

ing as bacterial chemotherapy a book is necessarily at a disadvantage in that important developments are prone to follow closely upon its heels. The authors have attempted in some way to offset this disadvantage by adding an addendum to the book. However, for those interested it is desirable to have the pertinent

facts in this important field collected together at frequent intervals. The authors are well suited to this task because of their experience both in the laboratory and in the clinic.

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SPECIAL ARTICLES

HYDROSOLS AND ELECTROLYTIC IONS

WHILE electro dialyzing some solutions of clay in water and in dilute acids and alkalies, a curious relation has appeared which throws light on the association of the electrolytic ions with certain of the hydrosols which may be present.

If a montmorillonite clay be brought to equilibrium with a dilute acid solution (say 1 per cent. hydrochloric) and then filtered and the solution electro dialyzed, it will be found that the silica is carried *equally* in both directions. Other ions present are usually found unequally in anode and cathode liquors, but the silica is strictly amphoteric, it either consists of equal numbers of anions and cations or is a carrier of equal numbers of such ions. After the effect was first noted, other experiments (25 in all) were made at different acid and alkali concentrations and on various clays including soil, all confirming the original findings or indicating necessary conditions.

The dialyzer used was an ordinary Mattson with the electrodes supplied replaced by others of sheet platinum. Cellophane membranes enclose the cell 1x10x15 cm. Electrode compartments are 3x10x15 cm. The current used was from a 116-volt line and held to below one ampere by a 100-watt lamp in series. Anode and cathode liquors were replaced by fresh distilled water four times at hourly intervals and each analyzed separately.

The clay solutions were prepared by digesting about 30 grams of 150 mesh (0.1mm) clay in two liters of acid solution for fifty hours at about 90° C. with frequent stirring. A few acid clays and acid-treated adsorbent bentonites require twice as long to bring to equilibrium. About 400 cc of the filtrate was evaporated to 150 cc for the dialysis. The total recoverable solids is from 1.5 to 5 grams per liter of solution according to acid concentration. At equilibrium, there is always free and adsorbed acid present as well as salts in solution.

Electro dialysis of a solution that has not come to equilibrium with a clay or soil shows an unequal partition of silica; an acid clay shows an excess of silica transported as cations, while a slightly alkaline soil gives a slight excess of silica as anions.

The first ions removed are H^+ and Cl^- . After the first hour the cations are largely the R_2O_3 bases.

If an electro dialysis of an equilibrium solution is stopped at an early stage and the three solutions analyzed, the silica will be found in equal amounts in anode and cathode liquors as though run to completion. When a pure silica gel solution is electro dialyzed, the silica is equally divided. An alkaline solution of a neutral clay (Florida fuller's earth) gave four times as much anion silica as cation silica. The same solution neutralized with HCl just before dialysis showed an equal division (49 vs 51 per cent.) of silica. A water solution of an alkaline bentonite (Wyoming swelling, 1.2 grams per liter) dialyzed 64.6 + vs 33.5 - without and 48.1 vs 43.7 - with HCl added before dialysis. But the same solution with NaCl added before dialysis gave for + silica 95.5 vs - 4.5. When insufficient ions are present electro dialysis gives a precipitate of silica in the cell.

It seems hardly possible that silica in solution can consist of equal numbers of anions and cations. The alternative seems to be that other charged ions are adsorbed in equal numbers on the silica and supply the motive power in a potential gradient. Anions and cations are present in necessarily equal numbers, hence in equilibrium clay or soil solutions they must also adsorb in equal numbers on the silica hydrosol micellae with which the cations were previously associated. Certain added ions prevent equal adsorption, others do not.

These results will be given in more detail in a later paper. It would be of interest to know whether similar relations obtain in other fields, say in the relation of the silver halides to the gelatine in photographic emulsions, of ions to hydrosols in sugar solutions, in plant saps and the like.

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U. S. GEOLOGICAL SURVEY

THE ASEXUAL LIFE CYCLE OF THE AVIAN MALARIA PARASITE, *PLASMODIUM CIRCUMFLEXUM*¹

EVIDENCE has been accumulating for some time that the life-cycle of the malaria parasite in the vertebrate is less simple than has been thought and that the plasmodia are able to parasitize not only the erythrocytes

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but also other types of vascular or phagocytic cells. This was first shown to be true of *Plasmodium elongatum* by Raffaele² and shortly afterward by Huff and Bloom.³ This species of avian plasmodium may be found in any type of blood or blood-forming cell, although it much prefers the erythrocytes. Since the work on this species, Raffaele,⁴ Kikuth and Mudrow⁵ and James and Tate⁶ have been able to demonstrate that there are also exoerythrocytic stages in *Plasmodium praecox*, (*relictum*), *cathemerium* and *gallinaeceum*, respectively; Kikuth⁷ in a recent paper with Mudrow has given a good summary of our knowledge of such stages to date. He remarks, however, that although he has looked for stages of this sort in *Plasmodium circumflexum* infections he has not as yet been able to find them. It may be noted here that the three species last named differ from *Elongatum* in that the parasites occur in the cells of the reticulo-endothelial system and, of course, in the red cells also, rather than in all the blood and blood-forming cells.

The authors of the present paper have for some time been engaged in a study of the immunological characteristics of various strains of *Plasmodium circumflexum*, and as a somewhat incidental part of the study a number of infected birds (female canaries) have been examined for possible exoerythrocytic stages. As a result it is possible to say that such stages occur in at least four strains, and they have so far been found in the lungs, spleen, liver, heart muscle, bone marrow and brain, but not in all the birds examined. Of the thirty-six birds in which they have been looked for, they were seen in fifteen of twenty-one active cases, and not in any of the fifteen chronic cases. Of the four strains, one originated in Germany, one in Cape Cod and the other two in Syracuse. Our results suggest that stages in other than the red cells are most likely to be found soon after parasites first appear in the peripheral blood, and prolonged search may be necessary to find them. Once found, however, they are frequently found to occur in localized areas in great numbers.

The question has recently been raised by Hegner and Wolfson⁸ as to whether, in certain cases at least, the parasites found in cells of the reticulo-endothelial system and interpreted as part of the asexual cycle of malaria, are not actually *Toxoplasma*. This is quite possible under some circumstances, for *Toxoplasma* may spread rapidly in the laboratory once it is present at all, and some stages strongly resemble what has

been regarded and figured as exoerythrocytic schizogony in the avian malaria species mentioned above. It should be pointed out however that *Toxoplasma*, usually, if not always reproduces by binary fission. In our experience, *Toxoplasma* has occurred only once in laboratory canaries, and in this case it was apparently acquired from English sparrows. The infection spread very rapidly among the sparrows and killed a number of them, but it had no connection with malaria at all, since most of the sparrows had been previously shown to be free from malaria infection of any kind. We have seen no evidence of *Toxoplasma* in canaries since, although numerous birds have been studied and autopsied over a period of several years. For this reason and because the stages which we have found in the *circumflexum*-infected birds mentioned above are much like those seen by the other investigators already cited in connection with the work on *praecox*, *cathemerium* and *gallinaeceum*, we believe that in *circumflexum* also it may be regarded as demonstrated that exoerythrocytic stages occur. From the evidence already existing it seems likely that similar stages will be found in the other species of avian malaria, and quite possibly in monkey and human malaria also. It also makes it probable that the biological relationship between the malaria parasites and *Hemoproteus* and *Leucotozoan* is closer than has been thought.

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THE PREVENTION OF TOXIC MANIFESTATIONS OF AN EXCESS OF VITAMIN B₁ BY SUPPLEMENTS OF MANGANESE TO THE DIET¹

In an earlier publication we reported that the addition of supplements, to our standard adequate diet, of vitamin B₁ in amounts of 50 international units per rat per day resulted after one generation in interference with lactation, loss of the maternal instinct, cannibalism and progressive loss of fertility.² Our standard diet contains rolled oats, meat scrap and bone meal, dried skimmed milk, fresh greens, fresh milk, salt, cod liver oil and brewer's yeast (in amounts equivalent to 2 or 3 international units per rat per day). With reduction in the excess amount of vitamin B₁ to 20 units or the elimination of the excess supplements of vitamin B₁ for short periods, normal lactation and normal interest in the young was restored. When the vitamin B₁ content was again increased the same toxic effects were observed. Further study completely confirmed our earlier findings. With supplements daily of 30 units of vitamin B₁, progressive decrease in

² Raffaele, *Riv. di Mal.*, 13: 332-337 and 402, 1934.

³ Huff and Bloom, *Jour. Inf. Dis.*, 57: 315-336, 1935.

⁴ Raffaele, *Riv. di Mal.*, 15 (5), Sez. 1, 3-9, 1936.

⁵ Kikuth and Mudrow, *Klin. Wschr.*, 16 (48): 1690-1691, 1937.

⁶ James and Tate, *Nature*, 139: 545, 1937.

⁷ Kikuth and Mudrow, *Zentralbl. Bakt.*, I Orig., 142: 113-132, 1938.

⁸ Hegner and Wolfson, *Amer. Jour. Hyg.*, 27: 212-220.

¹ From the Laboratory Division, Montefiore Hospital, New York City.

² D. Perla, *Proc. Soc. Exp. Biol. and Med.*, 37: 169, 1937.