a doubt could occur to the mind of any intelligent reader, reduced heights being invariably employed in the chapter in which the passage occurs, and in the book generally.

The charge of inconsistency which the Reviewer urges with so much gusto, is based on the following passage in my Preface, at the beginning of Part I :—

"There is great danger in the present day lest science-teaching should degenerate into the accumulation of disconnected facts and unexplained formulæ, which burden the memory without cultivating the understanding. Prof. Deschanel has been eminently successful in exhibiting facts in their mutual connection ; and his applications of algebra are always judicious."

Which, the Reviewer thinks, justified the expectation that I would omit as many as possible of Deschanel's applications of Algebra. It is not surprising that a writer accustomed to this style of inference should have an aversion to exact reasoning, and should characterise the solution of problems by the application of a little algebra as "intricate formulæ, which burden the memory without cultivating the understanding."

I may remark, with reference to my former discussion with W. M. W. in your pages, that the adoption of concrete units of mass, and derived units of force, has now received the official sanction of Sections A and G of the British Association, who have appointed a committee to frame a system of nomenclature on this basis. J. D. EVERETT

Newspaper Science

KNOCKED up with work, I reluctantly followed the advice of my medical man, and crossing the Channel so as to be more out of the way, resolved to eschew everything scientific for the next few weeks at least, in order to recruit before the winter's labours commenced. Even here, however, I soon found that the desired result was not so easily attainable as I had imagined, for the first thing this morning, on entering the reading room of the bathing saloon, a French acquaintance, placing the *Globe* (of Monday evening, September 11) before me, directed my attention to its leading article on Prussian Artillery, adding significantly—"*Voilà, mon ami*, a specimen of English scientific opinion !"

I must confess that it was not without a feeling of shame that I read an article, of which the following extracts will suffice to give a correct idea.

"Although the unchequered course of the late war was due to many causes, still it is now admitted on all sides that when the Krupp guns were brought into the field the conclusion was practically foregone." "The first public exhibition of what is now known as the Krupp gun was the gigantic specimen of a breech-loading steel gun sent to our Exhibition of 1851. The steel of which this gun was made differs entirely from our *Sheffield gun metal* or from Bessemer metal, and is a *composition invented by Krupp*, and the result of a special process. The iron is alloyed *with certain clays and also with a preparation of plumbago.* There are 100,000 '*creusets*' of this metal always in active employment in the factory, and each '*creuset*' contains from twenty to forty kilogrammes. The metal in a fluid state is poured into large cylindrical moulds, where it remains for two hours till it has completely hardened. But the chief difficulties of the process lie in subjecting it to the steam hammer. For years the hammer of greatest power in the factory had a force of 25,000 *kilometres*," &c. !

The italics are mine, and any one conversant with such subjects will perceive that no further comments are required. It only remains for me to express my astonishment at seeing such rubbish appear in the leading article of any newspaper of standing, and I am sure your readers will agree with me that it is high time that journals specially devoted to science should protest energetically against such representations being conveyed to the public at home and abroad as expressions of English technical or scientific opinion. DAVID FORBES

Boulogne-sur-Mer, September 13

THE NEW GANOID FISH (CERATODUS) RECENTLY DISCOVERED IN QUEENSLAND

AT the beginning of last year news reached Europe that a large "Amphibian resembling *Lepidosiren*" had been discovered in Australia, and the curiosity of naturalists was still more excited when it was stated that this creature was provided with teeth extremely similar to the fossil teeth (from the Jurassic and Triassic formations) known under the name of *Ceratodus*.

The interest attached to such a discovery will be easily understood, if we review briefly the history of *Lepidosiren*, and show the advance made by zoology in consequence of our acquaintance with this animal.

The discovery is due to the well-known Austrian traveller, Natterer, who sent two examples from Villa Nova on the Amazon River and the Rio Madeira to the Vienna Museum in the year 1837. Fitzinger, then Curator of the Collection of Reptiles, gave a somewhat superficial description of it under the name of *Lepidosiren paradoxa*, referring it without hesitation to the class of Reptiles. Nearly at the same time a very similar animal was found by Mr. Th. C. B. Weir, in Senegambia ; he presented two small examples to the Royal College of Surgeons ; and Prof. Owen, then Curator of the Hunterian Museum, published a full description of them under the name of *Lepidosiren annectens*, in the year 1839, explaining the reasons which induced him to regard this creature as a Fish. This view elicited further examination of the internal structure of the American species by Profs. Bischoff and Hyrtl, the former inclining to the opinion expressed by Fitzinger, the latter confirming, to the satisfaction of nearly all zoologists, the correctness of the conclusion arrived at by Owen.

Before the discovery of *Lepidosiren*, zoologists distinguished the class of Reptilia from that of Fishes by the organ of respiration, the former being provided with membranous lungs extending into the abdominal cavity, the latter breathing by gills only. Although the Batrachian reptiles were known to breathe by external gills, as fishes, during the early stage of their metamorphosis, and although some of them retain those gills through the whole period of their life, yet the development of lungs in the adult state and the co-existence of these organs with gills in the Perennibranchiates, were considered to be sufficient indications of their class-distinctness from fishes, among which no air-breathing organ was known. It is true Harvey and Hunter had pointed out that the air-bladder of the fish was homologous with the lung of higher vertebrates ; but functionally it could not be compared to it, as it receives arterial blood like any other abdominal organ, returning it in a deoxygenised condition.

Now *Lepidosiren* was found to be provided with gills, and a most perfect paired lung communicating by a ductus pneumaticus and glottis with the œsophagus, receiving venous blood by strong arteries, and sending it back directly to the heart in an oxygenised condition. Therefore, in this respect it did not differ from an Amphibian, and dogmatical believers in the stability of our zoological systems felt themselves quite justified in referring this creature to the Reptilians.

Nevertheless, the presence of certain other peculiarities of structure indicated rather an ichthyic than a reptilian affinity. The notochordal skeleton, and the apophyses arranged as in many fishes, and not as in Amphibians ; the organ of hearing enclosed in the cartilaginous capsule of the skull ; the dentition extremely similar to that of a Chimæra ; the intestinal tract traversed by a spiral valve ; peritoneal outlets near the vent ; no nasal canal to conduct air ; finally, the skin covered with scales, the fins supported by fin rays. All these are characters not found in Batrachians, and connect *Lepidosiren* with the class of Fishes ; but it was admitted that it makes the nearest approach in that class to the Perennibranchiate Amphibians.

The question had next to be settled, what place in the class of Fishes should be assigned to *Lepidosiren* ; and as the view entertained by Joh. Müller is that adopted by the majority of zoologists, we think it sufficient to refer to it alone. Having determined that all Ganoid Fishes agree with the Sharks and Rays in having an additional muscular division of the heart at the origin of the aorta, named *bulbus* *arteriosus*, and provided with transverse series of valves in its interior, he found that such a *bulbus arteriosus* was likewise present in *Lepidosiren*, but with a very different valvular arrangement. This peculiarity, combined with the development of a lung, he considered to be sufficient to distinguish *Lepidosiren* as the type of a separate subclass, which he named *Dipnoi*, and placed at the head of the entire class.

Thus, then, *Lepidosiren* was finally placed among the Fishes; but from the time of its discovery dates the tendency of zoologists to subdivide the assemblage of cold-blooded animals *not only where the development of a lung ceases, but also where the development of gills begins.* Or, in other words, systematists became more and more convinced that the old division of Reptiles and Fishes was insufficient, and that three classes of living cold-blooded Vertebrates should be distinguished, viz., Reptiles, Amphibians, and Fishes, some regarding the second as even more closely allied to the third than to the first.

When we find a group of animals represented by a very small number of forms in the existing Fauna, we look to Palæontology to fill up the seeming blanks; but *Lepidosiren* did not appear to have any fossil representatives. Prof. Owen stated (in 1839) that its teeth resembled "in their paucity, relative size, and mode of fixation to the maxillæ, those of the *Chimæra* and some of the extinct cartilaginous fishes, as *Cochliodus* and *Ceratodus*;" but no further inference was made from this fact as regards affinity. And Prof. Huxley (in 1861), when drawing attention to analogous structures in *Lepidosiren* and certain Devonian fishes, still maintained the entire absence of the Dipnoous type in the fossil state.

The discovery of a "gigantic Amphibian allied to the genus *Lepidosiren*, from rivers in Queensland," and named *Ceratodus Forsteri* by Mr. Krefft, promised to mark another step in the advancement of our knowledge, and to lend additional aid in determining the natural affinities of these animals. As soon as Mr. Krefft had recognised the importance of this discovery, the trustees of the Australian Museum of Sydney took steps to secure well-preserved examples. They sent a collector into the district where the animal was known to occur; and, with their usual liberality, they despatched to the British Museum, for examination, the first specimens they could spare, by which I was enabled to present a full account of its organisation to the Royal Society. It is not my intention to enter here into the details of the results of this examination; I must be satisfied with giving a short description of it, pointing out some of the bearings which this discovery has upon the advancement of science.

The fish (for this it proved to be, and even more so than *Lepidosiren*) appears to be not uncommon in some districts of Queensland; specimens have been obtained from the Burnett, Dawson, and Mary rivers, some high up in perfectly fresh water, others descending into the lower brackish portions. It is said to grow to a length of six feet, the largest example sent to the British Museum being about three and a half feet long. The flesh is excellent eating, and of salmon colour, hence it is called by the squatters Burnett or Dawson salmon. Its food consists of the decaying leaves of myrtaceous and other plants, with which the stomach and intestine are crammed. Probably now and then it swallows, perhaps accidentally, some aquatic animal; but it is rather doubtful whether it can be caught by using living animals as bait. It is also stated that it is in the habit of going on land, or at least on mud-flats; and this assertion appears to be borne out by the fact that it is provided with a true lung. On the other hand, we must recollect that a similar belief was entertained with regard to *Lepidosiren*, of which now numerous examples have been kept in captivity, but none have shown a tendency to leave the water. I think it much more probable that this animal rises now and then to the surface of the water, in order to fill its lungs with air, and then descends again until the air is so much deoxygenised as to render a renewal of it necessary. When we recollect that the animal evidently lives in mud or in water charged with the gases which are the product of decomposing organic matter, the usefulness or necessity of such an air-breathing apparatus, additional to the gills, becomes at once apparent. Further we shall see that the limbs of this unwieldy and heavy animal are much too feeble and flexible to be of much use in locomotion on land; they may assist it in its crawling, in water, over the muddy bottom of a creek; but the chief organ of locomotion is the compressed, broad, and flexible tail, denoting by its shape and structure that the fish can execute rapid swimming motions. However, it is quite possible that it is occasionally compelled to leave the water, although I do not believe that it can exist without it in a lively condition for any length of time. It is said to make a grunting noise, which may be heard at night for some distance. This noise may be produced by the passage of the air through the œsophagus, when it is expelled for the purpose of renewal.

It deposits a great number of small eggs, which are impregnated after deposition. Nothing is known of their development; but we may infer that the young are provided with external gills, like those of some other Ganoid Fishes.

The *Barramunda* (we will use the name given to it and other similar fishes by the natives) is eel-shaped, but considerably shorter and thicker than a common eel, and covered with very large scales. The head is flattened and broad, the eye lateral and rather small, the mouth in front of the broad snout and moderately wide. The gill openings are a rather narrow slit on each side of the head. There are no external nostrils. The tail, which is of about the same length as the body without the head, is compressed, and tapers to a point, but it is surrounded by a very broad fringe, supported by innumerable fine and long fin-rays. There are two fore and two hind paddles, similar to each other in shape and size, and very different from the fins of ordinary fishes; their central portion being covered with a scaly skin, and the entire paddle surrounded by a rayed fringe. If we were to cut off the hind part of the tail of a fish, the piece would bear a strong resemblance to one of the paired paddles. The vent is situated in the median line of the abdomen between the paddles.

In order to obtain a view of the inside of the mouth, it is necessary to slit it open, at least on one side. We then notice that there are a pair of nasal openings within and on each side of the cavity of the mouth. The palate is armed with a pair of large, long, dental plates, with a flattish, undulated, and punctated surface, and with five or six sharp prongs on the outer side, entirely similar to the fossil teeth described under the name of *Ceratodus*. Two similar dental plates of the lower jaw correspond to the upper, their undulated surface fitting exactly to that of the opposite teeth. Beside these molars the front part of the upper jaw (vomer) is armed with two obliquely placed incisor-like dental lamellæ, which have no corresponding teeth in the lower jaw. As we know the kind of food taken by the Barramunda, the use of their teeth is apparent. The incisors will assist in taking up, or even tearing off, leaves, which are then partially crushed between the undulated surfaces of the molars.

The skeleton consists of a cartilaginous basis, in the form of a long tapering chord for the body and tail, and in that of a capsule for the head. No segmentation into separate vertebræ is visible in any part of the notochord but it supports a considerable number of apophyses, the abdominal of which bear well-developed ribs, all being solid cartilaginous rods, with a thin sheath of bone. In the same manner no part of the brain-capsule is ossified, but it is nearly entirely enclosed in thin bony lamellæ. This is also the structure of the appendages of the skull, as the mandible and the hyoid and scapulary arches. From a study of the skull, it becomes apparent at once why in fossil teeth of *Ceratodus* nothing or very little of the bone attached to them has been preserved. Those teeth rest on cartilage as well as on bone, the latter being a very thin and porous layer which could not be preserved, unless the progress of stratification had been going on with as little disturbance as in the Solenhofen Schiefers; but the matrix in which fossil Ceratodont teeth are found shows that it was formed under very different conditions, and it is certainly not of a nature to permit the supposition that thin porous lamellæ of bone would have been preserved entire.

The structure of the skeleton reminds us much of that of the sturgeons, Chimæra, and especially of *Lepidosiren;* and of all the modifications by which it differs from these types, perhaps none is of greater interest than that observed in the paddles. The central part of the paddle, which we have found externally to be covered with scales, is supported by a jointed axis of cartilage extending from the root to the extremity of the paddle; each joint bears a pair of three- or two- or one-jointed branches. This is the case in the hind as well as fore paddles, and we are justified in supposing that those extinct Ganoids of which impressions of paddles with scaly centres have been preserved, were provided with a similar internal skeleton. Professor Huxley, some years ago, drew attention to the analogy existing between the filamentary limbs of *Lepidosiren* and the lobate fins of certain extinct Ganoids, and the correctness of this view is fully borne out by the discovery of *Ceratodus*, inasmuch as the *Lepidosiren*-limb proves to be typically the same as that of *Ceratodus*, but reduced to the jointed central axis.

The gills are perfectly developed, four on each side. They are broad lamellated membranes, free from each other, but attached to the outer walls of the gill-cavity. One can hardly doubt that, in water of normal composition, they are sufficient for the purpose of breathing. A lung, however, is superadded to them, a true lung, which receives blood from a branch of the aorta, and returns it directly to the heart by a separate vein. Whilst the Barramunda is in water sufficiently pure to yield the necessary supply of oxygen, the function of breathing rests with the gills alone, and the lung receives arterial blood, returning venous blood, like all the other organs of the body; under this condition it does not differ from the air-bladder of other fishes. But when the fish is compelled to sojourn in thick muddy water, charged with noxious gases, which must be the case very frequently during the droughts which annually exhaust the creeks of tropical Australia, it commences to breathe air in the way indicated above; under this condition the pulmonary vein carries purely arterial blood to the heart, where it is mixed with venous blood and distributed to the various organs of the body. If the medium in which the fish happens to be is perfectly unfit for breathing, the gills cease to have any function; if only in a less degree, the gills may still continue to assist in respiration. In short, the organisation of the Barramunda is such as to justify us in the assertion that it can breathe by either gills or lung alone, or by both simultaneously.

With regard to the structure of the lung, it shows a nearer approach to the air-bladder of other living Ganoid fishes than that of *Lepidosiren;* it is not paired, but consists of a single long sac extending nearly to the end of the abdominal cavity. Yet the interior of the sac shows a symmetrical arrangement of the right and left side, being subdivided into numerous cellular compartments, by which the respiratory surface is much increased in extent.

The next organ of importance for determining the systematic affinities of the Barramunda is the heart. Considering the great resemblance this fish has shown in other respects to *Lepidosiren*, I fully expected to find this organ agree also with the Dipnoous type; but this is not the case. Instead of the two longitudinal valves of the Dipnoous heart, the *bulbus arteriosus* is provided with two or three transverse series, of which one only is fully developed; or, in other words, *Ceratodus* proved to be a Ganoid fish. But, as *Ceratodus* and *Lepidosiren* are in all other points too closely allied to be separated in two distinct sub-classes or even sub-orders, we must arrive at the conclusion to drop the *Dipnoi* as a sub-class, and to refer *Lepidosiren* also to the Ganoids, which will then be characterised, not by transverse series of valves, but by the presence of a muscular, contractile *bulbus arteriosus* with valves, transverse or longitudinal, in its interior—a structure which they have in common with the sharks and rays (*Plagiostomata*).

The intestinal tract is a large straight sac with an internal spiral valve, as in the Ganoids and Plagiostomes. The kidneys are paired, the ureters enter a very small urine-bladder or cloaca at the back of, and partly confluent with, the rectum.

The organs of propagation show some noteworthy peculiarities. They are paired, in long bands. The male organs have no visible outlet, although a seminiferous duct has been found traversing the substance of the testicle through nearly its whole length; no outward opening could be discovered, and it is not known how the semen is discharged. The ova are small, very numerous, and attached to transverse laminæ of the ovaries; when mature, they fall into the abdominal cavity, as in the salmon tribe, and would appear to be expelled through two wide slits behind the vent. Yet each ovary is accompanied by a long oviduct, as in the sturgeon or *Lepidosiren*, though it probably has no function, and is only indicative of an approximation of this remarkable fish to higher types. Such are some of the principle features of the organisation of the Barramunda; and it remains now to add some remarks on its affinities and its place in the system. A. GÜNTHER

(*To be continued.*)

ON EXOGENOUS STRUCTURES AMONGST THE STEMS OF THE COAL-MEASURES

In a memoir recently read before the Royal Society, I propounded a new classification of the vascular cryptogams, and at the late meeting of the British Association at Edinburgh I brought the same subject forward, when my views were opposed by Mr. Carruthers, Dr. M'Nab, and Prof. Dyer, as reported in the columns of NATURE for Aug. 31. I was well aware that when I disturbed existing and time-honoured systems of classification I should meet with such opposition; but, being thoroughly convinced that my views are sound, and that they will ultimately be adopted, it only remains for me to face the conflict, and persevere with my demonstrations of what I believe to be true. My present object is to do what was impossible in the hurried and unsatisfactory discussions that frequently arose at the meetings of the British Association to accomplish, viz.: to take care that there shall be no misunderstanding as to the real points at issue. My opponents seek to interpret the gigantic arborescent stems of the coal-measures by the light of the dwarfed and degraded examples of vascular cryptogams which constitute their living representatives. I, on the other hand, claim to interpret the latter by the former, some of which, the Lycopods, for example, instead of being feeble things trailing in the grass, had stems three feet in diameter, and rising a hundred feet into the air. Instead of merely constituting a verdant carpet for forests of noble exogens and endogens, they were the forest; here, consequently, we might expect that whatever characteristic features they possessed would be developed and displayed in their utmost perfection.

Mr. Carruthers' fundamental argument is, that I, in my