sea at ordinary tides, but they are surrounded by an embankment, which defends them from floods.

7. The natural soil upon which the ullums are laid out is unmixed sand, to a depth of six feet or more, as far down in fact as our pits extended, upon which it would be impossible to make salt with profit. The beds, it is said, were originally made with six or seven inches of imported clay, and some clay mixed with sand still remains, but not enough to form an impermeable flooring. Fresh clay should be sought at once and applied to the pans throughout.

8. Brine is obtained partly from the estuary and partly (by those nearest to it) from Lawford's Canal, but mainly from pits which are said to yield a fair supply. The estuary and canal furnish sea brine at from 2·5 to 3° Beaumé even from the beginning of the season, as the works are near the bar. The pit brine I could not examine, as it was, at the time, mixed with rain water; but I find from Mr. Freer's Register that it averaged 6° Beaumé during last April, May, and June.

9. At one place where the pans are supplied from the northern or closed end of Lawford's Canal, the brine is of doubtful purity. There is no great current at this end, but rather the water inclines

to stagnate, as the tide enters the canal from the south and has to pass through a small culvert under the otherwise solid bridge before reaching it. A cocoanut tope lines the bank, and under its cover the water's edge is much frequented in the early morning by natives of the Old Town of Cuddalore. Two pucka latrines, for their convenience at all times, are built on the sloping canal bank. Two or three sewers, draining from the thickly populated native town, discharge into the canal here, and the jail night-soil is shot out somewhere about its upper extremity.

10. With such sources of contamination it is to be feared that this brine is sometimes, at low tide for instance, unfit for salt manufacture.

11. Believing, as I do, in the theory of the propagation of some grave diseases, by their germs set free in water through the taint of sewage, I think it possible that salt scraped from this brine might convey infection. For, although, all organised forms contained in brine as a rule perish and are oxydised during the process of its evaporation to crystal formation, this safeguard is removed here by the system of shallow irrigations, which often necessitates a last one, introduced immediately before scraping, merely to clear the salt from mud.

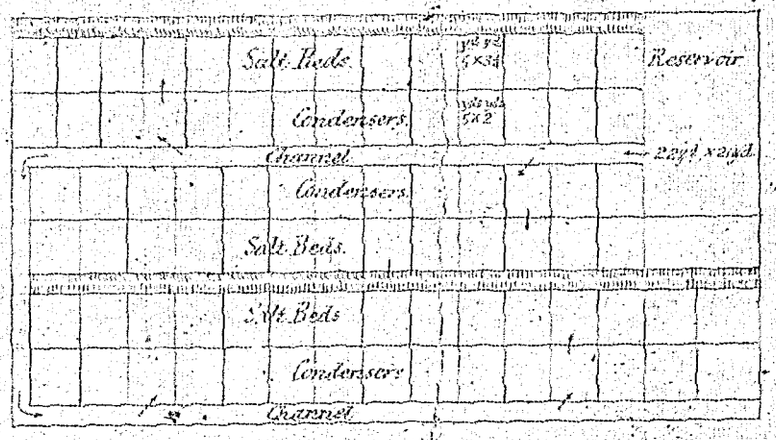
12. Either the north end of the canal should not be used in manufacture, which would be very inconvenient for the ryots, or the sewage, &c., should be carried elsewhere, and the water otherwise conserved, which would be equally inconvenient for others, or else the causeway replaced by a bridge, permitting the tide to swing round the salt island and scour out the canal.

13. The mechanism of the water-supply is unusually good at Gundalum. Brine is raised to the p[illegible]ns by means of the well picotah, armed with a large wooden tub holding 2766·10 cubic inches, which, owing to the slight difference in level, is filled and discharged by two men 16 times in the minute, giving a discharge of 1536·6 cubic feet per hour, as against 1,000 cubic feet obtained with the well picotah at Ennore, and 680 by two coolies working with slung baskets of Vadasaminjari.

14. Manufacture commences earlier here than at Merkanum; the first scraping taking place sometimes in the month of March; but there is nothing to prevent its still earlier prosecution to meet the pressing and chronic scarcity, unless it be the marked unwillingness of the ryots to begin work before the rice crops are gathered and the salt beds are dried by the sun without their intervention.

15. The subjoined sketch of a Gundalum ullum, furnished by Mr. Freer, shows the arrangement of pans adopted in this and the remaining stations in South Arcot. Area of ullum 17,860¼ square feet.

SKETCH No 2



16. With the exception of the dwarfed area of the ullum and the corresponding miniature pans, there is nothing new about it. It is essentially the same ullum with scores of crystallizing beds, and no adequate means of preparing brine which is met with, modified in outline, at most stations.

17. The system in use is that by multiple irrigations, with this difference that things are done here on a very petty scale. As I had no opportunity of seeing it in work, I take the following from a description furnished by the Deputy Collector, Mr. Freer.: "The irrigation of brine is never much more than half an inch deep, the brine when let into the salt beds being from 4° to 10° Beaumé. The beds are often irrigated a second and a third time, on the last occasion the irrigation is a little deeper. The small crystals which form after the last irrigation, or about the third or fourth day after the first irrigation, are scraped. The ryots will not irrigate deeper or wait longer, as the pans are leaky and the brine in the pits is scanty. As they have more beds than they can keep in work with the weak brine, they are afraid to diminish its quantity by condensation.

18. The physical characteristics of the salt I examined confirm the correctness of the foregoing description, to which, comment is superfluous. Salt may be scraped at any time from 9. A. M. to 5. P. M., as the ullums work pell-mell, but the ryots commonly prefer to scrape it at or about midday. When scraped, it is carried off at once, still moist, and added to the ryot's heap on the local platform, from whence it is removed occasionally to the Government stores in the Old Town.

19. The salt crystals are of a pale brown color, small, irregular, friable and very moist, yet of such light weight, that 424 mercals weigh less by 11645 lbs. than the official garce, whereas that quantity, as a rule weighs much more; at Merkanum for instance 498 lbs. more. The crystals are also somewhat bitter, and though no magnesium was visible, its presence may be inferred with certainty from the fact that the bitterns are a constant feature in the manufacture.

20. "Invariably" says Mr. Freer, "at the close of the manufacturing season, a kind of long-grained salt is produced in some of the pans, of a slightly bitter taste, which the people call saltpetre, and attribute to over-condensation of the brine by the westerly winds. It is neutralized, they say, by the showers of rain which come to their aid about that time, or by a supply of water direct from the sea or pits." There is no sense in this native idea of over-condensation of the brine by the land winds. Sulphate of magnesium crops up in the beds, when, through its accumulation in the bitterns they become saturated with it, its insensible produce at length culminating in a substantial crop. The French Government complain that Cuddalore salt is bitter; that it causes the itch and fever; and is unsuited for consumption.

21. All the other salt stations of this division manufacture precisely as at Gundalum. Kudikadu, the nearest, is situated on the west bank of the Paravenar river, four miles up from the sea. The pans are in four or five patches, varying from one to three feet above the high-tide level of the backwater, scattered here and there between elevated tracts of dry cultivation. As regards soil the site is well chosen, a thin layer of loam overlying a thick stratum of ochreous clay, forming the bed floors, but as regards water-supply not so well.

22. The water in the river, or backwater as it is called, from which the works are exclusively supplied, marked abreast of the pans on the day of my visit, 6th February, 0°Beaumé at high tide, and that in pits dug for the purpose of examinirg the sub-soil and testing the capabilities of the site for pit manufacture marked but 2° Beaumé. About the middle of April the rivier brine reaches 2·5° Beaumé, which degree it seldom passes during the salt season.

23. Small as are the ullums at Gundalum, those at Kudikadu are even smaller. A set of eight pansfour side and salt beds would in some instances be equivalent to a single salt bed at Ganjam, forming comparatively a mere toy or cabinet edition of what they ought to be. Why the ryots here cling to the small beds, it is difficult to say: as it is evidently much cheaper and less troublesome to make one large bed, than eight small ones, and I may add, as a matter of experience, which it puzzles me to explain, that the finest salt is known to be produced in the largest beds.

24. Probably the smallness of the ullums at Kudikadu, the best of which average but 9,720 square feet in area, and their minute sub-divi-

sion is due to the exemption of salt property from the law prohibiting the sub-division of land. A ryot partitions out his ullum amongst his sons as they marry, or sells his pans in small instalments to meet pressing wants. An ullum is attached by the courts and sold in satisfaction of a debt, the purchaser hiring it out in parcels to poorer men, who farm it and give him half the profits. Any of these things are done—and done to the great detriment of manufacture—not here only, but in other districts as well. Often without any notice being given to the Duputy Collector, I have heard of squabbles and of law suits, of negligent manufacture and idle pans all arising from these causes. A single side and salt bed have been known to form a distinct property; a single rupee, the annual earnings of a responsible salt manufacturer.

25. From a detailed statement showing the average amount of kudivaram drawn by the manufacturers of Gundalum division during the last five years, from which it must be remembered their working expenses have to be deducted, I find that on 78 occasions the actual sum of kudivaram, paid, amounted to less than Rupees 10 for the season's work, and that there are 54 pan-holders whose annual average amounts to less than Rupees 10. These men have no inducement to work carefully, nor indeed to work at all, were it not that the Deputy Collector can confiscate idle pans, which, for tradition's sake, the ryots are loth to part with. Besides, they make so little salt at a time, that in adding small instalments to their heap exposed on the platform, all of it becomes in-grained with dust and dirt, which cannot afterwards be removed. A strict limitation of the minimum size, of salt pans to be held and treated as a separate possession, to half or even a quarter cawny, would be a decided step towards the improvement of salt manufacture.

26. Manavary, the next station of the Gundalum division, is situated on the east bank of the Paravanar, two miles further up from Kudikadu. The pans are laid out some 50 yards from the river's bank, on very good soil, almost precisely similar to that of Kudikadu, which seems likewise to have been got at by excavation, as the pans are in two patches, separated by high sandy ground with perpendicular cut sides.

27. The water-supply is perhaps bitter here, as pits are used along with the backwater. The existing pits were filled with rain water when examined, but others dug to examine the sub-soil, &c., filled with brine marking 10° Beaumé. I have since received from Mr. Freer a register of the density of the brine procurable at this and the other divisions in South Arcot, and find that the pit brine averaged 5° Beaumé in May and June, and that in the backwater 2° Beaumé.

28. Kamblimodu, the last station of this very straggling division, is one mile further up the west bank of the river, and seven miles from the sea. The pans are for the most part about two feet above

the level of the backwater, on excellent soil, but at one place they are at a higher level, on pure sand and at the foot of some high ground which drains into them and inundates them with fresh water when showers occur. Mr. Freer is about to protect the whole station from fresh-water incursions, by cutting a channel between the pans and the high ground. When this is done, clay will be found for the ullums above-mentioned, at its proper level, a foot or two beneath the sand.

29. Salt is made here, as at the last station, both from the backwater and from brine pits; the former marked 0° Beaumé at the time of my visit, but I find from the register that it attained to 1·25° Beaumé in June; the latter contained fresh water when examined, but averages 5° Beaumé during the season. Brine in exploratory wells marked 10° Beaumé. It is somewhat strange that here and at Kamblimodu the existing pits yield on an average brine of about half the density of the sub-soil water obtainable from exploratory wells freshly dug.* It would seem that these old pits have dissolved out from their walls and the circle of ground they drain, the bulk of sodic chloride once held, and that occasionally shifting their position, would materially improve the quality of the brine.

30. It is noteworthy, that both here and at Manavari, with the example of the admirable Gundalum picotah before their eyes, the ryots have recourse to slung baskets to raise brine to their salt pans. They are, however, very poor people.

31. All these stations are watched over, as well as may be, considering the distance, by the Gundalum Superintendent, with the help of one assistant at each. Their ullums are similar. They manufacture in the same way and produce the same inferior description of salt, which is sent in boats to be stored and disposed of at Cuddalore.

32. The following statement shows the ordinary area of an ullum at each station in the Gundalum division, the produce, kudivaram, profit, and cost of manufacture:—

Stations.	Area of ullum in square yards.	Season's produce in garce.	Cost.	Kudivaram.	Profit.	Cost per garce.
			Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
Gundalum ... Patchankupum.	1984·5	4	22 0 0	40 0 0	18 0 0	5 8 0
Kudikadu ...	1080	3	22 8 0	30 0 0	7 8 0	7 8 0
Manavari ...	1639	4	27 0 0	40 0 0	13 0 0	6 12 0
Kamblamodu...	1279½	3½	24 9 0	35 0 0	10 0 0	7 0 0

33. This statement unfortunately throws very little light on the actual or relative condition of the pans. Gundalum combines a bad soil with a good water-supply. Its ullum is about 17 per cent larger than that of Manavari, which unites an excellent soil with an inferior brine, yet both produce four garce and realize Rupees 40 kudivaram.

* This is not owing to dilution with rain water, as the difference exists at all times.

So far, so good. At Gundalum cooly hire and materials amount to Rupees 20-4-0, and carriage of salt to the platform to Rupees 1-12-0—total Rupees 22. At Manavari the manufacturer farms the ullum and pays the real owner half the kudivaram, Rupees 20; he pays also Rupees 3-8-0 for carriage of salt to the platform, as it is much further off, and this, together with a sum entered as batta, brings his expense up to Rupees 27. The cost per garce at Gundalum is Rupees 5-8-0; at Manavari, which is a better station, Rupees 6-12-0. The dates of beginning and ending manufacture are left out, but it is certain that Manavari begins later and leaves off earlier, as it is six miles up the river, and has to wait longer for brine s, that if the true cost, i.e., that of the labor, were given, instead of half the kudivaram, the cost of manufacture would be least at Manavari.

34. Notwithstanding that these five stations send all their salt for sale to Cuddalore, the supply there is at present unequal even to the existing small demand. The dittum during the past 11 years has averaged 80,556 Indian Maunds, the out-turn in the same period has averaged 56,951 Indian Maunds. The scarcity of salt, which will become awkwardly apparent when the railway is opened to Cuddalore, necessitates a careful inquiry into the means of increasing the supply.

35. There are three ways, which may be employed either separately or together, at most divisions, by which we may increase the produce of salt. First, by extending the period of manufacture; second, by increasing the density or percentage of sodic chloride in the brine used; and third, by extending the area of ground under salt cultivation.

36. The first of these is decidedly the best where practicable, as it entails no extra expense upon Government. Subject to the necessary conditions of soil and water-supply, salt manufacture may be profitably conducted from January till the end of September. It is in fact carried on during every one of these nine months in some district or other along the East Coast. Ganjam, which presumably suffers most during the north-east monsoon, begins in January, whilst Madura and Tinnevelly, which are exposed to the south-west monsoon, work through till the end of September. Gundalum proper, as far as the natural requisites are concerned, might begin in February, but then, there are the ryots to be consulted.

37. *Secondly.*—The out-turn may be increased by increasing the percentage of sodic chloride in the brine used for manufacture, either by the use of collecting reservoirs, as in France, or by dissolving out the sub-soil salt, as at the Cheshire mines, but in some simpler way.

The Mediterranean collecting reservoir has been described. The salt water required for the use of the "Salins" is enclosed from the very beginning of salt operations, so that it may evaporate, strengthen, and yield more salt as work progresses. At Gundalum such a reservoir

may be made without much trouble or expense, by connecting both ends of the sand-bank in the estuary with the extremities of the works, leaving a sluice-gate at the north for the admission of sea water. All that is required is to complete the barriers which natural forces have already in part silted up, shown by dotted lines in the sketch, as seen at low tide.

38. How to dissolve from the sub-soil, by the use of sea or back water as the case may be, the largest quantity of salt, is an engineering problem into which I cannot venture at present; but this I feel sure that the system of brine-supply, which takes the greatest advantage of the salinity of the sub-soil, either by pouring sea water into transverse trenches cut down to a porous stratum, making it percolate to a common reservoir, or which otherwise as may be convenient, strengthens it from the great store of salt, which lies diffused in earth beneath the pans, will prove the most economic and the best.

39. In proof of the foregoing, I submit a table of the percentages of NaCl. contained in sea water, at different densities, up to 20° Beaumé, the strength of the sub-soil brine at Vedarnium, in June last, a few days after the advent of the Vishagum, or great sea wave:—

Sea Water Density in Degrees. Beaumé.	Percentage of NaCl. contained.	Sea Water Density in Degrees. Beaumé.	Percentage of NaCl. contained.
3°	2·7	14·00	12·3
3·50	3·	16·75	15·8
7·10	5·5	20·60	20·9
11·50	9·5	...	...

40. Brine containing more salt than at present can be obtained at Kudikadu by having recourse to the sub-soil water, which is stronger in January than the river in June. It is singular that the ryots there have been hitherto content to manufacture with water which appears never to attain the density of sea brine.

41. *Lastly.*—By extending the area under salt cultivation. This I consider as a last resort, because it is expensive, and because it tends to diffuse supervision and so to perpetuate the cooly system of manufacture and encourage smuggling. But its simplicity recommends it, and moreover it sometimes happens, as at Gundalum, that it cannot be avoided.

42. At Gundalum, sanction has, I believe, been already obtained to convert into salt pans the patches of land marked swamp in the sketch. They are at a little higher level than the other pans, but on exactly the same kind of soil, not only sandy to a depth of six or seven feet, but also riddled by a species of small crustacean, called "chipan" in Tamil, which burrows down to a depth of several feet, and must be eradicated before there is a chance of making salt. These pans, like the older ones,

will have to be made artificially with a top-dressing of good stiff clay which should not certainly be less than eight inches in thickness, and, considering the nature of the soil, might be made thicker with great advantage.

43. Having now attempted to describe, and to suggest remedies for, the state of salt manufacture at Gundalum, I would remark, before leaving it, that the task of improving and extending salt manufacture in this division is by no means an easy one. It will require unremitting attention and perseverance on the part of the Deputy Collector to improve the soil and brine-supply at each station; the levels and system of manufacture; to enlarge the miniature pans and substitute careful for negligent work, which has now the force of habit; to guard against minute sub-division and conflicting interests, and finally to prevail upon the ryots to begin work earlier.

3rd Division, Kille, arrived February 11, departed February 19, 1873.

1. Kille, the last division in South Arcot, is 18 miles south of Kamblimodu, and about 3 miles west of Porto Novo. It is divided into four stations, called Kille No. 1, Kille No. 2, Tillavadangam, and Nakaravandangudi. Of these, the first three are grouped together, and may be considered as one station.

2. No one acquainted with the aspect of salt works, walking in the month of February along the public road which leads to Kille, would suspect the near presence of the pans. Rice fields border on the road and stretch away in green undulations as far as the eye can reach. Neither the sea is in sight nor any estuary. The only water visible being that so abundantly used in wet cultivation. And at this season there is a complete absence of salt and of the signs which accompany its production. Some dark patches towards the end of the road, on either side, represent the salt pans.

3. The brine-supply at this station, as might be supposed from the unusual verdure, is not such as to encourage manufacture. The pans are more than two miles from the sea, and though connected with an estuary at the mouth of the Coleroon by means of a supply canal half a mile in length, the perpetual freshes in the river prevent their obtaining any sea water from that source. I find from Mr. Freer's register that the canal water marked 1° Beaumé on the 30th and 31st of May last, and that some showers in June speedily extinguished this feeble commencement of salinity. Brine is of necessity obtained exclusively from pits.

4. The Kille pits yield a remarkably small quantity of weak brine even in June, averaging not more than 3° Beaumé in density. It is a curious question whence this brine, which oozes from a stratum of sand five feet beneath the surface, is derived. Not from the sea. It is too far away, and besides the pit brine is sometimes at a higher level. A remark

of the ryots, that the water rises in the pits when there are freshes in the Coleroon, would appear to point to that river as the source whence it is obtained, though from how far off, or through what soils it percolates, it is hard to say. In any case it seems probable that the brine is deteriorating in strength, as the natural action now in progress is one of salt removal, and except at the pans themselves, which occasionally, though very rarely, are reached by the tide, salt is not renewed here.

5. The brown patches spoken of consist at the surface of heavy, impermeable clay, and were no doubt well chosen as a site for salt works, when such things were first brought out at Kille. The marine shells and salt scattered through the soil show that it must have gradually risen from the bed of an estuary to its present level and surroundings. But the forces, which have brought about this change, have not ceased their action. The patches are still rising and receding westward as the Coleroon spreads in deltas seaward the land it has worn from the interior, and manufacture is becoming every year less and less profitable.

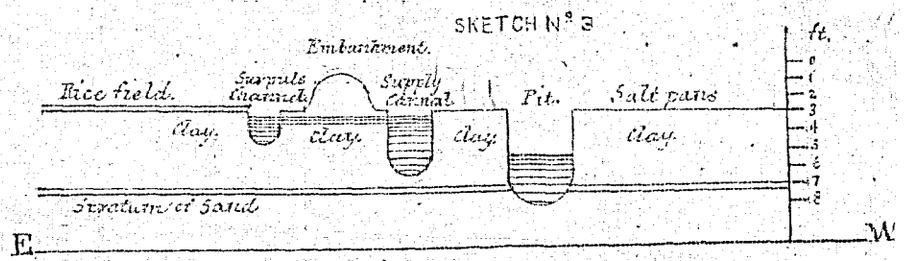
6. The ever-spreading rice fields attest this alteration going on at Kille, and are a measure of its progress. Where a few years ago an efflorescence of salt stopped cultivation, rice is freely grown, and there are men who would take over the pans themselves, confident that the soil is fit for the produce of cereals. In truth the present color and sterility of the patches are rather the consequence of artificial salt culture than a proof of the worth and capabilities of the soil for its manufacture.

7. The paddy fields in their turn re-act most unfavorably on the salt pans, tending with their surplus waters, according to the permeability of their floors, to wash out and diminish the salinity of the sub-soil. Here the rice crops seem to spring from three or four feet of clay, barring direct leakage, but injury here and there results from the surplus channels being sunk beneath the level of the clay.

8. Mr. Freer directed my attention to the weakness of the brine and the unproductiveness of some ullums, one of which, though worked for two years, is said to have turned out scarcely any salt at all, at the east of stations No. 1 and No. 2.

9. These stations, as indeed the rest, are completely surrounded by a supply canal, three or four feet in depth, which was intended to convey brine from the estuary to the works, but which brings fresh water from the Coleroon, and has now become an irrigation channel much utilized by the cultivators. The immediate effect of this, as of any similar canal, is, as deep as it goes, to isolate the enclosed ground, to prevent water entering it, to drain it in fact, and should it reach the bottom of the particular stratum, which carries the sub-soil water and supplies ordinary shallow wells, but more especially brine pit, to cut them off from their source of supply, by providing a freer and easier route for the sub-soil drainage.

10. The canal at Kille does not cut through the stratum, through which brine percolates to the pits, or manufacture would have ceased long ago, but it reaches to within a few inches of the sand, and is separated from it only by a soft mud partition, which allows of leakage into the sand, and from thence into the pits as shown by the following diagram :—



11. This diagram is intended to represent a vertical section of the pans to the east of No. 1 platform, running east and west through the salt pans, pit, supply canal, boundary embankment, surplus channel, and rice fields, continued down through the sub-stratum of sand which supplies the pits. It shows the surplus channel from the rice fields discharging into the supply canal, the floor of the latter almost in contact with the sand stratum which dips towards and is cut across by the pit at a little distance west. It will be evident from it, that water-leaking from the canal into the sand, will percolate to the pit, and there rising to the surface in consequence of its low specific gravity, will baulk the ryot in his endeavours to make salt.

12. The diagram is rather more elaborate and convincing than would be an accurate sketch from nature; it, however, faithfully represents the main features of the ground observed, and there is besides no other way of accounting for the facts mentioned in paragraph 8.

13. With these disadvantages, the ryots here, as elsewhere, use their pit brine in construction. Not weakened by rain, such as it is in the early season, but scant and condensed to 3° Beaumé, as it is found in April, postponing manufacture to the hot weather and working with irrigations half an inch in depth and brine of almost nominal density. Slung baskets are used in raising it to the pans, and some idea of its scarcity may be formed, when it is stated that, though the pits are about 12 feet deep and proportionately large, some yield but 100 small baskets in a day.

14. The ullums here approximate so closely in design to those of Gundalum, that no diagram or detailed description is required. Some of them have reservoirs, occupying a quarter of the whole space, the side beds two-fifths and the salt beds three-fifths of the remainder, but, as a rule, the crystallizing area is disproportionately large, as the following table shows :—

	Kille, Area in sqr. yards.	Tillavadangam Area in sqr. yds.
Pit	224	105
Reservoir	176	81
Condenser	330	210
Beds	330	210
Channel and ridges	105	105
Total area of ullum...	1,165	756

It will be seen that these ullums, like those of Gundalum, are remarkably small, measuring but 10,485 and 6,804 square feet each.

15. Manufacture is conducted in just the same way as at Gundalum, except that the mother liquors are pushed over every third or fourth scraping from the salt beds into the condensers, with the vain intent of getting rid of them. Salt is scraped at noon and carried off and heaped in the moist state.

16. The salt formed is very poor small stuff, rather dirty from admixture with sand, much resembling Gundalum salt, but heavier, 424 mercals weighing 145,177 ounces or *only* 800 lbs. 11 ounces less than the official garce.

17. Nakaravandangudi, as a separate station, scarcely requires a word of comment. It is situated in the midst of rice fields, more than a mile south of Kille, nearer the river, but further from the sea, on the same description of clay soil, but with a richer sub-soil and more abundant brine, found at a depth of 6 feet, marking 10° Beaumé. It is on this account a better site for salt manufacture.

18. As a general rule, little or no inferior salt is rejected at these stations. Last year five garce were thrown back into the pits and reservoirs, three for being dirty and two for being otherwise unfit, but however much required this measure may be here, the scarcity is so great as to prevent its adoption, except on very rare occasions, and with reference to glaring instances of careless manufacture. The average dittum which may be taken to represent local requirements is 48654·5 Indian Maunds, and the outturn from the whole division but 26,052 Indian Maunds per annum. The annual deficit is, therefore, about 22602·5 Indian Maunds.

19. To remedy this evil, it has been proposed to take up new sites and increase the salt outturn, by extending the area of its culture. Here no other course is open, as the brine-supply is not capable of improvement, and the period of manufacture may not be extended to

February and March, as for the want of labor, rice and salt cannot be cultivated together, and it would moreover for the stratigraphical reason given, be unwise to manufacture salt during the progress of the wet cultivation.

20. Sanction had already been obtained at the time of my visit for converting two waste sites to salt pans. Concerning these I have had the honor of addressing you in a separate letter, June 24, 1873, in reply to Board's Proceedings No. 1,007, of June 14, 1873. All that need be said here is that they are strips of permeable swamp, sandy to a depth of six or seven feet, in contact with, and at the level of, the Coleroon river, which is said to contain a large body of fresh water throughout the greater part of the year. The sites have been condemned by the Board in Proceedings No. 1,386, of 24th July 1873.

21. There are besides two other sites which I examined with the Deputy Collector. One a small patch to the south-west of, but almost in contact with, the Tillavadangan pans, sharing in the advantages and disadvantages of the Kille site; and the other, a large brown clay tract, covered with a saline efflorescence, which has hitherto defied rice cultivation, situated not more than 400 yards to the south-east of Nakaravandangudi, on the borders of the canal which leads to that station. A pit dug here passed into sand at the sixth foot, and filled rapidly with 4½ feet of brine, marking 6° Beaumé. Both these sites are quite equal to those now used for manufacture, and they are the best I could find in the neighbourhood which I went over carefully with Mr. Freer. We visited amongst the rest some clay islands in the estuary, which would make capital salt pans, if the brine-supply were good in quality and quantity, and if they were not liable to be flooded.

22. Want of knowledge of the brine-supply is the great difficulty in coming to a correct conclusion as to the capabilities of a site dependant on pits alone for salt manufacture. Its strength and amount, as found by experimental wells, are by no means constant quantities, and where the interests at stake are so great, it would be well, previous to opening these and similarly situated new pans, to keep a register for a whole season of the daily yield in cubic feet from a pit of given dimensions and the density of its brine. It would be well also, when using the sub-soil water at long distances from the sea, to have it analyzed first by the Chemical Examiner, as it is at least likely that its constituent salts will occasionally differ from those common to sea water, which have been fully noticed in my last report.

23. The manufacturers here are many of them poor people, who work their miniature ullums themselves with such dwarfed profits, that they are little concerned in salt culture as an industry, and would undoubtedly object strongly to any alteration or improvement, entailing the slightest expense upon them.

24. The following statement exhibits the cost and profit, &c., of salt manufacture at each station of the Kille division. If correct, especially the Tillavadangan return, it bears out my statement that small ullums cannot be worked profitably:—

	Ullum. sqr. ft.	Outturn. garce.		Expenses. Rs. A. P.	Kudivaram. Rs. A. P.	Profit. Rs. A. P.
Kille...	10,485	4	Implements ...	1 0 0		
			Cooly hire for 6 men at Rupees 3-8-0 per mensem.	21 0 0		
			Total ...	22 0 0	40 0 0	18 0 0
Nakaravandangudi.	21,828	2½		19 0 0	25 0 0	6 0 0
Tillavadangan.	6,804	1		13 0 0	10 0 0	Loss. 3 0 0

25. It seems strange that the Nakaravandangudi ullum, which is twice the size of that of Kille, and enjoys a better brine-supply, should produce little more than half the quantity of salt, but the important element of time has been left out of these calculations. No register of time was kept, as it was not foreseen that it would be required.

26. Some idea of the scale upon which manufacture is conducted may be formed from an examination of the register of kudivaram payments made to individual proprietors, at the rate of Rupees 10 per garce. During the last five years the payments made in this division have been on 302 occasions less than Rupees 10, sometimes less than Rupee 1, and there are 66 manufacturers whose average annual kudivaram is less than Rupees 10. When it is stated that there are but 205¾ ullums in the division, owned by 175 men, 80 of whom work their pans themselves, the bearing of these extracts illustrating the state of manufacture at Kille will be better understood.

27. The trade of this division is of course local: merchants buy the salt readily as it is very light, and there is no popular rumour in its depreciation. Indeed, Mr. Freer says, that Moulaka salt is unknown here, and it is just possible, though unlikely, that these wells may contain less magnesium than sea water. The district inhabitants have no objection to it. They are unconscious of the effect which a light salt has on the amount of their purchases; judging of it by its color, taste, and feel alone. They are said also to be careless as to its purity, but it is hard to believe that a people extremely careful in polishing and preserving their teeth, would habitually use salt, gritty with sand or bed silt, if they could possibly avoid it.

28. Before taking leave of the district, I would like to draw out and summarise from the foregoing matter and the separate Merkanam

report some leading facts which might perhaps otherwise escape attention, surrounded, as they unavoidably are, by the driest of technicalities. Merkanam is not, as it stands, a very good station. It is, however *par excellence* the salt station of South Arcot. The others are without exception on sites, either as regards soil or water-supply, one or the other, not naturally well adapted to salt culture. A porous soil may be made impermeable with clay, but a faulty brine-supply, whether through deficient amount or salinity, cannot so readily be altered at long distances from the sea. Gundalum may be clayed, and, presupposing a complete change in the method of manufacture in accordance with scientific principles, may be made to produce much more salt and of a better quality than it now does. But its extent places a limit, and considering the probable demand, a very narrow one upon its capabilities of supply. All the stations south of Gundalum are far from the sea, manufacturing chiefly from pits, which have the usual fault of scant yield without the redeeming feature of great density. They may be extended almost without limit as the soil is good and the sub-soil water saline, and improved by great exertion and watchful care, but it is doubtful that years of labor would bring them up to the level of Merkanum. Everything is against them, even to the character and habits of the manufacturers. Under the circumstances I would strongly commend Merkanum to the notice of the Board, for having Negapatam in view; it seems more than probable that, with the advent of the railway, the demand for salt at Gundalum will be increased far beyond the limits of supply which that and the neighbouring stations are capable of affording, and that upon the present development and extension of salt manufacture at Merkanum and Chunampet will depend the future condition of the salt market in South Arcot.

29. In conclusion I have only to say that the difficult task of adjusting salt matters in South Arcot is, I believe, at present in good hands. The Deputy Collector, Mr. Freer, has taken great trouble to acquire serviceable knowledge, and I think that he is now in a position to form a correct judgment as to the worth or worthlessness of any given site for salt pans. There are in all likelihood other eligible sites for salt works besides those we visited together, and if need be he can effectively report upon them. I have to thank him for his assistance whilst in the district, and for the detailed information which he subsequently promptly afforded me.

Tanjore District.

1st Division, Needavasel.—Arrived February 24, departed February 27, 1873.

1. The Needavasel salt pans are on rather a sandy site, at about the sea level, enclosed by earth works, which take the form of a paralellogram, whose long axis corresponds with the sea beach, from which the pans are distant, perhaps, 500 yards. On the east, a navigable fresh-water canal separates them from the sea-shore. On the west, rice is cultivated up to the embankment, on relatively high ground, without the interposition of a drainage channel.

2. There is an air of method in the trim embankment, the unbroken ground, and the absence of brushwood from these pans, which at first contrasts them favorably with those just left behind in South Arcot; but beyond this the comparison fails to be very favorable, and is in one respect quite the reverse. The soil at the surface is porous, containing more than 50 per cent. of sand. This, however, blends below with clay, forming a better stratum, still sandy, especially on the south, but capable of being worked up with care to a staunch flooring for the salt beds.

3. The brine-supply is derived by means of large and deep pits altogether from the sub-soil. Owing to the interposition of a fresh-water canal between the salt pans and the sea, sea water cannot be obtained. In quantity the brine is rather deficient; in density it varies with the position of the pits from 2° to 8° Beaumé. Those in the centre marked 8° Beaumé, those bordering on the canal 6° Beaumé, and those along the margin of the rice fields, unprotected by a drain, marked but 2° Beaumé.

4. Exploratory wells were sunk to examine the soil and sub-soil, and the yield and density of the brine. The north and centre wells passed through alternate layers of clay and sand, and contained, after the lapse of 48 hours, but 10 and 4 inches of brine respectively. The greater part of the brine oozed up from black silt and sand found at a depth of six feet, but some of it trickled from a curiously variegated thin stratum exposed in the walls of the pit.* The southern pit disclosed a much more sandy soil, and held, after a few hours, 2 feet 6 inches of brine. The brine averaged 6° Beaumé in density, and was strongest towards the centre of the works.

5. This cannot be considered a very satisfactory condition of supply. Though no great complaints were made, the character of the salt denoted scarcity of brine, and there were some who said they found it hard to work in May and June, the dry hot months, when thin irrigations rapidly yield salt in wretched, minute, and crumbling crystals. Salt water should be brought from the sea, across the canal, in an aqueduct of some kind, in pipes or tubing if necessary, if the canal which seems to be a disused fragment of some former work, cannot be drained

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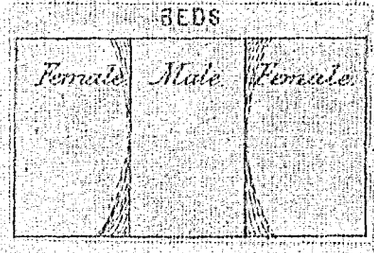
* Made up, judging by appearances, for the most part of soft concretionary nodules of red and brown hematite and yellow ochre. Ferric and orthic hydrated ferric oxides of iron, mixed with sulphides, pyrites, and marcasite, the latter of a pearl grey color. All exhibiting more or less of a radiated structure, as seen on section in the face of the pit wall, as if their particles had been drawn together from the contiguous strata by a special force or attraction of crystallisation.

and got rid of. A superficial trench carried round the west of the salt works, with a liberal fall, would protect the western pits from fresh-water percolation from the rice fields.

6. Two men working, with shallow conical baskets, 900·98 cubic inches in capacity, raise brine to the salt beds, discharging it at the rate of 807 cubic feet an hour. It has passed into a belief that natives are themselves the best judges of how most economically to lift water for irrigation purposes. A comparison of this with paragraph 10, Gundalum division, will show that they may learn something from each other. It seems to me to point also to the desirability of establishing, by inquiry from the different Salt Collectorates, what is the best and cheapest means of irrigating salt pans. The means will vary with the space available and the depth or difference in level; but these are much more constant in practice than are the forms of machinery the natives employ.

7. At the time of my visit, salt manufacture had not begun, but the pans were being prepared in the usual manner, and some were advanced enough for the first irrigation. Their design is uniform. It is novel and very simple. Each ullum consists of a number of similar units—to be described—linked together in rows which pass off from each other at any angle, according to the ground conformation. There are no reservoirs, nothing else.

8. A unit of manufacture consists of three beds, arranged as shown in the sketch. A central male, as it is called, having two females greater than it in area and at the same level, one on either side, which it supplies with brine. The shaded parts of the sketch are the platforms, on to which the salt is scraped.



9. The method of manufacture, as explained to me, is as follows:—"A depth of about nine inches of brine is maintained constantly in the male bed, by daily additions from the pit; from this, every third or fourth day, two inches are drawn off for the female beds, which are irrigated and scraped twice a week. Every third scraping or so, the female beds are cleaned out, and the slime thrown back into the male bed to strengthen it" (sic).

10. This, when examined, will be found to be an ingeniously bad plan of manufacture. The male bed, or condenser to begin with to be of any use as such, is disproportionately small. From the 9 inches depth, necessitated by uniformity of level and the daily additions of brine, it is clear that the prepared irrigation passed on to the crystallizing beds, is no stronger than pit water, *i.e.*, on the average 8° Beaumé, and that the

male bed, except in so far as it removes suspended matters, is a useless work. From the fact that scrapings take place twice a week, it is certain that the irrigations are less than 2, probably less than 1 inch in depth, as the mean rate of evaporation of saturated and unsaturated brine together was at the time 4½ days to the inch, and is never more than half an inch a day. From the use that is made of the bitterns it is hard to escape the conclusion, that they not only help to make bad crystals, but that they also adulterate the salt. Moulaka, or magnesic sulphate does, in fact, appear about April or May.

11. Salt is scraped in the afternoon, with the ordinary board, on to the raised ridges at the corner of the beds, where it is left to drain for one day, and then carried off to the drying ground, from whence, after the lapse of 30 days, it is brought into store. That which I examined was small, moist, and rather dirty. It is described in a note as being similar to a wet and sandy specimen of large-grained sugar. It appears to be much heavier than Kille salt, 424 mercals weighing 203,880 ounces, or 45,892 ounces more than the official equivalent; but whether this be owing to the method of examination, or to the greater moisture, I am unable to say. The weight of Kille salt is calculated from the weight of a single mercal,* that of Needavasel from the weight and measurement of half a garce.

12. The produce at Needavasel, 31·65 Indian Maunds, is a trifle less per 10,000 square feet in 30 days, than at Kille, where 33·23 maunds are turned out from the same space in the same time. The demand, also, exceeds the supply, which is obtainable from the existing 731 units of manufacture. As the available waste ground within the paralellogram is large, it has been determined to convert it into new pans, which were commenced, at the time I passed through in February, to the north of the existing ullums.

13 The cost of manufacture is high, averaging Rs. 8-11-0 per garce. The following statement furnished by the Deputy Collector, Mr. Rickets, has a note appended to it, in the original, that no reliance can be placed upon it. It was mentioned in last report that these statements are drawn up from data furnished by the ryots, who, it is notorious, furnish such information only as will tell in their favor if there be a question of altering the kudivaram. Nevertheless, as all are vitiated in like manner, they have some comparative value, and it will be found, as a general rule, that a co-relation exists between the merits of the site, the system, and the cost of manufacture.

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* This weight was since received from Mr. Freer. There was no salt in store at Kille at the time of my visit.

		Rs.	As.	P.
Area of ullum 27,576 square feet.				
Produce 10 garce. Kudivaram value	...	118	12	0.
Expenditure.	Rs.			
Repairs	11			
Implements	3			
Conveying salt to drying ground ...	5			
Do. to platform and storing ...	15			
Covering	2			
2 coolies for 6 months at Rupees 4 a month...	48			
Total ...	84			
Cost per garce Rupees 8-6-5.	—	84	0	0
Difference or Profit Balance ...		34	12	0

14. This statement of expenditure might be taxed in the matter of conveyance and storage of salt, as the two coolies, whose hire is shown as a permanent charge, were probably engaged in this duty, and also in the matter of covering, for I can myself bear witness that although this charge for covering is invariably shown on paper, I have never seen the ryots' heaps covered, nor the materials for covering them, with the exception of a few heaps in Ganjam, one or two on the Ennore canal, and some at Tada in the Nellore district.

15. From Ganjam to Needavasel, Government salt is stored in triangular, prismatic, ten-garce heaps, with gable ends, meeting at a right or an obtuse angle, roofed in with straw, or with palmyra leaf thatching. I have already expressed an opinion that, besides the skill required to place these materials properly, their instability, decay, and consequent cost, they do not afford good water-tight protection, unless they fall from each other at an acute angle. Here, for the first time, I had an opportunity of examining earth coverings, and contrasting them with those I have hitherto described.

16. At Needavasel, and at all stations south of it, salt is stored in 10-garce heaps, much the same in size and outline of base as in the north, but constructed on a different principle. The top of the heap is made like that of a bomb-proof roofed building, boldly convex, so that a transverse section, though the heap exhibits a segment of a solid circle or disc, varying in height and diameter, broader here, than in Tinnevelly. The whole is covered over with 12 inches of earth, the outer rind of which is mixed with a little clay, to keep it firm and as a protection from the weather. Pure clay is seldom used, as it cracks and opens out with heat. One would suppose that without a very large admixture of clay, an earth covering would be rapidly washed off in the rains, but such apparently is not the case. The heaps I examined

here and at the remaining salt stations, though cased with loam and deeply furrowed without, presented scarcely any trace of surface wastage within.

17. Still they had not been long in store, and judging from the state of their coverings I would say, that a jacket of pure clay, with straw mixed through it as a binder, might be substituted for loam with advantage and economy; as less earth would then be required, and the protection would be both better and more enduring. However this may be, the earth now used protects the salt much better than the palmyra leaves elsewhere in vogue, and the apparent wastage is so little, that it is at first sight a wonder that five per cent. is allowed to wholesale purchasers. The heaps are broken up and sold just as quickly, quite as cleanly, and with a little loss as in the north. And the cost of covering and of maintenance is much less, on an average Rupees 3-8-0 per annum, as against Rupees 10-12-0.

18. To recapitulate, the more important alterations which may fairly be trusted to improve manufacture here are the construction of a superficial channel, without the embankment, falling rapidly to the fresh-water canal, to carry off the drainage from the rice fields; the introduction of more clay into the substance of the bed floors; obtaining additional brine from the sea, which is close by; reversing the present usage of the male and female beds; making of the former a crystallizing, and of the latter condensing, beds; evaporating the bitterns at the end of every third irrigation to dryness; scraping up, removing, and destroying the product in the canal.

2nd Division, Tranquebar.—Arrived February 28, departed March 6.

1. The salt pans are about half a mile south-west of the town of Tranquebar, and about the same distance from the sea, on a square stretch of flat alluvial swamp reclaimed from the bed of the Nandalaar river. They are at about a foot above the mean sea level, enclosed by a good embankment and trenched round with a ditch, which carries off the waste water from some rice fields on the north, and discharges into the river close by. This river, or backwater as it is called, flows past the southern boundary of the pans.

2. The surface soil consists of a mixture of a little sand with good clay. It is about a foot in thickness, and well adapted to the formation of clean and firm salt beds. A stratum of fine sand, five feet in thickness, permeated by an abundant and tolerably strong brine, forms the sub-soil. The site is well selected for salt manufacture.

3. The water-supply is derived in the early months of the year, when the estuary is still fresh, in great part, if not altogether, from pits, which yield it much more abundantly than at Needavasel, averaging 8° Beaumé. Exploratory wells, sunk in different directions, filled in 24

hours with 2 to 3 feet of brine, the density of which did not appear to be much affected by the position of the pit; but the river was at the time already brackish, and the rice fields had commenced to dry.

4. In April the pit brine becomes so scarce, that most of the manufacturers abandon the sub-soil in favor of the estuary brine. A shallow supply-canal, one and a half feet in depth, passing round the station within the embankment, conveys sea water to the works. It is fitted with a self-regulating shutter sluice, which opens outwards from the pans, giving free exit to rainfall, &c. When the tide rises and its door is lifted, the sluice admits sea brine, and when shut down, the pressure of the sea upon its outer surface keeps it closed and prevents regurgitation from the channel. Such at least is the theory of its action.

5. I would prefer myself a sluice, the door of which opened inwards. It would admit brine at high tide, and the pressure of the water in the canal would keep the door closed during the ebb and fall. At present it is necessary to have a peon on the watch, day or night as the case may be, to lift the trap and admit brine at high tide. If the peon sleeps, as he often does, the tide presses idly against the door, closing it all the firmer, and no brine reaches the pans. If he does his duty, the water flows back out of the canal, as soon as the receding tide takes off the pressure from the door, and only so much water is retained as the fall in the canal can accumulate. In any case, the shutter sluice, which I have not seen elsewhere, would be a great improvement, if substituted for the sod bund, and other contrivances for the regulation of the water-supply, in Ganjam and Vizagapatam.

6. Two men raise water a distance of five feet, from the pits, by means of the well picotah with a leaking basket cup attached, delivering it at the rate of 637·2 cubic feet per hour.

7. Manufacture had not commenced at the time of my visit, but the work of preparation was well advanced. It begins usually in March.

8. No diagram or minute description of the ullum is required. It resembles many that have gone before, in having a small reservoir connected with a number of salt beds, collectively of much greater area and at the same level. In the usual statement furnished from the division, the condensing surface, inclusive of irrigation channels, is set down as 13,603·5 square feet, and the crystallizing surface as 38,304 square feet; but an average set of pans measured during my stay gave a reservoir area of 832 square feet, to ten crystallizing beds, aggregating 5,355 square feet. In either case it follows that the reservoir cannot supply the beds, unless it is made deep and constantly replenished, and in fact, that one examined was 18 inches in depth, and filled daily from the pits.

9. The system of manufacture is by single irrigations of the usual depth, which cannot, with the foregoing plan of ullum, be at all well

condensed. Salt is scraped at any time from 9 A.M. to 4 P.M., but commonly at midday, on to the raised corner of the bed, whence, after some hours' draining, it is taken to the drying ground, where it remains for two or three months before being heaped and stored for Government. The beds are cleaned out, and the refuse thrown into the supply-channel, about, every fourth scraping, but Moulaka salt, or $Mg.SO_4$, is said to appear early along the borders, and later in the hot weather, in large quantities in the beds, necessitating the usual measures for its removal.

10. The salt examined was small, badly crystallized and rather dirty; but, judging from the heap I examined, it is heavier and in every respect better salt than that made at the preceding divisions, with the exception of Merkanum.

11. The heaps here are covered with earth works, as at the last division, but with an additional skin of palmyra leaves beneath the earth, in contact with the salt. In the heaps examined the leaves were rotten and offensive and had stained the outer rind of salt, a dirty yellow. They are, on the convex back of the heap, almost useless as a protection. They decay rapidly in a few months, imbibing air and moisture from the gutters in the earth jacket. They do not obviate the necessity for scraping the dirty salt from the surface of the heap at the time of sale. They are disliked by native buyers and the Deputy Collector disapproves of them. Their use might, therefore, be discontinued with advantage.

12. The cost of manufacture here, Rupees 7-3-0, is less than at Needavasel; but as the statement furnished, marked unreliable, shows that the coolies are paid a moiety of the kudivaram there is no use in reproducing it: it is not a true test of the expenditure.

13. This is a better division, producing more salt per 10,000 square feet in 30 days—better salt and at a cheaper rate—than those that have gone before, with the exception of Merkanum. The pans are well made and compactly arranged. The drying ground and storing platform are conveniently situated and kept in perfect order by the Superintendent, an intelligent old Havildar of the Danish Native Army. The natural facilities for salt manufacture are great and all that seems to be required for their further development is the substitution of a more economic apparatus than the wicker basket for raising brine, and a scientific design of ullum and method of manufacture in place of those at present used.

Negapatam.—Arrived March 7, departed March 18.

1. Negapatam, the next division, is, owing to its connexion with the Great Southern of India Railway, the most important in the Tanjore district. It is divided, for administrative purposes, into four salt stations—Pulyia Ullum, Puthu Ullum, Pulyia Pojur and Puthu Pojur.

Of these, the first three on the west bank of the Vedarniem canal, are similarly circumstanced and within the same boundaries and the last is on the east bank a little further south. As the last alone differs in any way from the rest, the above distinctions will not be adhered to in this report, which will consider the salt pans as naturally divided into two sets, east and west, by the canal.

2. The west and largest set, comprising the first three stations named, is about three-quarters of a mile south of Negapatam, situated on an extensive barren alluvial tract, between the bed of the old, but still running river Cudaviaur on the north and west and its new channel of diversion, the Vedarniem canal, on the east. The swamp is composed mainly of clay at the surface, which alters gradually to a permeable sandy loam, found at a depth of five feet, yielding brine. It is between two and three feet above the mean sea level, well banked and drained by a channel provided with self-acting sluices.

3. The east pans, locally known as Puthu Pojur, are at much the same level on the opposite or east bank of the canal, a quarter of a mile further from Negapatam. They are within a large irregularly quadrilateral enclosure, which was bounded, when examined, on all sides by water. The soil is clay to a depth of three or four feet, below which is found abundance of wet, black and sometimes stinking silt, permeated by strong brine.

4. Both sites are supplied with well water. The well brine averaged in March 9° Beaumé towards the centre of the works, but was of markedly inferior density, in some spots, on the borders of the canal, showing that the canal water percolates its banks and mingles with the sub-soil brine. The canal gathers the ends of a net work of surplus channels, which at this season discharge into it waste fresh water from the rice fields. About the middle of April it is filled with sea water, which is sometimes utilized for salt manufacture. The pit brine is almost everywhere scanty and very dirty, sometimes of a pea-soup color or red from the presence of innumerable monads, often green and opaque, filled with zoospores and sometimes exhaling an offensive odor, the result of their decomposition.

5. The brine-supply before April is evidently bad. It is too scant and should be improved in some way, without abandoning the pits, which furnish the important element of strength. Strength though it is, as far as it goes, equivalent to bulk, seldom goes far enough to warrant the exclusive use of well water in manufacture. At 14° Beaumé, not an uncommon strength for pit brine, the percentage of sodic chloride is 12·3, four times greater than that in sea water. A measure at 14° Beaumé is thus equal to four measures at 3° Beaumé. It is as if an irrigation, four inches in depth of common brine, had been evaporated to less than one-fourth, so that viewed in relation to the time required

to get salt or to the quantity obtainable, the sub-soil water is often four times as valuable a source of supply as the sea, and should, therefore, be made as much use of as possible.

6. But, on the other hand, it will not do to use it as do the ryots, who are unwilling to leave any portion of their ullums idle; who pour the contents of their brine pit, perhaps enough to supply six beds, in a thin stream into 24 beds; for even at 14° Beaumé it must lose 54·7 per cent. of its bulk before reaching saturation; so that the crystals formed from the scant remainder, acted upon by magnesium and the other bye-products, are flaky, dirty, and inferior.

7. Nor will it do, in seeking a remedy, to copy the ryots, who having brought about this state of their salt pans, attribute it to over-heating of the pits and forthwith abandon them in favor of sea or backwater, using the latter, still in shallow irrigations, as if it were a saturated brine, thus keeping within a vicious circle, which can lead to nothing but bad salt.

8. Where pits are practicable, they should be always used, but in combination with sea water, if that be possible, or else, with water let into them and made saline by percolation through the sub-soil. It is a difficult question how best to supplement the pit brine, and one probably, which would be settled by local facilities. But this much is certain that pits are *per se* unequal to the strain of manufacture, except on a bad principle or on a very small scale.

9. Surgeon Macrae, Acting Chemical Examiner, supplies me with the following analysis of brine, taken from a pit in use this year at Negapatam:—

Sodic Chloride	7·434
Magnesic Chloride	1·020
Magnesic Sulphate	·615
Calcic Sulphate	·408
Water	90·523
	100·000

10. This analysis seems to show that sub-soil brine is considerably less pure than common sea water, for whereas, compared with the analysis of common sea water given at paragraph 10 of my report for 1872, the sodic chloride is not multiplied quite three times, the other salts and especially magnesic chloride, the most obnoxious, are multiplied very nearly four times. Whether or not the same thing may be predicated with certainty of the sub-soil brine at other stations, I am not prepared to say, but the conditions are very similar throughout, and it is at least probable that in addition to the more obvious objections for the exclusive use of well brine in manufacture, its impurity may now be urged.

11. The scarcity before April is aggravated here by the usual practice of making the ullums with strong pit brine. Not content with using the sub-soil water, the ryots at Negapatam bail off the weaker water, which rests at the top of the pits, into smaller hollows made expressly to receive it and use only the lower, heavier, or condensed brine in puddling their earth works.

12. Brine is bailed from the pits by means of the well picotah armed with a common earthenware chatty, holding 1,242 cubic inches. One man manages to work it, raising the brine five feet and delivering it, whilst under observation, at the rate of 383 cubic feet per hour.

13. The ullum is 23,760 square feet in area. It is composed of a variable number of salt beds, in two rows, connected with a brine pit by means of a feeding channel, which is at the same level or even at a lower level than the beds. It is of the worst kind imaginable, without any preparatory or condensing surface, but these are defects which have been too often pointed out to require further notice.

14. The system of manufacture is by single irrigation. Brine is stored to a depth of six inches in the feeding channel to give it such an elevation as will enable it to flow into the crystallizing beds. Taken from the pit, it is in some places quite green and thick, in the channel it begins to clear and in the salt beds, in a very short time, from one to three hours as the case may be, it becomes perfectly clear and transparent. This exemplifies the rapidity with which an evaporating solution of strong brine destroys and oxydises minute forms of organic life.

15. The following tabular statement shows the "mamool" or customary arrangements for making salt at Negapatam. The observations were made at the east pans, as they were the furthest advanced in manufacturing operations:—

	Pit Brine.		Fresh Brine.		Mother Liquor.		Prepared Irrigation.	
Beds.	Degrees.		Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I.	... 10° B.		1¼	11°	+ ¼	28° =	1½	13°
II.	... 8° „		¾	9°	+ ¼	28° =	1	12°
III.	... 10° „		¾	10°	+ ¼	28° =	1	14°

16. In studying this table, it is necessary to compare the irrigations of prepared brine, first, with the pit brine; second, with the fresh brine or that held ready for letting into the salt bed; and, third, to note what effect the mother liquors and rejected salt have had upon its constitution. To take No. 3 bed for example, the irrigation of prepared brine is an inch in depth, and 14° Beaumé in strength. Compared with the pit brine, it is 4 degrees stronger. Compared with the fresh brine, it is a quarter of an inch deeper and 4 degrees stronger. Its increased strength is, therefore, due altogether to admixture with the mother liquor. So far we find that one-quarter per cent. of the

depth of the prepared or finally exposed irrigation is mother liquor, and later 50 per cent. of its strength is due to admixture with rejected and residual salts. Rejected salt is that common salt left about the margins of the beds at the time of scraping as being too flaky for use. Residual salts are magnesic chloride and the other bye-products of salt manufacture. Comparing again the fresh brine with the pit brine, it is seen that the former is merely the latter under another name. The ¼ of an inch of mother liquor, at 28° Beaumé, shows under what depth of fluid salt is scraped, and what progress the magnesic salts are making towards saturation. And finally, the depth of the prepared brine to be evaporated, deducting that which will be retained as mother liquor, in connexion with the density and rate of evaporation, puts us in possession of the time allotted to crystal-formation and consequently of the physical characteristics of the crystals to be found. I have entered into the explanation of these observations rather fully, as it is the first time that they appear in this report, but I will not recur to them again.

17. The beds are cleaned out every third or fourth scraping and the bitterns and mud are thrown over into the feeding channel. When magnesic sulphate appears, as under the circumstances it must do in time, fresh or canal water is used to dilute the pit brine, the offending bitterns being still permitted to circulate in the system. All this is equally true of almost every other salt manufactory I have visited.

18. Salt is scraped with a board in the usual way from 10 till 2 P.M. The beds, it should have been mentioned, are firm and carefully made. The salt when examined was clean and apparently pure, but the crystals were hollow, irregular, friable and ill-adapted to railway carriage. When scraped the salt is left to drain at the pans' side until the evening and is thence removed and heaped on a small platform, conveniently situated near the pit, where it remains until deported in canal boats to the stores, which are close to the railway station at Negapatam.

19. The removal of the salt is effected here at the ryots' expense at irregular intervals as at Madras. It remains for a long time exposed to dust and chance showers and is soiled, so that the platform salt sold to the public differs a good deal in appearance, from that which is drawn from the beds.

20. The produce per 10,000 square feet, 60 maunds in 30 days, is very large as might be expected from the description of soil, the care expended in preparation and the density of the pit brine, yet, the cost of manufacture is high, so high that the statement of expenditure furnished, marked as usual unreliable, is worth analysing.

Statement of the Cost of Manufacture at a 2nd-Class or Medium Ullum at Negapatam.

Area of ullum 23,760 square feet.

		RS. A. P.	
Kudivaram value of produce, 7 garce of salt ...		105 0 0	
	RS. A. P.		
Maramut	17 0 0		
Implements	6 0 0		
One cooly to be paid ⅓ of the kudivaram.	35 0 0		
Conveying salt in boats, including lading and unlading, &c.	17 8 0		
Covering	3 8 0		
		79 0 0	
Profit ...		26 0 0	

Cost per garce Rs. 11-4-7.

21. The cost of manufacture, it will be seen, is greater than at any other salt station as yet examined, except Cheyur, as the kudivaram is also greater, and these two things, it is worthy of note, as a rule, observe certain relative proportions, Merkanum and Ganjam, for which we have reliable statistics, being the only exceptions I am aware of. Whether they conform for the sake of appearances, or are linked together by a common necessity, is a mystery of trade about which I would not stop to inquire, were it not that I have advocated, and still believe, that the embarkation of European skill and capital in salt manufacture, conducted on the same terms and under the same general conditions as at present, would be, not only a most profitable enterprise, but would also speedily effect those reforms in the method of salt culture which are badly required, and may be, I fear, vainly hoped for at present; and Negapatam is the place, where, I think, such an experiment may be tried with the greatest prospect of success.

22. Whilst at Negapatam at the salt pans, with Mr. Ricket's assistance, I made inquiries from many of the ryots who watched our proceedings, on what terms they worked their pans—for a large number are well-to-do men, who employ agents or coolies to look after their interests—and they informed us that one cooly tends an ordinary ullum of 40 beds, receiving Rupees 10 for maramut, or putting the beds in order, for the first scrapings, and one-third of the kudivaram afterwards, and that the implements, picotah, &c., cost about Rupees 5 and last for five years. This reduces the items, maramut and implements, to Rupees 12, and the cost per garce to Rupees 9-13-2. Then, Rupees 3-8-0 is the amount which ought to have been, but probably was not expended on coverings. I saw none, and speaking generally of this and other stations, not one heap in a thousand is covered, pending transfer to Government, as fresh crops are added from day to day as beds are scraped. Again Negapatam is said to be an expensive place to make salt, owing to the scarcity and price of labor, and for Europeans it may be so, but the terms disclosed here lead to quite other conclu-

sions. A payment equal to one-third of the kudivaram is, as matters stand, an easy rate, less than at other divisions, though with an improved manufacture it would have a very different significance. In this particular instance, which is put forward as representative of middle class ullums, it amounts, as the average duration of manufacture is eight months, to the hire of one cooly at the rate of Rupees 4-6-0 a month or a little over 2 annas a day, which is about the ordinary rate for a salt cooly. Finally, the cost, Rupees 17-8-0, for lading, unlading, conveying 30·8 tons of salt about 1,180 yards in boats, or at the rate of 12 annas per ton per mile, is one which an energetic firm, working with some capital, might expect to reduce in a short time to very small proportions.

23. I think it may be shown even from the *ex parte* statement furnished, of the working expenses of a middle-class ullum, of the most primitive kind, that salt may be very profitably manufactured for Rupees 15 a garce, as things stand, and this should awake the attention of men with idle capital to its manufacture as a source of wealth. The stock of salt at Negapatam is, the Collector states, utterly inadequate to meet the growing demands of trade and every effort is being made to increase the supply.

24. The terminus of the Great Southern of India Railway is erected close to the salt platform at Negapatam, from whence the lines stretch to Erode, placing the salt stores in direct rail communication with populous districts, which must obtain their salt from without in the best way they can. From Salem, which is about equidistant between Madras and Negapatam, the two great home salt depôts,* to Beypore on the West Coast, there are also 200 miles of railway passing through a country devoid of salt, which Negapatam, as the nearest manufactory, should supply. At present Madras salt penetrates to and beyond Erode and turning supplies some of the terminal stations on the Great Southern. Beypore gets the bulk of its salt from Bombay, and most of the stations west of Erode are supplied from the same source. Combaconum, Tanjore and its neighbourhood are supplied from Adramapatam, and Trichinopoly and the adjacent parts of Tanjore from Negapatam, with the assistance of Vedarniem, a station about 30 miles further south. Negapatam cannot yet, therefore, make near enough salt to supply even the territories thrown open by its own railway. Such being the case it can scarcely be doubted that the establishment of a large factory under private auspices, subject to the usual condi-

* I have not noticed Beypore as a salt depôt, although at present salt can be purchased there for Rupees 240 a garce as at Madras and Negapatam, because I do not think that it was ever intended that Bombay salt costing Rupees 55 a garce, should compete on equal terms on their own lines with Madras and Negapatam salts, costing but Rupees 12 and Rupees 15 a garce, respectively.

tions, would be welcomed in the district and meet with every encouragement. Nor can it be doubted, after what has been said of the salt stations in South Arcot, that the Tanjore and Carour junctions of the Great Southern with the Carnatic line will, when completed, throw the burthen of a still greater demand on the already straitened stores of Negapatam and bring still larger contracts into its market.

25. The steps taken to increase the outturn of salt are as usual the extension of the area of its culture. Mr. Rickets has found an excellent site as regards soil, but doubtfully situated as regards inundation and brine-supply, on the west bank of the Vedarniem canal, about eight miles from Negapatam, where he intends opening new pans. It is not easy to foretell from the mere inspection of the sub-soil what will be the amount and density of the pit brine-supply, but judging from his experimental wells, it will be about as satisfactory as at Negapatam. Upon this site I have had the honor to report separately, see letter, dated Madras, September 30, 1873.

26. Besides the above-mentioned site, there is abundance of room for extension within the boundaries of the present pans, east and west of the canal. Not half of the large quadrilateral drained and banked enclosure on the east, known as Puthu Pojur, has been converted into salt pans, though the soil is well-adapted to the purpose. The reason is that the ryots having to put salt on board the boats at their own expense, the further their holdings are from the canal, the less profit they obtain. Having already extended their holdings to the furthest profitable limit from the canal, it appears that they object to take up the waste land beyond this limit, on the ground that the soil is unfit for salt culture. But they somehow like to temper the financial objection, which is a good one as regards their scale of profits, with another, which is hollow and not meant, as might readily be proved by running a boat canal through the centre of the works, when all the land on its borders would be quickly occupied. Such a canal would, I think, be a useful work, as it is desirable to develop this site, upon the preparation of which money has been already spent, which is close to the salt stores at Negapatam, and which would not require any extra establishment for its supervision.

27. In any case an opportunity will be afforded by the opening of new pans to do something for the improvement of manufacture. An agreement should be made with the ryots, enabling the Deputy Collector to effect such changes as may seem called for, on grounds of utility and economy, when a thoroughly practical and exhaustive experiment has been made in the manufacture of salt.

28. I have since heard from Mr. Rickets that the canal alluded to above has been commenced, and will be finished next year, but that it is yet a doubtful question whether the work will be successful in

inducing an extension of the salt pans. It seems that the district suffers much from scarcity of labor, chiefly, as it is said, owing to emigration to the Mauritius, and that it is from the want of men that extensions in and around the Negapatam salt pans have not hitherto been effected. Either the inducements to emigrate must be great or the remunerations of a salt cooly low, as it is usual to suppose that emigration attracts a surplus population. But if the case be as he states it, and if we cannot manufacture enough salt for want of men, it would be well to invite the Emigration Agents to turn their attention, for a time at least, to some other district, where less inconvenience would result from their labors.

4th Division, Vedarniem.—Arrived May 29, departed June 23, 1873.

1. The Vedarniem salt pans are laid out on a large swamp, formed at the base or root of the promontory of Point Calimere, by the action of the Vishagum or storm wave, which rises every year, in May or June, about two or three feet above the level of ordinary tides, and inundates the low ground at the junction of the promontory with the main land.

2. This Vishagum wave appears to be a result of the change of wind and sea-current in Palk Strait, which accompanies the outburst of the south-west monsoon. It overruns the whole southern shore of Point Calimere, almost from the point to Adramapatam, a distance of full 40 miles, and settling in the hollow grounds forms a salt swamp of enormous extent. There does not, however, seem to be any sustained elevation of the sea-level along this shore during the monsoon, for at Vedarniem, this year, two or three days after the first appearance of the Vishagum, its waters were in full retreat, and in three weeks' time there was scarcely a vestige of it left.

3. The salt pans, though not more, perhaps, than a foot above ordinary high tide level, are well protected from inundation by an embankment. They are on different soils, as they are far out on the foreshore, or well inland; in the former case requiring to be strip of sand and prepared with artificial clay, in the latter enjoying an excellent clay site. The sand and coarse materials carried along in suspension by the Vishagum are deposited first, the clay in fine division being taken to the furthest limit fringing the high ground. Most of the ullums are laid out upon this clay fringe.

4. Salt is manufactured mainly from the sub-soil brine. At the time of my visit the sub-soil water was both strong and abundant. It filled rapidly into exploratory wells, and the ordinary pits, which were 12 feet deep, were all nearly full of brine, marking from 18° to 20° Beaumé. The Vishagum, it should be noticed, had but just rolled across the swamp and was still present, leaking through the sands and

spreading through the sub-soil. Manufacturing operations commence in January, and I very much doubt that the pits are able to sustain the drain of well-conducted irrigations from January till June.

5. In addition to the brine pits, there is a supply-canal, running out into the swamp towards the south, which is provided with a sluice gate to admit the Vishagum water when it arrives and to retain it for use, and there is the Vedarniem canal, which connects these salt works with Negapatam. The supply-canal does not seem to be of much use. It is empty before June when brine is badly required, and when after the occurrence of the Vishagum, the pits are brimful of brine, marking from 18° to 20° Beaumé. It contains common salt water at 3° Beaumé. Moreover, when in July, the pit brine sometimes passes 25° Beaumé, the canal contains no water wherewith to reduce the inordinate strength of that in the pits.

6. The Vedarniem canal lies well to the west of the salt pans. Only a few ryots who work near its terminal extremity are able to avail themselves of the brine it contains. From about the middle of May, when pit brine is scarcest, it contains mixed sea water and sub-soil brine. It would be a decided improvement to connect it by a short channel with the supply-canal and so bring home abundance of sea water to the manufacturers. The canal water is at a much lower level than the salt pans; there will be no difficulty, and but a few rupees' expense in effecting this junction. It has been more than once temporarily made to meet a pressing want, as when last year the pit brine reached the extraordinary density corresponding to 35° Beaumé.

7. The Vedarniem ryots have great faith in the Vishagum water, which is supposed to be possessed of special merits, as a source of salt manufacture. But tested with the hydrometer, it marked 3° Beaumé. They bail it into their pits with slung baskets and use it mixed with the well brine in liberal irrigations.

8. The ullums are very small, measuring but 8,977 square feet, and are composed exclusively of crystallizing beds carefully made. Brine is, therefore, passed direct from the wells into the salt beds without any preparation. At the time of my visit this was not of much consequence, as the brine was very strong, clear, free from suspended matters and poured in to a depth—which insured ample time for crystal formation. A month afterwards it became saturated in the wells and did not require any condensation before use, but still a better design of ullum is badly wanted here.

9. The salt I examined was very clean, hard, heavy and well crystallized, yielding 69 ounces to the Madras measure, as against 50 ounces obtainable from a measure of Ennore salt. The produce per 10,000 square feet in 30 days, 46·89 Indian maunds, is also large, but not as great as might be expected from impermeable salt pans, supplied

with brine of remarkably strong initial density. The produce per 10,000 square feet has been calculated from a statement of the date of commencing and ending manufacture and of the quantity of salt manufactured, at an average set of pans, during 11 years from the season 1861-62 to the season 1871-72, both included. In the following statement of accounts, furnished by a manufacturer, it will be seen the produce per 10,000 square feet in 30 days is 60 Indian maunds, a higher rate and probably the correct one.

10. The following statement exhibits the cost of manufacture per garce of salt and the profit or loss on the season's work, at an average description of Vedarniem ullum, measuring 8,977 square feet.

Receipts.			RS.	A.
Kudivaram value of 4 garce of salt at Rupees 15 a garce			60	0
Expenses.				
	RS.	A.		
One cooly for 8 months at Rupees 4 a month	32	0		
Implements	1	12		
Loading of salt in boats	1	4		
Covering	0	8		
Transport to Negapatam and unloading	28	0		
Total ...	63	8		
			—	—
			63	8
Loss			3	8

Cost of manufacture per garce Rupees 15-14-0.

11. This statement of accounts, notwithstanding that it exhibits a loss to the proprietor, appears, considering the size of ullum and small produce, to be a fair one. The average duration of manufacture is 8 months. Cooly hire at Rupees 4 a month is not an exaggerated charge, especially as, in all probability, the cooly and the proprietor are here one and the same individual, and Rupees 7 a garce is, Mr. Rickets informs me, the exact charge for conveying salt from Vedarniem to Negapatam in canal boats. In fact the statement cannot well be challenged, and although the manufacturer, who here styles himself one cooly, makes a living during eight months of the year, it is too modest a living to encourage him to manufacture good salt. The kudivaram, though nominally Rupees 15, is in reality but Rupees 8, as the transport charge to Negapatam, Rupees 7 per garce, has to be deducted from it.

12. Rupees 8 per garce is remarkable, as being the lowest rate of kudivaram offered in the Presidency. It was originally established on the understanding that Vedarniem enjoyed very special natural facili-

ties for salt manufacture, and if the water-supply at other seasons is as strong and abundant as at the time of my visit, which is doubtful, it would certainly be superior to all other stations in the Presidency, though scarcely, even then in my opinion, to the extent to be inferred from its rate of kudivaram.*

13. But no matter what the kudivaram rate within reasonable limits, and no matter what the facilities for making salt, one can make salt manufacture a certain loss, by limiting the area of the ground cultivated to such an extent that the quantity of salt obtained is of less value than the labor of obtaining it. This has been done at Vedarniem. An ullum producing at the high rate of 60 Indian maunds of salt per 10,000 square feet in 30 days is, owing to its small size, unable to pay the expenses of its cultivator. The Vedarniem ullum is now the smallest in the Presidency, and there is nothing to prevent its still further diminution. It is quite necessary, at once, to fix an ullum of a certain area and make it the lowest unit of ground to be cultivated as a separate salt manufactory. As things stand, the time may come, when, owing to the sub-division of salt pans in certain districts, Government will be obliged to raise the rates of kudivaram all round to enable the cultivators to make use of their salt beds.

14. There are two kinds of salt made here, one manufactured as described, the other made in a different way and called spontaneous salt. In addition, a certain but variable amount of swamp salt is obtained from large shallow basins in the neighbouring swamp in which the Vishagum water is retained and evaporated without artificial aid.

15. The so-called spontaneous salt is procured in the following way :— Two long lines of mud embankment, about six feet high, are run out parallel to each other into the swamp in a southerly direction, and are connected with each other at intervals of 100 yards or so by similar transverse embankments, so as to form a series of reservoirs in line resting on the level swamp. They are of large size and open into each other from end to end by means of a row of commodious wooden sluice gates in masonry frames. The rear wall of the first reservoir rests on the edge of the Vedarniem canal, which is four or five feet lower than the level of the swamp, the gate of the last reservoir opens far out directly on the swamp.

16. When the Vishagum or high wave rolls across the swamp, the sluices are left open, that it may enter and fill the reservoirs, and when it has attained its highest level, the sluice of the last or outermost reservoir is closed, whereby water is retained in all. As the end sluice is the only one which communicates directly with the swamp, the other sluices are closed at any time, they are of no great use.

* The Collector, the Honorable D. Arbuthnolt, has had the kudivaram raised from Rupees 13 to Rupees 17-8-0 from and for this year.

17. Having closed the sluices, all the preparations are complete. The water is allowed to evaporate without further interference until salt forms. If the season is a lucky one, a large quantity of excellent salt is found. If rains occur, as they sometimes do, it is quite a chance how much salt is obtained.

18. This year the Vishagum was accompanied by two or three days' sharprain, the reservoir water was in consequence very weak. Mr. Rickets and I examined the tanks about ten days after they had been filled, they then held two feet of brine, marking less than 1° Beaumé. As the ryots were unanimously of opinion that a second Vishagum would shortly appear, Mr. Rickets breached the near reservoir into the canal, and opening all the sluices, except two, drained off this weak brine. Most of the reservoirs were then ready for a fresh supply of sea water, but the second Vishagum had not arrived when I left on the 23rd June.* In any case, the brine at 1° Beaumé would not, I think, have yielded much salt, as the floors of the reservoir are of pure sand to a depth of two feet, and there is a considerable amount of leakage in consequence towards the Vedarniem canal and beneath the embankments.

19. It would be an improvement to turn up, along the edge of the cutting formed by the canal and within the embankments, which frame in the reservoirs, a clay stratum which lies two feet below the sand, so as to prevent leakage at the sides.

20. What salt forms here is gathered and conveyed in boats to the stores at Negapatam, where it is usually sold to export traders and shipped to Penang, Malacca, &c. It is excellent salt, clean, hard, heavy, well knit together and very pure, containing 96·7 per cent. of sodic chloride. It is just the salt for railway work, but its weight condemns it. Merchants won't buy it. It yields 156 measures less to the garce than Vedarniem manufactured salt.

21. It costs altogether Rupees 11-8-0 a garce. Rupees 4-8-0 for gathering, and Rupees 7 for transport, or Rupees 3-8-0 a garce less than Negapatam, and Rupees 6 less than Vedarniem manufactured salt. Yet it is the least profitable, as it has to be sold at cost price, Rupees 19-8-0, inclusive of establishment charges to exporters.

22. In the month of May last, the common salt at Tranquebar and Negapatam having been bought up, the native merchants were able to put up the price of salt from Rupees 2-8-0, the usual figure, to Rupees 3-12-0 a maund, notwithstanding that there were 200 garce of spontaneous salt in the Negapatam stores awaiting sale.

23. I look upon these spontaneous salt heaps as monuments of the patience of Government. Native merchants exploit the salt factories, searching out the worst, i.e., those that make the lightest salt and

* A second but smaller Vishagum wave did flow in, and 3,600 Indian maunds of spontaneous salt were obtained.

giving them their custom, offering, as it were, a premium to bad manufacture. They discourage the manufacture of heavy, well-crystallized salt. They compel Government to destroy all swamp and spontaneous salts, though of excellent quality. Indirectly they are the cause of much of the wastage which results from the manufacture of inferior salt. And the poor purchasers of salt by measure, the people who make the monopoly pay, get the lightest article that can be manufactured, the least amount of salt that can be built up, honey-comb fashion, to a measure, and this for want of an enactment, compelling the sale of salt by weight.

24. The custom of selling salt by measure is at the bottom of bad manufacture. The native merchants and salt ryots are naturally hand in glove together, the more salt that the one buys, the more the other makes. European merchants who deal in salt buy it at the Railway stores by the heap and are not concerned, if they are indeed aware, of the differences in weight at different stores. I do not, of course, in any way refer to them. I refer to the men who go about with bandies or bullocks and buy first a little salt, just to see if the year's crop is light stuff, and who, if it is not, pack up and go on to the next station.

25. An enactment compelling the sale of salt by weight would injure these men alone. It would be a great boon to the public, and I have reason to believe from conversing with Native Salt Deputy Collectors that it would be hailed by the people with satisfaction. It would enable the Salt Department to make use of the large quantities of swamp salt which are now annually destroyed, and it would tend at once to improve salt manufacture, and to elevate the tone of the salt ryots.

26. I had the honor of stating in my report on West-coast salt, that I believed a great annual saving could be effected by opening a salt depôt at Erode, and supplying it with salt from Negapatam, in lieu of the Bombay salt which is now supplied from Baypore. I also drew attention to the effect such a method of inland supply would have upon the traffic returns and guaranteed interest of the Great Southern of India Railway.

27. Here is a salt lying idle at Negapatam, about 500 garce of which are, on the average, procured every season, at a cost of Rupees 11-8-0, and which can be delivered at Erode for Rupees 36-8-0 a garce. Any desired quantity of this salt can be obtained. The spontaneous salt reservoirs are capable of almost unlimited extension. There are acres of foreshore beyond the last reservoir unused, simply because, owing to the distance, the cost of carrying the salt to the canal would make it rather expensive. A short prolongation of the canal of 500 or 600 yards extent would enable the Deputy Collector to prolong the spontaneous salt works and deliver at Negapatam as much salt as

would be required. This salt, it must be remembered, is purer than any of those as Bombay, Cutch, Goa, Madras, &c., which have been as yet analyzed, and it is also considerably cheaper, heavier and better adapted to railway carriage.

28. Swamp salt, or that formed in natural hollows of the swamp by the evaporation of the Vishagum water, remains to be noticed.

It forms chiefly in two extensive shallow undulations, about two miles south-east of Vedarniem. Its quantity is very variable. Last year it amounted to 24 garce. In some previous years it amounted to 500 garce. This year the Deputy Collector informs me that he gathered swamp salt to the extent of 267 heaps or 1,670 garce.

29. It was at one time the custom to destroy the swamp salt by hiring large herds of cattle and driving them up and down the swamp, so as to tread all the salt into the mud; but of late years attempts have been made to utilize it and with some measure of success. Formerly a prejudice, which had perhaps some root in experience, existed against its use. Now this has been, to a considerable extent, broken through at Vedarniem itself, though it still lingers at Negapatam. Partly owing to the existence of this prejudice and partly owing to the expense of carrying this salt to the canal, it is not forwarded to Negapatam. It is gathered and stored at a cost of Rupees 4-4-0 a garce on some high ground close to the swamp, where it is retailed for local consumption.

30. Vedarniem swamp salt is of average purity and cleanness. It occurs in small, irregular, rather light crystals, not much resembling the general run of swamp salt and decidedly inferior to that called spontaneous. There is no doubt that, with artificial aid, both its quality might be improved and the supply increased and rendered more certain. One of the hollows or shallow basins noticed might for instance, at a very small expense, be converted into an extensive reservoir for the formation of spontaneous salt; but, as a preliminary to increasing the salt out-turn, it would be necessary to bring forward the canal, as, without the means of cheap transit, this salt could not economically be brought into use.

31. Mr. Rickets has, I believe, for some time back, been most anxious to obtain sanction for opening up this canal. He estimates that it would cost less than Rupees 2,00,000, inclusive of all charges. It is a work that would eventually result in bringing considerable relief to the over tight salt market at Negapatam, always supposing that merchants would be induced to buy swamp and spontaneous salts by weight. It is little to say that if the weight of these salts was not a bar to their distribution, with such a canal, superabundance and not scarcity would be the prevailing feature of the Negapatam salt stores. Mr. Rickets thinks that these salts could be delivered at Negapatam for Rupees

7 a garce, and I think that if they took their proper place in the salt market, it would soon be found practicable to dispense with the Vedarniem contract for salt at Rupees 17-8-0 a garce.

5th Division, Thumbikottai.—Arrived June 25, departed June 25, 1873.

1. Thumbikottai, or Thumbikanallayankottai as it is also called, is a division about 30 miles due west of Vedarniem at the west end of the salt-fetid swamp shown on the district map. It has attached to it a station named Tamarankottai. The salt pans are laid out at about three miles' distance from the sea, on a long stretch of low-lying clay foreshore, covered with low mangrove brushwood. The two stations are close together, and occupy a belt of clearance in the swamp.

2. The pans rest on a stratum of thick, plastic, ochreous clay, nine feet in thickness, beneath which is coarse sand yielding a fair supply of brine 14° Beaumé in density. The sub-soil water is not used. Brine is obtained in shallow channels direct from the sea. It marked 4° and in some places 5° Beaumé. It is stronger than sea water, because the shallow channels, owing to their great length, expose a large evaporating surface to the sun, and act as condensers.

3. The soil is excellent, with very slight preparation it can be made impermeable. The brine-supply is also very good, but it might still be improved by making use of the sub-soil water which is here apparently nearly as strong and as plentiful as at Vedarniem.

4. The ullums are small, too small to be worked with much profit, they measure 13,896 square feet. They are planned as at Nizampatam. A variable number of large crystallizing beds and small condensers are united to each other in two rows and supplied by an irrigation channel. A sketch of this kind of ullum, together with remarks upon its disadvantages, will be found in my Report on Salt Manufacture in the Kistna District (pp. 38, 39.) The levels are well proportioned and the parts neatly arranged, little or no care has been taken in tamping the bed floors, as where nature does much to prevent leakage the ryots hold themselves released from the obligation of doing anything.

5. Brine is raised from the supply to the irrigation channel by means of a long, narrow, wooden scoop, suspended, camp-kettle fashion, from two upright sticks tied together at the top. One man working with the scoop shovels up brine at the rate of 554 cubic feet an hour. This is the largest discharge I have seen obtained with any mechanism worked by a single cooly, but it is only practicable, where, as here the height, water has to be raised, is not more than two and a half feet.

6. The following observations made at Thumbikottai will serve to illustrate the system of procedure at the two stations.

Beds.	Fresh.			Bitterns.			Prepared.	
	Inches.	Degrees.		Inches.	Degrees.		Inches.	Degrees.
I.	... 2	9°	+	½	32°	=	2½	15°
II.	... 1½	10°	+	½	28°	=	2	13°
III.	... 2	9°	+	½	30°	=	2½	14°

7. It will be observed that the brine which has been got ready for irrigating the crystallizing beds is only four or five degrees stronger than that obtained from the supply-channel, and that it is the same number of degrees weaker than the sub-soil water. Two and a half inches of brine at 14° Beaumé at the end of June, the mean rate of evaporation for saturated and unsaturated brine, being three days or less to the vertical inch, form an irrigation not calculated to yield very good salt crystals. It is hard, however, to manufacture properly with the form of ullum in use here and throughout the southern districts.

8. The beds, which I saw scraped in the usual way, gave large crops of clean good salt, but the crystals, though not small, were hollow and light. A garce measured 180·8 cubic feet. It would, therefore, yield about 2,704 Madras measures, each containing 58 ounces. The produce per 10,000 square feet in 30 days, 58·5 Indian maunds, is, as it should be, considering the capital facilities for manufacture enjoyed here, unusually large.

9. The cost of manufacture is shown in the return to vary, not from the nature of the pans or brine-supply, but simply according to the size of the ullum. The smallest ullums measure $10\frac{46}{121}$ guntas, and produce 420 maunds of salt in six months, at a total cost of Rupees 38-11-9. Of this total, the hire of one cooly for six months at Rupees 5 per mensem, amounting to Rupees 30, is the chief item. The largest ullums measure $21\frac{87}{121}$ guntas. They produce 750 maunds of salt in six months, at a cost of Rupees 40-6-0. The chief item being again hire of one cooly, Rupees 30, as before. The cost of manufacture with the small ullum is Rupees 11-1-0 a garce. With the large ullum it is Rupees 6-7-0. As the kudivaram is only Rupees 10-10-0, the proprietor of the small ullum loses by salt manufacture.

10. Assuming for the moment that these statements, which accord well with my experience, are reliable, Government may look forward to the time when the demand for an increase of kudivaram will be very piteous here; when, by the process of fission, the present pans have been multiplied and divided amongst the descendants of the present proprietors and all are, as the owner of the small ullum, making salt at a loss, or at what comes to the same thing as regards the demand for higher rates, a nominal profit.

It is enough that salt manufacture should in certain cases at Thumbikottai, with its admirable natural facilities, prove unprofitable, to show how necessary it is for the higher authority to step in and

prevent the ryots from reducing the area of the manufacturing unit beyond a certain point or limit, to be determined by experiment, as the smallest area capable of being worked with profit.

6th Division, Adramapatam.—Arrived June 23, departed June 26, 1873.

1. Adramapatam resembles Thumbikottai so closely in every respect, that, to save needless repetition, I will confine myself to comparing it with the previous station.

2. The Adramapatam salt works are laid out five miles south of Thumbikottai on a southern extension of the same foreshore. Though the pans are here only a mile from the sea and but two feet above its level, the swamp is characterized by the same clay surface, the same sub-soil and sub-soil brine, the only difference being that the thickness of the clay stratum is a trifle less and the quantity of sub-soil water a little greater.

3. Here again sub-soil water is not made use of. Brine is obtained from the sea, by means of shallow ditches, shorter, but more numerous than at Thumbikottai. The sea water, or delivery, marked 5° Beaumé. Brine is raised with the same wooden scoop. It is delivered at a quicker rate, as the disparity of level between the supplying ditch and irrigation channel is less—not quite two feet.

4. The ullum is planned as at Nizampatam. The levels are good, but the beds are not made with care. The average area of the whole ullum is 15,471 square feet. It may, therefore, be said to be 1,575 square feet, better than at Thumbikottai.

5. The following observations were made during my stay:—

Beds.	Ready.		Mother.		Prepared.	
I. ...	2½	9°	+ ½	32° =	3	14°
II. ...	1½	10°	+ ½	33° =	2	19°
III. ...	2	9°	+ ½	30° =	2½	14°

The rate of evaporation was about three days to the inch of brine. That is, it would take nearly nine days to evaporate three inches of common sea water to dryness, and more than nine days to evaporate three inches at 14° Beaumé.

6. The beds that I saw scraped gave large crops of remarkably fine looking salt. The crystals were very large, white and tolerably firm, but reticulated within and rather light. A garce would yield about 2,639 Madras measures, each weighing 59 ounces. It is a little better than Thumbikottai salt.

7. The produce per 10,000 square feet in 30 days, 61·8 Indian maunds, is larger than at either Thumbikottai or Vedarniem, and the cost of manufacture, Rupees 7-3-2 the garce, is lower, but then the system of payment is different; here the laborer farms the ullum and receives half the kudivaram, and besides the pans are larger.

8. Attached to Adramapatam is a sub-station, called Magalancottai, which is in very striking contrast with it. Magalancottai is three miles further south, and half a mile nearer the beach. The salt pans are laid out in patches, in what appear to be excavations made in some low undulating sand hills. The soil is nearly unmixed sand, through which the sub-soil water rises in springs, in many places in the salt beds themselves. These springs have to be surrounded with a clay wall to prevent the sub-soil water from mixing with the brine irrigations, and hindering crystallization. I think it would be next to impossible to make good salt profitably at these pans without raising their floors above the level to which the springs rise, and without giving them a good thick coating of clay throughout.

9. Though there is abundant sub-soil brine, marking 8° Beaumé, the pans are supplied from the sea. A reservoir, a condenser, and from six to 12 large salt beds form an ullum. The reservoir, which is intended to act as a condenser, is of no use as such. It is two feet in depth and the brine has not consequently the least chance of condensing during the short time it remains exposed in it.

10. I have no statistics of any kind with reference to this station. It is one of those which were closed in consequence of Mr. Clarke's report, and has been re-opened again this season for the first time. But I should be inclined to predict a small out-turn per 10,000 square feet, poorly crystallized salt and very small remuneration at the present kudivaram rates, as the result of working here.

11. Considering that Adramapatam, which has first-rate natural facilities for salt manufacture, may be extended east, south or north—in the last direction five miles if necessary—that it is but three miles distant, and that the Superintendent and staff are on the spot there, it would seem to me, in the absence of a knowledge of the special circumstances which led to the re-opening of the sub-station, to be a better plan as regards salt manufacture to extend the work at Adramapatam than to continue working at Magalancottai.

12. The Tanjore district has in the great fetid swamp, known as the Vedarniem swamp, which extends from Vedarniem to Adramapatam, a valuable mine of salt, which has as yet been scarcely drawn on. Vedarniem, Thumbikottai, and Adramapatam, all three divisions on its borders, are to my mind the three best places for salt manufacture in the Presidency. They are, however, but very small patches, on the extent of ground equally favored with the natural requisites for salt manufacture. Granting labor easily procurable, the two latter stations might be almost indefinitely extended. The great salt wave which rolls across the swamp in June, to subside away again in a few weeks,

might be caught and evaporated in a net-work of spontaneous reservoirs, and made to yield up its wealth of salt. Canals and other works, as suggested by the late Collector Mr. Cadell, would have to be constructed at great expense before another Cutch would arise here. But considering the scarcity that prevails and the difficulty that there seems to be in getting salt for the Railways, it is well to know that a store is there, which only requires developing, to satisfy all wants.

7th Division, Kattumavady.—Arrived 27th June, departed 28th June, 1872.

1. The Kattumavady salt pans, and those south of it in the Tanjore district, are very inferior to those just reported on. The south end of the district, judging from the soil here, and at the following stations, is without the influence of the Cauvery, and deficient in fluvatile earth deposits.

2. At Kattumavady the salt pans are excavated in a somewhat old and raised sandy beach or terrace, which now marks the limit of a long level tidal swamp, stretching out to sea, covered with a thick growth of mangroves. The excavations have been carried down to about three feet from the original surface, or to a plane corresponding to the mean sea level, and the *débris* thrown up, consisting of coarse sand and sea shells, has been arranged in high mounds. These enclose and separate many quadrilateral spaces, in which are the ullums, isolated and invisible one from another.

3. The soil upon which the pans rest is a coarse silt, thickly interspersed with marine shells; most unpromising material for the formation of impermeable bed floors. There is no clay about the locality, except that in the shore now rising, nor could we find any in the subsoil examined to a depth of six feet.

4. The pans are made with care and rammed to such purpose, that they are often as hard as stone, but still they are not impermeable, and there must be leakage or its alternative exosmose, probably the latter, as the sub-soil brine rises close to the level of the bed floors. Diffusion is so slow a process that with our system of shallow irrigations, rapidly evaporated, it does not lessen much the quantity of salt obtained.

5. The water-supply is derived directly from the sea by means of superficial channels, just deep enough to give direction to its flow. It is let on whenever required, without the use of picotahs or other machinery, by opening a small mud dam, which separates each channel from the ullum it supplies.

6. The ullum consists of a reservoir and five or six salt-beds according to the size of the enclosure. The reservoir is usually a narrow and deep trench running round the enclosure flanking the salt-beds.

It is the practice here to use up all the brine in the reservoir before replenishing it, so that the last irrigation has generally from 12 to 14 days' exposure and marks about 8° Beaumé. It would be much stronger if the reservoir were made broad and shallow.

7. The levels are, as a rule, well attended to. The brine flows from the sea into the reservoir, and from thence into the salt-beds without check or remnant. But there are some reservoirs sunk below the level of the beds, in which a foot or so of water always stagnates to the hindrance of condensation. The brine in these marked but 5° Beaumé.

8. I did not see any beds scraped, as much rain had fallen the day previous to my visit; but I was assured that the system of manufacture was in all essentials exactly the same as at Adramapatam. The store salt I examined was quite white, as it generally is, when scraped from a hard sandy bed. The crystals were fair sized and rather heavy. A garce, measured 157·6 cubic feet, which is equivalent to 2,356 Madras measures,* each weighing 67 ounces.

9. There was no magnesium present in the salt that I could detect. The weak brine drawn from the sub-soil by endosmose probably retains it in solution. It is a pity that sodic chloride diffuses more rapidly than magnesic sulphate, otherwise the latter might be got rid off in works like these by natural dialysis. A large number of marine shells, belonging to a species of cerithium, were scattered through the salt heaps. These are so abundant in the soil, that the ryots are unable to avoid them when scraping.

10. The produce per 10,000 square feet in 30 days, as calculated from a return of the duration of manufacture and out-turn from an average set of pans during the last 10 years, is very small, but 27·3 Indian maunds; compared with the produce at the last station, Adramapatam—it shows clearly the influence of soil on produce.

11. The cost of manufacture, Rupees 5-7-0 a garce, is lower than at the three preceding stations, perhaps, because the ullum which measures 18,288 square feet is much larger, but the system of payment being different, the rates do not admit of comparison.

8th Division, Arasanegerry.—Arrived June 29, departed June 30, 1873.

1. Arasanegerry, the last division in the Tanjore District, is 16 miles south of Kattumavady, but resembles it so closely that it might be described in almost the same words, with the exception, that the works are 500 yards from the sea, and at the northern end a little above its level; that the cerithium shells are absent, and that the soil

* I use in these calculations a Madras measure of 115·5 cubic inches capacity. It is the largest of several that I measured. A garce weighs 157,988 ounces.

found by excavation, upon which the pans rest, is of a better quality, being in fact a clay marl stratum, two feet in thickness: there is no difference between the two.

2. The works are supplied with brine, marking 3° Beaumé from the sea, as before, without picotah work, except at the northern end. The construction is a reservoir, resembling a ditch, and about a dozen salt beds enclosed between high banks. The levels are well attended to, and the salt beds are made with care.

3. The reservoir brine marked 5° Beaumé. The sub-soil brine, which rose to within a foot of the bed floors, marked 8° Beaumé. The latter is not used. Recent rains prevented me from making an examination of the system of manufacture as to "fresh brine," "mother liquor," and "prepared brine;" but it is said to be the same as at Adramapatam.

4. The salt examined was clean, apparently free from magnesium, small in crystal, but firm and rather heavy. A garee measured 180·8 cubic feet. It would yield 2,704 Madras measures, each containing 58 ounces weight of salt.

5. The average produce obtained during the last ten years per 10,000 square feet in 30 days from an ordinary ullum was 30·8 maunds. An increase of 3½ maunds on Kattumavady, probably due to the better description of soil.

6. The cost of manufacture worked out from the return sent to me is Rupees 7-14-0 a garee.

7. It is curious to note, before leaving the Tanjore District, that the Northern Divisions, as far as Vedarniem, manufacture salt exclusively from sub-soil brine, that Vedarniem uses sub-soil brine, alone, or in combination with sea water, when that is brought to it by the Vishagum, and that the stations south of Vedarniem use sea water only. Now this is a mistake as regards the north and south, but more especially as regards the north, for of the two, an abundant supply of sea water yields a better manufacture than ordinary scant, though strong, pit brine. For reasons already given, it is always best, where possible, to use sea water and sub-soil brine in combination. The southern stations can obtain good pit brine without any difficulty. The northern stations may also, I think, be supplied with sea water, by adopting measures, some of which have been detailed in the previous pages.

8. Almost all the ullums in the Tanjore District are conspicuous for the want of any adequate provision for clearing and condensing the brine; many of them, as at Negapatam and Vedarniem, consist entirely of crystallizing beds. There is great room for improvement in this respect, and also in the north in regard to the relative levels of the parts of the ullum.

9. The salt-scraper which I brought with me from South Canara to Vedarniem, a sketch of which is given in my report on Kundapur, is no improvement on the scraping board in use on the East Coast. It failed to give equal satisfaction in a competitive trial. Something of its failure was of course due to the awkwardness of our coolies in using it for the first time, and something perhaps to premeditated awkwardness, as it was held in suspicion as an innovation, but still enough was seen at the time to establish the superiority of our scraping board in simplicity of action and design. I am not sure even that ours does not wash the salt better, by drawing a larger quantity of brine over it. Our board is, at all events, a cheaper and a better instrument, and these facts I would recommend to the notice of Mr. Ball, Deputy Collector, South Canara.

10. In conclusion I beg to tender my most sincere thanks to the Honorable D. Arbuthnott, Collector of Tanjore, and to Mr. Rickets, Deputy Collector, for their kindness and assistance to me whilst I stayed with them in the district.

Madura District.

1st Division, Vettanam.—Arrived July 1, departed July 2, 1873.

1. Vettanam is but ten miles south of Arisanegerry, the last division in Tanjore, and the pans are laid out in very similar excavations, on the north side of a narrow sea inlet or backwater.

2. The excavations are carried down to about two feet below the mean sea level, but the ullums are not very regular in this respect, those furthest from the estuary having a greater excavation than those nearest to it. All are laid out on a stratum of plastic clay, averaging four feet in thickness, beneath which there is a water-bearing stratum of sand. If this sand be cut into through the clay, brine marking 15° Beaumé comes up and fills the beds; but there can be neither leakage nor diffusion, unless the clay be artificially removed.

3. The ryots, notwithstanding that strong and abundant sub-soil brine rises to the surface if an opening is made for it, make no use of it, but manufature salt from backwater only. The backwater marked 3° Beaumé. It is passed under the embankment, which separates the estuary from the works, through hollow palmyra trunks, opening into the reservoir, from whence the brine is conducted in little channels to the salt beds.

4. Brine is abundant, and is obtained without the labor of raising it, as the works are at a lower level than the sea. The surface soil is impermeable, or at least as nearly impermeable as any natural soil can be. So that as regards most of the requisites for salt manufacture, Vettanam is exceedingly well situated. I do not think that there is

any means of drawing fresh water off the pans if rains occur, nor do I think the mother liquors can be removed, except, in either instance, by being bailed up to the high ground, and carried elsewhere. These are draw backs that must occasionally be felt; they may be remedied, however, by careful attention to the levels, so that each excavation shall have a lower depth, for the reception of refuse, &c., attached to it.

5. There are no regular ullums in the Madura District; the salt works are an aggregation of salt beds, fed by little channels, and bordered by paths on to which the salt crops are scraped. The utmost economy of space prevails within the excavation; indeed it is difficult to get about, as the paths are very narrow, few and far between. There is not a trace of brushwood or other jungle; the pans lie as an open chess-board, and may be overlooked throughout their whole extent from any stand point on the embankment which surrounds them. In these latter respects the Madura stations contrast favorably with very many of those in the districts further north.

6. In the absence of anything resembling an ullum, a "Karai" or share of 56 crystallizing beds is the recognised unit of property. Fifty-six salt beds with their paths and channels usually cover an area of 16,016 square feet.

7. The crystallizing beds are made deep, and are well hardened and tamped with sand. Abundant irrigations are used, and salt is scraped clean without any difficulty. At the time of my visit the majority of the pans held from three to four inches of brine, varying in density from 30 to 33·5° Beaumé.

8. Three inches of sea brine at 31° Beaumé, in a salt pan five inches in depth and unconnected with a condenser, must be the result of either one of three things, or a combination of two, or of all. Either multiple irrigations, evaporated one on top of the other, must have been used, until the product reached a depth of three inches, with a condensation equal to 31° Beaumé,* or a large body of bitterns of great density must have assisted in the formation of the prepared brine, or, finally, a very large quantity of refuse salt from the last crop must have remained in the bed. The Superintendent informed me that it was not the custom to use more than one irrigation here. The refuse salt is only that which the cooly judges to be unfit to scrape, and is of little account. I am, therefore, driven to conclude that the state of the irrigations resulted from the operation of the second cause, and that they are, therefore, very impure.

9. The salt that had already formed from these irrigations was lying in the beds, in detached, thin flakes, precisely similar to the scrape,

*According to Mr. Ballard, sea water loses 97· per cent. of its volume in passing to 30·2 Beaumé.

known as wind salt, are treated as refuse elsewhere. This, as illustrating the action of magnesium in forcing out and hindering the proper crystallization of sodic chloride, strengthens the conclusion that its sulphate and chloride were unduly present in the brine from the beginning.

10. Seeing that it is the custom here, as at other stations, to continue the evaporation, until only enough brine is left to wash the salt as it is being withdrawn from the beds, and that brine of the density and composition of that observed no longer contains common salt, the further evaporation must have resulted in the manufacture of Epsom salts. I had a specimen of the salt scraped from these beds sent to me some days afterwards and it was, as I had expected, visibly adulterated with magnesic sulphate.

11. None of the beds were ready for scraping at the time of my visit, nor could they, with the depth and density noticed, evaporate to the customary mark for some days more, as at 31° Beaumé the rate of evaporation seldom exceeds one-sixth of an inch from the surface in 24 hours. I cannot, therefore, give a tabular statement of the system of manufacture, but enough has been said to show that it is a bad one. The fault no doubt is primarily one of construction. An ullum or karai, composed exclusively of crystallizing beds, must, if it is water-tight, yield up an equal proportion of all the solids contained in sea water.

12. The salt in store was clean, but very moist, and perhaps for that reason rather heavy. A garce would yield 2,465 Madras measures, each containing 64 ounces weight of salt. I did not notice any magnesic sulphate crystals in the store salt, but this is negative evidence of little value.

13. I examined lately at the chemical laboratory with the microscope and analytically several specimens of common manufactured salt, which were not visibly adulterated with Epsom salt crystals. The microscope generally revealed prismatic crystals, but it is cumbrous and uncertain. The prepared test invariably indicated, at once, the presence of magnesium, and showed that it may be contained even largely in the salt, without being at all visible to the naked eye.*

14. The yield of salt per 10,000 square feet in 30 days is uncommonly large here; it amounts to 96·7 Indian maunds. This I believe to be owing to the fact, that salt manufacture does not as a rule begin in Madura until a late season, until the mean rate of evaporation for brine of all densities reaches one inch (vertical) in 48 hours. Salt manufacture had but just commenced at the time of my visit, as also had a strong, hot land-wind, which blows steadily here during the

*The prepared test is a mixture consisting of a dilute solution of ammonia, one part, with a solution of sodic phosphate, three parts.

months of June, July, August, and September, and maintains a very high rate of evaporation.

15. The cost of manufacture is stated to be Rupees 7-14-0 a garce, very nearly a fifth of which, Rupees 1-8-0, is set down as the cost of conveying salt to the platform. There is but one platform and many of the pans are a longway off from it. This appears to me to be rather hard on the ryots, whose convenience is in this respect better attended to at most northern divisions.

16. Unquestionably the manufacture may be improved here by using in combination with sea water the sub-soil brine, which marks 15° Beaumé. It may be used alone as long as it suffices to supply properly the number of beds in use. The levels should be re-arranged and proper provision made for the removal of the bitterns and drainage, and a more scientific description of ullum should be employed.

2nd Division, Viravanadapatam.—Arrived July 2, departed July 3, 1873.

1. Salt manufacture had not commenced here at the late period of my visit, the Deputy Collector informed me, because, this being an exceptionally favorable year for rice culture, the people had been busy until June in raising and gathering a third crop of rice.

2. The salt pans are situated in excavations as at the last station, though not carried to the same depth, nor are they uniform in level. They are roughly divisible into two sets, one two feet above the sea level, supplied entirely by brine pits, the other one foot above the sea level, supplied at present entirely by sea water. Both have been hitherto supplied by pits. The lower pans are about 300 yards from the sea.

3. Both sets are laid out on a stratum of good, firm clay, about four feet in thickness, which rests on black silt yielding brine, averaging 15° Beaumé in density. The soil and brine-supply are, therefore, good; the latter might be improved, by using sea and sub-soil water in combination. It seems that the Superintendent here, being under the impression that pit water yields bad salt, had forbidden the ryots, who were near the supply canal and could obtain other brine, to use it. There are no good grounds for this assumption; pit water is stronger than sea water and so far better. It does contain a little more magnesium, but magnesic salts can be altogether eliminated by a proper system of manufacture.

4. As at Vettanam, there are no ullums; the pans are simply a lot of salt beds, without reservoir or condenser. The ryots were just beginning to put them in order when I left the division.

5. Some of the past season's salt examined was clean, but small and poor in crystallization and hardness. A garce measured 169·2 cubic feet. It would yield 2,531 Madras measures, each weighing 62 ounces.

6. The produce per 10,000 square feet in 30 days, viz., 68 Indian maunds, is larger than usual here for the same reason as at the last station. The cost of manufacture is stated to be Rupees 7-14-0 a garce.

7. All that has been said with reference to the plan of ullum, the system of manufacture, and the likelihood of procuring magnesic sulphate at Vettanam applies equally to Viravanadapatam, and the alterations required are the same.

3rd Division, Autengarai.—Arrived July 4, departed July 5, 1873.

1. Here also, and for the same reason as at the last station, salt manufacture had not commenced at the time of my visit. The ryots were engaged in, and I believe had but just begun, the work of getting ready the ground for salt manufacture.

2. The Autengarai salt pans are four miles from the sea, laid out on a low mud bank in the dry bed of a monsoon river, and protected from inundation by trenches and embankments. They are not, however, liable to flooding during the salt season, especially if that be taken to commence here in July, as the river dries up long before July, and the sea seldom reaches to this level even at spring tides.

3. The soil is not very good, but can be worked for salt manufacture without leakage if the beds are made with great care. It consists of between three and four inches of excellent stiff clay, overlying a sandy loam, which rapidly changes underneath into hard concretionary sand, apparently sand stone in process of formation. The brine-supply is obtained by means of wells from the sub-soil. It marked 10° Beaumé at the time examined, and is said to be sufficient in quantity.

4. There are no reservoirs or condensers here; the ullums or karais consist of a number of crystallizing beds, supplied by an irrigation channel as at Vettanam. Salt manufacture is conducted precisely as at Vettanam, and with all the faults noticed under the heading of that division.

5. The salt in store was clean, but very light and poor in crystallization. A garce measured 188·4 cubic feet, which is equal to about 2,818 Madras measures, each weighing 56 ounces.

6. The cost of manufacture, Rupees 6-12-0 a garce, is a trifle less than at the two preceding stations, apparently because the coolies being share-holders in the pans and having a stake in the, take an interest in their work and manage to get much more out of 1,000 square feet in 30 days, viz., 125 Indian maunds, than at most other divisions. Of course a very great deal of this apparent excellence is due to the intense heat of the season to which their salt operations are confined. The mean produce of the season here is the produce of the

hot weather only, unaffected by the small returns of February and March.

7. Notwithstanding the enormous forced hot weather produce of these pans, I am under the impression that Autengarai, with its four inches of clay, is not a very favorable place for salt manufacture, and that if the ullum and system of manufacture were altered, and the working period extended, as it should be at least from April to October, the brine-supply, which is at present doubtful would probably break down.

8. I regret that not having witnessed manufacturing operations, I am unable to report more fully on this and the preceding stations.

Paumben.—Arrived July 6, departed August 10, 1873.

1. From Autengarai I proceeded to Paumben to examine the swamp which supplies the island with salt, and also to give time to the other manufactories in Madura to get into working order before my arrival.

2. On the north side of Paumben, about two miles from the north end of the proposed Paumben canal, and perhaps half a mile from the sea, but linked to it by a series of shallow pools, there is an extensive, low-lying tract, which is inundated every October by the high tides, raised by the north-west monsoon, and by drainage from the surrounding high ground.

3. After the monsoon the tract, swamp, or inland lake as it then is, holds about four feet of mingled brine and fresh water, which evaporates gradually and yields salt in July or August. The salt varies in amount from 5 to 10 garce. It is very good stuff, much resembling Vedarniem spontaneous salt, and meets with a ready sale.

4. Should the long talked of Paumben canal be opened, this plain, if Government so wills, may become the site of a most important salt manufactory. It is claimed for the canal which Mr. Robinson advocates, that it will be the only place in India where cargoes may be taken in direct from shore to ship as at the wharf at home, and this, about which there can be no doubt, unless similar provision be made in the projected Madras harbour, will make the canal the most desirable place on the coast for loading salt, and of all goods, salt suffers most in transport. Shippers are often deterred from exporting salt by the want of anchorage, the loss of time, the expense, the wastage, and the trouble. The canal would practically put an end to these obstacles.

5. As the canal is still at least a possibility, and it may be desirable at some future time to utilize this site, I examined it carefully with a view to ascertain its adaptability to salt manufacture.

6. It possesses all the natural requisites for salt culture.

7. At the time of my visit the spontaneous salt crop had been gathered and the ground was dry and hard. It was covered with a fine white efflorescence of chalk and salt. Chalk or carbonate of lime is very

abundant here; it is derived from corals, an immense number of which, of a dozen different varieties, are found imbedded in the soil and strewn on the neighbouring shore.

8. The surface soil consists of whitish marly clay, nearly a foot in depth, quite free from sand and capable of making a clean and impermeable flooring for salt beds; beneath this there are found thin seams of alternate chalk and sand, and finally silt, yielding a good supply of brine, marking 12° Beaumé.

9. The whole swamp is a little below the level of high tides. It can be drained at low tides, and supplied with brine at high tide, by means of a channel, without the labor and expense of picotah work or other machinery. Mr. Burby, Superintendent of Sea Customs, cut a channel for me through the bar, and found that water entered at high tide. All that is required, therefore, is a cutting, 12 yards in length, through the beach, a sluice gate, and a raised aqueduct to convey brine to the works.

10. The Deputy Collector informs me, that he made last year, at a cost of Rupees 40, all the cutting that was required to obtain brine for the distant swamp. I examined his channel and found that it passed through irregularly stratified coral, and that it was in perfect order.

11. The area of the largest swamp is 1,550 × 450= 697,500 square yards. It is capable of supplying a large quantity of salt, and labor, I am informed, is easily procurable in the vicinity. Should the canal become an accomplished fact, it could supply the Calcutta market with 300,000 Indian maunds of salt annually. This calculation assumes that we should get 60 Indian maunds of salt per 10,000 square feet in 30 days. The average produce at all the divisions in the Presidency is only 50 maunds, but then many of them are on very badly selected sites, and some manufacture in a very peculiar way.

12. If I may be entrusted next season with the conduct of experimental salt works, I shall be able to ascertain what ought to be the produce of a given area, possessed of the common requisites for salt culture, in a given time, and this will be of material assistance in the future in determining what extension, &c., may be necessary to meet local requirements. My own impression is, that 60 maunds will not be found above the mark.

4th Division, Morekolam—Arrived August 10, departed August 13, 1873.

1. The salt pans are laid out in quadrilateral form in the centre of a large alluvial plain, two and a half miles from the sea and three feet above its level. They are enclosed by an embankment and surrounded by a broad ditch, *the* supply canal which conveys brine to the works.

2. The soil is of the purest clay. From the surface to a depth of five feet no porous stratum was found, and consequently no sub-soil brine.

Exploratory wells were not pushed further down, as enough had been seen to demonstrate the impermeability of the soil and the condition of the brine-supply was already known to be satisfactory.

13. Brine is obtained by means of the canal before mentioned from the extremity of a narrow, shallow creek, which runs inland to within 500 yards of the pans. It is a green opaque brine, but otherwise the supply is very good, as it is plentiful and marks 6° Beaumé. It is elevated by means of slung baskets, the usual machinery employed for the purpose in this district.

4. There are no regular ullums here, nothing but karais, consisting of salt beds, and channels with a few small condensers, which have been lately introduced. They already serve a very useful purpose, however in clearing the brine, and concentrating it, as will be seen from the following notes on the strength of the fresh brine used in manufacture.

5. System as evidenced by irrigations :—

	Ready.			Bitterns.			Prepared.	
Beds.	Inches.	Degrees.		Inches.	Degrees.	Inches.	Degrees.
I. ...	2 at	17·5° B.	+	1 at	30° B. =	3 at	14·5° B.
II. ...	2½ „	13° „	+	1 „	31° „ =	3½ „	14° „
III. ...	2½ „	12° „	+	1 „	31° „ =	3½ „	14° „

Prevailing mean rate of evaporation for brine of all densities half an inch (vertical) in 24 hours.

6. The salt made here is, as a rule, clean, as it is scraped from under a good depth of mother liquor (see Bitterns column) and for the same reason no magnesium could be detected. The crystals were small and heavy. A garce measured 154 cubic feet. It would yield 2,304 Madras measures, each containing 68 ounces.

7. The produce per 10,000 square feet in 30 days, viz., 73 Indian maunds is rather large, attributable to hot weather or rapid manufacture.

8. The cost of manufacture, Rupees 7-2-0 a garce, is much the same as at the other stations in this district, but it is not a true test of the expenditure, for, as at Autengurai, the coolies are in some sort partners in the profits; they receive a fixed share of the kudivaram, one-third, with which manufacture is debited.

9. There is in the neighbourhood of Morekolam, an old pagoda tank, in which, I think, a process is going on, similar to that which results in the formation of rock salt, in illustration of which I will describe it.

10. The Tripullani pagoda tank is situated in the midst of the village, having the houses on two sides, the pagoda on a third, and a fresh-water tank on the fourth.

11. The soil surrounding the tank is not very porous. It consists of alternate layers of clay and loam. Two exploratory wells sunk into the sub-soil near its margin filled with brine, marking 5° Beaumé; a third at 25 yards distance from the tank filled with fresh water.

12. The tank is 185 yards long by 130 broad. At present its water-spread is 165 by 120 yards, and its depth about the centre 8 feet.

13. Now, what is noteworthy about it and what drew my attention to it is, that it contains a bed of salt, the crystals of which are in large hoppers, an inch in the side, and as translucent as lumps of rock salt of equal dimensions.

14. This bed is in irregular blocks, scattered over an area of 60 by 30 yards, and the quantity of salt is estimated by the diver to amount to about 600 maunds at the present time, but in 1868, when the tank dried up, a stratum of salt half a foot thick was found, and estimated at 2,500 maunds.

15. The water in the tank is saline, but very far indeed from being saturated : it marks now 5° Beaumé at the surface, and 12° Beaumé at the bottom in contact with the salt.

16. That the tank was originally fresh there can be no doubt, such is the tradition, and flights of ruined steps attest that its waters were once used for the purposes of personal ablution and clothes washing.

17. It is said that about the beginning of the present century, an attempt was made to deepen it, which resulted in opening its floor into a loose sub-soil stratum, percolated by strong brine, which rose as a spring to its own level and half filled the tank.

18. However this may be, the quantity of water, its density, and the bulk of salt now fluctuate with the seasons as they are wet or dry, in the latter case, the first diminishing, and the two last increasing until the deposit of salt is laid bare.

19. The Deputy Collector informs me that the salt is formed in successive layers year by year in the hot weather after the brine reaches 25° Beaumé, and that after the rains the process is temporarily arrested until evaporation removes the fresh water.

20. The fresh water is generally small in quantity, and is derived chiefly from the direct rain-fall, as there are other tanks close by, made to catch the surface drainage from the surrounding country. It rests owing to its specific gravity on the surface, and diffusion is known to be an extremely slow process.

21. With the brine spring, the sun and the rain-fall, year after year, operating each to the same end, the one bringing the salt in solution, the other extracting it, and the third preventing too rapid crystal formation, we can imagine the tank to be filled in time with a deposit of the remarkably translucent salt that it now contains. Let it then rest for a geological period, and become covered with other strata

which shall crush it into a solid homogeneous mass, and we have rock salt formed.

22. The tank illustrates, in a very marked way, the slowness of diffusion and the slight solubility of salt in strong solutions of brine at rest.

23. It is needless to say that the salt is supposed to possess medicinal properties; that it is much sought after in consequence; and that it is never likely to accumulate in much larger bulk towards the formation of rock salt than that which exists at present.

5th Division, Mutturagunadapatam.—Arrived August 10, departed August 13, 1873.

1. The pans are laid out on a level piece of ground at the south end of the Pambari swamp. They are 1½ miles from the sea, and, though but little above high tide level, are protected from inundation by a high beach, and by a silting up of the near end of the swamp.

2. The soil is of excellent clay to a depth of four feet throughout the whole extent of the pans.

3. The works are supplied with brine exclusively from pits. The brine averages about 9° Beaumé in density, but is very scant and dirty. It has to be raised from a great depth, from 7 to 15 feet to the pans. The pits on the south side are all so deep that it is quite a wonder the coolies are able to get the brine up with their slung baskets. It must be expensive, as it is certainly very laborious work. A canal through the swamp would serve the double purpose of partially draining it, and of giving an abundant and cheap supply of brine to the works. The Deputy Collector has, I believe, applied for sanction for the canal.

4. As usual in this district, there are neither ullums, reservoirs, or condensers, but the salt beds are well made, and their channels are at a proper level.

5. The system of manufacture, as noted during my stay, was conducted as follows:—

	Fresh.		Mother.		Prepared.	
Beds.	Inches.	Degrees.	Inches.	Degrees.	Inches.	Degrees.
I.	... 2½ at	7° B. +	1 at	29° B. =	3½ at	10° B.
II.	... 2¼ „	9° „ +	¾ „	30° „ =	3 „	11° „
III.	... 2½ „	9° „ +	1 „	30° „ =	3½ „	11·5° „

Rate of evaporation, as at last division.

6. The system of manufacture here as regards construction and irrigation, &c., has no new features. It has been commented upon more than once before, and needs no further remarks.

7. Salt is scraped on to the ridges in the usual way, and is left there for three days, after which time it is taken and heaped on the platform without a covering for 27 days, and is then taken into store by Government. The salt in store is not nearly so clean as that

drawn from the salt beds, but the same may be said of almost every other division. And by the time the salt reaches the consumer it has acquired the characteristic appearance of Indian bazaar salt.

8. The salt scraped and in store that I examined was small in crystal, but otherwise very fair. It is a heavy salt, yielding to the garce 2,356 Madras measures, each containing 67 ounces.

9. The produce of these pans per 10,000 square feet in 30 days, viz., 123 Indian maunds, is very great; but then it will be found that the produce, in a given time in Madura and Tinnevelly, is uniformly high, owing, I think, chiefly to the duration and intensity of the hot land wind in those districts coinciding with the period of manufacture.

10. The cost of manufacture, Rupees 7-5-0 per garce, is here again not a true index of the price for which salt can be made, as the workmen are co-partners in the undertaking, and receive three-fifths of the kudivaram, and in the ryots' statement of expenses the cost is debited with their share in the profits. The kudivaram is Rs. 11-4-0 a garce.

11. About 300 garce of salt forms annually on the Pombari swamp, and is watched by the police until destroyed by the monsoon rains in October. A specimen of this salt forwarded to me was remarkably like the manufactured salt, and of the same weight.

12. The Deputy Collector thinks that the villagers steal it, and, having mixed with it a little of the manufactured article, sell it at 50 per cent. less than the monopoly salt. He thinks that it would be an economy to gather it on the spot, and sell it at a discount of from 10 to 20 per cent., which would involve a loss about equivalent to the cost of bringing it to the platform store—a relative loss as regards the monopoly price, but perhaps an absolute gain. The proposed Pombari canal will, I think to a great extent, prevent its formation, and what little does form might be utilized by being sold at cost price to the *bonâ fide* fish-curers, who now use saline earth taken from the very swamp in question.

13. Salt manufacture in the Madura district is conducted at a late season of the year when evaporation is going on very rapidly. It is carried on in crystallizing beds only. One would expect, therefore, to hear of badly formed salt and of out-crops of magnesium occasionally interrupting the process. In answer to my questions on this subject the Deputy Collector reports as follows:—"Moulaka, or Oosi uppu, as it is called in the south, makes its appearance in the hottest part of the year, and is collected and destroyed by being thrown into the pits, or the canal from which the beds are irrigated. The beds are then repaired and filled with fresh weak brine when that is procurable, but

where, as at Mutturagunadapatam, pits are used, manufacture is temporarily suspended during those months until the heat subsides."

14. Magnesium has its revenge, and where no proper provision is made for its elimination during salt manufacture, it is quite capable of arresting the process and reducing the manufacturers to confusion.

15. The average quantity of salt annually raised in the district is roughly estimated at 298,670 Indian maunds, and of this total, 38 per cent. is destroyed as being unfit for use through dirt, malformation and adulteration with magnesium.

These facts suffice to show the importance of a proper design of ullum and system of manufacture to the unfortunate ryots themselves, who, working on in ignorance, raise but a poor kind of salt at heavy expense, viz., Rupees 7-14-0 a garce, if the returns are to be believed; whereas, with the rate of evaporation accorded to them by the land wind, they should be able to make a superior salt for less than half that price per garce.

16. All the stations, with one exception, are pretty well off as regards the natural facilities for salt manufacture. Mutturagunadapatam alone is badly supplied with brine. There should be no delay in bringing sea water to it by means of a canal through the Pombari swamp.

17. N. Ramasawmy Modelly, Deputy Collector, Salt Department, accompanied me to all the salt stations in the Madura District. I derived great assistance from his intelligent observations and shrewd knowledge of the contractors, and have to thank him for his prompt attention to my wishes.

Tinnevelly District.

1st Division, Vypaur.—Arrived August 17, departed August 18, 1878.

1. Vypaur, the first division in Tinnevelly, is twenty-two miles south of the last station in Madura and about the same distance north of Tuticorin. The salt pans are situated on an excellent site within a banked and drained enclosure, about a mile from the sea.

2. The soil consists of ochreous impermeable clay to a depth of six feet from the surface, and beneath it there lies a stratum of sand containing a fair amount of brine, averaging 12° Beaumé in density. This combination of loose saline sub-soil, holding out a fair prospect of brine with a stiff soil barring leakage, is in every way favorable to salt manufacture.

3. Until lately these salt pans were supplied with brine exclusively from pits, which were arranged as an outer circle surrounding the salt station; but now the Deputy Collector is cutting a canal from the sea to bring salt water to the works, and, as this is carried round the pits, they are, as a general rule, abandoned. This canal is as yet incomplete; it has been taken round three sides of the enclosure, but is wanting on the fourth. It will be completed next year. It is made broad and deep, apparently it cuts well into the sub-soil, as it very seldom requires to be replenished from the sea, not more than once every four or five months, and the brine in it marked, at the time of my visit, 7° Beaumé, which seems to show that it is a mixture of seawater and sub-soil brine.

The brine-supply is, therefore, both strong and abundant, and in the essential requisites for salt-culture Vypaur excels most other divisions.

4. Brine is bailed with slung baskets from the canal to the irrigating channels, which convey it to the salt beds. The channels are at a higher level than the beds, and they fall gently and empty themselves completely without trouble. The arrangements so far are unusually good.

5. Every inch of the enclosure is occupied with salt beds, pathways, and conduits. There is no such thing as a reservoir or condenser in the division. The term ullum is unknown here; the holdings are known simply as the separate properties of individuals, a number of salt beds varying with their wealth. This takes away much from the general superiority of the division, for the reasons given when describing the Madura district, in which the same arrangements prevail.

6. As it is, they make very fair salt here. The beds are tolerably firm, and the irrigations have the merit of depth and abundance. The following figures relate to the system of manufacture as evidenced in the work done during my visit:—

Beds.	Beach Brine. Inches. Degrees.		Mother Liquor. Inches. Degrees.		Prepared. Inches. Degrees.
I ...	2 = 7°B.	+	1¼ = 32°B.	=	3¼ = 11°B.
II. ...	2½ = 6° „	+	1 = 29° „	=	3½ = 10·5°B.
III. ...	2 = 7° „	+	1¼ = 31° „	=	3¼ = 11°B.

Rate of evaporation, mean of saturated and unsaturated brine, about one inch vertical in 48 hours.

7. The 3¼ inches of brine shown here have an initial density equal to 11° Beaumé, and they will of course take a longer time to evaporate than would the same depth of sea water starting with a density equal to 3° Beaumé. I found that at this time three inches depth of sea water, exposed in a square vessel on the ground in the open air night

and day, evaporated to dryness, that is, formed salt in six days.* Three and a quarter inches at 11° Beaumé would probably take nine days, of which crystal formation, supposing the process undisturbed by the action of magnesic salts, would get a little more than three days.

8. The crops of salt were large, clean, and free from visible magnesic impurities, but the individual crystals were small and friable. They had been no doubt unduly hurried during their formation by the operation of the residual salts, for the removal of which no provision is made here. The salt was, however, rather heavy. A garce measured 154 cubic feet, which equals 2,304 Madras measures, each weighing 85 ounces.

9. Salt is scraped, in the usual way, on to the side path with the common scraping board as used in all the other districts on the East Coast. It is scraped about midday, remains on the path to drain till evening, and is then carried in the moist state to the ryots' heap upon the platform, where it remains exposed until purchased by Government.

10. Owing to the entire absence of an ullum, or of anything like it from these pans, it is difficult to say what may be the produce and the cost of manufacture. The kudiyaram is Rupees 10 per cent. The Acting Deputy Collector Raghava Iyengar states that there are 2,000 salt beds, each measuring 400 square feet, in the division, and that the total area is 998,000 square feet, made up as follows:—

	Square Feet.
Ridges	115,000
Salt-producing beds	800,000
Irrigating channels	57,000
Wells	26,000
Total ...	998,000

* This experiment was made in August in Tinnevelly. The weather was very cloudy throughout, but a strong west wind was blowing. The following notes made at the time may be of use or interest. The density is roughly calculated from loss of volume according to M. Usiglio's tables.

Dates.	1873.							2 A.M. to 2 P.M.
	28/8.	30/8.	31/8.	1/9.	2/9.	3/9	4/9.	
Depth in inches	3	2	1·4	·9	·5	·2	0	...
Inches evaporated	...	1	·6	·5	·4	·3	·2	In 24 hours = a mean rate of one vertical inch in 48 hours.
Volume	1,000	666·7	466·6	300	166·6	66·6	0	
Density in degrees Beaumé ...	3°	6°	9°	12°	18°	27°	...	

The second line compared with the fourth, shows the diminished power of evaporation and its rate at the degrees marked.

The out-turn during the past eight years has averaged 66,450 Indian maunds, and the period of manufacture 158 days. The produce per 10,000 square feet in 30 days is, therefore, 126 maunds. This is so much greater than at most other stations in the Presidency, that I have some hesitation in accepting the correctness of the figures; but it must be borne in mind here that, in addition to the advantages of soil and brine-supply which Vypaur possesses, manufacture begins in Tinnevelly at a late season as a rule, and leaves off in October, so that the process gets the benefit of a long-continued and powerful evaporation, which drives out the salt from the sea much more rapidly than where, as in the north, work begins and leaves off earlier in the year. From experiments made in Madura in June and July, I am decidedly of opinion that the rate of evaporation on the south-east coast during the months of June, July, August, and September, wherever the west or land wind blows regularly, is about one vertical inch in 48 hours, as shown in the note to page 60.

11. The cost of manufacture, as taken from a return furnished by the Acting Deputy Collector, is Rupees 7-2-0 a garce. The return is much too meagre in detail to be worth analyzing, but I am quite sure that with the soil, brine-supply, rate of evaporation, and produce per 10,000 square feet that have been noticed here, and with the prevailing rates for labor, it would require peculiar and signal mismanagement, such as allowing the sub-division of salt properties until a dozen salt beds constituted the separate property of an individual and were taxed with his labor to bring about such an expenditure per garce. But this is not the case, at least not to the extent required to explain the cost. A reference to another return shows that the 2,000 beds at Vypaur are in the hands of 68 men, which allows them 29 a peice, or, inclusive of ridges, about 12,000 square feet. I can only conclude, therefore, that the return is incorrect. 12,000 square feet is, however, less than half the area of the standard ullum, and in my opinion too small space on which to manufacture salt profitably under ordinary circumstances at present contract rates.

2nd Division, Arasady.—Arrived August 18, departed August 19, 1873.

1. These pans are about four miles north of Tuticorin, laid out on a properly drained and protected enclosure in the swamp, half a mile from the sea, and about three feet above its level.

2. The surface soil is first rate clay to a depth of two or three feet throughout the enclosure, with the exception of the west end, where some 300 new pans, which have been lately opened, require artificial claying. At a depth of four feet from the bed level the sub-soil yields brine marking 12° Beaumé. The brine-supply is obtained from the sea by means of a canal provided with a sluice gate, which is filled at the new and full moon tides. The canal is five feet deep, and, as at

Vypaur, appears to cut well into the sub-soil and to be strengthened by the sub-soil brine. The brine in it marked 6° Beaumé.

3. Here again the natural requisites for salt manufacture are, with the exception noticed, all that could be desired.

4. As at Vypaur the enclosure is completely filled with salt beds, and their irrigating channels, the levels of which are carefully arranged. There are no reservoirs or condensers or other means of cleansing and preparing the brine, but, on the other hand, there are no waste spaces as at most northern stations, every inch of ground within the embankments is occupied and worked. An ullum, as the term is understood in the north, is unknown here.

5. Brine is lifted with slung baskets from the supply canal to the irrigating channels, which conduct it to the salt beds.

The following notes were made on the method of manufacture practised during my stay:—

Beds.	Ready Brine. Inches.	Degrees.		Bitterns. Inches.	Degrees.		Prepared Brine. Inches.	Degrees.
I. ...	2¾	at 6°B.	+	¼	at 31°B.	=	3½	at 9·5°B.
II. ..	3¼	„ 6° „	+	¾	„ 35·5° „	=	4	„ 9·5° „
III. ...	1½	„ 6° „	+	1½	„ 31° „	=	3	„ 8° „

6. It will be noticed that the bitterns in the second bed are of very advanced density, that they have passed the point at which all observers agree—that magnised sulphate is largely deposited. This bed does not furnish an exceptional instance of strength; in many others that I examined, the irrigations actually evaporating for salt marked 35° Beaumé. I look upon this as the inevitable consequence of the primitive method of manufacture in use here, and doubt not that the salt formed is a very impure article, although I could not with naked eye detect more than a very slight sprinkling of magnesic crystals in the salt scraped from bed No. 2.

7. The Acting Deputy Collector says that Moulaka salt forms chiefly in the pans of Coilpatam and Arrasady, that it appears between June and August, and that its total produce amounts to not more than 3,600 Indian maunds. As to this it must equally exist at Vypaur, which possesses all the necessary conditions for its growth, though it may be perhaps, overlooked.

8. The presence of Moulaka salt necessitates the interruption of salt manufacture, whilst the pans are being washed and cleaned out and re-made. Independent, therefore, of the question of the purity of the salt, it is a false economy both of time and space to dispense with the accessories which accompany scientific salt culture.

9. The salt that I examined was white and apparently pure, but comparatively small, light, and friable. The Acting Deputy Collector mentions, in a return with which he has furnished me, that 1,620 Indian maunds were destroyed last year for being small and badly

formed, and 60 maunds owing to the presence of Moulaka or magnesic sulphate. It is to the presence of this Moulaka that the formation of small light crystals is in a great measure due; for from paragraph 5 it will be seen that the irrigations are of such depth as to afford sufficient time for the formation of fairly well crystallized salt.

10. A garce of Arasady salt measured 175 cubic feet. It would yield 2,618 Madras measures, each containing 66 ounces of salt.

11. The area of the division is 1,245,080 square feet, made up as follows:—

		Square Feet.
2,110	Salt beds	976,000
	Ridges	199,720
	Channels	69,360
	Total ...	1,245,080

The average monthly produce during the past ten years has been 13,413 Indian maunds. The produce per 10,000 square feet in 30 days is, therefore, only 17·7 Indian maunds.

12. There is a startling difference between the produce per 10,000 square feet at Arrasady and at Vypaur. It is so great that I cannot account for it, except upon the hypothesis that the returns furnished to me have been drawn up with some freedom of imagination. This appears probable, too, from the fact that another return shows that it cost 5 annas and 2 pies less a garce to make salt here than at Vypaur. The cost of manufacture at Arrasady is stated to be Rupees 0-12-10 a garce. The cost at Vypaur is Rupees 7-2-0 a garce. Now, as any given area of the Vypaur pans produces, according to the statement, more than seven times as much salt as the same area of the Arrasady pans in an equal time, it is inconceivable that it should be more expensive to make salt at Vypaur than at Arrasady. Salt is made in the same way at both places, and there is no peculiarity in the profit and loss account to explain the difference. The proprietors here have 35 beds each, a larger area than at Vypaur, against which to debit their expenses; but, as the area is very much less productive, this fact fails to throw sufficient light on the anomaly. I might mention some other similar puzzles which have developed from a comparison of the returns furnished from different districts, but enough has been already said on this subject to show the difficulties which an investigation like this has to contend with.

3rd Division, Tuticorin—Arrived August 19, departed August 22, 1873.

1. There are two separate salt stations here, half a mile apart, about two miles south of the town of Tuticorin. One of these, called Karapa, is within 500 yards of the sea, and has been worked for years,

but owing to the swamp around it, and the absence of good roads, it has obtained very little of the inland trade. The other, called Levingeperum, is half a mile further inland, in a more accessible situation. It was abandoned 10 years ago, but was re-opened in April of this year, with a view to provide for the growing trade of the division.

2. The Karapa salt pans are laid out partly on the edge of an alluvial stratum and partly on sand. On the south there is three feet of clay, which gradually thins off towards the north, where the salt beds are made with six inches of imported clay resting on a great depth of sand.

3. At three feet from the surface brine is met with, marking from 10° to 12° Beaumé. It traverses a stratum of firm compressed sand, the thickness of which we were unable to determine, and it is said to be sufficient in quantity, though this is at least doubtful.

4. At present, as heretofore, manufacture is carried on exclusively with pit water, but the Deputy Collector was cutting a canal from the sea at the time of my visit, which, when provided with a sluice gate, will ensure a good supply of brine for the future. Slung baskets are used in raising the pit brine to the works.

5. The pans are within an embanked and drained enclosure, and with their irrigation channels they completely fill it. There are no reservoirs or condensers. The salt beds were made with care, and the beds were well attended to.

6. The following observations relate to the work done by the ryots during my visits:—

Beds.	Steady Brine. Inches.	Degrees.	Mother. Inches.	Degrees.		Evaporated. Inches.	Degrees.
I. ...	2¼	15° B.	+ ¼	22° B.	=	7½	15° B.
II. ...	2¼	12° „	+ ¼	33·5° „	=	8½	14° „
III. ...	2	10° „	+ ½	33° „	=	9½	14° „

Rate of evaporation mean of saturated and unsaturated brine one vertical inch in 48 hours.

7. It will be seen that the irrigations are not so deep as at the last two stations, but that the prepared brines are stronger, which comes to the same thing as regards the time required to evaporate them and crystallize the salt.

8. Salt is scraped in the afternoon, left to drain an hour or two at the pans' side, and then carried off and heaped on the ryots' heap in the moist state. It is rather small in crystal, but very clean and apparently pure, notwithstanding that most of the beds here are allowed to pass the point at which scientific salt manufacture ceases, viz. 32° Beaumé. It is quite possible, however, that the Tuticorin sub-soil brine may hold less magnesium in solution than does sea water. The salt

is firm and rather heavy. A garce measured 161·2 cubic feet. It would yield about 2,411 Madras measures, each weighing 65 ounces.

9. The superficial area within the enclosure is 1,064,549 square feet, distributed as follows:—

	Square Feet.
Salt beds 2,000 in number	800,000
Paths and ridges	106,080
Brine pits	103,329
Irrigating channels	55,140
Total ...	1,064,549

The average monthly outturn during the past ten years has been 1,653 Indian maunds, which gives a produce of 15·5 maunds per 10,000 square feet per mensem. I am not at all satisfied with this result, which is very much less than I would expect from a station manufacturing with pit brine of the density of the sub-soil water at Karapa. If it be correct, it shows how difficult it is to procure a sufficiency of brine for continuous and liberal salt manufacture from the sub-soil, even in the near neighbourhood of the sea, for this poor outturn must be attributed chiefly to scarcity of brine with no doubt leakage at the northern pans.

10. That leakage exists is pretty clear, as the pans are at this station divided into three classes according to their yield of salt. The beds in the first class produce annually on an average 90 Indian maunds of salt; in the second class, 75 Indian maunds; and in the third class, 60 Indian maunds, so that there is a loss in the third class equal to one-third of the whole crop procurable from a staunch bed. The beds are all of the same size, and use similar brine. Those to the north require more clay, and of a better description than that at present used in their construction. The cost of manufacture is naturally, under the circumstances, rather high at Karapa: it amounts to Rupees 7-12-0 a garce. The sudivaram is Rupees 10-10-0.

11. The trade of this station is exclusively wholesale. A first rate road leads from the platform to the beach, where a wooden pier, running out into sufficiently deep water, affords every facility for exporters. It is somewhat unfortunate that large ships, such as those which are engaged in the salt trade with Calcutta, cannot approach nearer than five miles to Tuticorin, otherwise Karapa would be, I believe, the best place along the whole coast as regards facilities, from whence to ship salt.

12. Its faults as a salt manufactory are easily remediable. It only requires to re-arrange the pans and system of manufacture, to complete the canal which is to supply sea water, and to clay well the northern beds to make Karapa a good division.

13. Levingeporum, the retail station of Tuticorin, is a bunded and drained enclosure, about half a mile inland from Karapa, in the same swamp.

14. As before stated, this station was opened in April of the current year to meet the requirements of the increasing salt trade. Its superficial area is 848,461 square feet. A stratum of clay, about a foot in thickness, extends over the greater part of it, and beneath this there lies an indefinite depth of sand.

15. The brine-supply is obtained from pits, which are sunk to a great depth. It is procured, averaging 13° Beaumé in density, at a depth of 10½ feet from the surface. Exploratory wells, sunk here and there, showed that the sub-soil brine was least dense towards the west of the enclosure, where in some instances it marked as little as 3° Beaumé.

16. The Levingeporum salt works are nothing but salt beds and their irrigating channels. The beds are 1,609 in number, and are worked in the same way as at the three preceding stations.

17. It is too soon yet to ascertain the outturn from these pans and the cost of manufacture; but, if I might forecast from the materials available, I would say that they are likely to be somewhat disappointing. The brine-supply is scanty. A canal will have to be brought here from the sea. The tendency to leakage is very great, and there will be loss, unless the pans are prepared with great care; and, finally, the arrangement of pans and system of manufacture are of a type that denote a people low in the scale of knowledge of salt manufacture. All these things are, however, capable of improvement, and there is nothing to prevent Levingeporum becoming in the future a good salt station.

18. When the projected Great Southern of India Railway has been completed to Tuticorin, the present demands for salt will be multiplied in an astonishing way, and unless immediate steps are taken to provide for prospective requirements, confusion in the department and disappointment in the trade will inevitably result. This is of course well understood on the spot, and the Levingeporum pans are a first instalment of the work to be done. A road is being brought from Levingeporum to Tuticorin, which will place the railway after a fashion in connexion with the salt stores. Without wishing to disparage the road, I would remark that it passes through a swamp, and has a good deal of sand in its composition, and that any accident to it would effectually interrupt the salt trade in the wet season. I am not aware whether or not it be the intention of the railway authorities to run a line as far as the salt platform, as at Madras and Negapatam, but I venture the opinion that such a line would prove very useful.

19. At the Collector's (Mr. Puckle's) request, I examined some sites for the extension of salt works in the Tinnevelly District. I will describe here the most promising one of these, which lies immediately south of Levingeporum, close to Tuticorin.

20. It is an immense swamp. The Deputy Collector who measured it informs me, nearly a mile in length, by half a mile in breadth, which is flooded by the sea for about a fortnight during the north-east monsoon. The soil dries up in January, and is fit for the manufacture of salt during the working season, which commences here in February or March, and terminates, as a rule, in October.

21. The river Madakatta sweeps round the south and east of the swamp, between lofty artificial embankments, which have been erected to protect the surrounding low ground from inundation. How long this river remains in flood I am unable to say. It was dry when I examined the pans in July, but in any case salt pans, protected within a properly bunded and drained inclosure, need not fear fresh-water incursions.

22. The swamp is at the north end within 200 yards of a small estuary or arm of the sea, and is throughout from one to two feet above high tide level.

23. The soil is at the surface a thin layer of loam, which rests on a stratum of clay, the latter well adapted to the formation of impermeable salt beds. The sub-soil consists of firm, yellow sand, passing below into silt, which contains rather a plentiful supply of brine, averaging 14° Beaumé.

24. Eight exploratory wells, sunk in different directions to examine the soil and sub-soil, &c., cut from above downwards through the different soils, shown in the subjoined columns.

Wells.		1 N.	2 N.E.	3 N.W.	4 W.	5 E.	6 S.E.	7 W.	8 S.
Soils.	Feet. Inches. Loam	1′	1′	6″	...	...	4″	...	1″
	Clay	11′	3′	2′	1′	3′	...	2′	2′
	Loam and	3′	...	...	3′	...	...	...	21′
	Sand	1′	...	...	...	6′	3′	1′	...
Silt yielding brine		13′	3′	2′	14′	11′	14	1′	2′
Depth of brine		14′	3′	2′	11′	11′	1½	1′	2′
Strength of ,, ...		14B.°	10° B.	17° B.	16° B.	12° B.	17° B.	15° B.	14° B.

25. It will be seen that all the cuttings showed from one to three feet of good stiff clay covering the sand and other permeable strata, except at the south-east, where there was but four inches of loam. The south-east end should not, therefore, be taken up for salt manufacture, but it can easily be dispensed with, as the swamp is large enough without it.

26. We have in this site all the natural requisites for salt manufacture, an easily guarded and drained enclosure, covered with an

impermeable clay stratum, and capable of being easily supplied with an abundant and strong brine. I would recommend that the whole swamp, with the exception of the portion to the south-east, be enclosed, and that the loam, down as far as the clay, be removed and employed in forming the embankment. That a canal from the backwater, provided with a proper sluice-gate, be brought round the enclosure within the embankment, and cut to such a depth into the silt as to ensure a fair mixture of sea and sub-soil brine, and that the ultimate way be laid out in whatever way the experimental trials, which I may leave the conduct of next year, will demonstrate to be the most advantageous.

27. The whole of the swamp need not be brought under salt culture at one time. It can be taken up bit by bit as the trade increases; but should it be in its entirety converted into salt pans, as it may well have to be when the railway is opened, then the Levingeporama stores will be as extensive and important as those of Negapatam, and would as well repay the outlay on a short line of rail.

28. There is no scarcity of labor here, or other similar drawback to interfere with the opening of new works. The people of the villages of Paliacoil and other coast villages, who were thrown out of work when their salt pans were closed by Mr. Clarke in 1866, still retain a perfect recollection of salt culture, and a lively desire to re-commence operations. They waited on the Deputy Collector in a body, and expressed their willingness to remove to the neighbourhood of Tuticorin, and open out salt pans on the swamp I have just described. Indeed, in such high estimation is salt manufacture held in the Tinnevelly District, that beds put up to auction at the opening of new pans fetch sometimes as much as Rupees 10 a piece; whereas, as a general rule, in other districts they are gladly given away by the score to any one who will undertake to work them.

29. I examined, also, the site of the old pans at Paliacoil, and a swamp adapted to salt manufacture a quarter of a mile further east. The Paliacoil old pans have been abandoned for the last ten years; the ground they occupied is now covered with a very sandy loam, overgrown with grass. Beneath the sand, there is a thin stratum of clay, nowhere more than six inches in thickness, which covers several feet of sand. The soil is naturally ill-adapted to salt manufacture, and the brine-supply would have to be brought in a canal half a mile in length from the sea. It would scarcely be worthwhile re-opening Paliacoil, even if the swamp at Tuticorin could not supply the demand for salt. At about a quarter of a mile east of Paliacoil that is nearer the sea, there is a small swamp at about the mean sea level, having a good thickness of clay at the surface, and very abundant brine beneath, marking 10° Beaumé. This would be a better site for new

salt works than Paliacoil itself, should salt pans be required here; but I quite believe that the swamp at Tuticorin will meet the demand created by the railway, and that the salt trade in the rest of the district will consequently remain undisturbed.

4th Division, Coilpatam.—Arrived September 7, departed September 9, 1873.

1. Coilpatam, at present the largest division in the Tinnevelly District, possessing 3,400 salt pans within an area of 1,802,810 square feet, lies, as the crow flies, about 18 miles south of Tuticorin, but by the high road over 30 miles.

2. The pans are laid out on a stretch of morass or swamp, two miles from the sea, and are surrounded by a high embankment, a thick bramble hedge, and within by a canal for the supply of brine. The latter is not as yet completed the whole way round the works.

3. The soil is throughout very sandy, but firm and exhibiting well marked strike on vertical section, some of which denote strata of the density of sandstone. It passes into black silt and shell marl, yielding brine at a depth of six feet from the surface.

4. The brine-supply is derived at present, as it has been, I believe, since the opening of the works, from brine pits sunk to a great depth. These pits yield a moderate amount, averaging 8° Beaumé in density. The brine found in exploratory wells marked 15° Beaumé. It is always stronger in new wells, than in old, partly owing to the virginity of the soil, and partly to the collection of direct rainfall and surface drainage in old wells.

5. So far the natural requisites for salt manufacture are but badly fulfilled here. Art has done something to improve the site, but as yet not much. Imported clay has been used in forming the salt beds, but there is absurdly little of it, not more than two inches in thickness on an average, and nowhere more than four inches. The Deputy Collector is doing his best to improve the brine-supply by bringing sea water in a canal from a neighbouring estuary.

6. The canal water was nearly fresh. It marked at the most 1° Beaumé. The canal, which is in fact little better than a ditch, passes without embankments through an extension of the same morass in which the salt station has been formed. The plain lies in the course of the drainage of some large tanks, and is often swamped in fresh water. It was in parts under water at the time of my visit, though no unusual rain had lately occurred. The canal was, therefore, fresh and useless. It cannot be depended upon to convey brine until the swamp is drained, unless it be embanked throughout its whole length.

7. Ragava Iyengar, the Acting Deputy Collector, had a plan for draining the swamp, about which he was going to consult the Resident Engineer. If it prove successful, and good brine is obtained, a great

improvement will have been effected; but still the whole station should be re-slayed to a depth of 10 inches at least before it can be considered a good salt manufactory.

8. As at the other divisions in this district there is no semblance of an ullum; all the ground within the embankments is occupied with beds, paths, and irrigating channels, but here every sixth or seventh pan is called a male bed, and brine is exposed in it for a time just long enough to deposit its coarser impurities before being passed on to the salt beds, which are termed female pans.

9. The following notes made on the spot will give a fair idea of the method of manufacture at the time of my visit:—

Pit Water.	Beds.	Fresh. Inches.	Degrees.		Bitterns. Inches.	Degrees.		Prepared. Inches.	Degrees.
10° B.	I.	2 at 15°	B.	+	½	35° B.	=	2½	18
7° „	II.	1¼ at 10°	„	+	¾	37° „	=	2	14
6° „	III.	1¼ at 7°	„	+	1	36° „	=	2½	13

10. It will be noticed that the irrigations are evaporated to an extraordinary degree of concentration, far beyond the point of saturation of magnesic sulphate. It will not be amiss here to re-introduce the results of M. Ballard's observation on Mediterranean brine, which contains less magnesium than that evaporated at Coilpatam. He found that from 32° to 34° Beaumé it deposited a mixture of common and Epsom salts; from 34° to 36° Beaumé, a double sulphate of potassium and magnesium; and from 36° to 40° Beaumé, a double chloride of the same. As the sea brine at Coilpatam is stronger in magnesium salt than that examined by M. Ballard, and the irrigations exposed are made up in great part of litterns containing little else than magnesium, the manufacture must be very impure.

11. The effect of magnesium in hurrying and deteriorating the crystal formation of sodic chloride was seen in a very marked way here. The salt in the beds was in thin flakes, light and friable, comparable only to the wind salt which forms at the corners of the northern beds, and is condemned. A garce measured 226 cubic feet. It would yield 3,411 Madras measures, each weighing 40 ounces. It is, therefore, without exception, the lightest salt in the Presidency, as will be seen by a reference to the tabular statement at the end of this report. I think that it is also the worst salt.

12. The salt is clayey, and it is needless to say that it is well liked. Merchants find it so profitable that they consider it the best salt in the district, and come a long way to purchase it. The demand is consequently very great: it amounts to 280,000 Indian maunds, and the supply, 246,245 Indian maunds, is not far short of the demand. Thus, the average supply is but 3,695 maunds short of that made at the three preceding divisions—Vypaur, Arasady, and Karapa—put together, which produce only 250,420 Indian maunds per annum.

13. The yield per 10,000 square feet in 30 days is nevertheless small as one would expect it to be from a knowledge of the soil and brine-supply. It averaged during the last ten years but 13·9 Indian maunds. The cost of manufacture is not proportionately high. It is made the same as at the other divisions, viz., Rupees 0-13-0. This I cannot explain. It is impossible to draw any save very general conclusions from the returns furnished by the manufacturers of the cost of working, as they are admitted to be of very doubtful accuracy.

14. The ryots, when called upon for a return of the cost of manufacture, jump to the conclusion that their claim (they always have a claim) for increased kudivaram is about to be considered. The temptation is obviously under the circumstances, so strong to make the most of the occasion, that even the native officials, who are intimately associated with them, and rather inclined to support their cause, commonly admit that the returns furnished require to be digested with a grain of local salt.

15. With a properly slayed ullum, a good brine-supply, and an altered method of manufacture, there is no reason why Coilpatam should not be improved to the level of a good manufactory. It can never be made first-rate, as it is quite deficient in the natural requisites for such cultures.

16. During the past season (fasli 1282) 15,600 Indian measures were destroyed here, 12,000 for being small and friable, and 3,600 owing to the presence of magnesium. Probably that which was destroyed for being too small owed its physical deterioration to the presence of magnesium, which may be considered to have caused the whole loss. A knowledge of this would assist manufacturers to realize the advantage of working with a system which prevents the formation of magnesium.

5th Division, Kothankali.—Arrived August 27, departed August 27, 1873.

1. This division consists of two stations—Kuthankuli and Vizapathi—four miles apart; the latter of which is the furthest station south in the Presidency, being about 20 miles from Cape Comorin.

2. It would be difficult to pick out anywhere two salt stations resembling each other so closely, both in the natural features of the localities in which they are placed, and in the arrangements which have been made for salt manufacture.

3. The salt pans at both places are situated in two groups, north and south, one on either side of the rocky bed of a small river, which dries up early in the season, and forms a narrow basin or pool less than half a mile in length. This is filled with salt water once or twice a month, when the tide rises over the sand bar at the river's mouth at the new and full moon.

4. The works are connected together by means of a stone bridge, 30

yards wide, which stretches across the inlet. The beds are underlaid by irregularly scattered rocks, apparently granitic, from which they are separated by argillaceous earth or coarse silt, artificially procured for the purpose, and spread out on the rocky floor to a depth varying from six inches to three feet. Over all is spread a layer of clay mixed with sand about four inches in thickness. Rounded knolls or boulders of metamorphic rock or granite, crop up through the foregoing structures in every direction, and are frequently found appearing through the bed from themselves. There is every reason to fear leakage at both stations, which display rather too much of art and too little of the natural requisites for salt manufacture.

5. The brine-supply is of course abundant as the sea is close by. It is obtained from the pool, marking 3° Beaumé. At Kuthankuli there are a few pits which furnish a very scant supply at 5° Beaumé. They are immediately within the embankment at a lower level than the pool, and are supplied from it by percolation. They are of no account. There does not appear to be any sub-soil water here. Exploratory wells encountered hard rock at a depth of three feet. It is true they filled with brine in 24 hours, but from the fact that the beds are on a rough artificial platform, and that the brine in several instances marked 25° Beaumé, I am inclined to attribute this to leakage from surrounding salt beds.

6. For the rest, the works are protected from inundation by an embankment five feet high, which runs along the river's edge as far as they extend.

7. Brine is lifted by means of flang baskets nearly to the top of the embankment, and from thence is distributed in little clay aqueducts to the further corners of the works.

8. There is properly speaking no villum at either of these stations. The enclosures are filled with pans, some of which are known as male and others as female beds; there are 181 of the former in 337 of the latter at Kuthankuli, and 70 to 274 at Vizianathi, the smaller station of the two.

9. Manufacture is conducted in precisely the same manner at both places and that is the manner of Coilpatam and the preceding stations. The following notes were taken of the irrigations used during my stay:—

Beds.	Fresh. Inches.	Degrees.	Mother. Inches.	Degrees.	Prepared. Inches.	Degrees.
I.	4 at 4°	+	3 at 25° B.	=	7 at 9° B.	
II.	2½ at 6°	+	4½ at 60°	=	7 at 17°	
III.	6½ at 6°	+	1 at 31°	=	7½ at 10°	

Rate of evaporation, mean of all densities, one inch in 48 hours.

10. It will be seen that the irrigations of prepared brine are on the whole deeper than usual, but that they are less dense, which is often

all just as important a point in relation to the time taken in evaporation and crystal formation. The mother liquors are not so strong as at Coilpatam, probably because the initial density of the brine worked with is much less here.

11. The crops of salt obtained from the beds at each scraping struck me at the time as being remarkably scant. The crystals, however, were white, clean, and for the most part regularly formed, but very small and light. A garce measured 201·2 cubic feet. It would yield 3,010 Madras measures, each weighing 52 ounces.

12. The average produce per 10,000 square feet in thirty days, as calculated from a return furnished by the Deputy Collector of the produce during the last seven years, is 84 maunds for Kuthankuli, and 83 maunds for Viziapathi. There is, probably, some mistake in the return. The produce at the one place appears to me to be as much too great, as it is at the other too little, or rather I should say that the Kuthankuli return is the more incorrect of the two, and that the real produce is much below the mean found by adding both together.

13. I have not referred the matter back to the Deputy Collector, as I have long since given up the attempt to obtain accurate statistical information. As this report is now drawing to a close, and these are the last tables to which I shall have to refer, I will take the opportunity of stating that, although the returns that have been furnished to me from each district have been prepared, I believe, with care and attension, there have been so many mistakes in them that I could not, single-handed, attempt to rectify them by a correspondence. The statistics, such as they are, have separately only a local value, and I have been careful in drawing general conclusions from them, to do so as guardedly as possible.

14. The cost of manufacture at these stations is said to be 3 Rupees a garce; the kudivaram is Rupees 10-10-0.

Conclusion.

1. In conclusion there are just a few points which have been hinted at, here and there, through this report, which are well worthy of separate consideration, and to which I would like to draw the attention of the Board. The object of my inquiries during the past two years has been to ascertain the method of salt manufacture at present practised on our coast, and to effect, if possible, some improvement in it. For this purpose I have travelled from the north of Ganjam almost to Cape Comorin, and visited our solitary manufactory on the West Coast at Kundapur. Starting with such knowledge of the special subject of salt and its manufacture as could be obtained from the books at my disposal, I was not long in finding out that the method of manufacture in use was susceptible of great improvement. I had the honor last year, after inspecting the Northern Districts, from Ganjam to

Madras, of submitting a report, showing in what direction and to what extent their method of manufacture erred. I was not aware then, and it is well that it should be stated, that the salt divisions, upon the inspection of which my report was grounded, were, as regards the science and art of salt culture, the best in the Presidency. The southern divisions, which I have since examined, make salt without any pretence to science and their art is simplicity itself. Speaking generally, they evaporate salt water, as it is taken from pits or back-waters, without any preparation whatever, and scrape up the product. What is stated, therefore, in my report for 1872, with reference to the faults of manufacture in the north, applies with still greater force to the south, and the method of manufacture I then broadly sketched may be trusted, if it can be brought into use, to effect a larger measure of improvement in the south than I could at the time suppose. But I am now conscious that it is not enough to point out faults of system, and suggest their remedies. I am afraid that had I at hand a system of salt manufacture, the best that human ingenuity could devise, it would be practically valueless, unless the attempt to introduce it were preceded by other and general measures for the improvement of salt manufacture. It is to these measures that I would now draw attention.

2. Looking to the special circumstances of the case, the character of the natives and the conflicting interests that surround them, I doubt much that their method of salt manufacture will be improved, until, in the first place, their salt contract is altered in such way as to give power to Government to dictate in what manner salt is to be made. The ryots contract to supply a given amount of salt of a certain quality, and there the matter ends. Whether they make it by single or multiple irrigations, evaporated far beyond 32° Beaumé and with retained mother liquors, or otherwise, no one knows, and what is more to the purpose with the present supervising arrangements no one can know.

3. But it may be thought that, as the salt must be of a certain standard quality, it is needless to inquire how it is made. This is not the case. The standard is very seldom appealed to; and, moreover, who is to judge the quality; who is to tell whether the salt is pure or largely adulterated with magnesium? In my report on salt manufacture in South Canara certain rules are laid down for testing the quality of the salt, but at paragraph 86 I was careful to state that crystalline chemical impurities were difficult of detection. I thought so at the time from having failed to detect magnesic sulphate where I was morally certain of its presence, but I had not then examined salt made from bitterns registering 35°, 36° and 37° Beaumé, as I have of late frequently done in Tinnevelly, nor had I made the experiments referred to at paragraph 13, page 49 of this report. The result

is that I am now firmly convinced that magnesic sulphate may be, and is, at our salt pans where it is deposited during the active formation of large quantities of sodic chloride crystals, enclosed within the latter as an endomorph, impossible to detect without a good microscope or a chemical analysis.

4. Practically, then, there is only one way of making sure of the quality of the salt, and that is by seeing that it is made in a proper way; that the ullum is furnished with condensers as well as crystallizing beds; that there are waste beds at a proper level to carry off the impure mother liquors and refuse slime; and that the manufacturers adopt the process of salt culture corresponding to the design of ullum.

5. This requires an altered contract. It also requires supervision, not more nor of a better quality than exists at present, but more effectively placed. The number of separate proprietors, and consequently of independent salt manufacturers, is at present so great that it is quite out of the question for the single Assistant at many places to follow their daily operations. In Tanjore for instance the average number of manufactories in each division is 89; in some places it is much more, as at Thumbikottai 209, and the same may be said of other districts. There need be no limit to the area of ground under salt culture at any division, but there must be a limit to the number of distinct manufactories within the area, otherwise supervision becomes impossible.

6. I have already, more than once, had occasion to point out the effect which small holdings have in increasing the cost of manufacture and in deteriorating the quality of the salt; add to this the difficulty which the multiplication of separate properties throws in the way of efficient supervision, and the necessity for re-construction becomes manifest. I would make a minimum standard area known, to be capable of yielding good salt profitably as the basis of re-construction. It is called for in the interests of the ryots themselves, of the salt consumers, and of the revenue; for assuredly if sub-division proceeds unchecked as at present, it is merely a question of time when the point will be reached, at which it will entail loss to manufacture salt without further increase of the kudivaram.

7. It seems to me also a mistake to allow a number of wretchedly poor people to purchase, or obtain as a gift, small allotments of soil which they cultivate for salt and divide amongst their families until the diminished plots are unable to support them. Such men have been hitherto admitted to salt manufacture, no doubt, for want of better; but now there is some prospect of improvement. I would even say that there are foreigners waiting for the opening afforded by a sufficiently large contract to compete with native salt cultivators. In Tanjore and Tinnevelly the demand for salt is so great that they might embark

immediately on such an enterprise with every prospect of success, and yet without interfering in the least with existing arrangements. The advantage of having one or two wealthy and responsible manufacturers conducting business on a large scale and in an enlightened way, is so obvious that I need not dwell further on the advisability of throwing open large contracts to the general public by advertisement.

8. The interests involved in the salt trade furnish a clue to another measure of great importance in effecting an improvement in its manufacture. We require the salt for the people, and see that a sufficiency is made, but we do not distribute it to them. Native dealers, with one or two notable exceptions, come between the makers and consumers of salt, and are intimately associated with both as the link that binds them together. They sell by measure, and purchase by weight. It is their interest, therefore, to purchase light salt, that is, salt, a large quantity of which is required to weigh down the scales. This will be better understood by an illustration which I will take from the Tinnevelly District just reported on. Vypar is about 20 miles north of Tuticorin, in a straight line, and Coilpatam about 18 miles south, but Vypar has the better road; so that as regards trade facilities they are pretty nearly even. A garce of salt measured at Vypar 154 cubic feet, it would yield 2,304 Madras measures. A garce at Coilpatam measured 201·2 cubic feet, it would yield 3,010 Madras measures. Salt is sold by measure; I will say at one anna a measure. It is in reality more. A dealer, therefore, purchasing a garce of salt at Coilpatam would get 706 measures more than at Vypar; but 706 measures, at one anna a measure, is the equivalent of Rupees 44-2-0. It is evidently the dealer's interest, therefore, to purchase salt at Coilpatam. Turning to a return of the average demand and supply at these two places furnished to me by the Deputy Collector, I find that they are as follows:—

		Vypar. Indian Maunds.	Coilpatam. Indian Maunds.
Demand	...	50,000	280,000
Supply	...	45,000	246,815

Coilpatam attracts five times as much trade as Vypar.

9. So it is elsewhere. Dealers wander about from place to place until they have hit upon the division that makes the lightest salt, and then they give it all their custom. The place at once grows in importance; the contracts increase; and the ryots flourish. Nor are they ignorant of the cause. They know better than I could write it, to what they owe their prosperity, and make it their endeavour to retain and increase their trade by continuing to manufacture light salt. There is a direct inducement, therefore, to manufacture light salt. The strongest of all inducements, self-interest, and the manufacture of heavy salt is attended with the loss of trade. But light salt is itself intrinsically bad. It is

the product of such a system as that of Coilpatam in which the forcing action of magnesic salts plays an important part. It is, moreover, far the quickest to waste, and, as regards the poor consumer, it is almost unfair to allow the sale of such salt by measure. Compare, for example, Vypar salt, which is an average sample with that of Coilpatam. The purchaser of a measure of Vypar salt gets 68 ounces, whereas he who buys Coilpatam salt gets but 46 ounces to the measure, and unfortunately, as the trade is in the hands of the dealers, too often he has no choice in the matter.

10. There is but one immediate way of checking this evil that I can see and that is by inducing or compelling merchants to sell by weight.* They can regulate their price as they please. Competition will bring it before long to the level of moderate profit. Without this change it is evident from the foregoing that it will be very difficult to get the people to make good salt, as good salt is comparatively heavy—that made in nature's laboratory in our swamps, at Vedarnium, for instance, yields but 2,022 measures to the garce, but then each measure contains 78 ounces. Incidentally it may be noticed that such a change would enable the Salt Department to make use of all the swamp salt which is now guarded and destroyed, as the prejudice against it refers rather to its weight than to its composition, and is in great part fomented by the dealers.

11. Another measure, which, I think would tend directly to the improvement of salt, I cannot refrain from mentioning, though I would at the outset guard against any possible misconception of my views by stating that I have no personal concern in the matter. It is the appointment of an Inspector, whose duty it would be to visit all the salt stations from time to time; see that the wishes of the Board are carried out; and suggest improvements.

12. As a matter of fact, the greatest diversity exists at the present moment in every detail of manufacturing operations in the divisions scattered between Ganjam and Cape Comorin. When it is remembered that the higher salt officials for the most part graduate in the Revenue, Police, or some other department, it will not be wondered at that they are themselves† incapable of effecting much improvement, and that they adopt, on their promotion to Salt Deputy Collectorates, the *status quo ante*, under the guidance probably of the oldest Superintendent, a man on Rupees 50 a month and proportionate attainments. There is no one, as far as I know, with the requisite education and time

* The evil will be checked in the long run, no doubt, by an alteration in the method of manufacture, such as I propose, which will procure the outturn of a comparatively heavy salt: and the manufacture of heavy salt will also, in its turn, eventually lead to the ready sale of swamp salt, but all this requires both a long time and vigilant care, whereas the universal adoption of the weight standard for salt sales would effect the end required, without trouble, at once and permanently.

† With a few obvious exceptions.

at his disposal to stay at the salt pans and assist in their improvement. Stagnation is the art of salt culture results, and even the orders of the Board are misinterpreted, mislaid by changing officials, or otherwise unattended to. Add to this, that Salt Deputy Collectors, even in neighbouring districts, are often mutually ignorant of their several ways of conducting salt manufacture, and it will be seen that without some such agency as that proposed, it will be extremely hard to arrive at excellence, or even uniformity. I need not stop to prove the desirability of uniformity for, if an ullum or system is found to be good, it should be made good throughout the establishment. There are many things, too, of possible advantage to the revenue besides common salt, which an Inspector, technically educated, might, with his opportunities, bring to light. The want of such an official seems to have been felt in Bombay, where the appointment exists at present, and the salt manufactories of Bombay are not more valuable than those of Madras.*

13. From all that I have seen I would say that it would add much to the knowledge and efficiency of Deputy Collectors, if they were encouraged to visit each other once in a way to examine into the merits of their various systems of ullum and of manufacture, their irrigation appliances and methods of storing salt, &c. They would learn in a week everything of importance to know, and a great deal of good might result from such visits carefully conducted.

14. I had some difficulty in obtaining returns which threw light on the producing power of the salt stations, the most important thing to know about them; and I believe that no very accurate register is kept of the information I required. It would not be amiss, in future, to keep on record (1) the exact area of ground under salt culture, (2) the outturn at the end of the season, (3) the number of working days from first to last, (4) the rainfall in inches, and (5) the strength of the brine supply—for with these it is easy to calculate the outturn per 10,000 square feet in 30 days; also (6) the number of workmen employed throughout the pans, and (7) the rate of wages—for these added to the foregoing give the cost per garce, which can then be compared with the kudivaram. These seven returns will prove of great value in testing the condition of salt manufacture at the various stations, and their rate of progress and improvement, or, it may be, the reverse. They can be easily made out, and ought to be submitted annually for the future. An eighth return giving the mean weight of a struck measure of the season's salt, deduced from four or five experiments, could enable one to form a fair idea of the most important physical characteristics of the salt.

* An Inspector of salt works for the Madras Presidency did exist in the early days of the monopoly, before Collectors and their Assistants were allowed a percentage on salt sales. After the allowance was withdrawn, the Board took occasion to express their opinion that the re-appointment of an Inspector was desirable.

APPENDIX.

1. I must, before concluding the theoretical part of the subject, answer a question which has been proposed to me lately* with reference to the Beaumé's hydrometers which have been issued to the Salt Department. They were graduated in England, at the standard temperature at home, *i.e.*, 60° Fahrenheit, a fact noted on the stem, and the question is, whether they may be relied upon to give the same indications out here, as to the state of saturation or otherwise of the different salts contained in the brine, as they have been found to give in Europe, as described by me in my first report?

2. At the outset I may say that this question can be practically settled at the salt pans by any one, who, when using the hydrometer, will observe whether or not 25° Beaumé corresponds to the point of saturation or crystal formation of sodic chloride in the course of evaporation of pure sea water, and if not, what degree does. As regards the hydrometer, altered temperature should make no difference whatever. As 25° Beaumé corresponds to a certain density or specific gravity, it should indicate the same thing all over the world, with reference to the same, or similarly chemically composed solutions.

3. True, it is, that fluids expand with heat, and, therefore, give a different reading at different temperatures; but, if our sea water and that of the British Channel were alike, the only result would be that the hydrometer which would mark, say 3° Beaumé in sea water at home, at 60° Fahrenheit, would mark a trifle less out here, at 80° Fahrenheit; but again, from the moment our water, removed to the salt pans, had attained 3° Beaumé, the two solutions would, if evaporated together, yield like results in every respect.

4. If the two seas be in composition unlike, the points of saturation would be altered according to the alteration in the relative proportions of the contained salts. Thus a diminution of lime, with an increase of common salt, would cause the lime to fall before 17° Beaumé. A diminution of sodic chloride with a proportionate increase in magnesic chloride would cause the former to fall before 25° Beaumé, but this does not affect the hydrometer, which merely registers the densities at which we see these changes taking place.

5. Theoretically, the composition of the water in the English Channel and the Bay of Bengal ought to be much the same, as there is no line of demarcation distinguishing the Indian Ocean from the Atlantic, and both are in constant motion, passing to and fro. Moreover, as the sea is throughout in contact with more or less soluble rocks, whose solubility is in many instances increased

* Question proposed by Mr. Frere, South Arcot.

by heat, the density should not differ much, since increased solution of rocks in warm latitudes would counterbalance expansion.

6. In point of fact neither the density nor the composition differ much, and what is more important still, the common salt, and those more soluble than it, which influence its point of saturation preserve very closely the same ratios throughout, as will be seen by comparing the two following analyses, one of our sea off Madras by Dr. King, the other of the channel water off Brighton by Schweitzer.

	Madras Sea Water.	Brighton Sea Water.
Sodic Chloride	25·053	27·059
Magnesic Chloride	2·811	3·666
Magnesic Sulphate	1·323	2·295
Potassic Chloride	1·205	0·765
Calcic Sulphate	1·359	1·106
Water	966·748	964·809
	100·000	100·000

In the first case the three more soluble salts are to sodic chloride, as 44 to 100; in the second case as 41 to 100. The total solids are 33·25 per 1,000 and 35·19 per 1,000, and the contained salts are in each case the same, a little calcic carbonate and magnesic bromide having been omitted from both.

7. The hydrometers are, therefore, in every sense just as good out here as at home. Three of those in question, which I have seen in use, one each in the Tanjore, Madura, and Tinnevelly Districts, furnished the same indications that they had constructed to give in Europe or at least their error, if any, was so slight as to be inappreciable. It is well, moreover, to remember that Beaumé hydrometers, being intended for rough practical use, are not made with very great scientific delicacy, and fractions of a degree are not marked on the stem.

8. I constructed lately at the Chemical Laboratory, with care, a table of the specific gravities, corresponding to each degree of Beaumé on the hydrometers lately issued, which table will be found at the end of this report. I used for this purpose both the German instrument which has the specific gravities marked upon the stem, and seperately weighed each sample of brine, in the usual way, with a specific gravity bottle, in a delicate balance, and reduced the results to 60° Fahrenheit.

9. My results agree very closely with those found in Watts' Chemical Technology, and given in my first report; thus 17°, 25°, 32°, and 35° Beaumé, I found to correspond respectively with specific gravities 1·138, 1·208, 1·282, and 1·317. Watts says that they correspond to specific gravities 1·143, 1·210, 1·286, and 1·321, respectively—or in each case his degrees are about ·004 higher than mine. I mention that I found the specific gravities in two ways, which closely agreed, and that my results correspond with Watts', because there is another table* of the degrees of specific gravity, corresponding to the degrees of Beaumé, which differs very widely from both, giving specific gravities much lower again than mine.

* Fourth Edition 1873.

Table of Actual Specific Gravities, corresponding to the Degrees of Beaumé Hydrometers, issued to the Madras Salt Department in 1873.

Beaumé.	Specific Gravity.	Beaumé.	Specific Gravity.	Beaumé.	Specific Gravity.
0	1,000	14	1,110	28	1,238
1	1,010	15	1,118	29	1,249
2	1,019	16	1,128	30	1,260
3	1,029	17	1,138	31	1,271
4	1,038	18	1,148	32	1,282
5	1,049	19	1,157	33	1,293
6	1,058	20	1,167	34	1,305
7	1,065	21	1,175	35	1,317
8	1,063	22	1,182	36	1,328
9	1,070	23	1,190	37	1,340
10	1,078	24	1,199	38	1,352
11	1,088	25	1,208	39	1,361
12	1,093	26	1,217	40	1,376
13	1,102	27	1,227		

10. It may not be amiss on first receipt of a hydrometer, especially when dealing with pit sub-soil brine of unknown composition, to fix the point of saturation for sodic chloride, both to verify the accuracy of the hydrometer and to get an idea of the character of the brine, bearing in mind that excess of magnesic chloride will cause the salt to fall before 25° Beaumé, and its diminution the reverse. But, fortunately, practical salt manufacture does not exact very minute attention to scientific details.

11. In conclusion, I append a tabular statement of the chemical composition of the chief kinds of salt in use in India.*

Salts.	Sodic Chloride.	Magnesic Chloride.	Other Soluble Salts, chiefly Epsom Salts.	Insoluble Matter.	Water.	Analyst.
Peshawar	95·20	—	1·80	—	—	King, 1872.
Cutch	90·55	·30	2·11	3·00	3·98	Macrae, 1873.
Madras	88·87	1·93	3·04	1·00	5·21	Macrae, 1873.
Bombay	83·52	·82	3·23	4·32	8·11	Macrae, 1873.
Cheshire stored ..	99·25	·07	1·57	—	·11	Henry.
Marseilles	97·20	·40	1·70	—	·70	Berther.

12. This statement shows that the manufactured salts of Madras and Bombay are very inferior to the natural salts of Bengal and to the manufactured salts of Europe. Madras salt is shown in the first column to be very nearly 10 per cent. inferior to Cheshire and Peshawar salts in saline purity.

* Originally called for by the Honorable W. Robinson, C.S.I.

Earth salts have been condemned, and their use will be, in all probability, prohibited and discontinued. They are omitted from the table.

Bombay salt is about 5 per cent. inferior to Madras salt in the same way. But as regards the latter comparison, whereas water and insoluble matter, *i.e.*, sand, are the chief residues in the case of Bombay salt, water, Epsom salts and magnesic chloride, both the latter injurious to health, form the complement of a sample of Madras salt. There is not, therefore, much to choose between them.

The following Statement A. supplies information omitted when drawing up a table of results for the northern pans.

Statement A.

Divisions.	Produce per 10,000 Square Feet in 30 Days in Garces & Maunds.	Bulk of Garce in Cubic Feet.	Number of Measures = 115·5, i.e., in a Garce.	Ounce Weight of Salt in a Measure.
	Maunds.			
Ganjam	47·39	186	2,782	67
Itchapur	32·60	186	2,782	67
Nowpadah	62·22	202	2,927	64
Kupelli	67·24	212·2	3,175	49
Ijalapatam	45·41	173	2,587	54
Kurasa	64·01	184	2,752	67
Pallacottah	80·81	186·5	2,790	66
Penugudurn	30·81	201	3,007	52
Mangenapudi	56·02	176·5	2,640	69
Nizampatam	118·12	177·1	2,659	62
Chinna Ganjam	79·19	186·7	2,793	56
Kanupurti	61·55	173·8	2,604	65
Padarti	25·60	201·7	3,017	54
Painala	26·80	186	2,782	67
Tummalapenta	30·74	158	2,367	64
Kristnapatam	41·93	212·1	3,173	49
Dugarazupatam	32·10	183·5	2,739	63
Tada	32·20	189·5	2,839	54
Attipat	23·57	195	2,932	57
Pulicat	21·02	205·3	3,001	52
Royaloor	45·70	182·2	2,725	68
Ennore	27·21	189·9	2,847	55
Tullur	27·31	194	2,902	54
Vadasamingari *	27·05	..	..	..
Covelong	35·86	..	..	..
Cheyur	8·24	..	..	..

NOTE.—*Weights and Measures referred to in this report.*

WEIGHTS.

One maund equals 3½ mercals, or 82⅔ lbs. of Avoirdupois, or 37 kilos 392 grains, French.

One garce equals 9874⅔ lbs., or 120 maunds, or 4·4083 tons, or 157,958 ozs. of Avoirdupois 100 maunds = 3·674 tons. One ton = 27·219 maunds.

MEASURES.

The official garce measures 191·744 cubic feet. Official maund, 2731·1 cubic inches.

A Madras measure contains 115·6 cubic inches. The standard mercal measures 800 cubic inches, but the new salt mercal measures 828·33. The standard garce is 400 mercals, but the salt garce is 424 mercals.†

The following Statement B. exhibits at a glance the chief facts of interest concerning the Southern Salt Manufactories.

* Received incomplete returns for Vadasamingari, Covelong, and Cheyur.

† The use of mercals has been abolished, except in dealings with the French Government, who receive their salt by weight, getting 424 mercals to the garce.

Statement B.

Divisions.	Area of Ullum.	Condensing Area.	Crystallizing Area.	Brine Density in Degrees Beaumé.	Produce per 10,000 Square Feet in 30 Days.	Cost of Manufacture in	Kudivaram in	Bulk of Garce in	Number of Measures per Garce Meas. = 115·5 Cubic Inches.	Weight per Measure in Ounces Avoirdupois.	Quality of Salt.
	Sq. ft.	Sq. ft.	Sq. ft.			RS. A. P.	RS. A. P.	Cubic ft.			
Merkanum	81,241	38,795	17,280	3°	15·63	3 4 0	13 8 0	177	2,648	69	Good.
Gundalum	15,572	8,203	4,536	2·5°	63·34	6 11 0	10 0 0	216·9	3,245	48	Bad.
Killa	13,059	5,022	2,845	3°	33·23	7 12 4	10 0 0	208·5	3,119	50	Poor.
Needavasal	27,676	9,144	17,424	9°	31·05	8 6 6	11 14 0	148·5	2,221	71	Do.
Tranquebar	57,600	12,903	28,224	8°	46·66	7 3 0	11 14 0	142	2,124	74	Good.
Negapatam	22,760	6,480	16,120	9°	50·10	11 3 0	15 0 0	180·3	2,882	57	Fair.
Vedaranniem	8,975	216	7,560	18°	46·89	15 14 0	17 8 0	145·6	2,178	72	Very good.
Thumbikottai	13,896	6,166	7,560	5°	58·50	8 11 0	10 10 0	180·8	2,704	58	Do.
Adramapatam	16,471	6,524	5,640	6°	61·8	7 3 2	10 10 0	175·4	2,629	59	Do.
Kattumavady	18,282	7,644	10,368	3°	27·3	5 7 0	10 10 0	157·6	2,356	67	Poor.
Arasanegarry	25,069	8,133	13,594	3°	20·8	7 14 0	10 10 0	150·8	2,704	58	Fair.
Vettanam	16,016	..	16,016	3°	96·7	7 14 0	11 4 0	164·8	2,465	64	Poor.
Veeravanadapatam	16,016	..	16,016	9°	68	7 14 0	11 4 0	169·2	2,531	62	Fair.
Autengarai	16,016	..	16,016	10°	125	6 12 0	11 4 0	188·4	2,818	56	Poor.
Merekolam	16,016	..	16,016	6°	73	7 2 0	11 4 0	151	2,894	68	Good.
Muttuvagunadapatam	16,016	..	16,016	9°	123	7 5 0	11 4 0	157·8	2,356	67	Fair.
Vypaur	14,876	1,290	11,704	7°	126	7 2 0	10 10 0	154	2,304	68	Do.
Arasady	56,573	1,981	27,886	6°	17·7	6 12 10	10 10 0	175	2,618	60	Poor.
Tuticorin	24,756	3,585	16,004	12°	15·5	7 12 0	10 10 0	161·1	2,411	66	Good.
Coilpatam	27,706	5,331	13,207	8°	13·9	6 13 0	10 10 0	228	3,411	46	Bad.
Kulasekali	17,712	4,363	12,315	3°	84	8 0 0	10 10 0	201·2	3,010	[illegible]	Poor.
Vimapathi	20,681	4,406	14,358	3°	8·2	7 11 4	10 10 0	201·2	3,010	[illegible]	Do.

MADRAS, 13th January 1878.