THE MIDLAND HOTEL, WITHINGTON, NEAR MANCHESTER.

THIS building has been erected from the designs of Mr. William Dawes, architect, of Manchester, and is now being extended under his superintendence. It is situated at the corner of Burton Road and Lapwing Lane, and is near the Midland Station at Withington.

As will be seen from the illustration, it is designed in the half-timbered style, and is picturesque in treatment. The lower stories are built of brick with stone dressings. Adjoining the hotel are blocks of stable buildings, billiard-room, bowling-green shelters, etc. The building internally is well finished, and much good effect is produced by the introduction of tinted glass and ornamental tiling. Messrs. Southern & Sons, of Salford, were the contractors.

The following is the index to numbers on plan: 1, bar-parlor; 2, smoke-room; 3, tap-room; 4, billiard-room; 5, bar; 6, pavilion; 7, kitchen; 8, scullery; 9, yard; 10, wash-house; 11, harness-room; 12, stable; 13, stable-yard; 14, general coach-house; 15, private ditto.—*The Architect.*

ANTIQUES FROM THE LOUVRE.

THESE fine Greek and Roman sculptures are notable antiques, and furnish admirable subjects for frequent reference by the student. Good drawings of them are not often readily accessible. The Discobolus, or Thrower of the Discus, was the work of Myron, and is referred to by Ovid. The figure is shown in the moment of transition and pause between two energetic actions, when the quoit thrower has collected all his force for

ON THE ORIGIN OF THE HIGHER ANIMALS.

By Prof. W. K. PARKER, F.R.S.

IN the study of living creatures, whether plants or animals, we begin with that which is superficial and familiar, and then gradually pass to the deeper and less known. For one who dissects out the structures, there are hundreds who observe the outward form and habits; and for one who studies the embryological development, there are numbers who dissect and study the structure of the various types in their adult condition. So that, although this biological field is as wide as the earth and as broad as the sea, yet there are very few who go to the bottom of things, working downward until they see the origin of a type, and then afterward coming up to tell their less adventurous fellow-workers what facts they have found in those dark depths.

In seeking to trace the origin of organisms in the modern Darwinian manner, it is always easiest and safest to pass from the familiar to the less known, and every now and then to make a stand in the ways and to see what lies about us on this side and on that, and then to choose which way we will go, what untrodden path we will try to thread our way through. Inquirers, candid and uncandid, those who pray that they may know, and those who come fully assured beforehand that they know all about the matter already—both these sorts of inquirers ask for impossibilities; they seek to have the whole matter put into a nutshell, they cannot wait for evidence in detail. Yet the evidence of these things must come in detail or not at all.

None of those who mock shall understand; but

types, are ever adding to the weight of evidence in favor of this theory.

The workers of all sorts have well done what they have done, and they are a very useful and united family; but deep crieth unto deep below all that has yet been discovered, and the need for those who will go down into the very heart of things is still very great.

Now, we will suppose the candid inquirer to ask two questions; and then try to answer them according to modern lights:

1. Did the higher kinds of the vertebrata (that great sub-kingdom which is characterized by a jointed spinal column, a brain, and a spinal cord) arise suddenly, as by a creative catastrophe; or by metamorphosis of the lower kinds; or slowly, during the ages, by the accretion of gentle and easy modifications, caused by the surroundings of the creature?

2. Did the lower vertebrata arise suddenly by a creative catastrophe, or by metamorphosis of still lower, non-vertebrate types—the forms so metamorphosed subsequently undergoing slow, secular changes?

I.

The first question refers, of course, to the origin of reptiles, birds, and beasts—creatures that, from the time of their hatching or their birth, breathe air, and have no gills for aquatic respiration during any period of their life. These are the higher vertebrata. Fishes (such as the lamprey, shark, and perch) and amphibia (such as salamanders, frogs, and toads) all have aquatic respiration, either permanently or for a time. These form the lower stratum of the vertebrata.

Even in their outer clothing, the three great groups of the higher stratum—reptiles, birds, and beasts—

the highest effort in the great feat of athletic strength and skill. The face is that of a handsome Greek youth, noble and refined, but there is little expression in it. Discus throwing was one of the principal gymnastic games of the Greeks, and included in the Pentathlon. Claudius, the next figure here drawn, was Emperor of Rome, A.D. 41-54, and succeeded Caligula. His principal achievement was the triumph he obtained in South Britain, where he went in the year 43. He soon returned, leaving the conduct of the war to his generals. His fourth wife was his own niece Agrippina, who with a villainy all her own persuaded the wicked monarch to set aside his own son's claims upon him and to adopt her own son, Nero, whose name is forever associated with the most wicked of crimes. Claudius regretted this step, and was in consequence poisoned by his wife Agrippina in 54. Jason, the last of the three figures here illustrated, was the celebrated leader of the Argonauts. His voyage in the Argo to Colchis to obtain the Golden Fleece was perhaps the greatest feat recorded of him. He was aided by Juno in this enterprise. Medea, the daughter of the King of Colchis, fell in love with Jason, and, being a magician, gave him charms to protect him from danger. He afterward became enamored with Glauce, daughter of the King of Corinth, whom he married, having divorced Medea. She revenged herself by destroying her children in the presence of their father.—*Building News.*

GATTY bleaches goods containing colored yarns, such as alzarine red or indigo blue, by first scouring with soap, then passing them through a bleaching solution of 1-40 Tw., and steaming in an apparatus similar to those used by calico printers for cleaning the white of printed goods.

patient, and wise, and teachable minds shall be able to learn, not adequately, indeed, but in a very useful, practical, and pleasant manner. Assuredly, the best and most laborious of the biologists of this generation, and of that which has just passed away, have not been living in the region of old wives' tales, nor following cunningly devised fables. Men like Lyell, Darwin, and Robert Chambers, not to mention other great and cherished names, were of a sort not easily to be deceived. To say nothing of those in Europe, in America, and in the Isles of the Sea who are assured of the truth of the modern doctrine of development, we have here at home numbers of able men, each looking at the subject from a standpoint of his own, who have been convinced of the truth of this theory. There is indeed a marvelous consensus, or harmony, in the deductions of those who have been trained in these researches, and who are spending and being spent in this kind of work.

Those who know what it is to gather this excellent knowledge, who busy themselves in harvesting and garnering what Nature, in her lusty strength, has grown for them, without their sowing and without their tilling, are cheered on by the light and strength this theory gives them. These are they who, as botanists and zoologists, gather all that comes to hand, thus laying up in store all good things for the embryologist. In gathering and classifying and even dissecting the full-grown forms, they are only preparing the way, and filling the hands of the student of Development; yet there is nothing in the deductions they are able to make that has received or that ever will receive anything but corroboration from that slower but most important kind of work. Also those who do business in the veins of the earth, not merely near its surface, where it has been baked with frost, but deeper down—these men, who bring up the remains of old, extinct

have new and strange structures, such as are not found in the types beneath them. The exquisitely folded skin of the serpent, here wrought into parallel plaits and there into diamond-shaped tesserae, the plumage of the bird, and the hairy covering of the beast are all, in one sense, new things. They are adaptations to the new life on the dry land, in the open air. But you must have more than a hood if you wish for a monk, and the kind of clothing of these three groups is but the outside of what we have to deal with in biology.

The difficulty of supposing that the almost infinite variety of living creatures all arose from simpler, and still simpler and more generalized types, by a mere process of slow and gentle modifications, taking place during untold periods of time, is as great to the biologist as to one untrained in the science of life. To a certain extent, the old adage, *nihil per saltum*—nothing by leaps and starts—is true in Nature; but it is not universally true. Hence no well-informed naturalist is an absolute uniformitarian; he is also, more or less, a catastrophist. But if—leaving the great difficulty of such a problem unsolved for the present—we suppose the existing groups of higher animals to have arisen from some common, low, generalized stock, then we can easily imagine the huge results that may have taken place during long, almost unlimited, secular periods. The doubter should begin by considering, first, the close relationship of the races of one type or species, and then the little, non-essential things that separate or distinguish the various species of one genus. Thus, for example, the various races of oxen (*Bovidae*) differ only in non-essential characters, and no one can tell where a race ends or a species begins. In this family, even the ordinary test of the fertility or non-fertility of crosses fails the naturalist altogether. Our common oxen, the bison, the aurochs, the yak, and all the different kinds of buffaloes, all go together to form

one single special group, or family, in that order of ruminants which Moses characterizes in the following words: "Every beast that parteth the hoof and cleaveth the cleft into two claws, and cheweth the cud."

Now there are in this order certain distinctions easily observed, and at the same time very useful in zoology; they are derived from the most superficial modifications, from differences that are merely skin-deep. There are ruminants with hollow horns, with solid horns, and without horns. Oxen, sheep, goats, and antelopes have a hollow, bony core, covered with a horny sheath; the core is a growth from the bone of the forehead; its horny sheath is a modification of the outer skin; these horns are permanent, and are generally possessed by both sexes. In the deer family, a large branch of solid bone grows out of the forehead on each side, carrying with it the skin, which is covered with soft hair, hence called velvet. When the bone ceases to grow, the skin dies and is rubbed off against the trees. These horns, called antlers, are soon shed, and, as a rule, exist only on the male. The musk-deer, the chevrotain, the llama, and the camel have no horns of any sort. The two last kinds, the llama and the camel, differ so much from the rest, that they form a special subdivision of the order. They are evidently very ancient types.

Again, the larger cattle, besides being divided into ruminants and non ruminants, are classified as even-toed and odd-toed beasts. The noble and more modern types of even-toed beasts chew the cud; but there are some manifestly ancient forms still lingering on the planet which do not chew the cud, as, for instance, the hog, of which there are many species, and the hippopotamus. These, as is well known, like the more archaic ruminants, do not possess horns. All those beasts which have an even number of toes are destitute of the first or inner toe, corresponding to our thumb or great toe. In oxen the second and fifth toes are also suppressed, only the corresponding nails remaining as small hinder hoofs. In deer, notably in the reindeer, these hinder toes are present, but the bones are small.

As a rule, the ruminating animals have only one bone in their shank—the so-called cannon-bone; but in the early embryo, this is composed of two equal parts, each of which has a convex surface for articulation with the corresponding toe-bone; this accounts for the fact that the cannon-bone carries two toes. In the non-ruminating, even-toed animals—the hog and hippopotamus—these two bones never fuse to form a cannon-bone, but remain distinct; and this is seen in the fore legs of the African water-deer (*Hyomachus*—a name suggesting an intermediate position between the musk-deer and the hog). This animal and its small relatives, the chevrotains of Ceylon and Java, belong to an almost extinct family of ruminants.

The hippopotamus is manifestly of an older and more general type than even the pig; he stands almost alone as the living representative of a family of gigantic even-toed beasts. In former days giants of this kind were as common as the members of the hog family are now.

None of the odd-toed cattle chew the cud; only two families still exist—the several species of rhinoceros and the horse group, consisting of the horse, ass, zebra, and quagga.* The rhinoceros has three well-developed toes, each ending in a small hoof; but in the horse and his relatives only the middle toe is developed, and the bone with which this is articulated is a primarily single cannon-bone; the corresponding bone of the second and fourth digits being a mere splint, pointed below.† The rhinoceros on the one hand, and the horse on the other, are the culminating forms of the odd-toed beasts which have diverged during time into forms so remarkably unlike. It is very curious that these should be all we have left of the odd-toed herbivora.‡

And now the carnivorous tribes, the cat family, the dog family, and the kindred of the bears and seals, have all to be traced downward to some common stock; to say nothing of aquatic whales, aerial bats, lemurs, monkeys, apes, and men. All these, in their multitudes, come flocking for the registration of their ancestry; nor do they seal up the sum of this great and varied class, for the insectivorous kinds (moles, hedgehogs, and so forth), and the edentate tribes (the anteaters and pangolins with no teeth at all, and their imperfectly toothed relatives, the sloths and armadillos), these, lowly as they are, also belong to the noble (*Eutherian*) types of the mammalia.

Down to this point we need ask for no catastrophe, no metamorphosis, nothing but time and surroundings, and the marvelous working of that indwelling force which moulds and fashions each type into a form in harmony with its outward life and conditions. All these types now mentioned belong to the highest of the three platforms of mammalian life; all have the common characteristic that they carry their young, and do not "cast forth their sorrows" until a very considerable though varying ripeness has been attained; for a longer or shorter time they minister to the necessities of their progeny of their own substance internally, and afterward externally, by providing them with milk.

Before I go on to speak of the creatures on the next lower platform (the *Metatheria*), I must remind the reader that in the groups just mentioned all our zoological distinctions fall us. As we descend to the older and still older types, every landmark gets wasted away and removed, and the familiar terms that serve as distinctions in the existing fauna become utterly useless; the orders lose all order; Ruminants, Solipeds, Proboscideans, Carnivores, Rodents—all these distinctions melt away into one common, generalized, archaic group. Such a group must have contained the essence

of all the present, easily distinguished orders—"all these in their pregnant causes, mixed."

For instance, in the earlier tertiary periods, we come upon large herbivorous lemurs or types that cannot well be separated from that group of four-handed creatures that lies so close beneath the primates—monkeys, apes, and men. The term "Proboscidean," again, is now restricted to a group containing only two species, the African and the Indian elephant. But that ancient kind of creature, the tapir, has a rudimentary trunk; and in former times many sorts of quadrupeds supplemented their short and stunted features by a long, two-tubed, jointed nose; nay, there still exist among the lowest noble (*Eutherian*) kinds—the insectivora—certain American and African types that have a perfect proboscis, the cartilage of the snout being divided into rings as in the elephant. That *quasi*-mouse with curious snout, the shrew, has a very long, double nose-tube, though the cartilage encircling this tube is not segmented into rings; but in the young of a species of *Rhynchocyon*, from Zanzibar—a relative of the exquisite little elephant-shrews of Africa, as large as a rat—I have made out thirty double rings.

We may, therefore, safely leave the evolution of all the high beasts (the *Eutheria*) to the working of ordinary influences, and no "new thing" need be created; all that is wanted is merely a recasting and remodeling of "old things" to new uses; and even the dwarfing of certain types and the gigantic development of others may be left, mentally, to the operation of forces that have worked hitherto and do still work.

But here we have to let ourselves down as dangerous a cliff as any that "he who gathers samphire, dreadful trade," ever descended. We must, if true to Darwinian principles, ask for as few interferences as possible; we expect to find no new invention of the Absolute Eternal Mind; for, "known unto God are all His works, from the beginning of the world." Therefore, as the author of all meets with no unexpected difficulties in the evolution of His Eternal Purpose, we may, in the patient labor of hope, expect to find all things coming up, each beautiful in his season or time, the creatures of one season being the natural descendants or children of those of the preceding.

Time was when the higher mammalia were not; and the highest quadrupeds to be found on the earth were, as geology teaches, of the same low sort as those which we now find in certain very restricted zoological provinces. I refer, of course, to the marsupials, or pouched animals, which are found at the present time in the Western Tropics, and to some slight extent in the northern part of the New World, and which in the East are restricted to a territory south of "Wallace's line"—that is to say, to the Australian region.

Of these *Metatheria*, or intermediate beasts, I must now speak: of their lowliness, and of their intimate relationship with the higher sorts of those creatures that lay eggs—the air-breathing ovipara, reptiles and birds. If these meaner cattle can be connected with the nobler kinds, if they can be yoked on to the others without any violence, but gently and naturally, then we shall be able to dispense with a catastrophe for the next part of our journey downward. It may be remarked, in passing, that this journey downward is not a *facilis descensus*, but is hard, panting, laborious work; the mental descent and the mental ascent are equally hard. Nevertheless, if we "gird up the loins of our mind," fearing nothing but our own impatience of imperfect evidence, we shall discover things that have been kept secret from the foundation of the world.

One of the wisest and most judicious of "those whose talk is of bullocks" (scientifically, of course, and not as a mere grazer) suggested recently to the writer that the marsupials are the *true mammalia*; milk is all in all to their children. And why? The reason of this is partly open and plain, and partly lies deep down in the nature of these remarkable creatures; this shall now be explained.

There are various degrees of ripeness of the young at the time of birth; some, like the foal and calf, are strong-limbed and active, with their special senses perfect, while others, like the pup and kitten, are blind and helpless. This difference may occur in species of the same genus. The new-born rabbit is feeble and blind; the leveret is wide-awake and active from the first. In the bird class, we have whole groups, like the perching and climbing tribes—songsters, woodpeckers, and so forth—whose young are hatched in a tender state, and require great parental care; while in other birds—fowls, geese, rails, plovers, and the like—the young are strong and active as soon as they are hatched; and in the gull, they are in an intermediate condition. It may be noticed that, both in the mammal and the bird, the highest social conditions are developed in those cases when the young are born in a helpless condition. Now, in the marsupial animals the young are born, so to speak, prematurely, so that the little kangaroo, whose mother is the size of a sheep, is not so large as a new-born Norway rat; and although the mother still ministers to her young of her own substance, this is not done in the same manner as in the higher tribes, where, for many months, in some cases, the progeny and the parent are as much one organism, physiologically, as the fruit-tree with its ripening fruit. Here, among the marsupials, the germ develops itself by its own individualized morphological force, and then hastens to assume an independent life—but only partially independent, for it must now live on its mother's charity, and for many months she feeds it on milk sweet as charity.

Yet, there is no difference in all these various family arrangements that cannot be accounted for as resulting from the influence of surroundings, and the magnetic response of the organism to those surroundings.

Here, then, we are brought to reflect upon the lowliness of these pouched animals, which (although even they are not the lowest of all mammalia) are almost *oviparous*, and upon their relation to the truly *oviparous* types, monotremes, reptiles, and birds. In reptiles and birds, the developing germ, as is well known, is wrapped in an exquisite drapery of membranes, and has, suspended from its own body, a large store of rich food-yolk, an oleo-albuminous emulsion, fit nourishment for the tender, unhatched young. The marsupial embryo—opossum or kangaroo—has also these fine, gauzy foldings wrapped about it; but they are all small, because of its early birth; and thus the food-yolk is soon used up, and there soon arises the necessity for a fresh supply of nourishment. In the nobler ani-

mals the supply of food-yolk is again much smaller than in the marsupials, and the new supply is obtained by a re-grafting of the individuated germ on to the living inner walls of the parent, until the fullness of time comes for the new creature to take on a separate existence.

These instances show us that the ordinances of Nature—which are wonderful in counsel, and excellent in working—accomplished the maturation of the new individual in two very different ways, in the quadrupeds on the one hand, and the bird on the other. In the bird the food grows from, and is part of, the germ, which merely asks for the patient attendance of the nursing mother, for the sake of due warmth, until the chick is ready for hatching. In the nobler kinds of quadrupeds, where the germ itself is so poor in substance, Nature herself broods over the young. But in this ancient and lowly order of mammals, the marsupials, there is a condition of embryonic development which is, in some respects, below that seen even in the existing reptiles and birds, most of which are evidently modern types.

But if the humble marsupial thus runs down, in some of his characters, from his mammalian platform toward the non-mammalian vertebrata, his great relations, the higher mammalia, still cannot cast him off. They, some of them, bear in their bodies, even now, the traces of their relationship to him. In that remarkable insectivore, already spoken of, the *rhynchocyon* of Zanzibar—himself a low *Eutherian*—considerable tracts of the base of the skull are so unchanged from the marsupial type of structure that these parts, in fragments, could not be told from the corresponding parts in the skull of a phalanger or opossum. I have no doubt that many of the earlier tertiary cattle, whose remains are being brought to light daily, and in rich profusion, would be found, if they could be thoroughly worked out, to have skulls in which the characters of the marsupials are inextricably mixed with such as are diagnostic of the nobler forms. Hence, in the study of these ancient types the zoologists find that all their neat systems fall to pieces like a house of cards. The mere classifier, who only knows the new, high, special types, is put to confusion, for not only has the ruthless palaeontologist removed the old landmarks of the higher territory, but he has also broken the hedge that kept the *Metatheria* from the *Eutheria*, the low cattle from the high.

Again, in the secluded, lowly group of the marsupials the dog is typified and foreshadowed in the most wonderful manner; the thylacine, or dog-opossum, has made the most remarkable advances dogward. The wonder grows when the two types are carefully compared, so much alike are they in outward form, and, for the matter of that, in internal structure also. Yet the gulf between these two types—anatomically, in the whole structure of these beasts through and through—is almost incalculably greater than that between a dark, human savage and a black, brutal gorilla.

Not that this remarkable anticipation of the nobler mammalia, to be seen in the ignoble marsupial group, is at all unique; it is quite similar to the range of forms to be seen in the tailless amphibia (frogs and toads), which get very high up, considering their low origin, but still lie a long way down below the true reptiles. Facts of this class are very numerous; for when any particular group is arrested at a low level, and yet can go in and out and find pasture, so as to be able to increase and multiply upon the earth, then secondary, adaptive modifications are sure to arise. Thus the group becomes subdivided into various tribes and families, some of which in their intense specialization must become very unlike the general ancestral form.*

Now, having got thus far in our descent, which is not easy, but is a dangerous kind of scrambling downward, we have received no sudden shock—no Cerberus has barked at us. But let me not be misunderstood. I have not been asserting that no *lesser* sudden changes have taken place. There must have been many such in the evolution of a high and noble beast from a low, ignoble, ancient marsupial, a creature very much lower than a common rat. But any gardener could show you changes, apparently sudden, in numbers of the commonest cultivated plants, quite equal to anything that need from time to time have taken place in the slow, secular uprise of the nobler beasts of the field.

After this pause, we may recommence our descent; and, if we are cautious, we need not fear. We have got safely down from the highest to the second mammalian platform—from the *Eutheria* to the *Metatheria*; we have now to let ourselves down from the second platform to the lowest—from the *Metatheria* to the *Prototheria*.

Down a long way below the marsupial group lies that which is termed the *Monotremata*—hairy, *oviparous* creatures, much of whose structure is only on a level with that of an ancient kind of bird or reptile. This family has lost all its members but four or five; and these belong to only two generic types, *Echidna* and *Ornithorhynchus*. The former of these is the so-called "spiny ant-eater," of which there are three or four kinds; the latter is the duck-billed platypus, or great water mole. These are all shut up in the Australian region (Australia and New Guinea), nor have any fossil remains of them been found in any other zoological region, nor yet any of importance even in the Australian, though Sir Richard Owen has described some remains of a larger kind of *Echidna* than any now existing. Fossil mammalia belonging to the highest group (*Eutheria*) are found in large abundance in many regions, but we are much poorer in fossil specimens of the next division—the *Metatheria* or marsupials; and in the case of the monotremes or prototheria, it is a great disappointment and sorrow to the biologist that Nature has so effectually covered her slain. At present, therefore, we can merely study the structure and development of these stray living remnants of an old mammalian fauna; we have to work them out and compare them with other types of vertebrate animals, both above and below them, and then to make a cautious use of our imagination.

The marsupials, when they conquered the monotremes and possessed their cities, little thought that, in a few millions of years, a nation greater and mightier than they would appear, multiply exceedingly, and dispossess them in their turn. Some of these marsupials, in

* Naturalists, as a rule, include the tapirs among the odd-toed beasts. In reality they are a much more archaic group than the rest. They possess a well-developed fifth digit on their fore-foot; only the first being suppressed.

† Thus we see the remarkable difference in formation between the foot of a cow and that of a horse.

‡ Among the herbivorous tribes just mentioned no place has been found for the huge elephant, no place for the little hyrax (dayman or cone of the Bible); for these lie far off from the other cattle, and their kindred must be sought among the root-stocks of old and generalized types, from which sprang the forefathers of the existing rodents—the rat, squirrel, beaver, etc.

§ *Eutheria* (literally, "noble beasts"), *Metatheria*, *Prototheria*—the *Eutheria* being the placental mammals; the *Metatheria* the pouched animals, or marsupials; and the *Prototheria* those existing links which connect the mammalian group at its lower extremity with birds and reptiles.

* One word more about the marsupials. The Australian kinds, varying from the heavy, stupid, *cavy-like* wombat to that most active creature, the kangaroo, are all marvelously uniform in their essential structure. Thus no anatomist can be found who desires more than one common root-stock for all these types; and the American opossums have very near relatives among the Australian types.

their far eastern "reserves," grew, only lately (speaking geologically, to a gigantic size; most groups have done so when all things have gone well with them, when they have had peace in their borders and their mouth has been filled with all good things; these gigantic marsupials are all extinct now.

The ganoid fishes of the old red sandstone thus increased and became mighty in the streams and rivers of an ancient world; but the world that then was perished.

After that time the old forefathers of the amphibia thus increased—there were giants also in those days; they existed when the lower types of plants also became gigantic, in the days of the formation of the coal measures.

Later on, aquatic reptiles typified or prefigured the modern mammalian whales; and, still later, terrestrial reptiles grew into monsters, such as fancy never feigned nor fear conceived.

In a yet much later epoch, when, as we have just stated, the marsupials had grown into large and monstrous forms, the armadillos and sloths also—low Eutherian types—grew into ponderous beasts, whose remains, in many cases so happily recovered, are among the richest treasures of paleontology.

Similar overgrown creatures may have sprung up at one time in the family of the monotremes; but, although the biologist is calling aloud for a revelation of them, there is no voice nor any that regardeth. The biologist has to wait for evidence, and be patient, feeling assured that the earth is rich with hidden treasures of this kind, all of which would witness for him could they be brought to light. It does not disturb his composure when an opponent attempts to bring mere negative evidence wherewith to combat his theory of the earth and its inhabitants; for at any time, any day or hour, the links he is searching for may turn up.

Meantime we may learn much from those sibylline leaves that have become so intensified in their value, because of the destruction of the rest.

From these two living witnesses, the duckbill and the echidna, we learn what a curious reptilian creature a primary mammalian beast may be. These creatures have the great diagnostic, for they have a milk gland, or udder, though no teats; they have also the constant correlate of these glands, namely, a hairy covering. But deep down in their internal construction they are, if compared with the high and noble forms of mammalia, a sort of half reptile; indeed, in some respects more than half. The organs that relate to the maturation of the ovum (egg), and those that pertain to excretion, are quite like those of a bird or reptile. The bones that encircle the chest, the shoulder blades, and collar-bones are of a type far below what is found in the bird, and quite archaic as compared with their counterparts in the common lizard; they are curiously and strikingly like the bones of the shoulder-girdle of the great fish-like lizards of the secondary epoch, the ichthyosaurs. Their spine, ribs, and breast-bone show a curious mixture of reptilian and mammalian types of structure; their limbs, also, have much primitiveness in them in spite of their perfect specialization for digging purposes. Like birds and tortoises, they have lost their teeth during the ages that have given them so much leisure for special adaptation. The echidna needs none; he is an ant-eater, and for a long while was thought to belong to the same group as the South American ant-eaters, which, however, are low types of the highest group (Eutheria). The duckbill, however, has a sort of excuse for teeth, like the right whale among the higher mammals, and like geese, ducks, swans, and flamingoes in the bird class. The skull, jaws, brain, and organs of the special senses all bear witness to the mixed character—half reptile, half mammal—of these beasts.

He who, knowing these facts, does not draw some remarkable deductions from them must have lost some part of his mental machinery; he who is not excited by our growing knowledge of these ancient types must be as dull as "the fat weed that rots on Lethe wharf."

There is one thing about which biologists, even now, are somewhat doubtful. No low form of vertebrate foreshadows the mammals so much and so well as the *imago* stage of the higher existing amphibia—in plain words, frogs and toads after their metamorphosis. Yet the duckbill and the echidna strongly resemble the next higher group above frogs and toads, namely, reptiles; not, indeed, such as those now existent, lizards, snakes, tortoises, etc., but generalized, ancient types. This difficulty has to be looked in the face, and the question asked, Did the lowest mammals arise from, by transformation of, some true reptile—an air-breathing creature from the time of its birth or hatching? I believe not; the confusion and difficulty have arisen from our not having considered that modern transforming types (the cecilians, salamandrians and batrachians) must be merely waifs and strays from the fauna of a far distant age. These types, generally small, have large relatives in the coal period, and even they, the labyrinthodonts, may have been the modified descendants of much older transforming fishy creatures. Such supposed types must have begun life with gills for aquatic respiration, and, in their adult state, must have possessed lungs for aerial respiration also; they may or may not have lost their gills as they became adult.

Those who are not familiar with the metamorphosis of the lower forms of vertebrata must trust, not implicitly, to those who are familiar with these phenomena from lifelong observation. He who is acquainted with such matters feels and knows that the existing vertebrata are a sort of united family, after all. The extreme types may call each other "brother"; the lamprey and the man are not very far apart; the head of the group cannot say to the foot, "I have no relationship with thee." When the morphological worker has become familiar with those low fishes, the lamprey and its kindred, passing on to the various higher fishy types with their more and more perfect skeleton and soft organs—then, in studying the structure of the noble, air-breathing sorts, reptiles, birds, and mammals, he is constantly receiving pleasant surprises. He constantly comes across old things in new shapes; he finds structures which were adapted to low types transformed for new uses in creatures that roam over the earth, or take to themselves wings, and, spurning the earth, wing their way through the thin air. He is often to be found muttering over his work the question put by the old preacher, "Is there anything of which it may be said, See, this is new?" Yet these old things may be

so transformed during growth that it requires some acuteness to know them under their disguises; also, many things are dropped or suppressed, and others largely developed, while some parts remain permanently in an arrested condition. All this may take place slowly; but during incalculably long secular periods, very wonderful changes may have been brought about by these slow and gentle modifications. Yet changes of this kind, almost insensible, though very potent factors in evolution, are certainly not all that have taken place; some parts must have modified themselves suddenly; but partial, *per saltum* changes, must not be confounded with general metamorphosis.

By metamorphosis we mean such great and sudden *lifetime* changes as we are all familiar with in the insects among non-vertebrate creatures, and in the newt and frog among the vertebrates. Here is certainly something that takes place suddenly—a marvelous leap, so to speak, of an organism into new structural stages, which rapidly fit it for a nobler and higher kind of life than that with which it started. We may call this a catastrophe if we like; we are certainly not prepared with any very satisfying solution of the problem. It is a great mystery—greatest to those who are most initiated. I feel certain that when we have descended to where the three great roads meet—the way of the reptile, the way of the bird, and the way of the mammal—when we get near the great starting point or place whence these three diverged, we shall have to feign to ourselves metamorphic changes as taking place at that very distant point.

The passage from a generalized amphibian into a true reptile does not seem to ask for a very great metamorphic change; but the bird and the mammal, even in their outer covering of feathers and hair, present us with a greater developmental difficulty. The difference between the skin, with its appendages, of a frog or salamander on the one hand and that of a bird or mammal on the other is certainly as great as the difference between the hairy skin of the caterpillar and the scaly covering of the butterfly. Such outgrowths from the skin as feathers and hair are seen for the first time in the bird and mammal respectively; there are no structures comparable to them in any of the types below. Nay, even below the mammals and birds, among the true reptiles, we see modifications of the skin which are quite new to us in the scale of ascent. And these familiar but remarkable outward changes, seen in the three great groups of air-breathing vertebrata, are correlated with equally great internal changes which affect the whole structure of the animal. To me it appears that not even the lowest of these three groups—reptiles, birds, and mammals—arose, without metamorphosis, by gentle, insensible changes from an amphibian type; and I see no reason to suppose that they all three had one common metamorphosing parentage. I should rather be inclined to derive them from the same stratum of life—from the same intensely vital root-stock, but from independent suckers. They would then be quite near enough akin to have very much in common, while the special diverging development in each case may have been sufficient to initiate all those great differences that have appeared during the ages and generations since these air-breathing types arose; yet each group had, possibly, a *multi-larval* origin.

The various modes of the development and maturation of the larvæ (tadpoles) of frogs and toads, and the imperfect, hesitating, and irregular metamorphosis of several of the salamandrian types, help us greatly in this dilemma. Nature working, so to speak, after the counsel of her own will, allows a marvelous amount of liberty to her amphibian children, letting them settle their family matters in their own way. And during the chances and changes of amphibian life, now and in the past, there has been a necessity laid upon these lowly tribes to be wise in their generation, and prudently to hide themselves and their offspring from danger in this manner and in that.

Take the case of our common frog, whose eggs and larvæ are a prey to the teeth of a thousand greedy enemies. Those that escape these dangers have barely time to transform and take on aerial and terrestrial life before the streams and the brooks are dried up. In some cases, as in the primeval forests of South America, the eggs are laid and the tadpoles are developed in the midst of the moist herbage at the roots of the trees. In other cases the tadpole never develops more than the merest trace of gills, as in the monstrous toad (*pipa*) of Surinam. In this type the broad, flat back of the female is covered with a multitude of small pockets, each of which, in spawning time, is filled with a single egg about the size of a pea. The egg, being much larger than in the ordinary kinds, has an unusual amount of food yolk in it; and the embryo develops into the larva, and the larva into the perfect toad, in the closed pocket. By the time the young escape from the pouches on the back of the mother, they are as far advanced in development as are the young of the common frog and toad six months after the loss of their tail. In other kinds of South American tailless amphibia the eggs are placed in a large continuous pouch on the back of the mother, a cavity very similar to the abdominal pouch of a kangaroo or opossum.

Again, the tailed amphibia (salamanders and newts), all of which have gills either permanently or for a time, show great variations in the mode of their development. The newt, after hatching, swims about as a gill-bearing larva for some two or three months; but the true salamanders (*Salamandra atra* and *S. maculosa*) are viviparous, and in the latter species the young are retained for a whole year in the oviduct. Nevertheless, the embryo develops gills freely; and if these embryos are artificially born, they breathe by their gills, which they subsequently lose. Certain kinds of the tailed amphibia retain their gills throughout life, although the lungs also are well developed, as in that blind albino the *Proteus* of the subterranean caves of Carniola, and in the American *menobranchus*. The well-known, large, gill-bearing salamander of Mexico—the axolotl—is very apt to undergo transformation when young, and the transformed individual has to be placed in the highest group of the tailed amphibia, while those which do not undergo transformation belong to the lowest.

Directly below these transforming amphibian types, which, normally, have limbs with four or five digits, there is an order of fishes which are double breathers (*Dipnoi*), having both lungs and gills, permanently, like the lower, tailed amphibia; the limbs of these fishes

do not divide, like those of the amphibia, into fingers and toes. That these forms are very generalized and ancient is quite certain. They are nearly extinct, only one (*Protopterus*) being found in Western Africa, another (*Lepidosiren*) in Louisiana, and a third (*Ceratodus*) in Australia. The teeth of this last kind have been found in nearly the lowest secondary rocks of this country; it was the contemporary of the oldest known marsupial animals.

We are thus led to this important fact, namely, that below these remarkable metamorphosing types, the amphibia, there is a group of fishes, evidently very ancient, of so general a structure as to combine, in their organization, characters that make it difficult to say whether they are more related to cartilaginous fishes, to ganoid fishes, or to amphibia. Now, generalized types such as these double breathing fishes, and types that undergo metamorphosis, are most instructive to the biologist.

The development of these remarkable fishes has not yet been studied. It is very probable that they also undergo metamorphosis.* If this is the case, their larvæ will be found to represent a much simpler and lower kind of vertebrate animal than that of either the newt or the frog.

The facts detailed above will, I think, satisfy any reasonable mind that, although there is nothing in the development of the types that can be called a creative catastrophe, yet remarkable and often sudden changes do take place. If these variations are partial, they lead to the formation of species, genera, and families; but the uprise of such groups as reptiles, birds, and mammals from lower gill-bearing tribes can only be accounted for on the supposition of a complete metamorphosis.

If we knew as much about those ancient amphibia that we suppose were parental to the highest forms as we do about the modern amphibia, tailed and tailless, it is very probable that we should find nothing more to wonder at than we do actually find in the metamorphosis of these familiar types.

It is impossible here to enter into the details of the various stages that are to be found in the embryos of the highest types of the vertebrata; but the embryologist is perfectly satisfied that these are the unused, historical equivalents of stages which were utilized in active life in the ancient types from which the present high vertebrata have arisen.

II.

And now, having thus crept down from rank to rank of the great vertebrate hierarchy, we have found no variation which cannot be accounted for as having been brought about in one or other of two ways, either by slow and gradual modification, as in the case of the various divisions of the mammalia, or by metamorphosis, as, probably, in the rise of reptiles, birds, and mammals from low, generalized, aquatic types. So far, we have been able to give an answer to the first question. We now come to the second question, Did the vertebrata themselves arise suddenly by a creative catastrophe, or did they spring, by metamorphosis, from lower, non-vertebrate types; the forms so metamorphosed subsequently undergoing slow, secular changes?

The attempt to answer this question will be put in as few words as possible. The evidence here in favor of evolution, more or less gradual or sudden, is of precisely the same kind as that with regard to the rise of the higher vertebrata from the lower.

There is a misconception in many minds as to the relation of the vertebrata to the non-vertebrate tribes; the two groups are looked upon as practically the two halves of the animal kingdom. This view is quite erroneous. There are many groups that are the proper zoological equivalents of the vertebrata. The vertebrata are but the highest of the many culminations of the tribes that rise above the protozoa, or first and lowest forms of animal life. Hence, in any attempt to answer this second question, we must keep clear of all other culminations, the various groups of the highly specialized Arthropods, as insects, spiders, lobsters, etc., and also all the various orders of the soft-bodied, unjointed shell-fish (*Molluscs*), and, indeed, of many more groups which have become modified in this way and in that, along certain ascending lines.

Now, there is one mysterious little creature, the lancelet (*Amphioxus*), which is neither a vertebrate type nor a worm, but something intermediate between the two; this type yields the first and best light we get upon the difficult subject of the uprise of the vertebrata. The next type below this is the sea-squid (*Ascidian*); of this there are many kinds, species, genera, and families. The ascidians undergo metamorphosis, and are most useful to us in this inquiry while in their larval state. I can only give a very meager account of these two sorts of creatures—the lancelet and the ascidian—and of their relationship to the vertebrata.

First, let it be remembered that these low forms are classified with the vertebrata in one general group—the *Chordata*. They all have a cord of cellular tissue running along the axis of their body—throughout the whole length of the animal in the lancelet, only along the tail in the ascidian larvæ, and from the middle of the skull to the end of the tail in all the vertebrata. This tract of delicate tissue is inclosed in an elastic sheath. In the lancelet and in the vertebrata, the continuous nervous axis lies over this primary skeletal cord, which is more primitive even than the muscular segments into which in these types the body is divided.

Just above the lancelet comes the hag-fish (*Myxine*) with its relative, the large *Bdellostoma* of the Cape region. These also have no vertebræ; they have a strong skull, but their long body, with its numerous fleshy segments or rings, is supported, not by cartilaginous arches or vertebræ, but merely by a huge dorsal cord (the notochord), with its thick, tough, elastic sheath. The lamprey, during its larval life, has the same simple structure, and so have all the vertebrata for a time.

The respiratory organs of the fishes just mentioned, and those also of the tadpoles of frogs and toads, enable us to understand the morphology of the aquatic respiratory organs of the true vertebrate types, and to see that they are merely a modification of the huge, vascular, perforated throat of such forms as the lancelet and the ascidian. In these low forms, the large, upper

* Since the above was written, Mr. Caldwell has discovered that the Australian kind—*Ceratodus*—does undergo metamorphosis.

end of the digestive tube is highly vascular, and has a great number of clefts in it, so that water can pass freely through the walls; and thus fresh and fresh currents containing oxygen in solution are perpetually bathing the lining of the throat, with its fine network of capillary blood vessels. The respiratory organs of all gill-bearing vertebrata are but a modification of this simple apparatus, intensely specialized certainly, but fundamentally the same.

These are the most striking harmonies; but embryology is daily bringing to light new evidence of the intimate relationship of the vertebrata to those low, non-vertebrate types which agree with the high forms in having a perforated pharynx for respiration and an axial body cord.

There may have been in the earlier epochs—most probably there were—innumerable low and soft-bodied creatures which “died and made no sign”—left no fossil remains. Forms must have existed intermediate, on the one hand, between the sea-squid and the lancelet, and, on the other hand, between the lancelet and the low radical forms of the vertebrate types. The morphological distance between a newly hatched frog's tadpole and the adult frog is almost as great as that between the adult lancelet and the newly hatched larva of the lamprey.

Gradually, as biological laboratories and stations increase, and as studies of this kind become more general, so as to make it an opprobrium for any educated man to be entirely ignorant of such matters, the mists that rest upon these great subjects, and the misconceptions that are formed of them, will assuredly disperse. The wish of many, of whom better things might have been expected, is evidently that the shadow on the dial should be brought backward, and not be allowed to take its normal course. There is, however, “no variability, neither shadow of turning,” in the morphological force; it is perpetually clothing itself afresh and afresh with “the things which are seen,” itself an emanation from the Great Unseen, the Eternal.

In conclusion, we may rapidly traverse the ground already gone over. Thus we shall see if there is anything that stands in the way of the views here taken as to the origin of the nobler animal forms. If the groups made by zoologists—varieties, races, species, genera, families, etc.—are merely convenient pens into which we may put our cattle according to the nearness or distance of their relation to each other, then it is evident that there are no absolute distinctions between the groups. If, also, the fossil forms—all, as far as they go—suggest the gradual divarication of types from each other during secular periods, according to fixed laws, and if embryology in the revelation of the various stages of development of the embryo gives the same kind of evidence, then it is clear that we are on safe ground, and may confidently draw our deductions.

Now, this is certain, that, whichever great group of gill-less vertebrates we examine—reptiles, birds, or mammals—we may go to the bottom or foundation of that group without ever seeing the necessity for more than a very limited and partial amount of transformation. There, however, we must use our imagination; but if this be bridled and kept well in hand, we shall not be carried away to any region of “science, falsely so-called.” Once at the base of these three great groups, we must call in the aid of metamorphosis; yet this need be no greater nor more wonderful than that which we are all familiar with in the development of beetles and of butterflies, of newts and of frogs.

That great change which we call metamorphosis, a most marvelous transformation of an active living creature of a low type into one of a much higher grade, is certainly not quite a soluble problem to us at present. This change, however, is not a rare, momentary, miraculous cataclysm, but a perfectly normal mode, in which the morphological force works in the development of a very large proportion of existing animal forms. It still takes place in several orders of the vertebrata. There is no adult fish, except one or two manifestly degraded types—the hag and the lamprey—that is at all comparable for lowliness to the tadpole of the common frog or toad. Yet this creature, which might have remained in its larval state throughout life, becomes in a few months a much more elevated type than any fish.*

Once at the bottom of the fish class, we are in the neighborhood of forms which, as we have seen, are at an almost immeasurable distance below the vertebrata, and yet give promise of that pattern of structure which characterizes the vertebrata.

When modern biology is as old and as strong as modern astronomy, then those two great problems—the meaning, nature, and causes of metamorphosis and the uprise of the vertebrata from non-vertebrate types—will undoubtedly have received much elucidation. Meantime, there are those who, having put their hands to this plow, will not look back. By them the orderly sequence of organic phenomena is never even imagined as taking place without the introduction of the element of time. It has become absolutely impossible for them to imagine that the almost infinite complexity of a high kind of creature—say an ox, a horse, or a man—did at first arrange itself miraculously in an actual moment of time. According to the old notion of creation, atoms must have run into molecules, molecules have become protoplasmic cells, cells become differentiated, and transformed themselves into various tissues, these tissues have become organs of divers kinds, and these organs have been collocated and set to work—with all their harmonious correlations and co-adaptations—all this with an utter elimination of the element of time.

This timeless hurly-burly was devoutly attributed to the Eternal.—*Contemporary Review*.

THE CARP.

“It is almost incredible,” says the *Deutsche Fischerei-Zeitung*, “that for hundreds of years man should have been engaged in the culture of an animal without knowing on what it feeds; and yet such is the case with respect to the carp. The fish is treated in the methods bequeathed by tradition, and nature is left to do the rest. One after another has said that carp feed on

vegetable matter.” It appears from a long and carefully carried out series of experiments made by Mr. J. Susta, director of the Wittingau carp fishery, that carp feed chiefly—indeed, he asserts exclusively—on animal food, and that what little vegetable matter it takes into its stomach is taken in by accident when the fish is grubbing after larvae and insects. “The greenish color of the food found in the carp's stomach has given rise to the idea that it was vegetable matter; but, as soon as Mr. Susta made a closer examination, he got rid of the green color arising from the gall, by washing, and found the contents of the stomach to consist almost exclusively of animal remains. Carp full of food were taken from a whole series of ponds and examined, and it was proved that the larvae of flies, small crustaceans of the *Daphnia* and *Cyclops* genera, as well as the larvae of *Phryganidae*, form the principal food of carp.”

“It has been calculated that in one year a female *Cyclops* would become the progenitor of more than four billions of young.” The various species of the genus *Cyclops* abound in inland waters all over the world.—*Fishing Gazette*, April 4, 1885.

THE CULTIVATION OF TIMBER.

WHILE there has been a good deal said of late about the necessity of taking greater care of such timber land, overgrown with the original forests, as the country yet possesses, we think that far too little attention has been given to the starting and caring for of a second growth on lands already denuded by the lumberman and the tanner. In the care of most of the land so cleaned within the last fifty years in New York State, Connecticut, Massachusetts, Vermont, and New Hampshire, choice varieties of timber would probably furnish a more remunerative yield in the end than any other use to which the land could be put; for although it could not be made to pay immediately, as with ordinary agricultural products, the land itself has not been of a character to pay for ordinary farming purposes. Speaking of this matter, *Outing* truly remarks that “wood of some kind is the natural product of the soil; for if left to itself, it rapidly grows up, it may be, to chestnut, oak, hickory, or other valuable wood; or, it may be, to white birch, alder, poison sumac, or something else equally worthless. There is little doubt, that any land on which the latter kinds grow so spontaneously would, with a little care, produce some of the valuable varieties; for instance, land that seems too poor to bear anything but white birch might be induced instead to bear white pine, especially as this variety flourishes in very poor soil. In like manner, the swamps, which now abound in alder and sumac, might be made to bear white cedar, or even pine, as is attested by the various denuded pine and cedar swamps in the different parts of the State. One consideration worthy to be taken into account, when we contemplate making plantations of timber, is, that the soil will not be exhausted by its growth, as it is by many other crops. It is well known that trees derive a great part of their substance from the atmosphere and from water, the decaying leaves seeming to supply more fertilizing material to the soil than the roots extract from it; for who is not aware that our forest lands, when cleared, make excellent grass and grain lands until their fertility is exhausted by a process less in harmony with the operations of nature? But will it pay to cultivate timber? It might be questionable to put high priced land to such use, but we have abundance of rocky lands, and some not so rocky, which, on account of its distance from market, or other causes, is not highly valued for other purposes.”

THE HARVEST OF THE SEA.

If Mulhall's statistics are reliable, there are not far short of 150,000 vessels engaged in Europe and North America in fishing. Between 600,000 and 700,000 men are employed in this industry, and the total annual product of fish is not far short of 1,500,000 tons. Few people realize the full meaning of these latter figures. A ton of fish is equal in weight to about 28 sheep, and hence, if Mulhall's estimate is approximately correct, a year's fish supply for ten European countries, included in this estimate, and the United States and Canada, might be represented by 42,000,000 sheep. Of this amount the United Kingdom, Canada, Russia, and the United States, alone, aggregate 1,000,000 tons, equivalent to 28,000,000 sheep.

It has been truly said that we talk in a metaphor of the “harvest of the sea,” but we have only lately been able to realize all that the metaphor means. The Fisheries Exhibition in London in 1883 did a great deal to encourage the study of marine biology, and it is with no small degree of satisfaction that we are able to say that in this much-needed work the United States ranks second to no other country. On the other hand, Great Britain, whose fisheries are of vital importance to her for food, has done little, and cannot yet boast a laboratory on the sea shore. Indeed, Professor Lankester, an eminent authority on marine biology, declares the British fishing industries still barbaric. The produce of the sea is recklessly seized, regardless of the consequences of the method, the time, or the extent of depredations.

According to an English authority, the old proverb that “there are as good fish in the sea as ever came out of it” no longer holds good. The harvests of the sea in the future, like the harvests on land, will need cultivating. It was shown, not long ago, that in eight months 28 boats engaged in the haddock fishery at Ryemouth, England, used 620 tons of mussels—about 47,000,000 mussels—in the capture of haddock. Yet Professor Lankester says that no pains are taken in England to cultivate or preserve the mussel, and knowledge of its reproduction and growth is still incomplete, as it is of other bait. Soles are every year becoming scarcer, and oysters are becoming more difficult to obtain. At present, says this same authority, absolutely nothing is known as to the spawning of the sole; and the male fish is not even recognized. The reason for oysters being scarce is not known, nor how to make them abundant.

There are many economists in England who maintain that the haphazard and improvident methods of fishing are exhausting the fish supply of that country as surely as the mining is exhausting the supply of coal. The supply of many kinds of fish is rapidly diminishing, and the only way to check the waste is by systematic study of the conditions which regulate the

supply. It is undoubtedly true that “the world could not be fed if men sought their food on land with as little forethought and system as fishermen cast their nets into the sea.” To what extent these facts, which are causing considerable discussion in England, apply to the United States we are not prepared to say. The excellent work for many years of our Fish Commission exonerates our Government from the charge of total neglect of this important industry. Several States have fish commissioners, and, together with the National Government, have accomplished much useful work in the artificial breeding of codfish, shad, oysters, etc. Indeed, the production of fish all over the United States has undoubtedly been largely increased by scientific research. It is not improbable that the annual fish product at present in the United States is equivalent to from 4,500,000 to 5,000,000 sheep. With the increasing demand for food, and with abundant evidence from other countries of the result of neglect, we should rather increase than relax our efforts to understand more about the food, habits, spawning, and propagation of our fish, in rivers, lakes, and the sea, in order that the harvest may not grow less as the demand becomes more urgent.—*Philadelphia Press*.

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* The tadpoles of some frogs are two or three years before they transform, and may be made to remain much longer in the larval state. I strongly suspect that some individuals among the larvae of the paradoxical frog (*Pseudis*) do not transform at all. These facts must lead us to see the wide and powerful influence of surroundings, upon both the manner and extent of the development of the individual organism.