

f5H
367
I5H6

UC-NRLF



\$D 1 088

YH 00454

THE

PRESENT DEPLETION

OF THE

OYSTER-BED OF SIND;

ITS CAUSES AND THE REMEDIES.

BY

JAMES HORNELL, F.L.S.,

Marine Assistant, Madras Fisheries Bureau, etc., etc.



BOMBAY

PRINTED AT THE GOVERNMENT CENTRAL PRESS

1910



THE LIBRARY
OF
THE UNIVERSITY
OF CALIFORNIA

PRESENTED BY
PROF. CHARLES A. KOFOID AND
MRS. PRUDENCE W. KOFOID

THE
PRESENT DEPLETION
OF THE
OYSTER-BED OF SIND;

ITS CAUSES AND THE REMEDIES.

BY

JAMES HORNELL, F.L.S.,

Marine Assistant, Madras Fisheries Bureau, etc., etc.



BOMBAY
PRINTED AT THE GOVERNMENT CENTRAL PRESS
1910

THE

PRESIDENT DEPARTMENT

ON

OYSTERS AND THE

ITS CAUSES AND THE REMEDIES

BY

JAMES HORNELL, M.D.

NEW YORK: PUBLISHED BY THE AUTHOR, 1881.

PRINTED AT THE GOVERNMENT PRINTING OFFICE

1881

fSH367
I5H6

THE PRESENT DEPLETION OF THE OYSTER BEDS OF SIND ;

ITS CAUSES AND THE REMEDIES.

BY

JAMES HORNELL, F.L.S.,

Marine Assistant, Fisheries Bureau, and
Superintendent of Pearl and Chank Fisheries to
the Government of Madras.

I.—INTRODUCTORY.

II.—PHYSICAL FEATURES OF THE SIND COAST.

III.—HISTORY OF THE OYSTER INDUSTRY IN SIND.

IV.—THE PRESENT CONDITION OF THE BEDS.

V.—CONCLUSIONS.

VI.—THE REMEDIAL MEASURES PROPOSED.

I.—INTRODUCTORY.

The Sind creeks a few years ago produced edible oysters in great abundance; their collection and despatch constituted a lucrative minor industry in the district and earned for Karáchi, whence they were forwarded all over the north of India, a pre-eminent reputation for the excellence of its oysters.

2. Sixteen years ago a diminution of the prosperity of the beds was first noted; the decrease continued and became progressive in spite of various measures adopted to remedy this deterioration, and in the early part of 1908 Mr. H. C. Mules, the then Collector of Karáchi, felt compelled to recommend to Government the desirability of obtaining expert advice with a view to the initiation of suitable measures for the preservation and increased production of the beds. Attention was drawn to the fact that the institution of an annual close season and the alternate closure for two-year periods of the two sections into which the creeks were classified had proved unavailing to check depletion. The almost total disappearance of edible oysters from places which formerly furnished them in abundance was signalized; the beds were stated to be practically exhausted. Without the initiation of a more efficient system of conservation it was predicted as certain that edible oysters in Sind would be non-existent within a few years.

3. In consequence of this representation the Madras Government was requested by the Government of Bombay in January 1909 to permit me to undertake an inspection of the Sind oyster beds in order to investigate the causes of their exhaustion, and, if possible, to formulate a practical scheme for their regeneration. My services could not then be spared, but eventually it was arranged that I should proceed on a three-weeks deputation to Sind on my return from leave in the October following. To save time I returned to India *viá* Bombay. I landed there on 19th October 1909 and thence proceeded to Karáchi by the first steamer available. After reporting my arrival to Mr. W. H. Lucas, Commissioner in Sind, and to Mr. H. C. Mules, Collector of Karáchi, the latter was able to arrange, by the courtesy of Mr. F. S. Punnett, Chief Collector of Customs, that I should have the use of the Customs sailing yacht "May Queen" for my tour of the creeks as well as the invaluable services as guide of Mr. G. W. Judd, the veteran Head Preventive Officer. Eleven days of incessant work followed; of this time the greater part was spent in acquiring a first-hand acquaintance with the physical and biological conditions prevailing in the great net-work of waterways forming the seaward section of the Indus Delta. Time was also found to examine the Karáchi backwater and the oyster-deposits on the banks of the Hab river, the frontier between Sind and Baluchistan. The visit concluded with a camel ride to the Kuranji creek on 5th November, and on the evening of the same day I left Karáchi for Bombay and Madras.

4. Before proceeding to deal with the subject-matter in detail, I take this opportunity to thank most heartily all the officials named for the trouble they took to meet my wishes in every way possible and to provide me with every possible facility for my enquiry by furnishing me with the best available means to get about, by giving me access to all available records and by placing their own personal knowledge of the subject unreservedly at my disposal. Mr. Judd, Head Preventive Officer, I wish to thank most specially for the invaluable assistance he rendered throughout the investigation, often I fear, at the expense of great personal discomfort, for it is not every one who is able to withstand the effects of the pitching and rolling of a small vessel in breezy weather! No one has such an intimate acquaintance with the details and history of the local Oyster Fishery as Mr. Judd, and I should have been at a great disadvantage and the enquiry would have been much prejudiced had his knowledge not been available.

II.—PHYSICAL FEATURES OF THE SIND COAST.

5. To enable the details of the ensuing sections to be followed with greater ease and fuller comprehension, it may be of advantage if I preface them with an outline in brief of the more prominent physical features and characteristics of the coast district of Sind.

6. The Sind coast-line has an extent of some 130 miles from the boundary with Kutch on the east to that of Baluchistan on the west. Except for the extreme western extremity where a low range of sun-scorched barren hills descends to the coast to end in the bluff headland of Ras Muari commonly known as Cape Monze, the coast line is low and unmarked by any conspicuous landmarks eastward of Gizri creek immediately to the east of Karáchi City. From the latter point to Kori creek, the boundary with the native state of Kutch, the coastal lands of Sind are of purely deltaic origin, low alluvial flats intersected by a maze of waterways connected now or in times past with the delivery of the Indus waters to the sea. A narrow belt of low sand hills generally borders the seaward margin; behind this the land stretches inland for many miles in a long vista of muddy swamps, mostly submerged at high water of spring tides. Formerly large areas were covered with mangrove scrub, but to-day the firewood cutter has practically cleared the land even of this scanty vegetation to the distress of camel breeders who formerly were able to graze great herds of camels in this mangrove jungle. Occasionally some tamarisk bushes are seen and on the flats adjoining the Indus main channels—the Kediwari, the Baghiar and occasionally the Hajamro—extensive paddy cultivation is carried on after the floods subside.

7. The Indus, the creator of all this land, divides into two principal arms about 50 miles from the sea. These discharge during the flood season by a variable number of mouths, spread over a sea-face of nearly 100 miles; as the inundation subsides, the majority of the mouths cease to pass fresh water, the discharge becoming limited usually to two, the Kediwari and the Baghiar. August is the month of maximum flow. The local rainfall, a very scanty and fluctuating one, averages about 7 inches; the bulk of this falls in July. This rainfall turns the river beds opening into the Hab estuary, the Karáchi backwater, and Gizri creek, into raging torrents for a few hours, but its influence on the Indus discharge is trivial compared with the enormous floods, continuous throughout the summer, caused by the melting of the snows and glaciers on the Hindu Kush and the Himalayas.

8. The Creek mouths between Karáchi and the seaward opening of the Kediwari, at present the principal channel for the discharge of the Indus, are as follows in order from north-west to south-east, namely:—

Gizri, Piti, Khudi, Khai, Pitiani, Dubba, Sisa, and Hajamro.

Beyond the Kediwari mouth the creeks are less well known and as I was informed that no oyster beds of any value are found there, I did not visit this district. It may be mentioned, however, that the Baghiar is the chief discharge mouth eastward of the Kediwari and that the easternmost creeks, the Sir and the Kori, are now cut off from direct communication with the Indus by means of bunds. The Kori creek forms the boundary between Sind and Kutch.

9. Gizri mouth, six miles south-east of Manora Point, leads into Gizri and Kuranji creeks; the former penetrates northwards half-way to Karáchi, the latter leads inland and gives off on the south the tributary creek called Kadero through which access is gained to southward creeks and through them by circuitous channels to the Indus. The northern bank of the Kuranji is formed by a line of low bluffs, the escarpment of the low plateau of sandy limestone stretching east and north of Karáchi. Rugged precipitous nullahs or dry waterways cut through this line of cliff at frequent intervals, giving a distinct suggestion of cañon country to the plateau when viewed from one of the higher hillocks. As the creeks do not extend northwards across this plateau, we may infer that this escarpment set a northern bound to the Indus floods, so that we may consider the Kuranji as marking the most northern of the old time channels leading from the Indus to the sea. The southern bank of the Kuranji is low-lying and swampy, often inundated at high water of great spring tides; mangroves and other swamp bushes are fairly plentiful over these flats.

10. Piti mouth leads northwards into the J'hiri creek, eastwards into the Piti creek. On the banks of both these creeks are said to be the ruins of strongly built forts reminiscent of days when these creeks functioned as main outlets of the Indus, prior to deflection of the main arms to the more eastward course they have at the present day.

11. The next three mouths, the Khudi, Khai, Pitiani and Dubba, require no special notice here; they all lead into creeks which meander through low-lying mud flats, very sparsely furnished with mangrove scrubs. The inhabitants are few in number—fishermen and camel graziers living in poor huts surrounded with low bunds to keep out the tide, which at high springs submerges the surrounding country. Neither springs nor wells are found in this region; all sweet water has to be brought in boats from a distance and is stored in tiny tanks enclosed by mud bunds a few inches high.

12. Next comes the Sisa (or Jua) mouth leading into Sisa creek to the north-east, to Bhuri creek to the east and to the narrow Gabri creek into the Hajamro and through to Ketī, the only town near the embouchure of the Indus.

13. The Hajamro mouth and creek vary greatly in position and importance, sometimes forming for years one of the chief outlets of the Indus, sometimes being cut off and forming a purely salt water tidal creek. One of its active periods began about 1848 when it poured a large portion of the Indus water into the sea immediately to the south of the Sisa mouth. Since then its seaward opening has been deflected a considerable distance southward till to-day it is only five miles north of the mouth of the Kediwari. The mud flats at its entrance have also grown seawards some $3\frac{1}{2}$ miles since 1867, when it constituted the only navigable mouth of the Indus. This branch after a long period of closure at the point of junction with the Indus (Kediwari) was again opened during the floods some three years ago and at present shallow draft craft are able to pass to sea from Ketī either by this mouth or the Kediwari; they have the further convenience of being able to pass the whole way from Ketī to Gizri Bandar by inland channels without having to debouch at the Kediwari mouth, and then re-enter the creeks by the Hajamro or the Sisa mouths, as was necessary during the period when the Hajamro did not connect with the Indus at Ketī.

14. The main branch of the Indus has long been the Kediwari and there appears every probability of it so continuing. Like the creeks and channels already mentioned its banks are everywhere low and subject to more or less submergence during the height of floods. The power of the river water being much greater than the tidal influence in this outlet, paddy cultivation is extensively carried on along the banks as the inundation subsides. In those years when the Hajamro takes off from the Indus, cultivation extends down the flats bordering this channel as well, being again abandoned upon interruption of free communication, as the water then becomes wholly tidal and unfit for irrigation purposes.

15. So far as we know, the history of the northern (north-western) section of the Indus delta—that portion with which we are immediately concerned—begins about the end of the 7th century. At the time of Alexander the Great's invasion of the Punjab and voyage down the Indus and till about A.D. 680, this river appears to have flowed to the sea considerably to the east of its present course and to have entered the sea by what is now the Kori creek, the boundary between Sind and Kutch. Then about 680 A.D. the river cut a passage for itself through the limestone ridge between Rori and Bukkur and burst a new way to the sea some 70 miles to the westward, probably in the vicinity of the upper reaches of the Piti and J'hiri creeks. In the succeeding centuries the ultimate channels gradually straightened tending more and more to the south and east till they took their present form, with the Kediwari as the principal outlet. From this we may conclude that the northernmost creeks, the Kuranji, Piti, Khudi Khai and Pitiani, antedate those between the last named and the Kediwari; the former seldom pass any large volume of river water in normal years. Their main channels and their tributary creeks are subject to little change and, as will be noted on a later page, these are the localities where edible oyster beds have been most largely developed. Seldom have beds of oysters been found in creeks and channels having direct communication with the Indus—thus there were several beds in the Hajamro when this channel was bunded off by silting from the Kediwari, but these beds have entirely disappeared since the recent re-opening of communication and the constant rush of river water down this channel.

16. The character and history of the Karáchi backwater are distinct from those of the Indus creeks. Here we have no true deltaic formation but a great backwater all but shut off from the sea by a long narrow sandridge forming a natural breakwater extending N.-W. from Manora Point to a junction with the foot slopes of the range of hills terminating in Cape Monze. This long dividing bank is due to the interaction of the prevailing winds and currents with the scouring action of the heavy spates which once or twice a year pour into the backwater with great force from the Laiari River. The general set of the currents is to the south-east; in the S.-W. monsoon the force exerted on the sand brought down to the sea by the hill and plateau drainage streams of the neighbouring land is very powerful; a large amount of sand is also forced round the outlying head of Cape Monze from the sandy Baluchistan coast and this with the locally accumulated detritus is piled as a low barrier parallel with the coast. The floods from the land behind periodically scour away much of this current and wind accumulation keeping open a number of deep channels within, the principal being that from the Laiari River which now forms Karáchi Harbour.

17. There can be no doubt that the Laiari River originally opened directly to the sea; the small streams from the south slopes of the Hab Hills also descended direct to the sea. Gradually an obstructive sand bank grew out south-eastwards from the Hab slopes and with its growth the various streams behind turned in a like direction, till the time when the only outlet came to lie to the east of Manora bluff. The channels at the western end of the backwater are kept open by the flow during the rains of a number of small hill streams, those of the centre and east sections by the intermittent floods of the Laiari. West of Cape Monze the Sind Coast consists merely of the eastern bank of the estuary of the Hab River, a mountain stream rising southward of Kelat with a course of some 100 miles in length. The mouth is much obstructed by sandbanks which dry at low tide and leave open only a narrow channel close to the Sind side. Low cliffs of gritty limestone approach the river bank in several places along the Sind shore; the opposite or Baluchistan margin is backed for some distance by a sandy plain. Further details are given in the section descriptive of the visit paid to the oyster beds of this estuary.

III.—THE HISTORY OF THE OYSTER INDUSTRY IN SIND.

18. Prior to 1894 no official cognizance was taken of the fishery for edible oysters on the Sind Coast; the industry paid no dues, and was under no supervision. From statements by Umar Saffur and Sumar Ebrahim, two men who shared the trade of collecting oysters for sale to the wholesale dealers of Karáchi, and who were examined during the first enquiry (1895) into the condition of the beds, it appears that the trade began about 1855. When Umar Saffur commenced business, his supplies were obtained from the Nawa Nar beds in the western section of Karáchi backwater. He stated that extensive beds existed there originally. For a number of years the demand was purely local, none being sent up-country till the opening of the Sind Railway, and so long as this was the case the oystermen stated they had no difficulty in meeting the supply. With improvement in distributing facilities and the consequent growth of a demand in the Punjab, Baluchistan and the North-West of India generally, the Nawa Nar or Mauripur beds began to show signs of exhaustion. Difficulty was found in obtaining the quantities required and it became necessary to begin to fish the beds in Kuranji creek, east of Bram Haidri. This creek is the northernmost of the Indus deltaic system; the rocky escarpment forming its northern bank provides some outlying patches in the creek bed which render it very suitable to become oyster bottom. These beds, from the evidence provided by their present ruins and by the showing of the oystermen, must have been very rich—they and the Nawa Nar beds appear to have sufficed for all needs down to 1890. It is on record that in this year foul smelling sulphuretted water entered Karáchi Harbour and the three creeks to the southward—Kuranji, Piti and Khudi; in June 1890, Karáchi Harbour was full of dead fish.⁽¹⁾ There is general

(1) Sir Henry Mace is quoted by the Sind Gazette dated 16th August 1897 as having said that, when steaming along the coast of Baluchistan, he had seen the sea, for short periods, as if putrid, the fish being destroyed in myriads, so that, to prevent a pestilence, measures had to be taken to bury those that were cast up on the beach. He suggested that the cause was the outbreak of a submarine volcano and the liberation of sulphuretted hydrogen.

agreement among the fishermen and dealers that this foul water affected oysters equally with fish and they state that the oyster beds in the three creeks named were entirely destroyed. The deadly influence of the poisonous water appears not to have affected the waterways southward of Khudi, hence the oyster beds of the further creeks, Khai, Pitiani, and Dubba, were subject to a ruthless exploitation from 1890 till their virtual exhaustion some four years later. From about 1880 to 1893 was the period of greatest productiveness; the beds although limited in area were so rich that till 1892 or 1893 no difficulty was experienced in meeting the large and increasing demand. The Customs authorities have estimated the annual yield of the beds during the fat years of the early nineties at about 100,000 dozen made up thus:—

	Dozen.
(a) About 30 boats per annum, each carrying on an average 600 dozen large and 3,000 dozen small oysters	90,000
(b) By camels and donkeys from the Karanji creek and the Mauripur beds in Karáchi backwater	10,000
Annual total ...	100,000

19. In the early days of the industry the wholesale price was exceedingly low—6 pies per dozen according to Umar Saffur. The rate rose gradually till it treached one anna per dozen in 1890. By 1895 it had doubled and to-day it has risen to 3 and even 4 annas per dozen wholesale, when procurable, but the bulk of orders received by the Karáchi dealers have now to be refused for lack of supply.

20. The attention of the authorities to the rapidly increasing scarcity of oysters in the creeks appears first to have been drawn by Mr. G. W. Judd, the present Head Preventive Officer in the Karáchi Customs' service. In a letter to the Collector of Customs, dated 29th June 1894, he intimated that he had ascertained that the oyster beds in the Sind creeks which had supplied all the requirements of Karáchi for years previously, were being exhausted and that a great deal of trouble, delay and additional expense had now to be incurred in the collection of oysters. His attention had been directed to the matter by learning that the Karáchi oyster traders were negotiating with the authorities of the neighbouring native state of Las Beyla in Baluchistan to obtain supplies at Sonmiani during the ensuing cold season owing to the ever-increasing difficulty in obtaining a sufficient supply from the home creeks. Enquiries had been made at Sonmiani three years previously, but on the Jam's officials demanding a fee of Rs. 10 per boat-load, the traders declined to treat further for the time being. Mr. Judd also reported having examined the oyster beds in Kuranji and Piti creeks some short time previously; he found that "all that remained were empty shells to mark the spot where at one time boat-loads used to be removed." The letter concluded by expressing the writer's belief that within a short time the whole of the oyster beds in the vicinity of Karáchi would be entirely exhausted, unless measures of protection were initiated. The Mukhtyárkar of Karáchi confirmed the foregoing statements. He remarked that the exhaustion of the beds was due to the very large exportation of oysters to up-country stations during the cold season. He suggested that restrictive regulations might be enforced under the provisions of section 37 of the Bombay Land-Revenue Code (Bombay Act V of 1879) which vests in the State the ownership "of the bed of the sea and of the harbour and creeks below high water mark."

21. In February of the following year (1895), the Commissioner ordered an enquiry in order to ascertain particularly the general condition of the beds, the localities where they exist, the annual production, and the measures, if any, to be taken to regulate the fishery and to prevent its extinction.

22. Oystermen, fishermen, dealers and exporters were examined and ample testimony of the depleted condition of the beds was adduced.

23. It was shown that since 1890 the source of supply was limited almost entirely to the Pitiani, Khai and Dubba creeks and their branches. Fisher men from these localities agreed that few or no oysters were taken from these three creeks prior to the end of 1890, the year when the entry of foul water completed the destruction of the beds in the more northern creeks. For the first two seasons (1890-91 and 1891-92), the oystermen Umar Saffur and Sumar Ebrahim collected the oysters without the assistance of the villagers, so abundant was the supply. At the beginning of the 1892-93 season the oysters had become

less easy to collect in quantity and it was necessary to enlist the assistance of the fishermen and villagers to scour the waterways for the quantities required. For the first two years, the oystermen paid the villagers at the rate of Rs. 4 per 100 dozen. This price paid the collectors well for the first season; during the second it scarce sufficed for a bare living. At the beginning of the 1894-95 season oysters had become so reduced in numbers that the oystermen were compelled to raise the rate of payment for collection to Rs. 5 per 100 dozen. Even this ceased to be remunerative after the first few weeks of the season, so scarce were the oysters; indeed so extreme was the difficulty experienced in their collection in quantity that the majority of the men who had been employed gave up the work in disgust in spite of the temptation of money advances offered by the oyster dealers.

24. Apart from the harm done by actual overfishing, a very serious abuse came to light during this enquiry; it was found that for greater convenience in sorting as well as for personal comfort during cold weather, it had been customary for the fishermen to load up their small boats (toneys) with oyster clumps or clusters indiscriminately, transport them to some convenient place near high water mark and there do the actual separation of marketable oysters at leisure. This entailed great loss as the clumps removed consisted largely of dead shells frequently bearing numbers of immature oysters; when the former were knocked off, the latter died from exposure, no effort being made to replace this unsaleable material on the bed whence it came. As one fisherman justly remarked, the men destroyed more than they removed, as the young ones thus lost would have been ready for market the following season had they been either replaced or left on the mother-bed.⁽¹⁾ The oysters selected were usually kept in the channel adjacent to the fishermen's huts till the oyster dealer came round to the village with his boat.

The evidence given at this enquiry was considered to bear out fully the statements made regarding the perilous condition of the oyster industry and the imminence of permanent depletion unless safeguarding measures were at once taken. Various regulations were suggested but all that was done in 1896 was to close the beds during the hot weather and then upon their re-opening in October to make sure by inspection of the cargoes brought into Karáchi that no under-sized oysters were taken to market.

25. At this time Captain Shoplaud, an ardent Conchologist, happened to be Port Officer at Karáchi and this appears to have led the Commissioner to request him to make a personal examination with a view to furnish further suggestions regarding the measures most likely to lead to improvement in the supply.

26. The report was furnished in January 1897. It was couched in a most optimistic key, the view being taken that the institution of an annual and general close time from 15th April to 1st October for all the beds and the enforcement of a size limit would prove sufficient to restore prosperity to all the beds save those at Nawa Nar and in the Kuranji creek; for these latter he suggested a preliminary closure of two years. No oysters under 2 inches or over 6 inches in greatest length were to be fished.

27. From the enquiries made, Captain Shopland was able to furnish the following list of places in Sind whence oysters are obtained for the Karáchi market, *viz.* :—

Name of creek etc.	Number of beds of oysters.
Hab River	1
Karáchi Harbour	2
Gizri (Kuranji) creek	9
Piti creek	9
Khudi creek	5
Khai creek	8
Khanto creek	16
Pitiani creek	16
Dubba creek	5
Hajamro creek	2
Total of beds	72

⁽¹⁾From what I saw of the proceedings of oyster collectors during my inspection last year, I fully believe this to have been an important factor in depletion.

He reported also that no oysters were procurable in the Hab river at the time of his visit, as during the preceding rainy season the river altered its course and silted over with sand nearly all the oyster-covered rocks. Captain Shopland expressed the opinion that the Sind oyster is fit for the table when 2 years old, a conjecture based on the appearance of the shell and upon the measurements of a few oysters kept under observation for two months. During this period they exhibited very rapid increase, showing an improvement of from $\frac{7}{8}$ to 1 inch in length and of $\frac{1}{4}$ to $\frac{3}{8}$ inch in breadth within this time.

The details are worthy of record, namely :—

	On 12th November 1896.	On 11th January 1897.
No. 1	$1\frac{5}{8} \times 1\frac{3}{4}$ in.	$2\frac{1}{4} \times 1\frac{3}{4}$ in.
2	$2\frac{1}{4} \times 2\frac{1}{4}$ in.	$3\frac{1}{4} \times 2\frac{1}{4}$ in.
3	$2\frac{3}{4} \times 2\frac{3}{8}$ in.	$3\frac{1}{2} \times 2\frac{1}{2}$ in.
4	$1\frac{3}{8} \times 1\frac{3}{4}$ in.	$2\frac{1}{2} \times 2\frac{1}{8}$ in.

28. To gain reliable information as to the rate of growth he recommended the deposit of a few boat-loads of tiles or stones to serve as spat collectors during the ensuing April at the oyster beds at Nawa Nar and that the spat so collected be examined from time to time during the ensuing 5 or 6 years.

29. In accordance with these recommendations, an annual close season from 15th April to 1st October was ordered, the size limit suggested was adopted, and Mr. Judd, the Head Preventive Customs Officer, was instructed to deposit three boat-loads of cultch at Nawa Nar and to periodically examine and report on the progress of any spat which might settle thereon. The Customs Officers were charged with a general oversight of the beds at large, while the supervision of the imports into Karáchi was entrusted to the Port Officer. The better to control the trade, all collectors of oysters had to take out licenses, being charged a nominal fee. No special establishment was considered necessary to enforce the regulations.

30. The industry did show a slight improvement during the ensuing three seasons, the average yield approximately 17,000 dozen per annum from the whole Sind Coast. The yield fell greatly in the 1900-01 season, the combined yield from the Sind creeks and the Hab river scarcely exceeding a bare 9,000 dozen; the next season with a total of 9,640 dozen was not appreciably better, and had it not been for large imports from Kutch consumers would have fared badly. Bad as these years were, worse was to follow. Karáchi and the coast line in the vicinity was visited in 1902 by a cyclone of great violence; immense damage was done to property and vast quantities of sand were displaced along the seaward region of the creeks; many of the best oyster beds were lost by being thus covered several feet deep with sand. As a consequence a paltry 1,940 dozen were all that the beds yielded during the 1902-03 season. Apart from the exceptional cause of shortage in 1902-03, the low yield of the preceding years necessitated reconsideration of the protective measures in force which were clearly insufficient to prevent exhaustion of the beds. Mr. E. H. Aitken ("Eha") was Chief Collector of Customs at this time and we find him writing in July 1903: "I can come to no other conclusion than that the exhaustion of the once renowned oyster beds of Karáchi has been mainly due to their being destroyed faster than they could recover, especially since the practice of packing them in ice has made it possible to send them to up-country markets." He ended by expressing the opinion that all the beds in Sind might with advantage be left unworked for one year, at the end of which after fuller inspection they should be divided into blocks, each to be worked once in three or four years. He also pressed for further trial of experimental culture in order to ascertain the rate of growth and other points of importance to a proper control of the fishery. It was noted that the spat-collecting experiments tried several times in the Nawa Nar creek had failed owing to the prohibition against removing oysters from this locality having remained a dead letter. From the context it is evident that a certain amount of spat had attached to the tiles but no record of its early history, neither the date of settlement on the collectors, nor the size

attained during the first year's growth, was obtained, although it is mentioned that "men were caught removing them (oysters) from the very cultch put down by Mr. Judd." If they were worth removing, they must have been worth measuring! The Collector disagreed in part with the foregoing recommendations; from enquiries made he feared that closure of all the creeks would cause inconvenience and result in the market being occasionally without oysters during the season. It would be preferable, he considered, to close the creeks by compartments, those between Gizri and Kutch first, as such had suffered most, and those between Gizri and the Hab river in the next and alternate period. Any deficiency in the supply, he believed, would easily be made good by increased imports from Kutch, as 17,300 dozen were imported therefrom in 1901-02 and 21,600 dozen during the following season.

31. The Commissioner approved, and the necessary instructions were issued for the closing of the beds in one or other of two sections in alternate years in addition to the regulations previously in force. As the creeks south of Gizri were to receive attention during the first year, the following notice was issued:—

"GENERAL DEPARTMENT.

No. 2570, dated 27th July 1903.

Whereas under section 37 of the Land-Revenue Code (Bombay Act V of 1879) all the creeks on the Sind coast are the property of Government:

I hereby give notice that the taking or removing of oysters from the beds of the creeks mentioned below is prohibited until further orders.

Any person found taking or removing oysters from the creeks referred to will be dealt with according to law.

Creeks referred to:

All creeks between Ghizri creek near Karáchi and Sir Creek in the Jati Táluka. The names of the principal creeks and their branches are:

Main creek.	Branches or situation.
Kurangi ...	... Jori Chain, Charo, and rocks to west of Bram Hyderi.
Pheti ...	... Kund, Khari.
Khudi ...	... Chaglo.
Khai ...	... Memonki Pir Waro, Khanto.
Khanto ...	... Chitri Waro, in the bed of the Khanto creek.
Khanbrano	... Near Panju's Got.
Pirtiani ...	... Sanehri, Khamisa, Dumbri, Kun Chhino, Gudago, Chach in Wado Khamisa, Kotia Wari.
Dubho ...	... Kucher.
Hajamro ...	... Mithi Chbani, Ferti, Jhip."

32. Thus was initiated the protective system now in force. Study of the figures of oyster imports into Karáchi shows that at the commencement it gave fair promise of effecting the desired results; thus after two years closure of the Sind creeks the produce of their beds amounted in 1905-06 to 13,030 dozen as against 1,750 dozen in 1902-03, 9,300 dozen in 1901-02 and 8,503 dozen in 1900-01, the three seasons prior to the adoption of the new methods of regulation. Unfortunately the improvement was not maintained, for in the 1906-07 season the output fell to 4,930 dozen. In the same way the closing of the Karáchi beds at Nawa Nar for two seasons gave good results for the first year of re-opening, the produce of 1907-08 being 875 dozen, a very much better figure than any for the four seasons which preceded the two years of closure, namely, 340, 19, 70 and 10¹ dozen respectively for the seasons 1901-02 to 1904-05. Against this improvement must be set the fact that the produce of the Hab beds after two years' rigorous protection showed a decline of over 66 per cent. on the output of the year preceding closure, to wit, 1,100 dozen in 1907-08 against 3,400 dozen in 1904-05.

33. By the end of 1907 the beds were found so extremely depleted that Mr. H. C. Mules, Collector of Karáchi, became convinced of the complete failure of the measures adopted since 1896 to prevent the exhaustion of the oyster beds along the Sind Coast.

34. In a letter to the Commissioner in Sind of 30th January 1908, he pointed out that the measures hitherto adopted had been :—

(a) The observance of a close season from 15th April to 1st October each year, during which the removal of oysters is prohibited.

(b) The licensing of fishermen engaged collecting oysters for the market.

(c) Prohibition of the removal of oysters less than 2 inches and more than 6 inches in length.

(d) Closure of the creeks by compartments to oyster-fishing in addition to the annual fallow period, a two-years rotation being adopted.

(e) The preservation of the Vad creek as a preserve for experimental culture.

He remarked that the almost total disappearance of edible oysters from localities which previously furnished them in abundance had been attributed to reckless destruction by the oyster fishers and it was considered that the above listed regulations would prove an efficient remedy.

In conclusion he wrote: "These measures have been in full operation now for five years but the supply of the bivalve has continued to diminish and the beds are practically exhausted. The supply is not now sufficient to meet the local demand."

35. In view of the obvious deterioration of the beds, he recommended inspection by an expert with a view to initiate really effective methods for the preservation and increased production of the beds, and he added, "unless such a survey is carried out, it is certain that the edible Sind oyster will in a few years be non-existent."

36. In consequence of the local importance of the industry, I was honoured with a request to undertake this duty, and with the permission of the Government of Madras I carried it through during October and November 1909, as detailed in the following section of this report.

37. Before referring briefly to the culture experiments in Karáchi back-water, I give here a tabulation of the produce of the various beds, as shown by the imports into Karáchi, since 1896 when statistics first become available.

Statement showing the number of oysters imported into Karáchi from 8th December 1896 to 29th January 1908.

Years.	Indus creeks.	Karáchi (Nawa Nar).	Hab river.	Kutch.
	Dozens.	Dozens.	Dozens.	Dozens.
1896-97	9,000	.....	.....	3,000
1897-98	17,150	.....	.....	.....
1898-99	16,900	900	1,700	.....
1899-1900	15,700	.....	600	17,000
1900-01	8,503	.....	500	19,500
1901-02	9,300	340	.....	17,300
1902-03	1,750	190	.....	21,000
1903-04 ... ..	.....	70	500	17,500
1904-05 ... ..	.....	100	3,400	6,500
1905-06	13,030	.....	.....	7,900
1906-07	4,930	.....	.....	8,900
1907-08 ... ..	.....	875	1,100	4,800
Total	96,263	2,475	7,800	124,000

38. These statistics furnished by the courtesy of Commander Hewett, Port Officer, Karáchi, show very plainly the great falling off in the produce of the combined Sind beds since that time of prosperity prior to 1895 when we

are told that the beds produced 100,000 dozen oysters annually. As is seen by the table the total produce from 1896 to 1903 from the whole of the beds on the Sind Coast amounts to 106,538 dozen only, *i. e.*, the yield for 12 years barely exceeds the reputed produce of a single year in the days of greatest prosperity. The disparity is so immense that I am greatly inclined to believe the estimation named has been considerably exaggerated. However, even if we reduce it by 50 per cent., and make it 50,000 dozen per annum, this is immensely ahead of any figures reached since 1896; it is considerably greater even than the total imports into Karáchi for 1899-1900, inclusive of 17,000 dozen brought down from Kutch. In making reference to Kutch, it is noteworthy that the highest imports from that state were 21,600 dozen in 1902-03. This trade prior to 1896 was quite small. In 1896-97 it amounted to 3,000 dozen only; between 1899-1903 it attained its maximum ranging between 17,000 and 21,600 dozen per annum. During these years the Kutch Durbar levied an export fee of Rs. 15 per boat-load, a rate sufficiently low to place no impediment in the way of heavy exports. In 1904 the Kutch authorities had reason to fear that the heavy drain upon their beds might cause a depletion as disastrous as that which had overtaken the Sind beds; very wisely, in my belief, they sought to reduce the drain by imposing a much higher tariff on exported oysters. From Rs. 15 per boat-load they raised the rate to Rs. 50; as a direct consequence the amount exported to Karáchi in 1904-05 fell to 6,500 dozen; in the two succeeding years the export was 7,900 dozen and 8,900 dozen respectively. Even this reduction in export does not appear to have been sufficient to maintain the prosperity of the beds, for it is understood that the Kutch tariff had to be again raised in 1907, this time to as much as Rs. 100 per boat-load. At this high rate the Karáchi dealers find the trade much less lucrative than formerly, especially as considerable mortality occurs among the cargo on the voyage up the coast. Import from Kutch has therefore been much curtailed, only 4,800 dozen coming into Karáchi from this source in 1907-08.

39. *Culture Experiments in Karáchi Backwater.*—In accordance with the recommendation made by Commander Shopland in January 1897, three boat-loads of broken Mangalore tiles to serve as oyster cultch⁽¹⁾ were laid down during September 1898 in the Nawa Nar creek in the vicinity of the Maurypur salt-works in the western section of the Karáchi backwater. The work was entrusted to the Preventive Staff of the Customs Department. On 2nd October in the same year, the tiles were found to be covered with sand. Another spot believed to be less exposed to silting was then selected; one boat-load of tiles was deposited there on 7th October and a second five days later. A year after the Head Preventive Officer reported that the experiment had met the same fate as the first; in the later one, however, spat attachment had evidently taken place, as the officer reported that some oysters had developed to the size of $\frac{3}{4}$ inch when they died from the effect of silt deposit. It is greatly to be regretted that no record was made of the date when spat settled upon the tiles and what was the age when the size of $\frac{3}{4}$ inch was attained. A year later two boat-loads of stones were deposited at Nawa Nar. This third attempt likewise failed to give any tangible result, partly from lack of technical training on the part of the officer entrusted with the work, partly from the depredations of the licensed fishermen, who are reported to have removed what oysters did develop upon the tiles. The Head Preventive Officer reported in 1901 that he had on four occasions made collection of tiles with oysters adhering to them and deposited them apart; in every instance the oysters thus put on one side for further observation were removed, owing to some unfortunate misunderstanding whereby the licensed oyster-collectors were permitted to collect from the Nawa Nar bed during the progress of the experiments. In spite of the eventual failure of the experiments, useful information might have been gleaned as to spatting seasons and rate of growth had a detailed programme been furnished to the officer in charge, giving him particulars of what observations were necessary to make from time to time. Had such been done these experiments were sufficiently successful to have furnished much of the data we now stand in need of. In actual fact they were not failures, but there was failure to utilize the information they were ready to furnish to the seeing eye.

40. Owing to the difficulty experienced in safeguarding the oysters under observation, no further experiments were made on the Nawa Nar beds;

(1) Cultch is the technical term for any hard material deposited upon oyster banks to improve the bottom and afford increased surface suitable for the attachment of oyster spat.

a muddy creek, the Vad, opposite Shams Pir Island, was selected and here various lots of tile cultch were laid down from time to time, and the removal of oysters from this creek was interdicted.

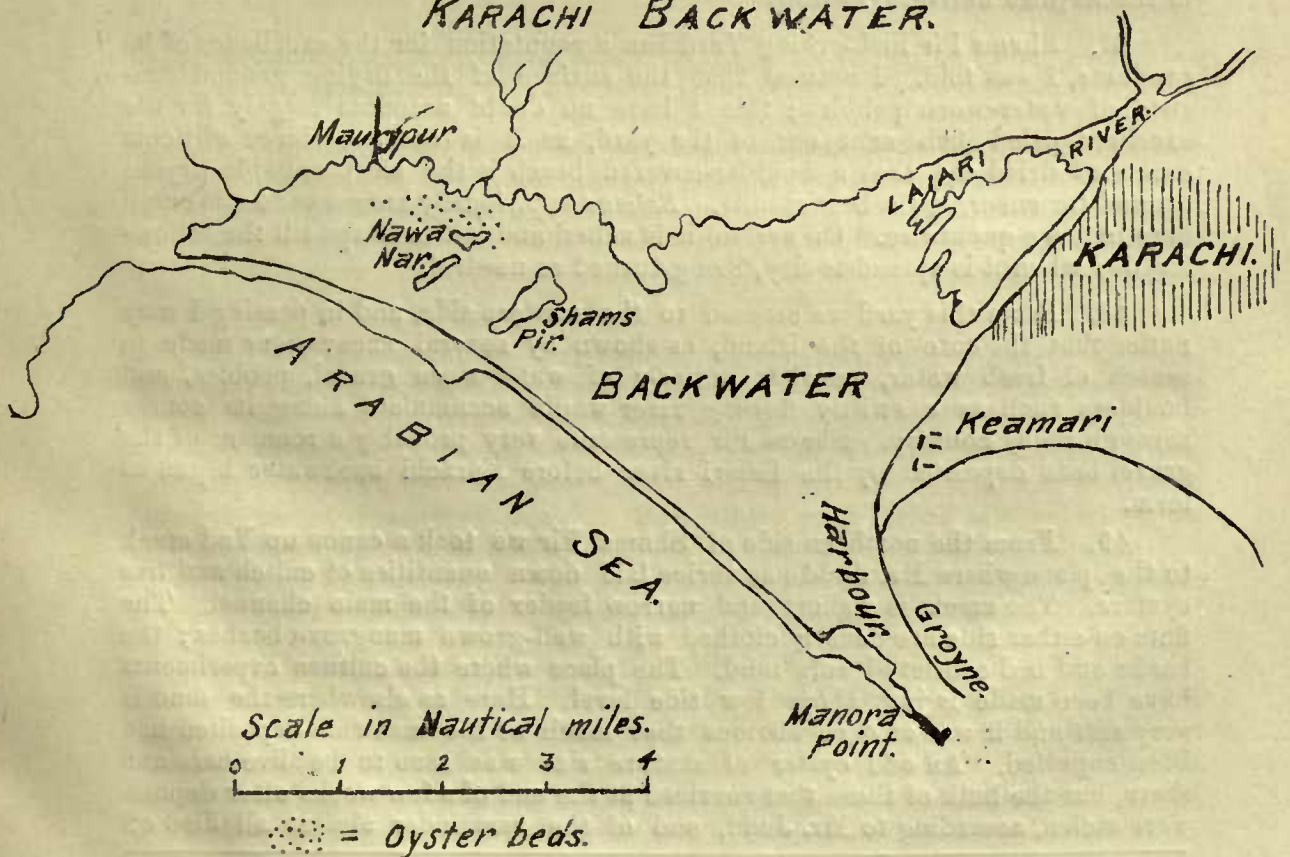
41. No results of any value are recorded from these later experiments, owing again, it is said, to the impossibility, for lack of watchers, of guarding the growing oysters from the depredations of the oyster-men. As I was afforded an opportunity of visiting the Vad creek, I shall defer further observations upon this culture experiment to the following section, where particulars will be given of the condition in which I found the cultch deposited in this place, merely remarking that the extreme softness of the muddy bottom of this creek makes it very unsuitable for culture experiments.

IV.—NARRATIVE OF THE INSPECTION; PRESENT CONDITION OF THE BEDS.

42. *Karachi Backwater.*—After some preliminary enquiries, the inspection of the oyster beds was commenced by an examination of those situated in Karachi backwater. Mr. G. W. Judd, Head Customs Preventive Officer, was kindly permitted to act as my guide and this was the best selection possible seeing that Mr. Judd is the officer who in 1894 drew the attention of the authorities to the distressful condition of the oyster beds; in the course of his long connection with the Karachi Preventive Service he has had unrivalled opportunities to become acquainted with the distribution of oyster beds on the Sind Coast.

43. Accordingly on 25th October 1909, piloted by Mr. Judd, I proceeded from Keamari in the Customs' launch to explore the western section of the Karachi backwater where alone edible oysters occur in beds.

FIG. 1.
SKETCH PLAN
OF
KARACHI BACKWATER.



44. As will be seen from the sketch plan (Fig. 1) given above, the backwater in outline is almost an isosceles triangle, the axis directed almost east and west; the apex terminates blindly and is the point furthest removed from the seaward entrance east of Manora Point. The apex is also at the opposite extremity of the backwater from the embouchure of the Laiari River. It is in this quiet apical *cul-de-sac* that the only oyster beds are found; they lie southward of the Mauripur Salt-works and are generally referred to as the Nawa Nar or Nai Nar beds.

45. On our way there, we landed on the beach of Shams Pir Island immediately in front of the Fish-curing Yard. The tide was falling rapidly, exposing a long stretch of gently shelving muddy foreshore. In the lower part the mud is deep and soft, but at the higher levels a considerable amount of shingle and water-worn pebbles is intermixed. In the March preceding our visit one of the Karáchi oyster dealers used this beach as a laying ground for a cargo of Kutch oysters. Part had been sold and a large number had died, I was informed; a fair quantity still remained alive and upon their valves as well as upon the dead shells scattered around, was a fair show of brood oysters, varying in approximate age (the rate judged by my experience of the growth of oysters near Madras) from 1 week to 1 month, suggesting thereby that the spatting season at Karáchi is identical with that of oysters in the Madras Presidency—September and October.

46. The general size of these Kutch oysters was relatively enormous; some were over 8 inches long and proportionate in thickness. They had the appearance of being very old and I judged that the beds they came from had not been worked for any length of time—virgin beds such as the Sind ones were when first fishing began there. For table use these oysters are much too large and coarse; for canning and cooking they would serve admirably, while the empty shells would make excellent cultch for the purpose of spat collection owing to their great size, irregular shape and the deep concavity of the inner surface. To judge from the general form of the valves and the apparent habit of growth they appear to be closely related to the Portuguese oyster (*Ostrea angulata*), differing conspicuously in one particular only—the colour of the adductor muscle scar. In the Portuguese and also in *O. cucullata*⁽¹⁾, the Madras species, this scar is of an extremely deep purple tint; in the Kutch oysters seen at Shams Pir Island and all Sind oysters subsequently examined, the scar is colourless as in the English native, *O. edulis*.

47. Shams Pir Fish-curing Yard has a reputation for the excellence of its products, I was told. I noticed that the surface of the drying ground consists of water-worn pebbles; this I have no doubt accounts largely for the excellent dried fish sent out of the yard, as it is the experience of Scots curers of dried cod that a boulder-covered beach is the most suitable drying ground for ensuring the best results. *Sciæna* spp., locally known as *sūa*, is cured here in large quantities. On arrival it is salted and left in heaps till the following day when it is spread to dry, being turned as needful.

48. From this yard we crossed to the western side, and in passing I may notice that the core of the island, as shown by several excavations made in search of fresh water, consists entirely of water-worn gravel, pebbles, and boulders such as a swiftly flowing river would accumulate along its course through rocky country. Shams Pir represents very probably a remnant of the gravel beds deposited by the Laiari river before Karáchi backwater began to form.

49. From the northern side of Shams Pir we took a canoe up Vad creek to the place where Mr. Judd has thrice laid down quantities of cultch and live oysters. The creek is a short and narrow feeder of the main channel. The flats on either side are densely clothed with well-grown mangrove bushes; the banks and bed consist of soft mud. The place where the culture experiments have been made is just above low tide level. Here as elsewhere the mud is very soft and it was at once obvious that much of the material deposited had been engulfed. An odd oyster of mature size was seen to be alive here and there, but the bulk of those that survived at the end of a few weeks after deposit were stolen, according to Mr. Judd, and of the remainder almost all died off

⁽¹⁾ The species common to Ceylon and Madras is identified in Prof. Herman's Report on the Ceylon Pearl Fisheries, but I believe further scrutiny will show it to be distinct therefrom.

eventually. The first loads of cultch, tiles and dead shells, were deposited in February 1904; in consequence of these becoming covered with mud, further lots of cultch, chiefly oyster shells, were laid down in the same place the following August, and in February of 1905 a boat-load of stones was added. Quantities of mature oysters were deposited as spat producers on several occasions in the same place.

50. All the tiles, stones, and shells not yet buried in mud, were slimed with fine mud and diatom scum, most inimical to spat attachment. By careful search I did however find four living oysters attached to tile fragments. They were well grown and I judged the age to be approximately about $1\frac{1}{2}$ year, the lengths varying from $3\frac{1}{2}$ to $4\frac{1}{2}$ inches. Among clumps of dead oyster shells, abundance of sponges of several species flourished, nudibranchs were plentiful, together with some *Turbo* and boring molluscs—a faunal association similar to that characteristic of the oyster beds in Pulicat Lake near Madras.

51. Returning to the main channel running northwards from Shams Pir, we followed it up till we came to the Nawa Nar beds opposite the landing pier at the end of the road leading from the Mauripur Salt Works. At this place a few patches of rock outcrop and several shoals occur made up largely of pebbles and small boulders. Upon the higher parts of these rocky patches and gravel deposits a Coxcomb oyster is found in profusion, while at and above low tide level the remnants were seen of what formerly must have been extensive beds of the local edible oyster. Here and there a few remained but they were scattered and sparse. These oyster patches exhibit every appearance of being thoroughly worked out. However, even in the present depleted condition I am given to understand that a man can still collect enough during spring tides to make it worth while visiting the beds occasionally.

52. Nawa Nar possesses many qualities which fit it either to sustain a natural oyster bed or to be converted into artificial oyster-parks. Natural cultch abounds—pebbles, gravel, and dead shells. By their presence in quantity the bottom is sufficiently consolidated to obviate any danger of oysters here sinking into the mud. Diatom food is plentiful—the mud flats and creeks surrounding Nawa Nar grow them in myriads. Not least in value among the natural advantages of this spot is the well-marked scour maintained by the tidal flow particularly during the ebb when the drainage of the great area of high-lying flats westward of Nawa Nar courses like a mill-race over the gravels between the reefs which uncover before half-tide and thereafter gradually narrow the waterways to a fraction of the high-tide width. The heavy scour thus produced prevents any undue accumulation of mud upon the oyster flats margining the low-tide channel.

53. In the preceding section some account has been given of the culture experiments made at this place. At the time of my visit a considerable quantity of the broken Mangalore tiles laid down in 1898 were still in evidence, proof of the stability of the surface of these gravel flats. Those lying on the higher levels were thickly crusted over with Coxcomb oysters while a couple of well-grown edible oysters were found on tile fragments near low-tide limit.

54. With the exception of the Nawa Nar gravels and reefs and the Shams Pir eastern beach, the bottom of the backwater is everywhere either soft mud or fine sand. As the tide recedes—there is a vertical fall of over 9 feet at ordinary springs—the channels gradually narrow till at low-water of a spring tide, nine-tenths of the area becomes exposed—a vast expanse of soft mud surrounding patches of mangrove scrub. But whilst such areas are valueless for oyster culture because of the softness of the surface, they afford suitable life conditions for the window-pane oyster, *Placuna placenta*, which flourishes there and provides a remunerative seed-pearl fishery from time to time.

55. The day following the visit to Nawa Nar was occupied with preparation for a week's tour of the Indus creeks. The Customs sailing yacht "May Queen" was kindly placed at my disposal and with Mr. Judd again as guide we left Karachi at 4 a. m. on 27th October, the weather fine and the sea smooth, but with a strong swell from the W.-N.-W.

56. From daybreak to 8 a. m. (standard time) great numbers of bonito were observed jumping in every direction as far as the eye could see. Their number must have been enormous. Gulls were numerous distributed generally. The sea at this time was olive green and fairly clear, the distance from land from three to four miles. Only a single fishing boat was in sight. At 9 a. m. (standard time) the bonito had ceased jumping.

57. A couple of hours later we entered the mouth of Khudi creek. The northern bank is slightly above high tide level and is fringed with low sand hills. On opposite sides of the estuary about three miles in, a group of fishermen's huts was seen, a few boats moored along the shore. The end of October marks the beginning of the prawning season, which lasts till the end of the cold weather in the early part of March. Most of the men occupying the huts were engaged in this fishing. Opposite the encampment on the left bank we saw a long range of prawn stake-nets, a sleeve net-trap fastened between each two stakes; further up the creek we encountered another set. The night previous to our arrival, two maunds of prawns were taken by one set alone.

58. All the men we questioned declared that no live oysters now exist in this creek or its branches; one man whom we met in the narrow canal connecting Khudi and Khai creeks said he knew a side creek three miles back where there are three beds or patches of oysters all dead, covered more or less with mud. Mr. Judd believes the cause of death to be silt, but I cannot hazard any definite opinion. Commander Shopland in 1897 recorded 5 beds of oysters to exist in Khudi creek; these are certainly now all dead. Possibly the oysters died from silting; more probably, judging from what I saw elsewhere, overfishing and the omission to put back on the bed any of the old shell cultch removed along with the living oysters, caused a lowering or degradation of the surface of the bed to such an extent that the cultch left eventually became lower than the surrounding mud surface, when the tendency would be for mud to drift into the hollow so formed, fouling and covering the cultch remaining. It may be, too, that the wholesale destruction of mangrove jungle along the banks of these creeks has led to increased erosion of the mud flats in some places. Formerly these great muddy plains, usually just overflowed at high spring tides, were densely covered with mangroves—thousands of dead roots are yet to be seen; firewood cutters destroyed this jungle and no efforts have been made to plant up these denuded areas. To-day they are naked mud flats readily eroded along the margin now that the protective silt-arresting mangrove scrub is destroyed. As a land-reclaiming agency, as a source of firewood, and as a grazing for camels, the re-planting of these mud flats appears to me extremely desirable.

59. Before passing through to Khai, we paid a visit to Faetor or Firti creek, a branch channel opening through the right bank, to inspect some beds of window-pane oysters (*Placuna*). Two separate beds were seen, the first consisting of the remains of a bed of full grown oysters fished this year; the other, much more extensive and a little higher up the creek, of immature individuals. These latter were exceedingly numerous. Our men brought up the oysters in handfuls; they described them as lying thick one over the other, so abundant that one could walk over the bed without sinking into the mud. The shells formed a veritable pavement. Earlier in the year the bed of mature oysters had been fished by the lessee of the *Placuna* fishery and when this was exhausted he was permitted to thin out the immature bed as it was considered that this by lessening the overcrowding would contribute to the more rapid growth of the remainder. I measured 20 of these immature individuals; the largest was $5\frac{1}{4} \times 5$ inches, the smallest 4 by 4 inches, the average being $4\frac{1}{2}$ by $4\frac{1}{4}$ inches. Associated with these *Placunæ* in Firti creek were huge colonies of a papyraceous and foliaceous Polyzoan, apparently akin to *Lepralia*. One cluster measured a foot in length by 8 inches in width. *Anomia*, the bastard oyster, some quite young, was frequent, attached to valves of *Placuna*. Small crabs and a colourless *Alpheus* sought shelter in the folds of the *Lepralia* clusters. Some fine hydrozoa were also present but no algae were seen.

60. Birds were numerous. Several pelicans and spoonbills marched along the shallows and several wild duck were shot. Gulls and snippets abounded. Khudi creek was full of fish; mullet of fine size were seen in quantity together

with great shoals of small silvery fishes. At one place two porpoises were seen in pursuit of fish.

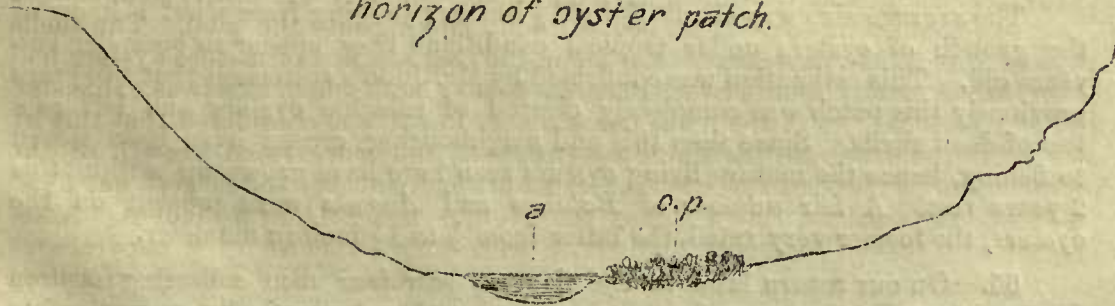
61. More noticeable however than all these larger creatures was the vast abundance of spherical free-floating algae. In all the creeks we passed through this day—even some little distance seawards of Khudi mouth (as also in Karáchi harbour) the water was turbid and choked with an extraordinary profusion of hollow brown spheres. The interior was filled with water, the cellular tissue being limited to the walls of the thin containing capsule. In size these brown dotted spheres ranged from a pin's head to 1 inch in diameter. These algae must be of immense food value and their abundance is probably to be correlated with the large quantities of prawns now in the creeks.

62. At 4-30 p.m. we returned to the "May Queen" which we found grounded in the narrow canal forming a passage from Khudi to Khai. When the tide began to flow shortly after, which it did with great strength, two currents were seen in opposition at the place we grounded, one coming from Khai, the other from Khudi. As soon as the tide had risen sufficiently we passed through the canal into Khai creek. Two beds of oysters were said to exist in Khai creek but time was pressing and as they were reported to be similarly conditioned to others to be seen further on we proceeded the next morning along the connecting creeks into Pitiani, anchoring at 10 a. m. off the village of Sappatari, two small collections of huts close to the seaward entrance. Fishermen and camelmen form the scanty population, the former busily engaged in prawning, the latter in grazing their herds among the mangroves higher up the creek. The low sand hills which adjoin the village are said to have been formerly the haunt of numerous snakes, whence the village is said to derive its name.

63. When the tide had receded sufficiently we took our small boat and rowed up Mall creek which connects with Pitiani near the seaward end. The side creeks of Mall and Dumbri were reported to contain the best beds of oysters remaining in this neighbourhood. The first we came to was just within the entrance to a narrow side-creek off the Mall main channel. The mud banks were steep and it was in fact only a drainage gully; at low tide a mere dribble of water was passing through it. The land on each side is a dreary mud flat covered with a few inches of water at high-water during spring tides; here and there at long intervals the bareness was accentuated by the presence of a scrubby mangrove bush. The patch of oysters seen at this place was located to one side and at a slightly higher level than the central runnel of water left at low tide, as is shown in the diagram below (Fig. 2). At the level of the patch the surrounding mud is exceedingly soft, little better than an ooze.

FIG. 2

Section of Mall side-creek at low-tide showing horizon of oyster patch.



a, Central runnel, o. p., Oyster patch.

64. The patch was isolated and of small extent, some 8 feet long by 4 feet wide. The foundation or core consisted of dead oyster shells mostly of very large dimensions and of characteristically elongated form—true “slipper-oysters.” These were more or less embedded in the mud; upon their upper edges were a considerable number of living oysters much younger and of more irregular growth than the dead ones beneath. A distinct tendency to broaden was noticeable due to the fact that the higher clumps of old oysters whereon they were seated were sufficiently elevated to free the living generation in large measure from that pressing necessity imposed on earlier generations to concentrate growth in an upward direction in order to avoid death through sinking beneath the surface of the mud; the death of several preceding generations has produced a plateau-like mass of shell concrete providing comparatively stable foothold for any brood which may now settle there.

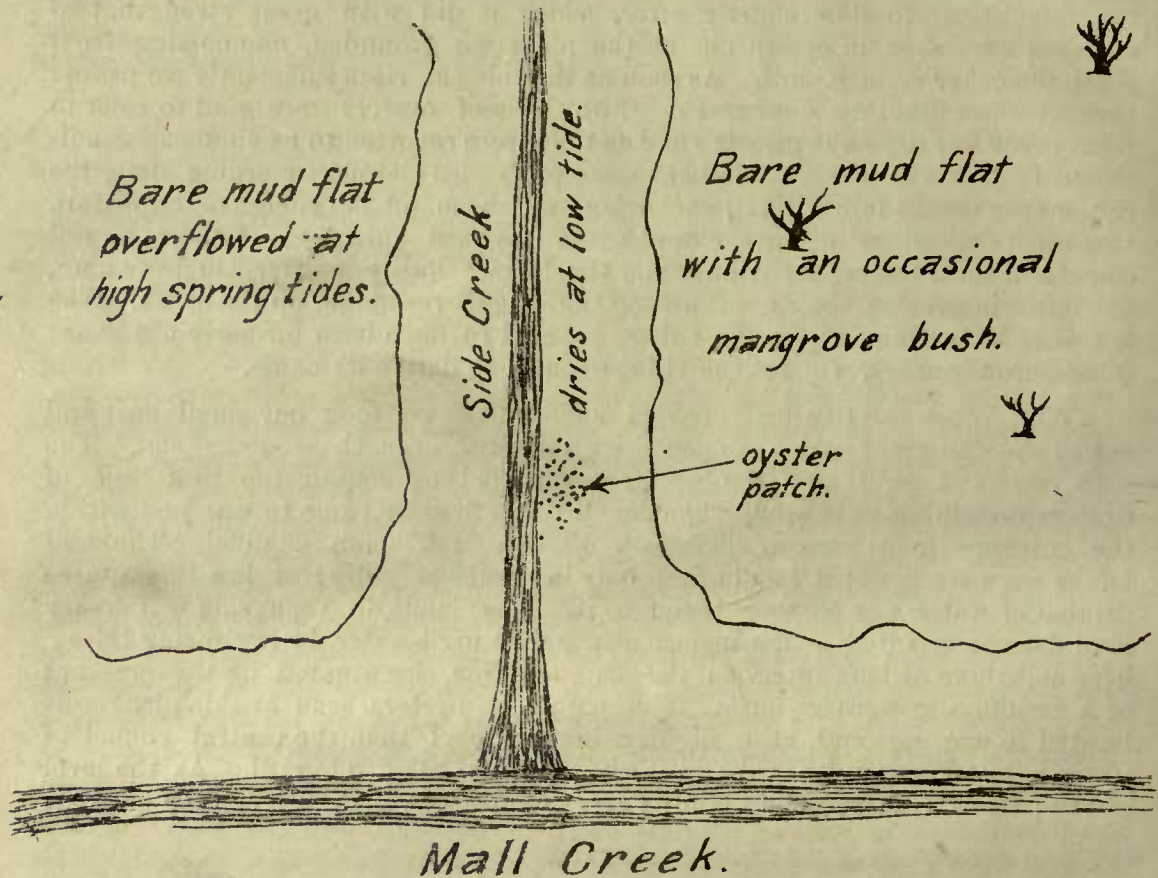


Fig. 3. Plan of small creek opening into Mall Creek, to show location of oyster patch referred to in the text.

The average size was about $3\frac{3}{4}$ by $2\frac{1}{2}$ inches; judging from what I know of the growth of oysters under tropical conditions they appear to be under two years old. This estimation was confirmed by Mr. Judd's statement that two years previously this patch was completely cleared of saleable oysters and left as a bed of dead shells. Since then this and neighbouring creeks have been closed to fishing, hence the mature living oysters seen here have grown up within this 2 years rest. A fair number of *Balanus* and *Anomia* were present on the oysters, the former very small, the latter from $\frac{7}{8}$ to $1\frac{1}{2}$ inch in diameter.

65. On our return later in the day we saw four men collecting oysters from this patch; they were finishing and had gathered practically every sizeable oyster. These were laid in a heap on the bank ready to load into their boat. The creeks had been re-opened to fishing a few days previous and the day of our visit was the first day this patch had been touched for two years. As I wrote in my notes at the time, "It will also be the last for a long time as there were not half-a-dozen living oysters left when these men finished. The bed has been cleared right out."

66. We next proceeded to Dumbri creek where we visited a long tributary ebb-dry creek indicated by our guide as containing a good oyster-bed. As the

FIG. 4
Mud flat.

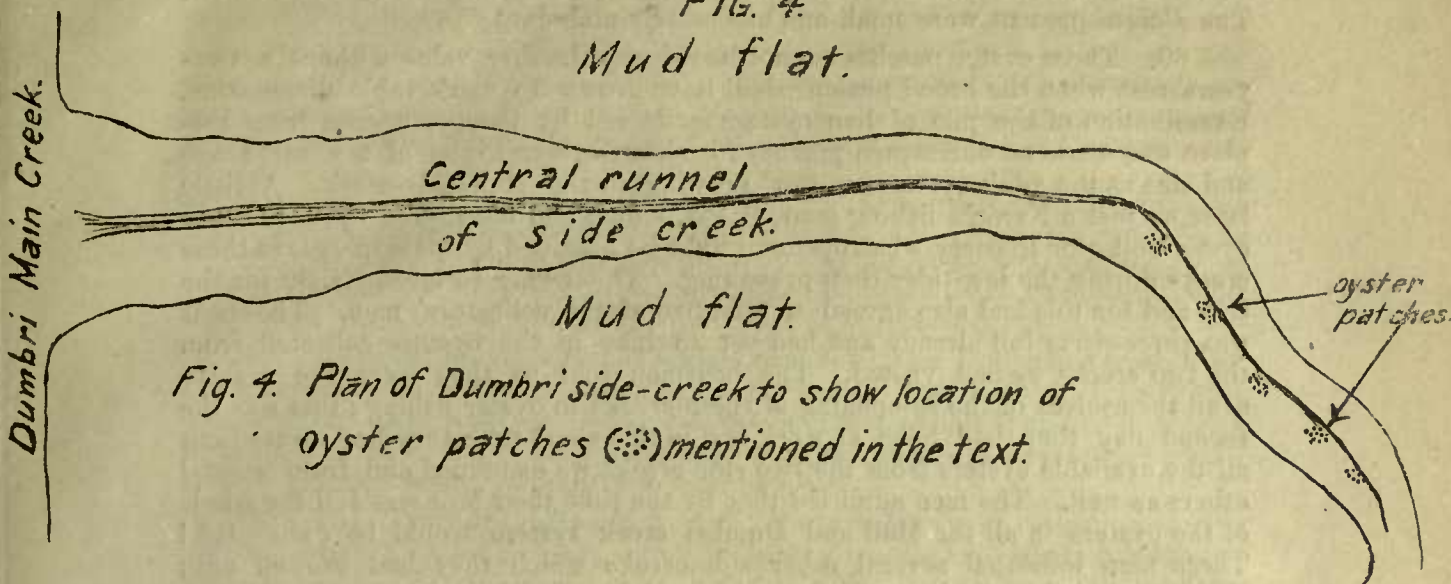


Fig. 4. Plan of Dumbri side-creek to show location of oyster patches (•••) mentioned in the text.

creek dries out at low-tide we left the boat at the mouth and tramped along the creek bank to where the oysters were—a weary undertaking owing to the softness of the mud and the intense heat experienced on these open flats during the middle of the day. Some 250 yards up the creek we came on the oyster patches, five in number stretched at intervals of 15 to 20 yards apart a little to one side of the centre where a small runnel still flowed. All the patches were small, varying from 6 to 12 square yards in area. (Figs. 4 and 5.)

Fig. 5

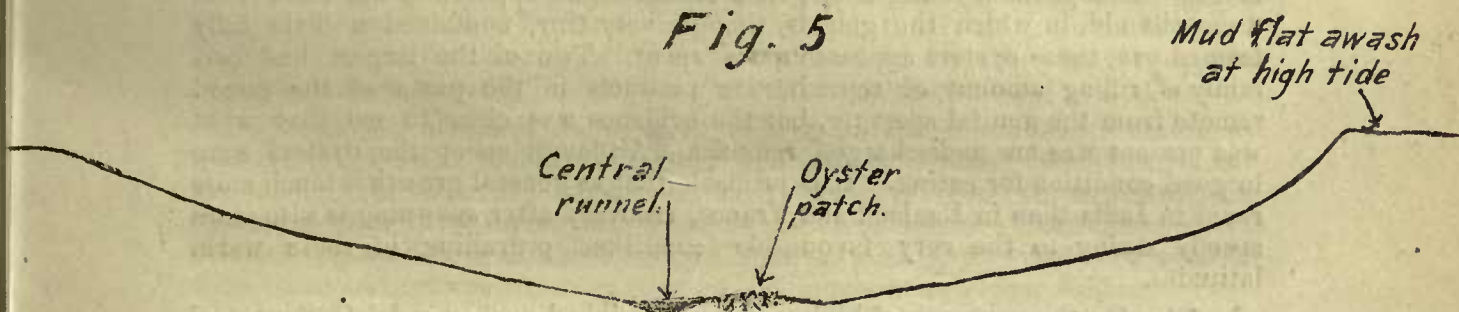


Fig. 5. Section through a Dumbri side-creek showing location of an oyster patch. Low tide.

Being of considerable width the muddy banks slope gently to the middle. Around the oyster patches the mud is particularly soft and I had considerable difficulty in reaching one, sinking over the knees a yard from its edge. When returning encumbered with an armful of huge shells the passage was worse and so deeply did I sink into the mud that I had to be ignominiously hauled out.

67. The dead oyster shells forming the basis of the patches here were the largest I have ever seen. Many ranged from 9 to 11 inches in length and one fragment representing a hinge region measured $7\frac{1}{2}$ inches long—when complete this individual could not have been less than 16 or 17 inches in length. As in the case of the dead oysters in the Mall creek these were markedly slipper shaped. Scarcely a single living oyster other than brood was found, a number of oyster-men having thoroughly harvested the crop that had become adult during the two years of closure just ended. Their haul we found on the return journey laid out on the bank of the main channel ready for shipment when their large boat should come up the creek.

68. The brood oysters seen adhering to shell cultch on the ravaged beds were few in number; in size they varied from $\frac{1}{2}$ to 1 inch diameter. Accompanying them were a fair number of the usual oyster bed habitués. *Anomia* of

from 1 to $1\frac{1}{4}$ inch across was very abundant, as also a small species of *Sabella* inhabiting mud-coated tubes. *Arca* was present together with a number of *Saxicava* boring into the thick walls of the old shells, while the boring sponge *Clione* had caused a considerable amount of damage by "worming" the shells. The *Balani* present were small and moderately abundant.

69. These oyster patches cannot be of any further value without a two-years' rest when the brood present shall have grown to marketable dimensions. Examination of the pile of live oysters collected by the oyster-men from this place was made on our return journey; it showed them to be of the same age and size as the adult oysters we saw growing in the Mall side-creek. A little later we met a Karáchi fishing boat, B 155, which had been hired by a licensed oyster-collector to carry what oysters might be obtained by his employés in these creeks during the low-tides then prevailing. The owner received Rs. 30 for the trip and for this had also agreed to feed five of the collectors' men. The boat was three-parts full already and had yet to take in the oysters collected from the two creeks we had visited. The boatmen told us they were the first to avail themselves of the re-opening of these creeks to oyster fishing; this was the second day they had been at work and in this short time they had cleared out all the available oysters from the two side-creeks we examined and from several others as well. The men admitted that by the time their boat was full the whole of the oysters in all the Mall and Dumbri creek system would be exhausted! These men indicated several other side-creeks which they had worked out; these were of the same general character as those visited and above described.

70. In the evening we returned to Sappatari village, where we saw large numbers of camels coming back for water from the mangrove scrub. Fine soles of large size are abundant in Pitiani mouth judging from the quantity the fishermen brought us.

71. The next morning, 29th October, while waiting for the tide to rise sufficiently to proceed, I dissected some of the oysters from Dumbri and Mall creeks. Except for a young one, $\frac{7}{8}$ inch diameter and apparently not more than 2 months old, in which the gonads, though very tiny, contained a little fully formed ova, these oysters appeared quite spent. Two of the largest had certainly a trifling amount of reproductive products in the parts of the gonad remote from the genital aperture, but the evidence was clear to me that what was present was an undischarged remnant. Although spent the oysters were in good condition for eating. It is probable that as general growth is much more rapid in India than in England and France, recovery after spawning is also more speedy owing to the very favourable conditions prevailing in these warm latitudes.

72. On the approach of high water, we weighed anchor and left Sappatari for Dubba creek where a large bed of oysters was reported by one of the local fishermen. The channel connecting Pitiani and Dubba proved very narrow and shallow in parts and we just managed to scrape through at high-tide. Along the flats on the seaward side we saw considerable stretches of low mangrove scrub; herds of camels come here to graze and here and there we observed low mud-bunded pools wherein boat-borne sweet water is stored for their use. Few mangroves are present on the landward bank but in one place we saw some tamarisk bushes, evidence I should say of the occasional presence of fresh water in this creek, and confirmation of the statement made by Mr. Judd that in some years the influence of the Indus floods is felt as far as Dubba and its branches; 1909 was such a year, the water in Dubba creek being drinkable at low-tide during the Indus inundation.

73. Considerable difficulty was experienced in locating the Dubba oysters. They were reported to be in the bed of one of the side creeks and there we searched a long time before finding them. At last when the stream had diminished to a gutter some 7 feet wide, one of our men stumbled upon the patch in the very centre of the runnel. The area occupied by the oysters was extremely restricted; four men engaged in gathering them and standing one at each corner touched elbows when they stooped. The patch was apparently a virgin one—never before fished, as a large proportion of the living oysters were of huge size, 8" to $9\frac{1}{2}$ " long, and some few were even of greater size. These large individuals were distinctly slipper-shaped. They formed the lowermost layer of the living oysters; smaller ones grew attached to the projecting ventral margins of the larger shells and also upon the flat of the valves. For its size

this patch was wonderfully prolific and it is no figure of speech to describe the oysters as existing three layers deep. Mr. Judd set his men to collect, and within 15 minutes a sackful of living oysters was obtained. This, however, virtually wiped the bed out. In obtaining these oysters the men brought the oyster clumps indiscriminately to the bank of the creek where they culled the living from the dead, and where they would have left the latter had I not made them return this valuable shell-cultch to the creek bed. It was an unrehearsed and enlightening demonstration of the reckless methods of spoliation whereby these creek beds have been brought to a state of utter ruin.

74. The patch is a difficult one to locate and this, taken together with its small extent, had doubtless protected it previously. Our local guide told us of another patch in a neighbouring creek, but no really large bed appears to be now existent in the branches of Dubba creek, the little patch examined being the "large" bed of our guide's description the day preceding.

75. As in the previous bed of oysters examined, this Dubba one rose from the soft muddy bottom of the creek; the only cultch was dead shell; a runnel occupied the centre of the creek, and the mud was so soft that our men sank to midcalf at every step; the surrounding low flat land was covered with salt-plant vegetation not more than 18 inches high.

76. The organisms associated with the oysters here were somewhat different from those we had met with previously; besides the usual *Anomia* and *Balanus*, we found a small species of anemone in some abundance, the column marked vertically with narrow stripes of a dark bronze green tint alternately with equisized stripes almost colourless. A small *Alpheus* was fairly common. Of polyzoa, a crusting species mantled large surfaces. No sponges were seen. Brood oysters were few and of a stunted appearance, measuring from $\frac{1}{2}$ to 1 inch in diameter. Subsequent dissection of some of the oysters from this creek showed the condition of the larger oysters to be distinctly inferior to that of the smaller as well as to that of those from Mall and Dumbri. The integuments of these older individuals were dark, pale brown in tint and not at all of an appetizing appearance. For their size they were distinctly thin, a condition due probably to their food supply being partly intercepted by the younger oysters perched on their edges. The gouds appeared to be spent.

77. At the mouth of Dubba creek, where we found the water extremely muddy, the brown spherical floating algae already noted were extremely abundant. The fishermen correlated the presence of these spheres with the abundance of prawns, saying that when the spheres attain 1 inch or more in diameter prawn fishing attains its zenith. At the time of my visit the spheres were small and prawns were reported as still comparatively poor fishing.

78. In the evening we set out for Hajamro creek where a bed of dead oysters was to be shown me, killed off, it was believed, by the recent diversion of Indus water into this channel. We sailed through the connecting creeks during the night and the next morning, 30th October, we entered the Hajamro from Gabri creek at 9-30 a.m. Small groups of huts were to be seen on both banks, with the signs of extensive paddy cultivation. Harvesting operations were in full swing and mat-covered bee-hive shaped stores of paddy were rising round the hamlets. The land here is almost as low as along the creeks we had visited—just above the high water of ordinary spring tides.

79. By noon we arrived off a small hamlet situated on the right bank of the Hajamro mouth where we learned that our errand was in vain—the fishermen informed us that all the oyster beds in this channel have wholly disappeared, every sign of them being obliterated by deposits of silt caused by changes in the channels since the Hajamro became an active discharge mouth of Indus water. The head fisherman stated that silt to a depth of two to three feet now overlies the oysters whereof he knew of 4 patches before this silting occurred, *viz.*, two in Kochi creek off which we were anchored and one each in Tuppan creek and in that at Pir Mohammad Makhan both opening from the opposite or left bank. He described these beds as having been originally (when alive) in the centre of the beds of deep creeks, in similar environment to that typical of the beds we had seen previously. This news caused a change in our programme and decided us to proceed direct to Keti Bandar, the only town adjacent to the mouths of the Indus. During the last two years the Kediwari branch of the Indus has encroached greatly upon the northern end of this important paddy entrepôt, destroying a large area of gardens and entailing heavy loss and

inconvenience upon the inhabitants. Low bunds hastily constructed were to be seen in every direction within and around the town and many stores have had to be removed to the south end. From what I saw it is likely that the river may cut its way across the land immediately north of the town (it passes to the west of it at present). I was informed that until about three years ago the Hajamro was not directly connected with the Kediwari and in consequence its water was tidal and saline, a coast creek. To-day it has direct connection with the Kediwari and is virtually a branch thereof, conveying an immense amount of Indus water to the sea. The whole of the paddy cultivation seen on our way up has arisen since this junction has taken place; it will disappear when another freak of the river again shuts off river connection. From what I have learned of the past history of these channels it appears there have been several of such alternations between fresh and salt-water conditions in the Hajamro.

80. Understanding from Mr. Judd that no oyster-beds exist in the creeks south of the Kediwari it was useless to prolong our cruise in that direction; we accordingly dropped down the river in the afternoon to be ready to pass the bar early the following morning. On our way we passed several flocks of pelicans fishing in most business-like manner by driving the fish together by means of a gradually narrowing semi-circular formation.

81. On the flats at the mouth great multitudes of a large-clawed Ocypod crab began to scamper about as the sun went down. They kept in large companies, some engaged in turning over the surface of the sand in search of food, others trooping towards the edge of the sea. They run swiftly and silently—a ghostly army. When one of them is intercepted, it turns on its pursuer most valiantly and even advances towards him, with claws raised threateningly and in defiance. They also eject a few drops of water from the mouth parts, sometimes so much as to form a slight jet!

82. The next morning we hove anchor at sunrise and attempted the bar although the tide had not long turned. We had no trouble and never found less than 6 feet of water. Head winds delayed us and the journey to Karáchi took no less than 14 hours!

83. The following day, 1st November, we left Karáchi at daybreak for the Hab River. Again we were plagued with head winds and it was night before we anchored under the lee of Churna Island, a bleak inhospitable rock rising to a height of 580 feet, 4 miles N.-W. of Cape Monze. We landed on 2nd November on the Sind side of the entrance of the Hab just within a great sand-bank which lies athwart the river mouth. A few fishermen's huts were located here and we saw a number of fine Tunny, sharks and plough-fish (*Rhinobatis*) on the beach, while a number of boats were cruising off the river on the lookout for shoals of *Sciæna* (Sūa), one of the crew perched at the masthead as lookout on each boat. *Polynemus* (Rawas, Sindhi) appears very abundant. We saw a large catch made inside the river by a peculiar form of shore seine. As the water off this coast is very clear the men say they are unable to employ tanned nets; the plan they adopt to preserve their nets is to dip them in a bath of thin chunam (lime). The copper sulphate method of preserving nets might be introduced to these men's notice with advantage; their catches would probably be increased and the life of the nets lengthened.

84. When the tide receded sufficiently we made our way up the river towards the oyster beds. On the way we crossed an ebb-dry creek running east or E. S. E. from the river, well suited it seemed to me for oyster culture as the bottom consists of a thin layer of fine mud, not more than $1\frac{1}{2}$ to 2 inches deep, overlying well consolidated muddy sand. Everywhere on this thin sheet of mud lay a brownish scum of diatoms. Continuing our way about a quarter of a mile we turned a bluff and came upon a series of low tabular rocks of varying area in the bed of the river close to the Sind side. Between these rocks is excessively soft mud, and so far as I could observe the base of the rocks is never left entirely dry.

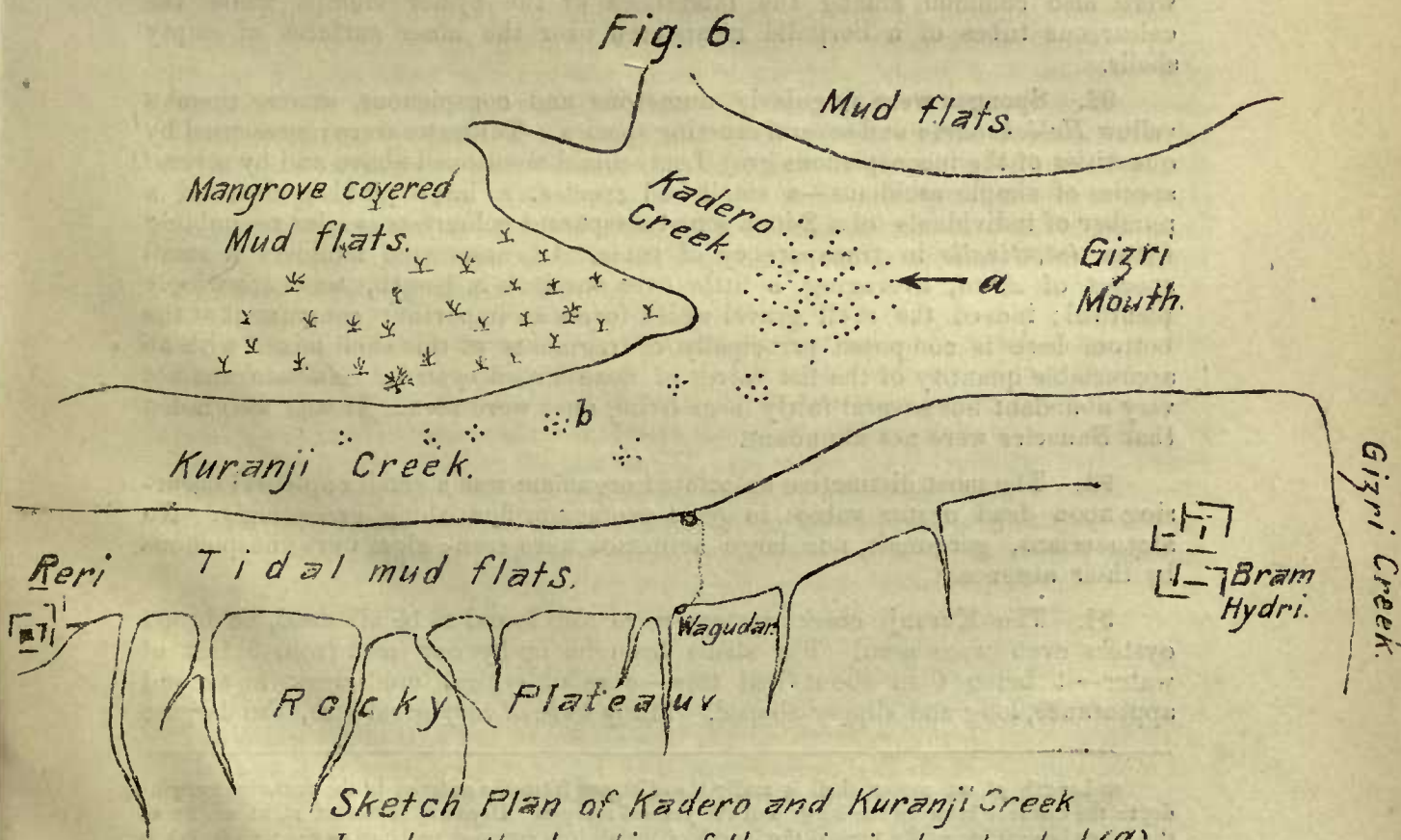
85. The oysters cluster thickly upon the sides of these rocks, extending upwards from the base to a height of about a foot or 14 inches. The slipper-form so typical of the creek oysters is all but suppressed here, although the species is identical; in form these oysters are extremely irregular and many malformed individuals occur owing to excessive crowding. The size is small compared with creek oysters, and I should say the majority are under two years

old. An oyster-man was busy collecting and had a heap ready to send to Karáchi. He told us he was paid at the rate of 4 annas a dozen delivered in Karáchi. After seeing these rocks I was able to understand why the oyster-men consider this the best locality for oysters. Even now in spite of constant depletion oysters abound here, and cover with living multitudes every available inch of rock. The rocks are composed of a coarse gritty limestone very suitable to give foothold to oysters. From the appearance of the cliffs and country around it is evident that when floods come the rush of water ensures a splendid scour and prepares and fits the surfaces of oysters and rock to receive and retain a plentiful amount of spat if it comes soon after—this I believe is the sequence, floods in July and August, spat-fall in September.

86. From the mouth upwards to the oyster beds, a line of bare gritty limestone cliffs margins the river; beyond the beds the cliffs and hills bend away from the river. The land along the right or Baluchistan bank is low and sandy, a single high rocky outlier alone breaking the level. The Sind side alone is of value in regard to oysters.

87. Returning to the "May Queen" we sailed for Karáchi at 7 p.m. but again made a long passage, not arriving there till 9 o'clock the following morning, 3rd November.

88. The period of my deputation necessitated departure for Bombay by the mail steamer sailing on the evening of 4th November. I had, however, not yet seen the dead or exhausted beds of Kuranji creek; these had once had a reputation for extreme richness, and as I attached considerable importance to an examination of their present-day condition, Mr. Judd kindly arranged the trip. Taking the morning train to Landhi, we thence went by camels to Wagudar, a noted spring issuing from the base of the rocky escarpment forming the northern bank of Kuranji creek. The spring is near the mouth of this creek; the dwellers and workers in the creeks come long distances for loads of this water which is conducted across a quarter of a mile of mud flats by a mud-banked gutter to a pool at low-tide level where boats load up. A boat was waiting for us in the creek with divers. The first place inspected was the wide



Sketch Plan of Kadero and Kuranji Creek to show the location of the principal oyster bed (a) and of the smaller ones (b) in Kuranji Creek.

expanse of water formed by the junction of the Kuranji and Kadero creeks, thereafter passing up the Kuranji as far as the village of Reri, frequently halting in order to obtain acquaintance with the character of the bottom, and the frequency or otherwise of dead oyster patches.

89. The evidence obtained fully confirmed the statements received of the former great abundance of oysters over this ground, particularly at the confluence of the two creeks where dead shells occur over sufficiently large areas as to fully deserve the name of beds rather than that of patches; for the sake of distinction we may term these the Kadero beds.

90. Up the Kuranji towards Reri the size of the patches gradually lessens in individual area and they occur at lengthening intervals. The two sets differ materially in the character of their physical environment, those up the Kuranji rising from a soft mud bottom while those at the mouth of the Kadero rise from a shelly gravel mixed with a certain amount of dark grey mud and some sand.

91. The dead oyster shells of the latter beds in the majority of cases exhibit a distinct divergence from the usual slipper form; they tend towards a marked broadening with a corresponding decrease in the ratio of depth to true length,⁽¹⁾ a difference due partly to the harder nature of the bottom here and partly to the effects of constant fishing when this bed was being exploited. Except for a single individual of 3 inches in depth and half a dozen stunted-looking brood varying from $\frac{1}{2}$ to $\frac{7}{8}$ inch in diameter, oysters were represented only by dead shells. Upon and among these a host of marine organisms of great variety found footing and shelter; indeed the diversity and richness of this associated fauna were surprisingly great and most notable in comparison with the relative poverty of such life found on the oyster patches in the creeks to the southward. All were of a distinctly marine type. Hydroids and polyzoa were abundant including quantities of a stout, alternately branching coarse and fleshy hydroid, $2\frac{1}{2}$ to 3 inches in height, the colonies usually crusted with patches of yellow sponge and grey leptoclinid. The branched tubes of *Eunice tubifex* were plentiful, as usual giving footing to sponges, ascidians, and polyzoa. The dark grey tubes of a small species of *Sabella*, 2 to $2\frac{1}{2}$ inches long, were also common among the interstices of the oyster clumps while the calcareous tubes of a Serpulid meandered over the inner surfaces of empty shells.

92. Sponges were singularly numerous and conspicuous, among them a yellow *Halichondria* and several crusting species. Tunicates were represented by quantities of the inconspicuous grey Leptochiuid mentioned above and by several species of simple ascidians—a small red species, a large pinkish one and a number of individuals of a 2-inch long transparent colourless species resembling *Ciona intestinalis* in transparency of tunic. Of associated molluscs a small species of *Arca*, averaging a little over one inch in length, was exceedingly plentiful; indeed the shell gravel which forms an important constituent of the bottom here is composed principally of fragments of this shell mixed with an appreciable quantity of the flat valves of dead brood oysters. *Anomia* was not very abundant but several fairly large living ones were seen. It was also noted that Banacles were not abundant.

93. The most distinctive associated organism was a small cup-coral occurring upon dead oyster valves in great profusion, flourishing exceedingly. No alcyonarians, gorgonids, nor large actinozoa were seen; algæ were conspicuous by their absence.

94. The Kuranji creek oysters were also found to be all dead, no brood oysters even were seen. The shells brought up by our men from 5 feet of water—it being then about half tide—were of typical mud-creek form and appearance, long and slipper-shaped. Many were of very great size, the largest

(1) Length of an oyster shell is really the distance from the anterior to the posterior margin, depth the distance between the hinge and the ventral margin. Depth is taken at right angles to the hinge line; it is usually termed the length of the shell in common parlance as the true length is usually less than the depth.

found being a much curved shell having a total "length" (depth) of 15 inches whereof the hinge region alone measured $6\frac{1}{2}$ inches. These shells were accompanied by a fauna notably poorer than that of the Kadero beds. The same species were however represented still but in small individual number.

95. With this visit to the Kuranji and Kadero beds my inspection terminated; the same evening I left for Bombay by the mail steamer "Linga"

V.—GENERAL CONCLUSIONS.

96. The results of the investigation show very clearly that the Sind oyster beds fall into several categories differing greatly in economic importance; the general exhaustion of the beds was verified; the causes of depletion were ascertained and sufficient information was obtained with regard to the physical and biological conditions prevailing to enable us to say where and why the regulations in force for years past have failed to arrest the ruin of the beds. With such knowledge we are also in a position to suggest a number of simple cultural operations which, if put in hand concurrently with the enforcement of revised regulations, should be sufficient to restore some portion at least of Karáchi's reputation as an oyster producing and distributing centre.

97. The three categories or classes of beds met with on the Sind coast may be termed respectively (*a*) creek beds, (*b*) estuarine beds and (*d*) backwater beds. These are distinguished by separate characters and differ in several important respects. The creek beds which comprise all those found in the Indus creeks with the exception of the two most northern (Kuranji and Kadero) are the least valuable. They are almost invariably beds of small extent occurring as isolated patches surrounded and their existence continually threatened by the enormous stretches of extremely soft mud forming the bottom of the creeks. No cultch exists anywhere in the creeks apart from the shells of the oysters themselves. As a consequence these beds labour under severe disabilities; while any increase in area is a matter of the utmost difficulty, they are constantly exposed to the danger of partial or complete destruction whenever any change occurs in the configuration and water circulation of the creek system either from deposit of unusual quantities of sediment or from the harmful effects caused by fresh-water floods. These latter dangers affect some creeks much more than others, and we may take it that while the beds in the Piti, Khudi, Khai, and Pitiani group are comparatively stable, those of Hajamro and Sisa are unreliable, frequently being destroyed entirely. Even where the beds are of comparative stability, the slow rate of increase, the smallness of the individual patches, their greatly scattered distribution and the difficulties of access and of supervision make these deposits much less valuable both actually and potentially than either of the two remaining classes of beds.

98. The estuarine beds are distinctly more valuable than those of the creeks. They are at present limited to those in the estuary of the Hab river, but till various causes eventuated in their destruction about 1890, the beds which are now represented by extensive stretches of dead shells at the meeting of the Kuranji and Kadero creeks would also have been included here. Such beds share with those of the creeks the dangers attendant upon river floods—death from excess of fresh water and burial under deposits of silt—but they are much more capable of making a rapid recovery from any temporary set back than are creek beds on account of the much greater area of foothold present. This foothold in the case of the Hab estuary consists of rocky outcrops from the river bed while at Kuranji and Kadero the bottom is thickly spread with cultch composed of dead oyster shells and shelly gravel. Both localities are subject to strong scour whenever heavy rain falls over the surrounding catchment area, the result being that the cultch present is freed from sediment and made fit to present clean surfaces for oyster spat attachment. Whenever there is a fair sized bed of breeding oysters in the vicinity, heavy spatfalls occur on such grounds and with a fair abundance of cultch present the resulting bed grows rapidly and gives a prolific yield.

99. Backwater beds form the third and most valuable class. On the Sind coast they are restricted to the western section of the Karáchi backwater; they comprise the well-known Nawa Nar or Mauripur beds. Reference to any plan of the backwater (see Fig. 1) shows how excellent this location is for the well-being of oysters. No large river is present at the western end; whatever fresh water enters during the rains is absorbed at once by the vast body of tidal water that presses up the channels twice a day. Rocky ground forms the northern boundary and outcrops here and there from the bottom; these reefs and submerged ridges and the gravels and boulders associated with them form the best of natural cultch materials and provide them in considerable abundance. The great areas of shallow water found at every state of the tide and the high temperature of the water for the greater part of the year are conditions highly favourable to the growth of the diatomaceous food-supply required by oysters and as a consequence the growth and fattening of oysters, so far as the observations made enable me to judge, appear to be unusually rapid.

100. Ample direct confirmation was obtained during the enquiry of the present complete exhaustion of all oyster beds on the Sind coast save in some part, those of the Hab river.

101. The Nawa Nar beds in actuality no longer exist; here and there a few dozen oysters may be gathered but this is at the expense of much time and trouble. No massing of oysters is to be seen anywhere, merely the occurrence of single individuals scattered here and there at considerable intervals. The beds in Kuranji and Kadero creeks have fared even worse, and nothing but dead shells mark the place where very rich deposits existed till 1890. In the creeks southward there is an appearance of rather better conditions; a two-years' closure of the beds had just terminated and some of the patches examined had recovered to some degree. This improvement was a most valuable object lesson as it enabled me to learn precisely the extent of nature's power in restoring the prosperity of a bed when given the time and opportunity to do so. The operations of the oystermen whom I saw engaged in collecting oysters afforded me the requisite information on the converse proposition of how quickly unrestricted fishing may exhaust the improvement made during the period of closure.

102. The only beds which do not show evidence of complete depletion are those of the Hab river. There every rock and every object fit to give footing to oysters are covered with them in densely packed masses. The general size was small and stunted due to mutual crowding, the consequence of insufficient cultch surfaces for the multitudes of spat emitted by the adult oysters found there. I was informed, however, that alterations in the course of the river have involved the silting up of many good rocky patches and other cultch, so that the oyster population at this place is less than it was some years since. The size-quality of the oysters is the fault here and not that of actual scarcity of individuals. On the other beds the fault is actual depletion of the oyster population; at the Hab, it is deterioration of quality that is the fault.

103. *Causes of depletion.*—My inspection of the beds confirmed fully the views which attribute the present exhaustion of the beds to the evils of overfishing. No other conclusion is possible. Overfishing is without doubt the main and preponderating cause of this catastrophe, emphasized and hastened, however, by the coincidence of several minor factors during the period when overfishing was being most actively pursued. The historical evidence given on a foregoing page and the pictures of the present-day condition drawn in the section dealing with the record of my inspection of the beds furnish convincing testimony and need be laboured no further. It is abundantly clear that in the past treatment of these beds *the first principle of oyster culture*, namely that *the average number of oysters annually removed must not exceed the number annually bred and reared to a marketable size*, has been consistently violated.

104. Of the minor contributory causes the most important have been, (a) cyclones, (b) freshets of the Indus and the Hab, (c) *mara pani*, poisonous and sulphuretted water of obscure origin. All three have played their part, aggravating locally the mischief being done generally by overfishing. It

seems very probable that the poisonous effects of *mara pani* completed the destruction of the Kuranji and Kadero beds in 1890. These beds have never recovered, a result due in the first instance to the destruction having been so complete in this neighbourhood that no spat was available for years and next to the fouling of the old cultch owing to the uninterrupted growth of a rich marine fauna. To-day the ground is foul and unsuitable in its present condition to the settlement of new spat.

105. The condition of the beds generally is bad, but far from hopeless. The Sind oyster has many good qualities; it is of excellent flavour, attains a marketable size very quickly and fattens rapidly. Two years are sufficient to rear it from spat to a size and quality suitable for table use. It is a species which undoubtedly will respond satisfactorily to culture; the cultural system may be of the simplest, indeed the conditions preclude any elaboration. Some experiments in spat collection have already been made; they have been considered failures, but enough is known of their results—some are patent to the eye to-day in the Vad creek and at Nawa Nar—to enable us to say that they might easily have been turned into successes had a little expert knowledge been available and had the condition of the experiments been recorded systematically. As it is, tiles bearing oysters of good size may now be picked up on the site of these experiments and the complaint has been made on several occasions that the experiments have been rendered of no account by systematic theft of the oysters which have grown upon the tiles. Myself, I read the story otherwise; the fact that the tile oysters were stolen repeatedly is evidence that these tile-raised individuals, the product of artificial methods, were sufficiently well grown to be worth collecting for market. Instead of discouragement, this fact should have spurred to further effort and to experiments on a larger and more systematic plan. The mistake seems to have been that it was not clearly recognized that the aim of first experiments should be directed solely to ascertain data; before practical culture can be started successfully we must have clear knowledge of the season at which the oysters spawn and of the physical factors which control or stimulate the simultaneous emission of milt and ova by large numbers of individuals massed in a bed. When we have ascertained the principal elementary facts relating to spawning then only are we justified in undertaking practical work; otherwise anything we do is a blind groping in the dark, a proceeding apt to lead to failure and the discredit of what is really an economically sound proposition.

106. The enquiry now ended has however furnished a certain amount of useful information concerning these beds and this, together with a fairly intimate acquaintance with the methods found successful in districts where oyster culture is systematically pursued, enable me to suggest the lines on which experiments are most likely to be successful, to forecast their results and to state a number of cardinal principles to be observed in the regulation as well as in the culture of the beds.

107. From dissection of a number of the oysters I found the sexes to be separate as in the common mud oyster of Southern India and in the Portuguese oyster (*O. angulata*) of Western Europe. As in these two species the ova and sperm are discharged when ripe into the surrounding water where fertilization takes place and where embryonic development proceeds; in the English oyster, *O. edulis*, fertilization of the ova takes place within the gills of the parent and the young remain there till they develop all the larval organs. When the larvæ of *O. edulis* swim away from the parent they are capable of immediate attachment to any suitable cultch they may encounter; in the case of our Indian edible oysters owing to the absence of any incubatory phase, the free-swimming period of life is prolonged and several days must elapse before development is sufficiently advanced to permit of attachment to cultch. Five or six days elapse before settlement is possible and when suitable surfaces are scarce the free swimming stage may be extended to double this period. We urgently require precise information regarding the season when general or wide-spread spawning occurs. In Europe and in the United States, that is, in temperate latitudes, it occurs when the shallow coastal waters warm with the

advance of summer. In Europe the spatting season ranges from the middle of June through July and on even to the middle and end of August according to the character of the weather and the number of hours of sunshine. In Pulicat Lake on the East Coast of India I find one spatting maximum occurs in September and the beginning of October, while at Tuticorin where the temperature and salinity of the harbour waters are remarkably stable the whole year round, the spawning of oysters is widely distributed throughout the greater part of the year and brood oysters appear to met with during practically every month. On the Sind Coast seasonal differences are much more distinctly marked than on the South Indian Coasts where hot and cold weather seasons are largely a figure of speech and not actualities. In Sind this is not so; during December, January and February a marked lowering of the temperature of the inshore waters takes place, while an even more emphatic rise occurs in July, August, September and October. A sudden alteration in the density of the water is another factor which sometimes has a distinct influence in accelerating or stimulating the emission of the reproductive products; around Karáchi the heaviest rainfall of the year occurs in July; in 1909, 3.29 inches of rain fell in Karáchi on the 14th, 15th, 26th, 27th and 29th July, the total average annual fall being about 7 inches only. Hence it may well be that under the combined stimuli of increase in temperature and a sudden decrease in salinity at the end of July, this period of the year may mark the usual spatting maximum in this locality. This is however merely a deduction based on knowledge of what holds good elsewhere and I am prepared to find when we obtain further information that the recession of the sea at the times of great spring tides during the hot weather season have more to do with emission than have freshets. Exposure to the sun's heat for a period of several hours daily on the occasions of those spring tides which occur during warm weather acts as a distinct stimulus to the reproductive glands of many littoral animals. I have noticed it of pearl oysters, edible oysters, and tube-dwelling worms (Sabellids), and it is a matter of common belief among oyster-culturists that spatting takes place always on a rising tide. The dates when spring tides occur during the months of July, August, September and October are the times when conditions are likely to be most favourable to induce spawning in edible oysters on the Sind coast and this is about all we can definitely say at present; the size of the brood oysters seen in Dumbri creek and at Shams Pir suggested their having been spawned during September.

108. The first experiments to be made should be directed to ascertain the month of the maximal spat-fall and the factors which accelerate or retard the emission of spawn locally.

VI.—THE REMEDIAL MEASURES PROPOSED.

109. The recommendations which I shall now make for the improvement of the Sind oyster industry fall into two divisions, (a) the administrative or regulative and (b) the cultural. With regard to the lack of success attending the enforcement of the various regulations made for the protection of the Sind oyster beds since 1897, those which enforced an annual close season and closure of the creeks by compartments for two-year periods suffered from the defect inherent almost always in such measures—the omission to limit or define the quantities to be removed during the open seasons. All the existing creek beds are very restricted in area and I have seen all the improvement effected in the Dumbri and Mall creeks by two years of closure nullified by two days' fishing upon the re-opening of the beds. It is not a matter of extending the period of closure; it is the control of the beds when open to fishing which is the essential of successful regulation. The object of closure is to afford protection to the adults from undue depletion and to give them an adequate opportunity to produce new generations. A little consideration will show that it is obvious that the good effects of closure will be in inverse ratio to the massing of the individuals to be protected. When the animals are sedentary and massed thickly over small areas, close seasons are of little value; the shortest of open seasons will suffice for practical extermination if the subject of

regulation be worth some one's while to engage a sufficient labour force wherewith to exploit it. Much preferable is it to do away entirely with open seasons and to regulate fishing by the issue from time to time of permits defining the numbers to be removed under each. This is done in respect of many species of large game which are accorded protection in the jungles of India, Ceylon, Africa and North America; it is a regulation which enables the licences issued to be proportioned to the varying abundance from year to year of the species involved. Should the numbers increase beyond a certain limit, permits are issued freely, while if the species become thinned out too greatly, the issue of permits may be suspended entirely till recovery takes place.

110. Oyster beds are particularly liable to damage from over-fishing; in the majority of natural beds the every day risks against which the beds have to struggle are so many and dangerous that the beds can but just make headway and keep up their average population with a narrow margin of increase during favourable seasons. Cumulative increase is very slow and the disregard or ignorance of this truth is the cause of the present depleted condition of the Sind beds. To ensure the continued prosperity of a bed no more oysters may be taken from it in one year than the average number reared annually to a marketable size. Every effort should be made to secure this but as I recognize the difficulties in practice of ensuring such a result, the alternative of maintaining a large breeding reserve of mature oysters at a central locality in each system of creeks should be arranged for and this reserve jealously guarded against interference.

111. Another measure that would certainly prove of great benefit to the beds would be the framing of regulations for the preservation of the present cultch and its increase in the manner shortly to be suggested. From actual observations and from statements made at past enquiries by fishermen and others, it is evident that ruthlessness and needless waste have always been characteristic of the conduct of this fishery. Dead and living oysters are indiscriminately haled in great clumps from the beds, carried to the banks and there culled; little or no effort is made to restore the dead shells to the beds—they are left to litter the banks at a level where they are valueless. Degradation of the level of the beds follows and the surrounding sea of mud gradually oozes in, filling the gaps whence cultch has been removed needlessly. For the preservation of the few oyster patches now remaining in the creeks and for their gradual extension and improvement, I consider the adoption and enforcement of the following regulations to be necessary, namely,—

(1) The limitation of oyster fishing on each bed or series of beds to a specified number of oysters per annum.

(2) The reservation and maintenance of one or more patches of oysters as breeding reserves at some central locality in each principal system or net work of creeks.

(3) The interdiction of the removal from any bed of all oysters measuring less than 2 inches or more than 6 inches in greatest length.

(4) The replacement on the bed of all dead shells and other cultch taken out during the removal of living oysters.

(5) The inclusion in the terms of every fishing permit or license given, of a condition binding the licensee to transport to the beds and there deposit as directed a boat load of cultch—stones, broken tiles, old bricks and the like—every time he visits the creeks for the purpose of fishing oysters.

(6) The licensing of each person engaged in the fishing of oysters.

(7) The exaction of a fee upon all oysters fished from Government beds.

112. *Limitation of fishing.*—This if adopted will involve the virtual permanent closure of the creeks save for a few days in each year. This is the procedure adopted with success in France to ensure the permanent success of the one great natural oyster bed now remaining, that of Caucale in the bay

of Mont St. Michel in Normandy. It was also the plan followed for nearly half a century to assure the prosperity of the common oyster grounds of the great oyster culture centre of Arcachon. Each year the administration examines the Cancale beds and decides the period during which free fishing shall be permitted. Immature oysters and all cultch have to be returned immediately to the beds and the time allotted to fishing is very limited. In the case of the Arcachon beds it never exceeded a total of *three hours in any one year* between 1883 and 1900 and no fishing whatever was allowed for 10 years out of the series of 18.

113. In order to control the regulation of the beds a preliminary essential is the preparation of a sketch plan of the creeks showing the position and relative extent in square yards (say by means of symbols) of all the beds now existing. Quite a rough sketch plan will suffice. When this is prepared, the creeks should be visited once each year and the condition and the approximate number of the oysters of marketable size, noted. This annual examination will provide the data necessary in deciding which beds shall be fished and the number to be taken from each.

114. *Breeding reserves.*—One or more patches should be reserved for this purpose in each of the creek systems of which the Kuranji, Jhiri, Piti, Khudi, Khai, Pitiani and Dubba form the main channels. A good healthy bed should be chosen in each case, the larger the better. When a series of patches occur up a side creek as in the case of the Dumbri branch detailed on a preceding page, those furthest up the creek should be the ones reserved.

115. *Size limits.*—The present regulation may be retained, although it is of small relative importance compared with the two preceding rules. The market may be trusted to look after its own interest in rejecting any very young or small oysters and with regard to the maximum limit, there are few if any of such size now existant—certainly there are none on the patches which have been regularly visited by the oystermen. Yet as it may happen that some hitherto unworked patches may yet be found in remote creeks it is well to retain the rule in order to afford protection to the large sized oysters seeing that individuals of 6 inches and more in length are of extremely high breeding value; where a 3-inch oyster may give out 1 million of ova, a female of double this length may be trusted to afford 3 or 4 millions at least.

116. *Cultching.*—The mention of the vast quantities of spawn emitted by oysters suggests a caution to prospective oyster culturists not to be misled by this wonderful fecundity of the oyster into limiting the reserves of breeders. In England it has often been said when arguing in favour of the unrestricted dredging of oyster beds, that as it is impossible to dredge up the last oyster from the banks, the few left, out of their prodigious fecundity, are sufficient to repopulate the bank. No greater mistake could be made. The fertility of the oyster is correlated with an almost equally prodigious mortality during larval life; the proper statement of the mutual relation of these two facts is to make the fecundity a consequence of the waste—the risks during larval life are so immense that to maintain the species, to ensure two of the progeny of any two oysters attaining maturity, a million or more ova have to be produced by the mother oyster. The chances against surviving to maturity are roughly a million to one; the actual chance is probably a very great deal less. This is said of oysters in the natural condition; when they and the beds are under culture of any from whatever, much may be done to improve the chance of a larger proportion surviving, indeed this is the great aim of the oyster farmer. Anything which tends to afford a greater area of clean surface for spat attachment, whether by cleaning of the cultch already present or by increasing the quantity available is of prime importance in this connection, hence recommendations 4 and 5. If the vital necessity for extensive cultching be once recognized and operations on a large scale be intelligently carried out, the oyster industry on the Sind Coast should eventually arise Phoenix-like and flourish once more. The suggestions numbered 4 and 5 have the advantage of necessitating no other expense to Government than that of general supervision; I cannot advise that direct expenditure be incurred upon cultching, at least not till progress has been made with the spat collection advocated below under the head of culture.



FIG. 7. A French Oyster-woman in working dress. On her feet are the wooden plates employed whenever the surface of an oyster park consists of soft mud.

117. In laying down fresh cultch on the creek beds full value can be obtained only if this be done immediately prior to the spawning season. This must first be ascertained and as it would not be politic to permit removal of mature oysters till some time after this be completed, it is evident that cargoes of cultch taken by the oystermen to the creeks at the time they go to collect oysters cannot with advantage be laid down on the beds at that time; before the next spawning season the cultch would be fouled with mud and slime and would prove of comparatively little advantage. The difficulty may be surmounted by unloading the cultch not on the beds themselves, but on the highest level of the adjoining flats where the material will be daily exposed to the sun and air and kept fairly clean till the approach of the oyster-breeding season, when a supervising officer with a few men under him may be sent round the creeks with instructions to deposit the heaps of cultch on and around the margin of specified beds. This visit should also be utilized for an inspection of the beds and the estimation of the number of oysters—not exceeding two-thirds—for which fishing permits may be issued during the ensuing year.

118. Both oystermen and the men engaged in cultching and inspecting should be made to use wide plate-like wooden-soled sandals during work on the beds, in order not to press the oysters and cultch into the mud. Such foot-gear is considered indispensable in working muddy oyster-parks at Arcachon, the greatest oyster centre in Europe. In size these wooden sandals should measure 10 × 10 inches. The upper surface is provided with a wooden ridge outlining the foot which is held in place by a leather band over the instep, while from corner to corner on the lower side run intersecting battens to prevent warping and give greater strength (see figure 7 which shows a French oyster worker wearing these wooden plates).

119. *Licenses and fees.*—An annual fee should be exacted from each man licensed to collect oysters; its amount will depend on whether, in addition, a fee per dozen or per hundred be levied on the actual numbers of oysters removed from the beds. Both to provide the means for efficient supervision and for culture operations and to give the administration proper control over fishing operations, I strongly urge the advisability of exacting a fee upon all oysters removed from the creeks. Without Government action the creek beds will continue depleted, indeed they will certainly die out altogether; to secure any improvement efficient supervision must be established and this cannot be done without incurring expense. The oystermen will benefit primarily, and the consumer will obtain the valued luxury he desires—it is but fair that a contribution towards the expenditure involved in effecting amelioration should be made. I consider as fairest that this should take the form of a rate per 100 on all oysters removed. So far as possible fishing in each creek should be limited to one or at least two tides per annum; those oysters not required for immediate use may be relaid by the collectors at some suitable locality in Karáchi back-water whence they may draw upon them as required. If simple cultural operations be begun at Nawa Nar, the presence of a number of store oysters in the vicinity might be found to exercise considerable beneficial effect in supplying additional spat. As an instance in point, I noted a considerable quantity of brood oysters upon the shells and stones of Shams Pir beach where a cargo of Kutch oysters had been relaid by a Karáchi oyster merchant in the early part of the year.

120. For the privilege of collecting oysters in the creeks; a fee of one anna a dozen would certainly not be too great in a time of oyster scarcity such as the present; the class who consume oysters would, I am sure, be very willing to pay this extra in order to obtain their requirements.

121. *Culture.*—The Indus creeks afford no field for oyster culture save for the limited measure of cultching proposed in the preceding section; no real culture work is possible in the creeks owing to the softness of mud bottom everywhere, for the extensive cultching necessary to prepare a proper surface or bed for cultivated oysters would entail such heavy expenditure as would be altogether prohibitive.

122. The confluence of Kadero and Kuranji creeks offers some potentiality of improvement under intelligent treatment, but the only really suitable localities for culture work on an extensive scale are Karáchi backwater and the estuary of the Hab river.

123. The first step in culture will be to ascertain the spawning season. To do this, it will be necessary to examine adult oysters every week or fortnight from May till October; the progressive development of the milky white reproductive glands enveloping the liver and alimentary canal—the fleshy mass lying between the hinge and the adductor muscle—must be noted and as soon as the glands begin to swell and the sperm or ova flows out readily from punctures made in the gland upon the application of gentle pressure, a quantity of limed tiles made up into small bundles should be immersed at intervals of ten days at low tide level in the neighbourhood of a quantity of mature oysters. The place I recommend for the experiment is Nawa Nar near the Maurypur Salt Works. Here is a large stretch of firm and stable bottom, plenty of natural cultch and a certain number of mature oysters. I cannot say if there be now a sufficiency of the latter present; fishing has been actively carried on here of late years and I think it is probable that a supply of old oysters to constitute a breeding stock will have to be provided, preferably from Kutch or Sonmiani, as large sized oysters are still procurable there. If any be procured from Kutch, care should be taken to import them during the cold season and effect their transport rapidly, as I understand there has frequently been great mortality among oysters imported from Kutch owing to head winds entailing a prolonged sea passage.

124. The place where the breeders are deposited should be fenced in with a palisade of such a description as will demarcate the ground occupied but at the same time offer no considerable resistance to the ebb and flow of the tide. Pl. 1, fig. 2 shows a form of palisade in use in France to protect oyster parks from the depredations of fishes. The bundles of limed tiles may be placed either within or without the demarcated area; in France spat collectors are usually outside and placed as far out in the channels as possible. In several experiments made at Ennore near Madras I bound the tiles into bundles consisting of 4 or 5 tiers of two tiles in each tier, each alternate row being laid at right angles to the one under it. Ordinary semi-cylindrical country tiles are the most suitable form to employ; Mangalore tiles are not of a useful shape. All the tiles in the bundles should be arranged concave side downwards as this arrangement contributes distinctly to keep this surface free from sediment; it also provides shady sheltered nooks for attachment such as oyster spat particularly love.

125. Were the tiles employed to receive no preliminary treatment this would not militate against a rich spat fall upon their surfaces, but it would have the great disadvantage that the brood oysters obtained could not be removed without usually fatal injury except by breaking the tile into fragments. To obviate this a process of covering the tile with a thin, friable, and easily detached coating of lime mortar has been devised. The oyster spat therefore adhere not directly to the tile but to this thin coating and when it is desired to remove them, this can be done readily and without damage to either oysters or tiles, by flaking off the lime by a series of short smart blows administered by means of a chisel-shaped knife.

126. The actual process of liming tiles as practised in France and Holland is described in detail in my report on "The Practice of Oyster Culture at Arcachon and its Lessons for India," forming Bulletin No. V of the Madras Fisheries Bureau. A description, illustrated with a series of photographs and figures, of the large crates in which the French oyster farmers pack their tile collectors is given in the same publication, a copy of which should be given for guidance to the officer to be charged with the operations now recommended.

127. During the first season's experiments, only small bundles of tiles need be used. Each should bear a metal label impressed with a serial number.



FIG. 1. Liming of tile-collectors, Arcachon, France.



FIG. 2. Cases of tile-collectors, placed in position. Arcachon.

If a series of bundles be deposited in a suitable place at ten-day intervals from say 1st July to 15th October and these be examined and the attachment or not of spat noted carefully at regular intervals, it will be easy to determine with approximate accuracy the date of general spawning. Once this be ascertained, spat collection on a much more extensive scale should be attempted in the following season. If the ground be well consolidated, parallel rows or walls of loose tiles 3 or 4 tiers high may be employed. The rows should run parallel with the direction of the channel, so that the tiles may be laid at right angles to it. Or the crates referred to above may be used; these are particularly useful on soft or muddy ground.

128. If the experiments prove successful and a large harvest of spat be obtained, the brood oysters should not be removed from the tiles till they attain a diameter of $\frac{3}{4}$ or $\frac{7}{8}$ inch. Under the favourable conditions for growth found in India, this will probably be attained within a month or 5 weeks from the date of attachment to the tiles. When this size is reached, the oysters should be stripped from the tiles and laid out on firm bottom protected by palisades from fish and the transporting action of tidal currents. Once it be demonstrated that oyster spat can be obtained by the outlay of a comparatively small expenditure of labour and expense, there should be little difficulty in persuading those interested in the oyster trade to enter upon the simple form of culture here advocated. Particulars of how to treat the growing oysters, how to protect them from crabs, fishes, and passive enemies are given in detail in my Madras Bulletin so that it is needless to recapitulate these here.

129. With every extension of culture in the Nawa Nar neighbourhood, the richness of the spat fall will increase. At Arcachon the whole of the annual production, averaging over 350 millions of saleable oysters, is the product of spat emitted by oysters under cultivation. The physical characters of Karáchi backwater are not unlike those of Arcachon and I see no reason why a very extensive culture production should not be yielded by the western section of the former. I believe too that the cost of oysters reared there, from spat artificially collected, should compare very favourably with the expenses now involved in sending boats and men to the creeks to collect from the natural beds.

130. One great advantage over French culture grounds possessed by Karáchi is the greater rapidity of growth which characterises oysters in India. From my observations in the creeks, I am fully assured that marketable size is attained in about two years from the date of being spawned, and possibly this period may be reduced under cultivation. In the extreme south of India the growth is much more rapid than this—I have note of oysters which have attained a size 2.90×2.70 inches within the incredibly short period of seven months and others which measure over 4 inches by 3 inches within 9 months—the latter a suitable size for market. Such phenomenal growth I do not expect to occur at Karáchi, but if fat, well-grown oysters can be reared within 2 years as I am certain can be done, there should be a fine future in store for Karáchi oyster-culture.

131. *Administration.*—I trust it will not be considered presumptuous on my part if I round off this report with the recommendation that the whole of the actual work of surveillance and experiment be entrusted to the officers of the Sea-Customs, the general direction of the operations to be undertaken resting with the Collector of Karáchi. There are two cogent reasons for the Customs Authorities being entrusted with all executive duties relating to coastal fisheries in the case of Sind. In the first place they maintain already a preventive staff whose duties involve the patrolling of the coast line and so give them unrivalled opportunities to ascertain and to control all fishing operations in the creeks and backwaters. If the Customs be given charge of this work, any extra establishment to be entertained will be most modest. The supervision and inspection of the creek oyster beds may indeed be dovetailed very largely with the ordinary duties of the Customs Preventive Staff. A second reason is that the Chief Collector of Customs is already in

control of the Sind Pearl Fishery and as the pearl oysters (*Placuna placenta*) and the edible oysters frequently live together in the same creeks it would scarcely be reasonable to place the new work under any other department. At present the Customs have no official connection with the edible oyster industry. The only executive duty, that of inspecting cargoes of oysters brought into Karáchi Port, is carried out by the Port Officer's Department, an arrangement due, I believe, to the fact that some years ago the then Port Officer, Commander Shopland, was an ardent conchologist and was requested to take up this work owing to his special interest in it. This personal reason having passed away, it will be well if the control of the pearl and edible oyster fisheries be amalgamated under one and the same Department.

JAMES HORNELL.

Tuticorin, 4th March 1910.

RETURN TO the circulation desk of any
University of California Library

or to the

NORTHERN REGIONAL LIBRARY FACILITY
Bldg. 400, Richmond Field Station
University of California
Richmond, CA 94804-4698

ALL BOOKS MAY BE RECALLED AFTER 7 DAYS

- 2-month loans may be renewed by calling (510)642-6753
- 1-year loans may be recharged by bringing books to NRLF
- Renewals and recharges may be made 4 days prior to due date

DUE AS STAMPED BELOW

DEC 19 2003

