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the reduction of the yolk-entoderm at the anti-embryonic pole is continued and is followed by that of the trophoblast cells, the latter losing for the greater part their respiratory and nutritive function and the scheme of the Sauropsidan egg is realised. Even in Rodents there is already an indication of this reduction of trophoblast cells at the anti-embryonic pole¹).

EXPLANATION OF THE PLATE.

Common abbreviations.

A. anal aperture. *Am.* amnion cavity. *Da.* intestine. *Dz.* umbilical vesicle resp. yolksack. *Emb.* embryonic area. *Ex.* exocoeloma. *Lb.* liver-outgrowth. *Pr* proam- nion-area. *SM* segmented body mesoderm (somatic mesoderm). *Som.* somatopleura. *Spl.* splanchnopleura. *Tr.* trophoblast. *Vm.* ventral mesoderm.

Fig. 1. Diagrammatic median section through an amphibian larva with large yolksack.

Fig. 2. Hypothetic transitional form between a yolkladen amphibian larve and the germbladder of viviparous Protamnota (median section).

Fig. 3. Diagrammatic median section through a germbladder of a Primate with ectoplacental proliferations on all sides.

In all the figures ectoderm is shown in black while mesoderm is dotted and entoderm hatched.

Chemistry. — “*Chemical actions in the subsoil of the dunes.*”

By Dr. J. VERSLUYS, M. E. Communicated by Prof. J. BOESEKEN.

(Communicated in the meeting of March 25, 1915).

In the dunes and the sub-soil thereof water containing the principal ions of sea-water is as a rule found at a slight depth but in quite a different proportion, as the ions Ca and HCO₃ are very predominant therein.

Still, the concentration of the Ca-ions, which in proportion to the other ions occur in very large quantities, is smaller therein than in sea-water. At a greater depth water is generally found in which the ions occur in about the same concentration and the same mutual proportion as in sea-water.

The water of the first class will in future be called the normal fresh water, the other the normal salt water.

As chief ions may be mentioned

Na, Mg, Ca, Cl, HCO₃ and SO₄.

In the normal fresh water, the concentration of all the ions is

¹) See SELENKA, l.c. H. I, 1883, Fig. 21, 24 and 25, T. II, and H. III, 1884, Fig. 9, T. XI, Fig. 13, T. XIII, Fig. 30, T. XIV and Fig 44, T. XV.

but slight, but of the cations the principal matter is Ca, and of the anions HCO_3 .

In the normal salt water, on the other hand, the concentration of all ions is much larger; the cations are principally Na, the anions Cl. The demarcation between these types of water is not sharp and there is a gradual transition.

This transition, however, cannot be explained by a simple mixing phenomenon. The elaborate analyses of a great number of samples of underground waters, which at the request of the Government Board for Water Supply were made during the last few years in the Central Laboratory on behalf of the Sanitary Authorities at Utrecht, render possible a more accurate study of the phenomena occurring therein.

Near the transition zone, where the chlorine content still quite corresponds with that of the fresh water, an important change is perceptible in the concentration of the ions Na, Mg and Ca and in such a manner that these ions are present in about the same mutual relation as in the normal salt water.

If the figures giving the concentrations of the ions Na, Mg and Cl are divided by the atomic weight of sodium and the half-atomic weights of magnesium and calcium, respectively so that the concentrations of the chemical equivalents are obtained, it appears that so long the concentration of the chlorine ions corresponds with that of the normal fresh water the concentration of the sum of the equivalents $\text{Na} + \text{Mg} + \text{Ca}$ also corresponds with that of the normal fresh water.

The ratios

$$\text{eq. } \frac{\text{Na}}{\text{Na} + \text{Mg} + \text{Ca}} = 0,886$$

$$\text{eq. } \frac{\text{Mg}}{\text{Na} + \text{Mg} + \text{Ca}} = 0,058$$

$$\text{eq. } \frac{\text{Ca}}{\text{Na} + \text{Mg} + \text{Ca}} = 0,056$$

however, already approach those of the normal salt water.

In some dune regions we may accept for normal fresh water the following value of the ratios.

$$\text{eq. } \frac{\text{Na}}{\text{Na} + \text{Mg} + \text{Ca}} = 0,251$$

$$\text{eq. } \frac{\text{Mg}}{\text{Na} + \text{Mg} + \text{Ca}} = 0,224$$

$$\text{eq. } \frac{\text{Ca}}{\text{Na} + \text{Mg} + \text{Ca}} = 0,525$$

and for normal salt water (sea-water)

$$\text{eq. } \frac{\text{Na}}{\text{Na} + \text{Mg} + \text{Ca}} = 0,787$$

$$\text{eq. } \frac{\text{Mg}}{\text{Na} + \text{Mg} + \text{Ca}} = 0,178$$

$$\text{eq. } \frac{\text{Ca}}{\text{Na} + \text{Mg} + \text{Ca}} = 0,035$$

Hence, near the transition zone where the concentration of the chlorine ions and that of eq. $\text{Na} + \text{Mg} + \text{Ca}$ are still the same as these of the fresh water, the mutual proportion in which Na, Mg and Ca are present is already about that of the salt water.

We may, therefore, imagine that in the normal fresh water — near the border to salt water — an exchange has taken place between equivalent quantities of Na, Mg and Ca and chiefly in such a way that Ca has been removed from the water and Na has been introduced.

The phenomenon might be explained as follows in connexion with the way in which the fresh water has arrived into the sub-soil. The sand of the dunes rests on an old sea bottom and before the formation of the dunes this local land was submerged by the sea. The soil might then have been permeated by sea-water to a great depth.

Since the formation of dunes thereon precipitant water has penetrated into the soil and displaced the salt water.

Where fresh water is found now, there has consequently formerly been salt water. The normal fresh water must then be looked upon as the penetrated precipitant water which contains carbon dioxide and has in consequence dissolved calcium carbonate from the shells present in the soil.

The normal salt water is the sea-water still present. If in the soil are present solid substances such as amorphous silicates of aluminium with sodium, magnesium or calcium, or may be aluminium silicates which like the zeolithes possess the power, when in contact with a solution of salts, of mutually exchanging the last three elements, the said phenomenon might occur.

So long as the soil was still permeated by water in which Na, Mg and Ca were dissolved in about the proportion in which they occur in sea-water, and particularly if this water circulated and

was constantly being replaced by new sea-water, there will have formed in a long period a chemical equilibrium between the ions Na, Mg and Ca in the sea-water and the atoms Na, Mg and Ca in the silicates.

When this sea-water became displaced by water in which the ions Na, Mg and Ca were present in another proportion, namely in that of the above-mentioned fresh water, the chemical equilibrium was upset and an exchange was bound to take place.

Whereas, as has been observed, in the normal salt water the sodium is very predominant, the calcium predominates strongly in the normal fresh water derived from precipitant water. In consequence of the exchange the proportion of the ions Na, Mg and Ca in the penetrated fresh water will agree more with that of sea-water, and only when the fresh water has circulated for a certain time, the proportion of these ions will, as has been observed, get again nearer to that of the normal fresh water.

By assuming that the solid matters in the soil endeavour to form a chemical equilibrium with the cations of the underground water it is possible, in connexion with the penetration of the fresh calcareous water to explain the formation of water rich in sodium but with a small chlorine content. For in the normal fresh water the ratio eq. $\frac{\text{Na}}{\text{Cl}}$ is about 1.38 and the ratio eq. $\frac{\text{Ca}}{\text{Cl}}$ about 2.38. If now the greater part of Ca is replaced by Na, the ratio eq. $\frac{\text{Na}}{\text{Cl}}$ becomes very great and approaches more and more to the sum of eq. $\frac{\text{Na}}{\text{Cl}} + \frac{\text{Ca}}{\text{Cl}} =$ about 4.

If such fresh water rich in sodium is evaporated to a small volume, the Ca is nearly all precipitated as normal carbonate, also the greater part of the Mg. In the solution thus remain principally Na, Cl and CO₂ with a little Mg.

For that reason such water has been called "water containing soda" or water containing an excess of sodium carbonate. The name "alkaline water" is also applied, presumably because the residue when redissolved in water has a strongly alkaline reaction.

This alkaline water is often met with in places where we may expect that the salt water has been displaced latterly by fresh water. Consequently it is found there where at a greater depth, the fresh water borders on the salt water, but also in the midst of the fresh water near beds of loam and clay.

This fact is apparently in conflict with the above-explanation of

the formation of fresh water rich in sodium, but not so in reality if we consider that in the beds of clay salt water is usually still present when it has already disappeared from the surrounding sand layers, because in the beds of clay the water circulates much less rapidly than in the sand. In and near beds of clay, just as anywhere else near the border of salt and fresh water, the expulsion of the salt water has taken place later than if far away from the beds of clay.

A second circumstance, which would promote the presence of water with an excess of alkalis in the vicinity of beds of clay or loam, is probably this, that clay and loam contain more solid substances that take part in the reaction than sand, so that the chemical equilibrium therein is less rapidly repaired. Hence, even after the salt water has already been quite leached the exchange between Ca and Na will take place still longer in beds of clay and loam than in beds of sand.

Finally it should be pointed out that, where the fresh water has got into the soil without expulsion of salt water, the diluvium still being above the sea level such as in the islands of Urk and Texel and the fresh water is moreover less calcareous, the phenomenon that the sodium content is large in the fresh water in proximity to the salt water, is not noticed.

In the above only sodium and not potassium has been mentioned, because analyses involving the separation of potassium and sodium have been but occasionally executed.

Hence, when sodium has been mentioned this really means the joint sodium and potassium.

It has been observed that in the arable soils there are present colloidal substances possessing the power of assimilating ammonia and potassium and parting with this again on addition of lime. These substances may also be present in the subsoil of the dunes both in the beds of loam and clay and in the mud which most sands contain. It is probable that these substances cause principally the mutual reaction, and they may have a composition resembling that of the so-called artificial zeolithes of GANS.

Moreover, amorphous sodium aluminium silicates are employed to substitute sodium for calcium in water intended for boilers.

Summarizing, we may repeat :

I. that the fresh water rich in sodium has not a larger content in eq. $\text{Na} + \text{Mg} + \text{Ca}$ than the normal fresh water, so that the increase in Na-ions has been accompanied by a decrease in other ions ;

II. that the ratio NaCl in the water rich in sodium is greater

than in the normal fresh water and also greater than in the normal salt water, so that a mixing of these two types of water cannot cause the larger sodium content.

III. That in places where the diluvium still rises above the sea level and where the fresh water has collected without expulsion of sea water, the proportion eq. $\frac{\text{Na}}{\text{Na} + \text{Mg} + \text{Ca}}$ does not increase near the border of salt- and fresh water;

IV. that the proportion eq. $\frac{\text{Na}}{\text{Na} + \text{Mg} + \text{Ca}}$ in the water rich in sodium approaches about to that in the normal salt water so that the assumption of a reversible chemical action being the cause is an obvious one;

V. that certainly the proportion eq. $\frac{\text{Na}}{\text{Na} + \text{Mg} + \text{Ca}}$ is by way of exception greater than in normal salt water, but that, looking at the fact that Mg also takes part in the reaction, the explanation given does not become invalidated thereby.

The formation of water with an excess of alkalis may thus be explained by assuming that the sea-water has ceded alkalis to the soil and that those, when the sea-water was being displaced by calcareous fresh water, have in turn been exchanged for calcium.

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