geological periods. Some indications have been offered in the course of the essay, as shown above. The Mesozoic floras in particular have yet to be carefully reviewed as tests of climate. Suggestive remarks on fossil Ferns and Conifers are then offered; and the Author says:—"We may expect that a closer study of the Geological floras, not only from phylogenetic and anatomical, but also from biological points of view may enable us to penetrate further into the life-conditions of those forests of which the Earth's crust affords us such numerous, though often too fragmentary, relics."

The list of works referred to in the text, occupying pages 134–146, well arranged and made serviceable with reference to the numerous footnotes, is a welcome bibliography for palæobotanists. The Essay has also a useful Index. Like other scientific works issuing from the University Press at Cambridge, this is well printed on good paper.

MISCELLANEOUS.

Comparative Researches upon the Organization of the Brain in the principal Groups of Arthropods. By M. H. Viallanes.

I have the honour of communicating to the Société de Biologie the principal results of researches which I have been conducting for several years upon the organization of the nervous system of Arthropods, and of which I have hitherto only published detached fragments, some in the 'Annales des Sciences Naturelles' and the rest in the 'Comptes Rendus de l'Académie des Sciences.'

Organization of the Brain of Insects.—In the Insects the brain is formed of three segments corresponding to the first three cephalic zonites. The first segment, or *protocerebron*, innervates the eyes; it is the seat of the visual perceptions, while the psychic centres also reside in it. The second segment, or *deutocerebron*, innervates the antennæ; it is the seat of the olfactory perceptions. The third segment, or *tritocerebron*, innervates the labrum and the initial portions of the digestive canal; in it is situated the centre of the gustatory sense.

Before entering further into detail as to the constitution of the cerebral segments, it may be mentioned that the first two are entirely preœsophageal, that is to say that the commissures which unite their symmetrical portions are situated in front of the œsophagus. In the case of the third segment the conditions are different; here all the commissural fibres pass behind the œsophagus, where they constitute the commissure known under the name of the *transverse commissure of the œsophageal ring*.

The protocerebron is composed of a pair of lateral masses termed optic ganglia and of an intermediate median mass. The constitution of the optic ganglia is most remarkable and most constant;

they are composed of a series of three ganglionic masses united to one another by decussating fibres. The median protocerebral mass is formed of a pair of lobes, which are intimately fused together and contain in their interior—(1) the pedunculate bodies, which are the seat of the psychic functions; (2) the central body, the organ whither fibres coming from all points of the brain converge; (3) the *pons* of the protocerebral lobes, a portion discovered by myself, the significance of which is as yet unknown.

The deutocerebron is composed of a dorsal portion, the structure of which has nothing particularly noteworthy about it, and of two olfactory lobes, which are highly differentiated in view of their special functions, and are characterized especially by the presence of organs known under the name of olfactory glomerules. The olfactory lobes, whence the sensory fibres of the antennary nerve originate, are united to the optic ganglia and to the pedunculate bodies by fibres which decussate in the median line; this connexion, which is absolutely constant, seems to be bound up with physiological necessities. Besides the antennary nerves, the deutocerebron gives origin to a pair of tegumentary nerves and to a pair of roots destined for the visceral nervous system.

The tritocerebron is represented in the Insect solely by a pair of ganglionic masses, which we will designate œsophageal ganglia; these are separated from the median line and united to one another behind the œsophagus by the transverse commissure of the œsophageal ring. Each of the œsophageal ganglia gives rise by means of a common trunk to a nerve, which is destined for the labrum, and to a root of the visceral nervous system.

In the Insects the visceral nervous system is composed—(1) of a series of three median ganglia, which are connected with one another, and of which the first, known by the name of the "frontal ganglion," is united to the œsophageal ganglia by a pair of roots, which are often double; (2) of a pair of lateral ganglia *. Each of these latter is connected, on the one hand, with one of the median ganglia, and on the other with the deutocerebron, by means of a nerve-root which has already been mentioned.

The brain of the Myriapods is precisely similar to that of the Insects in structure. But the visceral system of these animals exhibits a remarkable condition, for it preserves throughout the whole of life certain characters which in the Insect are only found in the course of embryonic development.

For our knowledge of the cerebral structure of *Peripatus* we are indebted to the researches of M. Saint-Rémy †; it is connected in the closest manner with that of Myriapods and Insects.

* The lateral ganglia are generally each divided into two little masses, termed by M. Blanchard the ganglia of the vessels and tracheæ ("ganglions angien et trachéen").

† M. Saint-Rémy has published (Arch. Zool. exp. vol. iii. *bis*) a most conscientious paper upon the structure of the brain of Arachnids, Myriapods, and *Peripatus*; this has been of great assistance to me.

The Brain of the Crustacea.—Like the Insects and the Myriapods, the Crustacea possess a brain formed of three segments—protocerebron, deutocerebron, and tritocerebron.

The protocerebron of the Crustacea is constructed upon the same plan as that of the Insects; we find in it an optic ganglion formed of the same portions, as well as pedunculate bodies, a central body, and a pons of the protocerebral lobes. In the same way their deutocerebron is in every respect similar to that of the Insects and the Myriapods.

In the Insects and the Myriapods the third cephalic zonite is devoid of appendages and only bears the labrum; in the Crustacea, on the contrary, the same zonite bears, in addition to the labrum, the second pair of antennæ. This difference entails a slight modification in the structure of the tritocerebron. While in the Insects and Myriapods the tritocerebron is represented only by a pair of œsophageal ganglia, in the Crustacea the same cerebral segment is formed by a pair of œsophageal ganglia, and, in addition, by a pair of antennary lobes intercalated between the latter and the deutocerebron.

The œsophageal ganglia in the Crustacea, as in the Insects and Myriapods, are united with one another behind the œsophagus by the transverse commissure of the œsophageal ring, and each of them gives rise, by means of a common trunk, to the nerve of the labrum and to a root of the visceral nervous system.

The antennary lobes, the commissural fibres of which pass with those of the œsophageal ganglia behind the œsophagus, give rise to the nerves of the second antennæ, to a pair of tegumentary nerves, and to the motor nerves of the eye-stalk.

The visceral nervous system of the higher Crustacea differs from that of the Insects in a single point, which is, however, of but slight importance. In the Crustacea the unpaired and the lateral ganglia, instead of being separated as in the Insects, are all fused into a median mass applied to the wall of the stomach, and known by the name of the *stomatogastric ganglion*. This mass is united to the brain by roots, which are strictly homologous with those which we find in the Insects. Like the frontal ganglion of the Insects, the stomatogastric ganglion of the Crustacea is united to the œsophageal ganglia by a pair of roots, which are generally double, and, like the lateral ganglia of the same animals, it is connected with the deutocerebron.

We therefore conclude, from what has been stated above, that, from the point of view of cerebral structure, there exists the closest relationship between the Crustacea, Insecta, Myriapoda, and *Peripatus*.

Limulus and the Arachnids, of which in other respects many zoologists recognize the affinities, constitute, as regards the organization of their brain, a most homogeneous group, but one which recedes considerably from the rest of the Arthropods.

In *Limulus* and the Arachnids the brain is composed of two

segments only, the protocerebron and deutocerebron, both of which are provided with præœsophageal commissures. The protocerebron, which innervates the eyes, is comparable to the protocerebron of the Crustacea and Insects; it is nevertheless to be observed that in *Limulus* the pedunculate body attains truly colossal proportions. The same organ, although considerably modified, is still recognizable in the Arachnids, in which M. Saint-Rémy has described it under the name of the stratified organ ("*organe stratifié*").

In *Limulus* and the Arachnids the deutocerebron, instead of innervating olfactory antennæ, as in the Crustacea and Insects, performs the same function for the cheliceræ, which are simply tactile appendages, and so is not differentiated in view of special sensorial perceptions. The tritocerebron is wanting in *Limulus* and the Arachnids, and the first ganglionic mass which follows the deutocerebron is devoted exclusively to the innervation of the first maxillipede or mandible *.

The visceral nervous system of *Limulus* and the Arachnids is represented only by lateral ganglia, which, as in the case of the Insects, derive their roots from the deutocerebron; the median ganglia are wanting; the absence of these centres is evidently correlated to that of the tritocerebron.

Finally, we may express the differences and resemblances presented by the different types of Arthropods as regards the organization of the brain by dividing these animals into two great groups.

The first of these, comprising the Arachnida and *Limulus*, is characterized by the absence of the tritocerebron and the non-differentiation of the deutocerebron into an olfactory centre.

The second, which embraces the Crustacea, Insecta, Myriapoda, and *Peripatus*, is characterized by the presence of a tritocerebron and the differentiation of the deutocerebron into an olfactory centre.

This group may be itself subdivided into two sections, the first containing only the Crustacea, which are provided with two pairs of antennæ, the second embracing Myriapoda, Insecta, and *Peripatus*, which possess a single pair of antennæ.—*Comptes Rendus Hebdomadaires des Séances de la Société de Biologie*, n. s., t. iv. (May 6, 1892), pp. 354–357.

On the Circulation of the Blood in young Spiders.

By M. Marcel Causard.

I have examined the circulation in young spiders belonging to fifteen genera of Dipneumones, of which the following twelve have been determined by M. Eugène Simon:—*Dictyna*, *Tentana*, *Theridion*, *Epeira*, *Zilla*, *Micariosoma*, *Chiracanthium*, *Textrix*, *Clotho*,

* The rostrum of Arachnids is analogous to the labrum of Crustacea and Insects, but it belongs to the second zonite and is innervated by the deutocerebron.