Ceylon

Literary Register.

Supplement to Daily "Observer." } VOL. V.—TUESDAY, SEPTEMBER 23, 1890.—No. 8. { Price 12½ cents R4 per annum.

THE FANFARE.

By Geo. Manville Fenn,

Author of "Black Blood." "Hard to Win," "The Master of the Ceremonies," &c.

I.

"What was that policeman there for?"

"Policeman, sir? Policeman, sir?" said Polly Repton, demurely.

"There!" cried John Berry, Esquire, of Carlyle Lodge, Denmark Hill, Camberwell. "There! now you have as good as confessed to it, you artful jade?"

"Well, I'm sure, sir!"

"Yes, and so am I. Now, look here, my girl," cried John Berry, the portly and baldheaded. "Once for all, I'll have no courting here. You can have your Sundays out, and your holidays, and policemen, and soldiers, and butcher-boys, and bakers—as many as you like; but I'll have no courting here."

Bang!

"Humph! Like her impudence, slamming the door like that," said the head of the house, as he strolled across the verdant carpet in which his feet seemed to be rustling through ferns, to the broad French window, to look through the verandah over his lawn toward London Town.

"Bah! Air's full of soot. Nothing grows well now."

He was walking back towards his easy chair when two exceedingly pretty girls entered the room in a knot—that is to say, with their arms round each other's waists, and their heads so close together that their hair—yellow and dark brown—was all mixed.

"Well?"

"Well, papa!"

"Well, uncle!"

"Well, uncle, indeed! No, madam, it isn't well."

"Why, uncle dear, what have I done?" said the dark-haired girl demurely.

"What haven't you done, miss? Regularly led Ida astray."

"Oh, papa, I'm sure she hasn't."

"Then you've led Dinah astray, ma'am," cried her father fiercely. "There, you needn't reply. I know you girls think of nothing but balls and parties, and flirting and dancing, and I will not have it."

"Papa!"

"Hold your tongue, miss; and as for you, Dinah, if I had known what a female, fleshy loadstone you were, I wouldn't have taken charge of you."

"Oh, uncle dear!" cried the dark girl, throwing her arms about his neck; "you don't mean it."

"Yes, I do. And don't kiss me; and—Yah! you've made my cheek wet. Thank goodness your father will soon be back."

"I—I—think you're very cruel, uncle."

"Do you, ma'am; and I suppose Ida thinks the same?"

"Yes, papa," said Ida, looking remarkably like a damaged wax doll, with her flushed face and red tearful eyes.

"Then I don't care what you think. Look here; do you see these?"

He dabbed a couple of letters down on the table, and the girls started.

"Two letters," he continued. "Oh, no, not directed to you. I should think not, indeed. I'd shoot 'em if they dared write to you. They're addressed to me, both of 'em, from a couple of conceited coxcombs."

"I'm sure Mr. Pallas is not conceited," cried Ida with spirit.

"And Mr. Denny is as modest and respectful"——

"As a puppy, ma'am," cried the old man, turning fiercely upon Dinah. "Think I don't know 'em? Nice pair! Been flirting and carrying on these five years with no end of young ladies, and now they've cast their eyes on you, and in the most condescending way request the honour of an interview this morning at——and here they are.'

There was a sharp ring which sent the girls into each other's arms and the old man to the window, where he could command a view of the gate.

"No; only one of 'em. The other won't be long."

"Oh, papa, pray don't say anything to Mr. Pallas."

"Oh, uncle, don't, don't, if you care at all for your poor little niece, don't say rude things to Mr. Denny."

"Be off to your rooms, both of you. Confound it all, am I plain John Berry, or?——Be off?"

He stamped his foot and the girls fled, leaving him chuckling.

"Scared 'em a bit," he said, smiling, and then he screwed up his face into a fierce frown as Polly entered with a card on a tray and an ill-used look on her face.

"Humph! Where is he?" said John Berry, taking the card.

"Library, sir."

"Show him in here."

He threw himself back in his easy chair, as Polly with her lips very tight and teeth set, whisked herself out of the room to return in a few moments ushering in a good-looking, gentlemanly young fellow, faultlessly dressed, and evidently rather ill at ease.

"Good morning, Mr. Berry."

"Eh? Yes. Sit down."

"I took the liberty of sending you a note, sir."

"You did, Mr. Philip Pallas—a confounded liberty, sir. No!"

"Mr. Berry!"

"I said no, sir. My daughter is not for sale, sir. Very condescending of you, sir, and I'm highly honoured; but have the goodness to understand me plainly as I answer the contents of your application; no, sir. You understand me? No, sir; and I wish you good morning."

The visitor looked at him aghast, and rose to go, but he could not leave the castle which contained his love without one more appeal; and after looking into his new hat and carefully reading the maker's name, he began:—

"Really, Mr. Berry, I don't think you are giving a man a chance."

"Well, sir, I don't want to; and once more, good morning." Some one coming. An engagement."

There was nothing left for Phil Pallas to do but to go, and he went out through the open outer door meeting another well-dressed young fellow of his own height coming up the path with Polly.

The two gentlemen looked at each other very sternly, saluted distantly, and one went out while the other went into the library, where he found it very hot, but the drawing-room far hotter, for after sending in his card he had to pass through a precisely similar ordeal to that of his predecessor, and then left the house.

"Poor young man!"

Polly was standing at the gate looking down Denmark Hill after the second visitor, and so intent upon the object of her thoughts that she did not hear a martial tread till a voice said sternly —

"Now, I've just ketched yer this time."

Polly swung round with her eyes flashing angrily as she sent two fierce currents from them at the speaker, P. C. Burnett 249 H. B. Then the gate was banged sharply and locked, and P. C. Burnett walked on.

"She may say what she likes," he muttered, "but that settles it. It is after her they comes."

"Such impudence! How dare he!" muttered Polly as she hurried in.

"That's the best way to bring them to their senses," said John Berry, in a self-congratulary way as he settled down to his paper, while, upstairs, Ida flew into the arms of Dinah, who did ditto, the concussion being non-injurious because they were delicate and soft.

"Oh, Dinah, we are two unhappy girls."

"Oh, Ida, we are two unhappy girls."

II.

Time glided on.

An incurable habit he has.

Papa and Uncle Joseph Berry were still absent from home, and Dinah remained at papa and Uncle John Berry's, at Denmark Hill, where she and Cousin Ida mingled their tears as they sat in the boudoir on one side of the big drawing-room, or in the little "libery," as Polly called it, on the other side of the drawing-room. Here or there they talked of the good qualities and manly looks of their lovers, vowed constant fidelity, and wrote long letters which were secretly dispatched by peculiar post, and answers thereto regularly received.

Polly was that peculiar post, and P. C. Burnett more than once wilily followed on the track, and saw those letters pass, what time he gnashed his teeth and swore terrible oaths of how he would some day "do" for the two "swells" who were leading his Polly Repton astray.

"I do love Cousin Dinah very, very dearly," said Ida Berry to herself, "but it would be dishonourable to dear Philip to make her the full confidante of how we correspond."

Ida is the dearest and best of girls, and I'd give anything to lay my aching head upon her shoulder and confess how Mark and I write regularly; but he said I was to be secret and true, and I will, till death."

Polly, too, had her troubles about the policeman whom she loved very dearly, for he was, as she said, "such a picture of a man."

"But if he is of a jealous disposition now's the time to cure him, and not wait till we're married. A nasty, suspicious wretch! Oh, I'll lead him such a life until he begs my pardon."

"I may trust you, mayn't I, Polly?" said Ida.

"Of course you may, miss."

Dinah seized her opportunity one day, and she too said:—

"I may trust you, mayn't I, Polly?"

"Why, of course, miss."

"Tell on 'em?" said Polly to herself, "'taint likely. Half crowns mount up, and are a deal better than penny stamps for sending love-letters. How I should like to read 'em. I wonder what sort of a letter my Tom could write?"

And there came a day when at breakfast John Berry said:—

"No letter from your father, Dinah. Now, what does that mean?"

Dinah said she did not know. And she cared very little, for her mind was fixed upon another letter she had received the previous night, and this letter had results.

Polly had a pantry, which lay just at the back of the dining-room; a snug room, sacred to herself, and where she cleaned plate, and behaved with bottles of wine quite like a butler out of livery.

That same morning, when accoutred in a green baize apron and ruddy gauntlets of leather, Polly was polishing spoons and thinking about the police, the door opened softly, a slight figure glided in, and a hand was laid upon her arm.

Bang went the spoon.

"Lor a mussy, Miss Ida! How you frightened me."

"Hush, Polly, pray. Polly, I was down the garden an hour ago, and *he* passed a letter to me over the wall."

Polly's eyes flashed. Half a crown out of her pocket!

"Well, really, miss, it ain't no business of mine. If young ladies and young gentlemen can get their letters, why of course it's nothing to me."

"Oh, Polly, don't you dessert me when I most want your help. Pray, pray, don't you be unkind."

"Want, my help, miss? What for?

"Mr. Pallas says he can bear this suspense no longer—that he must have an interview."

"Then you must tell him he can't, miss," said Polly, behaving very badly to the spoon.

"But—but—he says, Polly, that—that—as papa goes to bed so very early you might let him in by the drawing-room window, and let him speak to me a minute."

"He'd want more than a minute, my dear."

"Would he, Polly,"

"Course he would, miss; and it wouldn't be proper."

"But it would only be 10 o'clock."

"Just as bad if it was only 9."

"But it would n't be wrong if you were there, Polly."

"Wouldn't be so bad, miss; but it's impossible."

"Don't say that, Polly, or you'll break my heart and his. And, Polly, you would n't be offended if I ask you to accept my grey silk, would you?"

"Well, not exactly offended, miss; but"——

"Then pray take it, Polly. I'll leave it on a chair, and it would want very little altering."

"Thank ye, miss."

"And don't you think he might come for a few minutes, Polly?"

"Well, miss, you have such a way with you; but it must only be for a very few minutes, mind."

"No; and he said if you left the gate unlocked

he'd slip in and be at the drawing-room verandah at 10.

"All right, miss."

"Oh, you dear, good Polly!"

Ida kissed her and ran off, while Polly rubbed spoons, and excused herself on the ground that master was "such an old bear."

(To be concluded.)

MR. H. BYRNE ON IRRIGATION IN JAFFNA AND OTHER MATTERS.

In republishing Mr. Byrne's paper, we may say that we submitted it to a professional gentleman able to speak with authority on the chief points discussed. From him we have received a valuable paper of observations, which we publish, and we venture to preface that paper with a few extracts from a private letter which has reached us.

Replying to a remark of ours, our correspondent writes:—

"With regard to the low price of Indian rice in competition with Ceylon-grown rice, I was struck by the fact two years ago, when I took charge of some relief works, that in endeavouring to purchase the cheapest rice of a sufficiently good quality—(so as to give the people as much as possible for their money),—no Indian rice could compete with that from the Henaratgoda and Veyangoda districts. But local rice from the Wanni Hat Pattu, when there is any for export to other districts, is still cheaper, and some of the best rice that I have ever eaten came from that part of the North-Western Province.

"With respect to the Karachchi rice, you will find some notes in Mr. Henry Parker's Report on the works that were proposed to be undertaken for irrigating the tract referred to by Mr. Byrne. If you read over part of the Report of the Irrigation Commission 1866 you will see that there were other reasons for not adopting Mr. Byrne's scheme.

"He had no idea of the quantity of water that was needed for irrigation. In fact, it was well for the Colony that the scheme was not adopted, for it would most probably have resulted in failure.

"With regard to the high price of labour, everything depends upon the return to be obtained from the irrigated lands. Where a crop and a third are obtained per annum, and the yield is 25 bushels per acre, and a water-rate of R1 is charged per acre, the return is about R3·50 per acre, per annum. If 5 per cent be aimed at, the expenditure should of course not exceed R70 per acre irrigated, in this case. Any expenditure, therefore, up to R50 or R60 per irrigated acre is pretty safe to eventually yield a fair return in cash, without considering the other matters which a Government *must* take into consideration, such as the improvement in sanitary conditions, and in general well-being, and therefore the diminution of crime.

"With respect to *new* works, then, it is only necessary to show that the cost will not exceed R50 or 60 per acre, in order to prove that unless there are special reasons to the contrary they are likely to be 'commercially profitable.' As an example, I take the work on which Mr. Parker is at present engaged, the Deduruoya channel, as it is an entirely new work, and the largest new one that has yet been undertaken, and therefore suitable, in every respect, for the comparison.

"The expenditure on the part which has been adopted or sanctioned by the Government and Legislative Council will be some R475,000. This will provide water for about 10,000 acres of fields, nominally; but really it is much more likely to irrigate 12,000 acres. There are some very heavy works on it and altogether it will cost more, per acre irrigated, than other large schemes of a similar character would. For instance, a range of hills, rising up to 2,000 feet in height, separates the main tract of fields from the main channel, and a large subsidiary channel 9 miles long, is required to reach these lands. Again, there are several high ridges to be crossed by the channel, necessitating cuttings from 20 to 30 feet deep, one of them, the deepest, being over a mile long. Progress is being made with 2 that are 28 and 29 feet deep respectively. Of course, all these add greatly to the cost of the scheme, and they would probably not occur elsewhere."

We may add that we shall follow with great interest the progress of this really grand irrigation work in the North-Western Province,—not a restoration of an ancient work, but a new one founded on modern science and on the principles established by experience, ancient and recent. When completed this work will be one of the sights best worth seeing in Ceylon. A full description of the bold but well-considered scheme is contained in a Sessional Paper printed last year.

The observations on Mr. Byrne's paper furnished at our desire are as follows:—

"The statement regarding the percolation of fresh water from the sea into the wells of the Jaffna Peninsula is interesting; but its accuracy is still open to question, although the subject was treated somewhat fully by Sir Emerson Tennent, who expressed an opinion in favour of such percolation. The mere presence of a large supply of fresh water below the level of the sea is however far from being a proof that it is sea-water; there appear to be no records of experiments or observations that demonstrate anything more than this in wells which yield only fresh water. [See the extracts from the proceedings of the Ceylon Branch of the Royal Asiatic Society which we quote at the end of this paper.—Ed. *L. R.*]

"The tank districts include the area up to fully 450 feet above the sea, and not merely 100 feet, as stated by Mr. Byrne; and in these districts the flow of water in the rivers occurs chiefly in November and December, and in May, rather than in January and June. The author says that in 'a few instances only' were the rivers used as feeders of tanks; but it is now ascertained that nearly all were utilized in one way or another in former times. It is quite exceptional to find a river,—excluding only the largest ones,—across which there is not at least one masonry dam or earthen embankment. The tanks which form 'lakes of from 20 to 50 square miles in extent' are unknown, some 16 square miles being the area of the largest one; and the 'bunds of 10 or 15 miles in length' have shrunk to less than two-thirds of those dimensions. In stating that all were formed at the lower end of a drainage-basin, the author appears to have overlooked the reservoirs of the Mannar district. Flood overfalls are met with in all parts of the bunds, and not merely at the ends. In fact, the general design varies in all cases according to the site.

"The author attributes, without hesitation, the breaching of all the great tanks to 'inadequate provision in the length of the overflow.' Though there can be no difference of opinion as to the small size of the flood-escapes, it is not certain that the actual bursting of the majority of the great tanks was altogether due to the insufficiency. In most cases, the breach was formed at the spot where the embankment crossed the line of the stream that supplied the tank with water; and

this would rather lead to the conclusion that in such instances the bund gave way owing to leakage under it in this weak place, at the time when the flood rose to an excessive height over the waste weir, or spill-water. In some cases, doubtless, the bunds stood until the water rose over their crests; in tanks where there are two or three large breaches there can be little doubt that the destruction was caused in this manner.

"One may also hesitate to agree with the opinion that the insufficient size of the flood-escapes is 'not a matter for surprise.' Considering the number of centuries during which the Sinhalese engineers were gaining experience of great floods and their disastrous effects, one would expect that these overfalls, though at first too small, would gradually be enlarged so as to be generally adequate for the escape of the maximum floods. As this was not the case, it may perhaps be presumed that the great floods which breached the tanks occurred at such long intervals that tradition of the previous one was lost, and it was thought that such an exceptional one could not recur.

"The historical works, and tradition, show that in at least many cases the larger village tanks, and even some of the smaller ones, were constructed by order of the Kings of Ceylon, and not by the unassisted labour of the villagers. The assertion, submitted without a word of proof, that the population was divided into village communities 'on the failure and abandonment of the larger tanks' is one that will not bear examination, as any student of Sinhalese history knows.

"In coming to particulars, the author is unfortunate in his choice of the Giant's Tank. He repeats the old fiction regarding the supposed mistake of the designer of the 'Tekkam,' in the Mannar district, and the two storage reservoirs into which it was built to divert the water of the Aruvi-aru. It has since been proved that the levels of the designer were correct, and that the only error as to the relative heights was made by the engineer who surveyed the scheme during the first decade of this century. The remark by an engineer of the author's experience that the dam 'is still in as good order as when it left the masons' hands' is surprising, in view of the fact that part of two courses has been removed by floods, which also apparently completely washed away one end of the work—this breach being afterwards repaired. It is now known that of the two great reservoirs which were to be filled by means of the water to be diverted by this dam, one might easily have been constructed to hold water 20 feet deep, and the other some 15 feet deep; therefore it is incorrect to say that 'evaporation would not have left in them a month's supply of water for the area designed to be irrigated'—which was probably not much more than twice the area of the reservoirs.

"Now that paddy is carted from Anuradhapura to Pallai and Chavakachcheri—(say, 100 miles),—and the surplus crop of the Batticaloa district is taken to Jaffna by sea, it is interesting to know that in 1858 it was supposed that rice grown in the Karachchi delta, only 10 miles from Pallai, could not compete with that grain imported from India.

"In the concluding paragraph, the author remarks that in Ceylon it is known that 'the high price of labour must always render new works too costly to be commercially profitable.' If, however, the expression 'commercially profitable' refers to the yielding a return equal to the rate of interest payable on loans, together with a small amount for forming a sinking-fund, it may be applied with accuracy to many entirely new works. This is especially the case with those which depend upon the water-supply obtained from perennial, or even good seasonal streams; while it is probable that even new storage reservoirs in suitable positions will, although their first cost is necessarily high, eventually also yield a 'commercially profitable' revenue.

"The question as to whether the 'happier result' will follow from the small works or the great ones may safely be left to be answered by time in favour of the latter. The Sinhalese Kings tried the small ones, and ended by making the large works. No one who has seen the general misery and privation that accompany two or three consecutive years of low rainfall can really believe that the ancient rulers constructed the great reservoirs and anicuts merely, or even chiefly, for their own self-glorification."

[So far our correspondent. We may add that Mr. Henry Parker, after thorough examination of many of the great native irrigation works, thus concluded his notice of the greatest reservoir in Ceylon and for depth of water, when unbreached, the greatest in existence,—Padawiya in the Northern Province.]

"Unless some other extremely good reasons were shown against the ancient scheme, I should be disposed to adhere strictly to the outlines of the original design, which we may be quite certain was not adopted without grave consideration. Whether some of the land nearer the sea was brought under cultivation before the reservoir was made, as I think is likely to have been the case; or whether the land nearer the sea is more fertile than that near the reservoir; or whether it was more accessible than that in the interior; or the site was a healthier one; or whatever was the cause, some satisfactory reasons were doubtless forthcoming, or the laborious work required at the anicut would not have been undertaken. If we rashly think, after a mere glance at the site (in comparison, on the other hand, with the actual practical experience of the Sinhalese for nearly 1,000 years), that we can 'change all that,' and effect untold improvements on the general designs of the ancient works, we may find, when too late, that they were right and we are wrong. Experience constantly impresses on me that if there was one subject which these wonderful old engineers understood better than another, it certainly was the irrigation of paddy-fields, and the designing, at least in outline, of the great structures which were needed for that purpose.

"When one reflects that Padawiya is, so far as identification has gone, one of the earliest among similar works of the first rank in Ceylon, the boldness of the design of this,—the greatest of these reservoirs—(and, as regards capacity, of all existing reservoirs),—and the success with which it was carried into execution, cannot but fill one with astonishment.

"Although it may be found unadvisable to undertake the restoration of Padawiya at present, or even in the immediate future, a work that has existed for 1,600 years can afford to wait, if need be, for one or two centuries more. For the time will certainly come when it will be restored to all its former usefulness, and when the lands to which it once supplied water will again be peopled by thousands of busy cultivators."

In the transactions of the local Asiatic Society is a paper, by Mr. Folkard, we believe, recording observations on the rising and falling of water in the Puttur well, some passages of which we quote:—

It having been deemed desirable to investigate certain phenomena in connection with this well, the following experiments were made. This paper will contain no attempts to explain these phenomena, or to suggest any theory as a basis for discussion. Simply narrating facts, I leave it for others to determine the cause of the following effects.

As a guide however, I will venture to give an outline description of the Peninsula of Jaffna in which this well is situated, and of the appearance of the well itself with some general remarks on peculiarities noticeable in most of the wells of the Jaffna Peninsula.

The Jaffna Peninsula would appear to have been a comparatively recent formation and principally formed by gradual coral deposits. There would however seem to have been at some period or other, a volcanic agency which has upheaved strata of an earlier period, as the surface of large tracts consists of magnesian limestone, in which (whether worn or otherwise I cannot say) exist numerous fissures affording easy passage for an abundant supply of fresh water, within a very few feet of the surface.

This Peninsula is so free from elevations of any kind that the highest point found in its cross section was only 35 feet above low water level. Elevated ground is found at both sides near the sea, from which points the ground declines again leaving a table land almost entirely level 13 or 14 miles in extent, at an elevation above low water level of only 4 feet. This peculiarity during spring tides (of the North-east monsoon particularly) allows the sea to flow up numerous inlets, which seam the Peninsula in every direction and which rise during freshes to a height of 3 or 4 feet, and afford abundant opportunity for the manufacture of salt. It is worthy too of consideration in connection with the subject of the well, that, on subsiding, large deposits of naturally formed salt are left, which remain on the beds of the inlets throughout the year. Before leaving this subject, I might mention that the greatest width from north to south of the Peninsula is 20 miles, and its greatest length from east to west 30 miles.

The wells of Jaffna are subject to certain peculiarities. Their general level appears to be affected by the state of the tides, not however to such an extent as to cause a diurnal action. It is however a well known fact that during the north-east monsoon the rain wells of the district rise to their greatest height, and that height diminishes as the force of the monsoon decreases. The large mass of water in the Bay of Bengal affected by this monsoon causes the level of the Jaffna lake to be affected to the extent of 18 inches increase of tides at the same time that the above mentioned rise in the wells occurs. Another fact is, that cultivators in digging irrigation wells are obliged to observe the greatest possible caution, as after passing a certain depth the water becomes brackish, and this peculiarity exists throughout the Peninsula. Again it is equally curious to observe how closely fresh and salt water flow together without amalgamating. Whilst building a causeway at Vannatipalam across the salt inlet, in this Poottoor district, the foundations were laid in salt water, but close to this and in the centre of the inlet fresh water could be obtained in several places and in large quantities, although during freshes those spots are covered with 3 or 4 feet of salt water. These facts may prove of interest and of some use in considering any theory which may be based upon the results of the experiments, hereafter to be narrated.

The Pootoor well itself is a large rectangular pit in the limestone rock, and its dimensions are about 40 feet in length by 25 in width. A slope down to the water level has been made, as is common to all the artificial tanks of Ceylon and India. Tradition connects it with some springs on the Coast near Tondamanaar, but it is only tradition as it would be simply impossible to trace the course or source of any springs in so level a country. The only *previous experiments* made were in 1824, when engines of considerable power were employed, to raise water from the well, with a view of irrigating the district. The only result obtained however was the establishment of the fact that it was impossible to affect the level of the well or to check the curious rise and fall of its water. This latter phenomenon has earned for it the title of the "Tidal Well of Poottoor."

I think I have now mentioned all the facts I am aware of, which might assist any one in forming an opinion as to the cause of the peculiarities of this well. These peculiarities are three in number:

First in importance is the tide above mentioned.

Secondly, the presence of salt water from a depth of between 45 and 50 feet to the bottom of the well &c.

Thirdly, its apparent inexhaustibility. The experiments just completed were undertaken with reference to the two first conditions only, the experiments of 1824 being considered conclusive as to the third.

The fact so established is, that the level of the fresh water in the well coincides almost exactly with the low water level of the sea on both coasts.

The next experiment was conducted with a view of ascertaining at what depths the fresh water ceased and salt water commenced and to procure specimens of the water at various depths to be sent to England for analysis. An instrument with a closely fitting valve was made for this purpose, so arranged that the valve could be opened and closed again at any given depth.

The first symptom of brackishness was found between 40 and 50ft. down, and it appears certain that it is at this point that the salt water enters. Specimens of the water at the surface, 45ft., 95ft., 145ft. (the bottom) were procured and put into sealed bottles. The water from the bottom when first brought up, smelt strongly of sulphureted hydrogen.

The surface of the fresh water is 14 feet below the ground line, and the total depth of the well varies between 140 and 145 feet.

Dr. Ferguson of the Army Medical Staff kindly assisted me in making these experiments.

It being desirable to ascertain how far the tide in the well coincided with that of the sea on both coasts, Dr. Ferguson and myself at the well and two assistants at Jaffna and Valvettytorre respectively took notes at every half hour from 6 A.M., till 6 P.M. * *

By the foregoing table it will be observed that the well alternated 3 times during the day, whilst the sea was not affected to a similar extent.—The well also rose whilst the sea fell, and this part alone destroys all hypotheses that I have as yet heard discussed.

The subject therefore remains in an unexplained state and offers a field for scientific enquiry and discussion.

Then as to Sir Emerson Tennent's theory that sea-water was deprived of its salt by percolation through coral, we quote, from the same transactions, portions of the discussion between the author of the great work on Ceylon and Dr. Buist. Dr. Buist wrote:—

Sir Emerson Tennent notices the fact of all the wells along shore which keep their water during the dry season, being below high-water mark, and that to a small extent they rise and fall with the tides; and he assumes that they owe their water to the sea, which loses its saline matter by percolation. Nothing, surely, is more utterly opposed to the first principles of Physics than the doctrine, that salt held in chemical solution by water should be capable of being separated from it by the mechanical process of filtration. The phenomenon of tides in wells of moderate depth dug near the sea, is of universal occurrence all along the Malabar Coast, where the matter dug through is porous. It does not obtain in wells dug through trap. I have observed it hundreds of times at Bombay, and have often had occasion to describe it. The explanation is easy. The surface of the ground where the well is dug being always six or eight feet above high and twenty to twenty-six feet above low water, and being extremely spongy and porous down to where it comes in contact with the rock, or the blue-clay bed which commonly lies over the rock, it gets charged full of water during the rains. The superior length of column enables this

to expel the sea water, a proceeding which must have been completed shortly after the emergence of the land from the sea; while the interstices in the porous soil are so minute as to prevent the two mingling, As the saltest sea water has only a specific gravity of 1·050, the fresh water ponded back from it requires only to be proportionally higher in level to create an equilibrium. With a greater head than this, it will push the wall of salt water before it, and flow off. Of all this I have seen abundant examples at Bombay. It would occupy too much of your space to describe them. After six or eight months of rainless weather, when the discharge from the soil becomes feeble, the wells all become more or less brackish, and the apparent tide increases.

The *Edinburgh Review* states, that this theory of Sir E. Tennent's, of the desalinization of sea water by filtration (as already said, a phenomenon opposed to one of the first laws of Chemistry) explains the occurrence of fresh water on coral islands, and confutes the theory of Darwin, that this arises from rain, as rain falling on a substance already fully saturated with sea-water would not be absorbed, but would flow off. Not a doubt of it. But coral islands are not only not saturated, but so much of them as is above the sea level, three or four feet, is highly porous and perfectly dry, and presents all the conditions for absorbing the whole of the rain that falls on them. They present to the rain this much head of water to push out the sea and expel it pistonwise so far as the coral bed descends,—the sea itself forming the well of the reservoir. A well dug deep into the coral to draw off the rain-water, with which it is always nearly saturated up to low-water mark, is sure to secure a supply. An illustration of the two not mixing together, if the pores of the soil, rock or coral, be fine enough, may be obtained by making the experiment with capillary tubes.

Sir Emerson Tennent replied :—

Dr. Buist's explanation corresponds with that of Darwin; but Darwin, as it will be seen, glances at, although he rejects the theory of filtration from the sea; whilst Dr. Buist urges, that "Nothing is more utterly opposed to the first principles of physics than the doctrine that salt held in solution by water should be capable of being separated from it by the mere mechanical process of filtration." Dr. Buist, however, is not aware that since Darwin wrote, the late Mr. Witt, in a remarkable paper published in the *Philosophical Magazine* for 1856, "On a Peculiar Power possessed by Porous Media of removing Matters from Solution in Water" has made known the results of experiments carried on by him on behalf of one of the London water-supply companies, and has shewn that "water containing considerable quantities of saline matter in solution, may, by percolating through great masses of porous strata during long periods, be gradually deprived of its salts, to such an extent as probably to render even salt water fresh." The difficulty which I felt in applying Darwin's ingenious theory to the small coral islands in which fresh water abounds, as well as to wells sunk in the coral formation at the north of Ceylon, arose from the fact, that in the latter, rain falls with such proverbial infrequency as to be inadequate to furnish the supply of fresh water invariably present; whilst in the numerous little coral islands to the west, the area of each is so minute that their surface, even in the most rainy seasons, could not intercept enough to replenish the wells. Mr. Witt's discovery came opportunely to aid, and facts are recorded in other portions of my book (vol. 1, p. 20; vol. 2, p. 536) besides those which alone Dr. Buist appears to have seen, that in my mind established the fact that these wells are supplied, not by the banking in of rain by the surrounding salt water, but by the slow percolation of water from the sea through the masses of porous coral.

So far the very interesting controversy.

The question is, are there facts to support the theory that the natural process of fresh water flowing into the sea is ever reversed by sea water percolating landwards.

We now give the paper which has led to these prefatory remarks and extracts:—

IRRIGATION IN CEYLON.

BY

HENRY BYRNE, M. Inst. C. E.

(Excerpt Minutes of Proceedings of the Institution of Civil Engineers. Vol. LVII. Session 1878—79.)

The circumstances of Ceylon, as regards the benefits of irrigation and the methods of practising it, are so similar to those of India, that in view of how thoroughly the subject has been treated in the Papers relating to Indian irrigation in the Proceedings, some apology is needed for any remarks in reference to the smaller of the two countries.

Three different methods of obtaining water for irrigation are practised in the Island: 1st. Raising is by manual labour from wells and ponds; 2nd. Collecting it in tanks fed by the drainage of the neighbourhood; and 3rd. Tapping the mountain streams and torrents.

The first of these is adopted in the small densely-peopled district at the extreme north of the island, known as the Jaffna Peninsula, and in a few other places where the country is so uniformly flat as to present no site for tanks of the ordinary Indian type, and where there is no river or other natural source of fresh-water supply but the direct one of the periodical rains. Garden cultivation is, however, the only one to which the system of irrigation from wells is applicable; because it alone is sufficiently profitable to pay for the labour involved, and because less water is required for it than for the cultivation of the rice. Rice is certainly grown in the district, but to a very small extent, and only where the lands are unfit for other purposes; for, a successful rice harvest these depend upon the rainfall, which is very uncertain, and upon the ponds, which often fail, but which when full yield a supply of water in aid of the rains. The water is raised from these ponds by a scoop swung from a rude scaffolding, and worked by two, four, or six men. The country lies at a level generally less than 10 feet above the sea. The wells are sunk to a depth of 15 or 20 feet through the magnesian limestone, which almost everywhere underlies the soil within 2 or 3 feet of the surface; and, except for a few days in the year when heavy rain falls, they are supplied by percolation from the sea, the water being freed from salt by contact with the limestone and other mineral substances in its slow passage to the wells.* As may be readily supposed, wells thus filled are soon emptied; and in fact the supply is generally exhausted when a well has been drawn upon for a few hours; and from twelve to sixteen hours elapse before the supply is renewed. The mode of raising the water is by a lever, 20 to 30 feet in length, turning on an axle resting on two uprights, and having a bucket suspended by a rope or light pole from one end, which is lowered and raised by hand, the lever being weighted at the other end so as to counterbalance the filled bucket and facilitate the raising of it. When the well is deep and the lever long in proportion, the work is futher aided by a man, and in some cases two men, walking backwards and forwards on the lever, so as to contribute by their weight at the two ends alternately to the rapid rise and fall of the bucket. In this way about 600 cubic feet of water may easily be raised from a single well in one hour. On an average one well is sufficient for the irrigation of an acre of garden land in the driest weather where the soil is light, and of an acre and a quarter where the soil is less absorbent. As these wells never fail, being

* But *does* the water percolate from the sea and does the filtering process deprive it of its saline properties? Our impression has always been that the water raised from the Jaffna wells owed much of its fertilizing properties to the salts of lime contained in it.—Ed. *L. R.*

supplied from a source which is independent of rainfall, the successful raising of two, and even three crops, in the year from the same land is as much a matter of certainty as the recurrence of the seasons.

Those parts of the country where the system of tank irrigation prevails surround the district lying within what is called the Mountain Zone, and extend to within a few miles of the coast, embracing about three-fourths of the area of the island, and having an elevation of from 20 to 100 feet above the sea. For the most part the rivers intersecting these low-lying districts are dry for ten or eleven months in the year; but in January and June, when heavy rains fall, they overflow their banks, and inundate a wide stretch of country on each side. In a few instances only was any attempt made in former times to utilise them as feeders of tanks, by throwing weirs across them, in order to divert the water by canals to the desired storage ground. The general practice was to depend for the filling of each tank upon the rainfall within the limited area selected as the site for it. As the country is undulating, it affords thousands of sites where tanks could be formed by damming up the outlets of drainage basins. The early conquerors of the island, who (about five centuries before the Christian era) introduced into it the arts then known in India, recognised these natural advantages, and availed themselves of them—as did their successors for more than a thousand years—to cover the face of the country with tanks, mostly of large size, some few forming lakes of from 20 to 50 square miles in extent, having embankments or "bunds" of 10 to 15 miles in length, and capable of irrigating tracts of land as large as Middlesex. All were constructed on the same model, made familiar by the Papers on Indian irrigation read before the Institution from time to time, an earthen embankment being made across the lower end of a drainage basin, such embankment being pitched on the upper side with rough stone, and having at one end or at both ends an overfall for the discharge of flood waters, and sluices of elaborate construction for distributing the water to the fields below.

But all these great works were destroyed in succession, perhaps soon after their construction, owing to inadequate provision in the length of the overflow, and to the difference in height between it and the bund, to meet the case of an extraordinary flood. This need not be a matter for surprise; for, even had the designers of these tanks possessed that knowledge of hydraulics which would have enabled them to adjust the length of an overflow to the discharge of a given body of water in a given time, they had no means of ascertaining the quantity to be discharged. The rain gauge was unknown to them; and it is certain that the country was then covered, as it still is, with a jungle so impenetrable that nothing more could be known than the bare fact, that by throwing an embankment across the low land between two hills of moderate elevation, a reservoir might be formed of capacity presumably large enough for the purpose intended. Only those perhaps who, like the author, have had occasion to lay out works of this kind in such a country, can form an adequate conception of the difficulty of arriving at data sufficiently reliable for the design of such a bund and overfall as would be safe under all circumstances. There are no maps, like the ordnance maps of Great Britain, from which the area of any drainage basin can be ascertained; and the cost and labour of making a special survey for the purpose in any given case would be enormous.* Then, observations of rainfall have not extended over a sufficiently long period to show what ought to be taken into account in designing works of this nature; nor have they, owing to the want of intelligent observers, been carried out in all the most desirable localities. Thus, a rainfall 10 or 12 inches in depth in one day—a thing of almost annual occurrence in some locality or another—had till lately been commonly accepted as the limit of what was probable anywhere; but in 1872 there was registered at one station a fall of 18·9 inches, and at another a fall of 17·9 inches, in twenty-four hours.

* The change since Mr. Byrne's time has been wonderful.—Ed. *L. R.*

In view then of the difficulty of obtaining correct information on the two essential points of area and rainfall, it would almost seem that no work of this kind can be safe for any considerable length of time, unless the dam to retain the water be of masonry throughout, so as to form one continuous overfall, instead of being the smaller, be made by much the larger fraction of the whole length of the structure. The Author's impression to this effect has been strengthened by what occurred recently to several tanks of moderate size in the eastern province of the island, restored or reconstructed only a few years ago, on designs upon calculations which were believed to be perfectly safe. In the case of one of them, which may be taken as a fair sample of all, the overfall was of extraordinary length as compared with the bund, and it was believed that not more than 2½ feet depth of water could ever rise over it, while the top of the bund was from 6 to 7 feet above the estimated flood level. It seemed to the Author, who saw it several years ago, that the great length of the overfall afforded ample provision against all possible accidents. But in January 1878 the rainfall throughout the district was heavier than had been experienced for many years, giving rise to floods which carried away numbers of bridge and other works, and raising the level of the water in this particular tank to nearly 9 feet above the overfall, or just sufficient to overtop the bund and carry away a large portion of it.

Smaller tanks adapted for the irrigation of from 20 to 200 acres, which are most numerous in the northern and north-central provinces, and are the only structures of the kind now in use. These were formed in a much ruder manner than that followed in constructing the magnificent works which have fallen to ruin. They probably owe their existence to the small village communities, into which the population was divided on the failure and abandonment of the larger tanks, and when the country no longer possessed to any extent the skilled labour which the native kings had called into play when carrying out those immense works. In none of the hundreds of tanks which have come under the Author's observation was there, until quite lately, anything deserving to be called a work of art. The overfalls were, in most cases, merely a depression in the bund, protected sometimes by rough stone pitching, or they were scraped out of the hard ground against which the bund abutted; while the sluices were formed of undressed blocks or slabs of stone, and often merely of rough timber, without any better means of stopping the flow of water through them than a gate of wattles banked up with turf, which the cultivators removed when they desired to let the water through. That structures so rude should have lasted through so many ages, can be due only to the ease with which any damage to them might be made good by the villagers. But neglect on their part has so often led to damage beyond their power to repair, resulting in the stoppage of cultivation for two or three years in succession, that the Government, in the interests of the people as well as of the revenue, felt bound to step in by legislation which placed the management of these tanks, and of small irrigation works generally, on a proper footing, and removed all excuse for that neglect into which they were gradually falling. Under this improved system small works of restoration and repair are now carried out in all parts of the country, with skilled labour employed under Government supervision, and with a happier result than would probably have followed the realisation of those grand schemes, so often proposed, of restoring the larger works abandoned centuries ago, to bring which into operation would necessitate the introduction of a new population.

Of the exceptional class of works already alluded to, where the design was to dam up the water of a river and divert it by a channel to a tank, the most remarkable is the Giant's tank, in the northern province, of the date of construction of which there is not even a trace. In this case, the mistake committed was more unaccountable than that which caused the destruction of the ancient tanks; for the nature of the country

in which it is situated must have been easy to study, being a dead flat and generally open, the soil being incapable of supporting the luxuriant growth of jungle which renders other districts so difficult to explore. The dam or "anicut," across the river was formed of large rectangular blocks of roughly-dressed stone, so well put together that it is still in as good order as when it left the masons' hands. The tank on the right bank of the river, some few miles below the anicut, formed by an earthen bund several miles in length, but nowhere more than about 10 feet high, was nearly completed, and a similar tank on the opposite bank in part constructed, before it was discovered that the bed of each was at too high a level for the water to reach it; and that both tanks, even had it been possible to fill them, must have been so shallow, that evaporation would not have left in them a month's supply of water for the area designed to be irrigated.

In the district of Karetchi, near the neck of the Jaffna Peninsula, the rice fields lie in several patches on each side of one of those rivers which flow only at intervals when there is heavy rain. Like the fields in the peninsula, they are mainly dependent upon the direct rainfall, and upon the ponds which lie scattered amongst them. Although it was ascertained, by a survey which the Author made in 1858, that a tank sufficiently large to irrigate them abundantly might easily be formed a few miles higher up, it was not considered that the work would be remunerative, in view of the cheap rate at which rice could be imported from India; and the project of carrying out the work was therefore abandoned. But the people endeavour to supplement the scanty supply of water derived from the rains, by throwing out temporary groynes of timber and earth from each bank of the river just before an expected flood, to divert a portion of the flood waters by channels leading directly to their fields. When the floods are moderate these groynes do good service for a few weeks; but as often as not they are carried away. To check the tendency to erosion, by diminishing the velocity of water in them, the channels are made so tortuous, that their actual length is more than double what they would be if straight, and they are otherwise so badly formed that much of the small supply of water yielded by the river is wasted.

The third method of obtaining water for irrigation is practised in the mountainous districts by tapping the streams. The fields are numerous, but nowhere so extensive as those commonly met with in the lowcountry. For the largest of them a channel 6 feet wide and about 2 feet deep, conveys all the water necessary for thorough irrigation; and to divert along it as much water as may be required, nothing more is needed, in most cases, than to throw a few boulders into the stream just below the point from which the channel commences. In those few cases where, during dry weather, it is necessary to prevent any waste of the water brought down by the stream, there are properly-constructed stone dams with regulating sluices. The channels are scraped out of the hillside, following the contour of the ground, and for a short distance after leaving the stream they are protected by a low wall on one side, which acts as an overfall whenever an undue quantity of water is discharged into them, as happens when the rains swell each stream into a torrent.

None of the irrigation channels in Ceylon are large enough to be used for inland navigation; and for this reason they have been everywhere laid out with as great a rate of fall as is consistent with a view to safety against silting. For the most part their inclination gives a velocity of water of from 2 to 3 feet per second; but even where the velocity reaches 4 feet per second, as it often does, there is no appreciable erosion of the sides or bed. Much of course depends upon the character of the soil through which the channel may be cut. But, so far as the Author's experience goes the lightest soil will bear a velocity of 2 feet per second, where the sides of the channel have a slope of 2 to 1, while in stiff clay soils, a slope of even 1 to 1 is ample in the most rapid of these channels. Such an assertion may, no doubt, appear inconsistent with what is commonly set down in printed rules and tables as to the moving power of water at given velocities; but these rules, however valuable as a general guide, are based upon experiments tried under conditions which never, or but rarely, prevail in actual practice. The Author has generally found that silting (in the case of channels cut on a contour line in sidelong ground) is due, not to the diminished velocity of the stream, but to the surface drainage from the land on the upper side of channel. Yet even here the close vegetation above is usually sufficient to prevent the surface soil from being carried into the channel; and in the worst conceivable case, where the land above is bare and the soil loose, a catchwater drain above the channel, with frequent outlets under it, would be an effectual protection.

In no case has the Author found any tendency to the excessive growth of weeds in channels having an appreciable fall. It is in canals intended for navigation only, and where there is no current, that he has experienced any trouble in keeping down such vegetation; and a little attention on the part of the native overseers is sufficient for this. A small force of men is usually kept on a line of canal to prevent cattle from injuring the banks, and these men are provided with rakes, by which the weeds can be torn up and drawn to the banks as fast as they appear. Moreover, it is only in shallow canals used for flat-bottomed boats, where the depth of water never exceeds 4 feet in dry weather, that weeds are likely to spring up to any extent, and in these men can easily wade while working the rakes, if the canals be too wide for the weeds to be reached from the bank. The experiment of attaching large rakes to the stern of a boat drawn along a canal, in the hope of economising labour by a wholesale system of weeding, had a fair trial; but the primitive method of raking by hand was found to be as efficient, and much more economical.

The Author regrets that he cannot give any details of cost of the various irrigation works undertaken in Ceylon in recent times. Such details would be of little interest, except in connection with a statement of results as to the quantity of water made available, and the extent of land brought under tillage in each case; and trustworthy information on these points is not procurable. Enough is known, however, to prove that in Ceylon generally, and especially in the unhealthy districts, where tank irrigation is chiefly carried on, the high price of labour must always render new works too costly to be commercially profitable. For this reason attention has of late years been confined to the improvement and restoration of small works long existing, but which had either been badly constructed originally, or had been suffered to fall into neglect, and where the cost of restoration, though often great for the small amount of work done, is trifling in comparison with the benefit obtained. By the outlay incurred, land which had for many years lain fallow are now brought under cultivation; and the cultivators are no longer dependent for food upon imported grain, the price of which, however low at the sea ports, is increased enormously by transport to the interior.

Printed and published by A. M. & J. Ferguson.