

PROTOZOA.

Clione celata, Grant. R. & C. C.

PLANTÆ.

Conifer, sp. R. C. Waldringfield.XLVI.—*Physico-chemical Investigations upon the Aquatic Articulata*. By FÉLIX PLATEAU. Part I.*

THIS first part includes the investigation of the phenomena presented by the aquatic Articulata (Insects, Arachnida, and Crustacea) when placed in liquids the saline composition of which is not the same as that of the waters in which they habitually live. In the present memoir I have left out of consideration mineral waters properly so called, as their extremely varied composition would have necessitated a considerable number of experiments the results of which would have been of little use.

The influence of sea-water, or of salt water, upon the Articulata which usually inhabit fresh water, and that of fresh water upon the marine Articulata, on the contrary, possessed some real scientific interest. We have long known several species of fish which are able to live indifferently in both liquids, and we also know that there are Crustacea and beetles endowed with the same faculty. But, side by side with these few exceptions, what an enormous quantity of aquatic species which always seek the same water and the same conditions, and to which the least modification seems to be injurious! Why should the carnivorous larvæ of the fresh waters have a repugnance to exchange their ordinary fare for species of *Mysis*, *Slabberina*, and *Cetochilus*, or even young marine fishes? What is the cause that prevents many marine Crustacea from ascending the rivers by the aid of the tide, and taking up their abode in waters rich in living prey, and where, by their strength and the hardness of their integuments, they would soon reign as masters?

The very nature of the experimental researches to which these reflections have led me renders a summary exposition of them very difficult. As it is impossible here to reproduce the tables containing the results of numerous experiments, I shall confine myself to the enunciation of the various conclusions at which I have arrived, following these, if there is occasion, with some observations or with a few examples.

* Abstract of a Memoir in the 'Mémoires de l'Académie Royale de Belgique,' 1870. Communicated by the Author.

Freshwater Articulata.

1. Sea-water has, if any, only a very slight influence upon the aquatic Coleoptera and Hemiptera in the perfect state; this influence may be a little greater upon the larvæ.

2. Sea-water produces injurious effects upon the freshwater Articulata with a delicate skin or furnished with branchiæ; and these effects are, in general, the more marked in proportion as the delicate surface is considerable.

Thus larvæ of *Agrion* appear to live indefinitely in sea-water, whilst those of *Cloëon* die in it on the average in two hours and three minutes. Among Crustacea *Gammarus Roeselii* and *Asellus aquaticus* resist the action of sea-water for several hours; whilst the Cladocera, Ostracoda, and Copepoda perish in a few minutes. A special table shows the influence of the thickness of the integuments and of the presence or absence of branchiæ.

3. The freshwater Articulata which can live with impunity in sea-water are those in which no absorption of salt takes place by the skin; those which die in it in a comparatively short time have absorbed chlorides of sodium and magnesium.

The direct experiments which I have been able to make upon the aquatic Articulata had, as their starting point, a very important experiment of M. Claude Bernard's, which has lately been referred to and developed by M. H. Emery. M. Emery placed a frog in water containing about 25 per cent. of common salt. The frog at first moves about rapidly; in from three to five minutes it becomes insensible and motionless; it is then washed carefully and placed in pure distilled water, when the animal soon resumes its activity, and the distilled water is found to furnish an abundant precipitate with nitrate of silver.

I simply transcribe the description of a single one of my experiments, in order to show clearly how I operated in all those relating to the absorption by the skin or to the excretion of the salts of sea-water.

After ascertaining that the distilled water of which I was going to make use gave no precipitate with nitrate of silver, and carefully washing with this same water the glass tubes necessary for my experiments, I placed nine individuals of *Asellus aquaticus* in a solution of common salt containing (by weight) 6.092 of salt and 96.954 of water—that is to say, a quantity of salt exactly double that contained in sea-water.

The *Aselli* remained in this solution for eighty-seven minutes, at the end of which they manifested uneasiness; they were then taken out, placed for a moment upon bibulous

paper, and then washed five times with distilled water, until the last washing-water scarcely produced a perceptible turbidity with nitrate of silver. The nine *Aselli* were then placed for the sixth time in pure distilled water (10 cubic centimetres) and left therein for two hours. At the end of this time they had recovered all their vivacity; and the water in which they had remained furnished, with nitrate of silver, a distinct *precipitate* of chloride, soluble in ammonia.

I have varied the conditions of these experiments, employing sometimes water containing less chloride of sodium than sea-water, sometimes pure sea-water; and I have always arrived at results of the same kind. These seemed to me to place it beyond doubt that certain aquatic Articulata absorb chloride of sodium by the surface of the body; but it was still necessary to show that all the freshwater Articulata are not in the same case, and that those in which there is no absorption are precisely those which are able to live with impunity in sea-water. Now the experiments made upon Coleoptera, Hemiptera, larvæ of *Agrion*, &c. showed no excretion, and consequently no absorption, of chloride of sodium.

4. The injurious salts contained in sea-water are the chlorides of sodium and magnesium; the sulphates may be regarded as having no effect.

I have arrived at this conclusion by examining successively the action of solutions of chloride of sodium, of chloride of magnesium, and of sulphate of magnesia, in such proportions that in each case the weight of the single salt employed might equal the sum of the weights of all the salts contained in sea-water. The experiments were tried only with species in which the presence of a delicate skin or of branchiæ rendered a great absorption probable.

The action of chloride of sodium proved to be sometimes analogous to that of pure sea-water, and sometimes more energetic. The action of chloride of magnesium is of the same kind as that of chloride of sodium, or weaker, according to the species; this salt must therefore be regarded as inferior to the preceding one in its injurious effects. The solution of sulphate of magnesia produces no effect, or leads to death only after a very long time.

I have also been able to ascertain, by operating in accordance with the process 3, that the larvæ of insects and the freshwater Crustacea experimented on only absorb a very little of the chloride of magnesium, which may explain the slowness of the action of this salt in many cases. They generally do not absorb any trace of the sulphate.

5. The difference of density which exists between fresh and

sea-water does not explain the death of the freshwater *Articulata* in the latter liquid.

Resuming the experiments indicated by me in a former memoir, I exposed some *Articulata* on which I had ascertained that sea-water has an injurious action to a solution of cane-sugar in water, brought, by means of Fahrenheit's areometer, to precisely the density of the water of the ocean. Out of eleven species eight lived with impunity in the solution of sugar; and with the others the action was much slower than that of sea-water or of the chlorides.

6. When the freshwater *Articulata* pass, by a very slow transition, from fresh to sea-water, and reproduction has taken place during this transition, the new generation resists the action of sea-water longer than the ordinary individuals of the species.

The exposition of this experiment would occupy more space than is desirable in a simple abstract; I shall therefore take the liberty of referring the reader for its details to my memoir.

I slowly modified the fresh water in which a great number of specimens of *Asellus aquaticus* were living, in such a manner as to transform it in the course of two months into natural sea-water, taking all the precautions necessary to keep the water sweet and to provide the Crustaceans with nourishment. During these two months (from the 21st January to the 16th March) the *Aselli* reproduced.

The result of the experiment was, not a modification of the original individuals, as these gradually died out, and none remained on the 3rd March, but a modification of their descendants, which almost rendered them a new variety, as to their aptitude for living in sea-water. In fact, under ordinary conditions the *Aselli* do not resist the action of sea-water, at the maximum, more than 5 hours 15 minutes, and the young die more quickly than the adults in this liquid, whilst seven of the individuals born during the experiment lived in pure sea-water for 108 hours.

Marine Crustacea.

7. The commonest Crustacea of the Belgian coast die in fresh water after the lapse of a variable time, which, however, does not exceed 9 hours.

8. The marine Crustacea when immersed in fresh water give up to this the salts (especially chloride of sodium) with which their tissues were impregnated.

If the freshwater *Articulata*, when immersed in sea-water, absorb certain of its salts, the marine *Articulata* lose in fresh water the salts contained in the liquids of their bodies. Hence

the shortest resistance in fresh water ought to be observed in those Crustacea in which an extremely rapid respiration is combined with a comparatively delicate skin. This fact was, to a great extent, verified: the *Crangones* and *Gammari* which combine these two conditions are those which live the shortest time in fresh water; the young crabs whose skin is not thick perish more quickly than the hard-skinned individuals. A confirmation of these facts will be found under No. 10.

9. In most cases the presence of chloride of sodium forms one of the indispensable conditions of resistance for the marine Crustacea; but this salt appears to be the only one necessary.

The experiments consisted in the employment of saline solutions of the same compositions as indicated under No. 4.

10. The small individuals and those which have just moulted have the integuments delicate, and present less resistance than the others to the influence of liquids of exceptional composition.

11. The difference between the densities of sea-water and fresh water cannot be regarded as the cause of the death of marine Crustacea in fresh water.

12. (Applicable to both groups.) Endosmose enables us to explain the absorption of salts by the delicate skin or the branchial surfaces of freshwater Articulata when immersed in sea-water. Diffusion and dialysis, taking place with more energy in the case of the chlorides of sodium and magnesium than in that of sulphate of magnesia, show how it is that the chlorides of sea-water are alone absorbed. Lastly, dialysis explains how marine Crustacea, when placed in fresh water, lose the salts with which they are impregnated.

XLVII.—On the supposed Legs of the *Trilobite* *Asaphus platycephalus*.

To the Editors of the *Annals and Magazine of Natural History*.

DEAR SIRS,

I send you hereby an advance copy of an article of mine* on a subject which is exciting some interest, thinking that you would wish to publish it in your excellent Journal.

Yours truly,

JAMES D. DANA.

At the request of Mr. E. Billings, of Montreal, I have recently examined the specimen of *Asaphus platycephalus* belonging to the Canadian Geological Museum, which has been supposed

* In 'Silliman's American Journal' for May 1871.