researches of Masterman, which, if confirmed, must result in the placing of *Phoronis* among those peculiar allies of the early ancestors of the vertebrates known as Hemichordata. Perhaps it will be possible to introduce

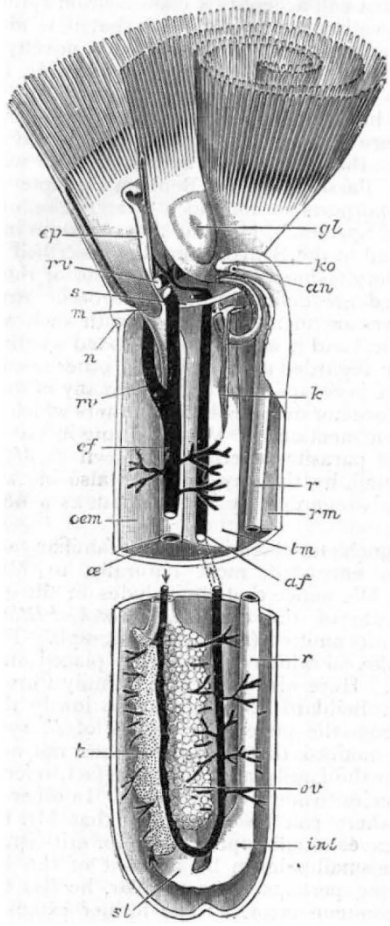

FIG. 2.—A schematic view of the interior of the body of *Phoronis*, with the middle ⅔ omitted. Magnification, which is great, is not stated.

it again in a subsequent volume for the convenience of comparative study. With regard to *Phoronis kowalevskii*, Mr. Shipley tells us that it is a name "given by

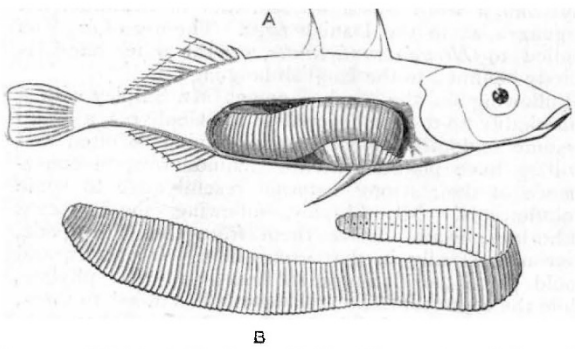

FIG. 3.—A. Stickleback (*Gasterosteus*) infested by an advanced larva of *Schistocephalus*. B. The larva. Both × 1½.

Benham to the species from Naples described by Caldwell, and replaces the name *Ph. cæspitosa*, which was given, but subsequently withdrawn, by Cori." This seems a roundabout way of stating that Cori s name was, as he has admitted, antedated by the name given by Benham. A name, once published, cannot be "withdrawn," even by its author

The volume concludes with an excellent index; but a review of any volume of the "Cambridge Natural History" that should conclude without an allusion to the admirable illustrations would indeed be incomplete. In this respect the present volume, though dealing with less picturesque animals, by no means falls short of its predecessors. As clear presentations of anatomical structure, we may draw attention to a diagram of *Planaria*[1] on p. 39, of *Leptoplana* on p. 14, of *Phoronis*[1] on p. 457, of *Alcyonidium* on p. 469, and many like them.

We may also notice the figures drawn from specimens in the Cambridge Museum, such as the stickleback[1] infested with a cestode larva, on p. 84, and many taken from the most modern writers, other than the authors, as Bürger, Haswell, Spencer, and others. Indeed, the only complaint we have to make with regard to the figures is that the name of the artist does not appear to be given in the volume.

Taken as a whole, the book is fully worthy of its place in this attractive series, and, even if the eye of a critical zoologist may detect a shortcoming here and there, his heart must be gladdened to see a general work published at last that treats these generally despised animals in a style to which their morphological importance entitles them.

INDIA-RUBBER AND GUTTA-PERCHA, AND THEIR SOURCES.

THE question of the supply of india-rubber to meet the present enormous demands caused by the progress of electrical science, and the rapid development of the application of the substance for cycle and carriage tyres, is one that has been much discussed of late, and continues to increase in interest. For some time past it has been well known that the trees which supply the best rubber known in commerce, namely, Para rubber, have been more and more difficult to get at, in consequence of the collectors having to proceed further into the forests in search of the trees (*Hevea brasiliensis*) which yield the valuable juice. But though greater distances have to be traversed in order to collect the rubber, there seems but little fear of the absolute failure of the rubber supply generally, or of this one particular kind. Though the quality of this rubber is of a very superior nature, we are fortunately not dependent alone upon it for the supplies of our markets, for from the East and West Coasts, as well as from Central Africa, and also from India and the Far East, we obtain very respectable quantities; indeed, the resources from tropical Africa in this respect have of late so much increased, that they promise to compensate for any loss of the American supplies, and the experiences of the past year or so, when a new source of rubber has been discovered at Lagos, is even more reassuring as to the future supplies, for other plants may yet be found capable of assisting in furnishing a substance that will probably, in the future, be in still greater demand than it is even now. So that it has become necessary for every one interested in this peculiar industry to take every precaution to prevent waste of material, both in the processes of collecting the milky juices and in the preservation of the plants yielding them.

It seems pretty certain that, whatever takes place in the discovery of new sources, the plants yielding these elastic juices must belong to one of three natural orders, for all the known plants furnishing rubber of commerce belong to the Euphorbiaceæ, the Urticaceæ,

[1] Reproduced here by permission of the publishers.

and the Apocynaceæ, as will be seen from the following summary.

EUPHORBIACEÆ (*Hevea brasiliensis*).—This is the source of the Para rubber already referred to, and the plant from which the earliest supplies of rubber were obtained when, in 1770, it first appeared in London as a new discovery for rubbing out pencil marks on paper, and realising about three shillings per cubic inch. At the beginning of the present century it began to be used in the treatment of woven fabrics, for air-tight and waterproof articles. So rapidly, indeed, did its use develop, that in the year of the Queen's accession Para rubber was imported into England to the amount of 141,735 pounds, and twenty years later it had increased to 3,477,445 pounds; while at the present time, when the trade returns are counted by hundredweights instead of pounds, the import accounts for 1896 showed the total of rubber from all sources to be 431,164 cwts., which were valued at 4,993,186*l*. The species of *Hevea* of which *H. brasiliensis* is the best known as a rubber producer are large trees, growing abundantly in the humid forests of tropical America, especially along the Amazon and its tributaries. As in most of the Euphorbiaceæ, the wood is soft and easily cut in the tapping process. The trees are locally known as Seringas. *H. brasiliensis* grows to a height of 60 feet, branching from the base. The collection of the milk commences about August, and is continued till the following January or February. In the wet season the milk is too watery to produce good caoutchouc. The trunk of the tree is wounded with a knife or a small axe-like instrument, a deep horizontal cut being first made a few inches from the base, and a vertical one from this, some distance up the trunk; oblique cuts are then made into this main channel, which conveys the milk into small clay vessels placed at the bottom to receive it. As these are filled they are emptied into a calabash or gourd, and when this is full it is carried to a more convenient place for coagulation; for this purpose, the contents of the calabash are emptied into a large earthenware basin. A kind of wooden paddle, with a widish blade and a long handle, is then dipped into the milk, and turned about over the smoke and heat of a fire made of the hard bony fruits of *Maximiliana regia*, or *Attalea excelsa*, which fire is enclosed with a thick earthenware covering, open at the top, like a small chimney, to allow the heat and smoke to escape. As the rubber coagulates upon the blade, in the form of a thin film, more milk is poured over it, and the same operation of holding it over the fire repeated. This goes on till a sufficient thickness of rubber is deposited, when it is cut through round the edge, and the paddle withdrawn. Various kinds of Para rubber are thus prepared, and are known in commerce under different names, according to the thickness of the deposit. The large round balls, generally known as "Negro-head," are made up of scraps of rubber tightly rolled together. This kind is often much adulterated, and one specimen in the Kew Museum contains in the centre, as shown when cutting the ball through, about one-third its weight of pieces of brickbat and cotton cloth.

Besides the process here described, some Para rubber is coagulated by the aid of alum, and by other means; but the quality of the rubber from this source is always good.

So far back as 1873, the necessity of securing supplies of rubber for future generations occupied the attention of the Kew authorities, and living plants of *Hevea brasiliensis* were sent to India, with the view of establishing the plant in that country. Smaller consignments were also made to the West Coast of Africa, Jamaica, Dominica Trinidad, Queensland, Singapore and Java. The history of this important undertaking is fully recorded in the Reports of the Royal Gardens, Kew, for 1873, and subsequent years, where, indeed, will also be found recorded the various experiments made by Kew in the introduction of other rubber-yielding plants into countries that were thought suitable for their extension.

Another rubber-yielding plant of the Euphorbiaceæ is that which furnishes the kind known as Ceara Scrap, from the fact that this kind always appears in commerce in masses composed of agglomerated scraps. The plant is a native of Central America, and is known to botanists as *Manihot Glaziovii*. In 1876 a large quantity of seeds and plants of this species were collected in Central America, and brought to Kew; they were rapidly propagated, and plants were sent to Ceylon, Singapore, Calcutta, and other places, in most of which the plants grew rapidly and yielded rubber, thus proving their capability of establishing themselves in their new homes.

URTICACEÆ.—In this order we find also a Central American rubber plant in *Castilloa elastica*, which, with perhaps some allied species, furnishes the commercial kinds known as Guatemala, Mexico, and West India rubbers. *C. elastica* is one of the species that has received much attention at Kew, and in 1876 was widely distributed. The Indian source of rubber (*Ficus elastica*) also belongs to this group of plants. The plant is so well known as a parlour plant in this country, producing its fine glossy leaves under almost any conditions, that the fact is scarcely realised that in India and Ceylon it produces a veritable forest of trunks, and covers the ground with its long-stretching buttresses or roots, which run sometimes for distances of 30 or 40 feet. It is the source of Assam rubber, which is collected by wounding the stems and buttresses in all directions. The milk is collected either in holes made in the ground, or into leaves folded in the form of a vessel to receive it. On the upper parts of the stems, or on the branches, the juice is allowed to coagulate by exposure. The largest yield is obtained in August, when, on an average, a tree will give about 50 ozs. of milk, yielding about 15½ ozs. of pure rubber. To prepare it for market it is sometimes poured into boiling water, and stirred until it is sufficiently firm to be carried about without sticking together. It is shipped from Calcutta in baskets made of split rattan, and mostly covered with a gunny bag. When cut the rubber has a mottled appearance, and is composed of pieces varying from cream, or flesh colour, to a bright pink, or even red. It is either in the form of separate stringy-like balls, irregular blocks, or large masses.

Another species of *Ficus*, namely, *Ficus Vogelii*, furnishes one of the kinds known as Lagos rubber. The tree is known in West Africa as the "Abba," or "Abo," and is fully treated of in the *Kew Bulletin* for 1888, p. 253, and 1890, p. 89. The quality of this rubber was never considered very satisfactory, as it was more or less resinous, and was consequently used for mixing with other kinds rather than by itself. Another kind of Lagos rubber has, however, since been discovered, which has proved to be of superior quality, and is next described.

APOCYNACEÆ.—To this order belongs the several species of *Landolphia*, climbing, branching, shrubby plants, supporting themselves on the surrounding trees of the forest. The stems of these plants average from 4 to 6 inches in diameter, and the principal species, furnishing what is commercially known as African rubber, are *Landolphia owariensis*, *L. florida*, and *L. Kirkii*. The quality of these rubbers, though mostly good, is by no means equal to the Para kind, but the discovery of a new source of Lagos rubber, from a tree known to the natives as the "Ire" or "Ireh," has given a great impetus to the trade of the West Coast of Africa in a rubber of extremely good quality. The *Kicksia africana*, unlike the species of *Landolphia*, forms a tree 50 to 60 feet high, with a trunk averaging 12 to 14 inches in diameter. It is said to be one of the most beautiful

trees of the forest, and is capable of producing in a good season as much as from 10 to 15 lbs. of rubber per tree. For the purpose of extracting the rubber, a deep vertical cut is made through the bark, and several oblique cuts on each side running into the main channel, at the base of which a vessel is placed to receive the exuding milk, which is coagulated by allowing a quantity to stand for some days in a cavity made in the trunk of a tree, so that the watery portion evaporates or soaks into the wood, leaving the solid portion behind, which is kneaded and pressed together into a solid mass, or the milk is placed in a vessel and boiled, the rubber beginning to coagulate almost immediately heat is applied. The whole history of this interesting discovery and development is given in the *Kew Bulletin* for 1895, p. 241, and 1896, p. 76, from which we learn that in January 1895, which practically marks the beginning of the industry, the exports were 21,131 lbs., valued at 1214*l.*, and at the end of December of the same year this had increased to such an extent as to show a total for the twelve months of 5,069,504 lbs., of the value of 269,892*l.* 13*s.* 10*d.*

As the *Bulletin* remarks, "The history of this new rubber industry in Lagos is full of interest, and illustrates the wonderfully rich resources of the vast forests of West Africa. It shows also very clearly how largely these resources can be developed by judicious and intelligent action on the part of the Government."

Besides the important sources of rubbers already mentioned, there are still others belonging to the same natural order Apocynaceæ, natives of the Far East, which may be briefly referred to species of *Willughbeia* and *Leuconotis*. *Alstonia plumosa* yields a rubber in Fiji, whilst *Forsteronia floribunda* and *F. gracilis* yield rubbers in small quantities in Jamaica and Demerara respectively, though not in sufficient quantities to be of any commercial importance.

From the foregoing list of plants, it will be seen how generally distributed the elastic juices are in Apocynaceous plants.

Space will scarcely allow us even to mention the allied substance gutta-percha, the history of the introduction, development, and threatened failure of supply of which is fraught with so much interest and warning: how that in 1842 the substance was first discovered in Singapore, and the trees cut down in such large numbers to supply the European demand, that in five years after only a few trees existed in Singapore, and a similar fate attending the trees which were afterwards found in Penang, are facts that are well known as applying to *Dichopsis gutta*, a sapotaceous tree, upon which the reputation of gutta-percha was at first founded, and from which the bulk of the commercial supplies have continued to be drawn, though it is more than probable that a similar substance is yielded in the East by allied trees, the botany of which, however, is but imperfectly known.

A substance very like gutta-percha is furnished by *Minusops globosa*, a large forest tree, growing to a height of from 60 to 70 or even 100 feet, in Trinidad, Jamaica, Venezuela, and British Guiana. It belongs to the Sapotaceæ, and the solidified milk, or gutta, was first brought to this country in 1859. Its use with us has fluctuated very much, and it cannot be looked upon as a perfect substitute for true gutta-percha.

The interest at the present time is much greater towards the rubber supplies than those of gutta, and this is borne out by a few facts referring to the probable demand, in the very near future, that have appeared in a recent number of our contemporary, *Commerce*, among them being a statement that the estimated outturn of cycles in Great Britain and the United States during the present year will amount to 1,750,000; besides this, there is the probable development of motor carriages, and the extended application of rubber for the tyres of ordinary vehicles. So that there is every probability that the interest in rubber-yielding plants will go on increasing.

JOHN R. JACKSON.

Museum, Royal Gardens, Kew.

THE RESOURCES AND THE NEEDS OF CAMBRIDGE UNIVERSITY.

HIS GRACE THE DUKE OF DEVONSHIRE, K.G., Chancellor of the University of Cambridge, has requested us to give publicity to a statement as to its financial position and requirements, which has been drawn up for him by an influential Committee of residents, and whose authority he states to be unquestionable. Its purpose is to make known to the public the true state of the University's finances in relation to its increased duties, in the hope that means may be found for raising its endowments to the level of its present requirements.

The statement seeks to remove the impression that the University is a wealthy body. The fall in agricultural values has so seriously crippled it and its constituent Colleges, that this impression is no longer justified; and a point has been reached at which, without new endowments, complete efficiency and necessary expansion are gravely impeded. Benefactions for the establishment of special prizes and scholarships have not been wanting; but the flow of contributions for general academic purposes has for years practically ceased, though it is such gifts that are most needed, and at present most likely to be widely useful.

It appears that while the Colleges undertake much of the teaching for the degree examinations in mathematics and classics, all the higher branches, and the entire round of the natural and physical sciences, are provided for by the University, which maintains the library, the observatory, the botanic garden, eight museums, and eight laboratories. The University staff consists of about 120 professors, readers, and lecturers, whose stipends are paid partly by the common fund, partly by their emoluments as Fellows and Lecturers of Colleges. A Professor's stipend of 700*l.* or 800*l.* is diminished by 200*l.* if he holds a Fellowship; but in nearly all the Colleges the dividend is less than this sum, and the Professor, therefore, does not receive his full nominal stipend. By the statutes there should be twenty Readerships at 400*l.* each: the University has been able to establish six only, and these, in general, at stipends of about 100*l.* to 150*l.* The University Lecturers are usually selected from the College staffs, and receive, as a rule, stipends of 50*l.* a year.

In consequence of the conditions established in 1881, four-fifths of the Fellowships are now held by resident graduates. The maximum dividend is fixed at 250*l.*, but in fifteen out of seventeen Colleges this sum is not reached, and in some the dividend does not exceed one-third of the maximum.

The revenue for 1896 consisted of about 40,000*l.* derived from fees; about 16,500*l.* contributed by the Colleges as a tax on their revenues and tuition-fees; and about 6000*l.* obtained from the University endowments (tithes, rents, &c.). Of this sum, over 33,000*l.* was paid in stipends; over 22,000*l.* for the maintenance of libraries, museums, laboratories, &c.; some 2200*l.* in repayment of a loan for buildings; and 5000*l.* in part payment of necessary sites for new buildings adjoining the present museums.

From fees it is not easy to see how more can be derived without diminishing the number of students and graduates; the endowments are insignificant, and steadily decreasing in value; and the College contribution has already, in view of the financial difficulties of these corporations, been more than once reduced. When the tax reaches its maximum in 1902, the most it can yield, in addition to its present amount, is probably about 2000*l.*

On the other hand, greater expenditure is called for in