Chloë Rhodani Pictet.
Chloë spec. L.
Ephemerenlarve.
Phryganea mixta Pictet.
Chironomus, 4 spec. Meig.
Tanypus, 2 spec. Meig.
Corethra spec. Fabr.
Tipula spec. Fabr.
Dipterenpuppen, 2 spec.
Käferlarve.
Pisidium Foreli Cless.
Pisidium nitidum, var. *lacustris* Cless.
Limnaea truncatula Müll.
Limnaea ventricosa Moq. Tand.
Fredericella sultana Gerv.
Cottus gobio L.
Hyla arborea L.

Die Copepoden wurden in zuvorkommendster Weise von S. A. Poppe, die Hydrachniden von F. Könike bestimmt.

In den nächsten Jahren sollen die Rhätikonseen noch wiederholt zu verschiedener Jahreszeit zoologisch durchsucht werden. Außer den vier bis jetzt bearbeiteten Wasserbecken werden noch einige weitere mit in den Rahmen des Excursionsgebietes zu ziehen sein. Gleichzeitig werden wir der Thierwelt kleinerer stehender Wasseransammlungen, Tümpel, Teiche, Brunnen, sowie der rasch fließenden Bergbäche Zeit und Aufmerksamkeit zu widmen haben. Endlich ist auch die Bevölkerung der zahlreichen wasserführenden Höhlen und Grotten des Rhätikon zu erforschen.

So dürfte sich nach und nach ein vollständiges faunistisches und biologisches Bild der wasserbewohnenden Thierwelt eines wohl umschriebenen Alpenbezirks herausgestalten.

Basel, 12. März 1891.

3. Farther studies on the brain of Limulus polyphemus.

By Alpheus S. Packard, Providence, R. I.

eingeg. 17. März 1891.

In a former memoir[1] I described the brain of Limulus, but was unable to satisfactorily work out the topography of the different lobes.

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[1] The Anatomy, Histology, and Embryology of *Limulus polyphemus*, Memoirs of the Boston Society of Natural History. 1880.

The following abstract is the result of farther observations based on transverse, longitudinal (sagittal), and horizontal sections of the supra-oesophageal ganglion, or brain, belonging to adult individuals about eight or ten inches in length, exclusive of the caudal spine. The transverse and sagittal sections were stained with haematoxylin, the horizontal with carmine[2].

The most striking histological feature of the brain is the immense development and singular arrangement of the convoluted, ruffle-like masses forming the thick layer of »nucleogenous bodies«, as we have called them, and which form the cortex of the cerebral and other lobes, and which enclose masses of myeloid or punctured substance. These appear to be simply nuclei, but when they are scattered they are seen to be ganglion cells. They are the ganglionic nuclei of Dietl, and »*cellules chromatiques*« of St. Remy[3], and as he describes in the brain of Myriopods and Arachnida, readily take a deep stain, thus contrasting with the unstained, white punctured substance of the lobes, and origins of the nerves. The enormous development of these chromatic cells, and their grouping into such a great number of nucleogenous bodies or plates is a peculiarity of the brain of *Limulus*. Another characteristic of the brain of *Limulus* as compared with that of other Arthropoda, including the Scorpion, is the remarkably small number of the normal ganglion cells.

In its shape and gross anatomy, the brain of Limulus, as we formerly stated, differs fundamentally from that of Arachnida, in sending no nerves to the first pair of appendages, the only nerves arising from the brain being those distributed to the median and lateral eyes, and to the integument, the »nerfs tegumentaires frontaux« and »nerfs tegumentaires fronto-inferieurs« of Milne Edwards. The brain of *Limulus* is thus homologous with the portion of the brain of spiders and scorpions situated in front of the origin of the so-called mandibular or cheliceral nerves, and which is the »forebrain« of Professor Patten. In the adult brain of *Limulus*, as seen externally, the largest nerves are those sent to the lateral eyes, and which arise very near the upper surface of the brain, one on each side of the median furrow. Below is the origin, in the median line, of the, for the middle and larger part of its course, unpaired nerve te the median eyes. A little below, but in about the upper third of the brain-mass, arise a pair of frontal, tegumental nerves, and directly below them are the descending fronto-inferior tegumental nerves. No nerves arise from the lower half of the brain, which

[2] The brains were prepared, cut, and mounted in balsam by Prof. H. C. Bumpus.

[3] Archives de Zool. exp. et gén. 2e Ser. T. V. bis. Suppl. 1887.

is full and rounded, and which internally is wholly occupied with the nucleogenous bodies or plates, the lobes which we are now to describe residing in the upper half. The nerves to the first pair of appendages do not arise from the base of the brain, but the ganglion cells giving rise to them are situated entirely outside of and behind the brain proper.

The brain as thus constituted is in the adult made up of three pairs of lobes enveloped by the very thick masses of chromatic cells. The first and uppermost are the pair of lateral-eye lobes. These lobes are situated at the top of the brain, and are widely separated from each other; they are somewhat pyriform, but below contract in size where connected with the cerebral lobes; the lateral-eye nerves are well developed and thick at their origin. The nervous fibrillae (or tubules) appear to originate from the chromatic cells, which do not here form dense masses, but are much scattered, forming a large incomplete ring in the interior of the lobe; these cells have a distinct thin protoplasmic zone enclosing the nucleus. The lobe just below the middle is seen to be embedded in the dense ring or ruffle-like masses of deeply stained chromatic cells, which we have called the »nucleogenous bodies«.

After passing in horizontal sections through the lateral-eye nerves, the knife cuts through the origin of the median-eye nerve and the lobes from which they originate. These lobes are in the adult brain situated far below the plane of the lateral-eye lobes, and they are difficult to detect, owing to the fact that they are small and slender and not much swollen or spherical. They form two narrow tracts of myeloid or punctured substance arising near the middle of the brain from the inner aspect of the cerebral lobes, their roots or base being situated not far from the cerebral commissure. Their lack of a definite pyriform shape and their small size indicate that they have probably somewhat atrophied. The nucleogenous bodies are closely packed around the origin of the nerves. There is below the median-eye lobes a pair of minute lobes, each sending off a bundle of fibrillae backward towards the cerebral commissure which may possibly give rise to a pair of tegumental or »haemal« nerves. I have been unable as yet to detect any traces of lobes or nerves belonging to Patten's »median eye of the first segment[4]«.

The third pair of lobes are the cerebral lobes. These are very irregular in outline, slender, and apparently shrunken, and very different

[4] Patten considers that a diverticulum of the median eye-bulb »represents in all probability, a pair of eyes belonging to the first brain-segment« and that consequently there are »three fused ocelli« in *Limulus*. On the origin of Vertebrates from Arachnids. Q. Journ. Micr. Sci. XXXI. 344. 1890.

in shape from the full well developed sub-spherical shape of those of Arachnids. They are narrow and thin, sending off lateral irregular lobules, and connected posteriorly by a thick commissure. This commissure, as numerous sections show, consists of fibrillae originating from the, as seen in section, crescent-shaped, central dense mass of chromatic cells near the posterior margin of the brain, and which overlies the median line of the great commissures leading to the oesophageal ring.

The central mass of the cerebral lobes does not pass much below the middle of the brain: but the posterior lobules on each side serve as the origin of the great commissures connecting the brain with the oesophageal ring, which is formed by the coalescence of the neuromeres of the post-oral cephalo-thoracic appendage-bearing segments.

We thus have been able to distinguish three pairs of lobes in the brain of Limulus viz.; those of the lateral, those of the median eyes, and the cerebral lobes.

Professor Patten describes and figures three eye-segments in the embryo; a first and second median-eye segment and the lateral eye-segment, and gives an interesting figure based on dissections and sections, of the »fore and mid-brain« of the freshly hatched *Limulus* The three pairs of neuromeres, he claims, succeed one another in regular order.

But afterwards this order is greatly changed; for the median eye-lobes are carried during subsequent growth down in under the lateral-eye lobes, the latter being far removed from each other and assuming a position anteriorly and at the top of the brain.

It is noteworthy that the rounded under side or base of the brain, which sinks below the level of the commissures to the oesophageal ring, is almost wholly occupied with densely packed nucleogenous bodies, or chromatic cell-masses, which are enormously developed compared with the similar bodies in the Arachnid brain. On the other hand the large normal ganglion cells are mostly grouped in one plane, that of the origin of the commissures to the oesophageal ring, to whose fibrillae the give origin. In the brain of the scorpion and spiders these cells as figured by Saint Remy, form a large part, more than half, of the cortical substance enclosing the lobes.

It will be seen from the foregoing description that the brain of the adult Limulus differs from that of Arachnids not only in not sending a pair of nerves to the first pair of feet, but in the structure of the brain itself, though on the whole it resembles that of Arachnids more closely than that of Crustacea.

The brain, or supraoesophageal ganglion, of Insects and Crustacea

have been divided by Viallanes[5] into three divisions; i. e. the protocerebrum, deutocerebrum, and tritocerebrum; these have divisions corresponding to the supposed three preoral segments of the head. At present I do not think that there are more than two preoral segments, in the head of insects. Saint Remy shows that the brain of the Myriopods has the same divisions, and is homologous with that of insects and Crustacea. He shows, however, that the brain of Arachnids lacks the deutocerebrum, while the tritocerebrum of Insects, Crustacea, and Myriopoda is represented by the rostro-mandibular ganglion of the Arachnida.

As the brain of *Limulus* does not, contrary to that of Spiders and Scorpions, send nerves to the first pair of appendages, and has only at the most three pairs of lobes, and originally, according to Patten, three pairs of neuromeres, representing a first and second median-eye, and a third, or lateral-eye segment, it follows that no deutocerebrum or tritocerebrum is represented in its brain.

It seems to us that this lack of homology between the brain of *Limulus*, and that of Arachnids added to the other brain-characters we have pointed out, together with the different mode of grouping of the appendages, and their shape; also the absence of urinary tubes, of tracheae, and the presence of branchiae, forbid the association of Limulus and other Podostomata (Merostomata and Trilobita) with the Arachnida, but are so fundamental as to warrant their forming a class by themselves. On the other hand both embryology and morphology show that the Arachnida and Podostomata probably had a common origin, one group becoming adapted to the land, the other and older, having originated in the sea. The Insects and Myriopoda may have had a common origin, while the Crustacea probably had an independent origin.

Providence, R. I., U. S. A., Brown University, Febr. 25. 1891.

4. The Development of the American Lobster.

By F. H. Herrick, Ph. D. of Adelbert College, Cleveland, Ohio, U. S. A.

eingeg. 21. März 1891.

This paper is an abstract of researches conducted during the part of two summers (1889—1890), at the laboratory of the U. S. Fish Commission at Woods Holl, Massachusetts. It deals mainly with the early stages in the development of the egg[1]. The general statements which follow in regard to the habits of the American lobster (*Homarus ameri-*

[5] Annales des Sc. Nat. VII. Ser. Tom. IV. 108. 1887.

[1] For a fuller preliminary statement, see the Johns Hopkins University Circulars, No. 80.