

Discussion.

The President. The PRESIDENT moved a vote of thanks to the Author for laying before the Institution, in so interesting a manner, the difficulties which beset the navigation of the River Hooghly; and he expressed the hope that the Paper would form a basis for measures for the improvement of the river.

The Author. The AUTHOR observed that he ought to mention a project known as the "Luff-Point scheme," which had been proposed since the Paper was written. Luff Point was a little below Gewankhali; and the proposal was that the Bengal-Nagpur Railway Company should choose some place on the right bank in the lower part of the Hooghly, where they could build jetties and form a coaling-station, and in that way avoid the James and Mary shoal and the shoals higher up the river. Such a station could be established near Gewankhali, where there was always deep water close alongside the right bank. The only objection, as regarded suitability, that might be raised against that site was that considerable erosion took place there, amounting, according to information he received in 1896, to about 8 feet per annum. He understood, however, from Commander Jarrad, who had advised the Company in regard to the navigation questions in connection with the proposed scheme, that that figure was somewhat larger than the actual amount. No doubt, if a coaling-station and jetties were established near Gewankhali, and if the erosion of the banks did not form an obstacle, the impediment to safe navigation offered by the James and Mary shoal would be obviated. The real objection to the scheme, however, was the important change it would effect in the route of navigation, and the removal from Calcutta of the trade it had always possessed.

Mr. Apjohn. Mr. J. H. APJOHN remarked that he had been responsible for the Author's visit to Calcutta to report on the Hooghly, and he thought the Institution was indebted to the Author for having put on record the history of that river in a form which would always be available in the consideration of any scheme for its improvement. When it came to an actual scheme, there was a wide difference of opinion on the subject. It was, he admitted, quite possible that the Author's proposals, if they could be carried out, might effect an improvement; but the question was, could they be carried out at any reasonable cost? The Author's estimate was £170,000; but,

speaking as one who had carried out works in India for many Mr. Apjohn. years, Mr. Apjohn considered that the work would cost about six-and-a-half times that amount. He might be wrong; but the very difference between the estimates showed how difficult the question was, and how hopeless it seemed to produce a scheme convincing enough to induce any public body to sink an enormous sum in what must be an experiment. But was the river quite as bad as was made out? He did not think there really was such great necessity for its improvement. Instead of getting worse, it seemed to him to be getting better. He had recently received curves of the Moyapur and James and Mary shoals, which showed a steady improvement in the last 20 years, and indeed a striking improvement since the Author visited the river. It was natural to think, as the Author did, that the gradual widening of the reaches must lead to a deterioration; but they had been widening for the last 20 years and yet for the same period they had been improving in depth. The draught and size of the vessels visiting the Port of Calcutta were increasing continually. In 1904 a vessel drawing 28 feet 3 inches made many voyages up and down the river with safety. Such a thing would have been regarded as incredible 20 years ago. He ascribed that not so much to the improvement of the river as to the improvement of the surveys of the river under the very able administration of Mr. Petley, who for the last 25 years had administered that department of the Port Trust. Twenty years ago only 1,225 miles were sounded every year, while in 1904 7,678 miles were sounded. Twenty-five years ago only 20 charts and notices were issued in the year; in 1904 there were 1,093 daily notices and small charts of the changing bars, which enabled the pilots to take the best course instead of the old system of following a straight track. There had also been a large increase in the number of buoys and river-marks, which had been increased in the period from 7 to 44, and from 57 to 138, respectively. Therefore it would seem that the improvement in the navigation of the Hooghly was due not so much to the river itself as to the surveying of it. The river-authorities could not afford to experiment, at the cost of, say, a million sterling, with works which might do harm—especially while they were being carried out. Even the Author's proposed training-wall might lead to serious trouble before it was completed. Although he did not entirely agree with all the details, he preferred Mr. Lindon Bates's proposal; at any rate, the works Mr. Bates proposed could be carried out with certainty, and there was no engineering difficulty about them. He

Mr. Apjohn. would be rather inclined to change slightly the position of some of these walls; and whether they should be above high tide or only up to half-tide level was an open question. He was disposed to agree with the Author that they should not be up to high tide. He was of opinion that the Author's wall should be above high-tide level, because otherwise he was certain it could not be carried out.

Commander
Jarrad.

Commander F. W. JARRAD, R.N., pointed out that the Luff-Point scheme submitted to the Government of India by the Bengal-Nagpur Railway Company, had really, among other reasons, been taken up in order to avoid the upper reaches of the river and the dangers attending navigation. Eventually a place lower down the river than that suggested by the Author had been selected, where there was deep sheltered water and facilities for mooring vessels in quietude, with suitable sites for jetties or docks. The scheme had been brought forward in the interest of the Bengal-Nagpur Railway Company, in order to get a better share in the coal-trade than they were getting by taking their coal across the river at Calcutta by ferry—a very unsatisfactory procedure. The proposal was to bring a short line down from Panchkura, one of the Bengal-Nagpur stations, to near Luff Point. Attempt had been made to greatly minimize the undoubted physical advantages of the proposed site by the opposition of the Port Trust of Calcutta, who not unnaturally preferred to load coal at Kidderpur Dock, in order to keep up their revenue, which they feared would fall off if the scheme were carried out. That idea had been exploded of late years. The building of Barry Docks had been supposed to threaten the trade of Cardiff, instead of which Cardiff had progressed; and the same would apply to Calcutta. The proposal was essential to the development of the coal-trade. He did not agree that the river could not be improved, nor did he agree that it was really improving itself in a measure, because his investigations went to show that the Author's statement that it was deteriorating was right. He knew that when he was in the Indian Survey years ago there were far fewer places in the Hooghly which gave trouble than there were at present. The Calcutta authorities had, he understood, ordered a very powerful dredger to dredge the shallows—a fact which did not indicate that the river had improved. Naturally the river would be improving about the present time, because it was just after the rainy season, and a period when the channels were really at their best. The Author had done great service in bringing together in the Paper the various schemes that had been put forward. It would be a great advantage if some scheme could be formulated, although

he thought the river had suffered from having "too many cooks." Commander
If only the Government of India could take up the matter and Jarrad.
get the advice of competent engineers, he had no doubt the
river could be dealt with to the great advantage of the port of
Calcutta.

The AUTHOR, in reply, observed that there were three places The Author
where, as he had pointed out, the river was evidently deteriorating,
namely, at Moyapur, Royapur, and the James and Mary reach. He
was much surprised that Mr. Apjohn said the river had been improv-
ing during the last 20 years. He did not know what had occurred
in the last 2 years; but certainly in the latest surveys that reached
him up to 1902, the Royapur crossing had a bar with less than 3
fathoms over it at the lowest low-water; whereas when he was in
Calcutta in 1896 there was no 3-fathom bar at Royapur at all,
although it looked as if there would be a bar there in the future,
as the river seemed to be deteriorating at that crossing. Moreover,
the Moyapur crossing was obviously in a much worse state in 1900
than in 1883 (Fig. 8, Plate 3; and compare Figs. 14 and 16,
Plate 4); and it was pointed out in the Paper that the surveys
showed a gradual deterioration of the James and Mary reach. He
agreed, however, with Mr. Apjohn's subsequent qualifying remark
that most probably the fact that the river was now navigable
by larger vessels than it was 20 years ago, was due to the very
good surveys which had been carried out, under the direction
of Mr. Petley, and the large number of notices issued to the pilots
at frequent intervals, giving the existing depths over the worst
shoals. But these precautionary measures could not be increased
indefinitely, and very soon it would become absolutely necessary
to do something to improve those particular bars in the river.
He was sure it would not be beyond the resources of engineers to
find a means by which the depth over these bars could be increased,
and the deterioration of these particular reaches by progressive
widening could be arrested. Moreover, though it might be beyond
the capabilities of engineering science to improve the estuary
beyond a moderate amount at a reasonable cost, a powerful suction
dredger might lower the highest parts of the bars and help the
channels to develop as they changed.

The PRESIDENT observed that the James and Mary shoal con- The President.
stituted a very serious danger to the navigation of the Hooghly,
from the fact that when a vessel touched on the sand it was, as a
general rule, lost in a few minutes; the ship heeled over and was
sucked in. Only lately he had received a graphic description of

The President. such an occurrence from a lady who was going down the river. She was in her cabin, when suddenly she found the ship on its beam ends, and she was just in time to crawl through the port-hole and climb outside on to the bulwarks, from which she was rescued by a steam-launch. He had passed over the James and Mary shoal between thirty and forty times, and always with a feeling of relief when the passage was ended. If anything could be done to improve the shoal it would be of considerable benefit, but any work undertaken would entail dealing with very large volumes of water, and would be work of considerable difficulty and expense. Moreover, with such complicated conditions as existed in the Hooghly the result must be always a matter of uncertainty. While improvement might be effected in one place, at the same time conditions might be set up which would make matters worse in another place. The question of taking the trade away from Calcutta was a very important one. The peculiarities of the coal-trade might of course enable this objection to be met by chartering special vessels; but an unsuccessful attempt had already been made to establish a port at Port Canning, on the Mutla river, by which the difficulties of the James and Mary shoal would have been avoided, and navigation simplified; but it was found impossible to draw the trade away from Calcutta, where the merchants' houses were established. The character of the foundations in this delta might be gauged from the fact that, when some cast-iron cylinders for foundations had been sunk to a depth of about 30 feet, they suddenly disappeared, and no trace of them could be found.

Correspondence.

Mr. Bellasis. Mr. E. S. BELLASIS observed that when a stream flowed round a curve the cross section of the stream was unsymmetrical, there being a deepening along the concave bank and a shoaling along the convex bank. In straight reaches, or at the "crossings" where one curve ended and another, bending in the opposite direction, began, the section was symmetrical. The deep stream tended to hug the bank more just below a bend than just above it. Hence, in a tidal stream which flowed sometimes in one direction and sometimes in the reverse direction, the flood-tide might tend, near