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I. *Observations on the Property ascribed to Oil, of calming the Waves of the Sea.* By I. F. W. OTTO *.

AN idea was entertained, in the earliest ages, that there were means capable of calming the waves of the restless ocean, and of rendering its surface tranquil and even. Aristotle says, that every body thrown into the sea when agitated, such as anchors, &c. tends to lessen the waves; because a kind of eddy is thereby created, which exerts itself in a direction contrary to their movement, and consequently weakens them. Plutarch † and Pliny ‡ ascribe this power to oil; as they assert that it possesses a property by which it restrains the restless movement of water, renders its surface even, and thereby causes the rays of the sun, which are refracted through the waves in different directions, to pass to the bottom free and uninterrupted. What the ancients have said on this subject is exceedingly vague and obscure. It

* From Von Zach's *Geographische Ephemeriden*, Vol. II. Part 6.

† *Quæst. Nat.*

‡ Ea natura est olei, ut lucem adferat et tranquillet omnia, etiam mare, quo non aliud elementum est implacabilius. *Hist. Nat.* lib. ii. c. 103.

does not appear clearly from their information, whether the divers, to whose testimony they refer, made their observations at the surface of the water, or at any depth. Besides, we are not able to ascertain whether they looked through the oil as through a window, or as through a magnifying glass: for if a drop of limpid oil be let fall upon water, it will form a very simple kind of microscope, and magnify objects placed at a convenient depth below the water. Plutarch seems to believe, that the oil spouted from the mouth of the diver formed, in ascending, a kind of canal, which facilitated the passage of the light through the water*.

Of this property of oil, apparently so wonderful, many testimonies were afterwards produced; and it was even consecrated by superstition for this purpose. Thus we are told, among the miracles of St. Cuthbert, that he gave a priest, for a sea voyage, some consecrated oil, by which he was enabled to allay the fury of the waves during a dreadful storm. Erasmus was acquainted with this property†; and at present it is not unknown among seamen, particularly in Holland.

Not many years ago, but before the celebrated Franklin communicated to the public his observations on this subject, the following article appeared in the *Annual Register*:—
 “At the late fire in Thames-street it was observed that the oil, which, to prevent the farther spreading of the fire, had been thrown into the river, visibly calmed the violent agitation of the water. This property of oil,” says another paragraph, “appears to have been long known. It is ordered, by an old marine law, that when goods, during a storm, must be thrown overboard, if any part of the lading consists of oil, it shall be the first article thrown into the sea.”
 In modern times we have a number of experiments which seem to leave no doubt respecting this circumstance. I shall

* Canisius Lect. Ant. Vol. II. p. 8. ed. Basn.

† His words are: Nonnulli procumbentes in fabulas adorabant mare, quicquid erat olei effundentes in undas. *Colloq. e recent. P. Rabi. Ulm.* 1747-8, p. 262.

here give an account of the most striking of them, without any fear of being thought too circumstantial, as experiments of this kind should all be decisive.

The inhabitants of the Bermudas employ oil in their fisheries, in order to render the water of the sea clear and transparent; and the Portuguese sailors, when they find the waves too violent on their entering the Tagus, pour a few flasks of oil into the water, by which means it is rendered calm, and their entrance becomes easy. The divers in the Mediterranean, when they labour under water, and when the sun-beams are prevented from penetrating to them by small waves, are accustomed to spurt a little oil from their mouths. One Gilfred Lawfon, who resided several years at Gibraltar, relates, that the seamen of that place were accustomed to pour a little oil into the sea, in order that they might thereby be enabled to distinguish the oysters at the bottom; and that the same practice was followed on the whole Spanish coast. The same thing is done on the coast of Provence, and also by the inhabitants of the Hebrides. The Ragufans, with the like view, are accustomed to sprinkle oil over the water with a brush; and they give to the drops, under which the water becomes transparent, the name of windows. Tys Tiremann, a Dutch mariner, made an experiment of this kind during a storm, after he had lost his rudder and some of his sails, and, with six half ankers of oil, calmed the fury of the waves. A lieutenant of the name of May observed in 1735, during a storm, that the sea was calm and smooth around two ships laden with casks of oil, some of which were leaky; and an experienced seaman, named Bewerwyk, recommends, for securing boats which might be sent to the assistance of ships in distress, to throw into the sea, oil and other fat substances, and even beer. In a description of the shipwreck of a vessel called the *Anna Cornelia*, this property of oil is also celebrated; and some experiments made at Portsmouth, in the time of a storm, were attended with the best success. In the year 1736 *Detouches de la Frenaye*

saw an old sailor, by this method, save a ship which was on the point of foundering. One Day was indebted for his own safety, and that of his ship, to half a ton of oil. Linnæus* learned from Gronovius, that the Dutch captains who frequented Greenland, and who were reproached with concealing this property of oil, always carried some casks of it with them when they went to the whale-fishery. The fishermen of the Texel carry oil with them for the like purpose. There is an instance of a herring-buss being saved by pouring out oil; while another, at the distance of two or three hundred fathoms, went to the bottom. Not only oil, under which is to be understood fat oil, such as olive oil, oil of rape-seed, and linseed oil, may be employed for this purpose; but also fat animal fluids, such as train-oil, &c. Ethereal oils do not possess the same property: a ship, for example, laden with oil of turpentine, which should employ it with the like view, would certainly fail in its end. This oil, however, diffuses itself very speedily over the surface of the water; but the covering it forms is so thin that it is separated by the smallest external force.

At Yarmouth the sailors are unanimously of opinion, that fat substances thrown into the sea prevent the agitation of the waves. Pennant† mentions an observation made respecting seals by the fishermen in Scotland. When these animals eat any fat fish, the sea in their neighbourhood is uncommonly still; a circumstance which induces them to search for them in such places. Sir John Pringle learned in Scotland, that the fishermen could discover at a great distance places much frequented by herrings, as the sea, by the oily fatness which these fish emit, has no apparent movement. It is observed at Rhode Island, that the water in the harbour of Newport is always calm and still as long as the Greenland ships remain there at anchor. The cause of this is ascribed

* Reise durch Westgothland, p. 304.

† British Zoology, Vol. IV.

to the sea-nettle, a kind of vegetable sea-worms from oily substances, which are thrown together in the hold of the ships, and the oil that oozes through between the staves of the casks, which, of course, is pumped out with the bilge water. Seamen have also observed, that the motion of a ship, the bottom of which has been newly payed, occasions much less agitation in the water than that of another which has not been daubed over with tar for a long time. Such instances, of which several more equally decisive might be produced, are sufficient to authorise this use of oil, in opposition to those who pretend that it can be employed only in ponds and other pieces of water of small circumference, where, by diffusing itself over a mass of water not much swelled up, it can easily produce a tranquil surface.

These facts seem to have been unknown to Dr. Franklin until he had an opportunity of making similar observations himself. On his passage from England to America some person told him that he had thrown into a lake a vessel containing oil in which flies had been drowned; that the flies, which were apparently dead, began in an instant to move, and went round with a circular motion on the surface of the water. Dr. Franklin ascribed this movement to a repulsive power maintained by the oil, which gradually issued from the spongy bodies of the flies. In the year 1757, being at sea in the middle of a fleet consisting of ninety ships destined for Louisbourg, he observed that the movement of the water was in one part of the fleet calm and uniform, while the water between the other ships was thrown into great agitation by the wind. As he could not at that time discover the cause of this phenomenon, he asked the captain of one of the ships, who replied, that the cook had, no doubt, thrown out the greasy water, which must have rendered the sides of the ship oily.

Franklin now paid more particular attention to this circumstance; and as he found that a drop of oil diffused itself

speedily over a large space of water, so that it formed a thin covering to it, which reflected prismatic colours, he resolved to make some farther experiments; and though they did not all succeed according to his wish, he declared himself convinced of the truth of the phenomenon.

One of these experiments I must here mention; for, though it does not appear very favourable to his ideas respecting the efficacy of oil in calming the waves, it at any rate shews that oil has a great influence on the motion of water. He discovered that oil excites on the water a kind of waves, under circumstances when neither water alone nor oil could produce the like. He suspended a glass half filled with water, and having made it to swing backwards and forwards, after the manner of a pendulum, the water remained at perfect rest. The case was the same when the glass was half filled with oil; but as soon as he had poured oil upon the water, and continued the swinging of the glass, the surface of the vibrating oil remained smooth and even, while the water below it was thrown into a regular agitation like that of the billows of the sea.

Franklin considers this phenomenon, which I have confirmed by experiments, to have in it something singular, and difficult to be explained. The cause of it, however, may perhaps lie in the difference of the specific gravities of these two fluids, by which they are susceptible of the impulse to movement in different degrees; and by the effort which the oil makes, on account of its lightness, to occupy the upper place on the surface, the water is violently agitated.

When a drop of oil is poured upon water in a state of rest, as for example in a basin, a fine vapour immediately arises and covers the surface of the water. It emits coloured rays, and disperses small bits of paper thrown upon the spreading drops. When the space on which the drop falls is small, it does not spread itself; but seems, as it were, to be attracted towards its centre. When a bit of paper, twisted together

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in a conical form, and soaked in oil, is thrown into water, the fluid which issues from it causes it to turn round with a rotary motion on its centre.

In an experiment which Franklin made on a small lake, the surface of which was raised into large waves by the wind, the oil spread itself with great velocity, but it did not moderate the waves. The reason of this was, that he poured out the oil at the leeward side of the lake. He therefore went to the windward side, where the waves originated; and there a small quantity of oil produced, in the space of several square rods, a calm, which gradually extended farther until it reached the other end of the lake; and this whole part of it, for the extent of half an acre, soon became as smooth as ice.

Of the various explanations given of this phenomenon, the following appears to be the most natural, if not altogether satisfactory:—The air and water have an affinity for each other, and they unite in a mechanical and chemical manner when they come in contact. It is well known that air always exists in water; that the latter can be freed from it under the receiver of an air-pump; and that, when the water is again exposed to the air, it absorbs a like quantity of it. When a mass of air presses, therefore, on the surface of a body of water, it combines itself in part with it, and forces it along with it. Now, if oil be poured upon water, the particles of the former attract each other with too great force to admit of their uniting with the water or the air. By the covering which the oil forms on the surface of the water, the latter is prevented from coming into contact with the air; and the wind is conveyed over its surface, without being able to force its way into it, and to raise it into waves.

The spreading of oil in water is ascribed by Dr. Franklin to a repulsive power which they both exercise against each other; but it is very evident that this explanation is far from being satisfactory. Even if such a power actually existed, and if the particles of the oil exercised a repulsive power

against the water, and an attractive power among themselves, they would be prevented from spreading, in an uniform manner, over the surface of the water: they would rather form insulated globules; and, as they touch the water, would equally recede, and proceed towards the bank or any other solid body. Oil, therefore, as it is lighter than water, must float on its surface when poured upon it, and, according to the laws of hydrostatics, endeavour to extend itself in a lateral direction; and on account of the strong adhesion of its particles, must form an extraordinary fine and continued stratum on the surface of the water. This diffusion, however, supposes that the surface of the water is horizontal: it therefore seems to follow, that the whole power of the oil consists in preventing the formation of new waves in the places on which it has been poured; but that it cannot be in a condition to disperse those which have been already formed. The billowy agitation of water supposes that some part of its surface has been previously raised. Bodies which float upon it oppose this rising by their gravity, consequently the billowy movement, and in part destroy it.

It appears therefore, to some philosophers, that this celebrated property of oil does not consist so much in its fluidity and toughness, as in its being a lighter body than water. From this it would follow, that all bodies lighter than water, and at the same time more distended, such as drops or masses formed by oil, must produce the same effect, but in a higher degree. Achard recommends for this purpose close leathern vessels, through which the water cannot penetrate; or, what would be still better, tin-plate boxes of from six to eight feet content in the base and two feet in height, which must be filled with air, but rendered impenetrable to water. Ships, he thinks, without much increasing their lading, might always carry with them some dozens of these vessels or boxes, to be thrown overboard, fastened to the ship with ropes, in case the agitation of the water should threaten danger. Achard made experiments, on a small scale, with tin-plate boxes of

this kind, which were attended with the wished-for success as when he employed oil: we know also, from the information of Scheldenburg, that the whirlpool of the Maelftrom has been moderated by throwing pieces of wood into it.

To form a decisive opinion respecting the utility of these means, it would be necessary to make experiments upon a large scale. At present oil appears to me to deserve the preference, as it produces the effect, not only by its being a lighter body, but also by its fluidity and toughness: besides, it possesses this advantage, that a small quantity of it is sufficient to spread over a considerable surface of water.

It has been objected against this use of oil, that the calmness produced by it has been observed to be only of short duration, and that the sea afterwards redoubles its fury: also, that a vessel which follows a ship sailing through water calmed by the above means, is exposed to so much greater danger; but of this circumstance no testimony of sufficient authority has been adduced*.

II. *Communication from Dr. MITCHILL, of New-York, shewing the Utility of constructing the Houses and paving the Streets of Cities with calcareous in preference to siliceous and argillaceous Materials.*

SIR,

New-York, June 6th, 1799.

IF you think the inclosed letter of any importance, I wish you would insert it in the Philosophical Magazine. It is so

* Transactions of the Society of Manchester, Vol. II. Achard's *Sammlung physikalischer und chemischer Abhandlungen*, Vol. I. Berlin, 1784, p. 83. *Essay sur les moyens de diminuer les dangers de la mer par l'assise de l'huile, du goudron, ou de quelque autre matiere flottante*, par M. de Helyveld, Amst. 1776. Letters and Papers on Philosophical Subjects, by Franklin, p. 438. *Meister de celebratis olei aquæ superflui effectibus opticis et mechanicis*, 1778.—The last work treats more on the testimony of the Ancients, than on the experiments that have been made.

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