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Title

A STUDY OF THE MUD DEPOSITS OF THE GILL NETS IN THE NASS RIVER, BRITISH COLUMBIA

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BRANDON COLLEGE
Brandon, Manitoba

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Major J.A. Motherwell,
Chief Supervisor of Fisheries,
Dept. of Marine and Fisheries
Vancouver, B.C.

Dear Sir:

In reply to your letters of Sept. 6 and Nov. 4 (file No. 12-2-A2) let me first state that I am very sorry to have caused you so much delay. However, as I am not in the employ of the Department but of Brandon College I felt that my first duty was to the college and unfortunately they have kept me very busy.

I dried the mud and the mine tailings to constant weight at 110°C and then compared their physical and chemical properties. The tailings are much more dense and dissolve almost completely in nitric acid; the mud dissolved scarcely at all. The behaviour of the two samples on ignition is also different. From these and other observations which I have made some might feel safe in saying that the two materials are quite distinct and unrelated. I am not quite so positive. All I can say is that I believe them to be different materials, and at the same time I draw your attention to the following facts:

First: The sample of mud from the nets may not have been representative. It may have contained an unusual amount of bottom mud.

Second: You mention that slag is being dropped into the sea. It is just possible but not very probable, that such a peculiar material as this slimy deposit on the nets arises from the slag by some decomposition caused by the water. (Water does not seem to act upon the tailings you sent to me. I left some in sea water for days but nothing slimy was produced. There was no apparent change.)

Third: It is well known that the carrying power of a stream varies as some function of the velocity of the water. Generally the carrying power is said to vary as the sixth power of the velocity but I believe this theoretically derived relationship does not hold. However, we all know that heavier particles settle more rapidly than lighter particles of the same size. It is possible but again not probable, that the heavy metal sulphides have all settled out before the material reaches the nets and that only earthy material is left. If such were the case that would explain why the tailings almost completely dissolve in nitric acid whereas scarcely any of the mud dissolves. I do not believe that this happens, but I suggest it to show the difficulties we are up against in deciding upon the origin of the slimy deposit on the nets. My belief is that the mud on the nets is probably just the fine silt carried by the river. I know nothing of the Nass River, its rate of flow, or the character of its suspended load, so can only suggest the following explanations. The very fine silt, possibly in an almost colloidal condition, is caused to flocculate into larger masses either as a result of some chemical in the nets (the preservative?) or of some change in the chemical condition of the river water. The silt, in coagulating catches up tiny plants and animals in the water and as this mass of material accumulates the nets are dragged down. The disgusting odour of the muck you sent to me was probably caused by the decay of the entrapped organisms.

I doubt whether the muddy deposit contains anything that would injure the fish. The greatest danger would be that the particles would clog up the gills. I am afraid this information will not help you very much, but that is all I feel justified in reporting under the circumstances. I believe the mud is distinctly different from the tailings, but I have not enough information about conditions in the Naas river to be positive about it.

Yours truly,

"C.C. Lucas".

ACKNOWLEDGEMENT

We wish to thank Mr. H. N. Brocklesby, Acting Director of the Fisheries Experimental Station at Prince Rupert, and his staff, for their interest in and generous assistance with the work.

We would also thank Mr. Walker, Manager of Arrandale Cannery and Mr. Harris, Manager of Mill Bay Cannery for their co-operation and hospitality while the field work was in progress.

Our best thanks are also due to Mr. McIver, Fisheries Inspector of the Nass district, whose office gave us shelter, and to Major J. A. Motherwell, Chief Supervisor of Fisheries, who has been most zealous in seeking the cause of the loss of nets on the Nass River.

A STUDY OF THE MUD DEPOSITS ON THE GILL NETS IN THE NAAS RIVER DISTRICT, BRITISH COLUMBIA

by

W. H. Martin

During July and August, 1929, the gill nets of the salmon fishermen operating near the mouth of the Naas River became so fouled with mud that a number sank through the weight of the mud and were lost. This mud was described by the fishermen as very gluey in nature, pulling out so as to cover sometimes the whole mesh of the net. It appeared suddenly following the high tides of July at the place where the fresh muddy waters of the Naas mix with the salty waters of Observatory Inlet and of Portland Inlet at the point "P" on the map. The trouble then appeared each day farther and farther down the Inlet, but less severe the farther down. A second but lesser attack followed the next high tide a couple of weeks later.

In the summer of 1930, the mud reappeared at the same place and at about the same time as in 1929, but in much greater quantity, and this time with disastrous results to the fishermen. Arrandale Cannery lost 24 nets, Mill Bay Cannery 6 nets, and Wales Island Cannery 6 nets, and only the heroic struggle of the fishermen prevented far greater losses.

So heavily were the nets laden with mud that they sank and could not be hauled into the boats. An attempt to haul them by force onto the deck of the tender only resulted in parting the net-lines and losing the nets. In 1930, as in 1929, the trouble developed a day or two after unusually high tides, progressing daily down the inlet, and becoming less severe from day to day.

Conjecture Regarding the Source of the Mud

Many of the fishermen attributed the source of the mud to the Anyox concentrator, which discharges a very large amount of milled rock into Granby Bay, a distance of almost 30 miles from the mouth of the Naas. The reasons for blaming the Anyox plant for the trouble were as follows:

(a) It seemed that the Naas mud could not be responsible for the net trouble, since those fishing in the fresh muddy waters up river from the mouth, experienced no difficulty; indeed muddy nets may be cleaned by rinsing in the Naas water.

(b) The fouling of nets did not occur until 1929. Many have a rather indefinite idea that Anyox began about this time to concentrate its ore by the flotation process. This is certainly not true. The process has been in use since March, 1924, and since that time all the tailings have been discharged in Granby Bay as at present. In 1924 the concentrator treated 1000 tons of ore a day; in 1925, 1200 tons a day; 1926, 1650 tons a day; 1928, 3800 tons a day; 1930, 5000 tons a day which is practically the total ore handled.

(c) The damage to the trees and other vegetation on the mountains along Observatory Inlet extends as much as 15 miles from the smelter and clouds of sulphur dioxide gas appear at times as far down as the mouth of the inlet. It seems reasonable to the fishermen, to attribute contamination of the water to an agency which so evidently contaminates the air for so great a distance.

Preliminary Studies

It was evident that the situation was a matter of great concern not only to the fishermen, but to the canning companies, to the smelting company and to the Department of Fisheries. The latter reported the situation to the

Biological Board of Canada in 1929 and forwarded samples of mud from the nets and tailings from the smelter effluent to the Pacific Biological Station. Mr. G. G. Lucas carried out a preliminary analysis and reported that the two materials were quite different in composition, that the mud on the nets was evidently river silt deposited possibly through action of sea-water salts or net preservative. In 1930, Mr. D.B. Finn, then Director of the Fisheries Experimental Station, undertook to carry the investigation farther and with the assistance of Messrs. Vollum and Marshall, made a more extensive study of the net mud. They made a trip to the scene of the net trouble and to Anyox, measured the acidity (pH) of the water in the neighborhood, observed the mud on the nets, and returned with samples from the nets and from Anyox for analysis. They found (1) that the waters of the inlet and river showed no unusual acidity (pH) at the scene of the trouble nor close to Anyox. (2) that the chemical analysis of the silt failed to show any characteristic element common to the net mud and to the mud from Anyox concentrator. Indeed the most striking feature of the analyses is the great difference in the amount of silica between mud from the two sources, the silica content of the Anyox mud being unusually low.

<u>The 1931 Investigation.</u>

The present investigation was begun on July, 1931, to determine if possible, the source of the mud. From July 3 to 8 the first trip was made to the Nass River and to Anyox to study the tidal and river currents, the salinity and acidity of the water, and to obtain samples of water and mud for laboratory study.

Observatory Inlet and Anyox

The data of the table will make it clear that no great flow of fresh water comes down Observatory Inlet. Only small streams from the mountains along the Inlet and a small stream at the head of Hastings Arm and another at the head of Alice Arm empty into this Inlet. The water from above the head of the Inlet drains either into the Naas on the east or Portland Canal on the west. Observatory Inlet is very deep, in some places more than 200 fathoms and in most places over 100 fathoms, and its waters are clear blue sea water. (Sp. Gr. 1.021) Near the mouth of the inlet on a rising tide the fresh muddy waters of the Naas come up as much as 5 miles, but this fresh water is wholly on the surface. Thirty feet down is always clear salty water. Samples of water taken with a Copenhagen standard sampling bottle at stations 5 miles apart, all the way up the inlet, showed clear salty water at all depths to 30 fathoms with no sign of mud except that near the mouth at the surface, which was evidently Naas River water brought up by the inrun of the tide.

The sluice from the Anyox concentrator at Granby Bay, discharges into the Bay 4500 tons a day of milled rock, 55% of which passes a 200-mesh screen. Most of this material is deposited immediately at the mouth of the sluice and has formed a bank which is exposed at low tide. As soon as the tide has run out and left this bank exposed, one may walk on it as on a hard road without picking up any mud. Only a tremendous current of water could wash away this material and no such current is to be found in this bay. The finer sediment passes out farther into Granby Bay and is to be found covering piles and bottom with a cement-like adherent coating. No barnacles are found on the piling close to the sluice though healthy flat fish and crabs are taken in the Bay.

A sample of water, taken about 500 feet from the sluice discharge, obviously contained much crystalline sediment which had entirely settled out in 30 minutes. Evidently there is no finely divided colloidal matter. The material from Anyox sluice is then a relatively coarse material which settles quickly to form a very firm adherent deposit on the bottom of Granby Bay and which is a substance most unlikely to be carried by tidal currents a distance of 30 miles to the seat of the net trouble.

Mr. W.B. Maxwell, Assistant General Superintendent of the Granby Consolidated Mining, Smelting and Power Company, very kindly explained the mill's operation and gave complete information as to the substances used in the flotation concentration. 4500 tons of tailings from which the copper has been almost entirely removed (96% recovery) are discharged daily from the sluice. In the treatment are used for each ton of ore treated:

Lime	2 lbs.	
Cyanide	.02 lbs.	
Pine Oil	.04 lbs.	
Raconite	.02 lbs.	(a Xanthate)

Such a quantity of lime could not conceivably have much effect on a large body of sea water, and indeed measurements of acidity show no abnormality in the water at Granby Bay and Observatory Inlet. The other materials are present in such immeasurably small amounts that they may be ruled out at once.

The quantity of sulphur dioxide discharged from the smelter stack is of much higher order. This gas overhangs the Inlet in a visible cloud and no doubt dissolves in its waters. A search was made for sulphur dioxide in the waters of the Inlet only a mile from the Smelter (station 8). Preliminary trial showed that quantities of sulphur dioxide as low as 1 part per million could be detected by the colour reaction of fuchsin. The water of station 8 showed, however, no positive reaction for sulphur dioxide. Probably it is quickly oxidized to sulphate and, since sea water contains 6 parts per thousand of sulphate, a trace more could do no harm.

Number of Station	Date 1931	Hour	Tide	Depth at which sample was taken	Appearance of Sample	Specific Gravity (Hydrometer)	pH (quinhydrone electrode).
1.	July 3	12:35	High water 16:04	Surface	Clear	1.014 at 12° C.	
2.	July 3	17:30		Surface	Very muddy	1.006 at 11°	
2.	July 4	21:10	Low water 22:38	5 fathoms	Very muddy	1.000 at 9.5°	
2.	July 4	22:00		34 fathoms	Very clear	1.021 at 10.5°	
3.	July 4	14:00		Surface	Very muddy	1.000 at 10.5°	6.8
				4 fathoms	Slightly muddy	1.011 at 11°	
4.	July 7	10:30	Low water 12:11	Surface	Quite muddy	1.001 at 12.5°	
				2 fathoms	Slightly muddy	1.002 at 12.5°	
				5 fathoms	Clear	1.016 at 11°	
				25 fathoms	Clear	1.022 at 11°	

Note: One Quarter-mile above station 4 at 10:15 July 7 near the east shore was a distinct line marking the limit to which Nass water had run in on the surface with the rising tide.

Number of Station	Date 1931	Hour	Tide	Depth at which sample was taken	Appearance of Sample	Specific Gravity (Hydrometer)	pH (quinhydrone electrode).
5.	July 5	9:00	Low water 10:54	Surface	Slightly muddy	1.002 at 11°	6.8
				2 fathoms	Almost clear	1.012 at 12°	7.55
				5 fathoms	Clear	1.021 at 10°	7.50
				30 fathoms	Clear	1.021 at 9°	7.50
6.	July 5	12:15	Low water 10:54	Surface	Very slightly cloudy	1.006 at 13°	6.75
				5 fathoms	Clear	1.014 at 11°	7.5
				40 fathoms	"	1.022 at 8°	7.4
7.	July 5	14:15		Surface	Clear	1.010 at 12.5°	
				3 fathoms	Clear	1.012 at 10°	
				30 fathoms	Clear	1.024 at 10°	

Note: Station 7 is quite beyond the influence of the Nass, and here the water of the Inlet is quite clear even on the surface.

Number of Station	Date 1931	Hour	Tide	Depth at which sample was taken	Appearance of Sample	Specific Gravity (Hydrometer)	pH (quinhydrone electrode).
8	July 5	17:15	High water 17:22	Surface	Clear	1.010 at 15°	7.0
				5 fathoms	Clear	1.012 at 13°	7.65
				40 fathoms	Clear	1.022 at 11°	7.5
9	July 5	20:00		Surface	Fairly clear	1.004 at 16°	7.5

Note: The water of station 9 is evidently slightly contaminated from Anyox sluice. Water appears somewhat dark muddy in bulk but almost clear in a glass bottle. Appearance is very different from that of Nass silt.

Number of Station	Date 1931	Hour	Tide	Depth at which sample was taken	Appearance of Sample	Specific Gravity (Hydrometer)	pH (quinhydrone electrode).
10.	July 6	11:40	Low water 11:31	Surface	Cloudy, filled with glistening crystals.	1.008 at 13°	7.1
				5 fathoms	Only slightly cloudy.	1.012 at 13°	7.55

Note: Station 10 is only 100 yds. from discharge of sluice with tailings from Anyox concentrator.

* Samples of water were taken with Copenhagen standard water-sampling bottle.

** pH was measured only when boat was steady enough to permit of measurements with potentiometer. Colourimetric measurements proved unsatisfactory, especially where water was fresh.

The Naas River and Observatory Inlet

The Naas has a large flow of very muddy water. At 9:10 P.M. July 4 (low tide at 10:57 p.m.), the river, 1 mile above its mouth off Kincolith village, was entirely fresh muddy water to a depth of 30 feet. (Sp. Gr. 1.000). The current was estimated at 1 1/2 miles an hour and the river here is over a mile wide, though part of this is over a mud flat which is dry at low tide. This Naas mud is glacial silt which is precipitated rapidly on admixture with salt water. The net trouble develops just where the maximum admixture of fresh and salt water occurs.

An experiment carried out with the Naas water showed that addition of 25 per cent of salt water caused the silt to settle out more than 10 times as quickly as it did without such admixture.

On July 7 before the incidence of net trouble the Naas water at station 2 contained .13 g. per litre of silt; on July 22 at the time of net trouble it contained .10 g. per litre; and on Aug. 4 after all net trouble had disappeared it had fallen off to .025 g. per litre. Evidently in August, 1931, the amount of mud coming down with the Naas had greatly fallen off, probably because the flow of water fell off greatly late in the summer.

The Naas silt is a reversible colloid, that is, it is precipitated by salty water but after rewashing with fresh water, it will again form a rather stable colloidal suspension.

Examination and Comparison of Net Mud, Anyox Mud and Naas River Mud.

Since earlier work had shown that the source of the mud could not readily be determined by the method of Chemical Analysis, it was decided this year to concentrate on the physical properties of the mud, particularly as revealed by the microscope. The examination was made with a Zeiss petrographic microscope, giving magnifications up to 900 diameters. The photographs shown were made with a Lucas photomicrographic camera, which could be adapted for use with the Zeiss microscope.

A. The Mud from Anyox Sluice and from the Waters of Granby Bay

Mud is a misnomer for this substance, as neither in bulk nor under the microscope does it show the characteristics of a mud.

Settling of the sluice form 2 layers,-- a layer of coarse particles settling almost instantly, and a layer of finer particles settling less quickly. There is no difference except in particle size between the two kinds of sediments. The sediment from the waters of the Bay is composed exclusively of the finer particles.

The particles are all fragments of crystalline minerals. No secondary changes are apparent, that is, no processes of weathering or decay have changed the mineral fragments (See Plate I). No particles even remotely resembling a clay are present. All fragments have sharp edges and corners and almost all transparent particles are doubly-refracting. There is very little material so fine as to be notclearly made out (unresolvable) under the microscope, and very few particles are small enough to show the Brownian Movement. A large number of the particles are black and some an opaque brown. By determing refractive indices (immersion method) and other properties, almost all mineral fragments could be identified:

(a) Considerable pyrite.

(b) Considerable pyrrhotite. An exceedingly magnetic form which clung to a magnet.

(c) Much hornblende (Refractive index greater than 1.62, greenish colour, highly doubly-refracting).

(d) Very little quartz.

(e) A mica of high refractive index.

(f) A feldspar of rather high refractive index.

B. The Nass River Mud.

The material examined was filtered from Nass water taken near low tide at station 2 and dried at 100°C. in a vacuum oven.

Unlike the Anyox material, the Nass silt is truly a mud. It consists almost wholly of a very finely divided amorphous clay-like substance and lacks the sharp-cornered transparent crystals of the Anyox mud. Most granules are less than .01 mm. diameter. Evidently the substance has undergone processes of decay. It has also reported the gluey and stringy nature of the mud. Both these observations suggest organic matter. The dried mud, however, showed no organic content except a number of diatom shells. Evidently the organic content could only be studied by first hand observation of the mud on the nets.

Arrangements had been made with Mr. Walker of Arrandale Cannery and Mr. McIver, Fisheries Inspector for the Nass district, to send word immediately when mud appeared on the nets. On July 20 mud appeared, though the attack was less severe than in 1930. We reached Arrandale on July 22, at noon, and thereafter for four days accompanied the tender, which visits the fishing boats daily to take their catch.

This year again the mud appeared first at the mouth of Observatory Inlet off Ramsden Point (point "P" on map), and again progressed down the Inlet, but with less severity from day to day, appearing finally as far down as Somerville Island, 15 miles below Arrandale, some 5 days after the appearance off Arrandale.

Samples of mud were taken from the nets as they came into the fishing boats and immediate examination made by the microscope, which was set up in Mr.

McIver's office.

As the fishermen had said, the mud was gelatinous and pulled out in strings. It was noticeable that every muddy net contained a large number of jellyfish, though jellyfish often come in on nets when there is no mud.

It is evident at once from a study of the fresh net mud under the microscope why it adheres to the nets. The mud is full of gelatinous fibres like the tissue of jellyfish. Some of these fibres are relatively large (Plate 2, 1 to 4) and others very small. (Plate 2, 5 and 6, and Plate 3, 1).

Each gelatinous fibre is the centre of a very large mass of clay which clings to it. By working the material under the cover glass, some fibres were freed from their clay so that their nature was disclosed. (Plate 2, 5 and 6). It is these gelatinous fibres which cause the mud to pull out in gluey threads. A sample of net mud, after it is kept for a day or two, develops a putrid odour exactly like that of a decaying jellyfish.

Other organisms are very abundant also in the net mud, and probably play a part in giving the mud its gelatinous nature. Diatoms are abundant (Plate 3); a ceratium was very abundant in one net sample (Plate 3, No. 5); a long-chain green alga and a spherical green alga were in some cases in sufficient abundance to make a rather gelatinous mass.

It was noticeable that on the first day of the appearance of the mud, it had no putrid odour and did not develop this odour until it had been kept for a couple of days. A few days later, however, the mud on the nets was putrid so that the odour was noticeable a short distance from the fishing boats. Evidently some sudden catastrophe kills the organisms and this catastrophe occurs at the time of or shortly preceding the first appearance of the mud on the nets.

What the nature of this catastrophe is, one may guess. The trouble each year has developed a day or two after an unusually high tide. Indeed this year Mr. Walker of Arrandale Cannery was able, from previous experience, to predict to a day the appearance of the mud. In this inlet such tides cause an unusually violent mixing of fresh Naas water with sea water. By direct experiment, it was found that jellyfish are very quickly killed by sudden admixture of fresh water. Addition of 3 volumes of fresh water to 1 volume of sea water containing a jellyfish, killed the jellyfish practically instantly, seeming to precipitate the jelly-like substance. Also admixture of salt water precipitates the mud of the Naas as direct experiment has shown. The jellyfish and other organisms adhere to the net at any time without doing obvious harm but when the precipitating mud from the Naas is also present, the mud adheres to the gelatinous organisms and its weight sinks the net.

It would require a skilled biologist to identify all the fragments of living creatures involved in the net mud. Parts of jellyfish, small medusae and tentacles are most common but a large number of algae are also present. Some gelatinous fibres are large enough to be fragments of the large jellyfish which are always present in muddy nets. Other fragments evidently belong to some very small medusae or larval forms.

The seasonal appearance of the net trouble is no doubt due to the seasonal fluctuation in the abundance of those organisms involved. Certainly no great increase in the mud of the Naas occurred in 1931 at the time of the appearance of mud on the nets. (see data on page 6), though the failure of the mud to reappear following the high tides of July 31 and August 1, 1931, may be due to the great decrease by this date of the amount of mud being carried by the Naas.

The amount of planktonic life in these estuaries and inlets of the northern British Columbia coast, seems to be at its height about the middle of July. The sea is exceedingly phosphorescent, jellyfish abound, and great masses of diatoms and other algae appear as clouds in the water. Without this abundance of life the Naas mud is harmless: without the mud the life adheres to the nets, but is harmless: the combination of the two factors is the cause of the trouble.

The Skeena River

Only a low divide separates the water of the Skeena from that of the Naas. Like the Naas, the Skeena brings down large amounts of glacial silt and this silt, as in the Naas, builds up great mud flats near the river's mouth. There is here, however, no sidearm of sea water corresponding to Observatory Inlet and the admixture of fresh and salt water is more gradual and takes place farther up the river, even beyond the fisheries boundary.

There is some evidence that on the Skeena there has occurred a net trouble of the same kind as occurs on the Naas, but in a much less acute form. Mr. John Gregory, who has fished the Skeena for a number of years has been good enough to record an experience at the mouth of the Skeena in 1926. I can do no better than quote from his exceedingly clear statement of his recollection of the event.

"Towards the end of the sockeye season, 1926, between August 1 and 20, a muddy substance appeared in the waters of the Skeena estuary, causing inconvenience and some loss of nets among fishermen from Oceanic Cannery. The visitation was of short duration, and was confined to a limited area. Fishermen declared they had never before heard of, or experienced a similar occurrence. Because only a few fishermen at that time were fishing where the mud appeared, and loss of gear was slight, little attention was paid to the cause or the character of the mud.

"There is no evidence as to the reappearance of the mud in subsequent seasons, and the brief manifestation of 1926 is almost forgotten. Fishing from the Oceanic Cannery that year, he himself had some experience with the mud. He recalls that hauling his net at dawn sometime in the period mentioned above, at a point in the area roughly between the spar buoy off Smith Island and the Genn Islands to the south, he found it heavily weighted with slimy mud. Amid the "rejoicings" with which a fisherman greets such situations, little attention was paid to the character of the mud or to its possible origin. It is recalled that the mud clung tenaciously to the net, to one's hands and apron and the woodwork of the boat. Drying, the mud caked firmly, and was fairly light in colour.

"The occurrence of the mud was recalled by Joe Kipp, a well known Skeena River fisherman. Unprompted, he substantiated its principle features as recalled by the writer, and he also stated that the mud was only troublesome at night. Concerning this it may be observed that towards the end of the season very little fishing is done in this locality during daylight hours."

On July 18 a trip was made to Haysport, some miles up the Skeena. Mr. John McIsaacs, fishing on July 14, off the mouth of the Skeena near Porcher Island found his net fouled with a slimy material which squeezed out through his fingers as he hauled the net and covered his clothing and the boat with a slime which on drying resembled whitewash. The slime was not heavy and the net was in no danger of sinking. On July 18, we were able to obtain some of this dried slime from his boat. Examination showed it to be almost entirely organic with a very little mud admixed. Two kinds of algae were very abundant on the dried slime; one a large spherical green alga and the other a chain alga. Neither calcium carbonate nor silica was present and the whole mass charred and then disappeared on heating to a red heat.

Arrandale fishermen, working off Port Simpson (see map) on July 30, 1931, encountered a similar slime though the writer was unable to obtain any of the dried slime from their nets.

In these cases the gelatinous organic binder was present in abundance but silt was lacking to give weight to the mass. The Skeena has thus far escaped serious net loss. However, the Nass had escaped also until 1929 so that the possibility of danger on the Skeena should not be ignored.

Is It Possible to Escape Loss of Nets in the Nass District?

The experience of the past three years has shown when and where to expect net trouble. Certainly the danger is less now that the fishermen have learned to anticipate the trouble. This year (1931) no nets have been lost, partly because the attack was much less severe than in 1930, but partly also because the fishermen now watch their nets more carefully when drifting in the danger zone.

The presence of considerable numbers of jellyfish in this region after July 1 should be taken as a warning of impending trouble, and the danger zone avoided, or else the nets watched very closely for signs of trouble.

The "corks" which float the nets are about three-quarters submerged at normal times, so that the safety factor is very small indeed, should any mud settle on the net. The canneries do not welcome a suggestion of larger "corks" as those in use at present are standard equipment; but, if the trouble is repeated from year to year, a larger cork would merit serious consideration. This year special precautions were taken at Arrandale Cannery to waterproof the corks thoroughly so as to maintain their buoyancy.

A study of method of net treatment might disclose some treatment which would prevent the mud from clinging to the nets. At Arrandale and at Mill Bay nets are treated once only when new, with boiled linseed oil and weekly, when in use, with copper sulphate solution. A few fishermen at Arrandale were using nets which had never been oiled and one of these nets held the heaviest load of mud observed during the summer. Mud had penetrated into the loose net fibre to a much greater extent than was possible with an oiled net. Oiling a net causes the individual linen fibres to cling together and form a hard twine. Thorough oiling of all nets in this region seems necessary.

Summary.

The mud adhering to the gill nets in the Nass River district is shown to be glacial silt from the muddy waters of the Nass.

The net mud, examined under the petrographic microscope, is very different from the material discharged from the Anyox concentrator.

The mud on the nets is found to be attached to gelatinous fibres of jellyfish and other marine organisms. This gelatinous material binds the mud to the net. Algae, including diatoms, also are involved in the mud though the gelatinous fibrous material seems to be chiefly responsible for the trouble, and to have its source in an organism, apparently a jellyfish.

The occurrence of the trouble at only the one season is related to the abundance of this marine life at this season.

Exceptionally high tides, causing great and sudden mixing of large amounts of Nass water with its suspended silt and of salt water with its abundant life, always preceded the onset of the mud attack.

No explanation is offered as to why the net trouble became so acute in 1930, nor why it has fallen off again in 1931.

Some evidence is submitted that Skeena River fishermen have experienced a similar, though much less severe form of mud deposition in recent years.

Certain suggestions are made as to precautions which may be taken to lessen the danger of mud deposits.

-:-:-:-:-:-:-:-:-:-:-

We wish to express our appreciation of the assistance given by Mr. John Gregory, who has been navigator in charge of the small boat from which the field work has been carried on.