(*Hyalonema*); and in some instances, from a mixture of membranous tissue with the earthy matter, they resemble cork.

4. Among the calcareous corals the texture or density of the coral is often of little importance, as it may vary in different parts of the same specimen, according to their full exposure to the free ocean waters or not.

In species with stellate cells there is always a definite number of rays to the *adult* cell, excepting among those that bud in the discs, and this number is some multiple of four or six, and usually of both. The characters of the cells—whether immersed or occupying a prominent calicle; and, *internally*, deep and open at bottom, or transversely septate, or spongy cellular or solid,—are important; also the peculiarities of the lamellæ, whether entire or not, equal or irregular, exsert or included.

In transverse sections of the stellate cells, the number of rays (when adult), the diameter, and the character of the centre and of the interstices, are generally good characteristics for species.

The corals of Alcyonaria never have rays to their cells or tubes; the Madreporacea have never more than *twelve* rays; the Caryophyllacea and Astræacea have always more than twelve; and the last order is distinguished by having the interval between the cells lamello-striate (see p. 109, III. 2) *internally*, with few exceptions, as well as *externally*.

This brief review of the characteristics of zoophytes has prepared the way for an exposition of the classification into which the species naturally fall.

[To be continued.]

XIII.—*On the Circulation in Insects.* By Emile Blanchard*.

The celebrated author of the 'Anatomie Comparée,' finding no other vessels in insects than the dorsal one, believed that no true circulation existed in these articulated animals. According to Cuvier, the tracheæ ramifying throughout the entire body of the animal, the air in them must proceed in search of the blood, just as, in animals having a pulmonary or bronchial respiration, the blood is conveyed to the air.

Since his time, many anatomists have studied the circulation in insects. They have usually selected transparent larvæ which have allowed them to distinguish, through the tegumentary envelope by the aid of the microscope, currents of liquid blood. In this manner Carus observed a circulatory movement in the larvæ of the Ephemeridæ and Agrions. Wagner, Bowerbank, Newport, and others have verified these facts. According to these observers,

* Translated from the Comptes Rendus for May 17, 1847.

the entire circulation in insects is reduced to this: the blood, urged forwards by the dorsal vessel, bathes the organs by being poured into the cavities of the body, where a retrograde movement causes it to return into the dorsal vessel by orifices at its posterior part. Léon Dufour, who has contributed so much to our knowledge of the organization of insects, denies, with Cuvier, the existence of any circulation whatever in these animals. According to that anatomist, the dorsal vessel is only a simple cord, without an internal cavity. Its movement, he says, is only the result of the simple contractility of its tissue, a kind of fibrillar vibration common to many living tissues.

Such are the various opinions regarding the circulation in insects. What might perhaps have caused surprise, was that, in accordance with the ordinary explanation, the circulatory and respiratory apparatus were to a certain extent independent, the tracheæ, according to the general opinion, not coming into contact with the nutritive liquid except by currents traversing the lacunæ between the organs. However, this did not attract attention. Their study by the aid of their transparency, not allowing of accurate details being distinguished, the question has always remained much in the same state.

A very simple means, however, of tracing the whole course of the circulation in insects would have been to inject coloured liquids. Recourse has not been had to this proceeding; or if so, no benefit has been derived from it. Nevertheless, among the invertebrate animals, there are few in which this means of investigation so easily yields a good result. Whether we inject by the dorsal vessel or the lacunæ, the entire circulatory system is immediately filled. Nothing is more remarkable and elegant than an insect properly injected: all the tracheæ, which ramify throughout the organs in such delicate branches, are coloured by the injection; however, not even the smallest drop of liquid penetrates their interior.

The tracheæ of insects, as well known, are composed of two membranes between which there is a thread spirally coiled. The sanguineous fluid penetrates between the two membranes. Every part of it thus comes into contact with the air contained in the tracheal tubes, and the re-organization of the blood is effected as in animals furnished with lungs, although the anatomical disposition is so different. This observation explains the structure of the tracheæ. The spiral thread not only serves to give them a certain solidity, it has also the purpose of keeping the two sheaths of which they are composed apart, and of keeping them open near the respiratory orifices so as to give passage to the nutritive fluid. When the tracheæ are vesicular the spiral thread disappears, and then the very numerous and excessively fine canals

traverse them in all directions. If we inject an insect by the dorsal vessel, the liquid, after having traversed it in its whole extent, is soon poured into the lacunæ of the head and thorax, and is diffused into the abdominal lacunæ. It then penetrates between the two tracheal membranes by lacunæ which surround the respiratory orifices; finally it is returned to the dorsal vessel by lateral afferent canals, which extend over the dorsal parts as far as the origin of the tracheal bundles. Thus these afferent canals are equal in number to the stigmata of the abdomen; it is the same with the number of segments of the dorsal vessel, which also varies according to the types.

The tracheal tubes, therefore, which convey the air into all parts of the body also carry the re-oxygenated blood to all the organs: the space existing between the two sheaths of the respiratory organs appears to perform the office of nutritive vessels. The circulation in insects is effected therefore in the same manner as in many invertebrate animals which have a partly lacunar circulation. But there is a very peculiar anatomical disposition: the activity of the circulatory movement here as elsewhere is in relation with the activity of the respiration.

I have investigated the circulation in a tolerably large number of genera of insects, so as to be assured that there is no essential difference between the different types of the entire group. I am convinced that the anatomical modifications are very trifling, even between the representatives of the different orders of this large class of animals.

My observations have been made, in the order Coleoptera, principally upon species of *Meloë*, *Dytiscus*, *Hydrophilus*, *Geotrupes*, &c.; in the Orthoptera, especially upon *Blatta*; in the Hymenoptera, upon the Humble Bees, Wasps, and especially on the Bee; in the Hemiptera, upon *Nepa* and *Ranatra*; several on Lepidoptera and different Caterpillars, and on some Diptera both in the larval and perfect state.

Throughout I observed the same facts, and I have proved that the larvæ and the adult insects do not differ in any but unimportant relations.

The facts I have detailed may very soon be verified by merely injecting a coloured liquid through a simple aperture in the abdomen of an insect: in this way all the lacunæ are immediately filled, as also the vascular portion of the tracheæ, and ultimately the dorsal vessel itself.