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THE CRUISE OF THE CLOVER—FURTHER REMARKS ON THE ABERRATIONS OF AUDIBILITY OF FOG SIGNALS—THE METHODS USED.[1]

BY ARNOLD BURGES JOHNSON, WASHINGTON, D. C.

IT is now about a quarter of a century since Prof. Joseph Henry, the first President of this society, commenced his investigation into the operations of the laws of sound in connection with the fog signals used by the Light House Board, of which board he was then the scientific member.

When I was made Chief Clerk of the Light House Board in 1869 it became my duty, as well as a privilege which I highly prized, to act to a certain extent as his amanuensis and aid in putting the results of his experiments in the form of reports to the Light House Board. In this way I became interested in this work and was, in a very humble way, associated with Professor Henry in its prosecution. Thus I entered with him into a practical discussion of the subject and became, after a fashion, possessed of his views as to the best way to follow up the investigation. I thus came to know something of his tentative plans and of his desire to make very practical use for light house purposes of the outcome of the investigations.

On Nov. 6, 1880, the great Long Island Sound steamer Rhode Island was stranded and finally lost on Bonnet Point in Narragansett Bay. Then, putting it roughly, a million in property was lost and thousands of lives were imperilled. The master and pilot of the steamer claimed that the fog-signal at Beaver Tail Point, about one and seven-eighths miles away, was not sounding at the time of the accident; and hence the casualty. The light keeper who was in charge of the fog-signal at the time, and who was in peril of losing his place, proved conclusively that at the time of the wreck the sound of the fog-signal was heard at Newport, five miles away, at Fort Adams, four and a quarter miles away in one direction, and at Narragansett Pier, four and a half miles away in another direction. The steamer people, who were in danger of forfeiting their licenses, came back with affidavits of many on board that they were anxiously listening for the fog-signal, and that it was not in operation, for they did not hear its sound.

Then the Light House Board took a hand in the matter. It had been shown by Professor Henry that, although a sound could be heard at a certain distance from its source, it might not be heard in the same direction, and at the same time, at a less distance. Could this be one of those cases? A naval officer in the service of the board, now ranking as a Commodore, was sent to the locality to find out. He had the fog-signal at Beaver Tail started, and cruised round it in a sail boat for some time, taking constant note of the intervals of the sound. He found, and reported to everybody's surprise, that not only did he fail to get the sound of the Beaver Tail fog-signal at Bonnet Point, one and seven-eighths miles away, where the Rhode Island was lost, but he failed to get it at other points even nearer to the fog-signal, while he heard it on the same day at different points farther away, and much farther away in a line with the nearer points where he could not hear it. This settled the question. The light keeper was relieved from the charge of failing to have the fog-signal in operation, and the steamer people were relieved from the charge of failing to act on the warning of the fog-signal, which was blowing, but which, while within earshot, they might not hear.

In 1881 the great propeller Galatea, while on the way from New York to Providence, ran onto Little Gull Island in Long Island Sound, imperilling many lives and much property. There was, and is, on that island, which is but one-eighth of a mile long, a powerful light and a powerful fog-signal. That fog signal has been often heard sixteen miles away. The defense of the steamer people was that the fog was dense and that the fog-signal was not blowing. The light-keeper, in his defense, showed that the fog-signal was blowing, that it was heard and noted at several different points in different directions, say at New London, Mystic, and at several light houses, many miles away, at the very time the Galatea ran on the little islet on which the fog-signal was at work. Again the Light House Board was required to look into the matter. Again careful investigation was made. And again it was shown that the fog-signal might be heard far off, and not close to, and the spots where it was not heard were noted and plotted on the chart; and again the steamer people and the light house people were exonerated from blame.

In 1881 I gathered these facts and submitted them to the Philosophical Society. My paper was printed in the Bulletin of the Society, and it was largely copied in maritime and scientific publications in this and other countries. The light house establishments of England, France and Spain reprinted the paper, each in its own language. And the eminent Emile Allard, head of the French light house establishment and a prominent officer of the French Corps of Engineers, plotted my numerical statement of the intensity of sound as heard from the fog-signals, in graphic form, that is, in lines of various width, and sent his diagrams to me in a letter in which he discussed the subject at length.

The Light House Board meantime was considering the matter from a purely practical standpoint. If, it was reasoned, there is a point within earshot of a fog-signal, where, from any cause, the fog-signal cannot be heard, then some other signal should be placed at that point, from which vessels can take a fresh departure. Acting upon that idea, investigation was made as to the region about each prominent fog-signal which it had been said could not be heard at points where it ought to be heard. In several instances I was sent to such points to make investigation and to report with recommendations. In the summer of 1885 I cruised about Point Judith, R. I., and the southeast end of Block Island, both at the entrance of Long Island Sound, and about the light house and fog-signal on Little Brewster Island, entrance to Boston Harbor. An area of silence was found and plotted about one and a quarter miles south of Point Judith, where the

[1] Read before the Philosophical Society of Washington, Nov. 25, 1893.

powerful fog-signal in operation at Point Judith could not be heard. That area was soon marked by a whistling buoy. A similar area was found and plotted five miles from Block Island, and a whistling buoy was placed in the centre of that silent spot.

A curious state of things was found off the light house on Little Brewster Island, Boston Harbor. Complaint had been made as to the action of the fog-signal there, which was a Daboll trumpet, and another and better fog-signal was wanted. Some asked for a siren, some for a steam whistle, and some for a larger and better Daboll. So a battery of fog-signals, one of each kind, was placed there, and I was appointed, with others, on an informal sort of a board to ascertain and report which of the three was best adapted to the place. It was found that the siren gave the best effect, and it was duly established there, and is there yet. But it was also found that there were several areas of silence within normal ear-shot of that fog-signal which were constant as to their general position, but which were floating or variable in their actual positions. There were already so many lights, buoys, spindles, etc., in that vicinity it was recommended that no more be established there lest it cause confusion. It was deemed the most curious concatenation of peculiar phenomena yet met.

In observing all these peculiar phases of non-audition of fog-signals at points where they should be heard, only one vessel had been used at a time. Hence, we had no record as to the sound at more than one place at a time, of a fog-signal. It had been a favorite plan of Professor Henry to use several vessels simultaneously about the same fog-signal, so as to learn where its sound was heard, as well as where it was not heard, at the same moment. The board decided to follow that plan this fall and in this way to re examine, with several vessels at the same time, the sound of the fog signal, which had heretofore been examined with but one vessel at a time.

This duty was devolved on me, and I was ordered to the Clover, a fast-sailing schooner, to carry it into effect. I was permitted to invite two members of this society, Prof. C. A. White, LL. D., Member National Academy of Sciences, and Prof. H. A. Hazen, Forecaster of the Weather Bureau, to go with me on this cruise, and the invitation was afterwards formally repeated by the board. It was planned that when I had reached a scene of operation and a proper day was found, I was to impress any other light house vessel within reach for that day, and the light house district officers were directed to give every practical aid to the expedition. This they did with great readiness and good effect.

Thus it has happened that observations have been made recently from three vessels simultaneously, at three different places, of the sound of a number of fog-signals at which abnormal phenomena had been observed and reported before; and the recent observations have been made, and have been plotted on the same scale as previous observations; so that all the observations made at each place whether in 1881, 1885 or 1893 are now comparable.

The methods used at Little Gull light house and fog-signal station, for instance, were as follows:

The Clover arrived at New London Harbor on the morning of Oct. 19. Leaving her trying to work up to the city, against a headwind, I went ahead in the steam launch. At the light house depot I found the light house steamer, Cactus, with banked fires. In half an hour she was under way, and towing the Clover toward Little Gull light station. Dr. White, Professor Hazen and I went on shore and the light keeper was directed to start up his fog-signal. Dr. White remained on the islet to see that the orders were carried out and to note any variations made from any cause in the usual sound. Then Professor Hazen went on board of the Clover and I returned to the Cactus, and each vessel ran over prescribed courses. Observations of the intensity of the sound were made on each vessel each minute. The direction and force of the wind, the temperature by wet and dry bulb thermometer, and the pressure of the atmosphere, as shown by the barometer, were duly recorded. The appearance of the sea and the sky were also noted.

The next day the Cactus was engaged on other imperative duty and the Clover went out from New London Harbor, where we had spent the night, without her. But Professor Hazen made a rather adventurous cruise in an open steam launch about the fog-signal, with excellent results.

On the third day Professor Hazen was on the schooner Clover, and I was on the steamer Cactus. Dr. White was landed on Great Gull Island, which is small, treeless, and uninhabited, where he had large opportunity, which he fully used, to get the sound of the fog-signal under circumstances not had before. Here Dr. White noted the action and the result of peculiar echoes, and his studies of these echoes have developed an important factor in the discussion.

Off Point Judith we had very light wind, almost no sea, though there was a heavy swell rolling in, and a fair sky; in other words, we had an excellent day for hearing.

The Cactus being again with us, I went on her, Dr. White stayed with the Clover, and Professor Hazen, in spite of the bad character of that vicinity for quick and severe changes of weather, again took to the steam launch; so we got simultaneous observations of the sound of the fog-signal at Point Judith from three vessels, each cruising about on different lines.

In our work about the light on Little Brewster Island, at the entrance to Boston Bay, which occupied two days, we had the help of two other steamers. Major Livermore, of the Corps of Engineers, U. S. A., and Engineer of the First and Second Light House Districts, went with us on his steam propeller, the Myrtle, and Lieutenant Commander Colby, U. S. N., assistant to the Inspector of the Second Light House District, accompanied us on the side-wheel steamer, Geranium. On the first day I was with Major Livermore on the Myrtle, Dr. White was in charge of the work on the Clover, and Professor Hazen went with Lieutenant Commander Colby on the Geranium. On the second day Dr. White went with Major Livermore; I stayed on the Clover, and Professor Hazen remained with Lieutenant Commander Colby on the Geranium. Each vessel ran on different courses on different days, and we got many simultaneous observations from the three vessels. Most of the time was spent on the open ocean between Boston light and Minot's Ledge light, or beyond, or between Boston light and Egg Rock light. Part of each day, as we were going and coming from Boston Harbor, was spent in the Narrows, or in Broad Sound, at the rear of the fog-signal we were observing.

Now, as to our tools. We had on the Clover an anemometer at the foremast head, and another at the end of the jib-boom. Both were connected by electric two-conductor cables with self-registering apparatus in the cabin. We also had a barograph which registered the pressure of the atmosphere, and we had a very delicate barometer by which to check the barograph These had been lent to the expedition by the Weather Bureau, and were under the charge of Professor Hazen, who looked after our meteorology. In addition to these, the Professor had brought his own sling pschycometer, an ingenious arrangement of wet and dry bulb thermometers, which he managed with great skill, and clung to with much affection. The Clover had her own complement of thermometers, barometers, etc., in addition to what had come to us from the

Weather Bureau. The balloon which the Secretary of the Treasury had asked the Secretary of Agriculture to permit the Weather Bureau to lend us, and which had been shipped to us, did not arrive. Had it come we might have had Professor Hazen looking down upon us from a great height, and we should have had him at the end of a rope, recording temperature, air currents, moisture, wind and sound from 1,000 feet above, and at intervals of 25 feet, till we landed him on our deck or in the water. Major Livermore, however, used toy balloons, with which to ascertain the force and direction of the upper air currents. The paper balloons were, say, four feet high, and one foot in diameter, at the widest part. They had an ingenious attachment for producing hot air, which, at night, lighted them, and made them for a while clearly visible. The longest flight I saw one of these make was 15½ minutes. Then the Major had spherical rubber balloons of, say, nine inches through, which he filled with hydrogen generated on the Myrtle, which were also quite useful.

The fog-signals we were sent to observe were three steam sirens and a steam whistle. Each signal has its own peculiar characteristic. The second-class siren at Little Gull Island, for instance, gave, during a fog, a blast of five seconds, and then after a silent interval of 40 seconds, and another blast of five seconds, and it continued this alternation of blast and interval while the fog continued. This blast and interval served to differentiate this signal from other signals within ear-shot, and especially that at New London light-house, which was a six seconds blast, alternating with a silent interval of thirty seconds.

The siren is the most powerful fog-signal in existence. The English Government adopted it after a favorable report on it made by a commission sent to this country headed by Sir Frederick Arrow, and also after a report by Professor Tyndall, who then bore the same relation to the English lighthouse establishment that Professor Henry did to the United States lighthouse establishment, that is, of scientific adviser.

Tyndall says of the siren in his book on "Sound," third edition, p. 316: "The steam siren is the most powerful fog-signal which has been tried in England." Again Tyndall says on p. 318: "We find the sound range on clear calm days varying from 2 1/2 to 16 1/2 miles." Again he says on page 319: "It may be relied upon at a distance of two miles; in a great majority of cases it may be relied upon at a distance of three miles, and in a majority of cases at a distance greater than three miles."

Now as to the full range of the instrument, Tyndall says on page 321 of the same book: "The most conflicting results were at first obtained. On the 19th of May, 1873, the sound range was 3 1/3 miles; on the 20th it was 5 1/2 miles; on the 2nd of June, 6 miles; on the 3rd, more than 9 miles; on the 10th, 9 miles; on the 25th, 6 miles; on the 26th, 9¼ miles; on the 1st of July, 12¾ miles; on the 2nd, 4 miles; while on the 3rd, with a clear, calm atmosphere and smooth sea, it was less than 3 miles."

I have quoted this much from Tyndall, for while he accepts the siren, he damns it with faint praise, and what he says is about the worst that has been said of it. The French, who also adopted it, speak in much higher terms of it, and the Light House Board, while constantly searching, has found nothing better. It remains the best fog-signal in the world, and it may be regarded as a constant memorial of the work of Professor Henry, who, for light-house purposes, was its inventor.

But good as the siren is, it leaves much to be desired. It is a great big clumsy, ugly machine, expensive to make, expensive to run, and expensive to keep in repair. It is maintained to make a great big ugly noise continuously, and of a certain kind and at certain intervals. It makes the noise, without regard to ethics or esthetics; but it might keep its pitch better; and it might maintain its intervals better. It is not an instrument of precision. It has its limitations. They are not entirely unconnected with the pressure of its steam; in other words, with its management. But it approximates exactness sufficiently near to answer the purposes for which it is intended. When the mariner hears it, and hears it aright, he knows where he is. The question we are discussing is not so much connected with the sound made as with the sound heard. It is not the aberration of the sound, but the aberration of the audition of the sound with which we are concerned.

Now as to the method used to determine the intensity of the sounds of the fog-signal we tested. This we did, on this cruise, by ear, and on the same scale and in the same way in which it was done in observations made in 1881 and 1885.

Each of the party on the Clover used the scale of 10. It was understood that 10 was the sound of the highest intensity, and 0+ the lowest sound observable. We divided the scale, however, thus: 1 1 plus, 1½, 2 minus, and then 2. Mr. Wallace, Major Livermore's assistant, used the scale of 100. I have no doubt that is just as good as my scale, but as I had commenced my observations on the scale of 10, I carried that scale through these observations in order that those made in '93 might be comparable with those made in '85 and in '81. The question of personal equation has arisen, but I have carefully avoided any comparison of the mode of hearing, or rather accuracy of hearing, between members of my party. My direction to each was to record 10 as the highest sound of the fog-signal that could be heard on board of the vessel in which he was making observations. When they were as near as they could get the vessel to the source of sound, the distance was, as a rule, not more than one-fourth of a mile. The minimum sound was 0. plus. One-half of the sound between 0+ and 10, I considered as 5, and half-way between that and maximum was called 7½, and half-way between 5 and 0+ was regarded as 2½, and then we divided still finer between those points. In that way I think we got a practical solution of the question, and are as nearly accurate as it is practicable for observers to be, that is, for practical, but not for scientific, purposes.

Each person preserves his own scale throughout, recording the maximum and minimum and medium, and dividing between those points according to the accuracy of his own ear. I noticed that different members of my party, and of Major Livermore's party, did not mark instances the same under some circumstances; but the differences were slight, and they could be accounted for by interfering noises in different parts of the ship, which affected different hearers in those parts of the ship, so that their hearing of the same noise was to a certain extent interfered with. I think the results reached were of a practical character, although they were not such as might be considered severely, or even scientifically, accurate. They were not such as would have been recorded by a self-registering machine, that is, they were not as finely phrased. I tried to put myself in the place of the mariner, who might hear a fog-signal without knowing what it was, and who might be forced to determine its identity by the character of its blast, the intensity of its blast, and the continuation of the silent interval between blasts.

Major Livermore has a large number of observations which have been plotted, and I think will be comparable with ours when ours are plotted.

We are now having very delicate instruments made with which to measure the character and the intensity of the sounds made by fog-signals; and thus I hope that

next year we may be able to give the intensity of the sounds heard, with an approach to absolute accuracy.

The results thus far obtained, however, are such as a captain of a vessel coming onto our coast in a fog and a gale would be apt to get. It is for him the fog-signals are established, and I have tried to put myself in his place and to hear with his tired and strained ears the sounds which must be distinguished and differentiated from the shrieking of the wind, the creaking of the cordage, the rattle of the machinery and the roar of the surf.

If he has heard aright the sound of the fog-signal and can tell from the length of its blast and the following interval of silence which one of the several fog-signals in that vicinity it is, he is certain of his position.

The experiments thus far made and the observations taken are to make sure that the mariner can hear aright what he does hear, and to provide against his acting upon errors in hearing, which, if acted on, may place his ship in peril.

SASSAFRAS TREES.

BY WALTER J. QUICK, COLUMBIA, MO.

As being of some scientific interest, it is worthy our attention to note the marvelous growth that ten trees of the above well-known variety have acquired here in Missouri—a growth that is so exceptional of this species that it has not been observed elsewhere in the United States.

The *Sassafras officinale*, of the order *Lauraceæ*, the Laurel family, is very seldom known as little more than a shrub or bush and generally as growing poorly or not at all on fertile soil. In truth, it is looked upon as being in its native element in company with and growing on thin land. This is not a fact, but the opinion prevails since old and worn-out fields, depleted of their fertility in greater part, when abandoned, grow up to "brush," not the least profuse of which is the sassafras. It is a native of America and has been found in every State in the Union, growing much more abundant on poverty-stricken soil, but more luxuriant and larger in proportion, we conclude, as the per cent of humus in the soil increases. In the poor, white clay lands of the New England States and some parts of Indiana, Kansas and this State we have observed it growing where it seems to sprout profusely and does not reach a height of over twelve feet, usually six or eight feet, while in the same States on richer land it will not be found in thick profusion, but scattered and attaining almost to the dignity of a tree in size.

Recently it was our pleasure to visit the beautiful farm of Mr. T. B. Hickman, near Columbia, Mo. During our stay we were shown the various interests of the owner, and our attention was summoned to some peculiar trees of the sassafras variety. Their difference from others of this species consists in their vigorous growth and extreme size, being the largest any one present had ever seen or of which we had in any way known. This preternatural development inspired us to investigation. They exhibited on measurement the surprising circumference of 80 to 82 inches—a diameter of over 26 inches. As the bark is thick and rough, similar to walnut, the diameter of the solid wood is not likely this much, but fully two feet. By triangulation we ascertained the height to be about fifty-five feet, and the whole ten will not vary much from these measurements.

While there is very little indication of decay, as a matter of fact, these trees are fully grown for this variety. Their location is very auspicious for the growth they have made, being the low, rich and moist soil of Bonne Famme creek bottom. The writer has never seen larger trees, and is unable to learn of larger specimens on this continent, with the exception of the species of sassafras of California and the western slope of the Rocky Mountains, known as *Oreodaphne Californica*, which attains a still larger size "in the land of big trees." The aroma from the leaves of this variety is more pungent, in fact, so much so as to occasion excessive sneezing, frequently during high winds. It has a greater reputation medicinally than ours, though the importance of the latter is by no means small.

Our *officinale* species has been introduced into England as *Sassafras laurus*. As is usual with anything imported, they appreciate it more as medicine than we do. A tree near the Royal Gardens at Kew has attained a height of about fifty feet, and is said to be over 110 years old. As there are no other figures given, we cannot compare the size with that of the Hickman trees, but the height is not so great.

Almost every country has one or more species of this tree, all said to differ in some characteristic from ours, but all having the same odor and similar aromatic, sweetish taste. But one country has larger trees. Those of New Zealand grow to a height of 100 to 150 feet. This tree appears in every clime, and is described as having "a large head of horizontal branches." The fruit is a small, black drupe, which is not palatable, but is eaten by birds. The sassafras oil of commerce is made from these seeds and the buds. The leaves of our species are very dark green, rather thick, broad, oblong and elliptical.

In Italy it is more like the American species than any other, and is known as *Sassafrasso*. The word comes from the Latin, *saxum*, a stone, and *frango*, I brake, so named because it was believed that the use of the tea made from it would desolve the gall stones of the bladder and prevent their formation.

In the southern states sassafras grows to the size of trees, generally small, but very abundant. The air is said to be more pregnant with its aroma than further north, and it can be detected a great distance at sea. The bark seems to be more fragrant, too, when steeped.

Sassafras tea is very popular in many sections of the countries where the tree grows. The bark of the roots is kept everywhere for sale, for that purpose. In addition to its use as a table beverage it is employed as a tonic and constitutional stimulant. In those localities where the sugar-maple tree is a native and abundant a very delightful drink is made from the "sugar-water," or sap and bark of the sassafras root. It makes the finest tea in the spring when the sap is forming and is then drunk mostly to resuscitate the system, improving the appetite and aiding the digestion. It is also valuable for boils, pimples and eruptions of all sorts, as well as for rheumatism.

The pith of the new growth and sprouts contains a gum or mucilage, used in eye medicines, as being important in reducing inflammation and granulations. This product is also prepared in the form of a drink for diseases of the kidneys, catarrhal troubles and dysentery.

In many localities there is perhaps no more popular farmers' remedy for diseases of horses. It is administered by grinding the root bark to a powder and giving it in the feed, or by preparing a decoction with which the feed is mixed. Frequently the roots are placed in the horse's feed trough, and he is permitted to bark them himself, which he willingly does, apparently with much relish. In the spring it greatly improves his appetite, strengthens him and assists in shedding and sleeking his coat.