place at which he does invoke the assistance of reversed selection is exactly the place at which reversed selection must necessarily have ceased to act. This place, as already explained, is where an obsolescent organ has become rudimentary, or, as above supposed, reduced to 5 per cent. of its original size; and the reason why he invokes the aid of reversed selection at this place is in order to save his doctrine of "the stability of germ-plasm." That the force of heredity should finally become exhausted if no longer *maintained* by the *presence* of selection, is what Darwin's theory of perishable gemmules would expect to be the case, while such a fact would be fatal to Weismann's theory of an imperishable germ-plasm. Therefore he seeks to explain the eventual failure of heredity (which is certainly a fact) by supposing that after the point at which the cessation of selection alone can no longer act (and which his first oversight has placed some 70 per cent. too low), the reversal of selection will begin to act directly against the force of heredity as regards the diminishing organ, until such direct action of reversed selection will have removed the organ altogether. Or, in his own words, "The complete disappearance of a rudimentary organ can only take place by the operation of natural selection; this principle will lead to its diminution, inasmuch as the disappearing structure takes the place and the nutriment of other useful and important organs." That is to say, the rudimentary organ finally disappears, not because the force of heredity is finally exhausted, but because natural selection has begun to utilize this force against the continuance of the organ—always picking out those congenital variations of the organ which are of smallest size, and thus, by its now *reversed* action, *reversing* the force of heredity as regards the organ.

Now, the oversight here is that the smaller the disappearing structure becomes, the less hold must "this principle" of reversed selection retain upon it. As above observed, during the earlier stages of reduction (or while co-operating with the cessation of selection) the reversal of selection will be at its *maximum* of efficiency; but, as the process of diminution continues, a point must eventually be reached at which the reversal of selection can no longer act. Take the original mass of a now obsolescent organ in relation to that of the entire organism of which it then formed a part to be represented by the ratio 1 : 100. For the sake of argument we may assume that the mass of the organism has throughout remained constant, and that by "mass" in both cases is meant capacity for absorbing nutriment, causing weight, occupying space, and so forth. Now, we may further assume that when the mass of the organ stood to that of its organism in the ratio of 1 : 100, natural selection was strongly reversed with respect to the organ. But when this ratio fell to 1 : 1000, the activity of such reversal must have become enormously diminished, even if it still continued to exercise any influence at all. For we must remember, on the one hand, that the reversal of selection can only act so long as the presence of a diminishing organ continues to be so injurious that variations in its size are matters of life and death in the struggle for existence; and, on the other hand, that natural selection in the case of the diminishing organ does not have reference to the presence and the absence of the organ, but only to such variations in its mass as any given generation may supply. Now, the process of reduction does not end even at 1 : 1000. It goes on to 1 : 10,000, and eventually 1 : ∞. Consequently, however great our faith in natural selection may be, a point must eventually come for all of us at which we can no longer believe that the reduction of an obsolescent organ is due to this cause. And I cannot doubt that if Prof. Weismann had sufficiently considered the matter, he would not have committed himself to the statement that "the complete disappearance of a rudimentary organ can only take place by the operation of natural selection."

According to my view of the matter, the complete disappearance of a rudimentary organ can only take place by the *cessation* of natural selection, which permits the eventual exhaustion of heredity, when heredity is thus simply left to itself. During all the earlier stages of reduction, the cessation of positive selection was assisted in its work by the activity of negative or reversed selection; but when the rudiment became too small for such assistance any longer to be supplied, the rudiment persisted in that greatly reduced condition until the force of heredity with regard to it was eventually worn out. This appears to me, as it appeared to me in 1874, the only reasonable conclusion that can be drawn from the facts. And it is because this conclusion is fatal to Prof. Weismann's doctrine of the permanent "stability" of germ-plasm, while quite in accordance with all theories which belong to the family of pangenesis, that I deem the facts of degeneration of great importance as tests between these rival interpretations of the facts of heredity. It is on this account that I have occupied so much space with the foregoing discussion; and I shall be glad to ascertain whether any of the followers of Prof. Weismann are able to controvert the views which I have thus re-published.

London, February 4. GEORGE J. ROMANES.

P.S.—Since the above article was sent in, Prof. Weismann has published in these columns (February 6) his reply to a criticism by Prof. Vines (October 24, 1889). In this reply he appears to have considerably modified his views on the theory of degeneration; for while in his essays he says (as in the passage above quoted) that "the complete disappearance of a rudimentary organ can only take place by the operation of natural selection"—*i.e.* only by the *reversal* of selection,—in his reply to Prof. Vines he says, "I believe that I have proved that organs no longer in use become rudimentary, and must finally disappear, solely by 'panmixia'; not through the direct action of disuse, but because natural selection no longer sustains their standard structure"—*i.e.* solely by the *cessation* of selection. Obviously, there is here a flat contradiction. If Prof. Weismann now believes that a rudimentary organ "must finally disappear *solely*" through the *withdrawal* of selection, he has abandoned his previous belief that "the complete disappearance of a rudimentary organ can *only* take place by the *operation* of selection." And this change of belief on his part is a matter of the highest importance to his system of theories as a whole, since it betokens a surrender of his doctrine of the "stability" of germ-plasm—or of the virtually everlasting persistence of the force of heredity, and the consequent necessity for a reversal of this force itself (by natural selection placing its premium on *minus* instead of on *plus* variations) in order that a rudimentary organ should finally disappear. In other words, it now seems he no longer believes that the force of heredity in one direction (that of sustaining a rudimentary organ) can only be abolished by the active influence of natural selection determining this force in the opposite direction (that of removing a rudimentary organ). It seems he now believes that the force of heredity, if merely left to itself by the withdrawal of natural selection altogether, will sooner or later become exhausted through the mere lapse of time. This, of course, is in all respects my own theory of the matter as originally published in these columns; but I do not see how it is to be reconciled with Prof. Weismann's doctrine of so high a degree of stability on the part of germ-plasm, that we must look to the Protozoa and the Protophyta for the original source of congenital variations as now exhibited by the Metazoa and Metaphyta. Nevertheless, and so far as the philosophy of degeneration is concerned, I shall be very glad if (as it now appears) Prof. Weismann's more recent contemplation has brought his principle of panmixia into exact coincidence with that of my cessation of selection.—G. J. R.

Newton in Perspective.

THE interesting modern science termed by the Germans *Geometrie der Lage*, and by the French and other Latin peoples *géométrie de position*, may be traced in germ to that part of Newton's "Principia" which deals with the construction of curves of the second order, and to what has survived in tradition of Pascal's lost manuscript entitled "Traité complet des Coniques." The more recent developments of this important subject cast much new light upon Newton's propositions, many of which we are now enabled to solve by easier and more direct methods. A noteworthy example is here fully worked out, in order to show how problems which Newton solved by indirect and circuitous processes may be solved more simply by the aid of modern graphics.

PROBLEM.—*Given the four tangents EA, AB, BC′, C′D* (*Fig.* 1), *as well as a point of contact; to construct the conic.*—First it will be necessary to give some faint idea of Newton's solution of this problem, without entering upon details which can be found in the Latin edition of the "Principia" edited by Sir William Thomson and Prof. H. Blackburn. Having expounded at great length a general theorem for the transformation of curves, Newton transforms the quadrilateral figure formed by the four tangents into a parallelogram. Then he joins the given point of contact y, transformed according to the same principle as the given four tangents, to the centre O of the parallelogram

—which is also the centre of the conic—and producing the line yO to y', so that Oy' may be equal to Oy, he determines a second point of contact y' on the conic, by which means the problem is reduced to the case dealt with in the preceding proposition, showing how to construct the curve when three tangents and two points are given. Having in this way found five points on the transformed conic, Newton next proceeds to retransform the whole of the figure to its original shape, in order to apply his well-known method of constructing a conic of which five points are known.

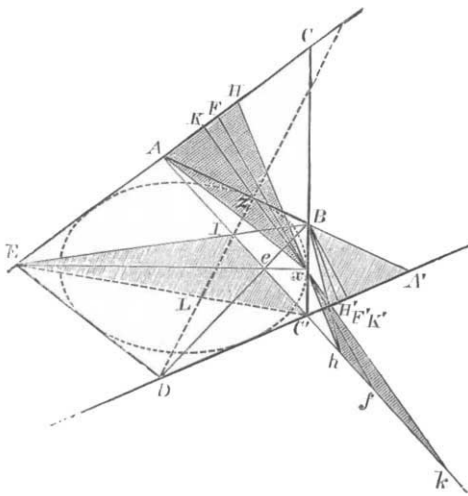

FIG. 1.

Now all these transformations and retransformations of lines and quadrangles involve very tedious and laborious operations, which can be avoided by borrowing a few simple principles of modern geometry. The following two original solutions of the above problem will serve to illustrate this statement.

SOLUTION.—*Case* I. *When the given point of contact x lies on one of the given four tangents.*—Assume the given point of contact x and the neighbouring apex B of the quadrangle as centres of projection, and the given tangent lines EA and C′D as punctuated lines. The meaning of the term "punctuated line," familiar to students of modern geometry, will appear in the sequel.

It will be seen that the fourth tangent AB cuts the first punctuated line EA in A and the second punctuated line C′D in A′. Now, according to a proposition of modern geometry, if the points A and A′, in which the tangent AB intersects the two punctuated tangents EA and C′D, be projected by rays xA and BA′ issuing from their respective centres of projection x and B, those rays will meet in a point A, situate on what is termed the perspective line of the pencils x and B.

Next imagine the tangent AB to revolve upon the curve so as gradually to approach the limiting position BC. In that case A will approach C, B will fall upon C′, and the intersection of the projecting rays xC and BC′ will coincide with C′, which is therefore a second point on AC′, the required perspective line of the pencils x and B. Wherefore, in order to find a fifth or any number of tangents to the curve, choose any point E on the punctuated line EA, and project this point from x, the corresponding centre of projection, upon the perspective line AC′ in e; and then project e from the second centre of projection B upon the corresponding punctuated line C′D in D. The line ED is a fifth tangent to the conic, and any number of tangents can be drawn in precisely the same way. Then, let F be any other point on EA. Join and produce Fx, intersecting the perspective line AC′ in f; and from the centre B project f upon the punctuated tangent C′D in F′. Then the line FF′ will be a sixth tangent to the conic.

COR. I.—Since the lines AC′, BD, and xE all meet in the same point e, it follows that, in any pentagon ABC′DE circumscribed to a conic, the opposite diagonals AC′ and BD and the line joining the fifth point E to the opposite point of contact x all meet in the same point.

Case II. *When the given point of contact z lies outside of the four tangents AEDC′B.*—By the corollary, Case I., if AB be the fifth tangent, it must pass through the given point of contact z in such a direction that the diagonals C′A and EB may intersect in a point I situate on a given line Dz.

Now let AB revolve about the fixed point of contact z as a fulcrum, whilst A and B describe the lines EC and CC′ (Figs. 1 and 2). Then, necessarily, z will be the centre of perspectivity of the punctuated lines EC and CC′, whose centres of projection are respectively C′ and E. But, by a well-known proposition of geometry of position, when the points of two converging punctuated lines, such as EC and CC′, are projected from opposite centres in this fashion, the locus of the successive intersections of the rays C′A and EB, or in other words the variable position of the point I, will describe a conic, which in the present instance is a hyperbola. But the problem is how to find the point I on the transversal Lz without constructing the hyperbola, four points on which are already known. For it will be observed that, when A coincides with E, the point B will lie on the prolongation of Ez, and the corresponding projecting rays Ez and C′E will meet in E, a point on the hyperbola. Similarly C′ is a second point on the hyperbola. Again, as AB continues to revolve about the fixed centre of perspectivity z, its intersections A and B with the punctuated lines EC and CC′ will ultimately coalesce in the point C, common to both those lines. Hence, since in that case the rays projecting the double point C from the centres E and C′ meet in C, this point must lie on the hyperbola.

Fourthly, if the line Cz be produced to intersect the line EC′ in N, it can be easily shown that i, the third point in the harmonic ratio GziN, is a fourth point on the hyperbola. A fifth point can be found by simply drawing AB in any direction traversing z and intersecting EC in A′ and CC′ in B′, and then projecting A′ and B′ from the centres C′ and E respectively by rays C′A′ and EB′ which will meet in a fifth point upon the hyperbola.

Thus, given these or in fact any five points EDiTH (Fig. 2)

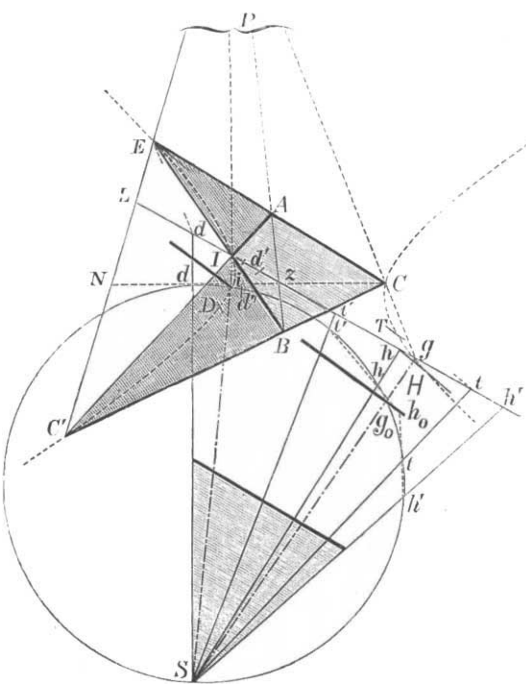

FIG. 2.

on the hyperbola, it is possible to find the point of intersection I of the given transversal Lz with the hyperbola without constructing the curve. First describe any circle in the plane of the five points, choosing two of these, such as E and i, as centres of projection from which to project the remaining three points DHT upon the given transversal Lz in the points dht

and $d'h't'$ respectively. Then, from any point S on the circumference of the circle, reproject the six points dht, $d'h't'$, upon the same circumference in the points similarly lettered.

By means of this double projection from the centres E and i the points DHT have been transferred in duplicate from the hyperbola to the circle, or from one conic to another of a different species; and it is proved in treatises on modern geometry that points so transferred lose none of their projective properties. Hence the points dht and $d'h't'$ on the circumference of the circle are allied projective systems. Therefore, in order to find the perspective line common to both systems, choose one point t of the first set as the centre of projection of the second system; and make t', the correlative point of the second set, the centre of projection of the system dht.

From t project the points d' and h' by rays td' and th', and from t' project the correlative points d and h by rays $t'd$ and $t'h$. Then the correlative rays td' and $t'd$ will intersect in a point d_0 on the required perspective line; and the correlative rays th' and $t'h$ will meet in h_0, a second point on the same line. This perspective line d_0h_0 will intersect the circumference in two points i_0 and g_0 which, being joined to S and produced, will determine the double points I and g common to the hyperbola and transversal Lz. The complete quadrangle EC'IC shows that the harmonic ratios CziN and gzIL are segments of the same harmonic pencil P.

The lines Ez and C'z are tangents to the curve at E and C' respectively; and z is the pole of the polar EC' with respect to the hyperbola. The proofs of these last two deductions may be found in any good text-book on geometry of position.

ROBERT H. GRAHAM.

Thought and Breathing.

PROF. MAX MÜLLER's article on thought and breathing, in your issue of February 6 (p. 317) has just come into my hands. In it he states that the power of retaining the breath is practised largely by Hindus as a means towards a higher object, viz. the abstraction of the organs of the human body from their natural functions. The same custom prevails amongst a certain sect of Mahometans also—the so-called Softas.

In 1878, when in the Central Provinces of India, I came across a native Christian—Softa Ali, as he was called—who had a history. His father had been a Cazi—or religious judge—and a wealthy man, who through scruples of conscience fell into disgrace with a certain native ruler, lost his all, and was banished. His son was, or became, a Softa, and after some years embraced Christianity from conviction, and at great cost to himself—for his wife and children would no longer consort with him. When describing to me the practices formerly enjoined upon him by his religion, this man stated that a Softa is required to draw in and retain his breath and respire it again in various manners. He did not give full details as to how this should be effected, but said that the object of this procedure was to worship with every organ of one's body—heart, lungs, &c., in turn. He added that this practice was a fruitful source of heart-disease.

The following year, when staying at Futtehpore Sikri, near Agra, I saw and heard a Mahometan, unknown to himself, make his evening devotions near the tomb of Suleem Chisti in the way above described; his movements, and the sounds he uttered, were most peculiar.

It has been often related, from well-attested evidence, that in the case of those who have been recovered from drowning, or of those who have been hung and cut down before life was extinct, a kind of automatic consciousness seems to be extraordinarily active in them at the time of their peril. It would appear that, as regards Hindu and Mahometan devotees, and the drowning or partially hung man, a kind of asphyxia is the result, and that, when sensation is almost gone, the intelligence acquires increased activity. In our ordinary life, if our minds are intently fixed upon a subject, we instinctively and involuntarily retain the breath.

When in Rajputana, and again when on the frontier of Chinese Tibet, I saw in each place a man who, to all appearance, seemed to have attained the power of perfect abstraction. In the former case, the villagers asserted that the devotee rose only once a week from his most uncomfortable and constrained position; in the second instance, the man—a most singular-looking person—remained absolutely immovable the whole day. Both seemed to be in a kind of cataleptic trance.

HARRIET G. M. MURRAY-AYNSLEY.

Former Glacial Periods.

I HAVE long felt convinced that geologists are being misled in reference to former glacial epochs by failing to give due thought to a consideration referred to on former occasions,[1] viz. that when the present surface of the globe has been disintegrated, washed into the sea, and transformed into rock, there will undoubtedly then be about as little evidence that there had been a glacial epoch during post-Tertiary times as there is at present that there was one during Miocene, Eocene, Permian, and other periods.

JAMES CROLL.

Perth, March 6.

AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE formation of this Association, mainly by the efforts of Prof. Liversidge, of Sydney University, and its first meeting in Sydney in August 1888, were noticed at the time in NATURE (vol. xxxviii. pp. 437, 623). One of the chief rules of the Association is that it shall meet in turn in the capital cities of the various colonies; and Melbourne was agreed upon as the second meeting-place. It was found inconvenient, however, to hold the Melbourne meeting during 1889, as should have happened in due course, for it is only after Christmas that all the Universities are simultaneously in vacation; and accordingly it was commenced on the 7th of January in the present year, and was continued through the following week. Some anxiety was felt as to the result of this choice of date, for there is always a risk in January of such continuous heat as would hinder the work and destroy the pleasure of the meeting; but the Association proved to be specially favoured in the matter of weather.

The following are the names of the officers of the Association and of the Sections. With regard to the latter, the rule obtains that Presidents are chosen from other colonies, while Vice-Presidents and Secretaries are chosen from the colony in which the meeting is held.

President, Baron von Mueller, K.C.M.G., F.R.S.

Local Treasurer, R. L. J. Ellery, C.M.G., F.R.S.

General Secretaries: Prof. Archd. Liversidge, F.R.S., Permanent Hon. Secretary; Prof. W. Baldwin Spencer, Hon. Sec. for Victoria.

Assistant Secretary for Victoria, J. Steele Robertson.

Sectional Officers:—Section A (Astronomy, Mathematics, Physics, and Mechanics)—President, Prof. Threlfall, Sydney University. Vice-President, Prof. Lyle, Melbourne University. Secretaries: W. Sutherland, E. F. J. Love.

Section B (Chemistry and Mineralogy)—President, Prof. Rennie, Adelaide University. Vice-President, C. R. Blackett, Government Analyst, Melbourne. Secretary, Prof. Orme Masson, Melbourne University.

Section C (Geology and Palæontology—President, Prof. Hutton, Canterbury College, New Zealand. Vice-President, Prof. McCoy, C.M.G., F.R.S., Melbourne University. Secretary, James Sterling,

Section D (Biology)—President, Prof. A. P. Thomas, Auckland. Vice-Presidents: J. Bracebridge Wilson; P. H. MacGillivray. Secretaries: C. A. Topp, Arthur Dendy.

Section E (Geography)—President, W. H. Miskin, President of the Queensland Branch of the Royal Geographical Society of Australasia. Vice-Presidents: Commander Crawford Pasco, R.N.; A. C. Macdonald. Secretary, G. S. Griffiths.

Section F (Economic and Social Science and Statistics —President, R. M. Johnson, Registrar-General, Hobart. Vice-President, Prof. Elkington, Melbourne University. Secretaries: A. Sutherland, H. K. Rusden.

Section G (Anthropology)—President, Hon. J. Forrest, C.M.G., Commissioner for Crown Lands, Western

[1] Quart. Journ. Geol. Soc. for May 1889; "Climate and Time," p. 266.