



gation there employed, and found it far inferior to irrigation in India.

After a long detention at Alexandria he embarked for Beyrout in an Italian brig, arriving there on January 4, 1833. A party was formed to proceed to Jerusalem, consisting of a young Pole on his way to Bagdad, a Danish missionary thoroughly acquainted with Syria, an Irishman born at Malta, a Dutchman, and Michael Trad, a young Syrian; "and it was of this hodge-podge," my father observes, "that an Arab who came to see us at an inn on the road asked if we were not all brothers—we were so much alike." He continues: "We had no want of languages among us, and found occasion at different times for Arabic, English, Spanish, Italian, Latin, Greek, Hebrew, French, and Hindustani; such is the variety of visitors to this place."

The party voyaged along the coast to Jaffa, and so by a roundabout route to Jerusalem. Afterwards he passed through Samaria, making a *détour* to take in Mount Carmel, and so to Damascus. He says: "I was glad to enter upon lands where I knew our Lord Himself had passed before me; almost every place was remarkable for some transaction in which the hand of God had especially appeared." In the vicinity of Mount Carmel the travellers experienced a tremendous storm, from which they found refuge in a convent on the mountain, and stayed there in wretched weather for two days. He commented on the so-called Holy Places at and near Jerusalem, saying: "Lies and absurdities and idolatry meet you at every step." "However," he adds, "forgetting these abominations" (alluding especially to the pretended issue of fire from the Sepulchre), "and remembering that here, indeed, our Saviour paid the price of my forgiveness, that this is the place where alone God has dwelt in a visible shape, and where our Saviour will again appear, as was positively declared at the time of His Ascension, it is full of interest. I went to the top of the Mount of Olives; on one side I saw the Dead Sea, the most decided mark that God is



not unconcerned in what we are doing, and, on the other, Jerusalem, showing, in its degraded state, the consequence of rejecting the Saviour."

It has already been stated that one of the travellers was a young Syrian gentleman, in whom the missionaries in Syria were much interested, as he had decided tendencies towards the adoption of Christianity. He had a great friend, Assad Shidiak, like himself a member of one of the old families of the Lebanon, who held an appointment in a Maronite monastery, but had received the truth of the gospel in its simplicity, and had written a book on the subject. His influence and the teaching of the missionaries had told on Michael, who was of a very amiable disposition and much attached to some of the missionaries.

It was thought that the journey to Jerusalem and Damascus, which Captain Cotton was taking in company with the missionary, Mr. Nicolayson, might be helpful to Michael, who joined them as interpreter. Somewhere on the way to Jerusalem, a Major Skinner joined the party, and they travelled together, Michael making himself of the greatest use to them by his pleasant, ready, tact and kindly way of ingratiating himself with the Arabs and in smoothing over difficulties. Probably this Major Skinner was the English officer who, as a roadmaker, has left his mark on Ceylon only less emphatically than my father has left his on Indian deltas.

Some weeks had been spent in Jerusalem, and the party went to Damascus. Captain Cotton and Major Skinner were the first Europeans to ride into the city in Frankish clothes. The country had been in a very lawless state, and there were fears of an outbreak, but Ibrahim Pasha's strong rule was beginning to be felt, and no disturbance occurred. The head of the fanatical party was executed by Ibrahim's orders during Captain Cotton's visit.

While they were at Damascus, Michael heard that his friend, Assad Shidiak, had suffered much persecution in the monastery for his faith, and had actually been put to death there. A young English merchant in the city,



named Todd, was much moved by Michael's distress, and laid the matter before Ibrahim Pasha, who at once offered him an escort of cavalry. He went direct to the monastery, and demanded admittance. Mr. Todd and the soldiers searched the place, the monks putting them off in vain with excuses, saying Shidiak had died of fever and had been buried. At last one old monk came to Mr. Todd and told him that Shidiak had been his loved friend, and he would show the niche in which he had been walled up, and for some time kept alive. He took Mr. Todd to the place, and pointed out where the wall had been broken down to take out the body, the stones still being about as when the workmen had finished their work. The monks were most subservient, offering refreshments to the escort as well as to Mr. Todd. The latter's reply was: "We will neither eat nor drink in this house on which the curse of God rests. He has seen your murder of His faithful servant." There had been a hope that they might have been in time to deliver the captive, but he had been some time dead.

From Damascus the party had planned to proceed to Bagdad, and were arranging for camels and horses, when Sherif Bey, the governor under Ibrahim Pasha, begged to be allowed to provide an escort and make all arrangements for them, the journey being a most dangerous one. This courtesy they gladly accepted. The Bey put them in charge of a sheikh, who had recently brought a large caravan from Bagdad, and was returning. He was a remarkable man, both in appearance and manners, who had frequently travelled to India with horses, remaining there until they were sold; so that he knew Europeans, and took great interest in the party thus placed under his charge.

They reached Bagdad in safety. The sheikh took them to sleep at his own house the first night. The next morning Captain Cotton went to the Mission House, where Mr. Groves, Mr. Parnell (afterwards Lord Congleton), and Mr. Cronin had been for two or three years.



The details of the desert journey are to be found in a letter to his mother, which my father sent from Bagdad on May 11, 1833. It more than justifies quotation in full, and was as follows:—

MY DEAR MOTHER,—

My last was dated Damascus, so you see I am making progress towards India, though not so rapidly as might be. After many delays and contradictory pieces of advice, we at length left that place, on the 3rd April, in company with a small caravan, and, after twenty-four days' hard marching, we arrived here in excellent health on the 26th. We have since discovered that the real cause of our difficulty in getting away from Damascus was the unwillingness of the sheik of the caravan to let us accompany it, for the Arab tribes are so sensible of the comparative riches of the Franks in general that, if they had discovered us in a caravan, it was to be expected that they would demand an enormous sum as tribute, and make the head of the caravan responsible. However, the sheik at last consented to our accompanying him, on condition that we were dressed like Arabs, and we had to pay a much larger sum than native travellers for our camels. The Pasha of Syria and the principal Bagdad merchants of Damascus committed us to the care of a sheik on whom they placed great dependence, and so we started as well cared for by men we never saw before as if we had been their sons and brothers. And the sheik did not fail in the smallest point of what he had been charged with, so that, excepting the unavoidable tedium of sitting twelve or fourteen hours a day on camels in a warm sun, I never made a journey in my life with less annoyance.

The caravan contained about six or seven hundred camels, divided into twelve or fourteen parties, each under its own sheik, and there were perhaps one hundred and twenty men with them, twenty or thirty of whom were mounted on dromedaries, armed with swords and matchlocks, and rode two or three miles in front, or on the



flanks, according to where they expected the Arabs of the desert to attack them. When no danger was apprehended, the camels were spread over a great space, sometimes more than a mile in breadth, but when Arabs were in sight the whole body kept together. At night the whole party slept in a very small space, the camels packing quite as close as bales of goods, and we all amongst them; from which we learnt that a stable is a garden of pinks and roses compared with the desert bedchamber of our nags.

However, you may suppose that after being on their backs for twelve hours, we had little time to consider whether we were near to or far from them at night. We usually started before sunrise, and continued without halt till near sunset, and sometimes till after that. The camels feed a great part of the day, as they go, wherever they find pasture, and there was no day on which they did not meet with abundance of such things as they like (which were chiefly strong aromatic plants), excepting on the banks of the Euphrates, where there was literally nothing.

At the time we crossed, the desert was in its greatest beauty, and you would be surprised at the variety of flowers; I think I must have seen fifty, half of which would be prized in any flower garden in England. The camels require no water when there is green food for them, and ours did not taste it for twenty days. We passed only two wells, which were in the beds of streams, for as the camels did not need water, the caravan came as straight as possible, considering that the sheik had no compass, and so steered their feet as well as he could by the sun. The camels may well be called Ships of the Desert, in one respect, for when we were on a perfect plain and saw any of them approaching us, and while they were still beyond the horizon, they looked so like vessels at a distance at sea that I could perceive no difference, and when the mirage was spread over the horizon, the illusion was complete. If they are to be called ships, however, we must consider them as belonging to the navy of Lilliput, for our whole



caravan only carried as much as a single one-masted vessel of one hundred tons would convey by sea, little more than a "flat." The desert at first consisted chiefly of a succession of very gentle undulations of ground, of gravelly soil covered, though very thinly, with aromatic plants, excepting in some spots where there was so much vegetation as to appear quite rich to eyes that had got a little accustomed to the desert.

Towards the Euphrates we passed plains of very great extent, without the smallest unevenness, not a plant or knoll rising one foot above the general level. The highest vegetable of any kind that we saw was the flower of a plant like rhubarb, which grew to the height of a foot and a half in some places.

After leaving Damascus two or three days, we did not see a single standing camp of Arabs, which you may suppose was not a very bitter disappointment to a peaceable man like me. We met two parties on the march. One of them took us for Ibrahim Pasha's army, and retreated without their property in great precipitation; neither party offered to molest us.

The leaders of our caravan were of a very peaceful tribe, a great part of whom are at present living within the walls of Bagdad, and they pay a fixed tribute per camel to the strange tribes through which they pass. We came to the Euphrates in flood, and crossed it in boats; it was quite full, and about one hundred and fifty yards broad. Between the Euphrates and Tigris we passed a real desert, for, though it was in the spring, not a blade of vegetation was to be seen in many parts. On arriving late at Bagdad, our sheik took us to his house, where we slept, and the next morning crossed the Tigris by a bridge of boats, and found a hearty welcome in the house of the missionaries.

Though we had so little trouble on our journey, I cannot tell you the delight with which we found ourselves among our countrymen again, and sheltered from the sun. On the last day we were seventeen and a half hours on our camels, and we rode about sixty miles, from which you



may judge that I was not much the worse for wear. This, however, must be qualified in some degree, for I was not in a condition to be refreshed by the sight of a wooden-seat chair. The motion of the heavy camels is exceedingly fatiguing, but our sheik had provided us with a very delicate nag, that could walk as prettily as any young lady, so I suffered little comparatively ; still, I found that it was not pleasant to make from forty thousand to fifty thousand low bows involuntarily in a day.

You may have heard that the year before last, out of sixty thousand inhabitants of Bagdad, fifty thousand died of the plague, and at the same time the whole city was laid several feet under water by a flood while an army was waiting to besiege it, which took up its ground before the wall as soon as the water retired. The present appearance of the city corresponds with these occurrences. In one night, when the flood first broke down the walls and entered the city, about one-fourth of the houses fell, and buried many persons in their ruins. Much of the space within the walls is now covered with heaps of ruins, and in the other parts there are whole streets without an inhabitant. There is scarcely a vestige remaining of the city's former magnificence ; it once contained three millions.

We have received the greatest kindness from the missionaries and the Company's Resident here. They are the only English in the place. There is an easy way of getting to Bussorah by the Tigris, and we hope to start in a large boat on Tuesday, that is, in three days, and to reach Bussorah in four or five days ; whence we have a good prospect of a vessel to Bombay. The climate of this place is at present delicious. My companion, Major Skinner, is one of the very few persons who can bear uncomfortable circumstances without annoying himself or anybody else. We hope to go on together.

Mr. Newman, of Oriel, an acquaintance of Richard's, was attached to this Mission, and I had a letter to him, but he left the place some months ago ; the others, how-



ever, required no introduction to give us a hearty reception. Colonel Taylor, the Resident, also would have quartered us, if we had not been provided for. Christians and Mussulmans appear to have agreed to shew us kindness every step we have taken from England here, excepting, indeed, our friends in the plains of Esdraelon, and then we received instantaneous redress.

I begin to fear now that the Post Office people at Bombay will have given me up, and sent away my letters, which would be a very grievous disappointment; but I hope not. How little did I think that I should be so long without hearing of you!

An application has been made to the Director from this Pashalik for some of their officers to superintend public works and organize troops, and the Directors of the East India Company have consented to the arrangement; so that there is some hope of a strong and settled government being again established in these miserable countries where every man's hand is against his neighbour.

Among other works in contemplation is the establishment of a regular line of steam boats on the Euphrates, and the cutting of a canal to connect that river with Bagdad, at the expense of the Pasha, thereby completely establishing this as the most easy and expeditious line of communication from England to India. I hope and trust you are all in health and prosperity, as when I left you, but I wish I could know it.

A large packet of letters has lately arrived from Constantinople, but they have been rather a long time on the road. They bring wretched accounts of Ireland. There has been a very serious mutiny discovered in the Madras Army among the native officers and privates, but the end of it is not known here. Our Resident here is in a most extraordinary position with respect to the government, as none of the Arab tribes in the open country, or of the different parties in the cities, can trust one another's word in the least; whenever any disturbances break out, nothing can be settled without getting the Resident to be



a party to the agreement, and they have the most entire confidence in the bare word of a Frank.

Some months ago the people in Bagdad rebelled, and attacked the Palace, and would certainly have put the Pasha to death had he not called upon the Resident, who interfered for him with the conspirators, and he was enabled to settle the business without further bloodshed. The same thing has taken place repeatedly in all parts of the Pashalik, so that what little peace is enjoyed here is by means of a man without any outward power whatever, solely his personal character, and that of his nation, being firmly established. I never saw so striking an instance of the effect of a single upright mind in the midst of a nation of faithless men.

My next letter, I hope, will be from Bombay. May God bless you, and all the members of the family. I send my kindest love to every one.

Ever your most affectionate Son,

ARTHUR.

One of the missionaries who welcomed my father to their homes at Bagdad, as mentioned in the letter, was Mr. Anthony N. Groves. His son, Henry, in an account of the mission, notices Captain Cotton's arrival; and, in another letter written quite recently, my father, referring to Henry Groves's death, says he remembers sleeping with him at this time on the roof of the Mission House. Mr. Groves afterwards accompanied him to Bombay.

They started from Bagdad on May 21, 1833, but were detained by my father's very dangerous illness at Bushire, on the Persian Gulf. The late Lord Congleton wrote to Mrs. Groves:—

"But for your kind husband, Captain Cotton would not, humanly speaking, have got through his illness at Bushire, so ill was he, and so near death. I doubt if he can remember anything about the matter."

He was, however (as he afterwards informed his friends), of the opinion that his grave was dug. "Michael," Mrs.



Groves says, "though most faithful in his attendance, was at times quite overpowered by the circumstances of his beloved master and friend, and almost broken-hearted at the thought of his death."

About the year 1863, Sir Arthur Cotton was recognised at a public meeting by a gentleman, whose name he could not remember, but who informed him that thirty years previously he was in command of the escort of the British Resident at Bushire, and had had charge of his funeral arrangements. My father often used to remark that "he supposed he was himself the only man who had ever visited his own grave."

After about twelve months from the time of his setting out from England Captain Cotton arrived at Bombay, and returned to Tanjore.

This, perhaps, may be the place in which to refer to other journeys made by my father. He visited Australia thrice and Mauritius once. The far-away days during which these journeys were taken, and the practical manner in which the traveller endeavoured to turn his observations and knowledge to the benefit of the country he visited, render a reference to them desirable.

He, who afterwards declaimed so strongly against the construction of railways in India because canals would so much more cheaply carry goods and provide means for cultivation, himself had charge of the construction of a small railway, which will be noticed in due course. At the conclusion of his work on the Red Hills Railway, near Madras, his health broke down, and he went to Tasmania on sick leave, a long, tedious, voyage in those days.

On his arrival in Tasmania he temporarily settled down at Hobart Town. Here he immediately occupied himself with experiments on a centrifugal steam engine, probably the precursor of the steam turbine, which at present is attracting such widespread attention. But the real rotary engine has even yet to establish itself. The idea of a rotary



engine, I believe, was entirely his own. This engine he certainly made himself. Whilst studying its working when it was in motion, unhappily with a boiler of poor quality—the only one he could obtain—the boiler burst, and there was an explosion, which injured him most severely.

In describing this misfortune he took his usual optimistic view of the event by saying: "Yes, the boiler burst and injured both my legs, taking off the flesh of one of them, but I succeeded in getting one hundred and fifty revolutions a minute." This result compensated him for all his sufferings! For many months he could not walk, and all his life he suffered more or less from the result of this accident, especially after work which fatigued him, or in cold weather. It is an interesting fact, however, that he was always a great walker; even after he was seventy years of age he could go long distances on foot. His light, active, figure and wiry frame stood him in good stead, and his energetic habit of mind caused him to greatly enjoy long hours of climbing, or the exploring of new country.

For many weeks after the accident he lay dangerously ill in an hotel in Hobart Town. When he was able to be moved, he was invited to the house of a gentleman, who lived a few miles from Hobart Town on the bank of the Derwent, and there rest and the beautiful scenery did much to help his recovery. He was able to be driven about the neighbourhood, which is, perhaps, amongst the most lovely in the world.

The river Derwent brings vessels of considerable size to Hobart Town, which lies at the foot of Mount Wellington. For eight months in the year the mountain is tipped with snow, while at its foot and for about two miles along its base the sides are covered with the most luxurious growth of plants of many kinds—blue, and red, and yellow—quite unknown in England or India. The charm to the invalid was great, and he improved much in that first change.

Then he became the guest of a family in the centre of



the island, where the scenery was less beautiful, but novel and peculiar, full of different interests, while the Christian society he enjoyed was always helpful and cheering. A farther move took him towards the north, to Norfolk plains, about sixteen miles from Launceston, where again he found Christian residents, whose hospitality and kindness he never forgot. He gradually recovered the power of riding and walking, and after some months returned to Hobart Town and India.

At the time of his first visit to Tasmania Sir John Franklin was governor of the island—a kind-hearted, genial, man, much beloved by those who knew him intimately. My father was a great favourite with him and Lady Franklin, and was often at Government House. He was warmly attached to the fine old explorer.

Before he left for India, the expedition of 1839 to the South Pole arrived in Tasmanian waters. The ships, *Erebus* and *Terror*, were anchored close together in the Derwent, and stayed there some months, Sir John greatly enjoying the society of his old fellow-midshipmen and friends, Sir James Ross and Captain Crozier, the latter of whom commanded the expedition. The society of so many scientific and Christian men was much valued by the community at large, especially by those who had the opportunity of meeting them constantly at Government House. Not many years later Sir John, with Captain Crozier and the same two ships, sailed for the North Pole, where both commanders perished, to the sorrow of many friends and to the grief of the nation.

A few years of strenuous toil in the Godavari Delta, and once more there was a breakdown in my father's health, so serious that the devoted Engineer was obliged to leave his work. Once more a voyage to Australia was determined upon. This time he was not alone. Wife and children were with him.

It so happened that at this time there was no vessel going direct from Madras to Melbourne, so he decided to break the journey at Mauritius, and we sailed for that



island, the ship being under the command of a captain who had on board a half-caste family, a queer conglomeration of relatives, who occupied the stern cabin next to our own.

We arrived in the harbour of Port Louis, the beautiful capital of a beautiful island, on a lovely moonlight night. The sight was most impressive; many ships were anchored under the shadow of Peter Botte, a high mountain whose summit is crowned with a round rock which is poised on the point of another rock—a remarkable feature standing, as the mountain does, quite alone. A British man-of-war was among the ships at anchor; its band was playing some lively strains as we drew to our anchorage, then there was a pause, and, to our loyal and devoted ears came the welcome strains of "God Save the Queen."

We remained at Mauritius for two months. First we stayed for a few days at Port Louis; then, finding this place very hot—the climate being most oppressive—we went to the village of Cure Pipe, where we occupied a lovely cottage surrounded by fields, with a running brook close to the house, in which we—the younger ones at least—delighted to wade, and on the banks of which we could gather lovely wild flowers.

When we arrived at Mauritius my father was quite prostrated with weakness as the result of his severe illness, but from the day that we entered our cottage he began to revive, and his strength soon returned to him, so that we had the joy of seeing him restored to health before we were obliged to leave the island for Australia.

At the house of one of our friends near Port Louis there was an enormous tortoise, so large that three or four of us used to amuse ourselves by riding on its back together. It would carry us long distances. Now and then it would disappear and be away for days together. My father called us one Sunday morning to look through a telescope across the lake which adjoined our friend's property, and there we saw the tortoise's head bobbing up and down as it returned from one of its solitary rambles,



swimming to us across this piece of water. I have sometimes heard doubts thrown on the enormous size of this creature as described by those who tell this story, but, in reading Admiral Keppel's life the other day, I found the same tortoise not only spoken of, but exhibited in a drawing as it walked along carrying on its back six men. Thus unexpectedly our description was corroborated.

From Mauritius we went to Australia to stay with my mother's relatives. During this time we had many interesting and curious experiences, but our great interest and pleasure was our father's companionship. He was at leisure and was constantly with us. He would take the greatest pains to teach us and give us information on every subject we could understand. When out for a day's ramble with him, we spent the heated hours of mid-day at an inn, where incidents revealing his exceeding kindness occurred which are as fresh in my memory to-day as when they happened.

The inn was rather a notorious place in that lonely district, lonely then, but now densely populated, being in the neighbourhood of Geelong. There was no other inn near it for many miles. It went by the name of "The Squeakers," and was frequented by a very rough and desperate class of men. On one occasion a relative of ours, who had been riding a great distance, arrived at this inn so exhausted that he threw himself on the bed in a small room, divided only by a wooden partition from the drinking saloon, where a crowd of ruffians were seated. As he lay quite prostrate, too tired to move hand or foot, he heard them saying that they thought it would be a good plan to rob the gentleman, drag him out of his bed, and put him out of sight where no one would ever find him again. During the conversation he heard one voice clear and distinct, marked by a strong Scotch accent, say: "You'll nae touch him; he's a guid man, he works hard. He has ridden fifty miles to-day, and I'll stand by him." This friendly word probably saved his life.

We used to go out early in the mornings to search for



manna. It is a strange thing that the manna described in the book of Exodus seems to be exactly reproduced in that colony. Every morning and evening we found it lying on the ground in large quantities on the sticks, on logs of trees, on blades of grass. It was white and sweet, and deliciously fresh and pleasant to the taste, but it would not keep. We used to collect it in bags, and enjoy it for our breakfast and tea; but if it was kept for a few hours it turned black and could not be eaten. It is generally thought that the manna of Australia is a kind of gum produced by an insect; it is snow white and very sweet. But I do not know that this explanation has ever been verified.

Whilst we stayed here, my father became friendly with the clergyman, the Rev. Mr. Hastie, a Scotchman, and used to go with him from place to place reading to the people. So great was the bond of sympathy between himself and this excellent man, that they corresponded afterwards, Mr. Hastie often saying how greatly he missed him when he was compelled to return to India.

My father was interested in the cattle farms belonging to his brothers-in-law, and also in their immense tallow works, which they had brought to great perfection. But he was even more interested in the plans, which he worked out with the most elaborate care, for the irrigation of the farms, for though, as a rule, rain was plentiful, it was uncertain in its fall, and he would often prophesy the serious results of one year without an ample water supply. He wanted to arrange for water storage on a very large scale, with simple canal systems from point to point, which would have made the owners quite independent, for a long time at least, of the fall of rain. Sad it is to remember that during the last week of his life he was reading a letter, which described the terrible drought then prevailing in that very part of the country. For a long period no rain had fallen, and this letter described the dying of the cattle and sheep from sheer inanition, dried-up stream-beds and the utter absence of grass everywhere. He looked up at me



with that intense look which he would assume when conversing on subjects very near his heart, and said: "If they had only taken my advice, given so many years ago, they would have saved fortunes, and gained others over and over again."

This leads me to allude to the one vein of sadness that ran through his whole life. It was neither more nor less than the burden, which always weighed upon him, of the vast needs of India, coupled with the knowledge that, had he the power to apply the remedies, he could have met these needs, and thus have saved the country from much of its famine and poverty. The plans which he recommended were his own, but he never desired to keep his knowledge to himself. He was always ready to impart it, down to the smallest detail, to any one who would listen to him or take his advice. But here was the difficulty. His schemes were considered Utopian; yet he could always answer such a suggestion by pointing to his magnificent works carried out on the Coleroon and Godavari rivers, which have abundantly repaid the expenditure incurred, and have formed an oasis in India during the long years that have followed their completion.

As an appendix to this chapter I give a paper on "Water in Australia," written probably in 1850. Although half a century has passed, and enterprise in Australia is not wanting, there is still much in this paper of value.

It was soon after we left the hospitable home of our relations there that gold was discovered in the neighbourhood. I have heard my father tell the story. He said that a gentleman, who was riding across the country, had stopped at a house near and asked for luncheon. After he had finished his repast he rode away. As he was crossing a plain not far distant his horse threw him. Before he could reach it, it had galloped away. In pursuing the horse, he found himself in marshy ground, and, as he seized the reins, the horse kicked up some soil from the marsh. In this soil the gentleman noticed a glittering and a sparkling of some material, that looked to him very much like gold. He took



up some of the earth in his hand, and the more closely he examined it the more he thought it could be nothing but fine grains of gold. There was no mistake. He rode straight back to the town and showed it to an expert, who told him that he had conjectured rightly—he had discovered a gold-field. In an incredibly short time the whole of that district was covered with small huts and tents; thousands of men arrived to try their luck in searching for the newly-found treasure. Of course, farming had to be abandoned there, and the owner moved to another part of the country.

St. Helena was a place we visited on our voyage to England some years later. A weird, desolate-looking, rock looming in the distance was our first sight of Napoleon Buonaparte's sea-girt prison. As the ship sailed into the harbour this tremendous mass of steep rock towered over us and looked an impregnable fortress. How was this summit ever to be reached? A small boat took us from the ship and scaling ladders were drawn down to the side of the rock, and we climbed up to the greener slopes above where the little town was.

After breakfast at the hotel, we rode on mules and ponies to the site of Napoleon's house and tomb. Our pathway lay through beautiful woods and the most luxuriant foliage. It was altogether a day to be remembered. The brilliant blue sky and the precipices that we passed as we explored the heart of the island were all most charming. The tomb, surrounded by an iron railing, was covered by a weeping willow—a beautiful spot, but an intense sadness seemed to rest over it, for it teemed with the interests of a great but broken life, and world-wide ambitions that had fallen like a crumbled ruin on this very spot. We afterwards went into the house where the valiant conqueror had lived during those long, sad, years of his history.

The weather at St. Helena was very changeable. Though the early morning had been brilliant, such heavy showers fell during our ride that our clothes were soaked through and through, and the result was, to myself, a serious



illness, which began that day and lasted for many weeks. However great the penalty we had to pay for our sight-seeing on that day in June, we always felt that we had gained something in visiting this most interesting spot.

Appendix

WATER IN AUSTRALIA

The first thing beyond all others in Australia is this question of water and its storage. This great fundamental point, on which the whole future of the country hangs, is now publicly acknowledged. How could there be ever any doubt about this in a land subject at moderate intervals to droughts of twenty months or more. Of late there has been an additional hindrance in the matter, from the subject of Irrigation being taken up, which, in itself a very important one, has been, in the circumstances, a terribly mischievous one by greatly drawing off attention from the vital point, which is, of course, in the case of long droughts, the storage of water.

In this way the Committee sent to America was most mischievous, because there the sole question was distribution. They have the water in abundance.

But, having at last fixed attention on the real point, the next thing that should be kept in view is that there is abundant proof that the storage of water is a matter of extremely small cost. This ought to have been the very first subject of the inquiries of the Committee, because the whole tone of further proceedings must be essentially affected by the probable task.

A Committee ought to have been sent to India and to France, where large reservoirs have been constructed, to obtain rough estimates of the probable cost of storing in Australia by similar works. Not, of course, with the idea of forming anything approaching net estimates, but merely to form a judgment, such as whether one thousand or one million cubic yards could be stored for one pound sterling, that is, to ascertain whether the cost of storage would be a real hindrance or not. My conclusion, from experience in India, is that the cost will be found so insignificant that there cannot be a question about the immediate



commencement of a complete system of storage for the whole country.

In India we certainly have, in the nature of the face of the country, extraordinary facilities for storing, and tens of thousands of tanks, containing from two hundred million cubic yards downwards, have been constructed, while there are many sites that would contain more than a thousand millions yet not occupied. One, on a main river which would require a bund one hundred feet high, and half a mile long, costing perhaps £200,000, would be converted into a lake ninety miles long by an average of about three miles wide, having a surface of eight hundred million square yards, and mean depth of ten yards, or a content of eight thousand million cubic yards, which would be forty thousand cubic yards per pound of capital expended, and a million cubic yards per pound of interest; or, if one thousand cubic yards would carry an acre of grass to completion, the charge would be a farthing per acre per annum.

And if in Australia it cost one hundred times as much, it would then be only two shillings per acre, a sum quite insignificant, even in respect of ordinary years, but what in respect of years of drought, when the lives of millions of sheep are in suspense! And it must be ever kept in view that when the country is filled up, it will not be a question of lives of sheep, but of men, as it is now in India, where five millions died in the last famine in spite of all the vast arrangements that were made to provide food, and even in Ireland, a little patch of land lying beside England, with the sea within easy reach of every part of it, some hundreds of thousands perished.

I am not acquainted with the nature of the surface of much of the country in Australia, and, therefore, can only attempt to give some material for calculating the cost of storage in one tract, for instance, the plains of the Darling. It must be, of course, in my hands, a mere rough sketch of what it might cost, but something like correct figures may be applied to this estimate by those who know the country.

Suppose the Darling has a fall of a foot per mile, and that a weir were built across it, throwing the water into a canal with a fall of nine inches per mile, into a tank twenty-four feet deep, formed by a circular embankment of earth ten yards high and ten miles in diameter.



Such a tank would cover two hundred and fifty million square yards of ground, and with a depth of eight yards contain two thousand million cubic yards of water. And if we allow five feet per annum for evaporation, or for a drought of two years, ten feet, it would leave fourteen feet for one, or seven feet for two, in case of an extreme drought, giving six hundred million cubic yards, or sufficient, I suppose, for six hundred thousand acres of corn or grass; that is, one thousand cubic yards per annum, or five waterings of one and a half inches each. The extreme evaporation recorded in India with half a gale of wind at 110° is half an inch per day, and the whole annual evaporation in the tropical part of the country is believed to be about six yards, or one-fifth of an inch per day. We may allow five feet in Australia near the tropics.

Now the earthwork in such tanks and canals would be about twenty-five million cubic yards, which, at one shilling per cubic yard, would be £1,250,000. To this amount must be added lining the upper part of the interior slope with loose stones to bear the work of the waves. The cost of this is, of course, quite uncertain. We may allow £250,000 for it with the weir and sluices, or £1,500,000 in all, the interest of which at six per cent. with management would be £90,000 a year for six hundred thousand acres, or three shillings per acre; or, if the value of the crop be £10, equal to one and a half per cent. upon it.

But this is only for an ordinary year, and supposing that twelve feet of water is always kept in the tank, at the end of the first year, what would be the value of this water in a great drought? Allowing a crop of grass to keep five sheep alive for the year per acre and no other benefit, at ten shillings per sheep, it would save the whole cost of the works in the one year.

But this also supposes that no advantage is taken of the formation of the ground. The works might cost one-tenth of this where the ground was favourable.

I only give this as a rude sketch of what I suppose might be done in the great plains of alluvium. What favourable valleys in the hilly country might be closed by short embankments is another great question. All the upper basins of the Darling, the Lachlan, the Murrumbidgee, and Murray, as well as other rivers, should be examined by men who have the peculiar talent for projecting such works, and who have obtained some knowledge



of the subject from visiting the great works in France and India.

But it is, of course, of the utmost importance that an engineer should be found who has such a peculiar talent; besides which a statesman will be required who can take in a view of the vast question in all other respects.

We have a terrible instance of a great work undertaken by an engineer who was unequal to the project in the harbour at Madras, where half a million has been expended, and in the late hurricane all the ships ran out of it, judging the hurricane safer than the harbour.

But the great point I wish to urge is that I am fully assured from my experience that the cost of storing water will be found in Australia perfectly insignificant in comparison with the results which would be secured.

I should add two or three remarks:—

First. The effect of such a tank is not confined to the thousand square miles irrigated by it. A vast extent of country round would be refreshed by dew and rain from the evaporation of four hundred million cubic yards of water per annum from the surface of the tank; besides that, the state of the air would be greatly improved by the moisture, for in those lands the air is altogether too dry. And the temperature would be considerably moderated.

Secondly. The moment such water is available patches of plantation would be made over the whole neighbourhood, as has been done in whole kingdoms in India, greatly modifying the climate and increasing the rainfall and dew. If the vast plains of the Darling were thus sprinkled over with tracts and plantations, the whole country would be so improved for human occupation that it would be entirely and essentially changed.

Some day all this will be done. When it is, and when many thousands of families are finding prosperity and comfort on areas now almost worthless, it is to be hoped my father's wise prescience may not be altogether forgotten.



CHAPTER IV

The Beginnings of Great Duties

"The nature of the irrigation works in the Madras Presidency and their historic development are best illustrated in the great Cauveri¹ scheme, which supplies a delta stretching from above the town of Trichinopoly to the sea. The chief systems of Southern India are all on the east coast, all deltaic, all modern adaptations of ancient designs, and all make river waters available by the same class of works. Any one of them will serve as a key to the rest, and this particular scheme, as the largest and most profitable, is naturally selected to indicate the type."—Hon. A. DEAKIN, M.L.A.

CAPTAIN COTTON'S beginnings in Southern India as a semi-independent officer with scope to exercise his growing faculties synchronized with that period, in Great Britain and elsewhere, of eager hope as to what the application of science would do towards increasing the productivity of the earth and the happiness of the various races of mankind. In England this period was, in a measure, inaugurated by the publication of the famous Bridgewater Treatises. The effort of the human mind, which they represented, finds expression in the phrase then so widely current: "He who makes two blades of grass to grow where one grew before is a benefactor of his race." There is a passionate desire in men to see some tangible result of their labour, especially if that labour be of a strenuous character. The test is always applied to an

¹ The new spelling in Indian words gives Kaveri for Cauveri. It has been thought advisable to retain, so far as may be, the old spelling throughout: but no hard-and-fast rule has been adopted by me.



enterprise, material or moral: Does it pay? And, if not carried too far, the test is not an unworthy one.

My father, in 1836, stands at the threshold of the most distinguished part of a great career. Looking, as we are able to do, from the end to the beginning, it is possible to say of his notable achievements, that they have been altogether good. Their effects were and are beneficial only. A builder of empire, of that particular Empire of Britain of which he was one of the most admiring of sons, and which he regarded as guarded by and blessed of God, there is no record of human suffering in all he accomplished; the stones which go to make his niche of fame are nowhere cemented by human anguish or the shedding of blood. All he did has been of a character to make life more prosperous to many millions, and to satisfy abundantly the most elementary needs of human life. This done, all else was possible. Continually hungry and poverty-stricken people can make no progress. Such a tribute as this, when Arthur Cotton's most important achievements are first taken in hand by him, is due to him; it was in a spirit which was ever mindful of the gain which would result to humanity that he undertook and carried, with so strenuous a determination, his great projects to success. Not a little of his success was due to his intense zeal and powers of hard work. Only such a noble ambition as he cherished could have carried him through what he did, not simply in travelling through the districts in all seasons, but also in the preparation of elaborate reports for the consideration of the Government. No detail was too unimportant for his personal consideration, no toil too severe for him to endure.

What did Arthur Cotton do in Tanjore?

He devised a great scheme for controlling the river Cauveri, and saving its almost priceless water from running to waste.

To grapple with the Cauveri's current was no mean achievement. Colonel Caldwell, the first British Engineer to examine the river with care, which he did in 1804, was



forcibly struck with the unusual character of the Cauveri; he predicted its total annihilation as a useful stream at no distant future, unless the river could be restored to what he believed to have been its original condition. My father's comment on this statement was as follows:—"But the evil, though progressive, is much slower than might at first be expected. The sand and heavier ingredients are deposited in the bed of the river, but a considerable portion of the firm soil, from its less specific gravity, remains longer in suspension, and is ultimately carried into the smaller channels, and from them into the rice fields, which it greatly enriches." It is clear *this* Engineer was not afraid of the vagaries of the stream.

"The original merit of conceiving the plan of so grappling with a great river like the Cauveri as to compel it to become an easily controlled agent cannot be impaired, and I may be permitted to express my admiration of the skill and courage they display, both in their design and execution." Thus said Colonel Baird Smith seventeen years after Captain Cotton's work had been begun. He further remarked: "The permanent prosperity of Tanjore is, without doubt, to be attributed in large measure to that first bold step taken by Colonel Cotton in the construction of the Upper Coleroon dam, under circumstances of great difficulty, with restricted means, against much opposition, and with heavy personal responsibilities."

There was no prosperity when Captain Cotton conceived his plan. On the contrary, the district was in a state of decay, the people, spiritless and suffering.

This testimony was the common opinion of every one capable of judging as to what was done. The official in charge of the district at the time (Mr. W. N. Kindersley, who is described by Sir Alexander Arbuthnot as "one of the ablest civil servants in the Madras Presidency") declared that there was "not an individual in the province who did not consider the upper anicut the greatest blessing that had ever been conferred upon it." Mr. Kindersley



also expressed his conviction that "the name of its projector would, in Tanjore, survive those of all the Europeans who had ever been connected with it."

That was civilian testimony. What would a brother Engineer say of the project? Brother Engineers were not wanting in the expression of their opinions. They shared the view of Captain Cotton's superior, the Chief Engineer of the Presidency, Colonel Duncan Sim (afterwards Commanding Engineer throughout the siege of Delhi), who was deputed to report upon the conception and progress of the work. Colonel Sim's praise was unstinted. "Simple and natural," he wrote, "as this course [the project of the anicuts] may now appear, no one previously to Captain Cotton thought of recommending it, and it was attended by a degree of responsibility and risk which few would voluntarily have undertaken. For the talent and judgment displayed by Captain Cotton in his patient investigation of the causes which were affecting the rivers in Tanjore, and for the boldness with which he proposed, and carried into effect, what appeared to be the only remedy, I conceive that officer is entitled to the highest praise." The same fine characteristic was exhibited by my father in the Godavari works, and received like commendation. Colonel Sim, contemplating the unfinished work near Dowlaisweram, and understanding all that was involved in it, turning to Major Fred. Cotton, exclaimed: "I am astounded at your brother's professional daring." More than forty years later, similar credit from similar authority was given to the Engineer. Forty years are a long period in a man's life; time enough to be forgotten twice over. But Arthur Cotton was not forgotten, and, in 1882, the high tribute of 1839 was virtually repeated in the report of the Chief Engineer for Irrigation in that year, when he remarked that, "to Captain (now Sir Arthur) Cotton is due the entire credit of the series of works which have fulfilled the purposes for which they were designed with such remarkable success."

Colonel Duncan Sim's reading of Captain Cotton's



characteristics bears a moment's consideration. With unerring discernment he brings to light what really were the guiding principles of the daring Engineer's character. Originality of thought: " . . . no one previously to Captain Cotton thought of recommending" the simple and natural course he adopted; courage in the carrying out of his convictions: "attended by a degree of responsibility and risk which few would voluntarily have undertaken." Originality and courage, added to these was loyalty and conviction. If my father lived for any one thing more than another it was that he might press forward the use of water for navigation and irrigation. At a discussion in 1877, following a paper read by him at the East India Association, one of the speakers said: "If Sir Arthur Cotton would open his mind to the great value of railways at the same time that he urges the real importance of canals, his views would undoubtedly commend themselves more cogently to many people acquainted with India and the points at issue, and the aim, for which he so laboriously and conscientiously worked for many years, would be more speedily advanced." The response to this was instantaneous and in high indignation. "That is," retorted the righteously annoyed Engineer, "if I would either be a party to what I know is false or would help to conceal the truth as to the very essential and fundamental point of the whole matter, it would be the way to promote the truth." Sir Arthur's friends will not need that any emphasis should be given to the haughty pride with which this assertion of fidelity to principle was made.

It will be seen that, unlike many men, Arthur Cotton had not to wait for many years until the joy of seeing difficulties overcome had become mitigated by a want of recognition. Though he never sought for praise it is clear the recognition which his work extorted was gratifying to him. It could not well be otherwise. But praise never spoiled him, never developed conceit, never led to self-assertion; on the contrary, he modestly accepted what was said of that which he had done, and found in it an



incentive to do something, immediately after, even more worthy of regard, even more useful in increasing the comfort and happiness of his fellows. From his earliest to his latest day this was a marked characteristic of his every act.

What, then, really was the work so highly praised for its conception and execution, and the financial results of which, as an investment of public money, were so marvellous and so gratifying? It was one which, as has already been stated, was destined to stamp Captain Cotton as an Engineer of pre-eminent gifts in hydraulic works, which, of all engineering works, are the most difficult to plan and to execute with complete success. The stability of bridges, for example, can be determined with mathematical accuracy, and they may be so designed as to be nearly independent of the action of water. But a system of dams and channels is no sooner established than the most watchful care¹ is needed to preserve it in efficiency; and any mistakes or oversight in the original design are

¹ Writing of the Sirhind canal, Mr. Deakin (*Irrigated India*, p. 214 and p. 224) says :—

"Every mile of the canal proves full of instruction as well as entertainment. Like a living organism, the great stream of water continually alters its environment, and is altered by it in time, so that the engineer's task is never over; he constantly meets new contingencies, and by the lessons of experience on his own or upon other canals learns to vary his expedients."

"Out of those far-off mountains and by this thirsty spectre land come the thin streams of water which are now filtered into the canal, to carry its boon of harvests for scores of miles into country almost as unprofitable as this. But in a few months there will be no longer this empty valley, and this quietness of air through which the voices of the Changras on the weir make a faint murmur. That great reef will then be hid in foam when the flood tide, spreading from bank to bank, and hoarsely roaring, will sweep down twelve feet to sixteen feet deep, half a mile wide, shifting its quicksands and shingle beds from side to side as a porter shifts his load, tossing its tangle of trees, grinding its ranks of boulders against the stubborn mass of stone and iron that will bar its way. . . . In the heat and in the storm the engineers will stand to their posts, and flinch from no contest with flood, fever, or famine, or with the river which they master (as their Government masters this people), to prevent the ruin which must certainly follow if its great subject forces should ever master them."



sure to make themselves manifest, and to require unforeseen and often very difficult remedies. Hence, discernment and foresight of a high order are essential in such designs. Captain Cotton's ascendancy in the possession of such qualifications was such as seemed unquestionable to those who were best acquainted with its engineering feats.

Before answering the question with which the preceding paragraph is opened, let this example of how the test: "Will it pay?" borne by Sir Alexander Arbuthnot, be recorded. Sir Alexander says:—

"The financial returns of these works have been such as have seldom resulted from any public undertaking. From the report above quoted, it appears that for six years after the construction of the anicuts, the annual profit on the capital expended was, in the case of the upper anicut, sixty-nine per cent., and in that of the lower anicut nearly one hundred per cent. The increased value of private property, due to the works, has been equally large, while in seasons of scarcity not only have these districts been preserved from the horrors of famine, but they have been enabled to pour large supplies of food into the adjoining districts."

My father shall be his own exponent as to what he wished exactly to do with what he had seen. "In considering how this noble river may be improved to the utmost," he wrote, "it immediately occurs that our grand object must be, not to let its waters run to waste into the sea. In high freshes an immense quantity is lost because it comes down faster than it can be applied to use; in low freshes a smaller, but still very large, quantity is lost at the very time that it is most required, because it is on too low a level for the lands to be irrigated by it. In the first case our object is to gain time, in the second to gain height.

"But, it is to the second point, namely the saving of water in low freshes, that I wish particularly to call the attention of Government, for the reasons already stated.

"The two plans usually adopted for raising the water from the bed of the river to a sufficient level to answer the



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purposes of irrigation are, first, by carrying a portion of the stream through a channel, having a less fall than the surface of the country till it has attained a level above that of the adjoining land ; and, second, by damming up the river.

"The first of these is preferable under certain circumstances, but it is very rarely indeed that the cost of diverting the water in a river can be secured in this way, for, generally, the cutting at the head of the channel must be so deep, and the channel must be of such great length to gain the required elevation, that it would be too expensive."

Of the scheme he recommended for approval he remarks :—

"The present cultivation of Tanjore would be entirely secured, except in extraordinarily bad years ; not only would crops be saved that are now lost entirely, but by far the greater part of the whole district would be made to produce larger crops ; in extraordinarily deficient years the amount saved by the dam would be far greater than in ordinary years."

When lecturing at the School of Military Engineering at Chatham, many years after, he said the history of this work would give an idea of the state of things under the Company's government. "In '27," he observes, "I was sent to inspect it, as the people were stated to be nearly in a state of rebellion from its neglect. I found the works in utter disrepair ; the Coleroon canal had six feet of silt in its bed, so that when it ought to have had eight feet of water flowing down it, it had two. Thus this work, which had a population of perhaps one hundred thousand and a revenue of £40,000 dependent upon it, had not been allowed £500 to keep it in repair. The Government could not afford it. Is it surprising the natives thought us savages ? I made a small estimate of £3,500 for some immediate repairs, but knowing what its fate would be, I proceeded to Madras, and arrived just in time to hear, as I expected, that the Government could not squander such sums as this upon the wild demands of an Engineer. We had, however, a Governor at that time who was accessible,



and I asked the Chief Engineer to go to him and speak to him about it. He said the papers had never been laid before him, and ordered the expenditure. In my ignorance at that time I thought the point was gained, as orders were sent to the Collector of the district, who had first called for my report on the case, and whose business it was, according to the absurd arrangement of that time, to execute the work. Soon after, I left the district, and did not return till '33, when to my astonishment I found that the Collector had not taken the trouble to spend the money, or the Government to enforce it; a small sum only had been spent, and the people were in such a state of rebellion that it had been feared troops would have to be sent into the district. Such was the inconceivable state of things under that admirable middle-class government."

The Cauveri is a large river rising in the range of mountains known as the Western ghats, which, catching the strength of the south-west monsoon, fill all the rivers draining their slopes with very large volumes of water. It is the biggest of the rivers in the south of the Peninsula, and runs for some hundreds of miles before reaching the head of the delta, at which point it throws off its first effluent, called the Coleroon.

Here it should be remarked, what Arthur Cotton himself frequently stated, he was not dealing with a virgin river or with virgin soil. Indian rivers were turned to irrigating purposes centuries before the British obtained a footing on the continent. Indian rulers of ancient times vied with each other in the execution of works which in a great degree proved of exceeding benefit to the country.¹

¹ "The practice of irrigation in India and in China antedates the historical epoch by an indeterminate period. The Greek Megasthenes, ambassador of Seleukos Nikator at the court of Sandrokothis, near Patna, who wrote an account of India three hundred years before Christ, says that then 'the whole country was under irrigation,' and very prosperous because of the double harvests, which by its means the people were enabled to reap each year. There are reservoirs in Ceylon and in Southern India more than two thousand years old."—*Irrigated India*, p. 141.



But even the most notable of these enterprises was marked by a paucity of idea and inadequacy of conception. In Tanjore and the adjoining district of Trichinopoly the indigenous works had proved comparatively successful. They, however, only made use of the river during the rains, when the water was least wanted. Our Engineer's conception and intention was to preserve the flood waters for the dry season. He did it. The doing of it removed the rice crops from the danger of utter destruction; rice being the staple article of food, what he did meant nothing less than rescue from starvation and misery for the whole population.

There was a singular appropriateness in the time at which the Coleroon was taken in hand. Within six months from the date of sanction of the plans, enough had been done before the monsoon burst, in what proved to be a dry season, to make the works most potent. So much water was stored, even at this early date from commencement, that much distress was prevented and the treasury instead of being depleted received additional revenue.

Arthur Cotton had great expectations as to what his anicuts would do. He thus expresses those ideas :—

"1st. An increased supply of water in Tanjore on one hundred days (counting those only on which the supply was deficient) would be ensured, the quantity varying from nothing to fifteen hundred thousand cubic yards per hour, or averaging five hundred thousand cubic yards per hour, and amounting in all to twelve hundred millions, or one-fifth of the total quantity that Tanjore received at present, which is on an average six thousand millions.

"2nd. It would entirely put an end to all disputes about the extension of the head of Seringam, etc.

"3rd. It would free the Trichinopoly ryots of Laulgoody entirely, and those of Seringam and part of Coanud in some measure, from the trouble and expense of making corumboes (temporary dams), and render the supply of water in their lands almost certain.

"4th. It would enable the people to use the early and



partial freshes to a much greater extent than at present, make the crop more rapid in its growth, and by both the harvest would be earlier, and consequently a more abundant supply would be left for the late lands.

"5th. It would greatly increase the effect of the under sluices, both by enabling us to open them oftener and also by giving a greater head of water. Hence there will be a most complete control over the level of the bed of the Cauveri, which is very important."

Again, he always considered, and reminded those who consulted him on this subject, that the value of irrigation works must be regarded as having two aspects:—

1st. *The additional revenue* brought to the Government by this method of employment of its public funds;

2nd. *The consequent increase in the value of the land itself* to the native community, and the *increase of their own incomes*; for which reason the land had a better saleable value. He added: "The price of land will greatly increase."¹

Once more: "The increase in the value of property to individuals is at least proportionately great." He reckoned that, "the value of the dependent crop would be augmented from its actual amount of £200,000 to £258,125; and the annual revenue from £75,000 to £103,125."

With such results already assured, no wonder that Arthur Cotton's life-long efforts were put forth to prove and to emphasize the fact that, "if a hundredth part of the time, labour, and money that had been lost by droughts, or expended in trying to obviate the effects of scarcities, had been expended in providing against them, very much might have been effected."

Captain Cotton likewise explained that "it was undoubted that, in the worst year of drought that ever occurred, enough water had been allowed to flow into the sea which, if used, would have irrigated ten times as much grain as would

¹ The italics in these paragraphs are Sir Arthur Cotton's.



have supplied the whole population." He added: "The Carnatic, I acknowledge (like England and every other country), is not able to support a large population if nothing is done to provide water, when naturally it would be deficient, and to carry it off, when naturally it would be in excess; but I am fully assured that there is no reason whatever why it should not be one of the most populous and fertile countries in the world, if the energies of its Government were exerted, as they must be, to bring out the capabilities of the country." In this, he was at one with Burke, who, in a great speech on the Nawab of Arcot, spoke of the water resources of Southern India as the national bank of the country.¹

Again, he argued most strongly that "the soil of these fertilized districts was by no means of especially good quality; its prosperous condition was owing entirely to its regulated supplies of river-water."

His next project was a similar work with regard to the

¹ "The Carnatic is not by the bounty of Nature a fertile soil. It is refreshed by few or no living brooks or running streams, and it has rain only at a season; but its product of rice exacts the use of water subject to perpetual command. This is the National Bank of the Carnatic, on which it must have a perpetual credit, or it perishes irretrievably. For that reason, in the happier times of India, a number, almost incredible, of reservoirs have been made in chosen places throughout the country. They are formed for the greater part of mounds of earth and stones, with sluices of solid masonry; the whole constructed with admirable skill and labour, and maintained at a mighty charge. In the territory contained in that map alone, I have been at the trouble of reckoning the reservoirs, and they mount to upwards of eleven hundred from the extent of two or three acres to five miles in circuit. From these reservoirs currents are occasionally drawn over the fields, and these watercourses again call for a considerable expense to keep them properly scoured and duly levelled. Taking the district in that map as a measure, there cannot be in the Carnatic and Tanjore fewer than ten thousand of these reservoirs of the larger and middling dimensions, to say nothing of those for domestic services, and the uses of religious purification. These are not the enterprises of your power, nor in a style of magnificence suited to the taste of your minister. These are the monuments of real kings, who were the fathers of their people,—testators to a posterity which they embraced as their own."—EDMUND BURKE.



Pallaur River, with its necessary provision of channels and reservoirs.

Indeed, from this time his active brain and earnest mind were ever at work, planning and scheming new enterprises, and always on a scale which was in accord with the size and volume of the rivers in question and the tracts of country which surrounded them. To these districts these huge forces of water must necessarily, in flood times, be an engine of destruction ; or, in drought, if not used—a loss, which could only cause famine, poverty, disease, and death ; on the other hand, they could be made productive of unlimited blessing and prosperity.

It was among the essential principles, always insisted upon by him, that the value of the irrigation works was not to be measured simply by the additional revenue yielded to the Government treasury, but that a much truer criterion is found in the enhancement of their income to the people and in the consequent saleable value of the land itself. Hence the importance of the observations which follow.

As to the profits of the people, he remarked, in a letter to the Board of Revenue, dated December 13, 1837, the year after the completion of the weirs, when noticing the increase of the revenue : "I believe the increase in the value of property to individuals is also at least proportionately great ; in Trichinopoly I have ascertained that the value of the lands in Seringam has actually doubled, and I am informed that the same is the case in the two South Arcot taluks. In Tanjore, also, I am assured that the price of land has greatly increased ; so, when it is considered that as much as five hundred and sixty thousand cawnies¹ of land are affected by the anicuts, the saleable price of which is, perhaps, £8,000,000, it does not seem too much to suppose that they have been the means of causing an increase of private property to the extent of no less a sum than £500,000."

To requote the remark on an earlier page of this

¹ A South-Indian term of land measurement.



chapter, "He who makes two blades of grass to grow where one grew before is a benefactor of his species," an extract from a letter from the Board of Revenue, written ten years after the construction of the anicuts, stating what was then officially known of their general results, may help to a reply :—

"Among the years succeeding 1836, some have been very bad and others equally good; but it is remarkable how uniform the rate of increase of production has continued, proving very clearly that the anicut has laid a new foundation of prosperity, so far as that may be measured by the productive power of the land. No other instrument could be employed to obtain the same results, because no other would tend in anything like the same degree to equalise the effects of favourable and unfavourable seasons, which are in themselves beyond any control."

The official figures showing the progress recorded fifteen and fourteen years respectively after commencement are :—

UPPER COLEROON ANICUT.

First cost	£8,340 ¹
Subsequent repairs	£27,238
Number of years	15
Aggregate net increase of revenue	£208,291
Average annual profit	£12,702
Aggregate profit	£172,713
Annual percentage of profit on first cost	144 $\frac{1}{8}$

LOWER COLEROON ANICUT.

First cost	£74,231
Subsequent repairs	£3,997
Number of years	14
Aggregate net increase of revenue	£14,230
Average annual profit	£9,879
Aggregate profit	£130,876
Annual percentage of profit on first cost	133 $\frac{1}{8}$

¹ The late General Bell, R.E., states that the cost was greatly diminished owing to a singular circumstance. "The stone for the upper anicut was quarried near the site of the works, but no such resource being available within a long distance from the lower anicut, all the required stone (with, of course, the consent of the Brahmins) was procured from the boundary wall of an ancient temple, standing in the jungle not far off, and long since disused."



The profits were reckoned on the original outlay on the anicuts, which were the basis of the whole system of irrigation, reforming it in one year with, as has been shown, almost magical effect. All the outlay for fifteen years under the head of subsequent repairs, but including many new subsidiary works, was compared with the former outlay for the same number of years for repairs, and found to be considerably less, proving that the anicut had not only provided water for irrigation, but, with its subsidiary works, had rendered the management of the river less expensive. The saving in this respect was, therefore, added legitimately to the profit on the works. On this point an extract from a minute by the Hon. John Sullivan, Member of Council, dated Sept. 5, 1840, is explicit and valuable:—

“It is satisfactory to know that after some of the heaviest freshes that have ever been known in the Cauveri, no damage whatever has been done to the banks of either river. On the contrary, the civil engineer reports that Tanjore was never so free from breaches as it has been this year.”¹

The almost phenomenal activity of my father's mind,—to be noted again and again in this biography,—was, probably, never more strikingly manifested than at this time. To turn the flowing current of a large tropical river, with little of experience to guide one, might have been

¹ The Principal Collector of Tanjore wrote to the Board of Revenue, on August 11, 1838, as follows: “I trust the Board will be satisfied, from what has been said, that the season of fasli 1246, A.D. 1836, was beyond all comparison worse than that of fasli 1241, both as regards the freshes and the rains. But as long as there was water for it to act upon, the effects of the anicut were most satisfactory, and the inference was not only fair but obvious; and that when, as was the case after the 25th September, the failure of the supply in the Agunda Cauveri was so great as to never afford a full river for a single day even with the assistance of the anicut; without it the failure of the crops must have been incalculably greater than it was.

“I cannot conclude without observing that, whilst so much doubt appears to be entertained of the advantages of the anicut elsewhere, there is not an individual in the province who does not consider it the greatest blessing that has ever been conferred upon it.”



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supposed to be enough to occupy the mind of a young man still considerably under thirty. Not so, thought Arthur Cotton. A suggestion was made that the roadstead of Madras should be formed into an enclosed harbour, or, at least, a breakwater or breakwaters should be provided. Merchants and others interested in the sea-borne trade of the Presidency, hearing of his Paumben Passage work, and of his interest in everything which made water subservient to the purposes of man, invited his opinions. He complied with their request, and briefly urged :—

1st. That the work best calculated to counteract the surf should be unconnected with the shore ;

2nd. That its shape should be a straight line parallel with the coast ;

3rd. That it should be of rough stone ;

4th. That it should not be within, nor much beyond, the outer line of the surf.

Colonel de Haviland, the Commandant of Engineers at Madras, approved of Captain Cotton's project and praised it highly, but the idea of such a breakwater was eventually relinquished, although at the time, so greatly did it commend itself to the gentlemen who had taken up the scheme, that at one meeting a very large sum of money was subscribed, with the intention of carrying out the plans.

On December 13, 1837, Captain Cotton addressed to the Board of Revenue an elaborate report on the duties of the Irrigation Department as a whole, but especially in relation to the numerous tanks referred to by Burke in the passage quoted on a preceding page. In this he treated, first, of the value of the works belonging to the Tank Department, not merely their capital value, as enterprises, but their annual value to the country if kept in good order; and then of the sum of money absolutely necessary year by year for this purpose. As to the then annual value, he shewed that it had greatly fallen off through want of attention. In conclusion, he remarked that, were these



works all efficient, the annual value of the dependent crop would be augmented from its then value (£3,200,000) to £4,130,000, and the annual revenue from £1,180,000 to £1,650,000.

There is, in almost every district in the Madras Presidency, an immense number of tanks constructed to catch the rainfall and conserve it for irrigational purposes. Most, if not all of these, are of Indian origin. A vast proportion has been allowed to fall into disrepair, their beds being used, in parts, for the growing of crops instead of their whole area utilised for the storage of water. An example of this will at once occur to every one who knows the city of Madras,—in the magnificent (but unused) area of the Mylapur Tank, which runs by the side of the splendid road to St. Thomas's Mount, and is a boundary to the many-mansioned townlet of Nungumbaukum. These, says the Hon. A. Deakin, M.L.A. (one of the Delegates to England in 1900 in connection with the Commonwealth Bill), in his valuable work on *Irrigated India*,¹ are all sizes, according to the catchment, and serve for the watering of an immense area. Nowhere else in India is there such a multiplication of minor storages. Mr. Deakin further remarks :—“ A calculation has been in circulation for some years, in which it is estimated that, if the embankments constructed with this end, within the Presidency, were added together, they would make a wall of earth six feet high, one and a half times round the globe.”

Arthur Cotton's next work was the superintendence of the construction of a short railway from Madras to the Red Hills, a few miles distant, intended for the transport of road material to the city. At this spot is now situated the reservoir which supplies the city of Madras with water. Circumstances arose which prevented the com-

¹ P. 262, *Irrigated India: An Australian View of India and Ceylon, their Irrigation and Agriculture*, by the Hon. Alfred Deakin, M.L.A., formerly Chief Secretary and Minister of Water Supply of Victoria. London: W. Thacker & Co., 1893.



pletion of the line, but it afforded practical experience, which was of considerable use to him in the execution of the Godavari works years after, where railway lines played an important part in facilitating the prompt construction of the great dams.

In a report, which he prepared about this time, he discussed the question of railways relatively to improved common roads, and makes mention of the short line between Madras and the Red Hills in illustration of his views. He had evidently no full conception then of the noble scheme of waterways for irrigation and transport, which, a few years afterwards, he brought before the Government and the public, and of which he never ceased to be a zealous advocate. In the light of the knowledge he then possessed, he set himself to prove the advantage of railways over the best roads, as he afterwards proved the superiority of steamboat canals to railways. There was thus no inconsistency in his ideas and writings. The one problem always before him was the cheapest and most serviceable transport for India, and to his subsequent solution of the same he, for more than forty years, adhered with inviolable fidelity.

Major-General Fred C. Cotton, the sole surviving brother of my father, has favoured me with some notes on the subjects last-mentioned.

"The Red Hills railway," he says, "was the first railway made in India, and the idea, that my brother was opposed to a railway system being begun in India, was incorrect. Later he came to feel that, when once large capital was expended on railways, there would be no chance of the country having the cheaper water carriage, which was, and ever would be, less costly for the transport of its products over the great distance they would require to be moved. In this he was quite right, and no one can doubt the value to India of a means of transport that would enable the producer, for instance, to undersell his competitors in the markets of other countries. Sir Arthur's expectations as to the fitness of canal-carriage



seem never to have been rightly understood in England, perhaps because the canal system in this country is on so small a scale. The canals and river navigation of India, as he would have had it, would have admitted of steam being used as the locomotive power in impelling vessels of great tonnage, which the size of the rivers and the cheapness of land for canalization promised in every way. And, as has been found, the very limited amount of tonnage even a costly railway can deal with, makes them quite insufficient in power for the object he had in view and the real requirements of the country. I only write this note, because it appears to me that some explanation is advisable of Sir Arthur's opposition to the costly railway system being adopted, to the exclusion of the infinitely more economical and more suitable carriage by water.

"And I would add to these that, when it was determined,—contrary to the advice of the late Lord Derby (at that time Lord Stanley), sometime Secretary of State for India,—to establish railways on the British system in India, every requisite for the purpose was immediately supplied: unlimited capital, qualified engineers in any number; rails, coaches, wagons, and locomotives needed only to be asked for to be forthwith supplied; the land, instead of being obtained through the expensive process of a Parliamentary committee, was provided directly by a decree of the Government; and, lastly, the necessary surveys were conducted with scarcely any difficulty through vast tracts of mostly level country. The broad rivers were entirely novel features; but these had, in many instances, been bridged by the Indian engineers, whose methods of construction were patterns of value to all future builders.

"On the other hand, a system of canal navigation would have required long and patient investigation and elaborate surveys by engineers accustomed to the construction and management of hydraulic works, and of such engineers very few then existed. It was no wonder, then, that, if



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such a system were thought of at all, it was rejected in favour of one perfectly easy of conception and execution, and needing only a guarantee to establish it all over the country."



CHAPTER V

Preparing for the Great Work—The Redemption of the Godavari District

THE bursting at Hobart Town of the boiler attached to the rotatory engine invented by Captain Cotton, with the resulting injury to himself, left alike its mark and influence upon him. When he reached Madras, he found himself in so unsatisfactory a state of health as to shrink from the heavy toil of an Engineer in charge of a Division. To him this was a serious disappointment. The long leave in Australia had afforded time for a consolidation of personal character and a great growth of mental force and professional zeal and acumen. India had taken hold of him. Not the India of Romance, but the India in Need. Consequently, it was with sorrow he felt himself unable to undertake what he wished to do. Arthur Cotton could afford to accept events with equanimity: he knew he was in God's hands, and was satisfied that, in His good time, the way would be made clear.

Weakened health necessitated light work, and light work was ready for him. It was, therefore, of signal benefit to himself, as well as to that part of the Madras Presidency in which his next service was to be performed, that he was appointed to superintend the building of a church at Vizagapatam, and also the construction of groynes on the beach at that place. Vizag, as it is familiarly called, was one of the most pleasant and salubrious stations in the northern districts.

Here he had a veritable rest, which well prepared him



for the engineering labours, which were to surpass all that he had, as yet, performed.

On their way from Madras to Vizagapatam the party had a direful experience. A cyclone burst in the Bay of Bengal, having (as is the wont of these circular storms) worked its way from that birthplace of the winds, in the neighbourhood of the Andaman Islands, whence have come so many destructive storms to devastate the Bay and to work havoc on the shores of Northern Madras and Orissa. Of this voyage my mother writes:—

“We left Madras for Vizagapatam, the sky all overclouded with the tokens of a hurricane coming on, and, before we had been on board many hours, the hurricane burst in all its fury. It was a remarkable voyage on account of the captain's wonderful presence of mind during the whole time the storm was raging. He behaved in a most Christian manner; no angry word was heard throughout the storm, nothing but his voice shouting, through a speaking trumpet, his orders to the officers; everything else was as quiet as possible.

“When the hurricane ceased we found that a ship, which had sailed from Madras at the same time as we had, had disappeared; the next morning the sea was strewn with wreckage, and a dismasted vessel was a striking object close by. The captain assembled all the crew and passengers, and thanked God for their deliverance. But the strain had been too great; his mind gave way immediately afterwards, and it was some time before he brought us into Vizagapatam.”

Nowadays the warning cone on Madras beach would have told of the coming peril, and the beginning of the voyage would no doubt have been delayed. Few who have not witnessed a “Bay cyclone” can conceive the widespread destruction often caused. In 1872 one such storm burst upon the (then) unprotected roadstead of Madras.¹ The violence of the wind increased

¹ This storm was marked by the loss of the *Hotspur* (1,045 tons), the *Arbeg* (925), the *Armenian* (901), the *Invershine* (717), the *Misset*



as night came on, and blew with terrific fury throughout the hours of darkness, causing much devastation. When day broke such a scene of wreckage was revealed, as had never before been known. Several vessels—some English, some Indian coasting ships—were strewn along three miles of coast, while the iron pier, stretching a long distance through the surf to deep water, had been cut in two by an Indian ship, which had been driven clean through the structure and wrecked on the opposite side. A "Bay cyclone" exhibits Nature in one of her most fearsome moods.

The party arrived safely at Vizagapatam, and were not long in finding a rough dwelling on the top of an isolated hill called the Dolphin's Nose. Some disused artillery barracks were found of use.

Two years were spent in the pleasingly diversified duties of building a church at Waltair and protecting the beach with groynes and other consolidating works. My father describes his early work there as the construction of a series of groynes at certain distances. These were built of large stone blocks, unhewn, and piled above the highest water-mark for some fifty yards out to sea.

Often, in later years, when he was visiting English harbours, he would talk over this simple, and yet most efficient, method of resisting the force of the waves, and even proving an effective barrier against a heavy surf, such as that which ever breaks upon the Indian coast. He has told us how, in those early days, he was ridiculed by older men, who were more learned Engineers. To suppose for a moment that piles of rough, loose stones thrown together could possibly resist the encroachments of such a sea! It was ridiculous. However, his groynes proved a grand success; they did their work, which was all that was wanted of them. Nay, they did more than was ex-

(700), the *Burlington* (676), the *John Scott* (655), the *Kingdom of Belgium* (592), and seventeen native craft. Thirteen Europeans and six Indians were drowned. A breach was made in the pier, and traffic was not restored for fifteen months.—C. A. L.



pected, for they made a splendid beach and added to the available soil by the silting of the sand above them. "A first-rate beach," he would say, with one of his earnest, impressive, gestures, when talking it over in later years.

My mother says of the experiences of that time:—

"The view from the Dolphin's Nose was very fine. The hill rose abruptly from the sea, and the great depth, looked down upon from the top, was sometimes awe-inspiring. Hawks and other large birds of prey above wheeled ceaselessly in circles, uttering their wild, weird cry. One house only beside the barrack was on the hill. The Chaplain of Vizagapatam had built it, and lived there—an agreeable companion and friend, who often spent the evenings in our society, frequently in studying prophecy together."

As bearing in some degree on what Sir Henry Sumner Maine, distinguished among the eminent jurists who have served India as Legal Members of the Governor-General's Council, has discussed in his address, "The Influence of India upon English Thought," this may not be an inconvenient place in which to make a remark on the effect of the solitary, or semi-solitary, existence in which so many Anglo-Indian officials perforce spend most of their time, upon those who pass through this experience. India has produced a special kind of British Christian. The Lawrences, the Edwardeses, whose biographies have delighted and profited many thousands of God-fearing folk, are representative of a very large proportion of Anglo-Indian residents. A convinced British Christian in India and Ceylon becomes a man (or woman) of intense conviction, of close study of the Bible, of more than average earnestness of life. Arthur Cotton was one of the most conspicuous of these unostentatious but deeply faithful and conscientious followers of the Saviour. To the very religious mind and mood of the Hindu, the character of such an one appeals with great force. General Rundall, R.E., an old colleague of my father, brings this out with great force when he remarks:—

"His [Sir Arthur Cotton's] character, as known to a