

## 8. *On the Luminous Phenomena that accompanied the Great Sanriku Tunami in 1933. (Part I)*

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### Introduction.

From time immemorial the coasts of Japan, especially the Pacific coasts, were very often swept by tunamis, or earthquake water waves, which caused tremendous damage to life and property. Above all, the coasts of the Sanriku districts, North Japan, were most often visited by seismic water waves, of which some were of catastrophic violence. It is true, though almost incredible, that in recent years there are many of the inhabitants of those districts who have suffered from disastrous tunamis once or twice, or even three times in their lifetime.

The seismic water waves are so frequent in Japan that accounts concerning the phenomenon are abundantly found in our historical and other miscellaneous works. In this respect, the author believes, she is unequalled in the world. And we often come across interesting accounts of the luminous phenomenon accompanying tunamis. To the best of the author's knowledge, there is no such datum in foreign countries, and this phenomenon has never been investigated by foreign scholars. Even in Japan, little attention has been paid to the subject by seismologists to this day. Prof. Sieberg says that luminous phenomena accompanying earthquakes are the darkest chapter in seismology.<sup>1)</sup> His statement holds true in this phenomenon.

### Instances of Luminous Phenomena accompanying Tunamis.

The oldest record in which luminous phenomena accompanying tunamis is mentioned is that of the great water wave which followed a violent seismic disturbance of Mutu province, North Japan, in 869 A.D. In "Sandai Zituroku" (三代實錄) it is stated that "On May 26, a great earthquake occurred in this region. Brilliant streams of light

1) A. SIEBERG "Erdbebenkunde," 120.

flashed several times, brightening up all things as in the daytime. People could not stand up and could do nothing but cry for help. Some of them were crashed under collapsed houses, some swallowed up in huge fissures in the earth. Cattle and horses rushed about in terror, and trampled upon one another. Innumerable castles, warehouses, gates, and walls were thrown down. Ere long roaring sounds like thunder were heard, and huge waves rolled in from the ocean . . .” In this account there is no statement that the sea or waves emitted light, but the manner in which the light was given out highly resembles that of the luminescence observed at the time of the Sanriku Tsunami in 1933. So it is not perhaps too much to presume that the brilliant lights might have flashed over the sea immediately before or just when the great waves arose.

For eight hundred years after that, seismic water waves, great and small, visited the coasts of Japan several times, but no historical record contains any statement about the phenomenon.

On the night of the 9th of October, 1677, great waves swept over the coasts of Hitati and Iwaki, destroying numberless houses and drowning many people and cattle. On the same night the coasts of Owari also were devastated by gigantic waves, many fishing boats being destroyed. Three fire balls burst out of the sea and flew away to the NW.<sup>2)</sup> In 1707 there occurred a great earthquake, the most terrible of all recorded earthquakes in Japan. The greater part of Central and South Japan suffered from destructive shocks and accompanying water waves. It is stated that, at the time of the tsunami, “weird round-shaped luminous bodies were seen in the gigantic oncoming waves.”<sup>3)</sup> In 1792 a land-slide occurred in Maeyama, a tholoide, near the town called Simabara, Kyûsyû, when colossal masses of rock and soil fell into the sea, and gave rise to enormous sea-waves, causing great destruction. At the time of the disaster “a light like a blazing flame burst out from the great wave and shone all around,”<sup>4)</sup> Another account states that “the mountain fell in two, and both the mountain and the sea emitted

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2) 泰平年表. A luminous ball of bluish white is said to have burst out of the sea, though not reliable enough, in case of the tsunami of 1933. Similar instance was observed in the Itô swarm-earthquakes of 1930. But the latter was not accompanied by tsunamis. See “Investigations into the Luminous Phenomena accompanying Earthquakes” by the author (*Bull. Earthq. Res. Inst.*, 10 (1932), 662 and 672).

3) 嘉永七年甲寅地震海翻之記.

4) 西肥島原大變聞錄.

flashes of light; then mountain-like waves arose."<sup>5)</sup> In the middle of the 18th century, a gigantic wave made havoc of the coast of Matumae, Ezo. "There had been no wind and no rainfall for some time before the fatal day. The sky looked somewhat cloudy. In addition, night after night flashes of light were seen in the sky from time to time."<sup>6)</sup> In this account, no exact date is given, but the author thinks it was most probably July 19, 1741, when a tsunami struck the coast. If that is the case, the flashes observed previous to the tsunami were probably lightning flashes which accompanied the explosion of Oosima, a volcanic island about 60<sup>km</sup> west of the town, because it is known that the volcano was growing restless from early July and burst into terrible activity and began an explosive eruption on the 16th of that month.<sup>7)</sup>

On both Nov. 4 and 5, 1854, dreadful earthquakes shook Central and South Japan, followed by great waves. During the tsunami, "the sky was overcast, and in the north-west it looked as if ablaze. It was found afterwards that the direction of the illuminated sky was exactly that of the coasts devastated by huge waves."<sup>8)</sup> According to another account, "dark clouds over the sea were lighted up as by a conflagration. The scene was dreadful beyond description."<sup>9)</sup> Another account states that "when the fatal day died into night, a sacred fire appeared, and hung motionless above the water all night. It looked as large as a *mari*,<sup>10)</sup> or a hand-ball, though the real size was unknown. On the next night, that is Nov. 5, a similar fire-ball again appeared above the sea."<sup>11)</sup> Another manuscript contains the following account: "There came sounds like cannon's roar several times from the south-west offing, and then I was greatly alarmed to see a pillar of fire moving along the cloud from north to south. Expecting the rush of a tsunami, I swept the horizon, but the sea was very calm. Thinking it wise to go to a safe place, I fled to a neighbouring village. It was about 6 p.m. When we reached an embankment and looked backward, our town had been engulfed by a huge wave."<sup>12)</sup>

5) 橋南谿 北窓瑣談卷之四.

6) " 東遊記卷之二.

7) 河野廣道 維新前北海道變災年表 10.

8) 大屋祐義日記.

9) 三災錄.

10) An ordinary Japanese *mari* is a little larger than a tennis ball.

11) 嘉永七年甲寅地震海翻之記.

12) 紀州日方町大地震津浪の記.

On June 15, 1896, enormous waves, 80 feet high in some places, swept away villages and towns in the Sanriku districts, destroying over twenty thousand lives. During the tsunami various kinds of luminescence were observed by not a few people. The following are the accounts given by eye-witnesses.

(1) According to a fisherman who was fishing on the sea 30 or 40 *ri*<sup>13)</sup> off Isatomae (伊里前), Rikuzen, a light like a flame was seen in NE, and before long a sound like the roar of a cannon was heard.<sup>14)</sup>

(2) Mr. Itinosuke Kametani (龜谷市之助), a fisherman, heard strange sounds in west on the sea about 5 *ri* NE off Tadakosi (只越), Karakuwa-mura (唐桑村). He believed the sounds were due to a steamer approaching his boat. The sounds lasted about twenty minutes. He tried to avert the danger of collision, but she did not come after all. About an hour later he noticed lights in several points in the direction of the land. He believed fires broke out on land. Except those sounds and lights nothing unusual happened on the sea.<sup>15)</sup>

(3) Mr. Siemon Suzuki (鈴木四右衛門), a fisherman, was fishing on the sea about 8 *ri* SE off Karakuwa-mura (唐桑村). About 8 o'clock p.m. a roaring sound like distant thunder was heard twice. While he was wondering at it, he heard again a sound like that of a steamer sailing at full speed. Immediately he prepared to avert it, but no steamer came. And, contrary to expectation, three sailing boats came in sight. All the crew of his boat shuddered with fright, because they believed the boats to be phantom ships, beyond all question. Presently the boats went out of sight. Then lights were seen in several points in the direction of the land. They took the lights for fires and hastened back to land.<sup>16)</sup>

(4) Mr. Sôzô Hayasi (林壯藏), a fisherman, states that he was engaged in fishing at Kominato (小湊), on the evening of the catastrophe, when he suddenly found the sea-water receded over 600 metres from the shore, and the surface of the sea and the exposed bottom gave out bluish white luminescence. It was so bright that trees in the vicinity were distinctly seen. Thinking that something serious was happening, he began to climb to a higher place. Just at the moment

13) One *ri* is equal to about four kilometres.

14) 伊木常誠「三陸地方津浪實況取調報告」震災豫防調査會報告 11, 8.

15) 宮城縣海嘯誌 5-6.

16) 宮城縣海嘯誌 7.

a huge wave more than 3 metres high rushed ashore.<sup>17)</sup>

(5) According to Mr. Satyû Yusa (遊佐左伸), a policeman, at 8.30 p.m., when he came near Noda (野田), Minami-kunohe-gun (南九戸郡), he heard strange sounds in the direction of the sea. Wondering what they were, he approached Noda, and to his great alarm, saw many weird luminous bodies as large as paper-lanterns, in that part of the village where houses stood and on the slope of the hill behind the village. Soon he heard the dreadful noise of houses crashing and terrible cries for help, and saw a tsunami rushing from the ocean. It was found afterwards that the lights were seen only in the part of the village which was struck by the waves.<sup>18)</sup>

(6) A villager of Kominato (小湊), Tarô-mura (田老村), states that he had scarcely heard an unusual sound when the sea-water retreated about 600 metres from the shore, and weird luminescence was seen at the bare bottom. Then a great sea wave rushed to the shore with a tremendous noise, and carried a sailing boat far ashore.<sup>19)</sup>

(7) In Hitokawame-mura (一川目村), Aomori, night after night before the tsunami occurred, ghastly luminescence was seen many times in the sky.<sup>20)</sup>

(8) It is reported from a certain man in Taneiti-mura (種市村), Minami-kunohegun, that at about 8.15 p.m. a bellowing noise was heard on a sudden in the east, and vibration like that of a steamer engine began to be felt, and it became stronger and stronger. Looking out to the sea, he found the sky over the waters was in a mist and looked pink. A rumbling sound, too, was coming from the same direction. Intuitively he knew something awful approaching and was preparing to escape the danger, when, all of a sudden, many huts on the shore were shattered to pieces by a gigantic wave with tremendous noise. At this he turned back and ran for his life, crying "Tsunami! tsunami! Run away! Be quick!"<sup>21)</sup>

(9) Mr. Tomehati Komatu (小松留八), a fisherman of Kosaba (小鯖), Karakuwa-mura (唐桑村), took a huge wave for a warship and the luminescence of the wave for electric lamps of the ship.<sup>22)</sup>

17) 風俗畫報 119. 18) 風俗畫報 120.

19) 風俗畫報 119. 20) 風俗畫報 120.

21) 風俗畫報 120.

22) 宮城縣海嘯誌 15. Judging from the account, the luminescence observed by him does not seem to have been flashes or a dim light, but several patches of light.

(10) Mr. Eizi Kigawa (黄川英次), of Otomo-mura (小友村), states that, when he came to the Simizu pass (清水峠) on his way home, a rumbling sound was heard. Feeling anxious, he crossed the pass, when, to his surprise, a deafening noise arose, and a brilliant white light flashed all over the sea, as if a snowy mountain had crumbled down. Then he knew it was a tunami.<sup>23)</sup>

(11) It is said that, at Ryôri-mura (綾里村), about 8.30 p.m., the moment something like whitish mist suddenly covered the whole bay, a wave 11-15 metres high rushed to the shore. In less than three minutes the whole village except the higher part was swept away.<sup>24)</sup>

(12) At the time of the tunami, pale flames appeared on the open sea, and a policeman of Noda (野田) observed luminous objects on the slopes of hills.<sup>25)</sup>

(13) According to Mr. Kasiwazaki (柏崎), headman of Yosihama-mura (吉濱村), the on-coming waves of the tunami in 1896 looked like black clouds falling from above, and the crest gave out terrible lights.

(14) When a gigantic wave rushed ashore, clouds of spray was lighted up by the light emitted from the crest. Though dark and foggy that night, it was so bright that people had not a difficulty in seeking safety, owing to the sea-light.<sup>26)</sup>

(15) An earthquake was felt about 8 p.m. The duration of the shock was long. An hour later a tunami came. A mountain-like wave with a luminescent crest advanced with a great velocity and broke near the shore.<sup>27)</sup>

### Instances in the Sanriku Tunami in 1933.

About 2.30 on the morning of March 3, 1933, the Sanriku districts were visited by an earthquake strong enough to startle people from sleep, though no damage was done. It is said that even octogenarians had never experienced such a severe shock as this. About thirty minutes later huge waves rushed upon the land, and caused tremendous destruction.

Soon after the calamity the author prepared a questionnaire and

23) 風俗畫報 120.

24) 同上

25) 山奈宗真 岩手縣沿岸大海嘯取調書.

26) 中央氣象臺 三陸沖強震及津浪報告, 222.

27) 中央氣象臺 三陸沖強震及津浪報告, 221.

distributed it all over the affected areas. In addition, the author, by order of the director of our institute, made a tour of the afflicted districts, and succeeded in collecting many reliable data. By the data thus collected it was confirmed that remarkable luminous phenomena like those above-mentioned accompanied the tsunami. But before dealing with the phenomena, the author must mention the luminescence observed before and during the strong earthquake that preceded the tsunami on March 3, 1933.

A. *The Luminescence seen before the Earthquake.*

It was reported by some that luminescence was observed previous to the strong shock on March 3. Among the data collected by the author the following two seem to be credible and noticeable. One was furnished by Mr. Zyunzirô Koikawa (小井川潤次郎), principal of the Tamonogi (田面木) Primary School, Iwate, and the other by Mr. Toyoiti Ikari (猪狩豊一), teacher of mathematics of the Watari (互理) Sericultural School, Miyagi.

"About 9.30 p.m. on March 1, I left the Uriiti (賣市) Primary School, and just as I came to the former site of the execution-ground, which is situated at a height, a bluish yellow light was seen through a cluster of trees in the direction of the sea. When I began to go downhill, the light became brighter and two (?) beams of bright light were thrown to the west. 'A ship has entered port,' I said to myself. It was twenty-nine hours later that the severe shock came. I learned afterwards that the light was not the search-light of a ship."

"About 8.30 p.m. on March 2, the sky in the direction of the Pacific was lighted by what seemed to be lightning flashes. But no peal of thunder was heard. The colour of the flashes was reddish yellow."

The above reports coincide with each other in some respects, that is, both of the lights were yellowish and they were seen nearly in the direction of the epicentre of the earthquake on March 3. It is noticeable that in the former report the light lasted for some time and resembled an aura. According to the "Kisyô-Yôran" published by the Central Meteorological Observatory, there was no thunderstorm from March 1 to 7 all over Japan; so the phenomena must be attributed to other cause. As regards the relation between the luminescence and the earthquakes on March 3, the present author has no ground solid enough to make a positive statement. But there are not a few

cases in which severe earthquakes were preceded by luminous phenomena, as has already been indicated by the author.<sup>28)</sup>

B. *The Luminescence seen during the Earthquake.*

Many reports state that luminescence was observed while the shock was on. The localities where the phenomenon was seen range from Hokkaidô in the north to the coast of Sagami Bay in the south. Most of the reporters say that the luminescence was like ordinary lightning or electric sparking, and its colour blue or bluish white. Many instances of this type of luminescence have been reported in the earthquakes which recently occurred in Japan. And it is most difficult to distinguish the luminescence from that due to short-circuiting of electric-transmission lines. But it is noteworthy that similar instances can be found in the records of old ages, when no electric line existed.<sup>29)</sup> Therefore it seems impossible to the author to attribute such type of luminescence to electric sparking without exception. The fact that Mr. Nakagawa, an electrical engineer, who observed a pale bluish-green arc of light which resembled a rainbow in the sky at the time of the earthquake on March 3, maintains that it was quite different from the luminescence due to electric sparking, seems to endorse the author's opinion.<sup>30)</sup>

One of the data collected by the author shows that directly the sky flashed, electric lights went out. In this case, at least, the luminescence may be due to snapping or touching of electric lines, and may have no direct relation with the shock. On the other hand, according to Prof. Yosii (吉井) of the Second Higher School, he observed a blue

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28) "On the Luminous Phenomenon that attended the Idu Earthquake," *Bull. Earthq. Res. Inst.*, 9 (1931), 177-215, (in Japanese, with English abstract). See also "Investigations into the Luminous Phenomena accompanying Earthquakes," *Bull. Earthq. Res. Inst.*, 10 (1932), 649-673, (in Japanese, with English abstract).

29) As an example of similar luminescence seen at the place where no electric-transmission line is in the neighbourhood, the author may cite the light observed at the time of the Okuni earthquake on Nov. 4, 1931. According to Mr. Katuemon Hurutate (古館勝右衛門), he was walking in the rainstorm on the night of the earthquake, when suddenly a great noise like that of heavy gun firing was heard above the head, and simultaneously with it a dazzling light like lightning flashed all around.

30) 中央氣象臺 三陸沖強震及津浪報告, 39-40.

It is said that an arc of light which seems to be similar to that observed by Mr. Nakagawa was seen in London on the night of Jan. 5, 1931, and an earthquake occurred two days afterwards.



light in the sky two minutes after the shock was felt; so, suspecting that it might be due to breakdown of electric lines, he made inquiries about it of the electrical department of the Sendai City Office. The reply was in the negative. Moreover, the fact that not a few people saw similar luminescence toward the open sea cannot be overlooked. Those lights may have been clouds over the sea illuminated by a light emitted in other direction, or the luminescence due to swarms of luminescent plankton stimulated by a sea-shock. But, for the present, luminous appearance over the sea at the time of earthquake is a mystery to the present author. The problem must be reserved for the future.

Another mystery is the fact that, in particular, the remarkable luminescence was observed by many people in the neighbourhood of Hatinohé (八戸), a city near the sea. This fact cannot yet be explained to the full. It may simply mean that the shock was felt more severely because the locality consists of rocks of younger formation compared with the Kitakami Mountain-land situated in the south,<sup>31)</sup> and accordingly there was electric sparking in all directions. This supposition seems to be strength-

31) The Kitakami Mountain-land is chiefly of Palaeozoic and Mesozoic formations, associated with various kinds of old eruptive rocks, while the locality near Hatinohé consists of recent deposits.

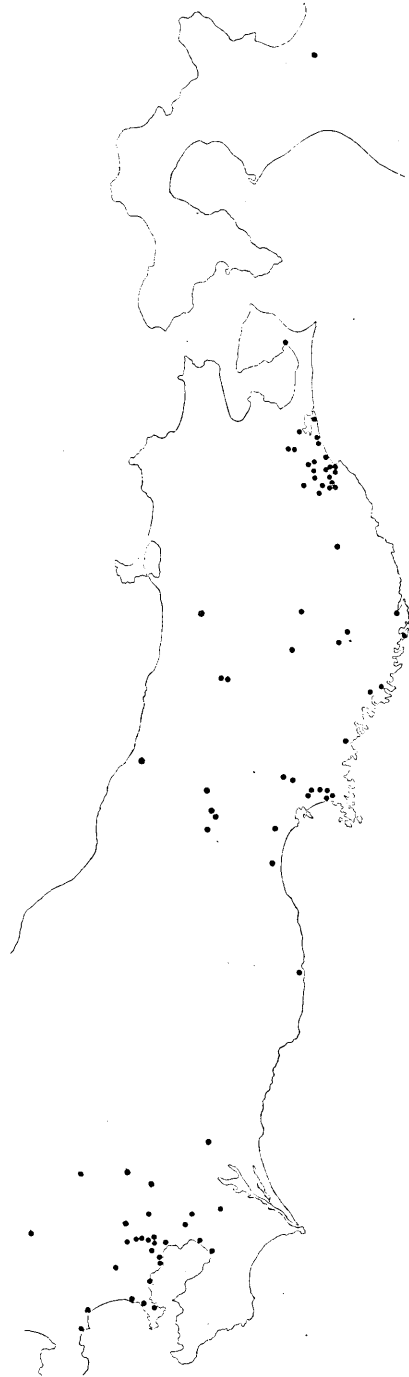


Fig. 1. The places where the luminescence was seen during the earthquake.

ened by the fact that the places in which the lights were seen isolatedly were mostly in basins and plains of alluvial deposits, such as the Syônai plain, the Yamagata basin, the Yokote basin, the valley of the Kitakami, the Kôhu basin, etc. Moreover, the fact must be taken into consideration that the population of the locality is dense in comparison with the neighbouring regions, which are very sparsely populated.<sup>32)</sup>

It is reported by some that luminescence was seen not above the sea, but on the surface of, or in, the sea. According to Mr. K. Suzuki who lives about one kilometre NNW of Isinomaki, a thriving seaport town, while the shock was on, many bluish luminous bodies, large and small, appeared and disappeared on the open sea in the east and in Isinomaki Bay in the west. The duration of each light was about 1-2<sup>sec</sup>. The more violent vibration was, the more lights appeared. The vibration soon ceased and luminous bodies vanished, too. A fisherman of Arahama (荒濱), Watari-gun (亙理郡), Miyagi, who was fishing off Kinkazan (金華山), is said to have seen bluish white flames bursting out of the sea. The crew of another fishing boat felt a seashock off Kinkazan, and at the same time, to their consternation, glittering lights appeared in the water. It may be the most rational to consider the phenomenon mentioned above as the luminescence due to luminescent organisms stimulated by a seashock.

### C. *The Luminescence that accompanied the Tsunami.*

The first huge wave reached the coasts of the Sanriku districts about 3 o'clock a.m. on March 3, that is, about 30 minutes after the principal shock. And it was immediately before the arrival of great waves at the coasts and while the shores were inundated by waves that the luminous phenomena were observed.

The luminescences reported by eye-witnesses vary greatly in character and intensity, but they may be classified as follows:—(I) The crest of the waves emitted dim continuous light. (II) The surface of the sea glittered all over. (III) When waves washed the coasts, the water of the shoreline gave out bluish light. (IV) When the sea-water receded previous to the oncoming of huge waves, the exposed seabottom gave out blue light. (V) A luminescent body like a meteor was seen. (VI) Well-defined round-shaped luminous bodies were seen

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32) 田中館秀三 東北地方人口密度の地形的分析 (地學雜誌 494, 495). 田中啓爾・山本熊太郎 日本人口分布圖.

in an oncoming wave. (VII) A weird round-shaped luminous body appeared above the sea. (VIII) Bright light radiated from the sea. These types will be mentioned in detail in the following pages.

(I) *The crest of waves emitted a dim continuous light:—*

This type of luminescence is reported from several places. In Huna-kosi (船越) the crest of the wave looked white in a straight line. A villager of Okkirai (越喜來) who looked at the advancing wave from a height told the author that the crest emitted white light, and the luminous zone was about 4 metres wide. According to a girl in Ryôri (綾里), it seemed as if white mist lay over the sea, when a gigantic wave came rolling. In Kesennuma (気仙沼) a huge wave advanced towards the shore emitting white light all over. Mr. K. Hukui of the Miyako Meteorological Observatory told the author that when the wave reached the mouth of Miyako Bay, the crest looked white.

(II) *The surface of the sea glittered all over:—*

According to a villager of Origasa (織笠) who happened to be at Ando (安渡) when the earthquake occurred, he was looking over the sea after the shock, when the surface glittered all over. It seemed to be different from that of *Noctiluca*. An old man who saw the phosphorescence with him, rushed into his house screaming, "Tsunami!" Immediately after that a great wave arose. A similar luminescence was observed

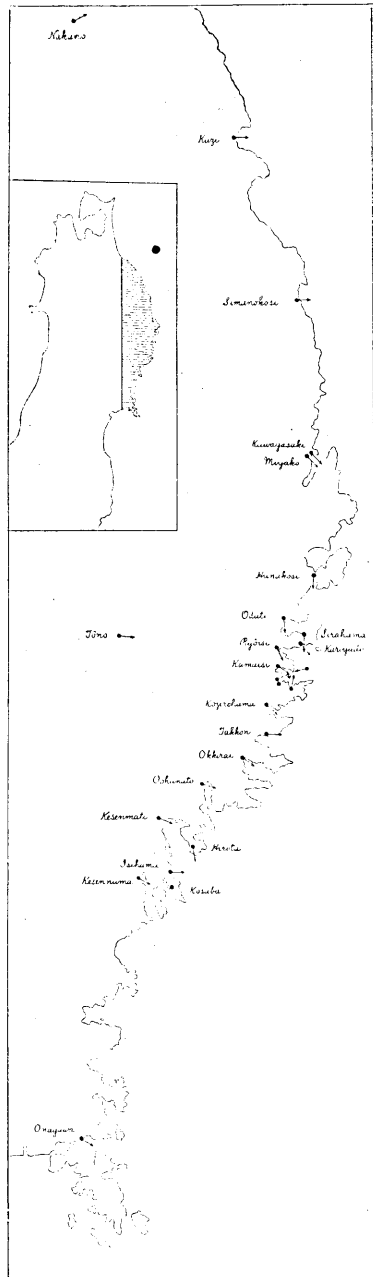


Fig. 2. The places where the luminescence was seen at the time of the tsunami and the directions of the luminescence.

at Sakihama (崎濱) of Okkirai, and at Kotumi (小積) on the Bay of Ogino-hama (荻濱), Miyagi.<sup>33)</sup>

(III) *When waves washed the coast, the water of the shoreline gave out bluish light:—*

At Sirahama (白濱) near the mouth of Kamaisi Bay, the author met with an old fisherman. He was swept away by a wave and narrowly escaped death at the time of the great tsunami in 1896. In the recent tsunami he was washed away again clasping his grandchild in his arms. When he turned and looked at the shore of his village, as he was tossed about in the wave, he saw the water of the shoreline was being highly disturbed as if it were boiling and the water was emitting bluish light.

(IV) *When the sea-water receded previous to the oncoming of huge waves, the exposed bottom gave out blue light:—*

According to Mr. Gennosin Ono (小野源之進), water-policeman of Kamaisi, it was 30 minutes after the strong shock that the water of Kamaisi Bay began to recede. In the twinkling of an eye the water retired about 100 metres from the shore, when bluish light was emitted from the bottom with water.

(V) *A luminescent body like a meteor was seen:—*

A primary school teacher of Oosawa (大澤) observed after the earthquake a luminescent body shooting obliquely like a shooting star. It was seen a little above Oosima (大島), an islet in Yamada Bay.

(VI) *Well-defined round-shaped luminous bodies were seen in an oncoming wave:—*

Mr. Yūiti Onodera (小野寺有一), headman of Kamaisi town, escaped to a height and was looking over the bay. While a great wave (probably the second wave) rushed in and advanced to the central part of the bay, well-defined round-shaped luminous bodies as large as a *suge-gasa* (sedge-sunshade) or a *tarai* (wash-tub), about three in number, were seen in a row in the wave, a little below the crest. Their colour was bluish purple like an electric discharge. They lighted up all around, so the curling crest and fragments of destroyed houses were clearly visible as they were tossed about by the wave. Besides him, many people who were in the neighbourhood observed them. Mr. Tyūzi Kobayasi (小林忠次) of the Kamaisi Fisheries Experimental Station, observed the same luminous bodies. According to him, the wave looked black, and above the crest several round-shaped luminous bodies were seen in a row

33) 中央氣象臺 三陸沖強震及津浪報告, 137.

at the same intervals. Those bodies advanced and receded in violent speed with the wave, and presently they disappeared one by one. The colour was like that of a lighted paper lantern. He thought that they were top-lamps of ships swallowed and carried by the wave. Another eyewitness is Mr. Gennosin Ono mentioned above. He told the author that: "After the earthquake I ordered the inhabitants to make a fire on the shore and keep watch. It being awfully cold, not a few people gradually came around the fire. About 30 minutes after the shock, the water began to recede; so we ran to a higher place to escape the coming danger. After running about 200 metres, I looked back, when a flash like that of searchlight was seen toward the mouth of the bay. Presently a great wave came, and a little above the crest several round-shaped bodies were seen in a row emitting blue light. Then the seawater reached where we were." A similar type of luminescence is reported from Kesen-mati (氣仙町). In that town jet-black water came ashore sluggishly, and several patches of blue light, 15—30 cm in diameter, were seen in the water which flooded the land.<sup>34)</sup>

(VII) *A weird round-shaped luminous body appeared above the sea:—*

Mr. Turumatu Harada (原田鶴松), a fisherman of Kamaisi, states: "At midnight we left Kamaisi on board the 'Kôeimaru' (幸榮丸), a fishing motor-boat, and were engaged in cod-fishing about 4 knots NE of Sanganzima (三貫島), a rocky islet near Kamaisi Bay. Then, ahead of us, that is toward Sirasaki (白崎), a cape near the bay, a large fire-ball suddenly appeared above the sea. It was as large as a full moon, and at a height of about 7—10 metres from the surface of the water. Believing it to be the top-lamp of a trawler, I starboarded and ported the helm, but the fire-ball drew nearer and nearer. I stopped our vessel, but the fire-ball still continued to draw near. Then I dared to advance our boat toward the fire-ball. Nevertheless we did not collide with the fire-ball. Presently the fire-ball diminished in size by degrees and disappeared. As soon as it vanished, we found a fire which broke out in

34) According to "The Report on the Strong Earthquake and Tunami of the Sanriku Districts" (in Japanese) published by the C.M.O., "about 20 minutes after the shock, a sound like that of dynamite explosion was heard at Ryôri, and ten minutes later the water began to recede with a tremendous velocity. Then about 15 minutes passed, when a ship with a lighted lamp was seen rushing from the mouth of the bay at a great speed." That light may not have been the lamp of a ship, but a patch of light in the water.

Kamaisi immediately after the tunami. The colour of the fire-ball was like that of live charcoal. That night the weather was fine, and the fire-ball was not accompanied by any sound or unusual phenomenon." According to Mr. Seisuke Huzisawa (藤澤清助), the very fire-ball was observed by not a few fishermen besides Mr. Harada while fishing in the same fishing ground.

(VIII) *Bright light radiated from the sea* :—

This type of luminescence was seen by a lot of people at Kamaisi and other places. The following are some of the typical instances from the many collected by the author.

1. About twenty or thirty minutes after the earthquake, a light that resembled lightning or sunrise was seen all over the open sea, and soon afterwards huge waves arose. (Simanokosi (島越), Tanohata-mura (田野畑村), Iwate).

2. About 3 o'clock, a little before the oncoming of the tunami, a lightning-like light flashed from west to east in the north-eastern sky. It was of blue colour and fairly bright. (Miyako).

3. About 2.40, lightning-like luminescence flashed twice (?) from behind the hills which are situated in NE. The colour was bluish, but paler than lightning. A similar light was observed in the south by fishermen while fishing off Miyako, and a rumbling sound like distant thunder followed. (Kuwagasaki (鉦ヶ崎), Iwate).

4. After the earthquake, flashes were seen thrice over the open sea. The colour was bluish white. (Omoe-mura (重茂), Iwate).

5. Between the principal shock and the first aftershock, there was a flash like lightning, and after the first aftershock a sound like that of gun firing was heard. (Morioka).

6. A fisherman heard a roaring sound off Tarô-mura (田老), Iwate, and the sky was lighted as if it were daybreak.

7. About 20 minutes after the shock, bluish white flashes radiated from the southern horizon three times in succession. It was a terrible scene. A little to the right of the flashes above mentioned was seen the fire in the town of Kamaisi. (Hunakosi-mura (船越), Iwate).

8. Off Ooduti-mati (大槌), Iwate, fishermen found that it became light all around as if a cloud of dust had risen high up in the sky.

9. Just before the arrival of the tunami, a light was seen toward the offing of Kamaisi. Some assert it was radiate, while others say it was a beam as of a searchlight. The colour was yellowish or reddish blue. (Ooduti-mati, Iwate).

10. During the tsunami a bluish white light was seen behind the hills in the south. It was not so bright as lightning, nor an instantaneous flash. It was supposed by some villagers to be a searchlight of the "Iwatemaru" (岩手丸) (Sirahama 白濱, Unozumai-mura 鵜住居, Iwate).

11. According to Mr. Kikumatu Kozima (小島菊松), a fisherman, about 20 minutes after the shock, a sound like that of heavy gun firing was heard. Simultaneously with the sound, a bluish white light flashed all over. It was so bright that the faces of people could be distinctly seen on the dark beach. Some of the villagers took it for a peal of thunder, and thought it would begin to rain. About ten minutes after that, the sea-water suddenly rose to the high-tide level, and then began to recede with great rapidity. (Ryôisi 兩石, Iwate).

12. Mr. Komatu (小松), a primary school teacher, states as follows:— He was keeping watch on the beach after strong shock was felt. In the great tsunami of 1896, about 80 % of the inhabitants of his village were swept away by gigantic waves. The villagers have since made it a rule to keep watch on the beach everytime an earthquake occurred. On the night of March 3, a lot of villagers were on the lookout as usual, warming themselves at a fire on the beach. About 30 minutes later there came from the offing a loud sound like the boom of a gun. Looking out into the open sea in surprise, it grew light over the waters in the east. It was not so bright, the colour being greenish. It looked like the light of several searchlights brought together. There were some who considered the sound and luminescence as a sign heralding the coming of a tsunami, but the majority believed them to be due to a thunderstorm. A few minutes passed, and the surface of the sea rose. The fishing boats which had been hauled ashore were tossed about; then the water began to retire with tremendous speed. Villagers, seeing it, fled in panic to a higher place. (Ryôisi 兩石, Iwate).

13. According to Mr. Kikumatu Kozima of Ryôisi, the luminescence was seen in SE at Kariyado (假宿) near the village.

14. The report from the Kamaisi Night School is as follows:—

*Time*—About twenty minutes after the strong shock, that is, at the same time as, and after, the arrival of great waves.

*Place*—The point from which the light was emitted was the mouth of Kamaisi Bay, and mountains around the bay were illuminated.

*Colour, etc.*—The luminescence was repeated several times in succession in a short time, and the light was radiated in various directions, as if a searchlight were turned this way or that. It was more bluish

than lightning, and looked like electric sparking on a grand scale or a searchlight turned to the land.

*Intensity*—Not so bright as to dazzle the eye; far weaker than magnesium flash.

15. The postmaster of the Kamaisi iron mine states that about six minutes after the second shock which occurred at about 2.50, a luminescence was seen in the east. The position of the source gradually shifted to the south. Then the sound of receding water was heard. The lights were brighter than a searchlight and less bright than lightning.

16. According to Mr. Gennosin Ono, a water policeman of Kamaisi, about 30 minutes after the principal shock the water began to recede, and in a twinkling of an eye it retreated about 100 metres from the shore. Then he ran hard about 200 metres to escape the danger, and looked back, when a flash like that of a searchlight was seen toward the mouth of Kamaisi Bay. Soon a great wave came rushing.

17. Mr. Tyûzi Kobayasi of the Kamaisi Fisheries Experimental Station states that a dazzling light suddenly shone all around as if a searchlight were turned to the town at the mouth of Kamaisi Bay. He believed that the "Hayatinemaru" (早池峯丸) kindly turned her searchlight upon the stricken town, as electric lights had given out, though it turned out afterwards that it was not the case.

18. According to Mr. Amerika Toku (アメリカ徳) of Kamaisi, he saw at first a light between Ureisi (嬉石) and Matubara (松原) on the shore opposite the town, and then a luminescence of great splendour blinded people. Women and children shuddered at it. As soon as the light vanished, the sea-wave flooded the town.

19. The crew of a fishing boat which was sailing near Matasaki (馬田岬), a cape at the mouth of Kamaisi Bay, saw a flash like a searchlight turned to the east, that is, the open sea.

20. Mr. Toyomatu Morimoto (森本豊松), correspondent of the Tôkyô Asahi, had just been talking to the Morioka branch office over the telephone, when he was informed of an ocean wave coming. So he fled by bicycle to escape from the danger. On his way to Suzuko (鈴子), he saw a brilliant flash toward the Osaki (尾崎) Peninsula, which projects into the open sea at the mouth of Kamaisi Bay. The source of the light must have been in the open sea beyond the peninsula, because he saw the dark outlines of the hills against the light.

21. A fisherman on board a fishing boat which was tossed about



in Kamaisi Bay till the disturbance of water subsided, saw bright flashes. It seemed to him to be a searchlight turned to the north from the south of Kamaisi. The luminescence, mostly bluish, was seen about ten times.

22. Mrs. Haruno Sasaki (佐々木はるの) in Sirahama (白濱) is one of those who observed the light at a place nearest to the source. According to her, after the principal shock, a bluish red light radiated from the sea at the mouth of Kamaisi Bay. Then the second shock occurred. At brief intervals a curling white-crested wave rushed in and behind it a huge black wave advanced into the bay.

23. Mrs. Sumiyo Tiba (千葉すみよ) in Heita (平田) observed the phenomenon at a position which is most suitable to look at the mouth of Kamaisi Bay. After the shock, she heard a sound as of gun firing in the south, and almost simultaneously with it, she saw an bright flash of red colour at the mouth of the bay.

24. Mr. Tomesiti Okada (岡田留七), a fisherman in Heita, heard a sound resembling the firing of artillery after the principal shock, and about three or five minutes later a rustling sound was heard. It was soon afterwards that he was informed by his elder brother that the sea presented an unusual appearance. (His brother, recalling that in the case of the great tsunami in 1896, the fishing boats which were at anchor were not lost, went to the beach to drop anchors. Then the sea began to recede, and when he finished the work, the water retreated so far that the bottom was exposed. Seeing this, he hastened to his younger brother's house which is situated on the beach, and knocked at the door.) At that time the electric lights gave out, and to the right of Matasaki (馬田岬), or at the mouth of Kamaisi Bay, a bright light radiated from the sea to the sky. It seemed to have flashed several times. Then he fled, and villagers ran away jostling with one another. He ran hard about 300 metres, when the wave reached the shore.

25. Mr. Tyû Takahasi (高橋忠) of Kozirohama (小白濱) on Tôni (唐丹) Bay was keeping watch on the beach, when a sound like that of dynamite explosion was heard, and a light resembling lightning was seen in the offing. About ten minutes later the water began to recede.

26. A villager of Kompaku (根白) on Yosihama (吉濱) Bay, reports that, immediately after the second shock, his brother went out to catch a pig which had run away from the sty, when he heard a sound and soon after a light was seen in the east.

27. Mr. Yokiti Suzuki (鈴木與吉), principal of the Oohunato (大船渡) Primary School, saw a light resembling sheet-lightning in the northern

sky. The duration of the light was longer, and the colour was more reddish, than ordinary lightning.

28. The report from the lighthouse keeper in Oosima (大島), an island in Kesennuma Bay (氣仙沼灣), states that a bluish white light like that of searchlight was seen in SE at 2.33 a.m. A roaring sound was heard in the same direction about 2.35. He took it for the boom of a gun on a warship. The tsunami came at 2.40.

29. Mr. Humato (船戸) of the Kesennuma Fisheries Experimental Station states as follows:—The severe shock started at 2.30 a.m., and the vibration lasted for about five minutes. Being anxious about the specimens of animals which he had in his charge, he at once left for the experimental station. On the way he saw two flashes of lightning beyond Kameyama (龜山), a hill in Oosima. It was about 2.50 a. m.

30. In Kosaba (小鯖), Karakuwa-mura (唐桑), Miyagi, many people were swept away by huge waves and calling for help, as they were tossed about in the sea. Then, all of a sudden, the sea was lighted up all over, and, owing to it, a lot of people were saved. At first it was supposed to be the searchlight of a steamer, but in reality no large vessel came at that time.

31. The crew of the "Kaiunmaru" (海運丸), 5 tons, saw a light resembling searchlight three or four times in the direction of Kinkazan at a position about 200 metres off the coast between Hirota Bay (廣田灣) and Karakuwa (唐桑). It shone all around as if it were daytime.

As mentioned above, the accounts of this type of luminescence are at variance with each other to some extent. But the general outline of facts may be guessed by piecing various information together; that is, the luminescence was visible a short time before the arrival of great waves at the shore and during the flooding of the tsunami on the coasts. The light flashed several times, though the number of times is not exactly known. There is every reason to believe that this type of luminescence originated at the mouth of Kamaisi Bay. Other sources of light cannot be accurately known, though it is sure enough that a similar light radiated from several points on the sea in the affected area. The light seems to have issued from the sea-surface.<sup>35)</sup> The colour seems to have been bluish, and the duration instantaneous or a little longer than lightning. The intensity of the light cannot be given in

35) A similar luminescence was observed by the crew of a fishing-boat on the Hyūganada at the time of the South Hyūga earthquake in 1931. This was described by the author in the *Bull. Earthq. Res. Inst.*, 10 (1932), 649.

exact terms, but it is quite sure that the light was visible at Hunakosi (船越), 20 km distant from Kamaisi Bay, at the mouth of which the light radiated. In addition, though not sufficiently trustworthy, it is said that it was seen at Tôno (遠野), about 36 km distant from the same bay. It is not certain whether sounds accompanied the light, but, at least, the first flash which originated at the mouth of Kamaisi Bay seems to have been simultaneous or almost simultaneous with the sound as of gun firing. The author, however, cannot positively assert that there was a relation between the light and the sound.

### The Possible Explanation of the Luminescence.

Though it is not easy to clear up the nature of those luminous phenomena, the author can imagine a possible explanation of the mystery. He is inclined to ascribe a greater part of those phenomena to microscopic organisms.

Firstly, as to dull continuous glow of the crest (I), myriads of brilliant sparks in the water (II), and bluish light emitted from the agitated water (III) as well as the bare bottom (IV), the author feels confident that they are due to luminescent planktonic organisms. It is a matter of common knowledge that similar phenomena are frequently observed on the shore as well as on the sea, especially in summer.

But, to make sure of it, it is necessary to ascertain whether there are luminescent microscopic organisms not only in the sea of those districts but in the season. In the first place, it is certain that luminescent plankton is found in the sea of the Sanriku districts. Fishermen in those districts are familiar with the luminescence due to marine floating organisms, and they call it "*Somé*," probably the contraction of *Siomé*," which means the "eyes of the sea-water." And it may be safely stated that *Noctiluca scintillans*, cosmopolitan in the temperate seas,<sup>36)</sup> is an important factor of the phenomenon. Besides *Noctiluca*, luminescent animals which live in the sand-bottom, such as *Chaetopterus* and *Cypridina* may have been a source of luminescence at the bare bottom after the receding of water. In a private letter Mr. Sakyô Kanda (神田左京), an authority on animal lights, writes that he is inclined to think the light is probably due to *Noctiluca*. In the second place,

36) According to Prof. S. Kokubo, *Noctiluca scintillans* is not a species which is characteristic of warm currents as was formerly believed, but a cosmopolitan in the neritic areas.

it is certain, too, that luminescent plankton is found in early spring. According to Mr. Suzuki, principal of the Hunakosi Primary School, phosphorescence is seen in the sea of the districts all through the year, though most conspicuous in summer. And, according to Prof. S. Kokubo, *Noctiluca scintillans* makes its appearance abundantly usually in April—June in those districts, though it is found in a small quantity all the year round.

There is reason to believe that the meteor-like luminous body seen in the sky (V) may have really been a shooting star, because some reporters state that meteors were seen on the night. But it is not the only explanation of the phenomenon. The direction in which the luminous body was seen is that of the narrow neck of a peninsula which projects between Yamada Bay and Hunakosi Bay. And, as it is known that the waves of the tsunami rushed over the neck from Hunakosi Bay to Yamada Bay, it would be possible that luminescent micro-organisms, such as *Noctiluca*, stimulated by the waves advancing over the land, emitted remarkable light. It may be possible, also, that the light given out by a swarm of plankton was visible as a luminous spot at Oosawa (大澤), distant 5 km from the neck of Hunakosi, if it had been of fair intensity.

The round-shaped luminous bodies seen in the wave (VI) are so wonderful that they may be regarded as an optical illusion. But, since three eye-witnesses belonging to the educated classes make nearly similar statements, and, moreover, similar accounts can be found in old records,<sup>37)</sup> it is absolutely impossible to deny them as a mere illusion. As regards the light, the statements of the eyewitnesses differ from one another in some respects. For instance, one of them says that those luminous bodies were seen in the wave, while the others maintain they observed them above the advancing crest. There is no knowing which is the real fact, but the author thinks it more probable that they were seen in the water<sup>38)</sup>. If the luminous bodies were in the water as the author conjectures, it seems to be most natural to ascribe them to luminescent organisms. The commonest marine organisms whose luminescence looks like a globe of fire are *Ctenophora* and *Pelagia*. These

37) *loc. cit.*, p. 88.

38) One of the reasons for this surmise is that, according to Messrs. Huzisawa and Ookubo of Kamaisi, no ship sank in the bay, though there were many which were greatly damaged or stranded. Therefore, it would not be rational to consider the luminous bodies to be toplamps of sunken ships.

jellyfishes look like faint full moons in the water at night, hence their Chinese name, “海月,” which means the “sea-moon.” But, the luminescence due to jellyfishes waxes and wanes in brightness, whereas, the eye-witnesses positively state that the luminous bodies observed by them were constant and steady. According to Messrs. S. Kanda and H. Aikawa (相川廣秋), the luminescence which is generally conceived in our country to be the light emitted by jellyfishes is, in reality, that of *Cypridina*. But the luminescence given out by *Cypridina*, too, waxes and wanes in a leisurely way. Moreover, it is doubtful whether the light emitted by an individual of *Cypridina* can be seen at a good distance. Therefore, it would be most rational to conceive that each of these luminous bodies may be a patch of light which was given out not by an individual, but by a swarm, of luminescent organisms, such as *Noctiluca* or *Cypridina*.

Next comes the weird round-shaped luminous body which appeared above the sea (VII). There are similar examples, though it is not at the time of tsunami that they were observed. Mr. Z. Kose (小瀬二郎) of the Imperial Fisheries Institute states: “It was a foggy night after a storm about November in 1903 or 1904. While boating to Misaki (三崎) from Tateyama (館山), we observed a red light about 30 cm. in diameter appearing above the sea, which approached our boat at high speed. We took it for a side-lamp of a large ship. It was on the point of colliding with our boat, when it suddenly vanished.”<sup>39)</sup> According to Mr. Kamada (鎌田) of the same institute, he, too, has seen a similar strange light. “It was on a stormy night about November in 1905 that our ‘Kaiyômaru’ (快鷹丸) was caught in a storm and drifting, being unable to sail, at a point about 30 knots off Kumano (熊野), the Kii Peninsula. A dim red luminous body approached our ship at high speed from the windward, became brilliant, and then disappeared. It was repeated three times. Being informed by a terror-stricken sailor, all the crew went on deck and saw it. It was about 11 p.m. The windward at that time was NE, and there was no land in that direction. In addition, the weather was very stormy, so a small steamer could not have been put to sea.”<sup>40)</sup> According to Prof. S. Fujiwhara, they were probably a kind of mirage.

There seem to be other kinds of fire-balls occasionally observed on

39) 藤原吹平・大森虎之助・田口克敏 曇氣樓調査 2 (氣象雜誌 2, 2), 108.

40) 藤原吹平・大森虎之助・田口克敏 曇氣樓調査 2 (氣象雜誌 2, 2), 118.

the sea. Some of them seem to be St. Elmo's Fire,<sup>41)</sup> and some to be images of the top- or side-lamps of ships reflected in the fog.<sup>42)</sup> Besides them, there may be not a few cases due to some unknown causes.<sup>43)</sup> Our knowledge on such a phenomenon is still in its infancy, therefore, it is impossible for the author to make clear the true nature of the weird luminous body seen off Sanganzima. The author cannot make a positive statement, also, as to the relation between the fire-ball and the tunami. But it seems to be worthy of note that a fire-ball which was seen above the waters two nights in succession in the great tunami in 1854<sup>44)</sup> bears a striking resemblance to the luminous body seen by fishermen off Sanganzima.

Lastly, the bright light radiated from the sea (VIII) is the most

41) Prof. Sukawa of the Merchantile Marine School in Tōkyō, saw a strange fire-ball several times during his seafaring life. In March, 1917, he was crossing the Indian Ocean on board the "Hitatimaru." At 11.30 in the night a bluish-white fire-ball about one metre in diameter appeared at the top of the foremast, and everytime the ship rolled the fire-ball swang to and fro without falling from the mast. Presently it gradually diminished in size and disappeared. On that day there were several thunderstorms from the morning. On the night of Feb. 2, 1922, a round-shaped light appeared again on the top of a mast in the same ocean (10°48'N. 59°27'E). At midnight on June 20 (?), 1904, that is, during the Russo-Japanese War, a large fire-ball appeared at the top of a mast of the "Taihokumaru," a miner. As 21 sailors had perished owing to the explosion of a mechanical mine on the 13th of that month, the sailors shuddered at the sight, taking it for a ghost. According to Prof. Sukawa, these are St. Elmo's Fire.

42) According to Mr. Marukawa of the Imperial Fisheries Experimental Station, it sometimes happens that a phantom-ship is met with on the open sea. It is the rule for a ship at sea at night to light a red lamp on the port side, and a blue one on the starboard, while on a phantom-ship the reverse is always the case. (丸川久俊 海をひらく, 11). The so-called phantom-ship seems to be an image of a ship reflected in the fog. The reverse positions of the side-lamps seem to serve as an evidence. It is perhaps not a rare phenomenon on the sea. According to Prof. Sukawa, during the Russo-Japanese War, a Japanese patrol ship, seeing a large warship loom through the morning mist, cleared for action with the crew at their posts, but presently the enemy vessel proved to be an image of their own ship. (須川邦彦 船乗りから見た海の不思議, 大正12年7月時事). The so-called phantomship belongs probably to this category.

43) A strange fire-ball was observed by Prof. Sukawa in the Japan sea in 1906. When he was sailing on board the "Kōtūmaru" (交通丸) from Turuga to Vladivostok, a fire-ball appeared at midnight in the direction 45°-50° to the right of the ship's bow, and it shifted with an enormous velocity to the left. The fire-ball did not stream horizontally over the sea, but the moment it disappeared, it reappeared a little ahead of the former position, and so on. The northerly wind was then blowing pretty hard. At first he took it for the light of a fishing boat, but its velocity was too great for a fishing boat or a sea-bird. The secret is still unrevealed.

44) *loc. cit.*, p. 89.

conspicuous light among those which were observed at the time of the tsunami. There is every reason to believe, as stated above, that the light was seen clearly at a place 20 km distant from the source. Accordingly, the light must have been very intense at the source. But it is quite possible that a light of great splendour is emitted by a swarm of luminescent plankton. The author may refer to two instances which were observed in the adjacent waters of Japan.

The so-called "Mysterious light in the Okhotsuk Sea" discovered by the crew of the "Unyômaru" (雲鷹丸), a training ship of the Imperial Fisheries Institute, is an example. According to Mr. H. Marukawa (丸川久俊), the light was so strong that it reflected on the top of a mast 80 feet high, and those on the deck could manage to read a newspaper by the light. On collection, it was found that the light was due to *Metridia longa*.<sup>45)</sup> Mr. T. Kumata (熊田頭四郎) perceived a remarkable luminescence in the Japan Sea on May 6, 1915. It was at a point 15 knots to the north of Kawaziri (川尻), Yamaguti prefecture. At first he saw a sublime luminescence on the sea in NE in the distance, and it looked like a searchlight turned horizontally; only the light was softer than a searchlight. When it approached, more than ten pillars of pale fire appeared, and the ship seemed to have been lighted with arclight. The water was examined, and it was found that the luminescence is attributed to *Pyrocystis pseudonociluca*.<sup>46)</sup>

Since such an intense light as given above can be emitted by a swarm of planktonic organisms, it does not seem unreasonable to attribute this type of light to luminescent plankton, so far as the intensity of light is concerned. But, in order to ascribe such a strong luminescence to phosphorescent micro-organisms, it must be admitted that a vast amount of luminescent plankton were present in the coastal water of those districts at the time of the tsunami.

Generally speaking, the richness of floating life cannot be expected early in March. And planktonic organisms which are possible to emit such an intense light—Noctiluca or its allies—are not usually to be found in abundance in the season. Therefore, supposing that there were a large number of luminescent micro-organisms in case of the tsunami, it must reasonably be attributed to unusual multiplication owing to some cause or other. There is a little doubt, however, as to

45) 丸川久俊 海洋漁場調査報告 (漁業基本調査報告 8), 123.

46) 丸川久俊 海をひらく, 211-213.

whether that was really the case, and whether there was a connection between the unusual multiplication of luminescent plankton and the earthquake. The author is making inquiries on the problem. The result of the investigation will be given in the second report.

#### Concluding Remarks.

By the author's investigation it has been made clear that the accounts of luminous phenomena described in the records on tunamis, ancient and modern, are not groundless nor illusion, and the accounts are in perfect agreement with the luminous phenomena observed at the time of the Sanriku tsunami on March 3, 1933.

Though the nature of the light is not exactly known at present, there is sufficient reason to believe that a greater part of those lights were due to luminescent plankton—most probably *Noctiluca* or its allies.

At any rate, since it is a scientific fact, as Prof. Terada stated on luminous phenomena accompanying earthquakes,<sup>47)</sup> the phenomenon of tsunami cannot be said to have been explained thoroughly, unless the nature of the luminescence is made clear.

Moreover, the last mentioned type of luminescence may possibly serve as a warning by which many persons can be saved from a coming disaster. It seems, therefore, this is a problem which cannot be made light of from this point of view, especially for the inhabitants of the doomed districts.

In conclusion, the author wishes to express his sincere thanks to Prof. Terada for his kind guidance. The author is also indebted to Prof. S. Kokubo of the Tōhoku Imperial University, Mr. S. Kanda of the Institute of Physical and Chemical Research, Prof. Sukawa of the Merchantile Marine School, Messrs. Aikawa, Kamiya, and Suehiro of the Imperial Fisheries Experimental Station, and Prof. Masuda of Waseda University for their cordial advices and suggestions, as well as to many persons for their kindness in furnishing the author with valuable data.

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47) 寺田寅彦 物質と言葉, 354.



8. 三陸津浪の發光現象について (第1報)

地震研究所 武者 金 吉

大津浪の際に發光現象が觀察されたと云ふ記録が本邦には少なからず存在する。筆者は 1933 年 3 月 3 日の三陸津浪に伴つた發光に關する多數の資料を蒐集し、其れについて些か検討を試みた結果、過去の津浪の記録に記されてある發光現象は幻覺ではなく、實際に存在すること、並びに今回の津浪の際に觀察された發光と過去の津浪の記録に見出されるものとを對比すると、色々の點でよく一致することが明らかになつた。

而してこの現象の大部分は、津浪の當時三陸地方の沿岸に夥しく繁殖して居る發光性浮游生物が、津浪のために刺戟を受けて光を發したのであると考へて大體に於て差支なき相に見える。併し津浪のあつた時期は帶鞭類のやうな發光性浮游生物の夥しく出現すべき時期ではないので、其の異常出現の原因及び地震と發光性浮游生物の異常出現との間に關係が存するかどうか等の問題について、未だ研究の餘地が充分にある。これに關しては目下研究中であるから、追つて其の結果を第2報として發表する考へである。

併し兎に角これが1つの科學的事實である以上、寺田教授が地震の發光現象について述べられた如く、この現象が明らかにされるまでは、我々は津浪について全部を知り盡したとは云はれない譯である。

のみならず、津浪の際に見られる光の中には、津浪による人命の喪失を減ずる上に幾分役立ち相なものもあるので、災害防止と云ふ點から見ても、この現象の研究は輕視しがたいものゝやうに思はれる。