## Glimpses of Nature.

By Grant Allen.

## IX.—A FROZEN WORLD.



HE pond in the valley is a world by itself. So far as its inhabitants are concerned, indeed, it is the whole of the world. For a pond without an outlet is like an oceanic

island; it is a system, a microcosm, a tiny society apart, shut off by impassable barriers from all else around it. As the sea severs Fiji or St. Helena from the great land-surface of the continents, so, and just as truly, the fields about this pond sever it from all other inhabited waters. The snails and roach and beetles that dwell in it know of no other world; to them, the pond is all; the shore that bounds it is the world's end; their own little patch of stagnant water is the universe.

A pond which empties itself into a river by means of a stream or brook is not quite so isolated. It has points of contact with the outer earth: it resembles rather a peninsula than an island: it is the analogue of Spain or Greece, not of Hawaii or Madeira. And you will see how important this distinction is if you remember that trout and stickleback and stone-loach and fresh-water mussels can ascend the river into the brook, and pass by the brook into the pond, which has thus a direct line of communication with all waters elsewhere, including even the great oceans. But the pond without an outlet cannot thus be peopled. Whatever inhabitants it possesses have come to it much more by pure chance. They are not able to walk overland from one pond to another; they must be brought there somehow, by insignificant accidents. Regarded in this light, the original peopling of every pond in England is a problem in itself —a problem analogous in its own petty way to the problem of the peopling of oceanic islands.

That great and accomplished and ingenious naturalist, Mr. Alfred Russel Wallace, working in part upon lines long since laid down by Darwin, has shown us in detail how oceanic islands have in each case come to be peopled. He has shown us how they never contain any large indigenous land animals belonging to the great group of mammals-any deer or elephants or pigs or horses; because mammals, being born alive, cannot, of course, be transported in the egg, and because the adult beasts could seldom be carried across great stretches of ocean by accident without perishing on the way of cold, hunger, or drowning. Vol xv.-33.

One can hardly imagine an antelope or a buffalo conveyed safely over sea by natural causes from Africa to the Cape Verdes, or from America to the Bermudas. As a matter of fact, therefore, the natural population of oceanic islands (for I need hardly say I set aside mere human agencies) consists almost entirely of birds blown across from the nearest continent, and their descendants: of reptiles, whose small eggs can be transported in logs of wood or broken trees by ocean currents; of snails and insects, whose still tinier spawn can be conveyed for long distances by a thousand chances; and of such trees, herbs, or ferns as have very light seeds or spores, easily whirled by storms (like thistledown), or else nuts or hard fruits which may be wafted by sea-streams without damage to the embryo. For the most part, also, the plants and animals of oceanic islands resemble more or less closely (with locally induced differences) those of the nearest continent, or those of the land from which the prevailing winds blow towards them, or those of the country whence currents run most direct to the particular island. are waifs and strays, stranded there by accident, and often giving rise in process of time to special local varieties or species.

Now, it is much the same with isolated ponds. They acquire their first inhabitants by a series of small accidents. Perhaps some water-bird from a neighbouring lake or river alights on the sticky mud of the bank, and brings casually on his webbed feet a few clinging eggs of dace or chub, a few fragments of the spawn of pond-snails or waterbeetles. Paddling about on the brink, he rubs these off by mere chance on the mud, where they hatch in time into the first colonists of the new water-world. Perhaps, again, a heron drops a half-eaten fish into the water—a fish which is dead itself, but has adhering to its scales or gills a few small fresh-water crustaceans and mollusks. Perhaps a flood brings a minnow or two and a weed or two from a neighbouring stream; perhaps a wandering frog trails a seed on his feet from one pool to another. By a series of such accidents, each trivial in itself, an isolated pond acquires its inhabitants; and you will therefore often find two ponds close beside one another (but not connected by a stream), the plants and animals of which are

nevertheless quite different.

Now, the pond in summer is one thing; the pond in winter is quite another. For just reflect what winter means to this little isolated, self-contained community! surface freezes over, and life in the mimic lake is all but suspended. Not an animal in it can rise to the top to breathe; not a particle of fresh oxygen can penetrate to the bottom. Under such circumstances, when you come to think of it, you might almost suppose life in the pond must cease altogether. But nature knows better. With her infinite cleverness, her infinite variety of resource, of adaptation to circumstances, she has invented a series of extraordinary devices for allowing all the plants and animals of a pond to retire in late autumn to its unfrozen depths, and there live a dormant existence till summer comes again. Taking them in the mass, we may say that the population sink down to the bottom in November or December, and surge up again in spring, though in most varied fashions.

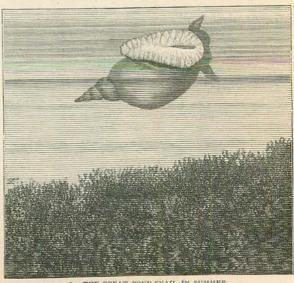
Consider, once more, the curious set of circumstances which renders this singular plan feasible. Water freezes at 32 degrees For the most part, under Fahrenheit. normal conditions, the water at the top of the pond is the warmest, and that at the bottom coldest; for the hot water, being expanded and lighter, rises to the surface, while the cold water, being contracted and heavier, sinks to the depths. If this relation remained unchanged throughout, when winter came, the coldest water would gradually con-

geal at the bottom of the pool: and so in time the whole pond would freeze solid. In that case, life in it would obviously be as impossible as in the ice of the frozen pole or in the glaciers of the Alps. But by a singular variation, just before water freezes, it begins to expand again, so that ice is lighter than water. Thus the ice as it forms rises to the surface, and leaves at the bottom a layer of slightly warmer water, some four or five degrees above freezing point. It is usual to point this fact out as a beautiful instance of special provision on the part of nature for the plants and animals which live in the ponds; but to do so, I think, is to go just a step beyond our evidence. Nature does not fit all places alike for the development of life; she does not fit the desert,

for example, nor the interior of glaciers or frozen oceans, nor, for the matter of that, the rocks of the earth's mass; nor does she try to fit living beings for such impossible situations. All we are really entitled to say is this—that the conditions for life do occur in ponds, owing to this habit of water, and that therefore special plants and animals have been

adapted by nature to fulfil them.

The devices by which such plants and animals get over the difficulties of the situation, however, are sufficiently remarkable to satisfy the most exacting. Recollect that for some weeks together the entire pond may be frozen over, and that during that dreary time all animal or vegetable life at its surface must be inevitably destroyed. For hardly a plant or an animal can survive the actual freezing of its tissues. Nevertheless, as soon as winter sets in, the creatures which inhabit the pond feel the cold coming, and begin to govern themselves accordingly. A few, which are amphibious, migrate, it is true, to more comfortable quarters. Among these are the smaller newts or efts, which crawl ashore, and take refuge from the frost in crannies of rocks or walls, or in cool damp cellars. Most of the inhabitants of the pool, however, remain, and retire for warmth and safety to the depths. Even the amphibious frogs themselves, which have hopped ashore on their stout legs in spring, when they first emerged from their tadpole condition, now return for security to their native pond, bury themselves comfortably in the mud in the depths, and sleep in social clusters through

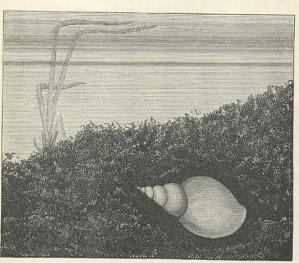


I. -THE GREAT POND-SNAIL IN SUMMER.

the frozen season. They are not long enough and lithe enough to creep into crannies above ground like the newts; and with their soft smooth skins and unprotected bodies they would almost inevitably be frozen to death if they remained in the open. On the bottom of the pond, however, they buddle close and keep one another warm, so that portions of the mud in the centre of the pool consist almost of a living mass of frogs and other drowsy animals.

Some of the larger pond-dwellers thus hibernate in their own persons; others, which are annuals, so to speak, die off themselves at the approach of winter, and leave only their eggs to vouch for them and to continue the race on the return of summer. A few beetles and other insects split the differ-

ence by hibernating in the pupa or chrysalis condition, when they would have to sleep in any case, and emerging as fullfledged winged forms at the end of the winter. But on the whole the commonest way is for the plant or animal itself in its adult shape to lurk in the warm mud of the bottom during the cold season.



2.—THE GREAT POND-SNAIL IN WINTER.

In No. 1 we have an excellent illustration of this most frequent type, in the person of the beautiful pointed pond-snail, a common English fresh-water mollusk, with a shell so daintily pretty that if it did not abound in all stagnant waters in our own island we would prize it for its delicate transparent amber hue and its graceful tapering form, resembling that of the loveliest exotics. This pondsnail, though it lives in the water, is an air-breather, and therefore it hangs habitually on the surface of the pool, opening its lung-sac every now and then to take in a fresh gulp of air, and looking oddly upside-down as it floats, shell downward, in its normal position. It browses at times on the submerged weeds in the pond; but it has to come to the surface at frequent intervals to breathe; though, in common

with most aquatic air-breathers, it can go a long time without a new store of oxygen, like a man when he dives or a duck or swan when it feeds on the bottom—of course to a much greater degree, because the snail is cold-blooded; that is to say, in other words, needs much less aëration. On a still evening in summer you will often find the surface of the pond covered by dozens of these pretty shells, each with its slimy animal protruded, and each drinking in air at the top by its open-mouthed lung-sac.

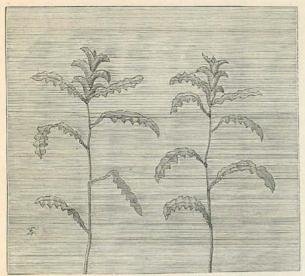
In winter, however, as you see in No. 2, our pond-snail retires to the mud at the bottom, and there quietly sleeps away the cold season. Being a cold-blooded gentleman, he hibernates easily, and his snug nest in the ooze, where he buries himself two or

three inches deep, leaves him relatively little exposed to the attacks of enemies. Indeed, since the whole pond is then sleeping and hibernating together, there is small risk of assault till spring comes round again.

Now, it may sound odd at first hearing when I tell you that what the animals thus do, the plants do

also. "What?" you will say. "A plant move bodily from the surface of the water and bury itself in the mud! It seems almost incredible." But the accompanying illustrations of one such plant, the curled pond-weed, will show you that the aquatic weeds take just as good care of themselves against winter cold as the aquatic animals.

In No. 3 you see a shoot of curled pondweed preparing to receive cold attacks at the approach of autumn. You may perhaps have noticed for yourself that almost all plants of stagnant waters tend to be freshest and most vigorous at the growing end—the upper portion; while the lower and older part is usually more or less eaten away by browsing water-beasties, or incrusted by parasites, or draggled and torn, or waterlogged and mud-smeared. The really vital part of the plant at each moment



-THE CURLED POND-WEED PRODUCING ITS WINTER SHOOTS.

is as a rule the top or growing-shoot. Now, if the curled pond-weed were to let itself get overtaken bodily by winter, and its top branches or vigorous shoots frozen in the crust of ice which must soon coat the pond, it would be all up with it. To guard against this calamity, therefore, the plant has hit upon a dodge as clever in its way as that of our old friend the soldanella which laid by fuel to melt the glacier ice in the Alpine springtide. Prevention, says the curled pond-weed, is better than cure. So, in No. 3, you catch it in the very act of getting ready certain specialized detachable shoots, which are its live-

liest parts, and in which all the most active protoplasm and chlorophyll (or living greenstuff of the plant) are collected and laid by, much as food is laid by in the bulb of a hyacinth or in the tuber of a dahlia. These shoots are, as it were, leafy bulbs, meant to carry the life of the plant across the gulf of winter.

In No. 4 we come upon the

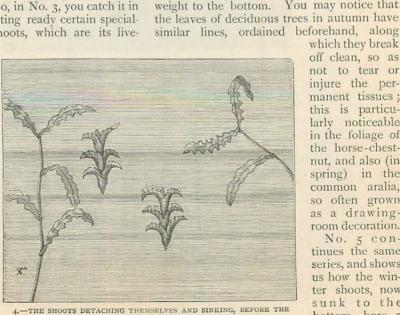
power of movement. In reality, plants, though usually more or less attached to the soil, have almost as many tricks and manners of their own as the vast mass of animals; they provide in the most ingenious and varied ways for the most diverse emergencies. winter shoots of the curled pondweed, for example, carrying with them the hopes of the race for a future season, are deliberately arranged beforehand with a line of least resistance, a point of severance on the stem, at which in the fulness of time they peaceably detach themselves. You can note in the illustration how they have glided off gently from the parent stalk, and are now sinking by their own gravity to the warmer water of the bottom, which practically never freezes in winter. And the reason why they sink is that, being full of rich living greenstuff, they are heavier than the water, and heavier than the stem which This stem has previously floated them. many air cavities to keep it fairly erect and waving in the water: but the winter shoots have none, so that as soon as they detach

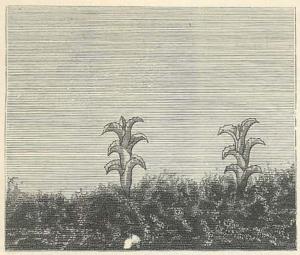
themselves, they sink of their own mere

next act in this curious and interesting vegetable drama. Most people regard plants as mere rooted things, with no will of their own, and no

> which they break off clean, so as not to tear or injure the permanent tissues; this is particularly noticeable in the foliage of the horse-chestnut, and also (in spring) in the common aralia, so often grown as a drawingroom decoration.

No. 5 continues the same series, and shows us how the winter shoots, now sunk to the bottom, bore a





5.—THE SHOOTS ROOTING AT THE BOTTOM WHILE THE POND IS FROZEN.

hole and root themselves in the soft mud by their sharp, awl-like ends; after which they prepare to undergo their sleepy hibernation. They are now essentially detached buds or cuttings, analogous to those which the gardener artificially lops off and "strikes" in our gardens. Only, the gardener's cuttings have been rudely sliced off with a knife, after the crude human fashion, while those of the pond-weed have been neatly released without injury to the tissues, the separation being performed by an act of growth, with all the beautiful perfection that marks nature's handicraft.

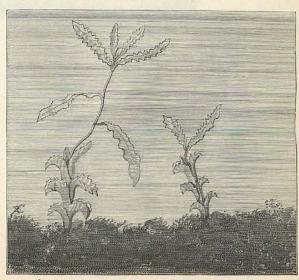
In the soft slimy mud, the shoots of the

curled pond-weed lie by during the frozen period, hearing the noise of the gliding skates above them, and suffering slightly at times from the chill of the water, but actually protected by the great-coat of ice from the severest effects of the hard weather. By-and-by, when spring comes again, however, the shoots begin to bud out, as you see in No. 6, and once more to produce the original type of pond-The weed then continues weed. to form leaves and stems, and finally to flower, which it does with a head or spike of queer little green blossoms, raised unobtrusively above the surface of the water. They are not pretty, because they do not depend upon animals for the transference of their pollen. could tell you some curious things about these flowers, too, which find

themselves far from insects, and destitute of attractive petals; so they have taken in despair to a quaint method of fertilization by bombardment, so to speak - the stamens opening in calm weather, and dropping their pollen out on the saucer-like petals, whence the first high wind carries it off with a burst to the stigma or sensitive surface of the sister flowers. But that, though enticing, is another story, alien to the philosophy of the pond in winter. I will only add here that the pond-weed does not set its seeds very well, and that chances of dispersal are somewhat infrequent, so that irregular multiplication by these winter shoots has largely taken the place with it of normal multiplication by means of

seedlings. At the same time, we must remember that no prudent plant can venture to depend for ever upon such apparent propagation by mere subdivision, which is not really (in any true sense) propagation at all, but is merely increased area of growth for the original parent, split up into many divergent personalities; so that the curled pond-weed takes infinite pains all the same to flower when it can, and to discharge its pollen and disperse its seeds as often as practicable. Only by seedlings, indeed (that is to say by fresh blood—truly new individuals), can the vigour of any stock be permanently secured.

Sometimes, again, the entire plant retires



6.—THE SHOOTS IN SPRING BEGINNING TO SPROUT AGAIN.

to the depths in winter, like the pond-snail. This is the case with that pretty floating aquatic lily, the water-soldier, whose lovely flowers make it a frequent favourite on ornamental waters. In summer it floats; but when winter comes it sinks to the bottom, and there rests on the mud till spring returns again.

In No. 7 you see how another familiar and fascinating denizen of the pond, the little whirligig beetle, provides his winter quarters. The whirligig is one of the daintiest and most amusing of the inhabitants of our ponds. He is a small round beetle, in shape like a grain of corn; but as he is intended to sport and circle on the surface of the water in the broad sunshine, he is clad in glistening mail of

iridescent tints, gorgeous with bronze and gold, to charm the eyes of his fastidious partner. You seldom see whirligigs alone; they generally dart about in companies on the surface of some calm little haven in the pond, a dozen at a time, pirouetting in and out with most marvellous gyrations, yet never colliding or interfering with one another. I have often

watched them for many minutes together, wondering whether they would not at last get in one another's way; but no, at each apparent meeting, they glide off in graceful curves, and never touch or graze. go on through figures more complicated than the lancers or Sir Roger de Coverley, now advancing, now retreating, always in lines of sinuous beauty, without angularity or strain, and apparently without premeditation; yet never for a second do they interfere with a neighbour's mazy dance, often as they cross and recross each other's merry orbits. Dear little playful things they seem, as if they enjoyed existence like young lambs or children. Sociable, alert, for ever gambolling, they treat life as a saraband, but with a wonderfully keen eye for approaching danger. They look at times as if you could catch them without trouble; yet put down your hand, and off they dart at once to the bottom, or elude you by a quick and vigilant side movement, always on the curve, like a good skater or a bicyclist.

This rapid skimming in curves or circles on the surface of the water is produced in a most interesting way by the co-operation of the various pairs of legs, which I can best explain by the analogy of the bicycle. The two shorter and active hind legs produce the quick forward dart, just as the main motion of the cycle is given it by the back wheel; the longer front legs act like the front wheel of the cycle in altering the direction; one of them is jerked out to right or left, rudderwise,

and gives the desired amount of curve to the resulting motion according to the will and necessities of the insect. The steering of a Canadian canoe comes very near it. Anybody who has sculled or rowed, indeed, knows well the extraordinary ease with which a boat can be shored off instantaneously from another, or the marvellous way in which gliding curves can be produced

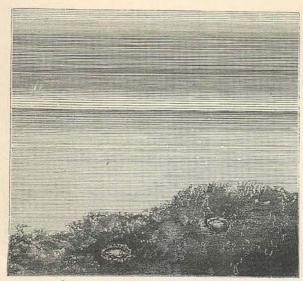


7.-THE WHIRLIGIG BEETLE IN SUMMER, DANCING.

on the almost unresisting surface of the water. The whirligig beetle has a perfect steering apparatus in his long and extensible fore-legs, and by their means he performs unceasingly his play of merry and intricate evolutions.

When whirligigs are alarmed, however, they dive below the surface as one of a pair is doing in No. 7, and carry down with them a large bubble of air, for breathing purposes, entangled in the joints of their complicated legs and the under parts of their bodies. On this quaint sublacustrine balloon they subsist for breathing till the danger is past and they can come to the top again.

Early in April, when the weather is fine, you begin to see the whirligig beetles dancing in and out in companies, like so many water-



3. - WHIRLIGIG BEETLES IN WINTER, SLEEPING.

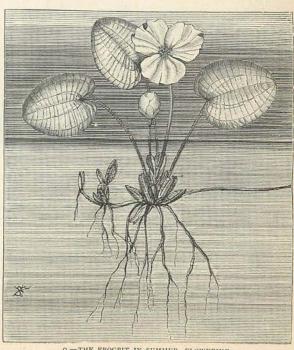
fairies, on the still top of the pond. They prefer calm water; when the wind drives little ripples to the eastern end of the pool, you will find them practising their aquatic gymnastics under lee of the shore on the western side; when an east wind ruffles the western border, you will find them gyrating and interlacing, coquetting and pirouetting, by the calmer

eastern shallows. As they move in their whirls, they form little transient circles on the water's top, which spread concentrically; and the mutual interference of these widening waves is almost as interesting at times as the astonishing velocity and certainty of movement in the beetles themselves. So, all summer long, they continue their wild career. seeming to earn their livelihood easily by amusing themselves. But as soon as winter approaches, a change comes o'er the spirit of their dream. They retire to the depths, as you may observe in No. 8, and bury themselves in the mud while the pond is frozen over. During this period they indulge in a good long nap of some five or six months, and, awaking refreshed in April, come to the surface once more, where they begin their gyratory antics all over again, da capo. It is a merry life; and though the whirligig can fly, which he does occasionally, 'tis no wonder he prefers his skimming existence on

the still, glassy sheet of his native waters.

The two larger British waterbeetles, which are such favourite objects in the aquariums of young naturalists, do not lead quite so exclusively aquatic a life; they pass their youth as larvæ in the pond, and they return to it in their full winged or beetle stage, being most expert divers; but they both retire to dry land to undergo their metamorphosis into a chrysalis, and they spend their time in the pupacase in a hollow in the ground. Something similar occurs with many other aquatic animals, which are thus conjectured to be the descendants of terrestrial ancestors, whom the struggle for life has forced to embrace the easier opening afforded by the waters.

In this respect, that rather rare and beautiful little English water-plant, the frogbit, shown in No. 9, has a life-history not unlike the career of the water-beetles. It is a quaint and pretty herb, which never roots itself in the mud, like the curled pond-weed, but floats freely about on the surface, allowing its long roots to hang down like streamers into the water beneath it.



9.- THE FROGBIT IN SUMMER, FLOWERING,

The short stem or stock is submerged; the leaves expand themselves freely and loll on the surface. Like most other floating water-leaves which thus support themselves on the top of the water, they are almost circular in form—a type familiar to all of us in the white and yellow water-lily, and also in the beautiful little fringed limnanthemum which stars the calmer reaches on the upper Thames. The reason why floating leaves assume this circular shape is easy to perceive; they need no stout stalk to support them, like aerial foliage, the water serving to float them on its surface; and as they find the

whole surrounding space free from competition, with no other plants to interfere with them, as in the crowded meadows and hedgerows of the land, they spread freely in the sunshine on every side, drinking in from the air the carbonic acid which is the chief food of plants, and building it up into their own tissues under the influence of so abundant a supply of solar energy. In short, the round shape is that which foliage naturally assumes when

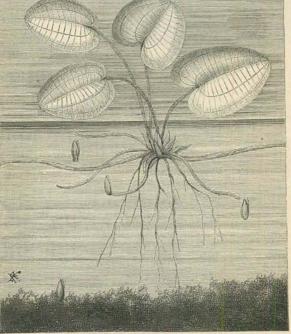
there is no competition, no architectural or engineering difficulty, plenty of food, and plenty of sunshine.

The frogbit as a whole, then, is not submerged like the curled pond-weed; it floats unmoored on the surface. It is not rooted, but free. Yet when it comes to flowering, it has to quit the water, just like the great waterbeetles, and emerge upon the open air above, so as to expose its flowers to the fertilizing insects. These flowers are extremely delicate and beautiful, with three papery white petals, and a yellow centre; they make the plant a real ornament to all the ponds where

it fixes its residence. The males and females grow on separate plants, and aquatic flies act as their ambassadors. Such is the summer life of the frogbit, while fair weather lasts; but, like all other pond denizens, it has to reckon in the end with the frozen season.

It does so in a way slightly different from, though analogous to, that of the curled pond-weed. No. 10 shows you the frogbit after the flowering season is over, when it begins to anticipate the approach of winter. It then sends out slender runners, like those of the strawberry vine, on the end of each of which is formed a winter bud,

which answers to the winter shoots of the curled pondweed. By-and-by, the pond will freeze, and the floating leaves of the frogbit will be frozen and killed with it. But the prudent plant provides for its own survival in the person of its offshoots, which are not its young, but integral parts of its own individuality. It fills them with starch and other rich foodstuffs for growth next season. About the time when the pond grows cool, the buds detach them-



IO. THE FROGBIT DETACHING ITS WINTER BUDS, WHICH SINK TO THE BOTTOM.

selves, like the winter shoots of the pond-weed, and slowly descend by their own weight to the bottom. But they do not root themselves there, as the pond-weed shoots did; they merely lie by, like the whirligig beetles, as you can see one of them preparing to do in the left-hand corner of No. 10. All the living material is drained from the leaves into these winter bulbs. The pond freezes over, and the remnant of the floating leaves decay; but the buds lurk quietly in the warm mud of the bottom, protected by a covering of close-fitting scale-leaves.

In No. 11 we learn the end of this quaint little domestic drama. Spring has come, and the pond has thawed again. The winter buds of the frogbit now undergo certain spongy internal changes, due to warmth and growth, which make them lighter—lessen their specific gravity. Air-cells are developed in them. So they begin to rise again like bubbles to the surface. You can see in the illustration one bud still entangled in the

slime on the bottom; another just starting to emerge; a third rising; and a fourth and fifth on the surface of the pool. Two more have already risen; one of these is just putting forth its first few kidneyshaped leaves; another has now grown pretty strong, and is sending out a runner, from which a third little plant is even beginning to develop. In time, hundreds

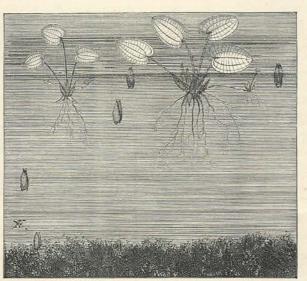
of such runners are sent forth in every direction, till the surface of the pond, in suitable places, is covered with a network of tangled and interlacing frogbits. They always seem to me in this way the plant-counterparts of the whirligig beetles; and it is because of this queer analogy in their mode of life that I have figured the two here in such close connection.

Indeed, I hope I have now begun to make it clear to you that the difference of habit between plants and animals is not nearly so vast as most people imagine. It is usual to think of animals as active, but of plants as merely passively existing. I have tried, here and elsewhere, to lay stress rather upon the moments in life when plants are doing something, and thus to suggest to my readers the close resemblance which really exists between their activities and those of animals. The more you watch plants, the more will you

find how much this is true. And in a case like that of a pond frozen in winter, where both groups have to meet and face the self-same difficulty, it is odd to note how exactly similar are the various devices by which either group has succeeded in surmounting it.

When you skate carelessly over the frozen pond in winter, you never perhaps reflect upon all the wealth of varied life that lies asleep beneath your feet. But it is there in

abundance. The smaller newt, to be sure, has gone ashore to hibernate: but his great crested brother lurks somnolent in the mud, like a torpid bear or a sleepy dor-mouse. Frogs huddle buried in close-packed groups at the centre, massed together in the soft ooze for warmth and company. Many kinds of aquatic snails slumber peaceably hard by, with various



II.—THE BUDS RISING AGAIN IN SPRING, AND SPROUTING INTO A

beetles beside the whirligigs. As for eggs and spawn and larvæ or pupæ, as well as petty crustaceans, you could count them by the dozen. Seeds are there, too, and buried plants of water-crowfoot, and winter shoots and winter buds, and a whole world of skulkers. The pond seems dead, if you look only at its hard and frozen top; but in its depths it incloses for kind after kind the manifold hope of a glorious resurrection. Let May but come back with a few genial suns, and forthwith, the watercrowfoot spreads its white sheet of tender bloom; the whirligig dances anew; the newts acquire their red and orange spots and their decorative crests; strange long-legged creatures stalk on stilts over the glass of the calm bays, and tadpoles swarm black and fat in the basking shallows. The pond, it seems, was not dead but sleeping. Spring sounds its clarion note, and all nature is alive again.