version into heat (wasted in space); and this, again, is an indication of the relatively small permanence in such a system, before pointed out as a probable fact. If there is not much free gas in a nebula, the heat radiated by the meteoric masses into space will be great, because unobstructed by the gas. If, on the other hand, there is much free gas in the nebula, it will fritter the translatory motion down by friction into heat. A translatory motion whose temperature equivalent (36,000° C.) is from ten to twenty times more than sufficient to volatilize the moving masses, if utilized, could scarcely exist for a lengthened epoch, or this would seem to be an unnatural state of things.

If the meteoric masses had a mean length of path at all comparable in relative scale to that of a gas at normal density; such as, for instance, if the mean path were (merely for illustration) 1000 times the diameter of the meteorite; then it is evident that the whole system—by a translatory motion of 5½ kilometres per second—would be resolved into gas in a few minutes or even seconds of time. The question then becomes, as it seems, How far does lengthening the mean path diminish the tendency to resolution into vapour by allowing time to cool between the encounters? or some mechanical relations might possibly be demonstrated here from elements[1] or physical data determinable apparently. S. TOLVER PRESTON.

Paris, February.

Upper Wind Currents over the North Atlantic Doldrums.

THE following observations were taken on board the steamship *Araucania* on her voyage from Liverpool to Valparaiso in December last:—

From the Cape Verde Islands down to 9° N. lat. the surface wind was steadily north-east, but the low clouds came as persistently from south-east, and the middle or high layers from south-west.

About 5° N. the wind worked gradually through east to south-east, and we experienced no calm doldrum, nor even a belt of variable winds. From here to the equator the surface wind remained south-east, while the low clouds came from between south and south-east, but the middle and high layers still passed from south-west.

From the line till about 10° S., while the surface wind continued to blow from south-east, the high cirrus moved from the north-west.

The circulation of the atmosphere, indicated by these observations, is very different from that described by myself in your columns on two former occasions. On one, while traversing the same track as now, only in the month of July 1885; and on another while going from Cape Verde to Cape Town in December of the same year, I found the highest current over the doldrums coming from the east. Now there was no doldrum at all, and though there were 200 miles of latitude between the place where the last south-west highest current and the first north-west highest current were observed, it seems somewhat improbable that there was a narrow belt of high-level east winds between these two currents from some point of west.

It may be noted that cirrus came from the south-west for about 300 miles of southing over the south-east trade, and that a low current from south-east blew over both trades from 6° S. to 13° N. RALPH ABERCROMBY.

Straits of Magellan, January 15.

The Giant Earthworm of Gippsland.

IN the last issue of NATURE (p. 394) I observe in an article upon *Megascolides australis* that a supposition is expressed that very large earthworms will be found to occur in South America as well as in other continents. It may be of a little interest to mention that I found near the town of Manaos, in Amazonia, in the year 1874, an earthworm that measured 30 inches in length by ¾ inch in greatest breadth. When found, in the early morning, it was quite fresh, though newly dead, being somewhat crushed near one end, probably by some passer-by in the darkness. Unfortunately the worm spoiled in the rum in which I attempted to preserve it. JAMES W. H. TRAIL.

University of Aberdeen, February 27.

Weight and Mass.

PROF. GREENHILL seems to have overlooked the fact that my letter in NATURE of February 7 (p. 342) related entirely to procedure in teaching. I merely stated that as the result of experience I have found it absolutely necessary to use terms strictly in the senses assigned to them by definition, and not to use the same term in two senses. I find that it conduces to clearness and accuracy to use the word "pound," for example, only in the sense of a certain quantity of matter, and to use the phrase "weight of a pound" when speaking of the force of gravity on that quantity of matter.

With the ordinary expressions used by engineers when addressing engineers or other persons who, presumably, are able to distinguish between the different senses in which the same term or phrase is used, I have no quarrel whatever, and must decline Prof. Greenhill's invitation to express an opinion as to the accuracy of the phrases which he quotes from NATURE.

University College, Bangor, February 25. A. GRAY.

The Formation of Ice.

IN connection with the discussion on the formation of ice in crystals, it might be worth while to record that on December 6, 1861, in a slight frost, I saw some in the process of formation in a trough of water. There were three thin pieces of ice in it, two irregular, but the third a beautiful star, 4 or 5 inches in diameter, having six feather-like rays which were branched twice or thrice, in all cases at an angle of 60°. Also, two days before, when the water in the trough was frozen over, I observed in it six-rayed stars several inches in diameter very slightly raised above the rest of the surface. T. W. BACKHOUSE.

Sunderland, March 2.

ROTIFERA AND THEIR DISTRIBUTION.[1]

IT is no longer possible, I think, for your President to give, as the substance of his address, a summary of the most important improvements of the microscope, and of the most remarkable results of microscopical research, which have been recorded in the preceding twelve months.

All this is now so fully and so admirably done in your own journal, by your energetic Secretary and his able colleagues, that your Presidents will most probably, in future years, have to follow the excellent precedent set by Dr. Dallinger, and choose for the subject of their address some topic directly springing from their own special studies. For, on an occasion like this, each President would wish to give the Society the best he can, and it is clear that this best must be sought for among matters of which he has a special knowledge.

Unfortunately, an accident, which befell me early last year, not only robbed me of the pleasure of being present at several of your monthly meetings, but also produced consequences that compelled me to put my microscope aside; and, as I had not long before finished my share of the "Rotifera," I feared at first that I had lost the power of pursuing any new investigations, just at the very time when I had published the results of all my old ones.

There is, however, still a portion of my subject with which I am familiar, and which, I believe, has not as yet been touched upon by anyone; and I venture to

[1] It is said that "The total energy of agitation in an isothermal adiabatic sphere is half the potential energy lost in the concentration from a condition of infinite dispersion" (NATURE, Nov. 29, 1888, p. 107). This is apparently the analogue of the ratio of Clausius, somewhat differently expressed, viz. the ratio between the two parts of the energy, translational and vibrational (internal motion), applicable to a rigid body, and calculated at ½ *a priori* by Maxwell. I would venture one remark here. It appears evident that if the mean thermal equivalent of *half* the potential energy lost were all accumulated in the meteorites, they would be volatilized. If, on the other hand, part of this thermal equivalent were dissipated in space by radiation, the meteorites could not possess their natural equivalent of thermal energy due to the translatory motion, and consequently it would seem that in the continued effort towards the equalization of these two forms of energy (translatory and thermal), the translatory motion would with tolerable rapidity degrade down to a value which could no longer support the weight of the superincumbent material. This would be another argument for the small degree of permanence of such a system.

[1] Address delivered at the Annual Meeting of the Royal Microscopical Society, by Dr. C. T. Hudson, President, on February 13, 1889.

hope that I may make it interesting to you. It relates to what may be called the foreign Rotifera; that is to say, to those Rotifera which have not as yet been found in our islands. One would naturally like to know what proportion these foreign species bear to the British; whether there are any families or genera entirely absent from the British fauna; whether there appears to be any law of distribution among the Rotifera; and how far it is possible to account for the existence of the same species in places which are thousands of miles apart. But many of the numerous memoirs, from which information on these points is to be derived, are only to be found, scattered widely, in various European periodicals; and so are difficult to be procured; while, of those that have been published separately, the best are rare.

Under these circumstances I thought it not improbable, that the members of our Society might be glad to know, that the task of studying and condensing these memoirs had been, in the main, accomplished; and that I am able now to present them with some of the results.

In the first place, I made a list of all the known species, and marked against each the various localities in which it has been found. It was curious to see, as the table grew, how certain well-known Rotifera were picked out by their rapidly advancing scores, till at last about fifty typical Rotifera were separated from the rest; while, of these, a smaller group enjoyed the further distinction of having a very wide range, not only in latitude and longitude, but also in altitude.

The same table showed at a glance that Great Britain decidedly outstripped all other countries in the number of its recorded species, having quite two-thirds of the whole. Nor was this all, for the Rotifera seemed, like trade, to follow the flag, and to haunt the British colonies just as if they were British ships.

The reason, for this curious pre-eminence of British Rotifera, is clearly seen when we notice how those species are distributed, which have as yet been found in one country only. There are about 240 such species, and of these no fewer than 173 (that is to say, more than two-thirds) are peculiar to Great Britain. It is, of course, obvious that this apparent selection of Great Britain as the fatherland of the Rotifera is simply due to the greater energy, industry, and skill with which the search for new species has been pursued in this country. It is, however, very remarkable that the naturalists of Great Britain should, in late years, have added to the Rotiferous fauna two and a half times as many species as the naturalists of all other countries put together have done; and this highly honourable result is mainly due to members of your own Society, and especially to my deeply-lamented colleague and dear friend, the late Mr. Philip Henry Gosse, F.R.S.

After I had seen how greatly the value of the recorded distribution of the Rotifera was affected by what I may term the "personal equation," I at first feared that I should obtain little else from my tables than a well-merited tribute to the energy of British naturalists. Further inspection, however, showed other points that are well worth your notice.

In the first place, my lists showed that Germany, Switzerland, and Hungary come next in order to Great Britain, in the total number of species that each records; and I have only to mention the names of Ehrenberg, Leydig, Cohn, Grenacher, Zacharias, Eckstein, Plate, Imhof, Perty, Bartsch, Vejdovsky, Zelinka, not to say many others, to make it obvious that the result is due, not to the real distribution of the species in these countries, but to the comparative skill and industry of their naturalists.

Next, my table shows clearly that in all cases a considerable number, and in some the great majority, of the above-named fifty typical Rotifera, range throughout Britain, France, North and South Germany, Denmark, Switzerland, Hungary, and Russia; so that we may reasonably conclude that a considerable proportion of the 450 known species would probably be found in almost any part of Europe, if they were diligently searched for. Here, for instance, is a list of thirty well-known Rotifera, all of different genera, and all recorded in at least five of the above eight European countries:—

Floscularia ornata	Diglena catellina
Stephanoceros Eichornii	Mastigocerca carinata
Melicerta ringens	Rattulus lunaris
Limnias ceratophylli	Dinocharis pocillum
Lacinularia socialis	Scaridium longicaudum
Philodina roseola	Salpina mucronata
Rotifer vulgaris	Euchlanis dilatata
Actinurus neptunius	Cathypna luna
Asplanchna helvetica	Monostyla cornuta
Triarthra mystacina	Colurus uncinatus
Hydatina senta	Metopidia lepadella
Notommata aurita	Pterodina patina
Proales decipiens	Brachionus urceolaris
Furcularia forficula	Anuræa aculeata
Eosphora aurita	Notholca striata.

Besides, many of the Rotifera are very tolerant of climate, and appear to be able to live anywhere that they can get food. For instance, *Rotifer vulgaris* is to be found all over Europe, and at all heights; thriving under moss, near the top of the Sidelhorn, and on the Tibia, at an altitude of 9000 feet above the sea. It has been met with also in Nubia, on the slopes of the Altai Mountains in Siberia, in Ceylon at the top of Adam's Peak, in Jamaica, and in the Pampas of La Plata. *Brachionus pala* has nearly as great a range; for it has been found in many parts of Europe, in Egypt, at the Cape of Good Hope, in Siberia, Ceylon, Jamaica, and New Zealand. Besides these, *Diglena catellina*, *Hydatina senta*, *Actinurus neptunius*, and a few others, have all been met with in different quarters of the globe. But the distribution of the Rotifera presents us with other facts quite as curious as these. For not only are European species to be found ranging over Asia and Africa, but America, and even Australia and New Zealand, in spite of their ocean belts, possess the same familiar creatures; and, moreover, seem to have hardly any peculiar to themselves. Here, for example, is a list of Rotifera that have been found in Sydney by Mr. Whitelegge, and in Queensland by Mr. Gunson Thorpe:—

Floscularia ornata	Conochilus volvox
,, campanulata	,, bullata (*n. sp.*), *T.*
,, cornuta	Asplanchna Brightwellii
,, Millsii	,, ebbesbornii
,, coronetta (*var.*), *W.*	Cephalosiphon limnias
Melicerta ringens	Actinurus neptunius
,, conifera	Rattulus tigris
Œcistes crystallinus	Notommata centrura
,, janus	Euchlanis triquetra
Limnias ceratophylli	Dinocharis pocillum
,, annulatus	,, triremis (*n. sp.*), *W.*
,, cornuella	Brachionus militaris
Lacinularia socialis	Anuræa cochlearis
,, pedunculata (*n. sp.*), *W.*	Pedalion mirum.

Mr. Thorpe has also found what seems to be a swimming Floscule, with a forked foot and a dorsal eye; as well as a new *Noteus* or *Brachionus*, with a strangely unsymmetrical lorica, bearing ten spines in front, and three behind. Who would ever have imagined that, in a sea-girt continent, at the opposite side of the globe—in a land whose fauna and flora are so strange as those of Australia—we should find that twenty-four out of thirty recorded species were British; and that, of the remaining six, one (*Floscularia Millsii*) had a habitat in the United States?

The United States, too, Jamaica, and Ceylon all reproduce the same phenomenon, though on a reduced scale; so that the question at once arises, How could these

minute creatures, who are inhabitants of lakes, ponds, ditches, and sea-shore pools, contrive to spread themselves so widely over the earth? Take, for instance, the case of *Asplanchna ebbesbornii*, which till quite lately had but one known habitat, viz. a small duck-pond in a vicarage garden in Wiltshire. The very same animal has been found by Mr. Whitelegge in the botanical gardens at Sydney, New South Wales. No doubt, in time, it will be found elsewhere also; but how, or when, did it pass from the one spot to the other?

Again, there is the strange Floscule, *F. Millsii*, a Rotiferon apparently linking together the genera *Floscularia* and *Stephanoceros*, and which has been found almost simultaneously by Mr. Whitelegge at Sydney, and Dr. Kellicott at Ontario. The possibility of its journeying between two such points seems quite as hopeless as that of *Ashplanchna ebbesbornii's* passing from New South Wales to Wiltshire.

And such cases are numerous. How did *Hydatina senta* and *Brachionus pala* get to New Zealand? or *Notops brachionus* and *Rotifer vulgaris* to the top of Adam's Peak, and the Pampas of La Plata? Again, there is *Pedalion mirum*: since I first found it, in a pond at the top of Nightingale Valley, at Clifton, it has been met with in four or five other places in England, including a warm water-lily tank at Eaton Hall; but, till quite lately, in no other country. Now I have just received a letter from Mr. Gunson Thorpe, telling me that he has found it swarming in a pool on a rocky headland in Queensland.

You have, no doubt, long ere this anticipated the solution of the puzzle, and see clearly enough that living creatures, to whom a yard of sea-water is as impassable a barrier as a thousand miles of ocean, could only have reached or left Australia, New Zealand, Jamaica, Ceylon, &c., in the egg; not the soft, delicately shelled, and quickly hatching summer egg, but the ephippial egg, which is protected by a much harder and thicker covering, which is constructed so as to bear without injury a long absence from the water, and which hatches, so far as is known, some months after it has been laid.

But this explanation still requires to be explained. The case of the free-swimming Rotifera is simple enough. They are most of them to be found, at some time or another, in small shallow pools, and their eggs either fall to the bottom of the water, or are attached to the small confervoid growth on the stones in it. Such pools frequently dry up, leaving the ephippial eggs to wait for the rainy warm weather of next year. Then comes boisterous weather, and the dusty surface of the exposed bottom of the pool is swept by a wind, which raises the dust high into the air, ephippial eggs and all. For these latter are minute things; few exceeding one three-hundredth of an inch in length, and many even half that size. Once raised in the air, I see no reason why they should not be driven by aërial currents, unharmed, half round the globe, falling occasionally in places where water, temperature, and food are alike suitable.

The dust of the eruption at Krakatão, which gave us such wonderful sunsets and green moons in 1883, travelled from the Sunda Isles to England in three months; and so the ephippial eggs of *Asplanchna ebbesbornii*, and other Rotifera, may have traversed the distance from England to Australia, and yet have been capable of hatching at the end of the journey.

It may perhaps seem a fanciful notion to account for the stocking of the ponds at Sydney by eggs carried thousands of miles in the air, but several well-known facts warrant the hypothesis. The tops of our houses, the heights of the Alps, the slopes of the Siberian mountain ranges, are haunts of the Philodines, which, being an exceptionally hardy race, have accommodated themselves to living in damp mosses at the edge of a glacier, or in a gutter which now holds a mere handful of stagnant water, now is a racing current, and now a dusty leaden basin, glowing under a blazing sun. No doubt eggs of all sorts of species fall on the same spots, but only to perish under trials that none but a Philodine could survive.

How various are the species whose eggs are thus wafted up by the air has been well shown by Mr. J. E. Lord, who has given a list of no fewer than forty-five species (contained in twenty-nine genera) that he found, in the course of twelve months, in the same garden pond. It was, however, admirably situated for catching whatever there was to be caught, for it lay in a flat plot of ground, where there was an entire absence of trees and shade, so that its surface was fully exposed to every wind that blew.

The eggs, of course, must often fall on unsuitable places, and be carried past suitable ones, and this accounts for the capricious appearances of Rotifera in some well-watched ponds, and for the frequent disappointments of the naturalists who visit it. To this aërial carriage of the eggs is also due the otherwise perplexing fact that, when any rare Rotiferon is found in one spot, it is frequently found at the same time in closely neighbouring ponds and ditches, even in such an unlikely hole as the print of a cow's foot filled with rain, but not at all in more promising places at some distance off.

Admitting, then, this fitful shower of eggs as proven, we at once see another way in which they may readily travel to distant lands. For it is quite possible that now and then they may fall on the cargo of an outgoing ship. Here they might lie safely in cracks and creases till, the journey being over, the knocking apart of packing-cases and the shaking of wrappers would set them afloat again, to drop down, it may be, into the Botanical Gardens of Sydney, the shore-pools of Ceylon, or the ponds of Jamaica. In fact, these Rotifera would have really done what I have already pointed out that they seemed to do—they would have followed the flag.

The eggs of the tube-makers, however, and of such Rotifera as live only in the clear waters of lakes and deep ponds, present a greater difficulty, for their eggs either lie within their tubes, or are attached to growing weeds, or fall down to a bottom which lies covered all the year round with several feet of water. The wind and sun here cannot be the only means of dispersion. Aquatic birds, and dogs, are probably assisting agents. The birds, as they swim among the water-plants, must frequently set free the eggs from the tubes of the Rhizota, as well as those which adhere to Confervæ, Potomagetons, and water-lilies, and so get them attached to their feathers. Then away they fly, carrying the eggs to some far distant lake, or shaking them off into the air with the flapping of their wings.

In confirmation of this idea, I may mention that the well-known naturalist, Mr. John Hood, of Dundee, who has added so many remarkable species of Rhizota to our Rotiferous fauna, informs me that the Scotch lakes most prolific in new and rare species are those which are visited annually by wild fowl from the North. Prof. Leidy also informs me that his collector, Mr. Seal, noticed sand-pipers haunting the duck-pond where he found an *Asplanchna* very similar to *ebbesbornii*, and that he thought that "these birds were especially instrumental in distributing the lower forms of aquatic life." I may also add that on one occasion I found in a temporary rain puddle, barely a yard across, a living ciliated ovum of *Plumatella repens*. Of course the puddle itself contained no adult forms, and the ovum must have been brought by some bird the distance of at least half a mile. The twin polypes were already partially developed inside the ovum, and it is curious that so delicate a thing should have borne this transport safely.

Dogs probably play a humbler part in the dispersion of the Rotifera; but they cannot help taking some part in it, by intercepting, as they swim, eggs that are slowly sinking

to the bottom, or by brushing off, on to their coats, eggs which have been already caught by the weeds; for the ephippial eggs are frequently armed with hooks or spines, which make them adhere easily to a pond-weed or to a hairy coat, and yet would not prevent a dog's vigorous shake, after his bath, from sending them flying into the air, or on to the dust, where sun and wind would do the rest.

Perhaps one of the most curious illustrations of this aërial conveyance of Rotiferous eggs is the account of *Callidina symbiotica*, which we owe to Dr. Carl Zelinka. It was in the depth of last winter that I read his interesting memoir, concerning a new *Callidina* that he had discovered inhabiting the little green cups on the under surfaces of the leaves of a scale-moss (*Frulliana dilatata*). As I knew that this plant grew on the elms of our Clifton promenade, I started off at once, on the rather forlorn hope of finding some living specimens of the new Rotiferon. When I arrived at the promenade I passed patch after patch of the scale-moss, hoping in vain to find something more promising than the withered liver-coloured stuff which alone was to be seen on the tree-trunks. At last I gave up further search, and pulling off a scrap of what looked like old ragged carpet, I carried it home. There I put a bit of it into a watch-glass, covered it with water, and gently teased it out with needles, till I found an under frond that had some pretension to being green. This I transferred to a glass cell, and placed it under the microscope with the cups turned towards me; and it was with no little pleasure that, in about a quarter of an hour, I saw first one *Callidina*, and then another, stretch its proboscis out of a cup, unfurl its wheels, and begin to feed.

No wonder that these *Philodinadæ* are to be found everywhere when they can bear to be frozen alive in the cell of a plant, or wasted by a midsummer sun in a leaden gutter!

Some chance breeze must have first wafted a *Callidina's* egg on to the scale-moss, just after a shower, when the whole plant was wet, and the little green cups were filled with water. The young *Callidina*, when hatched, could not have desired a better home. The rainfall, on an elm, flows down its furrowed bark in tracks as constant as those of a river and its tributaries; and the growth of the *Jungermann* follows these tracks. Every shower fills the spaces between its flat layers of overlapping leaves with water; and the lower layers, sheltered by the upper, retain for a long time water enough for the *Callidina* to creep about or swim in. And when, at last, the sun and air have dried up the water, the creature retreats into its green cup, which presents so small an aperture to the air, and is so fenced round with thick juicy cells, that the contained water is almost certain to hold out till the next shower. If it does not, the *Callidina* is still content; it becomes conscious of the coming crisis, draws in its head and foot, rounds its trunk into a ball, secretes round itself a gelatinous covering, and waits for better times.

But the Rotifera owe their wide dispersion not only to the ease with which their eggs are blown from one place to another, but also to their powers of endurance, and to their marvellous capacity for adapting themselves to new surroundings. A Philodine may say with Howell, "I came tumbling out into the world a true cosmopolite." I have already noticed how the *Philodinadæ* will endure such extremities of heat, cold, and dryness as Nature inflicts on them; but she does not put their full powers to the test, for, when time is given to them to don their protective coats, they can bear a heat gradually advancing to 200° F., or a fifty days' exposure to a dryness produced over sulphuric acid in the receiver of a good air-pump. Ehrenberg tells us that, whereas he killed *Volvox globator* with one electric shock, it took two of the same intensity to kill *Hydatina senta;* and that *Rotifer vulgaris* will swallow laudanum and yet "be lively," adding that a solution of cantharides seemed "to give it new life." The same irrepressible creature will flourish in water containing a perceptible quantity of sulphuric acid, while *Asplanchna priodonta* will swim about actively for twenty-four hours in a weak solution of salicylic acid, and *Synchæta pectinata* will do the same in chromic acid. The great majority of the fresh-water species die when dropped into sea-water, but some will bear sudden immersion in a mixture of one part sea-water to two fresh. We should not be surprised, therefore, to find not only that there are thirty-four known marine species of Rotifera, but that seventeen of these species are to be met with alike in salt-water and in fresh.

The following is the list of Rotifera found in salt or brackish water; those marked with a star are also the inhabitants of fresh-water:—

Floscularia campanulata*	Colurus amblytelus
Melicerta tubicolaria*	,, caudatus*
Rotifer citrinus*	,, dactylotus
Synchæta baltica	,, pedatus
,, tremula (?)*	,, uncinatus*
Pleurotrocha leptura (?)*	Mytilia tavina
Notommata naias*	Pterodina clypeata
Proales decipiens*	Brachionus Bakeri*
Furcularia forficula*	,, Mülleri
,, gracilis*	Notholca striata*
,, Reinhardti	,, spinifera
Diglena catellina*	,, inermis
,, grandis*	,, scapha*
Distemma raptor	,, thalassia
,, marinum	Anuræa valga*
Rattulus calyptus	,, biremis
Monostyla quadridentata	Hexarthra polyptera.

Although this is doubtless a very imperfect list, still it is sufficient to show how these fresh-water animals are slowly spreading into the tide-pools on the sea-shore. Some may have commenced their change of habitat in the field drains which are periodically invaded by the brackish waters of a tidal river. It was precisely in such a locality that I first found *Brachionus Mülleri*, in water only faintly salt, and at a height of 30 feet above the Severn. Ditches of this kind are to be found all down the Avon; from the highest point, that the tide reaches, to its mouth. As they approach the Severn their water becomes more and more brackish, and the preponderance of marine species in them more pronounced; so that it is easy to see how the descendants of a fresh-water Rotiferon, passing slowly down the river-side from ditch to ditch, may in course of many generations come to endure the sea itself.

In other cases the air-borne eggs may have dropped into the pools, of every degree of brackishness, which usually skirt the shores of our river estuaries. It is in such places, on the Scottish shore, that Mr. John Hood has found so many new marine species, and where no doubt so many more are yet to be found.

But the most noteworthy point about the above list is that the number of distinct genera is so great. One would rather have expected to find but four or five genera hardy enough to endure salt water; and yet here are no fewer than nineteen genera for the thirty-four known marine species; and of these latter, seventeen species are yet in the transitional state, inhabiting alike salt waters and fresh. Still more curious is it to find that all the four orders are represented; and that *Rhizota*, *Bdelloida*, and *Scirtopoda* have each furnished a contingent to the marine forms, as well as the more frequent *Ploima*. It is, of course, rather startling to hear that *Melicerta* and *Floscularia* are to be found inhabiting sea-water; but I know of no reason why any doubt should be thrown on Dr. Weisse's record of having so found them on the sea-shore at Hapsal.

The capacity of the Rotifera for adapting themselves to new surroundings is shown by a mere enumeration of the

strange places in which they are found. For these fresh-water creatures, the common inhabitants of lakes and ponds, are to be found in brackish ditches, sea-pools, the mud of ponds, the dust of gutters, in tufts of moss, on the blades of wet grass, in the rolled-up leaves and in the cups of liver-worts, in the cells of *Volvox*, the stems and sporangia of *Vaucheria*, in vegetable infusions; on the backs of *Entomostraca*, on their abdominal plates, on their branchial feet; on fresh-water fleas, wood-lice, shrimps, and worms; in the viscera of slugs, earth-worms, and Naiades; and in the body-cavities of *Synaptæ*.

But the great variability of every part of the external and internal structure of the Rotifera points to their fitness for playing the parts of cosmopolites. See how in *Floscularia* and *Stephanoceros* the head and its appendages are so developed that they dwarf all the rest; how in *Apsilus* the trunk predominates; while in *Actinurus* both head and trunk become appendages of a huge foot. The corona diminishes continually from the large complex organs of *Melicerta*, *Hydatina*, and *Brachionus*, down to the furred face of *Adineta* and the tuft of *Seison*, and vanishes altogether in *Acyclus*. The antennæ can be traced from long infolding or telescopic tubes, furnished with setiferous pistons, special muscles, and nerves, through a succession of shorter and simpler structures, till they become mere pimples or even setiferous pits in the body surface. The skin is hardened into a perfect lorica in *Brachionus*, is partially hardened in *Dapidia*, is merely tough in *Mastigocerca*, and is soft and quite unarmed in *Notommata*. The appendages of the body in Pedalion rise almost to the dignity of crustaceous limbs, for they have joints, and are worked by opposing pairs of muscles, passing across their cavities from point to point. In *Asplanchna* these appendages become stumpy projections, and the muscles, though still passing freely across the body-cavity, are reduced to threads. In *Triarthra* the appendages become chitinous spines; and at last, when we reach *Adineta*, *Taphrocampa*, and *Albertia*, we find that we have passed from a Rotiferon closely resembling a Nauplius-larva to one that is a simple worm.

The internal structure is just as plastic. The characteristic trophi exhibit a series of striking changes as we pass from one genus to another. In one direction the change is due to the degradation of the mallei, in the other to that of the incus; and in both this degradation is pushed so far, that the changing parts may be said almost to disappear. For in *Brachionus* and *Euchlanis* the mallei are well developed; in *Furcularia*, mere needle-shaped curved rods: in *Asplanchna*, so evanescent that it is hardly possible to find them in an animal killed by pressure.

By another set of changes, the rami are in their turn reduced almost to evanescence; becoming feeble loops in *Stephanoceros*, and in *Floscularia* two membranes attached to the unci.

Changes, great in degree, if not in variety, occur also in the excreto-respiratory system. For the contractile vesicle, which fills quite half the body-cavity in some *Asplanchnæ*, dwindles down in various species till it seems to vanish in *Pterodina* and *Pedalion;* while in one abnormal form, *Trochosphæra*, the connection between the lateral canals and the contractile vesicle is snapped, and the latter becomes an appendage of the cloaca only.

The nervous system, wherever it has been made out, is indeed always on the same plan; but its central organ, the nervous ganglion, is, in *Copeus* and *Euchlanis*, a great cylindrical sac stretching from the head below the mastax; while in *Floscularia* it shrinks into a small star-shaped body between the eyes and the organ of taste.

The alimentary and reproductive systems are those which vary the least; but even here the difference, in proportionate size, is very great between the stomachs of *Sacculus* and *Synchæta*, and also between the ovaries of *Asplanchnopus myrmeleo* and *Asplanchna priodonta*.

But not only do most of the external parts and internal organs vary in turn almost to vanishing, but these variations are not in any way simultaneous. The result is, that we find an organ, of a form characteristic of one family or genus, occurring in a species that belongs to another. Thus, for instance, the trophi of the *Melicertadæ* appear in *Pompholyx*, one of the *Triarthradæ*. Nay, more; it is easy to point out Rotifera that bear some striking characteristics of two or three other genera, or even of two or three other families. *Microdon clavus*, for example, has the central mouth and double ciliary wreaths of one of the *Rhizota*, the eye of a *Notommata*, the trophi of a *Diglena*, and the foot of a *Monostyla*. Again, *Pterodina patina* has the corona of *Philodina*, the lorica and transversely wrinkled retractile foot of *Brachionus*, the foot-ending of a young Rhizotan, and the mastax of the *Melicertadæ*. Then there is Mr. Thorpe's new Australian Floscule, which swims freely like one of the *Ploïma*, has the buccal cup and wreath of *Floscularia*, the dorsal eye of *Notommata*, and the body and forked foot of *Proales*.

To sum up, we may say that in the female Rotifera, the corona, head, foot, toes, appendages of the trunk, antennæ, eyes, and contractile vesicle vary down to almost absolute extinction; while, if we include the male in our survey, we must add that even the whole of the alimentary tract may disappear also. Moreover, the characteristics of the various groups interlace in so many ways that no organ—nor, indeed, any combination of two or three organs—can be relied upon to determine with certainty an animal's true position.

Two conclusions are, in consequence, irresistibly forced on us: the first, that the Rotifera, from *Pedalion* to *Albertia*, are related by descent; the second, that their curious habitats, wide dispersion and great variations in their structure are due to causes that have been at work for a very long period of time.

One other fact has also been made clear in this review—namely, that the British Rotifera give a very fair idea of the whole class. No doubt there are many foreign species, and some of these are very remarkable, and of great interest; but the greater number fall readily enough into the divisions that contain our own species.

And indeed it is a fortunate thing that we can here, at our own doors, study so many typical forms from life. For what books or drawings can give us the delight which we derive from observing the animals themselves?

To gaze into that wonderful world which lies in a drop of water, crossed by some atoms of green weed; to see transparent living mechanism at work, and to gain some idea of its modes of action; to watch a tiny speck that can sail through the prick of a needle's point; to see its crystal armour flashing with ever-varying tint, its head glorious with the halo of its quivering cilia; to see it gliding through the emerald stems, hunting for its food, snatching at its prey, fleeing from its enemy, chasing its mate (the fiercest of our passions blazing in an invisible speck); to see it whirling in a mad dance to the sound of its own music, the music of its happiness, the exquisite happiness of living,—can anyone, who has once enjoyed this sight, ever turn from it to mere books and drawings, without the sense that he has left all Fairyland behind him?

THE DARKNESS OF LONDON AIR.

A GREAT deal has been written at various times upon the subject of London fogs.

The constitution of these London fogs has been carefully gone into by several well-known men of science, from time to time; and the results obtained are of very great interest, as they prove, amongst other things, that during the winter London air has an unusually large amount of