younger stages of the whiting. The appearance and diagnostic characters of the various stages, which have frequently been difficult to distinguish in the past, are described very fully, and are illustrated by a series of figures.

THE DISTRIBUTION OF PELAGIC EGGS.

Mr. A. T. Masterman furnishes a review of the work done by the *Garland* in connection with the distribution of the pelagic eggs of food fishes in the years 1890-96, with special reference to the determination of the spawning areas and seasons of the various species and the direction taken by the eggs after they are shed. The observations made in the Firth of Forth and St. Andrews Bay throughout the above period are brought together and compared, lists being furnished of the principal species dealt with. The more important conclusions drawn from the study of the distribution of the pelagic eggs agree with those previously derived from the investigations into the distribution of spawning adults, namely, the season at which the various species spawn, and the place where the eggs are shed. It is shown that the more valuable forms, such as the cod, haddock, plaice, coal-fish, turbot and ling, spawn outside the three-mile limit, the floating eggs appearing first at the seaward stations and being gradually drifted in; on the other hand, less important species, such as the gurnard, flounder, and dabs, spawn within the limit as well as beyond it, and the sprat spawns principally within the limits of the Firth of Forth.

THE REARING OF LARVAL AND POST-LARVAL PLAICE AND OTHER FLAT-FISHES.

In connection with the artificial propagation of the food fishes a series of experiments were made by Mr. H. Dannevig in the rearing of the young fishes derived from the artificially fecundated eggs, which have yielded results of scientific interest. The natural food of the early post-larval plaice has been determined, and also the duration of the larval and post-larval periods. It was found that the larvæ from plaice eggs which were fertilised on April 28 and hatched on May 10, took eight days to absorb the yolk and enter on the post-larval stage, and other thirty-four days, or forty-two days from the date of hatching, before they settle permanently on the bottom as typical little flat-fishes. The changes during their development are described and illustrated in a plate.

MARINE DIATOMS.

Mr. George Murray, F.R.S., Keeper of the Department of Botany of the British Museum, conducted on board the *Garland* during part of the year an investigation into the distribution and reproduction of diatoms and minute floating vegetation found in the sea, which form an important constituent of the food of minute crustaceans and of fishes in their very early stages. In the paper describing the results it is pointed out that during the first months of the year there is a remarkable prevalence of diatom life in the sea off both the east and west coasts, the quantity diminishing towards the end of March, and thereafter remaining at a fairly constant minimum. The part taken by these minute vegetable forms in furnishing food for crustacea and young fishes is described, as well as the reproductive processes of the diatoms, respecting which the observations have been of great scientific importance.

Prof. Cleve, of Upsala, Sweden, also contributes a paper to the report, describing the characters and distribution of the diatoms and minute plant-life collected by tow-nets in the Faroe-Shetland channel during the expedition of H.M.S. *Research* to that region in August last year. The chief object of the inquiry was to determine, by comparison of the abundance and distribution of minute floating organisms, the movements of the water towards and from the North Sea.

THE INVERTEBRATE FAUNA.

Mr. Thomas Scott contributes to the report a paper describing the invertebrate fauna, as well as the fishes, of Loch Fyne, and furnishing lists of all the species which have been found in that loch, together with notes of their distribution. An account is also given of the parasites of the common copepod, *Calanus finmarchicus*, which forms an important constituent of the food of fishes. In another paper Mr. Scott gives the results of his continued investigations on the invertebrate fauna of the inland waters of Scotland, including that of several lochs in Cantyre, Bute, and Forfarshire, as well as of Shetland, in the examination of which he was assisted by Mr. Robert Duthie. Through these investigations some important additions have been made to the fresh water fauna of Scotland. In a third paper the invertebrate fauna, collected by tow-nets used on board H.M.S. *Research* in the Faroe-Shetland Channel, in August, is described, notes being furnished showing the distribution of the various species obtained.

PHYSICAL INVESTIGATIONS.

In addition to the regular determinations of the temperature and density of the sea water at various stations by the *Garland*, special physical investigations were made last year in the Faroe-Shetland Channel and in Loch Fyne. By the courtesy of Admiral Wharton, the Hydrographer to the Admiralty, a series of temperature observations were taken in the former area by the officers of H.M.S. *Research*, under the command of Captain Moore, and a large number of samples of water were secured from various depths for the subsequent determination of the density. Mr. H. N. Dickson has prepared a special paper on the subject, which is printed in the present report. The work was undertaken with the view of forming part of the continued hydrographic survey of the North Sea and the North Atlantic, instituted as an international scheme with Sweden, Denmark, Norway, and Germany in 1893, and the observations made on board H.M.S. *Research* form an important contribution to the subject. The observations in Loch Fyne and the Firth of Clyde were made by Dr. H. R. Mill in April and September, and are dealt with in another paper. They serve to confirm the previous conclusions as to the circulation of the waters in Loch Fyne.

THE PHYSIOLOGY OF THE EMOTIONS.[1]

THE respiratory movements have wide-reaching effects. They not only lead to the flow of air to and from the lungs, but they profoundly influence the circulation of the blood and lymph; they also affect the functions of the abdominal and pelvic viscera by rhythmically compressing and dislocating them. Now, these movements are liable to constant modification in the physiological acts of talking, shouting, singing, laughing, crying, sighing, and yawning (as also in the occasional and semi-pathological acts of sneezing, coughing, vomiting, and hiccoughing), and it therefore follows that these acts are more far-reaching in their effects than would at first sight appear, and hence are worthy of our careful study. This will the more readily be granted when it is added that they affect the body, not only by modifying the respiratory movements and thus producing the effects already mentioned, but by involving the expenditure of a considerable amount of neuro-muscular energy, and by inducing definite psychic phenomena which themselves have their physical accompaniments.

Seeing, then, how far-reaching are the effects of these several acts, and remembering how large a part they play in normal life, we may safely conclude that they influence the functions of the body beneficially, and that an undue interference with them is injurious. One is apt to forget how strong is the instinct to shout and sing, laugh and cry. It is especially noticeable in the savage and in the child. If these instincts are unduly repressed in the child he is sure to suffer. Crying should certainly be restrained within limits, but there can be no doubt that it is primarily physiological, not only favouring the proper expansion of the lungs and accelerating the circulation, but deadening the effects of pain and relieving nerve tension (especially in woman). Rosbach thinks it not improbable that many evils which manifest themselves in later life, such as chlorosis, contracted chest, and the phthisical habit, "may take their origin in the practice of mothers to stop their infants from screaming by soothing them to sleep in their arms or by stupefying rocking in the cradle." (Von Ziemssen's "General Therapeutics," vol. iii. p. 581). It is well known that children show a strong instinct to chatter and sing the first thing in the morning, and it should be allowed full vent as far as is practicable. The shouting which young people indulge in during their play is quite remarkable and is manifestly physiological. The same tendency to shout is observed in young adults, especially among the poorer classes in holiday time. Though from the physiological point of view justifiable, and even

1 "The Therapeutical Aspects of Talking, Shouting, Singing, Laughing, Crying, Sighing, and Yawning." By Dr. Harry Campbell. (Abridged from *The Lancet*, July 17.)

beneficial, the noises they make are certainly not always pleasing, especially to the sensitive nerves of the cultured, amongst whom this instinct is consequently suppressed, though whether altogether to the gain of the individual is questionable.

The various acts referred to will now be considered individually.

TALKING.

As regards the psychic aspect of talking, thought becomes much more vivid if it finds expression, whether in speech, writing, music, or artistic production, than if it remains unexpressed. The physical effects of thought are more pronounced in talking than in writing. The cortical nervous discharges underlying it send a stream of energy towards the muscles involved in speech and gesture, and both voice and gesture can be modified to convey subtle shades of thought and feeling which cannot find expression in writing. The very expression of these refinements enhances the vividness and intensity of mentation. Talking is for this reason stimulating, and its influence in this respect is in a measure proportional to the gesture accompanying it. Few things are more calculated to stimulate the body, to rouse it from lethargy, than "animated" conversation. In talking, as in laughing, shouting, singing, and crying, inspiration is short, while expiration is prolonged, the exit of air being checked partly by obstruction in the glottis and partly, perhaps, by the action of the inspiratory muscles. The actual amount of work done in talking is far more than might at first sight be supposed, and should always be taken into account in reckoning up the quantity of exercise taken during the day. The amount of talking done by barristers, politicians, and others enables them to dispense largely with exercise as ordinarily understood; for not only do they in this way expend a considerable amount of muscular energy, but they experience the manifold advantages of active respiratory movements continued for long periods together; indeed, I believe talking to be distinctly conducive to longevity. That talking involves a considerable expenditure of energy is shown by the exhaustion which it induces in those who are nervously run down. Such are often greatly exhausted, even after a moderate day's talking. This exhaustion is due to mental as well as to muscular expenditure; indeed, in the very neurasthenic the bare process of thought may be an effort and the mere effort to think may alone cause exhaustion; and if such is the case, how much more likely is the putting of thought into speech to do so, seeing that, apart from the muscular expenditure involved in speech, thought is so much more intense when spoken than when unexpressed. Talking is a beneficial exercise in heart disease, especially in those forms in which the blood tends to be dammed back upon the lungs. The good effect is here doubtless due to the increased amplitude of the respiratory movements and to the help thus afforded to the pulmonary circulation. It is for this reason that I always encourage talking in those suffering from passive engorgement of the lungs. "The breathlessness due to dilatation of the heart," observes Sir William Broadbent, "is often relieved by exercise of the voice. I have met with numerous instances in which a clergyman has climbed into the pulpit with the utmost difficulty, and has not only preached a sermon comfortably, but has been all the better for it" (*The Lancet*, April 4, 1891, p. 798). The good result, I take it, in these cases is attributable to the deep inspirations required by the loud voice necessary to fill a large building.

SHOUTING.

The psychic accompaniment of shouting is essentially emotional. Emotion is not only expressed, but sustained, and, indeed, intensified by it. Thus the shouting of children at play, itself the outcome of exuberant emotion and pent-up neuro-muscular energy, enhances the emotional outburst. In like manner the hurrahs of an applauding multitude, the cry of the huntsman, the war-whoop of the savage, the yells of an attacking force, may so exalt emotionality as to induce a condition bordering on ecstacy. A further effect of shouting is to dull sensibility, the emotional exaltation which it provokes, and the voluminous discharge of neuro-muscular energy accompanying it, inducing a corresponding depression in the sensorial sphere. It is on this principle that groaning, and still more the shriek of acute agony, bring relief. The mere sound produces a similar effect by violently energising the acoustic centres.[1] The shouting and gesticulation which accompany an outburst of passion act physiologically by relieving nerve tension; and, indeed, as Hughlings Jackson has suggested, swearing may not be without its physiological justification. Passionate outbursts are generally succeeded by a period of good behaviour, and, it may be, improved health. One frequently notices this in children, and I have also observed it in the adult. It is possible that the outbursts of irritability observed in disease, as, for instance, in gout, have their physiological as well as their pathological aspect. As regards the modifications in the respiratory movements caused by shouting, the important practical point to notice is that they are increased in depth. Hence shouting favours the development of the lungs and accelerates the circulation of blood and lymph.

SINGING.

Singing, like shouting, is more emotional than intellectual, the degree of emotion called forth depending upon the extent to which the individual throws himself into the spirit of the song. The nature of the attendant emotion varies of course considerably, and there is a corresponding variability in its physical correlatives: if the theme of the song be joyous the proper rendering of it is highly stimulating. From the medical standpoint singing is a most important exercise, both by virtue of its influence on the emotions, on the respiratory movements, and on the development of the lungs. The good average health enjoyed by professional singers is in large measure attributable to the mere exercise of their calling.[2] Such therapeutic importance do I attach to singing that I recommend it wherever opportunity affords. It is especially useful in defective chest development and in chronic heart disease. Oertel speaks enthusiastically of the beneficial influence of singing on the general health, and especially on the lungs, and he refers to the fact that almost all eminent singing masters can tell of serious cases of lung disease which have been cured by their method of singing. He thinks there can be no doubt that weak chests of various kinds can be greatly improved by it, and he would even appear to include phthisis.

LAUGHTER.

The psychic accompaniment of laughter being joyous emotion, its effect is stimulating, and it has been truly said that the man who makes us laugh is a public benefactor. Its beneficial effect on the body is illustrated by the saying, "Laugh and grow fat." The expiratory act in laughter is greatly prolonged, and, the glottis being partly closed, intra-pulmonary tension is increased; and thus in excessive laughter there may be considerable impediment to the flow of blood through the lungs, as shown by the turgid head and neck. This disadvantage—for in most cases of heart disease it is a disadvantage—is far more than compensated for by other effects, foremost among which must be reckoned the deep inspirations which separate the individual paroxysms.

CRYING.

In thinking of the term "crying," one must distinguish between the mere shedding of tears, and weeping accompanied by sobbing. In the one the effects are limited, while in the other the entire body may be convulsed. I have already referred to the beneficial effects of crying in children. The crying of the infant is peculiar. Expirations are prolonged sometimes for as much as half a minute, and are interrupted by short inspirations. During the expirations the glottis is contracted, and the intra-pulmonary pressure rises considerably. Not only is the pulmonary circulation thereby greatly impeded, as shown by the swollen veins of the head and neck, but bronchial mucus, flatus, and other noxious matters are evacuated. The paroxysm is succeeded by rapid deep respirations, which restore the equilibrium of the circulation. Women likewise often derive benefit from "a good cry"—the profuse flow of tears lessens blood-pressure within the cranium; the voluminous discharge of nerve energy relieves nerve tension; the sobbing movements of respiration influence in a very decided and doubtless beneficial way the circulation and the movements of the abdomino-pelvic

[1] A famous quack extracts his patient's teeth to the blare of trumpets and the boom of the big drum.

[2] The splendid chest development of public singers is, of course, not entirely attributable to the constant exercise of the voice, since no one can attain a high excellence without having a good chest development in the first instance. It must also be observed that every singer who attains to fame is careful to lead a healthy life.

viscera; while the widespread contraction of the muscle system has probably also a good effect. How pronounced are the dynamic effects induced by completely abandoning oneself to a fit of crying is shown by the exhaustion which it entails. It is partly through this exhaustion that crying induces sleep; we hear of "crying oneself to sleep," though this must be but a very crude explanation of the phenomenon. The tendency of women to cry should, of course, be kept within proper bounds, but certainly harm may result from its complete suppression, as Tennyson recognises in the line—

"She must weep or she will die."

It is said that women who are able to find relief in tears keep their youth longer than those who repress them. The internal cankering action "like a worm i' the bud" of pent-up emotion is not only a beautiful poetic conceit, but a profound physiological truth. In short, strong emotion should receive expression—"give sorrow words."

SIGHING.

"A sigh is a deep thoracic respiration, with retraction of the abdomen."[1] The retraction of the abdominal muscles leads to a compression of the splanchnic veins. This compression is probably increased by slight descent of the diaphragm. The blood is thus pressed out of those veins into the right heart, and the flow into this chamber is further favoured by the deep inspiration which also aids the circulation through the lungs. A more common cause of sighing I believe to be shallow breathing, however induced. Thus sadness and a sense of weariness or boredom are wont to be attended by shallow breathing, and in all of them sighing is frequent. In consequence of this shallow breathing, blood-aeration lags behind, and the blood tends to accumulate in the right heart and systematic veins. The sigh benefits by promoting the aeration of the blood and quickening the pulmonary circulation, and it is for similar reasons that sighing is apt to occur during a state of "breathless attention"—when the attention, *i.e.*, is so strained that one forgets, as it were, to breathe adequately.

YAWNING.

There can be little doubt that one of the objects of yawning is the exercise of muscles which have been for a long time quiescent, and the acceleration of the blood and lymph flow which has, in consequence of this quiescence, become sluggish. Hence its frequency after one has remained for some time in the same position—*e.g.* when waking in the morning. Co-operating with this cause is sleepiness and the shallow breathing which it entails. This factor, as well as muscle-quiescence, is apt to attend the sense of boredom which one experiences in listening to a dull sermon. Hence it is that the bored individual is apt to yawn. As in the case of sighing, the deep breath which accompanies the act of yawning compensates for the shallow breathing, which is so apt to excite it.

ON THE ASCENT OF WATER IN TREES.[2]

WITHIN the last few years the problem of the ascent of water has entered on a new stage of existence. The researches which have led to this new development are of such weight and extent that they might alone occupy our time. It will be necessary therefore to avoid, as far as possible, going into ancient history. But it will conduce to clearness to recall some of the main stepping-stones in the progress of the subject.

The two questions to be considered are: (1) What is the path of the ascending water? (2) What are the forces which produce the rise?

(1) The first question has gone through curious vicissitudes. The majority of earlier writers assumed that the water travelled in the vessels. This was not, however, a uniform view. Cæsalpinus, 1583, seems (Sachs' "History of Botany," English Trans., p. 451) to have thought that water moved by imbibition in the "nerves." Malpighi and Ray held that the vessels serve for air, and the wood fibres for the ascent of water. Hales ("Vegetable Staticks," p. 130), who believed in the "sap-vessels" as conduits, speculated on the passage upwards of water between the wood and the bark. Also (*loc. cit.* p. 19), that water may travel as vapour not in the liquid state. In the present century Treviranus (Sachs' "History"), 1835, held that water travelled in vessels; De Candolle, 1832, that the intercellular spaces were the conduits. In Balfour's "Manual of Botany," 1863, vessels, cells, and intercellular spaces are spoken of as transmitting the ascending water.

The change in botanical opinion was introduced by the great authority of Sachs,[1] who took up Unger's view[2] that the transpiration current travels in the thickness of the walls as water of imbibition.

Then followed the reaction against the imbibitionists—a reaction which has maintained its position up to the present time. Boehm, who had never adopted the imbibition theory, must have the credit of initiating this change; his style was confused and his argument marred by many faults, but the reaction should in fairness be considered as a conversion to his views, as far as the path of the travelling water is concerned. Nevertheless, it was the work of others who principally forced the change on botanists—*e.g.* von Höhnel (*Pringsheim's Jahrb.* xii., 1879), Elfving (*Bot. Zeitung*, 1882), Russow (*Bot. Centr.* xiii., 1883), R. Hartig ("Ueber die Vertheilung," &c., *Untersuchungen aus dem Forst. Bot. Inst. zu München*, ii. and iii.), Vesque (*Ann. Sc. Nat.* xv. p. 5, 1883), Godlewski (*Pringsheim's Jahrb.* xv., 1884), and others.

(2) The second question has a curious history, and one that is not particularly creditable to botanists generally. It has been characterised by loose reasoning, vagueness as to physical laws, and a general tendency to avoid the problem, and to scramble round it in a mist of *vis à tergo*, *capillarity*, *Jamin chains*, *osmosis*, and *barometric pressure*.

An exception to this accusation (to which I personally plead guilty) is to be found in Sachs' imbibition theory, in which, at any rate, the barometric errors were avoided, though it has difficulties of its own, as Elfving has pointed out.

But the most hopeful change in botanical speculation began with those naturalists who, concluding that no purely physical causes could account for the facts, invoked the help of the living elements in the wood. To Westermaier (*Deutsch Bot. Ges.* Bd. i., 1883, p. 371) and Godlewski (*Pringsheim's Jahrb.* xv., 1884) is due the credit of this notable advance, for whether future research uphold or destroy their conclusions, it claims our sympathy as a serious facing of the problem by an ingenious and rational hypothesis.[3]

We may pass over the cloud which arose to witness for and against these theories, and proceed at once to Strasburger's great work (*Leitungsbahnen*, 1891), in which, with wonderful courage and with the industry of genius, he set himself to work out the problem *de novo*, both anatomically and physiologically. In my opinion it is difficult to praise too highly this great effort of Strasburger's.

Strasburger's general conclusion is now well known. He convinced himself that liquid can be raised to heights greater than that of the barometric column in cut stems, in which the living elements have been killed. Therefore, the cause of the rise could not be (1) barometric pressure, (2) nor root pressure, (3) nor could it be due to the action of the living elements of the wood. His conclusions may be stated as follows:—

(*a*) The ascent of water is not dependent on living elements, but is a purely physical phenomenon.

(*b*) None of the physical explanations hitherto made are sufficient to account for the facts.

Strasburger has been most unjustly depreciated, because his book ends in this confession of ignorance. I do not share such a view. I think to establish such distinct, though negative, conclusions would be, in this most nebulous of subjects, an advance of great value. Whether he has established these conclusions must of course be a matter of opinion. To discuss them both would be to go over 500 pages of Strasburger's book, and will not here be attempted. Conclusion (*a*) that the ascent is not dependent on living elements must, however briefly, be discussed, because it is here that the roads divide. If we agree with Strasburger, we know that we must seek along the physical

[1] L. Hill: *Journal of Physiology*, vol. xv. p. 48.

[2] A paper read before Section K of the British Association at the Liverpool meeting, by Francis Darwin, F.R.S. (Revised January 20, 1897).

[1] *Physiol. Végétale* (French Trans.), 1868, p. 235, and more fully in the *Lehrbuch*. Sachs also partially entertained Quincke's well-known suggestion of movement of a film of water on the surface of vessels.

[2] *Sitz. k.k. Akad. Wien*, 1868. Dixon's and Joly's paper in the *Annals of Botany*, September 1895, gives evidence in favour of a certain amount of movement of the imbibed water.

[3] It is of interest to note that Hales, in speaking of the pressure which he found to exist in bleeding trees, says: "This force is not from the root only, but must also proceed from some power in the stem and branches." ("Veg. Staticks," 1727, p. 110.)