Tristan d'Acunha, and Juan Fernandez if it was not carried there by man; yet it already shows some divergence from the type, and the specimens from the two latter islands, though they are so far apart, are alike. This is not extraordinary if we assume that like climatic conditions produce like effects, since the two islands are both far out in the ocean, at about the same parallel.

The problem becomes complicated, however, when we find *Amalia gagates* reappearing on the Pacific coast of North America, apparently quite native, though separated by long distances from other localities for the species. This Pacific form generally goes under the name *hewstoni*, given by Dr. Cooper, but I have examined authentic examples, and am convinced it is only *gagates*. Nor is this all, for in Australia and New Zealand are species of *Amalia* so very near *gagates* that some recent students have merged them in it. I have examined *A. antipodarum*, Gray, *A. emarginata*, Hutton, and *A. fuliginosa*, Gould, from New Zealand. *A. emarginata* I consider certainly a form of *antipodarum*, but this and *fuliginosa* appear to me to be valid species. They very much resemble *gagates* in structure, it is true, but, if they are really the descendants of imported slugs, the amount of modification they have undergone is remarkable. *A. fuliginosa* is in the British Museum also from the "Polynesian Islands"—exact locality not stated. There is also an *Amalia* in the Sandwich Islands, evidently very near to *gagates*, but whether identical with it or an endemic form cannot be ascertained in the absence of specimens.

Thus it is seen that *Amalia gagates* and its allies present to us some curious problems, which can only be solved by the collection of specimens from many localities, and their very careful comparison. Because the slug was described from and abounds in Europe, it does not therefore appear certain that specimens found in distant localities, closely resembling *gagates*, are descended from imported examples. We have often good reason for believing that this is their origin, but there is none of the certainty that we feel in regard to other species now found at the antipodes. Quite a similar example is afforded by *Agriolimax loevis* and its allies, which seem certainly native in very widely-separated places. It seems that *A. gagates* and *A. loevis* are very ancient species, surviving in those places where the climate suits them.

A STUDY IN POLARIZATION.—PRELIMINARY NOTE.

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USING a voltameter with platinum electrodes, separated by a glass partition bored in the centre with a hole two centimetres in diameter, over which was sealed a smaller glass plate bored with a hole one and one-half centimetres in diameter, this smaller hole being covered by metal plates of various thicknesses sealed tight over it, a study has been made of the polarization phenomena upon these thin metal partitions in different electrolytes and under various conditions as to thickness of partition, current strength, temperature, etc.

Without now going into details of the apparatus, methods, and results, the following summarized statement may be interesting:—

1. The polarization on a gold-leaf partition in good-conducting H_2SO_4 is zero, or too small to detect with our apparatus, for the range of current used.

2. The "critical thickness" in good-conducting solutions of H_2SO_4, $CuSO_4$, and NaCl is *greater* than .00009 millimetres for gold; .00015 millimetres for platinum; and .0005 millimetres for aluminum, under the above conditions. It is *less* than .0004 millimetres for gold; .002 millimetres for platinum; and .002 millimetres for silver.

3. The "upper critical limit" of thickness under these conditions seems to be about .004 millimetres, rather less than No. 3 gold.

4. Tables I., II., and III. all point to the conclusion that between "critical limits" of thickness the polarization for a given current increases with the thickness.

5. Table II., showing relation of polarization to current, expresses two interesting facts: (*a*) that the polarization on "thick" plates is about the same, in this voltameter, for all currents between .2 ampere and, say, .01 ampere, provided time enough be allowed in each case for the current to become constant, i.e., between the upper limit of current, at which the development of gas is so profuse as by mechanical obstruction and irregular escape to interfere, and the lower limit, at which the formation of gas is no faster than it can be dissipated. (*b*) Quite different is the case for "thin" plates, where, within the limits of current and thickness prescribed, the polarization is dependent upon the current and gives for each thickness a different curve, or rather straight line, for they are all straight lines converging to the origin, and differing only in *slope*. The current strength at which the polarization on very thin plates would reach a maximum is far above that used, being, perhaps, expressed in amperes instead of tenths and hundredths.

By *thick* plates are defined those above the "upper critical limit;" by *thin* plates, those below this limit of thickness.

6. Inspection of Table III., which gives the time-change of the polarization, will show a similar distinction between "thick" plates and "thin" plates, as was noted in the last paragraph, viz., that for thick plates the change is considerable and continues slowly for hours; for thin plates, the change of polarization with time is both less pronounced and extends over much less time.

7. It was noted, especially in the case of $CuSO_4$ as electrolyte, that there was polarization on gold-leaf if the gold exposed came in contact with the solution some distance beyond the edge of the hole in the glass plate to which it was sealed; thus in $CuSO_4$, for the stronger currents used, there was a symmetrical deposit of Cu, decreasing in thickness from the outside toward the centre, and vanishing at a small distance from the edge of the hole, this distance being less the stronger the current. If only one corner was left exposed, the Cu was deposited there. This phenomenon was further tested by bending a thick strip of aluminum, 4 centimetres long, into the shape of a narrow U, and simply hanging this U in the *open* hole of the glass partition, in $CuSO_4$, and closing the circuit on the voltameter; the two ends of the metal strip being thus in contact with the $CuSO_4$ on opposite sides of the glass two centimetres from the edge of the opening, there was decided deposit of Cu on one end and escape of oxygen from the other end.

8. In $CuSO_4$, all the plates except those below the critical thickness were destroyed by oxidation. No. 1 silver was destroyed is less than one minute. Of course, gold and silver above the critical thickness could not be used in NaCl, because of chemical action, though the thinnest plates were quite unaffected. Only the No. 7 gold was tested in KOH, as it dissolved the sealing-wax.

9. Thick plates of gold were strongly oxidized in H_2SO_4, especially with strong currents. Thin gold plates were apparently only oxidized under action of strong or long-continued currents. Compare Tables II. and III. Silver was even more easily oxidized than gold. Aluminum was so intensely oxidized by the current that no satisfactory measurements could be made for this metal, though the thin foil was unaffected.

10. With H_2SO_4 as electrolyte, after a thick plate of pure gold had been used as partition for the time-change of Table III., the end cathode was found to be gilded. A thick Pt plate being then substituted for the gold in the same solution for the results of No. 1 Pt in Table III., the Pt partition was found, on removal, to be gilded. The polarization for No. 1 Pt in this case was somewhat less than for the same Pt after both it and the end electrodes were thoroughly cleansed, the electrodes re-platinized, and fresh solution made.

11. The polarization in $CuSO_4$, using Cu electrodes, reached a maximum almost immediately and remained very constant. The maximum polarization for thick Pt in $CuSO_4$ was hardly 75 per cent of that for the same in H_2SO_4. In NaCl the polarization became constant very quickly also, but its value was decidedly greater, especially on thin plates, than in H_2SO_4; though the same distinctive behavior of thick and thin plates was maintained.

12. In H_2SO_4 of different concentrations the maximum polarization for a partition was of the same order of magnitude; but its value for very weak currents was decidedly greater in weak solu-

tions than for the same current in stronger solutions, up to 30 per cent. This shows itself especially with thin plates, and also in the shorter time required for thick plates to reach a maximum polarization with weak currents. The greater change in temperature and the greater change in concentration of weak solutions may account for this.

For currents between 0.1 and 0.2 ampere, the polarization on the end electrodes was:—

For H_2SO_4, 1.84;
" NaCl, 1.98;
" $CuSO_4$, 0.00, with Cu electrodes, though, if the current density was too great or the time long, the anode would oxidize and become irregular. C. Fromme, in a paper, "Ueber das Maximum der galvanischen Polarisation von Platinelektroden in Schwefelsäure" (*Annalen d. Physik u. Chemie*, Band XXXIII., s. 80–126), states that the maximum polarization varies both with the concentration and the relative size of the electrodes, the extreme limits being given as 1.45 to 4.31 volts — the minimum polarization coinciding with maximum conductivity. His method for measuring polarization was somewhat similar to that used in this work. As bearing upon "the change of polarization with time," I would refer especially to the investigation of Dr. E. Root upon this subject, discussed by Professor von Helmholtz, *Wisch. Abh.*, Vol. I., page 835. These experiments by Dr. Root seem to prove clearly that the liberated ions penetrate deeply into the electrode, even when liberated upon but one side of it, as in this case. I take great pleasure in expressing here my thanks and deep obligation to Professor A. Kundt and Dr. L. Arons for their kind sympathy and direction in this work.

Using $CuSO_4$ on one side of the partition, and H_2SO_4 on the other side, careful determinations have developed the curious fact that, although there is no visible development of ions (neither Cu nor O) at the gold-leaf partition, yet the Cu does not pass through the gold-leaf with the current, but H appears on the cathode instead, provided the current density at the partition be not greater than about .2 ampere per square centimetre.

The "critical current-density" at which the ions just begin to appear visibly on a gold-leaf partition varies for different electrolytes between the limit of 5.7 amperes for 30 per cent H_2SO_4 and sensibly zero for lead acetate.

This "critical current-density" is proportioned to the conductivity of the electrolyte. It therefore also has a decided positive temperature co-efficient.

ON THE FORMATION OF ALUMINUM SULPHATE IN THE SHALES THROWN FROM COAL-MINES.

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My attention was recently called to a white crystaline formation found on and between the layers of a red-colored shale that is much used for walks in Columbia, Mo., and is obtained from the old waste heaps of coal-mines in the vicinity. Upon examination I found it to consist of aluminum sulphate, which is readily soluble in water, and has an alum-like taste. Occasionally some iron sulphate is present. The question arose as to how the aluminum sulphate was formed in between, and on, the layers of the shale.

For the purpose of studying the formation, I visited the Reece mine at Henry Station, on the Wabash railroad, and there collected the following waste materials as thrown from the mine, viz., fire-clay taken from below the coal, clay-parting from a layer about six inches from the bottom of the coal seam, iron pyrites mixed with coal from spots throughout the coal seam, clay containing iron pyrites and carbonaceous matter from just above the coal, and a blue argillaceous shale from above the coal.

The waste materials thrown from the mine, and exposed to the air and moisture, go through the process of slacking or burning, and it is during this process that the aluminum sulphate is formed. I also collected specimens from the burned and from the burning heaps about the mine.

Upon examination of the fresh specimens I found that the fire-clay contained no free aluminum compound that would form aluminum sulphate after the slacking or oxidation of the heaps. The clay-parting and other specimens containing iron pyrites and carbonaceous matter, will oxidize so rapidly when exposed to the air that the mass takes fire and we have iron sulphate and sulphuric acid formed. The sulphuric acid combines with the aluminum in the shales and clays about it, forming aluminum sulphate which crystalizes on the surface.

The shale from above the coal contains some simple compound of aluminum (probably the hydrate), and a considerable quantity of free sulphur. The presence of the aluminum was shown by the cobalt-nitrate test, and, also, when some of the shale was boiled with hydrochloric acid and filtered, the solution gave a white precipitate of aluminum hydrate upon the addition of ammonium hydrate.

Some pieces of the shale contained so much free sulphur that they would burn, upon ignition, with a blue flame, giving off fumes of sulphur dioxide. When some of the powdered shale was leached with carbon dioxide, and the solution evaporated, a residue of sulphur was obtained. These tests indicate that the sulphur and aluminum thoroughly penetrate the shale. When the heaps burn the sulphur becomes highly oxidized, and combines with the aluminum, forming aluminum sulphate within the shale. Heat drives the aluminum sulphate to the surfaces, hence it will crystalize between the layers and on the surfaces of the shale.

Free sulphur is found deposited in a crust at the top of the burning heaps. This shows that there is an excess of free sulphur in the waste materials.

The red color of the shale is due to the red oxide of iron formed when the water is driven off by the heat.

CURRENT NOTES ON ANTHROPOLOGY. — XXX.

[*Edited by D. G. Brinton, M.D., LL.D., D.Sc.*]

Prehistoric Ethnography of Northeastern Africa.

THERE are two very learned and suggestive articles in the *Beiträge zur Assyriologie*, Bd. II., Heft II., 1892, which may be combined to present the latest substantial opinions on the relations and sequence of linquistic stocks in the valley of the Nile and the lands adjacent. The one is by Franz Pastorius, on the Hamitic languages of East Africa; the other on the relations of the Semitic and Old Egyptian languages, by Fritz Hommel. In what I present on the latter theme, I have also had the advantage of a paper read before the Oriental Club of Philadelphia, by the able egyptologist, Professor W. Max Müller.

Scarcely any question in early ethnography could be more important. It touches directly on the origin of the two oldest civilizations of the world, — the Egyptian and the Babylonian. According to Hommel, the Old Egyptian of the Pyramid Texts, and the Old Babylonian (Semitic) tongues agree so closely in grammar, in sequence of words, in phonetics, and in lexicography, that their near relationship or their common origin must be admitted. Professor Müller informs me that in the Egyptian of the Rammesside epoch at least sixty per cent of the words in use were clearly Semitic. These relations are, however, distinctly not with the western Semites, but directly between the eastern Semitic (Babylonian) and the Old Egyptian. Hommel very pertinently adds that this by no means justifies the conclusion that the original home, *die ursprüngliche Heimat*, of the common stock was in the valley of the Euphrates; it might just as well have been on the Nile.

Some strength is given to the latter possibility by his comparisons of the Old Egyptian with the Berber dialects. He finds that the lexicon of these latter is Old Lybian, but that their grammar and syntax are very closely related to the Old Egyptian. There is no doubt but that the characteristic forms of the perfect and imperfect tenses were at one time common to the Berber, the Old Egyptian and the Semitic tongues. Besides these, as pointed out by Pastorius, the Hamitic (or Berber) dialects had in common with the original Semitic the personal pronouns, the feminine in *t*, and a number of minor structural elements. He is convinced that the East African Hamites (sometimes called Kushites) have been dwellers on the upper tributaries of the Nile, in Abyssinia, for many thousand years. Of their dialects,