the calculation, he made use of the method employed by L. Struve in his memoir on the determination of the movement of the solar system, in order that the two results might be strictly comparable. Prof. Bakhuyzen has also repeated the calculations, using stars in the same part of the heavens as the above, but with proper motions not exceeding 0″·075. The first method gave, as the position of the apex,

R.A. = 264°, Decl. = 30°.

The result obtained by the second calculation was—

R.A. = 290°, Decl. = 24°.

The position found by L. Struve was—

R.A. = 273°·3, Decl. = 27°·3.

Prof. Bakhuyzen is at present occupied in determining the apex from stars of small proper motion in the Milky Way.

THE ORIGIN OF NEW STARS.—In the current number of *Die Natur* Prof. G. Hoffmann surveys the various new stars discovered since Tycho Brahe's Nova Cassiopeiæ, and the different theories advanced to account for their appearance. He is inclined to endorse the views of Prof. Seeliger, according to which the sudden brightness is produced by a heavenly body entering a "cosmic cloud" consisting of sparsely distributed matter. Prof. Hoffmann thinks that all new stars may be regarded as essentially of the same type as the variables of long period.

THE MINUTE STRUCTURE OF PLANT HYBRIDS.[1]

DR. MACFARLANE'S paper will not fail to impress biologists by the suggestiveness of some of his speculations and with the importance of his observations. Nor are his conclusions limited to the plant hybrids, which he discusses, but they apply, though with certain limitations, to all organisms resulting from sexual reproduction.

Of course, in the case of hybrids, the parental characters are often very different, and can therefore be easily recognised in the offspring, whence the examination of their characters, including, of course, their minute anatomy, becomes important to all who are interested in the problems of reproduction. For in the case of fusion of reproductive cells of the same species, where the parental characters differ often very slightly, it is difficult, and at times impossible, to distinguish whether the characteristics of the male or female parent predominate, or whether a complete blending has taken place. Theoretically perhaps we should expect this blending of characters, but our everyday experience brings to our mind so many instances of almost unadulterated inheritance of paternal or maternal characteristics, that we are somewhat prejudiced against a conclusion to which Dr. Macfarlane's observations on hybrids lead him, and which ought equally to apply to normal offspring.

The study no doubt presents many difficulties, which are, it is true, recognised by the author, but do not seem to him insuperable. First and foremost we have the variability of what are usually termed true species; and the author is careful to point out that "for hybrid investigation one should be acquainted with the parent individuals and the conditions under which they were grown, or try to choose an average specimen for study." But in either case errors may creep in. For if one of the parents has varied abnormally, though some of the offspring will inherit such a variation, others may revert to the more normal condition of their grandparents or great-grandparents. If, on the other hand, we choose the average specimen, we are entirely in the dark as to any special variation of the parental form. Nothing short of selecting normal individuals as parents and examining all or a large number of the hybrid offspring would afford sufficient basis for such conclusions, as the author deduces from his less complete observations. But Dr. Macfarlane does not even state in each case whether his observations are taken from the parents themselves, or only from average specimens.

The conditions of growth, too, enormously affect some of the characters which the author has chosen for comparison. The character of leaves for instance, especially as regards their transpiratory functions, can be completely altered by the treatment of the young plant. If, therefore, the number of stomata per unit of surface are to be of any value for comparison of forms, both the parents and the offspring must be raised under similar conditions. If this is not the case we should expect the offspring to resemble in this particular that parent which was grown under conditions most similar to itself. Nor does the author fail to find such a case. *Hedychium Sadlerianum* approaches very nearly in the number of stomata on the lower surface the condition of one of its parents, *H. coronarium;* but we are told nothing as to the condition under which the parents or offspring were reared, and the tendency to "sway towards one parent" is explained by the assumption that it is "a morphological adaptation in the hybrid for physiological work, or in the truest sense a case of physiological selection."

Having thus briefly stated some of the difficulties besetting the problem, we may state that all his observations and measurements, down to the size of the plastids and starch grains, lead the author to the conclusion that plant hybrids, at least seed hybrids, are, both in their minute structure and in their general life-phenomena, intermediate between their parents.

This complete blending is, to say the least, very extraordinary, and we are tempted to question whether the author has investigated a sufficient number of individuals of each hybrid. Surely the variability of hybrids would be sufficient to supply any investigator with numerous examples which were not intermediate. The unanimity of the observations published make it imperative that some further investigations should be undertaken with regard to the variability of hybrids, a factor to which sufficient prominence is not given in the present paper.

Darwin insists both in his "Forms of Flowers" and also in his "Cross and Self-fertilisation of Plants," upon the correspondence between the crossing of distinct species and legitimate unions of dimorphic and trimorphic heterostyled plants. Yet from Dr. Macfarlane's paper we must conclude that in some respects at least there is no correspondence.

For Darwin states that though "the shape of the stigma and the length of pistil both vary, especially in the short styled form, I have never met with any transitional states between the two forms in plants growing in a state of nature." Now the difference in these forms extends also to anatomical details, such as the size of the pollen-grain and the size of the stigmatic hairs; and yet the offspring will all resemble either one or the other parent, and thus differ radically from all the hybrids which Dr. Macfarlane has examined, all of which represent forms intermediate between the two parents. Dr. Macfarlane has of course come across some exceptions, but we are not told whether they are merely individual variations approaching one or other of the parents, such as we should expect to find, or whether in the production of the hybrid there was always a tendency to approximate the male or female form. Whichever be the case, the author is of the opinion that the number previously asserted to diverge towards one of the parents has been considerably overestimated.

The author's contribution, however, to the investigation and discussion of graft hybrids is extremely valuable, and we cannot help wishing that he had found more similarity in the characters of graft and seed hybrids. We feel convinced, though we should not like to impugn the evidence brought forward, that the latter does not represent the average condition of the structure of plant hybrids, but that there must be more variation in their characters than the author has found in the specimens he was enabled to examine, especially more variation towards one or other of the parent forms, though we should not expect it to be so pronounced as in the case of graft hybrids. F. E. W.

COMPULSORY LAWS OF ERROR IN DRAWING.

Digest of the Phenomena, with Examples.

THE object of the following paper is to present the facts in the briefest and, it is hoped, the plainest possible manner, for the purpose of calling attention to phenomena connected with the art of drawing, or depicting form in outline. It is to prove that error made in such drawing comes under the dominion of natural law, or compulsion, and is not the result of individual misconception of truth. The phenomena are altogether distinct

[1] "A Comparison of the Minute Structure of Plant Hybrids, with that of their Parents, and its Bearing on Biological Problems." By Prof. J. Muirhead Macfarlane. (Transactions of the Royal Society of Edinburgh, vol. xxxvii. part i. no. 14.)

from intellectual aptitude, the intelligent and the dull being equally liable to commit the errors in the forms which will hereafter be specified.

Consideration will first be given to the existence of *general laws*, of which there appear to be three, so strongly marked as to stand clearly distinguishable as including in themselves the minor manifestations. These laws are as follows :—

(1) There is a general law making us fundamentally incapable of drawing in perspective. It is a radical condition—not of ignorance of the laws of perspective but of active negation of them. It is a natural necessity to show by the arrangement of lines the exact contrary to true perspective. It is persistent, and exists long after correct knowledge of the true arrangement of the lines is acquired, and the error is always liable to appear on any occasion of forgetfulness—that is to say, when drawing is not done with the true principles immediately in remembrance in the mind. It is perceivable in the form of direct *divergence* of lines (parallel in nature) which in perspective should *converge* to their vanishing point.

(2) Another general law is a natural incapacity to erect a proper perpendicular for an object unless the same occurs close on the line of direct sight (forward). If the perpendicular be situate laterally, and especially if it be short, it is liable to a deflection. This deflection occurs in the following manner :—If the same be on the right hand the line inclines from its top towards the central line of sight (forward) ; its foot is therefore nearer this central line than its top. On the left hand the phenomena are directly reversed. This error occurs whether the perpendicular be the obvious physical corner line of a solid or whether it be the integral (invisible) line of any such solid or of a drawn figure.

(3) The next general law is less distinct, but still abundantly provable on test. It affects those lines which, being in right angles to the observer, lie laterally to him ; that is to say, if a line of the surface (horizontal) of a figure occur on the right or left hand, at a little distance, the line is not drawn with perspective inclination to the *vanishing point* in front of the observer, but is *drawn as a perpendicular*, or, as is evident, in such a manner as would be the true fact of its direction, void of the influence of perspective. Thus, if a square lie two or three feet to right or left of the draughtsman, those two sides of it which are the sides rectilinear, not sides parallel to the base of the picture-plane, are drawn as two perpendiculars, while they should be converging lines towards a point which leads them diagonal-wise across the paper.

These brief particulars are intended to give an account of the primary, or general, laws. All other manifestations are deducible from them—that is, in every case where a special aspect of a figure draws out its special error, this is seen to have its origin in one or other of these three primary laws. From this point I now proceed to illustrate with examples selected from three figures—the cube, the pyramid, and the hexagon—instances of special error. Other geometrical figures may at a future period be likewise illustrated, but the intention is in this paper only to broach the subject.

The Cube.

It is in all cases assumed the object lies on a table before the observer.

Position 1.—Let the cube be placed on the right or left, and with two planes parallel to the picture-plane, two in right angles.

Error 1.—The perpendiculars will be inclined as radiants upwardly.

Error 2.—The 3 perspectives visible will diverge.

Error 3.—Or these will be neutralised of perspective, and the true perpendiculars be inclined.

Position 2.—Let the cube be situate anglewise on the direct line of sight.

Error 1.—All 6 perspectives to right and left diverge.

Error 2.—Or the top is drawn as a *square*.

Position 3.—Poise the cube on an edge, so that one plane, resting exactly balanced on its corner, is in the direct front, and parallel to picture-plane.

Error 1.—The perspectives (3) will diverge.

Error 2.—The square of the front plane will be confused as rhomboidal.

Position 4.—Still having the cube poised on an edge, let it be turned so that three faces are seen at one time, and it presents perspectives in 9 lines.

Error 1.—All the perspectives, in groups of 3 each, for each plane, will diverge.

The Pyramid (Square).

Position 1.—Let the pyramid lie exactly in front, parallel to the picture-plane.

Error 1.—The two parallel edges of the square base, extending in right angles from the eye, will diverge.

Error 2.—The further side of the pyramid will thus be longer than the nearer side.

Position 2.—Let the pyramid lie on the same spot, but with an angle presented, so that the sides of the square extend in equal angles.

Error 1.—If the view of it should be isometrical, or the pyramid *flattish*, the perspectives will be shown diverging.

Position 3.—Place the pyramid point downwards towards the observer, in front, and with one side for a base.

Error 1.—The two parallel retiring lines of the inclined *real base* will show divergence.

Error 2.—Consequently, the further line of base will be longer than the nearer and upper of this sloping square.

Position 4.—Place the pyramid so that it still lies on a side for a base, but in front, and the apex and the central point of a side of the real base are on a line parallel to picture-plane.

Error 1.—The apex, which should thus lie horizontally *even* with the central point of that line of real base, which touches the ground, will be shown *below* that line. The true relation to central point given is never seen.

Error 2.—Such perspectives as occur will diverge.

The Hexagon.

Position 1.—Place a solid hexagon upright in the exact front of observer, with two planes parallel to picture-plane.

Error 1.—All perspectives of the parallel sides will diverge.

Error 2.—Consequently, the two parallel lines (integral) which connect opposite angles of the hexagon will lose *their* perspective.

Position 2.—Place the hexagon on a side, so that its lines, then horizontal, are parallel to picture-plane and the object is in a lateral situation, or not in front.

Error 1. The end, which is now a plane in right angles, will show the integral connecting lines between top and bottom angles *leaning*, because these are essentially perpendicular ; therefore the perpendicularity is distorted. (General law 1.)

Error 2.—The line (integral) connecting the two angles midway between top and base line of this plane, and which should be of course *parallel* to these, and partaking of their perspective, will have a course diagonal to them, always, deflected downwards.

Error 3.—The lines which indicate the further, or unseen plane of hexagon will show exact conformity to this error ; also diverging perspective.

Position 4.—Place the hexagon again laterally, with its end as a front plane, and a side on the ground, the direction of the object being in a due rectilinear line.

Error 1.—The perspective bias will be lost (general law 3) and the lines traced as perpendiculars.

Error 2.—Or these will indicate divergence in place of convergence.

Error 3.—The plane parallel to picture-plane, and essentially void of distortion, will be nevertheless distorted.

Position 3.—Place the hexagon, still resting on a side, so that its lines take a diagonal line with regard to a line parallel to the picture-plane, and it must be in front.

Error 1.—The displacement of the integral perpendiculars will occur in the end planes, as in Error 1 of Position 2.

Error 2.—The Error 2, in Position 2, will be repeated.

Error 3.—The perspectives will diverge.

ARTHUR L. HADDON.

THE DEPARTMENT OF SCIENCE AND ART.

THE fortieth Report of the Department of Science and Art has just been issued, and is of a highly satisfactory character. From it we learn that in 1892 there was a very large increase, not only in the number of students and classes, but also in the number of schools or separate institutions in which science is taught. The number of classes in different branches of science in 1892 was 10,352, as against 8,568 in the preceding year, and