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TRANSACTIONS

OF THE

ROYAL IRISH ACADEMY.

VOL. XII.

THE

TRANSACTIONS

OF THE

ROYAL IRISH ACADEMY.

VOL. XII.

DUBLIN:

Graisberry and Campbell, Back-lane,

PRINTERS TO THE ROYAL IRISH ACADEMY.

1815.

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ERRATA.

SCIENCE.

Page	Line.	
48 —	1	Dele full point after *p*
	11	Dele *p*. after 19″,28
78 —	5	*Read* He derives by, &c.
88 —	11	For $s=i$ read $s=1$

POLITE LITERATURE.

61 —	2	After the word *press* add a comma, and dele the comma after the word *every*
82 —	11	*For* non una *read* nulla
88 —	1	*For* from meaning *read* from the meaning
89 —	27	(Last line of the poetry) *for* Far *read* Fan
97 —	8	*For* these pursuits; *read* their pursuits;
	11	*For* to rectify *read* to purify.

DIRECTIONS TO THE BINDER.

In Science—The Water Spout to be placed opposite page 39.
——————Plate relative to Back Horizon Glass opposite 5.

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SCIENCE.

* The folio of this page, and the seven subsequent ones, are, by an error of the press, duplicates of the folios of the eight preceding pages.

POLITE LITERATURE.

SCIENCE.

AN EXPLANATION

OF THE METHOD OF ADJUSTMENT

OF THE

BACK HORIZON GLASS

OF

HADLEY'S QUADRANT,

BY TWO NEAR OBJECTS:

ALSO A DESCRIPTION

OF A PROJECTED ADDITION TO THE QUADRANT,

FOR REFLECTING THAT ADJUSTMENT ACCORDING TO THE METHOD OF MR. BLAIR,

BY THE REV. JAMES LITTLE.

Read, January 28th, 1811.

HOW desirable as well as difficult it is, to adjust on every occasion the Back Horizon Glass of *Hadley's* Quadrant with necessary precision, is declared by the many different contrivances which have been suggested for that purpose; and this I hope will procure an indulgent approbation of the present, as well as the future, attempts that may be made for that end, till it shall be accomplished in every manner desirable. The mode of its adjustment, by two near objects, has been described by the late *Rev. Mr. Ludlam* in his treatise on the quadrant; and it may by this be accurately performed, if executed with due and intelligent attention to the requisite circumstances: but as neither *Mr. Ludlam*, nor any other person that I know, has explained the grounds of the directions he has given; and as these directions will probably be applied in an unskilful and negligent manner, unless it be generally understood and impressed of what importance they are: as moreover this is the method, at least the most generally practicable, of adjusting the back hor^{n}. glass, as well as of trying the accuracy of the construction of the quadrant for effecting it in *Mr. Blair's* method; and is also subservient to the contrivance hereafter mentioned for accomplishing it in the same way; it is necessary, before I proceed to the description of it, to state the principles on which *Mr. Ludlam's* judicious instructions are founded.

He directs that the back horizon glass may be adjusted at right angles to the index glass, by the means of two near objects, such as two lines sustaining plummets in water, or two candles *, &c. lying in the plane of the quadrant placed horizontal, and in a line joining the objects equidistant from the $quad^{t}$.; one of them being before, and the other behind the observer; by reversing the instrument by turning it half round in its own plane, and shifting its position laterally on either side, till the images of the two objects are seen, through the back sight vane, to coincide, when each of them alternately is viewed by the observer, by di-

* When plummets are used, they must be placed at opposite doors or windows against the light of the sky: and if candles be employed, their light should be seen through a small slit in a screen placed before each.

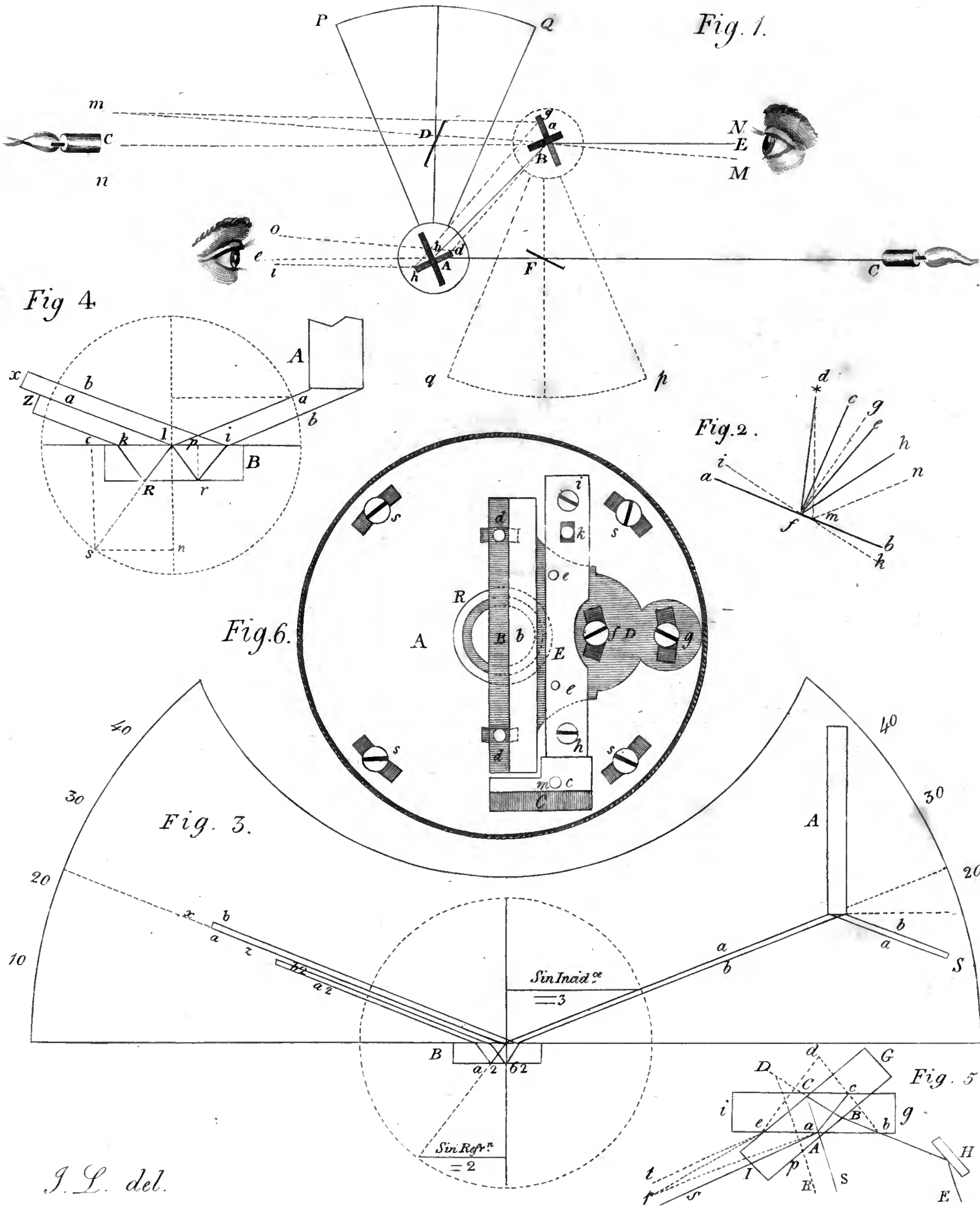


Fig. 1.

Fig. 2.

Fig. 3.

Fig 4.

Fig. 5

Fig. 6.

J. L. del.

rect vision after a half turn of the instrument; the index fixed at o, and the back horizon glass shifted, till the images are brought to coincide, whichsoever of them be viewed directly. The quadrant is to be supported on a moveable stand, on the points of two erected pins fixed on the stand, inserted into two conical holes made in the middle of the heads of the screw pins in the back of the instrument, which fasten the central pins supporting the index and the back horizon glass; the placing the respective glasses alternately on these points, in the manner represented in fig. 1., will reverse the quadrant, by giving it just a semicircular motion in its own plane. The manner of performing this adjustment has been fully described by *Mr. Ludlam*, to whom I refer; but as I have seen no demonstration of its accuracy, I give the following proof of it; assuming the established optical principles.

Let $A\ P\ Q$ (fig. 1.), be the octant, fixed on two points under the centres of the index glass A, and the back horizon glass B, or any two other fixed points; and let C and c be the two candles or objects by which the glass B is to be adjusted. The image of the object C will be seen by the eye E, looking through the sight vane, coincident with the object c, when the stand of the quadrant is properly placed, by the ray $E\ B$, parallel to $A\ C$, if the glasses are at right angles. Let the quadrant now be turned half round, and placed on the points in the position $a\ p\ q$; and if the back horizon glass is properly adjusted, then the eye looking through the vane at *e*, will see the reflected image of the object *c* coincident with the object *C*: because in these different positions of the quadrant, the incident rays become the reflected ones, and *vice versa*; and the index glass in the 2nd position *a*, will be parallel to the same, as it was in the 1st position *A*; as also the horizon glass *b* to *B*.

But if the speculums *A* and *B* were not rightly adjusted at right angles to each other, the reflected ray *B E* in the former position of the quadrant would not be parallel to the incident ray *C A*, but these rays would make an angle, equal, (suppose) to *E B M* (or *E B N*); and consequently this *B M* (or *B N*) is the reflected ray, by which, and in the direction of which, the image of the object *C* is seen: then the object *c* must be placed at *m* (or *n*) in order to coincide with the image of *C*, which appears only in the direction of *M B* (or *N B*). Let them coincide in *m*; and let the quadrant now be turned half round, and put into the position *a p q*; in which the glasses *a* and *A*, and *b* and *B* are parallel: the angle of incidence is now one half of the angle *m a d* greater than half *c a A* or *C A B* by the angle *c a m*; so that the reflected ray *a d* will fall without the angle *c a b*; and will therefore either fall quite without the horizon glass *b*, or at least at a distance from its centre: in the former case the image of *c* would not be seen by the eye at *e* at all, unless the index glass were so long, and the object *c* so near, that a ray *m g* could fall on it in an angle so much less than the half of *m a d*, as that the reflected ray *g h* would fall on the glass *b*, and be again reflected to the eye at *e*.*

But if the rays forming the image are reflected from the middle part only of the mirrors, the image of *m* or *n* could not be seen to coincide with C by the eye at *e*; for if the incident ray were different from *c a*, as suppose *m a*, the re-

* In order to understand the theory of the reflection of the rays forming the image seen in the back horizon glass, the following circumstances are to be considered:

1st, Because the speculum *b* is parallel to *B*, whatever inclination *B* has, which diverts the image of the object *C* from the point *c* to *m*, the same inclination *b* also has, tending to divert the image of *c* to *o*, let the reflected rays *g b* or *a d* fall where they will on the speculum, or with whatever inclination.

2d, If the mirrors were at right angles, the rays *m a*, *m g* would be reflected from the mirror *b*, in a direction parallel to themselves, *i. e.* the ray *m a* falling on the point *d* in the mirror *b*, would be reflected in *d o* parallel to *m a*; and the ray *m g* falling on *h*, in the mirror *b*, would be reflected in *h i* parallel to *m g*: but when the mirrors are inclined to each other, the rays *d o*, and *h i* will decline from such parallelism in an angle equal to *c a m* double the inclination of the mirrors.

3d, When the angle *c a m* exceeds the angle *a m g* subtended by half the length of the mirror *a*, by a difference equal to, or exceeding the angle, subtended by half the length of the horizon glass at the middle of the index glass; all the rays reflected from the latter will fall without the horizon glass, and not be reflected by it; but when the angle *c a m* is less than this, some of the rays incident on the index mirror *a*, will fall from it on the mirror *b*, and be again reflected: and since the object *c* or *m* is so near that there is a considerable difference in the incidences of the rays diverging from it on the mirror *a*, from the point *a* to *g*, (the greatest difference equal to *a m g*), and the same in the reflections from the mirror *b*, the image of the object *c* placed at *m*, may be seen in different places by some of the rays diverging from this mirror.

4th, The difference of the incidences of the rays *m a* and *m g* is that of their reflections in *a d* and *g h*; and the difference of the incidences of *a d* and *g h* will be that of their reflections from the mirror *b*; and the angular motion of the speculum *b* will be half of either these or those, in order to its reflecting one of these rays in the same direction in which the other had been reflected.

flected ray would be different from $a\ b$; *i. e.* it would not fall on the speculum in the point b, nor consequently be seen (by the eye at e), to coincide with C; but would fall without $a\ b$ as at d, and would be reflected in $d\ o$; in which direction the image would be seen, and would be painted in the bottom of the eye, in a different place from that of the direct image of C; so that these images would be divaricated; and it would be necessary to make them unite, by giving such a motion to the little mirror, as would have made the first reflected ray $B\ E$ parallel to the incident ray $C\ A$, by which the first image would be transferred from m to c, and the second image from o to the eye at e.

In the same manner it may be shewn, that if the second reflected ray tended to any point N on the other side of the line $B\ E$, from an inclination of the speculum B on the other side, there would be a divarication of the images to the eye at e, till such inclination of the glass was removed. It also appears that the objects C and c, by which the adjustment is made, may be placed very near the instrument, provided the reflection be made from the middle part only of the glasses, especially of the index-glass, the incidence of rays being different in different parts of it; for unless the sight vane or eye hole for the little mirror, be large, so as that the eye could shift across the vane the axis of vision, which ought to be fixed, or the hole be very near the mirror; the image, if reflected from a part of it distant from the middle, would yet not appear coincident with the object seen directly through the middle, so as to prevent the separation of the images; because when the rays which form both images, cross one another, and proceed in different directions, though they should even cross in the same point in the mirror, yet they will penetrate the eye diverging, and form different images on the retina. But if the image may be seen by reflection from any part of the index-glass *a*, the angle of incidence of a ray *m g*, (of the near object *c* removed to *m*,) falling on that glass at a point *g* distant from its middle point *a*, will be less than that of a ray incident on the point *a*, by the angle *a m g*: (for if the line *a g* were produced, the external angle at *g* would be equal to the angle at *a* and also to *a m g* together; and therefore as much as the external angle at *g* is encreased above that at *a*, as falling toward a perpendicular from *m* to the line *a g* (El. 1. 32. cor.) the internal one, or the angle made with the mirror, is diminished;) but if the incidences on *a* and *g* were equal, the reflections would be so too; i. e. both *m a* and *m g*, and also *ad* and *gh* would be parallel; which is the case when the object is very remote, the angle *a m g* then vanishing. Also since by reflection from any number of plane mirrors, the direction of the rays is changed, but not their inclination to each other, the ang. *a m g* made by the rays incident on the index-glass, will be likewise the measure of their divergence reflected from the horizon glass.* If therefore the glasses

* The angle *b a d* is equal to *c a m*, and the angle made by *e b* and *o d* is equal to either; and an angular motion of the speculum *b* equal to half of any of these

are uncovered, the eye may see the image of *m*, (by rays incident on *a* and *g* in the mirror *a*, and on *d* and *h* in the mirror *b*,) in different places, whose angular distance is *a m g*; and if the sight vane or hole at *e* be of any breadth, the second reflected image may be seen in two extreme places, whose distance will be as near to that angle as the breadth of the vane and of the horizon glass will allow, and it may be also seen coincident with the direct image *C*, because the unsilvered part of the glass *b* extends across its whole breadth, so that in whatever part of it the reflected image appears, the sight may be directed through that part to *C*. *

angles would make *d o* issue parallel to *b e*; but if the speculums were uncovered, the difference only of the angles *a m g* and *c a m* would require to be corrected by an angular motion of the speculum *b*, which would be half of this difference; and this being done the image of *m* would be seen in the direction *b e* by the ray *m g*, while the same image would be visible at an angular distance equal to *a m g*, by the ray *m a*; so that the image of *c* or *m* might be seen in different places under the same inclination of the glasses; i. e. the adjustment would be uncertain.

* To shew that what is here stated is applicable to observations made with the quadrant, let *d* (fig. 2.) be a luminous body, from which light falls on the mirror *a b* with an angle of incidence *d f c*: its image will be visible to an eye at *e* in the direction *e f*, when the angle *e f c* is equal to *c f d*. Let the mirror be turned on its axis *f*, carrying the perpendicular *f c* with it: when this has arrived to the position *f g*, the angle of incidence will be encreased by *c f g*; and the angle of reflection must be augmented by the same, so as now to be equal to *d f g*: if therefore the image is to be seen still in the point *f*, and no other point in the speculum, the eye must be placed at *h*; when *g f h* will be equal to *g f d*; in which case the angle *e f h* will be equal to twice the angular motion *a f i* of the speculum, or of its perpendicular *c f*, which is the same; i. e. *e f h* will be equal to twice *c f g*. If the eye may be shifted from the place *h* to a different place, as *n*, by looking through a hole or vane, whose breadth is equal to the interval *h n*, the image of the object *d* may be seen by reflection from the mirror *i k* in a different place or di-

From this it appears, that to adjust the horizon glass properly by two near objects, the face of both mirrors should be covered, except the middle parts only, or means must be used to view the images by those rays only, which are incident on the middle of both mirrors But if according to *Mr. Ludlam's* direction, the object *C* be seen directly through the middle of the glass *b*, and if the image of no other part of the glass *a*, but its middle part also, can be seen by reflection from the middle of the mirror *b*; then no rays incident on any other part *g* of the index glass could be seen to coincide with the object *C*. Suppose this to be effected as *Mr. Ludlam* directs, by covering the index glass with a piece of card-paper, equal in size to itself, and lying close to it, having a black line marked on the middle perpendicular to the plane of the instrument: and the whole card to be made visible in the horizon glass *b*, and the black line to appear in

rection *n m*, visible in the mirror not in the place *f*, but in *m*, by a ray *d m*, reflected in *m n*, making an angle with the former line of vision *f h* equal to the angle *f d m*; and as the eye shifts along the interval *h n*, carrying with it the axis of vision through the different points in that interval, the line of direction of the image, or its visible place will also shift through the interval *f m* in the mirror with an angular motion finally equal to the angle *f d m*. Hence the place of a very near object seen by reflection from a mirror through a vane, also very close to the mirror as in the back observation for this adjustment, may be very inaccurately determined, unless it be seen only in that place or spot in the mirror from which spot the image had been reflected in a reversed position of the quadrant in the adjustment. When the object *d* is so remote, that the angle *f d m* becomes insensibly small, then the apparent place of the image will be the same, in whatever part of *f m* in the mirror it is seen reflected from: but when the object is near, since the axis of vision cannot be fixed by contracting the eye-hole to a point, the images must be seen in the same place in the mirror.

appear in the middle of *b*, through which the object *C* is seen directly. As the whole card covering the mirror *a*, is seen equidistant from the extremities of *b*, every point in the surface of *a*, and consequently every ray reflected from such point, must be in the same manner seen to preserve their relative positions, and as the picture of *a* seen in *b*, should occupy nearly its whole surface; the extremities of *a*, or any rays reflected from such extremities, could not be seen in the centre of *b*; but if the objects *C* and *c*, being small, could not subtend at the eye so great a space as the whole mirror *a*, the image of *c* would cover but a small part of the image of *a*; and if that image proceeded by reflection not from the centre, but the extremity of *a*, it would be visible in the extremity of the image of *a* as seen in *b*; i. e. at a distance from the centre of *b*, (and consequently remote from the image of *C*;) if it were seen in the centre of *b*, it must be reflected from the centre of *a*; but if the whole surface of *a* were not apparently coincident with that of *b*, this might not be the case.

Hence appears the justness of *Mr. Ludlam's* direction, that the centres of both mirrors should be seen to coincide in the horizon glass with the object seen directly; for the images can appear thus, in both positions of the quadrant coincident only under a certain and invariable position of the specula, though their whole surfaces were uncovered; it is hard however to distinguish by the eye what is the middle part of the back horizon glass.* By the glass hereinafter proposed to be used for Mr. Blair's adjustment, instead of the polished edge of the index glass, the beam of light is reflected to the eye undivided, which will allow the axis of vision to pass through the axis of the back horizon glass; as it ought to do, whether for adjustment of this glass, or for taking angles; and as the axis of vision cannot be the same

* This glass lies so oblique to the eye, that I think it yet remains to be enquired what is to be considered as its middle part, whether the middle of the fore or back surface, or the middle of its substance, or lastly that point in the same, which is the vertex of the angle made by the incident ray with the same refracted by its fore surface after reflection from its silvered surface. It would appear to me of little moment, which of the two beams of light, proceeding singly from the middle of the index-glass, and reflected double from the two surfaces of the horizon glass, be chosen for adjustment as the fixed axis of vision, (for both cannot be indiscriminately used, as emerging from different parts of the glass,) provided the reflected image be seen only by the same beam, issuing from the same part of the horizon glass in all reversals of the quadrant; were it not that the axis of vision ought to pass through the middle or axis of the glass, for the convenience of direct as well as reflex vision; according to which the reflected ray cannot, in the oblique position of the glass, impinge on the middle of either surface; but must be made (by turning the instrument in its plane, and placing the sight vane properly,) to fall on its fore surface between the middle of it, and the edge next the eye, if the reflection is to be made from the fore surface; and between the middle and the remote edge, if the image reflected from the back surface is to be seen. The proper place for reflection in the designed axis of vision, may be marked on the face of the glass, by sticking to it a fine waxed thread; and then the black line on the card before mentioned, covering the face of the index-glass, (or such another thread fixed along the middle of it,) must be made to coincide with this thread in every position of the quadrant for this adjustment; and as two images of the line will appear from the two surfaces, one only of them must be invariably used: the card to be removed in order to view the objects, when the line on it is made coincident with the thread.

for both these, since the incidence of the rays from the middle, and of those from the normal edge of the index glass on the horizon glass, is different; so the position of the back sight vane, and the position and direction of a telescope, (if one be used,) must be altered for these different purposes. The vane may, without moving its support, have its position changed, by having the eye hole made in a little moveable plate fastened on the support; but a complicated motion would be requisite for the telescope, to place it in the best manner for each of the above intentions. If it is expected to answer by only a circular motion of its upright stand, changing its direction, without moving it from its place, the stand should be placed as near as possible to the back horizon glass; for the farther it is removed from it, the more distant in one of its two positions will its axis be from the axis of that glass.

To ascertain the direction of the sight and of the telescope in making an observation by the edge of the index-glass, or of the glass here to be proposed for the same purpose, let a moveable rule or square, perpendicular to the face of the quadrant, be applied to the farther side of the quadrant opposite to the back horizon glass; and when the direct and reflected images are brought to unite, as the eye looks through the axis of the glass, let the rule be shifted, till its edge is made to appear in the place of their coincidence. If then a mark be made on the side of the quadrant at the edge of the rule, a line drawn from the mark through the axis of the horizon glass, will point out the axis of vision and direction of the telescope. If the position of the latter be wrong, the observations will be erroneous, unless *Mr. Hadley's* correction be applied. *

If the object which by the eye at *E* is seen in *m*, i. e. the object *c* removed to *m*, were to be brought to appear to the eye at *e* to coincide with *C*, by giving the mirror *b* an angular motion sufficient for this, such motion would be too great; for then the incident ray *m a*, and the reflected ray *b e*, would not be parallel, nor consequently the glasses perpendicular: only half this motion must be given, and then the stand changed, or the object *m* moved to *c*, till the object and image are made to unite; (it being the same in effect, whether the stand be moved toward the object, or line joining the objects, or the object toward the stand); and then the quadrant must be turned half round to its first position, and the images brought half way together by turning the horizon glass and united as before: this to be repeated at every semirevolution, so often as necessary, till the adjustment of the horizon glass is perfected.

When the objects *C* & *c* are very distant, a small removal of the quadrant to the right or left of a line joining the objects,

* Whether the eye, which is itself a telescope, and with a large aperture, ever requires a correction of this sort, when it looks through a sight vane, is not questioned; nor whether it views any thing obliquely; i. e. whether its axis be always the axis of its vision; but enough is said here to shew the errors that may arise in some cases, from looking through an eye hole or vane of too great magnitude; and these errors would not be corrected by using a telescope, unless *Mr. Hadley's* correction, (in his 5th corollary,) were applied.

will make no sensible difference in the angle of incidence and reflection of the rays, nor consequently alter the place of the images, as would be the case if the objects were near.

If the quadrant, instead of being turned half round from the position *A P Q* to *a p q*, were to be so inverted, that the index and horizon glasses *A* and *B* should be placed on the lines *E c*, *C e*, the adjustment could not be made, unless the objects were so remote, that the interval between the glasses would make an insensible angle at either of the objects, and that any little motion on either side of a line joining the objects, which might accidentally be given in reversing the quadrant, would cause likewise only an imperceptible divarication of the images. For if the quadrant were to be turned upside down, and so that the centres of the mirror would fall on the lines *C e*, *E c* as before, the centre *A* on *D*, and *B* on *F*; then the angle of incidence of a ray falling from *C* on *D*, would be different from that of a ray from *C* on *A*; it would therefore not be reflected to *F*; so that it would be necessary to turn the instrument in its plane, in order to make the image of *C* be visible in the horizon glass; by which the glasses in the 2d. position would not be parallel to themselves as they were in the 1st. nor is there any certain position in which they could be placed, as this will depend on the distance of the objects. So that the horizon glass cannot be adjusted by reversing the face of the octant, unless the objects by which this is to be done, are so far removed, that the distance between the glasses subtends at them an imperceptible angle; which *Mr. Ludlam* says will be, when they are removed at least half a mile off:* and for the same reasons, the adjustment cannot be made by the observer's turning himself half round with the instrument, without reversing it, unless the objects are at a distance as great as this, if it be not fixed on the same points, as above directed; by which alone the parallelism of the glasses is preserved, and also the same incidences and reflections, which are only exchanged one for the other by a half turn of the instrument; so that when the horizon glass is rightly adjusted, the direct and reflected images are reciprocally visible and coincident.

By this mode of adjusting the back horizon glass, by placing the quadrant on two fixed points between two near objects, a contrivance is made practicable, of using with full advantage the excellent method proposed by Mr. Blair of adjusting it at all times, by placing it parallel to a reflecting plane perpendicular to the index glass: for ascertaining which perpendicularity, the above mode of adjustment is necessary; as without knowing and making allowance for any deviation from it, in all observations taken, they would all be erroneous; which circumstance, as also this adjustment being the test of the accuracy of the addition, which I am to propose to the furniture of the quadrant, is the reason why I have been so diffuse in the explanation of this method.

The reflecting plane *Mr. Blair* proposed to be formed of

† This depends on the magnifying power of the telescope, and the smallness of the ang. it will render discernable.

the lower edge of the index glass itself, by grinding and polishing this edge perpendicular to the plane of the glass. The adjustment would be thus rendered admirably easy and certain, if the edge of the glass be formed perfectly plane and truly at right angles to it's face; were it not that this edge is necessarily so narrow, as not to afford a sufficient field of view to the observer, for distinguishing the object by which the adjustment is to be made: for the rays fall on the edge of the mirror so obliquely (making an angle with the plane of the edge, of no more than about 21 or 22 degrees, and forming on the back horizon glass an image equal in breadth, on its oblique surface, to the edge), that if the index glass were so great as half an inch in thickness, its edge would subtend at the eye near the horizon glass an optic angle of about 85 minutes; and if its thickness be, as usual, $\frac{1}{8}$th of an inch, it would take in a field of only about 20 minutes; which is too small to distinguish with ease the terrestrial objects to be viewed, though it would serve with difficulty for adjustment by the contact of the edges of the direct and reflected images of the sun or moon: this however it would do with all facility, if the thicknesses of the index and horizon glasses were such, and so proportioned to each other, that the image of the former might be reflected from the fore and back surfaces of the back horizon glass, single, so as to form one image of double breadth, by the double-reflection: for which purpose the back horizon glass must be very thin, and the index glass too thick; as otherwise the image from the under surface of the former would emerge at a distance from that reflected from its face; and the interval would to the naked eye appear like a shaded list, preventing the contact of the images observed from being seen by the double reflection, and confining the field to one of the images emerging from one surface of the glass; which will be as contracted as above stated.* However, as it will always be easier and more

* This will readily appear on inspection of Fig. 3: in which *A* is the index glass, and *B* the back horizon glass, placed at right angles to each other; each glass being $\frac{1}{8}$th of an inch in thickness: on which a beam of light *a b*, proceeding from a remote object *S*, is incident on the edge of the mirror *A*, in an angle with the plane of the edge of about 22 degrees, being the complement of the angle of incidence on the same; which in the quadrant is generally about at least 68 degrees: from which edge it is reflected to the glass *B*, and reflected again from both surfaces of the same; the extreme rays *a* and *b* of the beam of light, being throughout its progress, distinguished by the same letters; and those reflected from the back surface marked *a* 2, and *b* 2: their course (as the fig. itself will shew), is traced with sufficient exactness; from which it appears, that the beam of light *a b*, contracted by reflection from the mirror *A* to the $\frac{1}{20}$th part of an inch in breadth, preserves the same dimension till it enters the eye; both in the beam *x*, reflected from the anterior surface of the glass *B*, and in the beam *z* reflected from its back surface: for though this latter is diffused when it has penetrated the surface of the glass, it is again contracted on emerging from it; and is, as reflected from both surfaces, become a double and divided beam, the interval between both its parts being almost the thickness of each of them, which is equal to the sine of 22 degrees to a radius $\frac{1}{8}$th of an inch: and if the thickness of the index glass were to that of the horizon glass, as the sine of the refraction of the rays to its cosine, the interval between the beams would be equal to the breadth of either. To fill up the vacuity of the reflected light in this interval, by making the beams *x* and *z* issue contiguous, the thickness of the index glass must be to that of the horizon glass, as double the sine of refraction, to the cosine: this may be made evident as follows.

Let the beam of light *a b* (fig. 4.), be reflected from the edge of the index glass *A* to pleasant to adjust by *Mr. Blair's* method, when the eye takes in a sufficient field of view; and moreover as not every where a quadrant can be procured, furnished with an index

the horizon glass *B*, in the same manner, and with the same incidences, refractions and reflections as in fig. 3: on the mirror *C* it will occupy a space *I i*, equal to the breadth of the edge of the mirror *A*; and will cover the equal space *R r*, on the back surface of the mirror *B*; after reflection from which, it will be refracted in the surface *I k*, emerging in the beam *z*; the several rays in this beam issuing at distances from *I* toward *k*, equal to the distances of their first incidence from *i* toward *I*; the last ray *b i* emerging coincident with the ray *I a*: so that if the beam *x* did not fill the space *i I*, the beam *z* would not fill the space *k I*, but would leave an interval next to *I* equal to the deficiency toward *i*. Let the line *p r* be drawn perpendicular to the mirror, bisecting the line *I i*, and the angle of incidence and reflection *I r i*, and parallel to *c s* the cosine of the angle of refraction *n I s*, which angle is equal to *c s I*. In the similar triangles *s c I*, *r p i*, the side *r p*, the thickness of the mirror *B*, is to *p i* half the thickness of the mirror *A*, as *s c* the cosine of the angle of refraction, to *c i* or *s n* the sine of the same; so that when the thickness of the mirror *B*, is *p r* the cosine of refraction, the thickness of the mirror *A* must be double of *p i* the sine of the same angle. Now to make the index mirror of so great thickness may produce a small inaccuracy, when angular distances are to be taken between very near objects, at which a small part of the length of this mirror would subtend a perceptible angle; for the thicker the glass is, and the greater the complement of the angle observed, the greater intervals on its surface will there be between the places of incidence and emergence of the rays forming the reflected images; which will therefore be seen, sometimes by rays issuing from the middle of this mirror, and sometimes by rays distant from the same: from which variation I have above stated the errors that may arise: and because every minutia in the construction or use of this admirable instrument is deserving attention, it may be worth while to shew the manner in which this happens.

Let *I G* (fig. 5.) be the index glass, in its position when the index is at *o*, and *H* the horizon glass at right angles to it; its adjustment being made by the reflected image of an object *S*, seen by the eye at *E* to coincide with another opposite object visible in the direction *E H*. The image of *S* is conveyed to the eye by the ray *S A* refracted in *A C*, mirror, whose edge is ground accurately at right angles to its plane, and the edge also set up perpendicular to the plane of the instrument; (for which the purchaser must generally rely on

reflected from *C* to *B*, thence refracted again in *B H*, and reflected by the mirror *H* in *H E* parallel to *S A*. Since the mirror *H*, and the axis of vision *E H* are fixed, the ray *B H* is also fixed, in all observations taken; and every object must be seen by rays ultimately coincident with *B H*. Suppose it be required to find the angular distance of another object *s*, from the object seen directly in the line *E H*; and that for this purpose, and to make the image of *s* appear in *E H*, the index is moved to the position *i g*, through half the angular distance *S A s* of the objects, (the lines *S A* and *E H* being supposed the same, and the interval *A.H* to be accounted for): then the image will be seen by the ray *s a*, inflected, as before traced, in the lines *a c*, *c b*, *b H*, and *H E*; and the thickness of the index glass being moderate, there will be an interval between the place of incidence on it of the rays *S A* and *s a*, so small as to be imperceptible, and to occasion no error. But if the thickness of this mirror were great, as *A D* or *a d*, and the rays to be reflected from *D* and *d*; the image of *S* would be visible by the ray *R p*, proceeding in *p D*, *D B*, *B H*, and *H E*; and the image of *s* by the ray *t e*, *e d*, *d b*, *b H*, *H E*. So that when the adjustment was made, by the ray *R p* incident at *p*; the object *s* would afterward be seen, and the angle *s A S* measured, by the ray *t e*, incident at *e*, considerably distant from *p*. If the object *s* was very remote, the rays *s a* and *t e* would be as it were parallel, and their incidences and course the same; but if the object *s* were near, as at *r*, then the incidences would differ, and the error of observation be equal to the angle *e r a*, so much the greater, as the object is nearer, or as the complement of the angular distance observed is greater: and the same will be the case in the fore as well as in the back observation; which latter may be made as true as the former, if the line of direction of the sight be accurately fixed, by a long eye-tube, or telescope rightly placed, and if the other requisites above mentioned be observed.

Thus though in observing remote objects, and for nautical uses, no inconvenience will arise from the thickness of the index glass; (which if it be duly proportioned, as here stated, to that of the horizon glass, and its edge truly formed, is doubtless the best and surest mechanical organ for adjusting the latter); and though no error can hence arise in performing the above described adjustment; wherein the position of the index glass the maker; and few artists can be furnished with the exquisite apparatus, which must be employed for effecting the former); I think it may be to many desirable to have an

to the object is not changed, nor consequently the incidences of the rays on it; yet in observing very near objects, as the height or angular distances of buildings, offsets in surveys, bearings, &c. a great thickness of the index glass will produce a variable error, which though trifling, is unsatisfactory in an instrument, whose general excellence would make one wish it to be exempt from even the smallest imperfection. And this error can be diminished only by choosing such a certain position for the index glass with respect to its centre of motion, as would cause a part of the field of view to be lost in measuring angles but little exceeding 90°, when the rays fall very obliquely on the index glass, and when also the error encreases, as does the complement of the observed angle to 180 degrees. For the point *e* (in fig. 5.), can be made to approach to the point *p*, only as the triangle *e d b*, which is of given dimensions, shifts toward the mirror *H*, by its angle *b* advancing toward it in the line *b H*, the triangle being moved parallel to itself; by which the point *b* would fall beyond the end of the mirror *i g* at *g*, and the field would be contracted. But the face of the mirror *e b*, and consequently the triangle *e b d*, will be elevated, by advancing toward *H*, more or less, as the centre of motion of the index is placed farther from, or nearer to, the line *p B* the face of the index glass: so that the point of incidence of the ray *t e* cannot fall nearer to that of the ray *R p*, without causing a part of the field to be lost, and this where it is most contracted.

It has been made evident here, that if the thickness of the index and horizon glasses be equal, or as formerly in use, there will be an interval between the beams of light reflected from the opposite surfaces of the latter; and in this interval the reflected image is not visible to the observer; who can only see there the object directly through the glass: and if he is to view both images coincident, he can only do so in the space filled by the beams; as in *x* or *z* fig. 3; for if he attempted to make the extremities of the images to coincide at the internal edge of either of the reflected beams, he could not hold the quadrant steady enough to keep them there; for which purpose it would require to be absolutely immoveable.

On these accounts, if advantage is to be taken of the double reflection, (without which the narrowness of either beam of light, and the evanescence of the reflected easy contrivance to be substituted, where required, instead of this operation on the edge of the mirror; and which can be executed with little additional labour by any instrument-maker; so as to afford a sufficient field of view, with a capacity for accurate adjustment.

This I have effected by the contrivance of a second small index mirror; requiring only one plane surface, and fixed on the index at right angles to the great mirror; being totally free and detached from the index mirror, and capable of every adjustment for itself, without interfering with, or impeding any motion requisite for that purpose for the index glass, or altering its position. The following description of such a one, which I have made, will shew that it is a very simple and easily fabricated addition to the quadrant.

image in their interval of separation, will make the observation with the naked eye uncertain and troublesome); it is necesary that the light from both surfaces of the glass, should be contiguous, having no interval; which can only be effected, either by making the index glass almost one quarter of an inch thick, or by reducing the thickness of the horizon glass to less than $\frac{1}{12}$th of an inch; or by such a mutual compensation of both, as would still leave one as much too thick as the other would be too thin, for the uses above stated: and though this may be remedied, while yet the glasses remain of their due and proper dimensions, by using a telescope, whose aperture is large enough to take in both beams of the reflected light with the interval of their separation; yet in ordinary quadrants, of simpler construction and more moderate price, not designed to be furnished with a telescope, or mirror with a polished edge, I cannot but think that an easy and cheap substitution for both, would, if found to answer, be very useful; as securing at all times the advantages of *Mr. Blair's* invention for the back observation, (at least for taking altitudes), to those navigators, who do not furnish themselves with a more perfect and expensive instrument; as well as to those who on land desire, in surveys, to ascertain large angular distances by the quadrant; or by an artificial horizon

The ichnographical plan and position of both the mirrors is represented in fig. 6. as they are fixed on the head of the index.

B is the great mirror, and *b* is the cock supporting it, with its case; *D* the wing or adjusting lever of the cock; *f* and *g* the screws for erecting it perpendicular to the plane of the instrument in the usual manner; and *e e* are the steady pins in the index fastening the cock; *d d* are two pins on which the edge of the mirror rests.

A is a round brass plate, with a milled edge of the same size with the head of the index, and with the fig. both being three inches in diameter, and screwed fast to it, concentric with the index, by the four screws *s s s s* screwed into the index. *C* is the little mirror screwed to the plate by the screw *h* passing through the wing *E* of its cock *c*: it is erected and fastened perpendicular by means of the screws *h* and *i*, in the same manner as the mirror *B* is by the screws *f* and *g*: *m* is a steady pin fastened in the cock *c*, inserted into a hole in the plate *A*; and *k* another strong steady pin rivetted in the plate, the upper part of which, being cylindrical passes up through a hole in the strong bar or wing *E* of the cock *c*, which hole it exactly fills, but allowing the cock to be elevated or depressed a little for adjustment of the mirror, without any angular mo-

to take altitudes or angles exceeding 45 degrees, to find the latitude, &c., for which the back horizon glass must be used. It is also desirable for the interests of science and navigation, that quadrants of snfficient performance should be made capable of being fabricated in different places.

tion about the centre of the index. Thus by the screws *h* and *i*, and the steady pins *k* and *m*, the little mirror is made erect and fixed on the plate *A*: it is also set at right angs. to the index mirror *B*, by loosening a little the screws *s s s s*, and turning the whole plate *A* by its milled edge, round its centre on either side, so far as necessary; and when this is found to be accurately effected, the screws *s s s s* are to be again made fast; when the little mirror will be perpendicular both to the plane of the instrument, and also to that of the great mirror, and cannot, without suffering violence, alter its position.

This circular motion of the plate *A*, and of the little mirror fastened to it, is permitted, without communicating any motion or even contact of it, to the index-glass, its cock, steady pins, or screws, by the following contrivance.

Through the plate *A* are cut long holes or slits, formed as represented in the fig. concentric with it, at the places of the screws *s s s s*, *f*, and *g*, and also at the pins *d d* and *e e*: these slits are made just so wide, as that the screws and pins will not touch them, and that the heads of the screws will, when screwed down, press upon the edges of the slits: the slits at *e e* are not represented in the fig. to avoid confusion: the slits at *s* and *g* should be so long as to allow the plate *A* to turn through the space about $\frac{1}{10}$th of an inch on each side of the screws fixed erect; and the slits at *d d*, *e e*, and *f*, may be shorter, according as they lie nearer the centre, each slit bounded within the same sector of a circle.

Through these slits in the plate *A*, the screws *s s s s*, *f*, and *g* are inserted, and all except *g* fastened in the head of the index; in which latter, the pins *e e* penetrate also through the wing *D* of the cock of the index-glass, to steady it.

The edge of the index-glass *B* rests on the pins *d d*, which project only so far above the surface of the plate *A*, as to keep the mir^r. and the wing *D* of its cock clear of it, so as that the plate can turn about under both without touching them: and the bar or wing *E* of the cock *c* lies about $\frac{1}{8}$th of an inch above the wing *D*, so as to be quite clear of it, and permit adjustment by raising or depressing the wing. It may be supposed that the cock *c* and its wing *E* must at first be so formed that the mirror *C*, when fastened to them, will be nearly at right angles to the mirror *B*, when the bar *E* lies parallel to the index mirror, and the screws, &c. are in the middle of the slits in the plate *A*; that a small motion of the plate *A* on either side, will suffice for an exact adjustment of the mirror *C*.

There is a round hole in the middle of the plate *A*, a good deal wider than the head of the pin, about which the index turns; and the plate is made to turn concentric with the pin by a little ring or socket *R*, brazed in the hole in the plate, or by an annular ledge formed on it projecting downward below the under surface of the plate about $\frac{1}{12}$th part of an inch. The outside of this projecting ring is to be exactly fitted into a circular groove or cavity formed in the index, so far distant from the head of the pin, that the ring will not touch it, nor affect its motion or position.

The cock *c* and its cap are formed with an indenture in them, (as in the fig.) at the end of the index-glass, in order that the mirror *C* may lie nearer to it, which will allow the little mirror to be made broader, without enlarging the brass plate *A* and the head of the index; while the part of the cock not indented may, as well as its wing *E*, be made so massive and strong, as not to be bent and strained easily by any accident: a notch is cut in the side of the bar *E* at the screw *f*, to allow this screw to be turned, without touching the bar: thus both the mirrors may be adjusted independent on each other.

The little mirror *C* requires not to be silvered on the back, and consequently its opposite surfaces need not be parallel, so that it may be made of a piece of well polished and plane looking glass, but the polish must be taken away from its back surface by grinding it on a plate with fine emery and water; and the surface thus made rough should be smeared over with a feather dipt in oil of turpentine mixed with lampblack, to prevent all reflection from that surface.

The addition of this mirror to the index adds no trouble to the business of fixing the index-glass: the extra work required is that of the little mirror and of the plate *A*; and the fabrication of this plate will be greatly facilitated, if it be cast from a model, in which the slits and perforations, and the central annular ledge, (the former to be of a size a little less than requisite in the plate when finished,) are already made in their proper places. The plates cast from this model will require no measurement nor piercing, and only want to be filed, turned and polished.

The mirror *C* is to be adjusted by making it, by a fore observation, parallel to the back horizon glass, by turning with the left hand the plate *A* by its milled edge, till the images of the object viewed are seen to coincide; and then fastening the plate *A* to the index by the screws *s s s s*: it follows, that the back horizon glass must itself be for this purpose previously adjusted at right angles to the index-glass, in the way before mentioned, which may always on land be easily performed. And I should imagine that even atsea, when the sea is calm, it might perhaps be practicable, by fixing up two papers, with a black line drawn vertically on each, on the adjacent sides of two masts of the ship; by which lines, the quadrant fixed on two points of a moveable stand, placed on deck between the two masts, may have the back horizon glass adjusted as above, in order by this means to try at any time whether the little mirror *C* has its adjustment altered; which, however, must be very unlikely to happen, especially if the contiguous sides of the plate *A* and of the index be not polished, lest the plate should slide on the index. At other times the back horizon glass is to be adjusted by the mirror *C*, supposed to be itself right in position; and indeed considering that this mirror is not, as the horizon glasses are, rested on the points of two pins like a lever, and that these glasses are moved and secured, not by the outer edges of the circular plates of their frames, but by the small axes of those plates, very near the centres of their motion; whereas the mirror *C* is fastened firmly on a broad plate, screwed tight near its margin by 4 screws to the head of the index, it is not easy to conceive how it can alter its adjustment; though from the above mode commonly in use for fixing the horizon glasses, it is not unaccountable why they should frequently do so, not being fastened by the margins of their frames. These frames, however, are sometimes moved by endless screws playing in their ratched edges; and this construction when well executed, is much better than the former.

Read 21st May, 1810.

Two Proofs of the BINOMIAL THEOREM, *by the* REV. SAMUEL VINCE, *A. M. F. R. S. Plumian Professor of Astronomy and experimental Philosophy, in the University of Cambridge*

Read May, 1810

WHEN n is a whole positive number, it is proved by common algebra, that

$(1+x)^n = 1 + nx + n.\frac{n-1}{2}x^2 + --- n.\frac{n-1}{2} ---- \frac{n-r+1}{r}x^r +$ &c.

Now if this be not true when n is a fraction, let the general co-efficient be $C + n.\frac{n-1}{2} ------ \frac{n-r+1}{r}x^r$. Then the quantity C must vanish when $n=1, 2, ----- \infty$. Now as C is expressed in terms of n and given co-efficients, it must always be of the same form whatever n is, and, as it must vanish when $n=1, 2, ---- \infty$, it must be represented by $n \times \overline{n-1} \times \overline{n-2} \times ---- \overline{n-\infty} = n\,(n^r - an^{r-1} +$ &c.$)$ where r is infinite; this therefore must be the value of C. But when n is a fraction, this value of C becomes infinite, which it cannot be, and as no other value of C can enter in addition, but this, the general value of the co-efficient of x^r can be no other than $\frac{n.\,n-1}{2} \cdots \frac{n-r+1}{r}$.

IDEM ALITER.

Let n and s be indefinitely great, whole, positive numbers, so that $\frac{n}{s}$ may represent any fraction; then by common algebra

$$(1+x)^{ns} = 1+nsx + ns.\frac{ns-1}{2}x^2 + \&c.\ (P^s)$$

$$(1+x)^n = 1+nx + n.\frac{n-1}{2}x^2 + \&c.\ (P).$$

Now it is proved in my Fluxions, that $(1+x)^{\frac{n}{s}}$ may be represented by a series of the form

$1 + ax + bx^2 + \&c.\ (P)^{\frac{1}{s}}$, where the *form* of the series in respect to x is the same as that of the above series; we have therefore only to consider what is the relation of the corresponding co-efficients. Now the series (P^s) and (P) are exactly of the *same* form in *every* respect, the factor ns in the former being represented by n in the latter. If therefore we perform the *same* operation on these two series, the results must have the *same* form, and whatever change may take place on ns in (P^s), the same must take place on n in (P). If therefore we extract the s Root of (P^s) and (P), the forms of the two series expressing the roots must be the same, and the roots be deduced by the same rule. Now the reduction of (P^s) to (P) is made by writing for the quantity ns in (P^s) that quantity divided by the root s to be extracted, or writing n for ns; the reduction is therefore made simply by the root s to be extracted, dividing ns by s, and writing the quotient for ns; hence we extract the s^{th} root of (P) by the same rule, that is, by writing for n in (P), n divided by s; hence

$$(1+x)^{\frac{n}{s}}=1+\frac{n}{s}x+\frac{n}{s}\cdot\frac{\frac{n}{s}-1}{2}x^2+\text{\&c.}$$

It matters not *how* the s^{th} root of the series of the form $1+ax+bx^2+$ &c. can be extracted, or whether we should have been able to accomplish it if we had not known that the series (P^s) and (p) are represented by $(1+x)^{ns}$ and $(1+x)^n$. By *whatever* process the s^{th} root of (P^s) is extracted, whether discoverable or not, by the same process the s^{th} root of (P) will be extracted. The Binomial Theorem shews the series (P) to be the s^{th} root of (P^s), which is all we want to ascertain.

On certain Properties of Numbers, by the REV. SAMUEL VINCE, *A. M. F. R. S. and Plumian Professor of Astronomy, in the University of Cambridge. An extract of a letter to the Rev. J. Brinkley,* D. D. F. R. S. M. R. I. A. *and Andrews' Professor of Astronomy in the University of Dublin.*

Ramsgate, June 26, 1810.

EULER in his *Introductio in Analysim Infinitorum,* in the chapter *de partitione Numerorum,* has shown, that by a combination of the numbers in each of the Geometric Series 1, 2, 4, 8, &c. and 1, 3, 9, 27, &c. all the natural numbers 1, 2, 3, 4, &c. may be formed, as far as the sum of each series goes. This he has proved, from assuming the products of an indefinite number of factors $(1+x)(1+x^2)(1+x^4)(1+x^8)$ &c. in the first instance, and $(x^{-1}+1+x^1)(x^{-3}+1+x^3)(x^{-9}+1+x^9)$&c. in the second; shewing that in each case, such products may be represented by a series containing the terms $1+x+x^2+x^3+x^4+$ &c. the indices of which must necessarily arise from the combination of the indices in the assumed factors. But the property now stated may be otherwise proved in a very simple manner immediately from the expression for the sum of each series. I have also added the rules for filling up the intervals of the terms, which EULER has not given; and shewed under what circumstances, other series will have the same property.

First, for the series 1, 2, 4, 8, &c.

The sum of $1+2+4+8+\cdots\cdot 2^{n-1} = 2^{n} - 1 = S$; hence, $S+1=2^{n}$ the next term. The difference, then, between the sum S of n terms, and the next term 2^{n}, is 1; therefore the sum S of n terms, carries on within 1 of the next term. If therefore you can for n terms, make up all the natural numbers to their sum, you make them all up to the number next less than the next term 2^{n}; and by adding all those numbers to 2^{n}, you get all the numbers to the number next less than 2^{n+1}. If therefore the rule be true for n terms, it must be true for $n+1$ terms. Now if we take two terms 1, 2, we get $1+2=3$, that is, we get all the numbers as far as the sum of the two numbers, and within 1 of the next term. But, as proved above, if the rule be true for 2 terms, it must be true for 3 terms; if true for 3 terms, it must be true for 4 terms; and so on; hence, the rule is true in general.

Secondly, for the Series 1, 3, 9, 27, &c.

The sum of $1+3+9+27+\cdots\cdots 3^{n-1}=\frac{3^n-1}{2}=S$; hence, $2S+1=3^n$ the next term. The difference, then, between the sum S of n terms and the next term 3^n is $S+1$; therefore the sum S subtracted from the next term 3^n, leaves $S+1$; that is, it brings you back to the number next greater than the sum S. If therefore you can for n terms make up all the numbers to S, the same numbers subtracted from the $\overline{n+1}^{th}$ term will bring you back to $S+1$, the number next greater than S; thus you fill up all the numbers in the interval between the n^{th} term and the $\overline{n+1}^{th}$ term; and if the same numbers be added to the $\overline{n+1}^{th}$ term, you make up all the numbers as far as the sum of $n+1$ terms; if therefore the rule be true for n terms, it must be true for $n+1$ terms. Now if we take two terms 1, 3, we have $3-1=2$, $3+1=4$, and 4 subtracted from the next term 9, leaves 5 the next number greater than the sum of two terms. But, as proved above, if the rule be true for 2 terms, it must be true for 3 terms; if true for 3 terms, it must be true for 4 terms; and so on; hence, the rule is true in general.

The intervals of the *first* series may be filled up by the following RULE.

Let A be any number, and 2^n the term next less than A. Take 2^r next less than $A-2^n$; 2^s next less than $A-2^n-2^r$;

2^t next less than $A-2^n-2^r-2^s$, and so on till there be no remainder; and then $2^n+2^r+2^s+2^t+$ &c. $= A$.

In the *second* series, all the numbers in the general interval from $3^n - 3^{n-1} - 3^{n-2}$ &c. $------ 1$ to $3^n+3^{n-1}+3^{n-2} +$ &c. $----- +1$, including those terms, may be made up by the following Rule.

After 3^n for the *first* term put -3^{n-1} for 3^{n-1} times, then cyphers as often, and then $+ 3^{n-1}$ as often.

For the *second* term put -3^{n-2} for 3^{n-2} times, then cyphers as often, and then $+3^{n-3}$ as often; this to be continued *three* times.

For the *third* term put -3^{n-3} for 3^{n-3} times, then cyphers as often, and then $+3^{n-3}$ as often; this to be continued *nine* times.

For the *fourth* term put -3^{n-4} for 3^{n-4} times, then cyphers as often, and then $+3^{n-4}$ as often; this to be continued *twenty-seven* times.

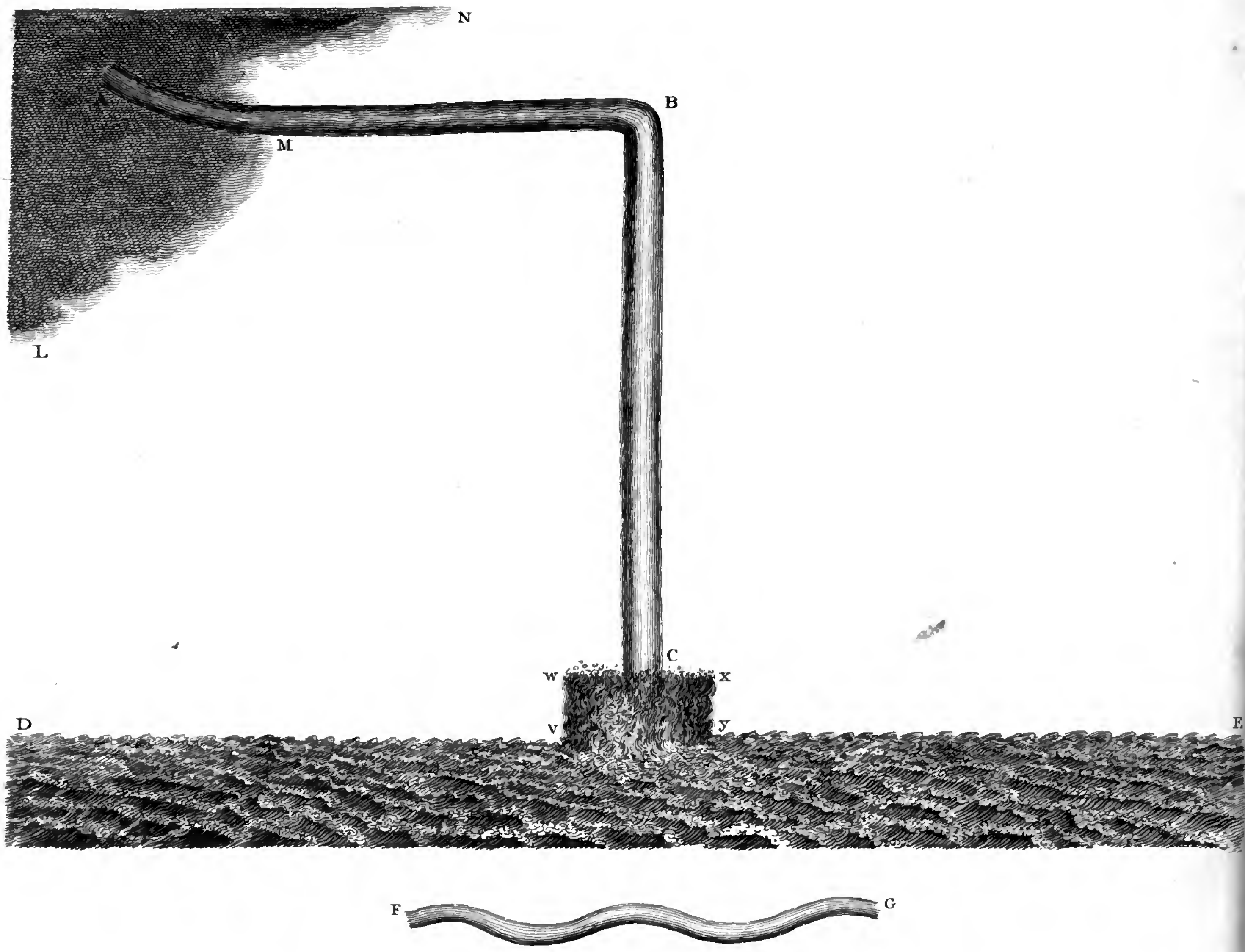
In general, for the $r^{th.}$ term put -3^{n-r} for 3^{n-r} times, then cyphers as often, and then $+3^{n-r}$ as often; this to be continued 3^{r-1} times.

Proceed thus through all the terms, and you will fill up all the numbers.

But besides these two series, there are many others which have the same property; of these, the two first terms must necessarily be 1, 2, or 1, 3, or the interval between the two first terms cannot be filled up. The series must also have this further property, that the sum preceding any term (*P*) must reach at least half way from (*P*) to the next term (*Q*), or to (Q—1). The following series have this property.

1, 2, 5, 10, 17, &c.
1, 2, 7 17, 33, &c.
1, 3, 6, 10, 15, &c.
1, 3, 9, 19, 33, &c.

and many others; but the series which requires the smallest number of terms to fill up the interval from 1 to any given number, is, 1, 3, 9, 27, 81, &c.


N
B
M
L
C
w
x
D
v
y
E
F
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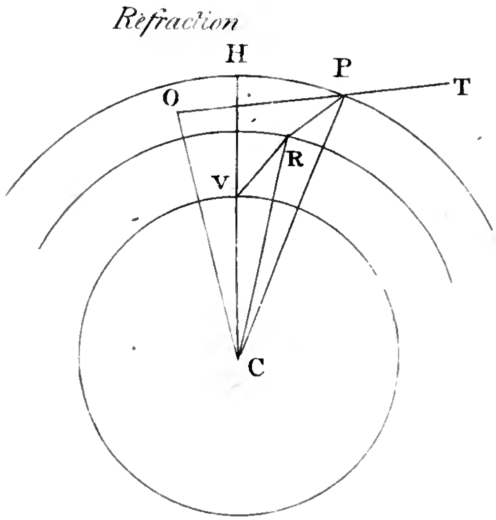
An Account of a very remarkable WATER SPOUT, which appeared at Ramsgate, July 16, 1810, a little before 3 o'clock in the afternoon, just after a Thunder Storm; by the REV. S. VINCE, A. M. F. R. S. Plumian Professor of Astronomy and Experimental Philosophy at Cambridge.

IN the annexed figure, *L M N* represents a cloud, in which there first appeared a figure in the form *F G*, resembling an huge serpent; this immediately stretched itself out in an horizontal direction *A M B*; at *B* it turned at right angles downward in the direction *B C* to the sea *D E*, the sea immediately under it rising up in a cylindrical form *v w x y* to meet it. The horizontal part, (which was straight), I judged to be about 3 or 400 yards long, and the perpendicular part *B C* in the proportion now represented, the greatest diameter of which I estimated to be about 5 or 6 feet. It was attended with an hissing noise, and continued about 5 minutes, when it almost instantaneously disappeared, every part of it at the same time dissolving as it were into air, the water in the sea then ceasing to rise up. Water Spouts are an electrical phenomenon, lightning being sometimes seen to play in them. Perhaps this, which appears to be of a very singular form (for I have never seen such a one described), may be thus accounted for. If the cloud *L M N*, and the air at *B* were charged with different powers, the spout might take the horizontal direction *M B*; and if the air at *B*, and the sea immediately under it were also charged with different powers, the spout might take a perpendicular direction downward, and the sea rise up to meet it. The spout could not be water in its liquid state, for water in that state projected from the cloud, must necessarily have descended in a curve; and further, had it been water in that state, when the supply from the cloud ceased, from the ceasing of the cause, it would have disappeared gradually from the cloud, shortening till it vanished at the sea; whereas it vanished altogether almost instantaneously. From all the circumstances attending the spout, it appears that it was nothing but part of the cloud drawn out in a very condensed state, for although the cloud was very black, the spout was much blacker, the part in the cloud appearing very distinctly in the cloud itself. On this supposition we may account for the sudden disappearance of the spout; since, by the operation of the electric power, the watery vapour might be resolved into its two constituent airs, and thus disappear almost in an instant. All water spouts, as they are produced by the same cause, we may conclude to be of the same nature, that is, a very condensed watery vapour. They have, perhaps, been considered as water, from the torrents of rain which frequently attend them, so as to render it difficult to distinguish that from the spout; and also from the rising up of the sea where they fall, the effect being such as might arise from the falling of such a body of water as the spout has been supposed to be.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An Account of Observations made at the Observatory of TRINITY COLLEGE, DUBLIN, *with an Astronomical Circle, eight feet in diameter, which appear to point out an annual parallax in certain fixed stars.*

Also a Catalogue of North Polar distances of forty-seven principal fixed stars, from recent observations, and a comparison thereof with those of the same stars, obtained by other instruments, and by the same instrument, at a former period. By JOHN BRINKLEY, D. D. M. R. I. A. F. R. S. *and* ANDREWS' *Professor of Astronomy, in the University of Dublin.*

Read May 9, 1814.

TO prove the motion of the earth about the sun, by actual observation of change of distance from some of the fixed stars, at different times of the year, has long been an object of research. Soon after the Copernican System became generally adopted, and while Astronomy was yet in an imperfect state, this was considered in some measure necessary to establish the truth of that system. Afterwards the discoveries in physical astronomy made this enquiry, as far as the above motive was concerned, less interesting.

Modern astronomers have looked to this object principally with a view of ascertaining whether any apparent annual motion of the fixed stars, from this cause, existed necessary to be noticed, in computing the mean place from the observed.

Dr. Bradley, by his celebrated observations, which led him to the discovery of the aberration of light, first established that as to certain stars no parallax existed capable of being noticed. His observations were made with an instrument, that, for observations near the zenith, has not since been surpassed.

Since his time it seems to have been generally allowed, that the annual parallax of every fixed star was too small to be noticed, till lately M. Piazzi, of Palermo, conceived that his observations pointed out a parallax in certain stars. An account of his conclusions is given in the Conn. des Temps, 1808, together with an account of some observations made at Rome on α Lyræ.

My observations, by the eight feet circle, which commenced in 1808, have pointed out also a parallax in α Lyræ, but considerably less than that observed by M. Piazzi. It is only with respect to this star and Arcturus that our conclusions agree in pointing out a parallax.* My observations

* I can only refer to the account of M. Piazzi's observations given in the Con. des Temps. 1808, p. 432. In which it is mentioned that the observations themselves are to be found in the 10th vol. of the Italian Society. By the account in the Con. des Temps, it appears that M. Piazzi observed in Procyon, a parallax of declination, such

tend to point out a parallax in α Lyræ, α Aquilæ, Arcturus, α Cygni, and α Ophiuchi, and some others. M. Piazzi considers α Aquilæ as having no discernible parallax, whereas my observations tend to point out that α Aquilæ has a greater parallax than any other star that I have observed. Besides this discordance between the results of my observations and those of M. Piazzi, it is to be noticed that other results obtained by instruments executed by the first artist, and by observers justly celebrated, do not accord with mine in pointing out a parallax. It is therefore with great diffidence that I offer my results to the Academy. These results tend to prove that the parallax (the angle subtended at the star by the *diameter* of the earth's orbit) of α Lyræ, by 152 observations amounts to 2″; of α Aquilæ, by 96 observations = 5″, 5; of Arcturus, by 92 observations = 2″, 2; of α Cyg-

as would result from a double parallax of 20″ whereas by my observations I find no indication of parallax in this star. Indeed from the account given in the Con. des Temps, by M. Delambre, the results of M. Piazzi, as to parallax, cannot be considered as entitled to much confidence, and in consequence M. Delambre may appear justified in making the following remark.

" Malgré les efforts dont nous venons rendre compte, il ne parait pas que nous " ayons encore rien de bien certain sur la distance des étoiles. Cette connaisance est " peut être du nombre de celles qui nous seront toujours refusées."

No one should consider this as reflecting any censure on the observations of a person who has rendered such excellent services to astronomy. It should only be understood that the instrument used by M. Piazzi was inadequate to the research.

ni, by 47 observations = 2″, 1.* The results as to other stars I shall reserve till my observations have been more numerous.

I shall endeavour to make such remarks respecting these results, that the Academy may form a proper judgment how far they serve to establish the important conclusion, which I conceive may be derived from them.

For this purpose it is necessary to give some account of the instrument by which the observations have been made.

The superiority of circles over quadrants, and the advantages derived from the micrometer microscope, are so well known, as to make it quite unnecessary, that they should be stated here.

About the year 1788, soon after the late celebrated artist Mr. Ramsden had strenuously recommended those improvements, which his mechanical skill had rendered so very practicable, the Provost and Senior Fellows of Trinity College, Dublin, by the advice of my predecessor, Dr. Usher, di-

* Perhaps it may be objected to me that what I call parallax, should be called double parallax, since properly the parallax is the difference between the observed and mean place. In this way the

parallax of α Lyræ	=	1″,0
of α Aquilæ	=	2,7
of Arcturus	=	1,1
of α Cygni	=	1,0

But I believe that, generally, when the parallax of a fixed star is spoken of, the greatest change of place is intended, which is equal to the angle subtended by the diameter of the earth's orbit at a fixed star.

rected a circle, ten feet in diameter, to be made for this observatory. Mr. Ramsden protracted for many years the execution of the instrument. After beginning one of 10 feet diameter, he afterwards rejected it for one of 9 feet, which was actually divided. The latter he also rejected, and at his death he left unfinished our present instrument of 8 feet diameter. This was finished by his successor, Mr. Berge, and placed in the observatory, about the middle of 1808. The long period which elapsed, while the instrument was expected, will be always a subject of regret to myself. On some future occasion I may, perhaps, lay a detailed account of this instrument before the Academy. At present I shall only mention such particulars, as may be necessary to render intelligible the method of making observations with it, and the degree of accuracy to be expected from it.

The circle is supported in a frame, which frame turns on a vertical axis. The upper part of the frame is of cast iron, turns in a collar, and is connected with the lower part of the frame by four hollow brass cylindrical pillars. The lower part of the frame, which is also of cast iron, terminates in a pivot of steel, which turns in a socket of bell-metal. This socket is moveable south and north, by one screw, and east and west, by another, for the purpose of adjusting the vertical axis.

The axis cf the circle, a double cone four feet in length, is supported on Ys which are themselves supported by strong bars of brass attached to the cylindrical pillars. The pressure of the weight of the circle and its axis is relieved by an ingenious application of friction wheels and the lever. There is also an ingenious contrivance for adjusting the axis horizontal.

The circle of brass is divided into intervals of 5 minutes, which intervals are subdivided by micrometer microscopes into seconds and parts of a second as usual.

There are three microscopes. One called the bottom microscope, opposite the lowest part of the circle: a second opposite the left extremity of the horizontal diameter, and a third opposite the right extremity of the horizontal diameter.

The frame carrying the circle turns on the vertical axis with the greatest steadiness. The circle also turns on the horizontal axis with equal steadiness.

The vertical axis of the instrument is adjusted by a plumb line. The plumb line which performs this adjustment is about 10 feet long, and is suspended from a point about 8 inches from the centre of the top of the frame, and passes over a point below, 8 feet from the point of suspension. By help of this point which is moveable by a screw, and by the moveable socket below, the axis of the instrument is made vertical. The adjustment of this axis, as to the north and south positions is, it is evident, of the most essential consequence to the exactness of the zenith distance of the object observed. It is likewise evident that, from the great interval between the upper and lower parts of the instrument, the temperatures above and below must occasionally differ, and thence the relative positions of the point of suspension, and of the point below, be changed. To obviate this inconvenience, which would be fatal to the accuracy of the observations, the point of suspension is on a compound bar formed of bars of brass and steel, and the point below is also placed on a similar compound bar. By this the distance of the plumb line from the vertical axis remains always the same. This contrivance appears to answer in a very satisfactory manner. *

The axis of the instrument being adjusted vertical, and the plane of the circle in the meridian, and facing the east; let b, l, r, be the zenith distances of a star as shewn by the bottom, left and right hand microscopes respectively. When the plane of the circle is in the meridian, and facing the west, let b', l', r', be the zenith distances of the same star as shewn by the respective microscopes. Then the true zenith distance $= \frac{b+l+r+b'+l'+r'}{6}$ or $\frac{1}{2}\left(\frac{b+l+r}{3}+\frac{b'+l'+r'}{3}\right)$. And the correction of the mean of the three microscopes

$$=\frac{1}{2}\left(\frac{b+l+r}{3}-\frac{b'+l'+r'}{3}\right).$$

The accuracy of the result of an observation is affected

* The circular instrument in plate 8 of Professor Vince's Practical Astronomy, may be referred to for our circular instrument. Except that in our instrument there is no azimuth circle. The plumb line is suspended in the position represented, but the compound bars are not represented. Also the pillar F is perforated for the insertion of the bottom microscope. The horizontal microscopes are not represented, and there is no microscope at n.

1. By the error of the mean of the six readings arising from inaccuracy in the divisions and error of eccentricity.

2. By inexact adjustment of the vertical axis.

3. By error of reading off,

4. By error of bisection of the star.

5. By error from change of temperature affecting the parts of the instrument.

From my examination of this instrument, I have reason to conclude there is no sensible error of eccentricity, and that as far as the divisions are concerned, the mean of the six readings can never occasion a greater error than 1″, and an error of this amount will take place only in very few parts of the circle. A comparison of the results determined by the bottom, and by the two horizontal microscopes: also a comparison of the corrections of the mean of the microscopes determined by stars at different distances from the zenith, seem to leave no doubt on this point.

It may appear an imperfection in this instrument that we cannot avail ourselves of a microscope at the highest part of the circle. The reading off a microscope so placed would be highly inconvenient, and on account of the circumstances of the instrument, the use of it might be attended with some danger, both to the observer and instrument. However it does not appear that the accuracy of the results would be materially affected by such an addition.

By means of the plumb line the vertical axis can in general be adjusted with great precision; but this operation is oftentimes very troublesome, and, it is to be feared, sometimes cannot be performed with the desired accuracy. The plumb line passing near the plane of the circle*, no screen can be used. Hence even a slight agitation of the air occasions a slow motion in the plumb line; and the observer, without much tedious precaution, may be deceived as to this essential adjustment. From hence, doubtless, have arisen greater discordances in the observations than would have otherwise taken place. This imperfection arises principally from the situation of the plumb line, it would not be difficult to give it another situation in which it might be safely screened from the agitation of the air, and were the instrument within a convenient distance from the maker, I should endeavour to have this alteration effected.

Notwithstanding this imperfection, I think I may safely pronounce that as far as errors of observation are concerned a mean of 10 observations (five the face of the circle being east, and five the face being west) will give the zenith distance exact to much less than one second, and that a mean of 20 observations, according to a very high degree of probability cannot induce an error of nearly half a second as far as errors of observation are concerned.

* An adjustment of the microscopes was intended by means of the plumb line, and four gold dots placed on the limb of the circle. This made it necessary that the plumb line should pass very near the plane of the circle. But the method of observing thence resulting I found inferior both in accuracy and convenience to that in which the plumb line is only used for the adjustment of the vertical axis.

In errors of observation I include errors of adjustment in the vertical axis, errors of bisection of the star, errors of reading off, and also errors arising from changes of temperature in the instrument.

From what has been said, the principal circumstances relative to the astronomical circle at our observatory will be readily comprehended.

The angle to be obtained by each observation is the exact zenith distance of the object, from which, the zenith distance of the pole having been previously determined, the polar distance or declination of the object is known. The zenith distance can only be had by the assistance of a plumb line or spirit level. The inaccuracies and inconveniencies to which both these instruments are liable have long been known, and as the zenith distance is not necessary for finding the polar distance, it has been, sometime ago, proposed to find the polar distance without a reference to the zenith point, by simply observing the arches of the meridian intercepted between the object, the polar distance of which is required, and stars, the polar distances of which are known, or can be obtained by help of circumpolar stars.

Mr. Troughton, whose fame as an artist is justly so celebrated, has made several circles with this view, and has lately made a mural circle of 6 feet in diameter for the Royal Observatory at Greenwich. The recent construction of this instrument, in which Mr. Troughton has availed himself of his long experience and the latest improvements; the circumstance of the telescope admitting of being shifted to different parts of the circle; the number of microscopes used, and the firmness of their position in the pier; and the great knowledge, skill and assiduity of Mr. Pond, the Astronomer Royal, all promise very important results for Astronomy.

There is, however, one circumstance to be noticed, respecting this method of observing, of some importance, and which bears particularly on the question, whether any of the fixed stars have a visible parallax.

In the mode of ascertaining the north polar distance of an object by the mural circle, it is requisite to know the north polar distances of certain fixed stars with the changes from precession, effects of the semi annual equation, aberration, nutation and refraction. If some of these stars be also affected by annual parallax, it is obvious that if no notice be taken of this, the north polar distance required will be inexact. It may be said that the same correction being obtained by different stars, will shew that no such annual parallax exists so as to be sensible. This point certainly might be ascertained in this manner by a sufficiently numerous set of observations. Still, as it may be suggested, that many of the fixed stars may have small sensible annual parallaxes, observations, which will point out only the differences of these, are not so proper as those by which the whole quantity would be pointed out. This may perhaps be better understoood by considering what would have taken place had this mode of observing been used before the discovery of the aberration of light. It would have been extremely difficult to have separated the compound results, and assigned the proper quantity to each star, as Bradley was enabled to do at once, as to his observations by his zenith sector.

The observations I am about to state point out changes of zenith distance in certain stars at different seasons of the year, which changes are explained by annual parallax, and after long and anxious consideration I have not been able to assign any other cause.

α Lyræ near Opposition.

Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.	Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.
		° ′ ″	+			° ′ ″	+
1808, July 28	W	14 46 19,93	,77	1811, July 17	E	14 46 20,80	,84
Aug. 21	E	20,41	,55	20	W	19,05	,82
23	E	21,58	,53	21	E	21,28	,82
24	W	18,03	,52	22	W	18,22	,81
1809, June 17	E	21,49	,87	23	E	17,56	,80
July 5	W	17,38	,87	26	W	17,41	,78
8	W	19,93	,86	29	E	18,02	,76
13	E	21,03	,85	31	E	19,44	,75
14	E	18,31	,84	Aug. 1	W	19,48	,74
15	E	17,86	,84	3	E	20,94	,72
18	E	18,46	,83	4	W	18,40	,71
19	W	18,74	,83	5	E	21,81	,70
20	E	17,43	,82	6	W	18,04	,69
23	E	19,18	,80	1812, June 28	W	18,79	,88
24	W	19,29	,80	July 3	E	18,10	,88
25	W	21,79	,79	Aug. 6	E	18,42	,69
Aug. 4	W	19,76	,71	7	W	18,07	,68
8	W	19,15	,67	8	W	18,44	,67
9	E	20,73	,67	11	E	16,25	,65
1810, July 1	E	19,67	,88	24	E	20,28	,52
8	E	19,69	,86	25	W	19,69	,51
9	W	19,22	,86	27	E	19,59	,48
15	E	18,26	,84	1813, July 2	E	20,42	,88
24	W	18,27	,80	3	W	21,11	,88
26	E	21,25	,78	4	E	21,30	,88
27	E	17,32	,77	7	W	20,57	,87
30	W	19,59	,75	8	E	19,44	,87
1811, July 2	W	19,20	,88	10	E	20,22	,86
7	W	18,96	,87	14	W	19,63	,85
9	E	19,43	,87	15		18,81	,85
10	W	19,49	,87	20	E	16,21	,82
14	E	20,20	,85	23	W	18,68	,80
16	W	18,13	,84				

α Lyræ near Conjunction.

Time of observation	Face of Circle	Mean Zen. Dist. Jan. 1. 1811.	Mult. for Paral.	Time of observation	Face of Circle.	Mean Zen. Dist. Jan. 1, 1811	Mult. for Paral.
1808, Oct. 22	W	14° 46′ 20″,61	,33	1811, Dec. 10	W	14° 46′ 21″,53	,83
Nov. 2	E	22,59	,48	11	E	20,43	,83
6	E	22,57	,53	13	W	17,66	,85
Dec. 4	EW	18,99	,80	28	E	22,14	,88
5	EW	21,74	,81	29	W	22,62	,85
19	EW	20,91	,85	1812, Jan. 14	W	20,32	,83
22	EW	20,33	,88	19	E	21,25	,81
1809, Jan. 22	E	22,19	,80	20	E	21,48	,80
30	W	22,65	,73	21	W	20,68	,60
Dec. 7	E	19,53	,82	29	E	22,95	,72
1810, Jan. 22	E	22,20	,79	Dec. 2	W	20,85	,79
23	W	20,04	,78	8	E	21,58	,82
Feb. 4	E	21,30	,68	10	W	22,19	,83
9	W	20,81	,63	11	E	21,19	,84
13	E	18,49	,59	14	W	20,46	,85
18	E	18,53	,52	15	E	19,74	,85
1811, Jan. 10	E	20,14	,84	22	E	21,70	,88
11	W	18,71	,86	31	W	20,07	,88
12	E	21,65	,85	1813, Jan. 4	E	21,01	,87
15	W	22,89	,83	6	W	19,97	,86
16	W	21,62	,83	Nov. 28	E	19,48	,76
17	E	19,70	,82	Dec. 6	W	21,64	,81
20	W	19,71	,80	9	W	22,90	,83
21	E	21,73	,80	14	E	20,11	,85
22	W	22,55	,79	20	W	21,63	,87
23	E	22,86	,79	21	W	20,20	,87
Nov. 19	W	20,76	,68	26	W	19,85	,87
Dec. 2	W	20,79	,79	28	E	21,55	,88
5	E	23,24	,81	29	W	21,36	,88
				30	E	20,17	,88
				1814, Jan. 3	W	22,40	,88
				4	W	22,34	,88

α Lyræ near 6 o'clock in the Evening.

Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1. 1811.	Mult. for Paral.	Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1. 1811.	Mult. for Paral.
1810, Aug. 28	E	14 40 19,17	+,46	1811, Oct. 11	E	14 46 20,38	—,17
Sept. 5	W	17,79	+,35	12	W	18,91	—,17
7	E	20,00	+,32	16	E	20,03	—,24
8	E	19,98	+,31	1813, Sep. 29	W	18,09	—,00
16	W	21,21	+,20	Oct. 1	E	19,85	—,03
Oct. 1	E	20,61	—,03	3	W	20,21	—,07
2	E	20,56	—,06	6	E	21,03	—,11
5	W	18,84	—,10	7	W	19,67	—,13
6	W	21,53	—,11	8	E	22,95	—,14
7	E	20,64	—,13	11	W	17,48	—,17
8	E	20,16	—,14	14	E	20,35	—,22
15	E	22,82	—,23	15	E	20,85	—,23
1811, Oct. 9	W	22,78	—,14	18	W	20,88	—,27

The first column points out the day of observation. The second shews the position of the face of the circle. The third the mean zenith distance, Jan. 1, 1811, to which the observations have been reduced as being a middle epoch between the observations. The last column is the multiplier of the semiannual parallax to obtain the parallax in zenith distance at each observation. The product is to be applied, according to the sign, to the zenith distance in the third column, to obtain the mean zenith distance.

Let *p*. represent the semi annual parallax of α Lyræ.

	Mean	Zen.	Dist.
	°	′	″
Then by the first 20 observations near opposition	14	46	19,51+,76*p*
by next 20 - - - -			19,07+,82*p*
by next 25 - - - -			19,26+,75*p*
Mean of 65 observations near opposition	14	46	19,28+,78*p*
By first 20 observations near conjunction -	14	46	20,84—,72*p*
by next 20 - - - -			21,24—,81*p*
by next 21 - - - -			21,01—,85*p*
Mean of 61 observations near conjunction	14	46	21,03—,79*p*

Hence $19'',28p.+,78p = 21'',03—,79p.$

or $p = 1'',1$

and the parallax of the annual orbit for α Lyræ = 2″,2.

Thus the mean zenith distance

of α Lyræ, Jan. 1, 1811, by 126 observations = 14° 46′ 20″,15

By the 26 observations, near 6 o'clock in the evening, the mean zenith distance, Jan. 1, 1811=14 46′ 20″,25—,05*p*.

If the above conclusion respecting the parallax of α Lyræ be not admitted, some explanation of the differences of the zenith distances must be sought for.

First, it cannot arise from errors of observation, comprehending error of adjustment in the vertical axis, error of bisection of the star, and errors of reading off. These errors by their nature are corrected by taking a mean of repeated observations, and an inspection of the result of each observation will shew that it is impossible a mean of 60 observations can be affected by a greater error of observation than a very small fraction of a second.

It occurred that the mean of the observations made and read off in day-light might differ from the mean of the observations made near midnight. It soon however was satisfactorily ascertained that the differences could not arise from this cause.

Secondly, the difference cannot arise from errors of division, for in fact the same divisions are used as to the same star. The correction of the mean of the microscopes, obtained by observations of different stars, which have been used to deduce the observed zenith distance of α Lyræ, although affected by errors of division, occasions no error in the result, because care has been taken that the numbers of observations East and West should be nearly equal. The zenith distances corrected for the mean of the microscopes have been put down merely to shew the consistency of the observations. The means of the zenith distances at each time of the year, depend only on the observations of α Lyræ itself.

Thirdly, it cannot arise from uncertainty in the changes of refraction. This star is too near the zenith for any material uncertainty of this kind.*

* These observations have been calculated by Bradley's refractions. Had they been calculated by the French Tables, (which I have used for α Aquilæ and Arcturus) the parallax would have been about two seconds. This alteration arises from the differ-

Fourthly, it cannot arise from any uncertainty in the maximum of aberration of light; whether we take the maximum at 20″ or $20\frac{1}{4}$″ Because when α Lyræ passes the meridian near noon and midnight, the aberration is very small, and therefore not affected by a small error in the maximum.

But it is necessary to compute with precision according to the sun's longitude at the time of the passage, as the aberration changes rapidly at these times. The semi annual equation is nearly the same at these times, and therefore no error from thence. The precession or any small uncertainty in the quantity of proper motion can occasion no error.

When indeed α Lyræ passes near 6 o'clock, then an uncertainty in the maximum of aberration may affect the conclusion, because the aberration in declination is nearly a maximum, and therefore in this enquiry it is of some consequence to know the maximum of aberration.

Hence the observations of α Lyræ near quadrature are less proper for this enquiry, and have accordingly been less attended to. Those that have been made are however very consistent with the observations made near noon and midnight.

The only solution, perhaps that we have left, unless we admit of parallax, is, that in different degrees of tempera-

ent laws of change of density from change of temperature in Bradley's, and in the French Tables.—In α Lyræ it is scarcely worth notice, but is considerable in α Aquilæ. In that star the parallax comes out less by the French, than by Bradley's Refractions.

ture; the figure of the instrument changes, and gives different results for the same star. This cannot be the case.

For 1st. with respect to several stars, the results are the same when the means of the thermometer differ by many degrees. Thus,

α Polaris.

14	observations	mean therm.	55°,2	give seconds in zen. dist.	-	5″,79
23	do.	mean therm.	39	give do.	-	6,27
11	do.	mean therm.	41½	give do.	-	6,02

α Polaris S. P.

23	observations	mean therm.	59°,8	give seconds in zen. dist.	-	25″,26
21	do.	mean therm.	39,2	do.	-	25,65

The above are even computed by Bradley's formula for refraction which certainly gives the change of refraction from change of temperature too great.

Arcturus.

18	observations	mean therm.	59°	give seconds in zen. dist.	-	34″,68
20	do.	do.	64	do.	-	34,92
23	do.	do.	40	do.	-	35,23

These are also computed by Bradley's refractions.

Secondly, if the figure of the instrument changed in different degrees of temperature, the zenith distance of a star, determined by the bottom microscope only would not preserve, in different temperatures, the same relation to the zenith distance determined by the mean of the three microscopes. No alteration however is observed to take place. Thus for α Lyræ the following are the corrections to be applied to the zenith distance by the *three microscopes* to give the zenith distance by the *bottom microscope* only.

			Correction.
Summer	-	1811	—0″40
Winter	-	1811	—0,26
Summer	-	1812	—0,46
Winter	-	1812	—0,07
Summer	-	1813	—0,03
Autumn	-	1813	—0,24

This indicates no change of figure, and the same is observed with respect to other stars. In α Aquilæ, for instance, the quantity to be applied to the mean of the three microscopes to give the result by the bottom microscope only = + 1″ nearly, and no material change occurs in different temperatures. *

Besides if this parallax arise from some deception, it ought to appear in *all* stars sufficiently near the zenith, so as not to be affected by uncertainty in change of refraction.

* The difference between the mean of the three microscopes and the bottom microscope is no where greater than for α Aquilæ.

Capella, β Tauri Procyon, Polaris, above and below the pole, γ Draconis, β, ζ, η, Ursæ majoris and other stars do not shew changes of zenith distance similar to what appear as to α Lyræ, Arcturus, α Aquilæ, α Cygni, and α Ophiuchi.

The mean zenith distances from a number of observations of the pole star above and below the pole are given, as instances where no changes of zenith distance are noticed.* Also the results as to α Aquilæ, Arcturus and α Cygni. The results as to other stars which seem to have a sensible parallax will be given when the observations are more numerous.

If parallax be not admitted, it must appear very remarkable that in no stars have annual changes of zenith distance been observed by this instrument that cannot be explained by a parallax. It might be expected that in some stars the changes would have been quite opposite to the changes from parallax.

It may perhaps be suggested that there may be some unknown peculiarity in my mode of observing, that would explain these appearances of parallax. In answer to this it is

* In the observations of the pole star, each zenith distance is the result of observations made before and after the meridian passage of the star, the instrument having been reversed in the interval. This has sometimes been done for other stars, but not often. The value of this instrument may be considered as much enhanced from being capable of being used at a small distance on each side of the meridian, by noting the time of observation.

only necessary to mention that many of the observations have been made by my son, Mr. John Brinkley, A. B. and comparing the results of our observations no differences are observed.

α Polaris in the Spring,

Time of Observation.	Face of Circle.	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.	Time of Observation.	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.
		° ′ ″	+			° ′ ″	+
1809, Mar. 3	EW	34 54 44,51	,86	1810, Apr. 24	EW	34 54 46,35	,91
Apr. 10	EW	46,84	,98	26	EW	44,27	,91
22	EW	44,70	,97	May 27	EW	45.65	,56
				29	EW	44,98	,54
23	EW	46,45	,93	30	EW	44,15	,53
May 9	EW	46,33	,80	1811, Mar. 27	EW	45,90	,99
10	EW	43,77	,80	Apr. 22	EW	46,11	,93
14	EW	43,77	,74	1814, Feb. 2	EW	45,63	,50
22	EW	45,09	,65	7	W	47,17	,58
23	EW	45,67	,64	9	W	44,54	,61
27	EW	44,50	,62	16	EW	45,05	,69
1810, Mar. 5	EW	44,27	,88	24	E	44,80	,79

The mean of 23 gives mean zenith distance $= 34° \; 54' \; 45'',24. + ,76p$.

The greatest zenith distance of the pole star when above the pole as affected by parallax, is on Oct. 4. and the least on April 2. Here as well as in the results which follow, the refraction has been computed by the French tables.

α Polaris in the Autumn.

Time of Observation.	Face of Circle.	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.	Time of Observation.	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.
			—				—
1809, Oct. 5	EW	34 54 43,22	,99	1811, Oct. 16	E	34 54 44,27	,97
7	EW	45,01	,99	22	W	45,42	,94
22	EW	44,50	,94	23	W	45,38	,94
26	EW	46,75	,91	27	W	46,42	,91
29	EW	47,04	,91	Nov. 5	E	45,47	,85
Nov. 1	EW	43,70	,88	19	W	46,07	,71
6	EW	42,71	,84	20	E	45,49	,69
14	EW	43,67	,77	29	W	47,43	,56
17	EW	47,06	.73	1812, Oct. 20	W	45,32	,95
18	EW	45,57	,72	24	E	46,88	,94
19	EW	45,09	,71	25	W	46,37	,93
21	EW	46,45	,69	26	E	45,76	,92
29	EW	44,95	,58	27	E	45,19	,92
Dec. 3	EW	46,70	,51	28	W	44,55	,91
7	EW	46,97	,44	Nov. 3	E	47,65	,87
10	EW	44,57	,39	5	E	46,84	,85
12	EW	47,44	,36	6	W	45,54	,84
1810, Nov. 6	EW	44,58	,84	7	E	44,93	,83
26	EW	43,85	,60	8	W	44,61	,82
Dec. 1	EW	45,64	,53				

Mean of 39 observations gives mean zenith distance = $34° 54' 45'', 51—79p$. Comparing the two last sets of observations, viz. 23 in spring and 39 in autumn, we have
$45'',24+,76p. = 45'', 51—,79p$ or $p = 0',17$.

From which may be inferred that α Polaris has no sensible parallax.

α Polaris S. P. in the Spring.

Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.	Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.
			—				—
1809, Apr. 14	EW	38 18 48,55	,96	1810, Ap. 19	EW	38 18 47,54	,94
20	EW	49,89	,94	26	EW	47,83	,90
23	EW	49,81	93	27	EW	48,36	,89
May 9	EW	44,81	,80	28	EW	46,45	,88
10	EW	46,48	,78	30	EW	45,61	,87
14	EW	46,96	,74	May 2	EW	45,34	,86
18	EW	47,58	,70	5	EW	48,76	,83
22	EW	45,44	,67	1813, May 5	W	48,09	,83
23	EW	47,08	,66	9	E	46,67	,79
24	EW	45,68	,65	16	W	49,20	,72
June 4	EW	46,38	,47	19	E	48,03	,68
15	EW	46,16	,30	20	W	47,29	,67
17	EW	45,77	,26	21	E	47,92	,66
25	EW	45,74	,15	26	W	48,71	,59
			+	28	E	47,00	,56
July 10	EW	46,21	,09	29	W	48,58	,55
				June 1	E	46,89	,52

Mean of 32 gives mean zenith distance $= 38^\circ\, 18'\, 47'',21 - ,68p$.

α Polaris S. P. in the Autumn.

Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.	Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.
		° ′ ″	+				+
1809, Aug. 25	EW	38 18 46,97	,78	1811, Nov. 3	E	38 18 45,48	,87
Sep. 30	EW	48,11	,99	5	W	47,58	,85
Oct. 5	EW	44,78	,99	6	W	47,50	,85
24	EW	46,20	,93	11	E	47,70	,80
28	EW	48,98	,91	18	W	49,49	,72
31	EW	47,95	,88	22	E	46,27	,66
Nov. 16	EW	45,25	,74	1812, Oct. 14	W	45,77	,98
17	EW	46,51	,73	15	E	47,45	,98
18	EW	45,42	,72	20	W	46,57	,95
19	EW	47,14	,71	21	E	46,90	,95
21	EW	45,79	,69	23	W	48,10	,94
23	EW	46,90	,66	25	W	47,30	,93
Dec. 1	FW	46,75	,53	27	E	46,07	,91
11	EW	46,98	,37	28	W	45,75	,91
1810, Nov. 16	EW	47,35	,72	29	E	47,87	,90
1811, Oc. 15	W	46,31	,98	Nov. 2	E	45,46	,87
16	E	46,07	,98	3	W	46,66	,87
19	W	47,81	,96	4	E	47,05	,86
24	W	46,25	,93	5	W	45,65	,86
25	E	45,35	,93	6	E	45,83	.85
Nov. 1	W	46,99	,88	7	W	47,68	,84

The mean of 42 observations gives mean zenith distance = $38°.18'.46'',76+,84p$. A comparison of the mean of the observations in spring and of the mean of these in Autumn gives $47'',21—,68p = 46,76 + ,84p$. or $p = 0'',30$ from which also I infer that the parallax of α Polaris (if any) is too small to require to be noticed.

α Aquilæ.

Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.	Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.
		° ′ ″	+			° ′ ″	+
1809, July 20	E	45 0 32,48	0,48	1811, Aug. 6	W	45 0 28,89	,42
Aug. 21	E	27,44	0,32	10	W	30,46	,40
22	W	27,99	0,32	16	W	31,57	,36
23	E	29,60	0,31	19	E	28,83	,34
24	W	29,88	0,30	20	W	28,68	,34
27	W	28,35	0,28	22	E	31,99	,32
28	W	29,07	0,27	25	W	31,80	,30
1810, July 30	W	30,90	0,45	27	E	28,69	,28
Aug. 26	E	28,82	0,29	31	W	31,03	,25
1811, July 14	E	28,80	0,50	Sep. 1	E	29,55	,24
16	W	28,99	0,49	1812, Aug. 6	E	28,29	,42
20	W	29,18	0,48	7	W	29,29	,42
21	E	31,48	0,48	8	W	29,88	,41
22	W	30,77	0,48	9	E	32,15	,40
23	E	27,84	0,48	16	W	29,54	,36
26	W	30,63	0,47	24	E	28,13	,30
29	E	30,34	0,46	25	W	27,07	,29
31	W	30,81	0,46	26	E	28,79	,28
Aug. 3	E	31,38	0,44	Sep. 5	W	31,02	,21

The mean of the above 38 observations gives mean zen. dist. $= 45° \ 0' \ 29'',74 + ,38p$. The effect of annual parallax as to α Aquilæ makes the zenith distance greatest, Dec. 29, and least June 29.

α Aquilæ.

Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.	Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.
		° ′ ″	—			° ′ ″	—
1808, Nov. 29	W	45 0 32,49	0,44	1811, Dec. 13	W	45 0 31,40	0,50
Dec. 19	EW	34,22	0,51	18	E	32,63	0,52
22	EW	32,97	0,52	21	W	33,36	0,52
1809, Jan. 30	E	30,63	0,44	29	E	31,33	0,52
Feb. 11	E	32,42	0,37	1812, Jan. 4	W	32,56	0,51
16	E	30,73	0,33	8	E	29,84	0,50
1810, Feb. 4	E	29,17	0,41	21	W	29,68	0,48
13	W	31,58	0,35	29	E	32,10	0,44
18	E	31,58	,032	30	W	32,22	0,44
Mar. 10	W	33,26	0,16	1813, Jan. 20	E	31,08	0,48
13	E	31,06	0,13	25	W	33,61	0,46
1811, Jan. 27	E	30,53	0.45	Feb. 5	E	32,00	0,41
28	W	32,99	0,45	6	W	32,61	0,40
Feb. 3	W	32,92	0,42	9	E	31,75	0,38
13	E	31,80	0,35	15	W	32,01	0,34
19	W	34,16	0,31	19	E	29,78	0,31
23	E	32,29	0,28	20	W	31,98	0,30
24	W	33,55	0,27	21	E	31,07	0,29
Dec. 11	E	29,44	0,50	22	W	32,65	0,29

The mean of the above 38 observations gives the mean zen. dist, 45° 0′ 31″,87—,40p. Hence by comparing the preceding set of observations with these, we have 29″,74 + ,38p = 31″,87—,40p or p = 2″,73.

Hence the parallax of α Aquilæ = 5″,5. The refractions in the

French tables have been used in the above. Had Bradley's refractions been used, the parallax would have come out considerably greater. The value of p is less exact, on account of the smallness of its co-efficients.

A mean of 20 observations near six o'clock in the evening, gives mean zenith distance $= 45°.0'. 30'',64 - ,1p$.
The mean of the above 76 $= 45.0.\ 30,80 - ,01p$.*

* M. Delambre in his remarks on M. Piazzi's observations, proposes to examine the effects of the parallaxes in changing the right ascensions. This confirmation would be very satisfactory, and might be readily attained, were some stars so much affected by parallax as M. Piazzi has supposed. But if the parallaxes be so small as my observations tend to point out, no expectation of this kind could be entertained as to α Lyræ, Arcturus, and α Cygni.

As to γ Aquilæ, the right ascensions in March and September would differ by about $\frac{4}{10}$ of a second of time, and, under the circumstances of the case, it would require attention to detect this quantity, but it might be done. If this difference exist it ought to be allowed for in computing the apparent from the mean right ascension.

Arcturus.

Time of observation	Face of Circle	Mean Zen. Dist. Jan. 1. 1811.	Mult. for Paral.	Time of observation	Face of Circle.	Mean Zen. Dist. Jan. 1, 1811	Mult. for Paral.
			—				—
1808, Oct. 27	E	33° 12′ 54″,86	,54	1811, Oct. 16	W	33° 12′ 55″,72	,47
31	W	52,88	,55	18	W	55,57	,48
Nov. 1	W	56,15	,56	25	E	55,02	,53
11	EW	53,55	,60	26	W	55,01	,53
27	EW	52,93	,61	Nov. 1	W	56,21	,56
29	EW	54,51	,61	3	E	52,72	,57
Dec 10	EW	53,14	,59	18	W	55,87	,61
13	EW	52,50	,59	19	E	55,71	,61
14	EW	52,74	,59	22	E	56,67	,61
1810, Sept. 6	W	52,56	,12	29	W	54,49	,61
10	W	57,61	,16	Dec. 1	W	53,94	,61
21	E	53,98	,27	1813, Oct. 14	E	56,02	,46
Nov. 5	E	53,75	,57	19	E	55,16	,49
6	W	55,48	,58	31	W	56,52	,56
16	W	56,62	,60	Nov. 2	E	54,27	,57
22	E	55,42	,61	3	W	57,61	,57
26	W	54,86	,61	11	E	55,23	,60
Dec. 1	E	55,97	,61	12	W	55,90	,60
10	E	53,57	,59	14	W	57,50	,60
1811, Oct. 11	W	56,74	,44	Dec. 14	E	56,32	,58
12	E	55,84	,45	16	W	57,69	,57

In deducing these results from the observations of Arcturus, the annual change of *N. P. D.* has been taken = +18″,81. The annual proper motion of Arcturus may be considered in some measure uncertain, and it may be thought that the conclusion respecting parallax will be affected thereby. But this is not the case. Let the annual variation in *N. P. D.* = 18″,81+*e*. *

Then the mean of the above 42 observations gives
the mean zenith distance = 33° 12′ 55″,11—,54*p*—,45*e*.

* The annual variation in N. P. D. of Arcturus seems by my observations to be at least +19″,1. But the interval since they commenced is too short to speak with much confidence.

Arcturus.

Time of observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1811.	Mult. for Paral.	Time of observation	Face of Circle	Mean. Zen. Dist. Jan. 1, 1811.	Mult. for Paral.
		° ′ ″	+			° ′ ″	+
1809 April 20	E	33 12 53,83	,52	1811 May 19	E	33 12 56,07	,61
28	EW	54,85	,56	26	E	52,35	,61
May 14	EW	53,70	,60	29	W	53,79	,61
21	W	54,64	,61	June 9	E	52,83	,60
June 25	EW	51,80	,52	12	W	53,89	,59
1810 April 25	E	53,27	,53	17	W	54,71	,56
26	W	56,24	,55	18	W	52,89	,56
27	E	51,90	,55	1813, May 11	E	53,32	,60
28	W	53,76	,56	16	W	56,07	,61
30	E	51,48	,57	20	E	54,16	,61
May 2	W	52,22	,57	28	W	54,95	,61
4	E	55,26	,57	29	E	52,87	,61
5	W	53,10	,58	30	W	55,48	,61
6	E	53,34	,58	June 2	E	55,52	,61
29	W	52,41	,61	4	W	52,69	,60
31	E	54,27	,61	5	E	53,81	,60
1811, May 11	W	56,77	,60	8	W	53,17	,59
16	E	53,11	,61				

From the above 35 observations
the mean zenith distance $= 33° \; 12' \; 53'' ,80 + ,59p - ,35e$.

Hence $55'',11 - ,54p - ,45e = 53,80 + ,59p - ,35e$

$p = 1'',1 - ,09e$.

e cannot be so great as half a second, and therefore $,09e$ is too small to be noticed. Therefore from these results the parallax of Arcturus $= 2'',2$.

And by 77 observations, the mean zenith distance $= 33°.12' \; 54'',45 + ,05p - ,4e$. By 15 observations in July and August, mean zen. dist. $= 33° \; 12' \; 54'', \; 50 + ,2p + ,68e$.

κ Cygni.

Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1. 1812.	Mult. for Paral.	Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1. 1812.	Mult. for Paral.
		° ′ ″	—			° ′ ″	—
1810, Mar. 9	W	8 46 26,21	,59	1813, Jan. 9	E	26,78	,88
10	E	26,31	,58	10	W	24,44	,88
17	W	23,91	,49				
18	W	24,77	,48	11	E	24,03	,88
1811, Jan. 28	W	21,77	,89	19	E	24,50	,88
Feb. 3	W	23,59	,87	25	W	26,53	,90
23	E	26,42	,74	Feb. 4	E	25,81	,90
24	W	25,68	,73	5	W	26,46	,86
28	E	25,35	,70	6	E	22,83	,86
Mar. 12	W	26,22	,56	1813, Dec. 26	W	23,48	,81
14	E	25,64	,53	27	E	27,29	81
1813, Jan. 8	W	25,55	,88	28	W	24,40	,82
				1814, Jan. 4	W	23,81	,86

The above 24 observations give the mean zen. dist. =
8° 46′ 25″,07—,76*p*.

α Cygni.

Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1812.	Mult. for Paral.	Time of Observation	Face of Circle	Mean Zen. Dist. Jan. 1, 1812.	Mult. for Paral.
		° ′ ″	+			° ′ ″	+
1811, July 26	W	8 46 22,77	,90	1811, Sep. 5	E	8 46 26,63	,67
28	E	24,49	,90	1812, Aug. 24	E	24,03	,77
Aug. 3	E	24,24	,89	25	W	26,09	,76
10	W	23,08	,85	26	E	23,98	,75
13	E	24,31	,83	27	W	22,93	,74
16	W	22,16	,82	Sep. 5	W	24,81	,67
19	E	22,93	,80	7	E	23,87	,64
20	W	21,03	.80	10	W	22,52	.61
22	E	24,90	,79	11	E	23,67	,60
25	W	21,22	,76	12	W	23,46	,59
27	E	22,54	,74	Oct. 1	E	23,78	,33
31	W	21,59	,72				

The above 23 observations give the mean zen. dist. = $8° \; 46' \; 23'',48 + ,74p$.

Hence $25'',07 - ,76p = 23'',48 + ,75p$

Therefore $p = 1'',06$

And the parallax of α Cygni $= 2'',1$.

REMARKS.

If the results deduced from the preceding observations should be admitted, it follows that the brightest fixed stars are not so near to us as some others. α Aquilæ, which is far exceeded in splendor by α Lyræ and Arcturus is only at half the distance of the two latter. However extraordinary this may appear, it results from observations that appear to me fully adequate for the conclusion.

My observations on α Lyræ were commenced with the view of examining the question of parallax; but the results of the observations of α Aquilæ forced themselves as it were on my notice. This star would not on any account have been selected for the investigation. The effect of the annual parallax in declination is only about half the whole parallax: The star itself has not that splendid appearance that would lead us to suppose it as near as many others. Also its zenith distance in this latitude being so much as 45°, some uncertainty in so delicate an enquiry might be apprehended from refraction.

My conclusions may be considered as deriving little or no support from the results of the observations of M. Piazzi.

According to him (as appears from the Conn. des Temps 1808) the double parallax of α Lyræ is nearly five seconds, according to me only two seconds.

According to him the double parallax of Arcturus is less than that of α Lyræ (the quantity is not stated in Conn. des Temps.) according to me two seconds.

According to him α Aquilæ has no sensible parallax; according to me the double parallax is five seconds and an half.

According to him Procyon has a considerable double parallax amounting to about $20''$; according to my observations it has no sensible parallax.

According to him Sirius has a considerable parallax. This star in this latitude is too much affected by refraction to afford any satisfactory conclusion.

The small changes of zenith distances which I find in α Lyræ, in Arcturus and in α Cygni, and from which I conclude the parallax of each, will, it is not doubted, make astronomers hesitate as to the degree of confidence with which they will receive them. It is not pretended that these quantities can be ascertained to the tenth of a second; but by continuing the observations, it appears to me, that I shall at last arrive at that degree of exactness. There seem to be no sources of errors in making these observations, which will not disappear by taking a mean of a great number of observations. However, until my conclusions are supported by other instruments, it is not likely that I shall impress astronomers with the same confidence which I myself possess as to the results.

The astronomer royal, Mr. Pond, observing with the new mural circle, made by Mr. Troughton, has not hitherto confirmed my results, although he finds indications of parallax in α Lyræ and α Aquilæ. * I had felt such confidence in my results that I did not doubt that one of the first services that would be rendered to astronomy, by the Greenwich mural circle, would be the confirmation of the existence of annual parallaxes in certain stars. But, allowing the greatest accuracy in the observer, and excellence in the instrument, I conceive a very probable account has been given, why this has not yet taken place. Many of the stars, even of the second magnitude, such as Polaris, γ Draconis, &c. may be affected by a parallax in declination, amounting to a fraction of a second. Were we certain that the standard stars were not affected by parallax, or had we ascertained the quantity, if any, then the method of observing by the mural circle would be far preferable to the methods of observing in which the plumb line is used. †

* Phil. Trans. 1813, part 2.

† I can feelingly bear testimony to the great superiority of the mural circle over our instrument, as to the convenience of the observer, and the consequent facility of multiplying observations. In the mural circle no care is necessary but in making and reading off the observations. In our circle the previous examination of the plumb line is often a very tedious and sometimes unsatisfactory operation. Many observations have been lost thereby, a serious inconvenience in a climate ill adapted to astronomical observations. The calm weather which we so often experience during a high state of the barometer, both in summer and winter, is generally unfavourable to the astronomer, be-

The same number of observations that I have given might have been completed in a smaller space of time, but unfavourable skies, necessary interruptions, and the expectation of having my results confirmed by other instruments have made the earlier observations less numerous than they otherwise would have been. It soon appeared that increasing the number of observations would not materially change the results that I had already deduced. However the consistency of the observations in the several years may with some add weight to the conclusions.

My future exertions shall be directed in making such observations as may serve to throw further light on this subject,

If I should meet with any circumstances that shall appear to me to invalidate the conclusions I have now ventured to make, I shall cheerfully communicate them. I shall be fully satisfied with the consciousness of having, to the utmost, exerted myself, as my duty led me, in the examination of this important question.

ing attended with a cloudy atmosphere. Clear skies oftener prevail during high winds. These circumstances are much against the use of the plumb line.

MEAN NORTH POLAR DISTANCES OF FORTY-SEVEN PRINCIPAL FIXED STARS, JAN. 1, 1813.

Names of Stars.	No. of Obs.	By Ref. in French Tables. Co-lat. 36° 36′ 46″ 5 N. P. D. Jan. 1, 1813.	Ref. Brad. Tab. Co-lat. 45″,8 *N.P.D*	G	P	D
		° ′ ″	″	″	″	″
* Polaris	36	1 41 21,77	21,71	+ 0,08		+ 0,14
* β Ursæ min.	38	15 4 49,45	49,26	— 0,31		
* β Cephei	21	20 15 31,41	31,14	— 0,44		
* α Ursæ maj.	10	27 14 30,88	30,29	+ 1,17		
* α Cephei	9	28 12 13,90	13,30	— 0,83		
β Ursæ maj.	18	32 37 4,72	4,07			— 0,29
ε Ursæ maj.	19	33 1 22,05	21,44			
* α Cassiopeæ	8	34 29 22,59	21,91	+ 0,60		
ζ Ursæ maj.	8	34 54 42,68	41,01			
* γ Ursæ maj.	10	35 15 56,22	55,53	— 0,26		
* γ Draconis	27	38 29 3,70	3,00	+ 0,65		+ 0,28
* η Ursæ maj.	20	39 44 58,37	57,61	+ 0,27		
* α Persei	10	40 48 51,36	50,62	+ 2,05		
* Capella	30	44 12 20,71	19,90	+ 0,57	+ 2,34	+ 0,48
* α Cygni	22	45 22 58,34	57,52	— 0,60	— 0,42	— 1,90
* α Lyræ	51	51 23 0,84	59,93	+ 0,53	+ 2,21	+ 0,11
* Castor	10	57 42 47,54	46,64	+ 0,09	— 0,48	— 2,40
* Pollux	10	61 31 56,07	55,12	+ 1,23	+ 0,91	— 0,55
* β Tauri	18	61 33 44,22	43,19	+ 0,47	+ 0,37	— 2,28
* α Andromedæ	10	61 56 30,32	29,31	+ 0,30	+ 2,44	+ 0.81
* α Cor. bor.	19	62 38 55,51	54,44	+ 0,99	— 0,09	— 2,34
* α Arietis	9	67 25 36,76	35,82	+ 0,67	+ 0,41	+ 1,35
* Arcturus	20	69 50 19,33	18,19	+ 0,89	— 1,90	— 1,09
* Aldebaran	20	73 52 35,98	34,62	+ 0,74	— 0,79	— 1,64

Names of Stars.	No. of Obs.	Ref. by French Tables, Co-lat. 26° 36′ 46″,5 *N P D* Jan. 1, 1813.	Brad. Ref. Co lat. 45″,8 *N.P.D*	G	P	D
		° ′ ″	″	″	″	″
* β Leonis	18	74 22 56,44	55,22	+ 2,09	— 0,18	+ 3,33
* α Herculis	10	75 23 14,64	13,22	+ 0,82	— 3,17	— 2,26
* α Pegasi	15	75 47 52,80	51,71	+ 0,00	— 1,04	+ 0,19
* Pegasi	10	75 51 21,18	20,00	+ 1,00	+ 0,91	— 0,46
* Regulus	20	77 7 23,06	21,79	+ 0,90	— 0,57	+ 0,42
* α Ophiuchi	25	77 17 40,49	39,19	— 0,03	— 2,76	— 1,25
γ Aquilæ	10	79 50 1,34	0,11	+ 0,55	— 0,98	— 2,55
* α Aquilæ	30	81 36 59,85	58,54	+ 0,12	— 2,67	— 2,53
β Aquilæ	10	84 3 5,22	3,79	+ 0,30	— 0,53	— 3,31
* α Orionis	18	82 38 15,94	14,69	+ 1,03	+ 0,53	— 1,35
* α Serpentis	18	82 58 38,81	37,40	+ 1,86	+ 1,14	— 1,49
* Procyon	16	84 18 15,33	13,87	+ 0,49	— 0,41	+ 0,19
α Ceti	10	86 39 2,04	0,74	+ 0,01	— 0,46	— 0,67
α Aquarii	10	91 13 21,75	19,96	+ 1,68	+ 0,49	+ 0,90
α Hydræ	12	97 51 10,99	9,39	+ 1,91	+ 1,45	+ 0,82
Rigel	10	98 25 34,27	32,67	+ 1,18	— 0,61	— 0,41
Spica Virg.	13	100 10 51,33	49,23	+ 2,07	— 0,74	— 0,60
1 α Capricorn.	9	103 4 36,09	34,09	+ 1,36	— 2,16	— 3,04
2 α Capricorn.	10	103 6 52,03	49,68	+ 2,64	+ 0,57	+ 0,89
2 α Libræ	10	105 15 22,59	20,02	+ 2,67		+ 1,41
Sirius	10	106 28 4,27	2,47	— 1,77	— 2,23	— 2,11
Antares	10	116 0 16,77	13,77	+ 2,86	+ 2,04	+ 1,55

I find by above 500 observations of circumpolar stars the latitude of the observatory of Trinity College, Dublin, 53° 23′ 13″,5 using the French tables of refractions published in 1806. Or 53° 23′ 14″,2 using Bradley's refractions.

In the preceding catalogue the third column shews the mean north polar distance, Jan. 1, 1813, the refractions having been computed by the French tables, to which tables I give the preference for reasons assigned in the paper which follows this.

The fourth column shews the seconds of the north polar distances, as computed by Bradley's tables.

It appeared to me on several accounts of much importance, to compare observations made nearly at the same time by different instruments. The mural circle at the royal observatory, Greenwich, and the circle at the observatory of Trinity College, Dublin, may be ranked amongst the best instruments that have been constructed. As soon therefore as I was informed that the Greenwich circle was in use, I determined to repeat my observations of the principal fixed stars, and the present catalogue is the result of observations in the latter part of the year 1812 and in the year 1813.

To institute a comparison between the north polar distances deduced by Mr. Pond and myself, it is necessary that the same tables of refraction should be used by each. Therefore as Mr. Pond has used the tables of Bradley, I also computed my observations by the tables of Bradley, and the result of the comparison of the observations is found in the column *G*. The quantity in *G* is to be applied to the fourth column to give the north polar distances by the Greenwich mural circle.

The 30 stars marked * are those which Mr. Pond uses as standard stars; the north polar distances of which he has determined by a great number of observations in 1812 and 1813. (vid. Phil. Tran. 1813, part 2.) Now among these 30 stars there are 24 in which the results do not differ by 1″, four in which the differences exceed 1″, but do not amount to 2″, and two in which the differences exceed 2″, but do not amount to 2″$\frac{1}{4}$. This is highly creditable to the divisions of our circle. In the Greenwich circle the errors of divisions, if any, will entirely disappear in a mean of a great number of observations, in consequence of the telescope being moveable. And in fact in this way Mr. Pond has ascertained that the errors of division of the Greenwich circle are too small to be noticed. (Phil. Tran. 1813, p. 281.) In our instrument the effect of the errors of division in the mean of the six readings of the microscopes, cannot be made to disappear. The above comparison shews satisfactorily that no material error can arise from thence.

For the stars not marked * the comparison has been made with the north polar distances given in the Phil. Tran. 1813, part 1. The differences as to these low stars are greater, and may probably be attributed partly to the uncertainty of refraction, and partly to the use of Bradley's tables. In Dr. Bradley's formula for refraction the effect of the change of temperature on the quantity of refraction is taken too great. This appears certain by the direct experiments of T. Mayer, Dalton and Gai-Lussac on the expansion of air at different temperatures. It also appeared evident to me by observations of low stars in different temperatures. The consequence of which is, that even supposing the utmost accuracy in the instruments and in the observations, the zenith distances of stars will appear greater in winter than in summer, and the more so the greater the zenith distance.

The column *P* shews the quantity to be applied to the fourth column to obtain the north polar distances according to M. Piazzi, at Palermo. His north polar distances given in the Conn des Temps, 1812, having been reduced to Jan. 1, 1813, and also reduced to what they would have been according to Bradley's refractions. I do not know the exact date of these observations, but I suppose them recent. I believe also that M. Piazzi takes the mean refraction at $45^{\circ} = 57'',4$ and makes the same allowance for changes in the thermometer as Dr. Bradley. If so, the correction to be applied to the north polar distances, as determined by M. Piazzi, to give what would have resulted from the use of Bradley's refractions $= -0'',69 - 0'',5$ (tan. $N.P.D. - 53^{\circ}.53'$). This quantity has been applied accordingly.

The column *D* is the difference between my results in 1809 and 1813. The quantities according to their signs are to be applied to the results in column 4, to give what would have resulted from the observations in 1809. In making this comparison, the annual motions in north polar distance, as given in the last catalogue of Dr. Maskelyne, have been used. These certainly are in several instances inaccurate from the proper motions used, and to this may be attributed some of the differences between 1809 and 1813, but it is by no means a sufficient explanation as to others. In the case of β Leonis, particularly, there appears a difference that I cannot attempt to account for. Considerable differences between the results of observations of the same star when separated by several years have, however, been before observed in several instances, and yet remain to be accounted for. A comparison of the means of the results of the observations of Dr. Hamilton, at Armagh, M. Piazzi, at Palermo, and Mr. Pond, at Westbury made about the same period, (Phil. Trans. 1806) and of the present results of the Greenwich, and of our instrument, furnishes a striking instance. A comparison some years hence of the present results and of new ones obtained by the same instruments will probably clear up this point.

It may also be remarked that the observations in 1809 were computed by Bradley's refractions, and also no attention was paid to the circumstance of parallax. The results of 1813 are from observations made when the zenith distances from the effects of parallax were greatest and least. Hence also perhaps may be explained part of the differences in column *D*.

In computing my observations I have used max. aberration of light $= 20'',00$

Lunar nut. in $N.P.D. = 8'',28$ sin. (AR—Long. moon's node)

$+ 1,22$ sin. ($AR +$ Long. moon's node)

Solar nut. in $N.P.D. = 0'',48$ sin. (2 Long. sun—AR.)

Analytical investigations respecting ASTRONOMICAL REFRACTIONS and the application thereof to the formation of convenient TABLES together with the results of observations of circumpolar Stars, tending to illustrate the Theory of Refractions.

By JOHN BRINKLEY, D. D. M. R. I. A. F. R. S. *and* ANDREWS' *Professor of Astronomy, in the University of Dublin.*

Read May 9, 1814.

A BRIEF detail will explain the objects of this paper. M. Le Comte Laplace first shewed that the fluxional expression for refraction may be integrated by approximation, as far as about 74° from the zenith, without a knowledge of the variation of density in the atmosphere. *

T. Simpson had deduced by the principles of the 8th section of the first book of Newton's Principia, the fluxional expression for refraction, by considering a particle of light as a body acted on by a force tending to the centre of the earth.† He and others since deduced the integral on the hypothesis, that the density of the atmosphere decreased

* Méc. cél. Liv. 10. c. 1. tom. 4. † Math. Dissertations, p. 51, &c.

uniformly. The simplest form of the integral is that used by Bradley.

Laplace uses the same method of obtaining the fluxional equation as Simpson had done, and then proceeds to investigate the laws of reflection and refraction. He deriveb y an analytical process the conclusions, which Newton had de duced in the 14th section of the first book of the Principia. Laplace next derives his fundamental fluxional expression for refraction which he shews may be integrated as far as 74° from the zenith, without a knowledge of the variation of density in the atmosphere.

In this paper the same fluxional expression, that Laplace obtained, is deduced by a very short method, and by using the common principle of the given ratio of the sines of incidence and refraction. Besides the simplicity of the investigation it has the advantage of avoiding hypothetic principles iespecting the rays of light.

The integration of the fluxional expression is also obtained by a method that may be considered as entitled to notice. If the surface of the earth were a plane, then whatever the law of variation of the densities of the different *strata* of air parallel thereto might be, the refraction for any zenith distance would be simply found from the knowledge of the refractive force at the surface, by tbe constant ratio of the sines of incidence and refraction. By the method given this part is separated from the rest, and the effect of the spherical form of the atmosphere is shewn. The formula for refraction consists of two parts, one the refraction that would take place were the earth a plane, the other the effect due to the spherical form. The latter at 80° zenith distance amounts only to about 12″, and at 40° zenith distance is insensible.

It is shewn that at 80° 45′ the error of the formula deduced cannot amount to half a second, whatever be the variation of density in the atmosphere.

As the approximate formula for refraction as far as about 74° from the zenith is independent of the law of variation of density, it follows that, whatever law be assumed, the same conclusion ought to be deduced as far as about 74°. This is shewn from direct investigation by assuming different laws of variation of density; which beside affording some conclusions useful in our enquiries on this subject, may be considered as interesting.

The results of the experiments of M. M. Biot & Arago on the refractive force of air, and of Mr. Dalton and M. Gai-Lussac on the effects of the change of temperature on the density of air are applied, and a general expression for refraction at any zenith distance less than about 80° obtained, which is entirely independent of astronomical observations.

From this general expression I have formed two tables, by help of which the refraction at any zenith distance less than 80° may be calculated with much convenience.

From a comparison of the co-latitude determined by stars near the pole, and of the same determined by stars more remote, I find, by 525 observations of circumpolar stars, the refraction at 45°, (Bar. 29,60 inches and Therm. 50°.) $= 57'',42$

The same by the French Tables - - - $= 57,57$

The same resulting from the direct experiments on the refractive force of air, applied to the formula. - - $= 57,67$

The quantity in the French tables was ascertained from the results of the observations of M. M. Piazzi & Delambre, applied to Laplace's formula by Delambre himself.

My result from the number of observations, from the care used in making them, and from the excellence of my instrument, seems entitled to as much confidence as can be given to a conclusion derived from observations of circumpolar stars, and there is no difference worthy of notice between my result and that of Delambre. But from the nature of the direct experiments on the refractive force of air, the results seem capable of greater exactness than can be derived from observations of circumpolar stars, and therefore strictly perhaps we ought to adopt the result so deduced. However the quantity in the French tables is so nearly equal to this that no inconvenience can arise in the nicest researches in astronomy from adopting these tables.

It is of much importance that the same tables of refraction should be used by astronomers, and it will afford satisfaction to the author of this paper, should it in any manner conduce to this desirable end. It cannot be doubted but that sooner or later the refractions as given by the French tables as far as

80_0, or a very slight modification thereof will be generally used by astronomers.

The form of the French tables may not be generally adopted, others more convenient perhaps may be derived. The new form given in this paper will serve as a check in the use of the French tables, and may be thought more convenient than these for observations of the sun, moon and planets.

Below 80° zenith distance, a knowledge of the law of variation of density is absolutely necessary for computing the quantity of refraction. As this cannot be had, all tables for these zenith distances must be in a manner empirical. The French tables are less so than any others, from the method used by Laplace. But the quantity of refraction varies so much from some unexplained cause, the heights of the barometer and thermometer remaining the same, that observations below 80° can be of little use. This irregularity is very manifest at 80° 45′ in the observed refractions of Capella below the pole. Sixty-five observed refractions of this star are given, and compared with those computed from the formula.

Forty-two observed refractions of α Lyræ below the pole, (zen. dist. 87° 42′,) are also given. In these the irregularities of refraction are very considerable. The mean of the observed refractions serves for shewing that refraction is greater than would result from a density decreasing uniformly, and less than would result from a uniform temperature. The mean also serves as a criterion of the accuracy of the French and of other tables at this zenith distance.

Investigation of the fluxional equation for refraction.

Let $VRPT$ be the path of a ray of light refracted at P and R, and let CO be perpendicular to TP produced. (Fig.)

Let the apparent zenith distance $HVR = \theta$*

CV the radius of the earth $= a$

$CR = r'$

$CP = r$

The density of the air at $P = \varrho$

The density at the surface $V = (\varrho)$

The height of an uniform atmosphere at $V = l$

Let $m : 1$ represent the ratio of the sine of incidence to the sine of refraction, when light passes from a vacuum into air of the same density as that in VR.

$k' : 1$ the same ratio for air of the density of that in PR, and $k : 1$ the same ratio for air of the density of that in TP

Then it readily appears that

$\sin. VRC : \sin. CRP :: k' : m$

$\sin. CPR : \sin. CPT :: k : k'$

* The same quantities are denoted by the same letters which Laplace has used (chap. 1. liv. 10. tom. 4. Méc. cél.)

Consequently

$$a \sin. CVR = r' \sin. VRC = \frac{k'r'}{m} \sin. CRP = \frac{k'r}{m} \sin. RPC$$

$$= \frac{kr}{m} \sin. OPC.$$

Hence $\sin. OPC = \frac{am}{kr} \sin. \theta.$ (1)

This equation is evidently true, whatever be the number of points of refraction between P and V, and therefore is true when VRP is a continued curve as in atmospherical refraction.

The refraction R, that takes place between P and $V =$ the inclination of the lines PT and RV. Hence

$$\dot{R} = \frac{\dot{O}C}{OP}.$$

By equation (1) $OC = \frac{am}{k} \sin. \theta.$

The refractive force of air is as its density, and the refractive force in TP is also as k^2-1, (vid. Newton's Optics, book 2, Prop. 10. Horsley's edition, vol. 4, p. 171.)

Therefore let $b\,\rho = k^2-1$, b being a constant quantity Then $k = \sqrt{1+b\rho}$ and $m = \sqrt{1+b(\rho)}$

Hence $OC = a \sin. \theta \frac{\sqrt{1+b(\rho)}}{\sqrt{1+b\rho}}$

and $OP = r \frac{\sqrt{1+b\rho - \frac{a^2}{r^2} \sin.^2 \theta \left(1+b(\rho)\right)}}{\sqrt{1+b\rho}}$

Therefore $\ddot{R} = \frac{\dot{O}C}{OP}$

$$= \frac{-\dot{\rho}\, a\, b \sin. \theta \sqrt{1+b(\rho)}}{2(1+b\rho)\, r \sqrt{1+b\rho - \frac{a^2}{r^2} \sin.^2 \theta \left(1+b(\rho)\right)}} \qquad (2)$$

This is Laplace's fundamental equation (3) vid. Méc. Cél. tom. 4, p. 244. b here corresponding to $\frac{4K}{n^2}$ in Laplace's formula.

2. The integral of this equation from $\varrho = (\varrho)$ to $\varrho = 0$ gives the atmospherical refraction required. It is obvious that to obtain the complete integral, it is necessary to know the relation between r and ϱ, or the law of diminution of the density of the atmosphere. This is at present unknown; but notwithstanding, we can approximate sufficiently to the value of R for all values of θ less than about 80°.

From the zenith to 74° zenith distance the result is the same whether we approximate to the integral, without knowing the relation of r and ϱ, or whether we assume any given relation, and reduce equation (2) to a convenient form for finding the integral.

Also by assuming two certain laws of variation of density we may obtain two integrals, one of which must give the refraction greater than the truth, and the other less. We find that as far as 80° 45′, * these refractions do not differ by one second, therefore a mean of the two must always give the refraction true within half a second so far from the zenith.

* The apparent zenith distance of the bright star, Capella, when below the pole, is in this latitude =80°45′, and having made many observations of this star S. P. I have taken that zenith distance as a limit.

Approximate integration of the Fluxional Equation.

3. Let Q represent the refraction that would take place if the surface of the earth were a plane, and the different *strata* of air parallel thereto, in which case the ratio of a to r would be the ratio of equality. Therefore equation (2)

becomes $\dot{Q} = \dfrac{-\dot{\rho}\, b \sin.\theta \sqrt{1+b(\rho)}}{2(1+b\rho)\sqrt{1+b\rho-(1+b(\rho))\sin.^2\theta}}$ (3)

Hence $\dot{R} = \dfrac{\dot{Q}\, a\sqrt{1+b\rho-(1+b(\rho))\sin.^2\theta}}{r\sqrt{1+b\rho-(1+b(\rho))\frac{a^2}{r^2}\sin.^2\theta}}$

Let $\frac{a}{r} = 1-s$ (4)

Then $\dot{R} = \dfrac{\dot{Q}(1-s)}{\sqrt{1+\dfrac{(2s-s^2)(1+b(\rho))\sin.^2\theta}{1+b\rho-(1+b(\rho))\sin.^2\theta}}}$ (5)

or $\dot{R} = \dot{Q}(1-s)(1-s\tan.^2\theta) = \dot{Q} - \frac{\dot{Q}\, s}{\cos^2\theta}$ neglecting the second and higher powers of s, also ϱ, (ϱ) and their powers. It is obvious that for the part of the atmosphere which makes the refraction sensible, s must be very small.

By equat. (3)

$\dot{Q} = -\frac{1}{2}\, b\,\dot{\rho}.\tan.\theta$ neglecting ϱ, (ϱ) and their powers.

Hence $R = Q + \int\frac{\dot{\rho}\, b\, s \tan.\theta}{2\cos.^2\theta}$ nearly. (6)

Now $\int\dot{\rho}\, s = \varrho\, s - \int\varrho\,\dot{s} = \varrho\, s - \int\frac{\rho\,\dot{r}\, a}{r^2}$ (by equat. 4.)

Let p = the pressure of a column of superincumbent air of a given base, at the distance r from the centre. Then the pressure of a particle of air being measured by its magnitude, density and gravity, supposing the gravity at the surface represented by unity

$$-\dot{p} = \frac{\rho \dot{r} a^2}{r^2}$$

Hence $R = Q + \left(\rho s + \frac{p}{a}\right)\frac{b\ tan.\ \theta}{2 cos.^2 \theta} +$ Constant.

when $R = o$, Q and $s = 0$ and $p = l\ (\rho)$.

Therefore constant $= -\frac{b(\rho) l\ tan. \theta}{2\ a\ cos.^2 \theta} = -\frac{(m^2-1)\ l\ tan. \theta}{2\ a\ cos.^2 \theta}$

consequently the whole fluent from $\rho = (\rho)$ to $\rho = 0$ is

$R = Q - \frac{(m^2-1)\ l\ tan. \theta}{2\ a\ cos.^2 \theta}$ or because m is nearly = unity

$$R = Q - \frac{(m-1)\ l\ tan.\ \theta}{a\ cos.^2 \theta}. \qquad (7)$$

This expression as will be shewn farther on can be easily reduced to that of Laplace (Méc. cél. tom. 4. p. 268.) But it remains to shew how far from the zenith it can be used without inducing an error greater than a small fraction of a second.

4. The principal part Q of this expression is, it is evident, the deviation of a ray of light refracted at a given incidence θ from air of the density (ρ) into a vacuum, and hence is entirely independent of the variation of density in the atmosphere. When m is known Q is known. The method of finding m will be considered hereafter.

The seconds in the latter part of the expression $=$ $\frac{(m-1)\,l\tan.\theta}{a\cos.^2\theta\sin.1''}$. To compute this quantity it is necessary to know m, l and a but not with much precision.

If we take $\theta = 80°$ and use, for the present, round numbers, taking $m = 1{,}0003$ and $\frac{l}{a} = \frac{5\text{ miles}}{4000} = \frac{1}{800}$, $\frac{(m-1)\,l\tan.\theta}{a\cos.^2\theta\sin.1''} = 14''$ nearly. The terms which have been neglected, must obviously be much less. The limit may be thus computed.

Let the equations (3) and (5) of the last article be expanded, neglecting products of *three* dimensions of s, ϱ and (ϱ) and we shall obtain

$$\dot{R} = \dot{Q} + \frac{\rho b\tan.\theta}{2\cos.^2\theta}\Big(s - b\varrho s - \tfrac{3}{2}s^2\tan.^2\theta + bs(\tan.^2\theta + \tfrac{1}{2}\sec.^2\theta)\,((\varrho)-\varrho)\Big)$$

Now of the terms that compose the factor of $\frac{\rho b\tan.\theta}{2\cos.^2\theta}$, the first s has already been considered and found not to produce in integrating a quantity greater than a few seconds, as far as $\theta = 80°$; therefore after integration, the 2d and 4th on account of the smallness of $b\,(\varrho)$ and $b\,\varrho$ must be quite insensible; but the third $-\frac{3}{2}s^2\tan.^2\theta$, will produce a term $\int -\frac{3\rho b s^2\tan.^3\theta}{4\cos.^2\theta} =$ $-\frac{3\rho b s^2\tan.^3\theta}{4\cos.^2\theta} + \int\frac{3\rho b s\dot{s}\tan.^3\theta}{2\cos.^2\theta}$.

The law of decrease of the density of the atmosphere is between that which a uniform temperature gives, and that of the density decreasing uniformly, as will be shewn further on. The true value of the above integral will therefore be between the values deduced from an uniform temperature and an uniform density.

(1) For an uniform temperature. The density on this hypothesis is as the compressing force, and we have the well known equation

$$\varrho = (\varrho)\, c^{\left(\frac{a}{r} - 1\right)\frac{a}{l}} \quad \text{where } c = 2{,}7128 \text{ \&c.}$$

$$\text{or } \varrho = (\varrho)\, c^{-\frac{as}{l}}$$

Hence $\int \frac{3\,\rho\, b\, s\, \dot{s}\ \tan.^3 \theta}{2 \cos.^2 \theta} = \frac{3\,(\rho)\, b \tan.^3 \theta}{2 \cos.^2 \theta} \int s \dot{s}\, c^{-\frac{as}{l}}$

$$\int s\dot{s}\, c^{-\frac{as}{l}} = -\frac{l}{a} s c^{-\frac{as}{l}} - \frac{l^2}{a^2} c^{-\frac{as}{l}} + \frac{l^2}{a^2} \text{ from } s = o$$

Therefore from $s = o$ to $s = i$ and from $\varrho = (\varrho)$ to $\varrho = o$

$\int \frac{3\,\dot{\rho}\, b\, s^2 \tan.^3 \theta}{4 \cos.^2 \theta} = \frac{3\,(\rho)\, b \tan.^3 \theta}{2 \cos.^2 \theta} \cdot \frac{l^2}{a^2}$ having taken $c^{\frac{-a}{l}} = o$ on account of its extreme smallness, it being $= \frac{1}{(2{,}7128)^{800}}$

whence the term in question produces a quantity in seconds $= \frac{3\, l^2 (m-1) \tan.^3 \theta}{a^2 \cos.^2 \theta \sin. 1''}$

Taking $\theta = 80° \ 45'$, $\frac{l}{a}$ and m as before

this quantity $= 2'',60$

Taking $\theta = 74°$

It $= 0'',16$ a quantity not requiring notice.

(2) If the density of the air decrease uniformly, it will be proved that

$$s = \frac{(\rho) - \rho}{(\rho)} \times \frac{2l}{a} \text{ nearly}$$

Hence $\int \frac{3\,\dot{\rho}\,b\,s^2 \tan.^3\theta}{4 \cos.^2\theta} = \int \frac{3\,\dot{\rho}\,b \tan.^3\theta}{\cos.^2\theta} \left(\frac{(\rho)-\rho)}{(\rho)}\right)^2 \frac{l^2}{a^2}$

$= [\text{from } \varrho = (\varrho) \text{ to } \varrho = o]\, \frac{b\,(\rho) \tan.^3\theta}{\cos.^2\theta} \times \frac{l^2}{a^2} = [\text{in seconds}]$

$\frac{2\,(m-1)\,l^2 \tan.^3\theta}{a^2 \cos.^2\theta \sin.\,1''}$

Taking $\theta = 80°\ 45'$ this quantity $= 1'',73$. Consequently the true value of $\int \frac{3\,\dot{\rho}\,b\,s^2 \tan.^3 80°\ 45'}{4 \cos.^2 80°\ 45'}$ is between $2'',60$ and $1'',73$ and therefore the mean cannot err quite half a second from the truth, and so the following formula may be considered as giving the refraction as far as 80° 45′ true to less than half a second, viz.

$$\text{Refraction} = Q - \frac{(m-1)\,l \tan.\theta}{a \cos.^2\theta \sin.\,1''} + \frac{5\,(m-1)\,l^2 \tan.^3\theta}{2\,a^2 \cos.^2\theta \sin.\,1''}. \quad (7)$$

The third term is insensible when θ is less than 74° and the second and third insensible when θ is less than 40°

It is evident that the two first terms *must* be derived from assuming *any law of variation* of density, and then investigating the quantity of refraction as far as these terms. The following investigations in different hypotheses of density may be considered useful.

Hypothesis of uniform density.

5 Let CR be the radius of the uniform atmosphere, the height of which is l (vid. Fig.)

θ' = angle of incidence at the point R; $t = VRC$, then

ref. $(R) = \theta' - t$, and $\frac{a}{a+l} \sin.\ \theta = \sin.\ t = \frac{\sin.\ \theta'}{m}$ (1)

Hence $a\, m \sin.\ \theta = (a+l) \sin.\ (t+R)$ (2)

but supposing the surface of the earth a plane

$$m \sin.\ \theta = \sin.\ (\theta+Q) \qquad (3)$$

Hence $\sin.\ (t+R) = \frac{\sin.\ (\theta+Q)}{1+\frac{l}{a}}$ (4)

making l, t and R to vary, in order to apply Taylor's Theorem.

By equat. (4)

$$(\dot{t}+\dot{R}) \cos.\ (t+R) = \frac{-\dot{l}}{a\left(1+\frac{l}{a}\right)^2} \sin.\ (\theta+Q)$$

By equat. (1)

$$\dot{t} \cos.\ t = \frac{-\dot{l}}{a\left(1+\frac{l}{a}\right)} \sin.\ \theta$$

Hence computing $R+\dot{R}+$ &c. making $R = Q$, $t = \theta$ $\frac{l}{a} = o$

and then $\frac{\dot{l}}{a} = \frac{l}{a}$, we have by Taylor's Theorem

$$R = Q - \frac{l}{a}\left(\tan.\ (\theta+Q) - \tan.\ \theta\right) + \text{\&c.} \qquad (5)$$

But $\tan.\ (\theta+Q) = \tan.\ \theta + \frac{Q}{\cos.^2 \theta} +$ &c.

Also making m and Q vary in equation (3)
We get by help of Taylor's Theorem

$$Q = (m-1) \tan. \theta \ \&c.$$

Hence substituting in equat. (5)

$R = Q - \frac{(m-1)\, l \tan. \theta}{a \cos.^2 \theta}$ as was found before in art. 3.

Hypothesis of density decreasing uniformly.

6. By the density decreasing uniformly is understood, that the density is as the distance from the highest part of the atmosphere. It is obvious that in this hypothesis, not taking into consideration the variation of gravity, the height of the atmosphere will be double of that of an uniform atmosphere of an uniform gravity. And it is also obvious that the effect of the variation of gravity can be but small. Lest however there should be any doubt on this head, it will be safer to investigate the height of the atmosphere on this hypothesis, gravity being supposed to vary.

Let this height $= l'$
the pressure at any height $z = p$
the pressure at the surface $= (p)$
a, l, ϱ &c. as before.

Then $\dot{p} = \frac{-\dot{z}\rho a^2}{(a+z)^2}$, the gravity at the surface being represented by unity.

On this hypothesis.

$$\varrho = (\varrho) \times \frac{l'-z}{l'} \qquad (1)$$

Therefore $\dot{p} = \dfrac{-\dot{z}(\rho)\,a^2\,(l'-z)}{(a+z)^2\,l'}$

and by integration,

$$p = \frac{(\rho)\,a^2}{a+z} + \frac{a^2\,(\rho)}{l'} \text{ h. log. } (a+z) + \frac{a^3(\rho)}{l'\,(a+z)} + \text{const.}$$

Hence this integral from $z = l'$ to $z = o$ gives

$$(p) = (\varrho)\left(a - \frac{a^2}{a+l'} + \frac{a^2}{l'} \text{ h. log. } \frac{a}{a+l'} + \frac{a^2}{l'} - \frac{a^3}{l'(a+l')}\right)$$

The right hand side of this equation being expanded according to the powers of $\frac{l'}{a}$ there results

$$(p) = (\varrho)\left(\frac{l'}{2} - \frac{l'^2}{3a} \text{ \&c.}\right)$$

but $(p) = (\varrho)\, l$

Hence is easily deduced $l' = 2l + \frac{8\,l^2}{3\,a}$ nearly

Having obtained l' we immediately deduce by equat. (1) the relation between ϱ and r on this hypothesis,

viz. $a - r + 2\,l + \frac{8\,l^2}{3\,a} = \frac{\rho}{(\rho)}\left(2\,l + \frac{8\,l^2}{a^2}\right)$

Whence $\frac{r}{a} = 1 + \frac{(\rho)-\rho}{(\rho)}\left(\frac{2l}{a} + \frac{8\,l^2}{a^2}\right)$ or regarding only one dimension of $\frac{l}{a}$, $\frac{a}{r} = 1 - \frac{(\rho)-\rho}{(\rho)} \times \frac{2l}{a}$ (2)

or $\frac{a}{r} = \left(\frac{1+b\rho}{1+b(\rho)}\right)^{\frac{2\,l}{b\,(\varrho)\,a}}$ b being introduced to form the factor $b\,\varrho$.

Let $1 + b\varrho = x$, $1 + b(\varrho) = (x)$ and $\frac{2l}{b(\rho)a} = f$

Then equat. (2) of art. 1 gives

$$\dot{R} = \frac{-\dot{x}\, x^{f} \sin.\theta\, (x)^{\frac{1}{2}}}{2(x)^{f}\, x\sqrt{x - \frac{(x)\, x^{2f}}{(x)^{2f}} \sin.^{2}\theta}} =$$

$$\frac{-\dot{x}\, x^{\frac{2f-3}{2}} \sin.\theta}{2(x)^{\frac{2f-1}{2}}\sqrt{1 - \left(\frac{x}{(x)}\right)^{2f-1} \sin.^{2}\theta}}$$

This by integration gives

$$R = -\frac{1}{2f-1}\left(\text{Circ. Arc. rad. 1 and sin.} = \left(\frac{x}{(x)}\right)^{\frac{2f-1}{2}} \sin.\theta\right) +$$

constant.

When $R = o$, $\varrho = (\varrho)$

Therefore constant $= \frac{1}{2f-1}\theta$.

Hence the integral from $\varrho = (\varrho)$ to $\varrho = o$ gives

$$R = \frac{1}{2f-1}\theta - \frac{1}{2f-1}\left(\text{Circ. Arc. rad. 1 and sin.} = \frac{\sin.\theta}{(1+b(\rho))^{f-\frac{1}{2}}}\right) \qquad (3)$$

or nearly

$$\frac{\sin.\theta}{(1+b(\rho))^{f-\frac{1}{2}}} = \sin.\left(\theta - (2f-1)R\right)$$

This is equivalent to Simpson's Rule, page 58, Math. Dissert.

By the well known analogy between the sum and diff. of the sines of two arcs and the tangents of the $\frac{1}{2}$ sum, and $\frac{1}{2}$ diff. the equat. (3) gives

$$\text{Tan.} \frac{2f-1}{2} R = \frac{1}{2}\left(\frac{2f-1}{2}\right) b(\varrho) \tan.\left(\theta - \frac{2f-1}{2} R\right) \quad (4)$$

or $R = \frac{b}{2}(\varrho) \tan.\left(\theta - \left(\frac{2l}{(\rho)ab} - \frac{1}{2}\right) R\right) =$

$$\frac{m^2-1}{2} \tan.\left(\theta - \left(\frac{l}{a(m-1)} - \frac{1}{2}\right) R\right) * \quad (5)$$

From equation (5) we may obtain the same conclusions as in art. 3.

For if the surface of the earth were a plane, equation (5) would become

$Q = (m-1) \tan.(\theta + \frac{1}{2} Q)$ nearly

Also because R and Q are very nearly equal at all zenith distances less than 80°. By equat. (4)

$R = (m-1) \tan.(\theta + \frac{1}{2} Q - f Q)$.

From this equation it readily appears that

$$R = (m-1) \tan.(\theta + \tfrac{1}{2} Q) - \frac{m-1 f Q}{\cos.^2 (\theta + \frac{1}{2} Q)}.$$

Therefore $R = Q - \frac{(m-1)\, l \tan.\theta}{a \cos.^2 \theta}$ as before in art. 3.

* The formula used by Bradley is $R = k \tan.(\theta - n R)$. He determined n from the comparison of the horizontal refraction, and the refraction at a given altitude. This would be exact if the density of the atmosphere decreased uniformly. But k and thence n may be determined by direct experiments on the refractive force of air, and also by observations of circumpolar stars at zenith distances not greater than 80°. With these values of k and n the refractions at the horizon and low altitudes may be computed, and are not found to agree with observations, therefore the density of the atmosphere does not decrease uniformly.

7. *Remark.* This last conclusion might have been very easily deduced from equat. (6) art. 3; but the above investigation has been used for the sake of deriving the formulas of Simpson and Bradley.

By equat. (4) art. 3 $s = 1 - \frac{a}{r}$

Therefore. by equat. (2) art. 6, $s = \frac{(\rho) - \rho}{(\rho)} \times \frac{2l}{a}$

Hence by equat. (6) art. 3.

$$R = Q - \int \frac{\dot\rho\,(\rho) - \rho\dot\rho}{(\rho)} \times \frac{l}{a} \times \frac{b \tan.\theta}{\cos.^2\theta} = [\text{from } \varrho = (\varrho) \text{ to } \varrho = o]$$

$$Q - \frac{b\,l\,(\rho) \tan.\theta}{2a \cos.^2\theta} = Q - \frac{(m-1)\,l \tan\theta}{a \cos.^2\theta}.$$

Hypothesis of an uniform temperature.

8. By the equat. (6) art. 3 we also derive the same conclusion on the hypothesis of an uniform temperature, in which case, as has been stated art. 4.

$$\varrho = (\varrho)\,c^{\frac{-as}{l}} \text{ or } \dot\rho = -\frac{a\dot s}{l}(\varrho)\,c^{-\frac{as}{l}}$$

Hence by equation (6) art. 3.

$$R = Q - \int \frac{a s \dot s}{l}(\varrho)\,c^{-\frac{as}{l}}\,\frac{b \tan.\theta}{2 \cos.^2\theta} = (\text{from } s = o \text{ to } s = 1)$$

$$Q - \frac{b\,(\rho)\,l \tan\theta}{2a \cos.^2\theta} \text{ (vid. art. 4.)} = Q - \frac{(m-1)\,l \tan\theta}{a \cos.^2\theta} \text{ as}$$

before.

Reduction of the formula for refraction to one convenient for computation.—Comparison with Laplace's formula.

9. From the equation which takes place, supposing the surface of the earth a plane.

Viz. $m \sin. \theta = \sin. (\theta+Q)$

We obtain, making $\dot{m}$ constant,

$$\dot{m} \sin. \theta = \dot{Q} \cos. (\theta+Q)$$

$$0 = \ddot{Q} \cos. (\theta+Q) - \dot{Q}^2 \sin. (\theta+Q)$$

Hence making $Q = 0$ and then $\dot{m} = m - 1$ we have by Taylor's theorem

$$Q = (m-1) \tan. \theta + \frac{(m-1)^2}{2} \tan.^3 \theta + \&c.$$

taking $m-1 = ,0003$ and $\theta = 80°.45'$

$$\frac{(m-1)^2 \tan.^3 \theta}{2 \sin. 1''} \quad 2'',1$$

the following terms are therefore insensible.

Hence substituting in equat. (7) art. 4.

We obtain for all values of θ less than about $80°.45'$

$$R = \frac{(m-1) \tan. \theta}{\sin. 1''} - \frac{(m-1) l \tan. \theta}{a \cos.^2 \theta \sin. 1''} + \frac{5 (m-1) l^2 \tan.^3 \theta}{2 a^2 \cos.^2 \theta \sin. 1''} + \frac{(m-1)^2 \tan.^3 \theta}{2 \sin. 1''} \qquad (1)$$

The two last terms are insensible except when θ is nearly 80°.

10. The formula of Laplace (p. 268. tom. 4. Méc. célest.)

$$\text{in seconds of a degree} = \frac{\alpha \tan. \theta}{\sin. 1''} \left\{ 1 + \frac{\frac{1}{2} \alpha (2 \cos.^2 \theta + 1) - \frac{l}{a}}{\cos.^2 \theta} \right\}$$

in which $\alpha = \frac{2K\,(\rho)}{1+\frac{4K}{n^2}\,(\rho)} = \frac{\frac{1}{2}b\,(\rho)}{1+b\,(\rho)}$

But $\frac{\frac{1}{2}b\,(\rho)}{1+b\,(\rho)} = \frac{m^2-1}{2\,m^2}$.

Therefore expanding $\frac{m^2-1}{2\,m^2}$ by the powers of $m-1$

$\alpha = (m-1) - \frac{1}{2}(m-1)^2$ &c.

substituting this value for α in Laplace's formula.

Ref. $= \frac{(m-1)\,tan.\,\theta}{sin.\,1''} - \frac{(m-1)\,l\,tan.\,\theta}{a\,cos.^2\,\theta\,sin.\,1''} + \frac{(m-1)^2\,tan.^3\,\theta}{2\,sin.\,1''}$, the same as equation (1) article 9, excepting the term there introduced to make the formula applicable as far as $\theta = 80^\circ.45'$.

Value of $\frac{m-1}{sin.\,1''}$, and of $\frac{l}{a}$ —*Tables of Refraction.*

11. The refractive force of air being assumed proportional to its density, the value of m is variable, and its changes are known by the variations of the barometer and thermometer.

Let m' be the value of m when the height of the barometer = 29,60 inches, and the height of Farenheit's thermometer = 50°. Let also b represent the height of the barometer, and t the height of the thermometer corresponding to m.

It appears by the results of the experiments of Dalton and Gay Lussac, that a column of air denoted by unity at the temperature of 32° of Farenheit becomes 1,375 at the temperature of boiling water. In fact this agrees nearly with Mayer's conclusions made long before. It becomes therefore for t degrees of the thermometer $= 1 + ,002083\ (t - 32)$ It is not probable that the ratio of expansion is sensibly changed at different heights of the barometer within the limits of its usual variation. That is the ratio of the volumes at 32° and 212° is the same when the barometer is $28\frac{1}{2}$ inches as when $30\frac{1}{2}$ inches.

The increase of height in the barometer from the expansion of mercury by increase of temperature may be considered $\frac{1}{10000}$ for every degree of the thermometer.

Hence

$m - 1 : m' - 1 ::$ density of air bar. b and therm. t : density bar. 29,60 and therm. $50° :: b \times (1 - (t - 50) \times ,0001) \times 1,0375 : 29,60 \times (1 + ,002083\ (t - 32))$

Therefore $m - 1 = (m' - 1) \times \frac{b}{29,60} \times (1 - (t - 50),0001) \times \frac{1,0375}{1 + ,002083 \cdot (t - 32)}$.

The quantity $(m' - 1)$ may be deduced from the experiments of Biot and Arago (Mem. Inst. tom. 7.) who have most carefully repeated the experiments of Hawksby, or who rather by a different process, have accurately determined the refractive force of air. They have found when the height of barom. = 0,76 metre and centesimal therm. = 0 that is barom. 29,93 inches and F. thermometer = 32° that

$m - 1 = ,0002946$.

Hence $m'-1 = \frac{,0002946 \times 29,60}{1,0018 \times 1,0375 \times 29,93} = ,0002803$

And $\frac{m'-1}{sin.\ 1''} = 57'',82$.

The height of an uniform atmosphere is not affected by the variation of the barometer, and therefore, if l' represent the height of an uniform atmosphere, the thermometer being 50°

$$l = l' \times \frac{1+,00208\ (t-32)}{1,0375}$$

a very accurate value of $\frac{l'}{a}$ is not required. If we take $l' = 5$ miles and the semidiameter of the earth $= 4000$ miles $\frac{l'}{a} = ,00125$. This in fact is sufficiently accurate.

But it will be more exact to take $l' = 5,095$ miles and the semidiameter of the earth $= 3979$ miles, and then $\frac{l'}{a} =$ $\frac{5,095}{3979} = ,00128$.

It is evident that the third and fourth terms of the value of the refraction in equat. (1) art. 9. cannot be sensibly affected by the variation of m, and therefore its mean value may be used as to these terms.

Hence substituting for $\frac{m-1}{sin.\ 1''}$ and $\frac{l}{a}$ in equat. (1) art. 9. we have

$$Refraction = \frac{1,0375}{1+,002083\ (t-32)} \times \left(1-,0001\ (t-50)\right) \frac{b}{29,60} \times 57'',82 \tan.\theta - \frac{b}{29,60} \times 0'',0739 \frac{\tan.\theta}{\cos.^2\theta} + 0'',000238 \frac{\tan.^3\theta}{\cos.^2\theta} + 0'',0080 \tan.^3\theta.$$

It is worthy of notice that the second term is independent of the thermometer, this circumstance enables us to put the three last terms into a very convenient table, the arguments of which are the zenith distance and height of the barometer.

12. The above expression for atmospheric refraction is entirely independent on astronomical observations.

The French tables are derived from observations of circumpolar stars. By these tables the refraction at 45° = 57″,57 when the barometer shews 29,60 and Farenheit's thermometer 50°. Hence by equat. (1) art. 9.

$$57'',57 = \frac{(m'-1)}{sin.\ 1''}\left(1-\frac{2\ l'}{a}\right) = \frac{m'-1}{sin.\ 1''}(0,99744).$$

Therefore $\frac{m'-1}{sin.\ 1''} = 57'',72.$

By 525 observations of circumpolar stars made by myself with the eight feet astronomical circle (vid. art. 14.) I deduce $\frac{m'-1}{sin.\ 1''} = 57'',56.$

Thus the value of $\frac{m'-1}{sin.\ 1''}$ by the French tables is between the values resulting from direct experiment and from my observations. I am inclined to give the preference to the result from direct experiment for reasons afterwards mentioned. But the difference between this result, and that from the French tables is so small that no inconvenience can occur in adopting the French tables. Thus, bar. 29,60 inches, and Farenheit's therm. 50°.

Zenith distance.	Refraction deduced from the experiment.	Refraction by the French Tables.
°	"	"
45	57,7	57,6
50	68,7	68,6
60	99,7	99,4
70	157,3	157,0
74	198,6	198,2

Therefore, as it is of considerable importance, particularly with a view of comparing observations made in different places, that the same refractions should be generally used, no objection, I apprehend, can be made to the general adoption as far as about 80° of the French refractions which are now so well known,

13. Perhaps the following tables deduced from the above formula, may be considered rather more convenient in many instances than the French tables; they will certainly furnish a useful check. The advantage they afford is derived from the facility with which the computation can be made by help of tables of logarithms and of logarithmic tangents to four or five places of figures, such as are in the "tables requisite to be used with the nautical ephemeris." By these the log. tangent of the zenith distance can be taken out at once, and the inconvenience of proportioning for the minutes of zenith distance avoided, which is greater than the new inconvenience occasioned by the second table. Hence the tables here given

may be considered more convenient for observations of the sun, moon, and planets.

In computing these tables 57″,72 was substituted in the above formula instead of 57″,82, and therefore the refraction deduced from these tables will agree with those deduced by the French tables.

TABLES FOR REFRACTION.

Table 1.

Far. Therm. °	Logarithms.	Far. Therm. °	Logarithms.	Far. Therm. °	Logarithms
10	0.3283	34	0.3048	58	0.2827
11	0.3273	35	0.3039	59	0.2818
12	0.3263	36	0.3030	60	0.2809
13	0.3253	37	0.3020	61	0.2800
14	0.3243	38	0.3011	62	0.2791
15	0.3233	39	0.3001	63	0.2782
16	0.3223	40	0.2992	64	0.2773
17	0.3213	41	0.2983	65	0.2764
18	0.3203	42	0.2974	66	0.2755
19	0.3193	43	0.2965	67	0.2746
20	0.3183	44	0.2956	68	0.2737
21	0.3173	45	0.2946	69	0.2728
22	0.3163	46	0.2937	70	0.2720
23	0.3154	47	0.2928	71	0.2711
24	0.3144	48	0.2919	72	0.2703
25	0.3134	49	0.2910	73	0.2694
26	0.3124	50	0.2900	74	0.2685
27	0.3114	51	0.2891	75	0.2677
28	0.3105	52	0.2881	76	0.2668
29	0.3095	53	0.2872	77	0.2660
30	0.3086	54	0.2863	78	0.2652
31	0.3076	55	0.2854	79	0.2644
32	0.3067	56	0.2845	80	0.2636
33	0.3058	57	0.2836	81	0.2627

Table 2. Barometer.

Z. D. °	28,50 ″	29,00 ″	29,50 ″	30,00 ″	30,50 ″
80	10,5	10,7	10,9	11,1	11,4
79	8,1	8,3	8,5	8,7	8,9
78	6,3	6,4	6,6	6,7	6,9
77	5,1	5,2	5,3	5,4	5,6
76	4,1	4,2	4,3	4,4	4,5
75	3 4	3,4	3,5	3,6	3,7
74	3,0	3,0	3,1	3,1	3,2
73	2,5	2,5	2,6	2,6	2,6
72	2,1	2,1	2,2	2,2	2,2
71	1,8	1,8	1,9	1,9	1,9
70	1,5	1,5	1,5	1,6	1,6
69	1,3	1,3	1,3	1,4	1,4
68	1,2	1,2	1,2	1,2	1,2
67	1,0				1,0
66	0,9				0,9
65	0,8				0,8
64	0,7				0,7
63	0,6				0,6
62	0,6				0,6
61	0,5				0,5
60	0,5				0,5
58	0,4				0,4
56	0,3				0,3
54	0,3				0,3
52	0,2				0,2
50	0,2				0,2
45	0,2				0,2
40	0,1				0,1
30	0,0				0,0
0	0,0				0,0

Logarithm in Tab. 1. + log. barom. + log. tan. zenith dist. = log. approximate refraction.

Appr. ref.—Number Tab. 2. = refraction.

Example. Zenith dist. 71°. 26′, barom. 29,76 inches and therm. 43°.

Log. Tab. 1	-	-	0.2965	Appr. ref. 175″,4	
Log. barom.	-	-	1.4736	Tab. 2.	2, 0
Log. tan. 71°.26	-	-	0.4738		
				Ref.	173,4 =2′.53″,4
Log. approx. ref.	175″4	-	2.2439		

The Co-latitude of the Observatory of Trinity College, Dublin, deduced from Observations of Circumpolar Stars, by different Tables of Refraction.—Observed Refractions of Capella, below the Pole.

14. Comparisons of the Co-latitude as determined by stars near to, and remote from the pole, serve for a criterion of the accuracy of the tables of refraction used.

In the following table the co-latitude is determined by four different methods of computing the refraction.

1. In column A, by the formula $56'',9$ tan. $(\theta—3,\ 2\ \text{ref.}) \times \frac{bar.}{29,6} \times \frac{500}{450 + therm.}$.

2. In column B, by the formula $56'',9$ tan. $(\theta—3\ \text{ref.}) \times \frac{bar.}{29,6} \times \frac{400}{350 + therm.}$.

3. In column C, by the preceding tables, which give the same results as the French tables.

4. In column D, by the value of $\frac{m'—1}{sin.\ 1''} = 57'',82$ as deduced from experiment.

The second formula is Bradley's.

The first formula is what appeared to me by my observations in 1809, to give the refraction at low altitudes more exactly than Bradley's formula, and also to give the effects of the changes of temperature more exactly.

But both these formulæ must be considered empirical. We are entirely unacquainted with the law of variation of density at different heights, and therefore as has been shewn we cannot deduce from theory a formula of refraction that will serve much below 80°. It has been shewn indeed, art. 6. that if the density decrease uniformly, the refraction may be expressed by a similar formula, and that above 80° the refraction will not be sensibly changed by any law of variation of density; but then if 56″,9 be the constant quantity, the co-efficient of refraction *must* be 4,14,* that is the mean ref. $= 56'',9$ tan. $(\theta - 4{,}14$ ref.) Therefore the two formula used in columns A and B are certainly inexact for all zenith distances less than about 80°. For greater zenith distances, the first formula will perhaps be found as exact as any other now known, at least as far as 87° 40′. But I do not attach much importance to it. I had deduced it before I was so well convinced as I am at present of the little value of observations near the horizon, and I may add of the impossibility of investigating an exact formula.

The mean of column C gives 36°. 36′. 46″,54 for the co-latitude of the observatory or 53 23 13,46 for the latitude, which I conceive cannot possibly err $\frac{1}{4}$ of a second from the truth.

* For if $\frac{m-1}{\sin. 1''} = 56'',9$ $m-1 = {,}0002758$, and therefore $\frac{l}{a(m-1)} - \frac{1}{2} = 4{,}14$ vid. art. 6. equat. (5)·

The co-latitudes are each determined by a mean of the number of observations of each star above and below the pole as annexed.

Names of Circumpolar Stars	Obs. above Pole.	Obs. below Pole	Co-lat. A	Co-lat. B	Co-lat. C	Co-lat. D
Polaris	62	74	36°. 36′. 45″,65	36°. 36′. 45″,71	36°. 36′. 46″,19	36°. 36′. 46″,26
β Ursæ min.	20	18	46,18	46,42	46,77	46,85
β Cephei	10	10	45,43	45,64	46,37	46,46
α Ursæ maj.	10	8	46,91	47,19	47,33	47,44
α Cephei	10	9	45,56	45,71	46,42	46,53
β Ursæ maj.	21	21	45,49	45,95	46,62	46,75
ε Ursæ maj.	24	23	45,21	45,52	46,22	46,36
α Cassiopeæ	21	23	45,90	45,81	46,64	46,79
ζ Ursæ maj.	8	10	45,10	45,30	46,00	46,15
γ Ursæ maj.	18	21	45,81	46,18	46,85	46,90
γ Draconis	32	32	45,93	46,69	47.08	47,27
η Ursæ maj.	10	10	44,90	45,40	46,20	46,40
α Persei	10	10	44,53	44,35	46,29	46,51
Mean	256	269	36 . 36 . 45,58	36 . 36 . 45,84	36 . 36 . 46,54	

By 226 observations in 1808 and 1809 I had deduced
for column A 36°. 36′. 45″,65
B 45 ,85
C 46 ,54

15. Let $c =$ the correction of 57″,82, that is, let $\frac{m'-1}{\sin. 1''} = 57'',82 + c$, then by comparing the co-latitudes in column D determined by Polaris, β Ursæ minoris and β Cephei with the same determined by the other ten stars, we have

$36°.\ 36'.\ 46'',52 + ,82\ c = 36.\ 36.\ 46,71 + 1,56\ c.$ The co-efficients of c are obtained from the tangents of the respective zenith distances.

This equation gives $c = -\frac{0'',19}{,74} = -\ 0'',26$

and therefore $\frac{m'-1}{sin.\ 1''} = 57'',56$. By which, the mean refraction at $45° = \frac{m'-1}{sin.\ 1''}\left(1 - \frac{2\,l'}{a}\right) = 57'',42$.

Now from the number of observations used, it cannot be doubted that the above conclusion is free from the errors of observation. The only error by which it can reasonably be supposed affected, is that arising from errors of division.

It is difficult to state the limit of error from hence arising, but it will readily appear that much dependence cannot be had on a correction so small as that which I have deduced. For each star or each co-latitude, 12 points of the circle are used so that the quantity $36°.\ 36'.\ 46'',52$, the mean of the results of the three first stars is affected by the mean error of 36 points of divisions of the circle. This mean error must certainly be very small. Yet it is not improbable that it may amount at least to $0'',15$.

The error of the quantity $36°.\ 36'.\ 46'',71$ must be smaller, being only affected by the mean error of 120 points, yet it is not improbable it may amount to $0'',04$ and so the whole quantity $0'',19$, the numerator of the value of c, will be accounted for.

Thus it appears that observations of circumpolar stars are not adapted for obtaining extreme accuracy, and that the quantity of mean refraction at 45° so determined cannot reasonably be *depended* on to less than a quarter of a second.

The direct experiment for determining the refractive force of air may be made independently of the divisions of an instrument. The whole quantity of refraction is ascertained, instead of the differences of refractions as in circumpolar stars. There are also other sources of accuracy by which the result may bere ndered very exact.

For the above reasons, the determination $\frac{m'-1}{sin.\ 1''} = 57'',82$ or the mean refraction at 45° (bar. 29, 60 and therm. 60) = 57,67 appear to me more to be relied on.

16. In deducing the above value of $\frac{m'-1}{sin.\ 1''}$ from the observations of circumpolar stars, I only used such stars as were less than 80° from the zenith when below the pole.

It is well-known to those conversant in observations made with good instruments that near the horizon an irregularity in refraction hitherto unexplained shews itself. This commencing even at less zenith distances than 80°, is at first very small, but increases to a very considerable irregularity as we approach the horizon.

The bright star Capella being within the limits of this irregularity has not been used for the co-latitude. A considerable number of observations of this star below the pole have however been made by me, which may serve for two purposes.

(1) To shew the effects of the abovementioned irregularity of refraction, by which it appears that at zenith distances not greater even than 80°, no use can be made of observations for the nicer purposes of astronomy.

(2) As it is reasonable to suppose this unexplained irregularity* will disappear from a mean of a great number of observations, this star, which is just at the limit where the quantity of refraction ceases to be independent of the variation of density, may also serve as a criterion of the exactness of the value of $\frac{m'-1}{sin.\ 1''}$ or of the quantity of mean refraction.

The refraction observed and the refraction computed by the formula in Art. 11. are placed by the side of each other, and also the correction of the computed refraction to give the observed refraction. This correction is often far beyond the limit of the error of observation, and is to be attributed to the abovementioned irregularity of refraction.

* The hypothesis upon which refractions are computed is that the different strata of air are concentrical with the earth's surface, circumstances may be easily imagined to affect this hypothesis, with respect to low stars.

Refractions of Capella below the Pole.

Time of Observations.	Bar.	Ther. int.	Comput. Refrac.	Observed Refrac.	Corr. comp. ref.	Time of Observation.	Bar.	Ther. int.	Comput. Refrac.	Observed Refrac.	Corr. comp. ref.
1808, July 28	29,50	63	5′ 30,3″	5′ 28,8″	− 1,5″	1811, Jan. 23	30,33	32	6′ 3,4″	6′ 5,2″	+ 1,8″
Aug. 11	29,51	61	31,9	29,1	− 2,8	27	29,40	27	5 56,3	5 59,8	+ 3,5
23	29,97	67	32,6	31,3	− 1,3	28	29,32	24½	57,5	55,3	− 2,2
24	29,98	66	33,4	33,9	+ 0,5	July 1	29,64	64½	30,7	31,6	+ 0,9
30	29,16	62½	26,8	26,2	− 0,6	3	29,49	54½	36,5	42,9	+ 6,4
Nov. 23	29,84	42	49,7	42,4	− 7,3	6	29,78	61½	34,4	43,7	+ 9,3
Dec. 4	29,77	44	47,4	43,5	− 3,9	9	29,81	64½	32,5	35,8	+ 3,3
21	29,30	51	52,1	47,8	− 4,3	14	29,42	58½	32,4	32,6	+ 0,2
1809, Jan 20	29,31	30	52,7	48,3	− 4,4	16	29,46	57½	34,6	36,2	+ 2,6
22	29,33	27	55,6	48,5	− 7,1	17	29,46	58	33,3	34,7	+ 1,4
May 29	29,50	54	36,7	43,0	+ 6,3	20	29,80	63½	33,2	35,3	+ 2,1
June 14	29,70	54	38,9	41,6	+ 2,7	21	29,73	64	32,1	29,4	− 2,7
15	29,72	55	38,4	38,8	+ 0,4	22	29,78	61	34,8	36,6	+ 1,8
17	29,61	56	36,5	38,6	+ 2,1	23	29,83	62	34,5	40,1	+ 5,6
July 8	29,90	63	34,6	39,1	+ 4,5	26	30,00	65½	34,1	37,5	+ 3·4
10	29,97	63	35,5	36,7	+ 1,2	Dec. 9	28,67	40½	37,2	34,0	− 3,2
15	29,88	62½	34,7	39,3	+ 4,6	9	28,87	38	41,4	37,0	− 4,4
17	29,80	55½	38,9	35,6	− 3,3	13	29.75	40	50,3	47,1	− 3,2
18	29,89	57½	38,4	41,0	+ 2,6	18	29,15	45½	39,0	34,1	− 4,9
19	29,92	60	37,1	38,3	+ 1,2	29	29,84	30½	58,8	54,2	− 4,6
23	29,71	60	34,7	35,5	+ 0,8	1812, Jan. 4	29,20	29½	51,9	43,7	− 8,2
Aug. 22	29,19	53	33,9	29,8	− 4,1	14	29,42	37	48,4	47,2	− 1.2
24	29,16	55	32,1	30,5	− 1,6	20	29,69	37	51.9	50,1	− 1,8
1810, Jan. 20	29,83	58½	37,2	40,0	+ 2,8	Oct. 28	29,33	46½	40,1	38,1	− 2,0
22	30,12	62	37,2	43,6	+ 6,4	Dec. 9	29,52	36	50,0	46,7	− 3,3
23	30,02	62½	36,4	42,0	+ 5,6	21	29,48	35	50,7	50,6	− 0,1
25	29,98	57	39,9	42,7	+ 2,8	31	29,57	40	47,9	47,8	− 2,1
July 1	29,58	58	34,6	39,4	+ 4,8	1813, Jan. 4	29,59	42	46,5	39,4	− 7,1
8	29,50	58	33,8	36,7	+ 2,9	11	29,36	34	50,0	42,7	− 7,3
24	29,73	59	35,7	29,9	− 5,8	18	29,88	36	54,7	52,0	− 2,7
27	29,24	58	30,4	25,2	− 5,2	19	30,02	35	57.2	57,3	+ 0,1
Aug. 14	29,29	58	31,4	27,3	− 4,1	25	30,15	29	6 3,5	6 3,6	+ 0,1
1811, Jan. 20	29,66	37	51,5	42,9	− 8,6						

The preceding 65 observations give the mean correction $= -0'',49$. This would give $\frac{m'-1}{\sin.1''} = 57'',74$ and the ref. at $45° = 57'',58$ very nearly the same as the French tables, but this exactness cannot be depended on, even if we supposed the irregularity of refraction to disappear in the mean, because the zenith distances of Capella above and below the pole may be affected by errors of division. If we suppose the co-latitude exact, and take the error of the mean of the six microscopes in each position of Capella $= 0'',5$ and also take the error of refraction arising from using the mean between uniform temperature and uniform density $= 0'',25$. The above correction may become $= -(0''49 + 1,00 + 0'',25)$ $= -1'',74$

or it may become $+ 0,76$.

The first will make the ref. at $45° = 57'',37$

the second - - $= 57,79$

These are probably two limits.

Limits of Refraction.—Observed Refractions of α Lyræ below the Pole.

17. It has been stated in art. 4. that the quantity of atmospherical refraction is less than would result from an uniform temperature in the atmosphere and greater than what would result from a density decreasing uniformly.

(1) The former readily appears from the equation

$$\dot{R} = \frac{\dot{O}C}{OP} \text{ art. 1.}$$

For since the temperature decreases as we ascend, it follows that the *same* density takes place at a distance from the surface greater than in the case of an uniform temperature. Now the only variable quantity in OC is ϱ, therefore $\dot{O}C$ remaining the same, OP is increased, and consequently $\dot{R}$ diminished, therefore refraction or $\int \dot{R}$ is greater in the case of uniform temperature than in the actual state of the atmosphere.

(2) By the annexed observed refractions of α Lyræ, below the pole, it will appear that the actual refraction is greater than would take place, did the density of the air decrease uniformly.

The mean of these 42 observations of α Lyræ below the pole gives the refraction at the zenith distance 87° 42′ 10″ = 17′ 26″,5, the mean of the heights of the barom. = 29,50, and the mean of the heights of the therm. = 35°,0.

These heights of the barom. and therm. give, (vid. art. 11.) $\frac{m-1}{\sin. 1''} = 59'',50$ and $\frac{l}{a(m-1)} - \frac{1}{2} = 3,803$. Hence if the density of the air decreases uniformly, At 87°. 42′. 10″, refraction = 59″,5 tan. (87°. 42′. 10″ — 3,803 r)* = 16′. 51″,0.

This refraction is less by 35″,5 than the mean of the observed refractions. Hence we may safely conclude that the actual quantity of refraction is between the results from an uniform temperature and from a density decreasing uniformly.

Laplace has shewn the same from the horizontal refractions computed on each hypothesis, and compared with the observed horizontal refraction. But it does not appear that the mean observed horizontal refraction has hitherto been ascertained with much accuracy.

Laplace has also in the case of uniform temperature integrated the fluxional equation for refraction, in which he

* This form or $r = k \tan. (\theta - n r)$ may be readily computed by help of an auxiliary angle y.

$$\log. \tan. y = \log. \tan. \theta + \log. \left(\frac{2k}{1 + nk \sin. 1''}\right) + \tfrac{1}{2} \log. \frac{n \sin. 1''}{k}$$

then $\log. r = \frac{1}{2} \log. \frac{k}{n \sin. 1''} + \log. \tan. \frac{1}{2} y$

For $k \tan. (\theta - n r) = \dfrac{k \tan. \theta - k \tan. n r}{1 + \tan. \theta \tan. n r}$

Hence $\dfrac{(1 + n k \sin. 1'') r}{k\left(1 - \frac{nr^2}{k} \sin. 1''\right)} = \tan. \theta$

let $\tan. \frac{1}{2} y = r \sqrt{\frac{n}{k} \sin. 1''}$

then $\dfrac{1 + n k \sin. 1''}{2k} \sqrt{\dfrac{n}{k \sin. 1''}} \tan. y = \tan. \theta$

Whence $\log. \tan. y = \tan. \theta +$ &c.

&c. &c.

has exhibited a striking specimen of his great mathematical skill (vid. Méc. cél. tom. 4. p. 246—253.)

His series is sufficiently convenient for computing the horizontal refraction, but in deducing from it the refraction at 87°42′10″ zenith distance, a good deal of calculation is necessary. I deduce the value of α=,0002882 for the heights of the barometer and therm. abovementioned, and then the six first terms of the series (Méc. cél. tom. 4. p. 251)= 817″ + 171″,4 + 50″,2 + 17″,4 + 6″,4 + 2″,7 + &c.

The sum of this series must be nearly = 1067″.

Therefore we have at zen. dist. 87°42′10″, barom. 29,50 and therm. 35°.

Refraction,	density decreasing uniformly	= 16.′51″,0
	by observation -	= 17. 26, 5
	uniform temperature -	= 17. 47, 0

Hence as far as this zenith distance the refraction differs only a few seconds from the mean resulting from the two hypotheses. The difference is far less than what may arise from the irregularity of refraction.

At the same zenith distance, and same heights of the barom. and therm.

By the French tables ref.	= 17′.21″,0
By Bradley's formula	= 17 48, 2
By what I considered an improvement of Bradley's formula vid. art. 14	= 17 25, 3

Refractions of α Lyræ below the Pole.

Time of Observation	Barom.	Ther. int.	Ther. ex.	Zenith distance observed	Ref. observed	Corr. French Tables
1809, Jan. 22	29,25	25		87° 42′ 1″,6	17′ 57″,4	+ 23″,7
Feb. 18	30,01	43½		42 40,7	17 24,8	+ 3,4
20	29,78	43½		42 41,6	17 24,2	+ 10,7
Mar. 5	30,09	42½		42 33,0	17 34,7	+ 8,7
12	30,05	44		42 22,1	17 46,2	+ 26,0
1810, Feb. 13	28,94	34	30	42 57,0	17 3,1	— 3,5
19	30,02	32	29½	42 5,9	17 55,6	+ 10,2
Mar. 17	29,62	36	33	42 31,0	17 33,4	+ 9,4
1811, Jan. 18	29,90	33½	32	42 12,2	17 38,1	— 0,2
23	30,27	35	32½	41 55,1	17 56,6	+ 9,1
28	29,35	27½	21½	41 58,5	17 54,6	+ 22,7
Feb. 3	29,44	31½	30	42 34,3	17 20,4	— 7,7
7	29,24	39	38	42 52,5	17 3,2	— 2,8
8	29,28	39	35	42 51,2	17 4,7	— 2,3
12	29,03	38	34	42 58,4	16 58,4	— 2,6
13	28,91	35	33	43 3,3	16 53,7	— 10,2
Dec. 28	29,39	30½	25½	42 3,0	17 38,7	+ 12,2
1812. Jan. 2	29,07	31½	30	42 22,0	17 21,2	+ 6,9
3	28,95	29½	26½	42 34,0	17 9,5	— 5,8
4	29,11	27½	23½	41 56,2	17 47,6	+ 24,6
7	29,93	32	31	42 2,1	17 42,6	+ 0,6
21	29,64	34	28½	42 1,2	17 47,9	+ 20,7
30	29,18	39	35	42 36,4	17 19,2	+ 17,2
Feb. 7	29,42	38	33	42 27,2	17 26,4	+ 13,9
Dec. 22	29,66	33	26½	41 48,0	17 50,7	+ 21,1
1813, Jan. 1	29,64	36	31	42 9,1	17 32,7	+ 9,4
3	29,90	42½	40	42 23,0	17 19,5	+ 0,7
11	29,52	36	31½	42 11,8	17 33,2	+ 14,2
19	30,04	36	32	41 58,2	17 40,2	+ 12,6
26	30,16	33	28	41 46,2	18 3,2	+ 16,1
Feb. 6	29,40	39	38	42 45,8	17 5,6	— 5,1
15	28,50	40	38	43 24,8	16 29,6	— 10,0
18	29,26	39	37½	43 0,0	16 55,0	— 12,0

Refractions of α Lyræ below the Pole.

Time of observation	Barom.	Ther. int.	Ther. ex.	Zenith distance observed	Ref. observed	Corr. French Tables
1813, Feb. 22	29,24	42	36½	87° 42′ 52″,3	17′ 3″,3	+ 4″,0
Dec. 26	30,19	35½	31½	41 55,8	17 43,6	+ 0,1
27	30,01	36½	34	42 21,2	17 18,5	— 17,3
31	29,88	35½	33½	42 1,0	17 40,0	+ 7,5
1814, Jan. 1	29,69	35	32½	42 21,2	17 20,1	— 8,4
4	29,11	26½	23	41 59,6	17 42,7	+ 17,4
22	29,88	21	17	41 25,7	18 22,2	+ 18,2
26	28,95	33	32½	42 56,2	16 52,8	— 16,5
27	28,78	32½	30½	42 49,8	16 59,4	— 4,2
29	28,63	31½	29	42 51,5	16 58,4	— 2,1
Feb. 13	29,67	41½	39	42 47,1	17 6,3	— 8,4

To the preceding observed refractions of α Lyræ *S.P.* are annexed the corrections to be applied to the refractions computed by the French tables to give the observed refractions. These corrections sufficiently point out the irregularities of refraction at low altitudes.

The French tables from 74° zenith distance to the horizon may be considered less empirical than any other, since they are deduced from a formula of Laplace assumed so, that, partaking both of the arithmetical and geometrical progressions of variation of density, it gives the diminution of heat observed in ascending in the atmosphere. Gay Lussac having ascended in a balloon to a considerable height found the diminution of temperature nearly as resulted from Laplace's formula.

But from the circumstances of the case there seems to be no reason to expect any exact and convenient method of determining the quantity of refraction for low altitudes.

It is not likely the irregularities will be ever submitted to any law, and investigations respecting formulæ for refractions for zenith distances greater than about 80° may be considered more curious than useful. For less zenith distances, the French tables, as it has been a principal object of this paper to shew, seem as accurate as can be desired.

APPENDIX to the Account of observations made at the Observatory of TRINITY COLLEGE, DUBLIN, which appear to point out an annual Parallax in certain fixed Stars, &c &c. By JOHN BRINKLEY, D. D. M. R. I. A. F. R. S. and Andrews' Professor of Astronomy in the University of Dublin.

Read March 6, 1815.

THE results from the observations of Arcturus, α Lyræ, α Aquilæ and α Cygni made during the last twelve months' agree sufficiently with the former results, and combined therewith, may be considered as adding additional weight to what I have before stated respecting the parallax of these stars.

Arcturus.

By 20 observations in May, June and July, 1814, mean zenith distance, Jan. 1, 1814.	33°. 13′. 51″,54+,57p

By 20 observations, October, November, December, 1814, mean zenith distance, Jan. 1, 1814. 53° 13′ 52″,60—,55p

or $p = \frac{1,26}{1,11} = 1'',1$

Combining these observations with the 77 observations before given, $p = 1,1$ or the double parallax = 2″,2 as before.

The above 40 observations (taking the annual motion in N. P. D. = + 18,81)

give the mean N. P. D. Jan. 1, 1813 =	69° 50′ 19″,66
The former determination gives	69 50 19 ,33

γ Draconis.

By 26 observations in June, July and August, 1813 and 1814, the mean zenith distance, Jan. 1, 1814,	1°. 52′. 17″,74
By 32 observations, November, December, January and February, 1813, 1814 and 1815, the mean zenith distance, Jan. 1, 1814,	1 52 17 ,86

This indicates no sensible parallax, and the argument from thence derived appears very conclusive. This star passes the meridian within about half an hour of the passage of

α Lyræ, and is not quite 13° distant in declination from it. Therefore if any unknown cause should occasion an appearance of parallax, and render the observations of α Lyræ inaccurate, the same ought to affect the observations of γ Draconis in a similar way. But the above results shew that it is not the case, and consequently afford a powerful argument that the difference of the zenith distances of α Lyræ in summer and winter is occasioned by parallax.

The above 58 observations give the mean N. P. D. Jan. 1, 1813,	38° 29′ 3″,58
By the former determination	3 ,70

α Lyræ.

By 20 observations in June, July and August, 1814, the mean zenith distance, Jan. 1, 1814	14° 46′ 10″,87+,78 p
By 20 observations in Decem. 1814, January and February, 1815, the mean zenith distance, Jan. 1, 1814,	14 46 12 ,00—,78 p

Hence $p = \frac{1,13}{1,56} = 0'',72$.

In computing the above observations the French refractions were used. In the former computation of the observations of α Lyræ, Bradley's refractions were used. Had the French refractions been used, the parallax, as was observed, would have been 2″, or $p = 1''$. Combining the former 126 observations with the above 40, $p = 0'',9$ or the double parallax from 166 observations $= 1'',8$.

The above 40 observations give the mean N. P. D. Jan. 1, 1813,	51° 23′ 0″,94
13 observations in August and September, 1814 - -	51 23 0,51
The former determination -	51 23 0,84

If we reckon the observations near six o'clock in the evening, we may consider the determination of the parallax of α Lyræ as resting on 205 observations of that star.

α Aquilæ.

I was able to obtain only 10 observations of this star in 1814, near the time when the zenith distance from parallax appears least, I have therefore joined with these 11 observations when the zenith distance is near its mean quantity. In this way the errors of observation have a greater influence on account of the smallness of the co-efficient of p. The result * gives a parallax greater than before, but being combined with the former one, the conclusion is not materially different. It sufficiently establishes the great parallax of α Aquilæ.

* If the 10 observations only had been used, the result would have agreed very nearly with the former result.

By 24 observations in the winter, mean zenith distance, January 1, 1814, -	45° 0′ 5″,35—,47 p
By 21 observations, summer and autumn, 1814, mean zenith distance, Jan. 1. 1814,	45° 0′ 3″,00+,21 p

Hence $p = \frac{2,35}{,68} = 3'',5$

Combining this result with the result of the 76 observations before given $p = 3,''0$, or the double parallax $= 6''$. This result exceeds the former by half a second, but, as has been observed, the smallness of the co-efficient of p necessarily precludes great accuracy.

The above 45 observations (taking the mean annual motion in N. P. D. $= -9'',12$) give the mean N. P. D. Jan. 1, 1813 =	81° 36′ 59″,42
The former determination was	81 36 59,85

α Cygni.

By 12 observations near conjunction, mean zenith distance, Jan. 1, 1814, -	8° 45′ 59″42—,80 p
By 10 observations near opposition, mean zenith distance, Jan. 1, 1814, -	8 45 58, 47+,72 p

These observations are too few in number to be of much weight by themselves, but, combined with the former 47 observations, give $p = 0'',9$ or the double parallax $= 1'',8$. The former conclusion was $2'',1$.

The above 22 observations give the mean N. P. D. Jan. 1, 1813,	45° 22′ 58″,06
The former determination was	45 22 58 ,34

POLITE LITERATURE.

AN

ESSAY

ON

THE SUBJECT PROPOSED

BY

THE ROYAL IRISH ACADEMY,

" Whether, and how far, the pursuits of Scientific, and Polite Literature, assist, or obstruct, each other."

If we can direct the lights we derive from the exalted speculations of philosophy upon the humbler field of the imagination, we may not only communicate to the taste a sort of philosophical solidity, but we may reflect back upon the severer sciences some of the graces and elegances of taste, without which the greatest proficiency in those sciences will always have the appearance of something illiberal.

Burke's Introduction to Treatise on Sublime and Beautiful.

AMONG the many errors of the understanding, by which the learned have been misled in their conclusions, or distracted in their attempts at more cautious investigation, few have been of greater injury to the cause of truth, than the mistake of a concomitant for a cause, of a casual for a necessary connection, and a fortuitous contiguity in point of time for some fixed and established relation in the great system of natural dependencies. Cotemporary phænomena we accustom ourselves either to refer to one common principle of causation, or to attribute to the one some degree of influence on the production of the other: we are naturally pleased with this order of things to which we ourselves have given existence, and we veil our rashness in instituting analogies under the specious appellations of "love of simplicity," and "a study to preserve unbroken the general harmony of nature." An error of this kind has for a long time partially prevailed relative to the subject proposed by the Academy for discussion, and though in itself it by no means requires a formal refutation, yet from it's connection with our question it derives at present a degree of adventitious importance.

It has been observed, that while science in these latter ages has soared to a height not only inaccessible but incomprehensible to the ancients, Polite Literature still remains in the neighbourhood of those regions where the remotest antiquity had placed her—that while the pensive brow of the severer Muse has been gradually relaxing into a smile of greater complacency, the votaries of her more graceful sister have had but little reason to boast of any encrease in her partiality. Hence it has been concluded, that there is some natural repugnance between the two pursuits, and that particular attachment to one must necessarily be attended by inferiority in the other. Thus the grand cause of Learning has been split into factions, and the two presiding deities been considered not as allies faithfully and perseveringly united in the dispensation of the blessings of civilisation and refinement, but as rivals, each jealous of the other's ascendancy, and punishing any particular attention paid to her competitor by manifest indications of coldness and neglect.

In order to answer this objection, there will be no occasion to enter into a minute historical account of their connection in their origin, progress, and decline in each country, where their happy influence has been felt: it will be sufficient at present to mention a few leading facts, from which it may be seen, that the two pursuits are not in their own nature irreconcileably averse to each other; and to enumerate some circumstances, from which we may easily account for their comparative states in ancient and modern times, without having recourse to such a bold and unwarranted hypothesis.

In that twilight state of human existence, which intervenes between the dreary gloom of savage solitude, and the chearful lustre of civilised society, the poets were the first, who, from their superior elevation of soul, were enabled to catch the first partial rays of knowledge, as they struggled through the clouded atmosphere of error and the mists of superstition. It must, indeed, be confessed that the light, which they thus contributed to diffuse over the yet unexplored paths of learning, was in some degree diverted from the direct line of philosophical accuracy, and tinged with the lively and variegated hues of poetry; their knowledge of a new star was announced by the deification of some celebrated mortal; their attempts to explain celestial phenomena, or describe the constitution of the universe, were delivered under allegorical representations; and their morality, instead of being inculcated in the plain didactic form, was insinuated in the specious garb of narrative and of fable. But, therefore, to deny the original union of poetry and philosophy, would be as unreasonable (says an * old writer), "as to assert that day-light proceeded from some other cause than the diffusion of the sun's beams over the surface of the earth. For if we deliver poetry from the restraints of mètre and versification, and remove the veil of mythological obscurity in which its sentiments are enveloped, what other difference will then remain between it and philosophy, than a difference as to the dates of their respective origin?" "During the earlier ages (continues † he) the human mind required a milder species of philosophy, that would calm the restlessness inseparable from primitive rudeness, sooth the affections by the blandishments of harmony, captivate the attention by interesting fable, and lead mankind, as it were by the hand, into the paths of knowledge; in short reason was

* Maximus Tyrius, Dissert. 9. Οιον ει τις ἢ τὴν ἡμεραν αλλο τὶ ἡγησαιτο πλην ἡλιȣ φῶς πίπτον ἐις γῆν, ἢ τον ἥλιον ὑπὲρ γης θέοντα ἄλλο τὶ ἢ ἡμεράν. ȣ̂τω τοι τὰ τῆς ποιητικης πρὸς φιλοσοφιαν εχει. Καὶ γὰρ ποιητικὴ τι αλλο εςι η φιλοσοφια, τῳ μὲν χρονῳ παλαια, τῃ δε άρμονιᾳ εμμετρος, τῃ δε γνωμῃ μυθολογικη; και φιλοσοφια τι αλλο η ποιητικη, τῳ μεν χρονῳ νεωτερα, τῃ δε γνωμῃ σαφεςερα, τῃ δε άρμονιᾳ ευζωνοτερα;

† Η ψυχη, προτερον δὲ άπλοτητα, και την καλȣμενην ταυτην ευηθειαν, εδειτο φιλοσοφιας μȣσικης τινος και πραοτερας, ἡ δια μυθων δημαγωγησει αυτην, και μεταχειριειται, καθαπερ αἱ τιτθαι τȣς παιδας μυθολογιας βȣκολȣσι

then in its infancy, and demanded from its instructors such treatment as children receive from their nurses." We are not to imagine, that these expressions of the Greek writer are necessarily confined to moral philosophy, though the nature of the subject, of which he is treating in that dissertation, prevents him from extending the observation, for (as Mr. Twining * remarks) the earliest philosophy was natural philosophy, and the earliest vehicle of that philosophy was verse. Orpheus, Hesiod, Parmenides, Empedocles, and Thales, are all mentioned by Plutarch as poet-philosophers of this kind, and Pythagoras is said to have written a poem on the Universe in Hexameters." But to return to Tyrius— † "When at length (says he) reason had encreased in strength and approached to the maturity of manly understanding, it became filled with incredulity and suspicion, too judicious to admit the fables without investigation, or approve of the obscurity in which their signification was involved; then it was that philosophy was divested of her former decorations; the pompous train of poetic imagery was dismissed, and the mystic veil of allegory removed from before her." Yet, though they thus became separate, they were still sympathetic existences, they flourished not, but in association, they appeared united in one common fate and governed by

* Commentary on Aristotle's Poetics.

† Προϊȣσα δε (ἡ ψυχη Scil.) εις δεινοτητα και ανδριζομενη, και ὑποπιμπλαμενη απιςιας και πανεργιας, και τȣς μυθȣς διερευνωμενη, και ȣκ ανεχομενη των αινιγματων, ἐξεκαλυψε τε και απεδυσε φιλοσοφιαν τȣ αυτης κοσμȣ, και εχρησατο γυμνοις τοις λογοις.

one common law, they seemed as mutual moons, each invariably attending the other in its revolutions through the universe, each deriving its chief lustre, and more resplendent radiance, from the same inexhaustible source of light and truth, yet not a little enlivened by the reflex beams of the other. And although the* genius of the Roman people seemed averse from such pursuits, every man in the earlier ages of that state devoting himself particularly to those studies, which were calculated to procure him political pre-eminence, and even to the latest period of the Commonwealth the policy or superstition of the Senate discountenancing the Grecian philosophy, yet has Rome produced on a philosophical subject one of the most sublime, and occasionally, the most harmonious poems in any language; and when learning began to sink under the overwhelming force of barbarism, we find Boethius, one of the latest of Roman poets, singing a hymn of consolation to declining philosophy. If we carry our historical view still farther, we find that in the gloomy interval of Gothic ignorance, both were equally neglected and uncultivated, that these were the ages of phantastic hypotheses and unmeaning quibbles, as well as monkish rhymes and puny witticisms, and that religion was equally corrupted by absurd legendary tales, and frivolous stories of saints and devils, as by the scholastic jargon of metaphysi-

* Populo Romano nunquam ea copia fuit, quia prudentissimus quisque maxime negotiosus erat, ingenium nemo sine corpore exercebat. Sall. Bel. Cat.

cal theology. Whatever has been said of the original union of poetry with philosophy may be extended to eloquence; for, in the earlier ages of learning, the philosopher and orator also were united, and it was supposed that their respective ends would be most effectually accomplished by their co-existence; * "Hanc enim perfectam philosophiam semper putavi, quæ de maximis quæstionibus copiose posset et ornate dicere." After the light of learning was restored, the two arts continue still associated, those countries which have been particularly distinguished for their poets, orators, historians, and critics, have also to boast of the most illustrious names on the records of mathematics and philosophy, whether natural, moral, or metaphysical. To conclude this sketch of their connected history, we may say (adopting an idea of † Grattan's) that in every country Polite Literature has rocked the cradle of Philosophy in its infancy, has lamented it's decline, and followed it's fall; that it hailed it's resuscitation, when it rose from the tomb of Gothic barbarism, and has since uniformly accompanied it in its descent through the vale of time, and that wherever the sublime communications of science have been disregarded, there the politer muse has not deigned to raise her fascinating voice.

The mathematical sciences, like the objects of which they treat, may be considered as quantities capable of en-

* Tully Tusc. Quæst.

‡ "I have rocked the cradle of Irish Independence, and I have followed its hearse."

crease by the addition of the least part, it is in their nature therefore to be progressive, and since the grounds of comparison are innumerable, and the circumstances of relation infinitely diversified, their progress knows no assignable limit. If the extent of number considered in one direct line transcend the utmost efforts of thought, and outstrip the most rapid methods of calculation, what are we to think if this infinity be propagated on every side by the inexhaustible power of combination, each successive change presenting a new order of the whole system, resolvable into an indeterminate number of new dispositions among its elementary parts, and every different mode of juxtaposition susceptible of an endless variety of relations undiscovered during the contemplation of former arrangements? Again, if on account of the innumerable variations in the length, the number, and mutual inclination of lines and surfaces, pure geometry alone afford such a vast field for speculation, that the human intellect, after having exspatiated there for near three thousand years, finds still new tracts abounding in objects unnoticed by former inquiries, what bounds can now be prescribed to discovery, when new and extensive principles have been adopted, new modes of investigation applied, when regions, hitherto unknown, even in name, or considered incapable of being rendered subject to mathematical research, have been added to the dominions of science? In scientific subjects every new discovery, however noble in itself, however admirable for the skill and ingenuity displayed in the research, and the simplicity and universality of the conclusion, derives its principal claim on our consideration from the fertility with which it supplies new deductions, each successively unfolding new properties, and pointing out relations hitherto unobserved. Thus every step that we ascend in the progress of discovery, at the same time that it gives us a more commanding view of the ground that we have passed, enables us to catch a glimpse of some more elevated pinnacle, which the interposing objects had hitherto prevented us from observing, and when at length we have obtained the possession of this eminence, we value it chiefly as it facilitates our approach to a summit still more elevated and remote. The discovery, for which Pythagoras thanked the gods by the sacrifice of a whole hecatomb, was entitled to the gratitude of future mathematicians for consequences of which the philosopher himself could have had no conception, for establishing the connection between arithmetic and geometry, and opening the passage to trigonometrical computation. The exultation, which drew from Archimede the proud exclamation "Ευρηκα," has long been lost in the ardor of ulterior discovery; and his method of exhaustions, beautiful and accurate, and scientific as it is, retains it's place in the list of great discoveries principally from it's having given birth to the method of indivisibles, and prepared the way for the more extensive and philosophical reasonings of the immortal Newton. The observations and researches of every one whose name is mentioned in the history of Science, from the first rude gaze of the Babylonian shepherd to the accurate examinations of a modern astronomer, assisted by the elaborate apparatus of a royal observatory, all were indispensably necessary for the perfection of astronomical knowledge, and the consummation of that great monument of human industry and human understanding. Before a Newton or a La Place could have shone forth upon the world, it was likewise necessary that the Egyptian husbandman should have made the first feeble efforts at geometrical measurement, that succeeding and more enlightened minds should have contributed their assistance in extending and improving the confined views of the former, that Euclid, and Apollonius, and Archimede should have added their labours, and that afterward, in a more advanced age, Cavallerius, Vieta and Wallis, should have enriched with unexpected treasures, and enlarged with new possessions, the orbis habitabilis of the scientific world. Thus, even though no very distinguished man should arise for ages, the great work of science continues advancing, fresh materials are every day added to the mass of acquirements; every year, as it passes, brings some new offering of light and truth, until at length, when the fulness of time is arrived, and a sufficient quantity of splendor has been collected in this chaos of accumulated information, the whole collected body undergoes one general purification, one effulgent soul is made the receptacle of all the light thus separated and refined, fresh rays of origina brightness are annexed to it, and it becomes a sun to illuminate a long succession of future ages.

But with respect to those more refined and elegant pursuits that are usually comprehended under the name of Belles Lettres, it may be easily perceived that the case is widely different. From the very constitution of his nature, and from the state in which he finds himself, in the very infancy of society, man is necessarily an orator, and the objects and business of oratory are nearly the same in all ages. Among all the melancholy pictures that travellers have given from time to time of human degradation, hardly any one has ever yet been exhibited of a race of men denying the existence of a Supreme Being. However defiled and disfigured the character of the Creator might have been by attributing to it their own depraved propensities, they still considered Him with awe and reverence, and submissively offered the homage of their adoration. Hence we always find, in every age and nation, some whose peculiar office it was to appease the Deity by prayer, and to unfold the secrets of their wild mythology, to set forth to the people the supposed revelations of their god, and to explain the superstitious rites observed in their worship, to prescribe rules of conduct for the living, and to celebrate the praises of such departed heroes and sages, who had formerly improved and adorned their community. Such were the offices of a priest in the earliest days, and these necessarily introduced the characters of poet and of orator, of both conjointly, for at first the division was unknown; oratory every where lisped in numbers, and * "song" was considered, "but as the eloquence of truth." Again, man has never been found to exist in that state of absolute solitude, which some philosophers are so fond of imposing on the world as the state of nature; he is every where a social animal, and as to the nature of the association, the connection of an insignificant tribe of savages differs not so much in kind, as in degree, from the constitution of the most powerful and civilised nation. In the councils of the most barbarous horde, leagues offensive and defensive, truces and alliances, justice and injustice, life and death, war, peace, and commerce, are the subjects of debate: and of what other description are the decisions of the most learned tribunals, or the discussions of the most enlightened senates? If from the consideration of such rude times and uncivilised people, we pass to those periods of Greece and Rome when the powers of oratory were most conspicuous, we will find that all those subjects which are ever introduced in the speeches of the most refined and learned speakers, were then almost as well understood as at the present day. Whatever related to the administration of states, or management of families, to prudence in legislation, and vigour and dexterity in execution; whatever tends to produce wisdom in council, address in business, and elegance in conversation, all these were perfectly understood and successfully practised. Few modern orators could be instanced who would bear a comparison with Cicero, in their

* Gertrude of Wyoming.

knowledge of the various duties of life, the distinctions of virtue and vice, and all those delicate questions which are so ably and elegantly discussed in his philosophical writings.

From such obvious considerations it appears, that the objects of eloquence admit of but trivial variation, and in like manner it will appear from a little reflection, that the manner of treating the subjects of discussion is no less limited. "Initium dicendi (says Quintilian) dedit natura, initium artis, observatio." As Nature has bestowed on all men the first rudiments and principles of oratory, so has observation and experience gradually suggested those rules which have established it as an art, and received the sanction of all civilised and enlightened nations. If we now consider what that is, from the observation and experience of which men have been enabled to draw these precepts, it is immediately evident that this source is human nature; by a conformity with this is the whole art to be judged, and the value of each particular precept to be estimated; and all the atchievements that have ever been performed in oratory, resulted from a judicious management of the passions, intermixed with well-timed appeals to the common sense of the audience. But as amidst all the fluctuations of manners and customs, the diffusion of knowledge, and the progress of refinement, mankind, from the barbarian to the philosopher, partake of one common nature, this identity imposes on the orator an unalterable necessity of exerting his persuasive powers nearly in the same manner.

Poetry is an imitative, or rather a descriptive art, and the objects with which it is principally conversant, are the actions and characters of man, and the external appearance of nature. Now that the actions and characters of mankind are nearly the same in all ages, we need not here repeat; and as to the manners, it is an observation equally old and just, that the most favourable æra for the higher orders of poetry is a period of imperfect civilisation. In this state, man being more dependant on his own individual exertions, than in a more perfect form of society, is less under the necessity of regulating his behaviour according to the pleasure of those around him, his actions are restrained by no artificial delicacy, his manners mellowed indeed from the harsh asperity of the savage, but far from that insipid sweetness too generally found in the modern fine gentleman. The bold swellings of his soul are not taught to subside to the level of good breeding, nor is the strong and varied expression of his feeling lost in (what is too often) the monotony of decorum. Here therefore, before man has assumed that veil of politeness, which, except to a very minute inspector, gives such an uniform appearance to society, the poet has an opportunity of observing the natural movements of the mind, the original and unconstrained features of the human character. Accordingly we find in Homer the most natural characters, which will always retain their power over the mind, because being founded in our nature, similar ones will daily fall under the observation of all in every age and country. As man advanced in civilisation, the poet was obliged gradually to have recourse more to his invention than observation, and hence poetical characters began to assume less of the species, and more of the individual, less of those grand and striking features, that are common among men in general, and more of those unimportant and accidental differences, that are the result rather of private caprice than general nature. Of this we have a remarkable instance in one of the greatest poetical characters that England ever produced. "Spenser (says * Mr. Hume) contains great beauties, a sweet and harmonious versification, easy elocution and fine imagination, yet does the perusal of his work become tedious. This effect is usually ascribed to the change of manners, but manners have changed more since Homer's time, and yet that poet still remains the favourite of every reader of taste. Homer copied true natural manners, which, however uncultivated, will always form an agreeable picture; but the pencil of the English poet was employed in drawing the affectations and conceits of chivalry."—Hence in a great measure it arises, that in a highly civilised country, the lighter departments of poetry are always more successfully cultivated than the higher. Even in such compositions, however, we should not be surprised, if absurd, and perhaps sometimes unnatural

* History of England, App. 3.

representations of manners be introduced; or if at best the characters, however true, should be superficially traced in the ever-varying tints of custom and fashion, rather than deeply and distinctly marked by the impressive stamp of passion and of nature. We should ever remember that all cannot be equally novel and natural, and that a poet, if he be strictly confined to the latter class, must make the same confession and defence to which Terence had resorted so many ages before him.

——— Eas se non negat
Personas transtulisse ex Græca———
Quod si personis iisdem uti aliis non licet,
Quî magis licet currentes servos scribere,
Bonas matronas facere, meretrices malas,
Parasitum edacem, gloriosum militem,
Puerum supponi, falli per servom senem,
Amare, odisse, suspicari? denique
Nullum est jam dictum, quod non dictum sit prius,
Quare æquom est, vos cognoscere et ignoscere,
Quæ veteres factitarunt, si faciunt novi.

Prol. ad Eunuch.

If we now turn our attention to the grand source, from which poetry derives all its similes, allusions and illustrations, it is immediately apparent that the progress of time has not added to natural objects any qualities with which they were not originally endowed, and therefore no such object is better adapted now to excite in the mind a train of poetical images, than it had been in the primæval days of poetry.

Whatever exalts the imagination by its sublimity, raises our admiration at it's magnificence, or awes us into a still more violent emotion by its terrific grandeur; whatever on the other hand fascinates us by its beauty, charms us by the harmonious variety of it's colours, or delights by the exquisite delicacy of it's proportions, every such object was equally, and, in some cases, better qualified to make the same impression on the poetic mind three thousand years from the present period. The din of battle, and the roaring of the winds and waters, must have possessed the same solemn and fearful qualities; the melody of the lyre, the gaiety of a vintage feast, and the serene tranquillity of a summer's eve, must have had the same chearful and enlivening effect in the days of Homer, as at present. When Virgil breaks forth into that exclamation——

> "Oh quis me gelidis in vallibus Hæmi
> Sistat, et ingenti ramorum protegat umbra!

or cries out,

> "Oh fortunati nimium, sua si bona norint,
> Agricolæ!"

the charms of a country life must have appeared as attractive to him, as to Thomson or any other modern. And Horace, when he sang the following verses, must have felt the pleasing pain of love with a sensibility as exquisite as Moore himself can pretend to—

———" Urit me Glyceræ nitor,
Splendentis Pario marmore purius,
Urit grata protervitas,
Et vultus nimium lubricus aspici."—

The fields of Ullin were as green, and the health of Morven as gloomy, in the days of the real Ossian as of his pretended translator, " the blue waves of Erin" presented then as brilliant a prospect, " when they rolled in the light of the morning," and the interval of ages has certainly not rendered " the grey mountains" more capable of producing a train of melancholy ideas. It may be said that the store of nature is inexhaustible, and that a true poet will always find something there, which though it had escaped the notice of his predecessors, is capable of being used to advantage, as an apt illustration of his sentiments, and a valuable ornament of his composition. That this is true in a philosophical sense, there can be little room for doubting, it is certain that we may be for ever approaching to a more intimate acquaintance with the works of the Creator, without ever arriving at complete knowledge; He alone, who made them, can perfectly comprehend the design, utility, and extent of His own stupendous performance; but its truth in that sense in which only it is considered advantageous to the poet, will appear, on a little consideration, to be extremely questionable It must be granted, that by a close and minute examination of surrounding objects, several ideas will suggest themselves, which would escape the transient glances of a more careless observer: but in order that your comparison should make the desired impression on the hearer, he must be previously acquainted with that fact or natural appearance to which your simile alludes. The end of poetry is not so much to instruct as to please, and the business of the poet is not to inform his reader of the existence of that phenomenon itself, but to discover to him some connection between it and the subject which it was intended to illustrate. It is in this respect nearly the same with poetical description as with logical definition, and in order that a definition be intelligible, it is necessary that your reader should be previously acquainted with the signification of all the terms used in the explanation. I have not thought to make any mention of history in this slight survey of the Belles Lettres, for as it is evidently much more limited in its objects, and circumscribed as to the use of ornament and illustration, than poetry or oratory, it must admit of still less variation; different successive histories may be composed, but they are all models of the same grand fabric, the colouring, the ornaments, and the style of architecture varying perhaps in the minuter parts, but the general outline, the proportion of the principal members, and the most striking features unaltered.

It has been now shewn that the sciences are in themselves progressive, both from the nature of their objects considered in the abstract, and the inexhaustible variety of the creation contemplated in a philosophical manner. The objects of the politer arts, on the contrary, admit of but trivial alteration, and that is of such a nature as to produce rather delicacy than strength, a chaste and frugal accuracy, rather than an irregular and exuberant boldness. The sciences address themselves to the reason, a faculty which grows with their growth and strengthens with their strength, the extent of whose improvement is illimitable, and which we are led to expect may continue its progress through an endless series of ages. The Belles Lettres on the contrary appeal to the common sense, the passions, and that branch of the imagination, where the train of thought is suggested rather by sensation than reflection; the first of which three is nearly the same in the savage and philosopher, but in the other two, the Celtic or Scandinavian bard has a great and evident advantage over the refined versifyer of modern times. From these considerations it is abundantly evident that there is no occasion to have recourse to the hypothesis mentioned in the beginning of this essay, but there are other circumstances, which, though they are well known as the principal causes of the retardation of the ancients, it may not be proper entirely to omit.* 1st. In philosophical investigations they made no use of mathematical reasoning, or of that species of induction, which since Lord Bacon's time has been justly called philosophical. 2d. In pure mathematics they were too cautious in their methods of demonstration, the foundations of mathematical

* I have avoided mentioning any of the other causes enumerated by Bacon, because they have been equally prejudicial to modern, as to ancient, writers; it would be easy to give instances, were it to the present purpose.

learning indeed were laid with due attention to strength and security, and its base was constructed with solidity and elegance, but still the plan was confined, and the dimensions of the intended fabric contracted; that microscopic nicety, with which they examined every minute particle of the mass, prevented them from taking a general survey of the rich materials that lay before them; and thus when they came to the construction of the pillar itself, they were unable to produce any thing worthy of the exertions or talents employed on it, or of the pedestal prepared for its support.

Having thus treated at large of this objection, it is proper that we come to the more immediate consideration of the question itself. Without entering therefore into a panegyric on the reasoning faculty, it is fit that we state briefly, that as it is the distinguishing and noblest faculty of men, so likewise it is that which demands the most diligent cultivation; its fruits, though the richest and most abundant, are scarcely ever spontaneous, and no high degree of literary excellence, whether in polite or scientific learning, has ever been attained without a due discipline and improvement of it. The savage of Otaheite may have been gifted with as much natural talent as Milton or Newton, and yet when we reflect on the transcendent sublimity of mind, which characterised these great men, and the groveling spirit of the other, we are almost tempted to pronounce them not of the same species. There is no one, who will deny the advantage and necessity of this cultivation of the reasoning faculty for the production of the orator, the critic, or the historian, but it may be said, perhaps, "that as reason and imagination are independent faculties, this necessity of the improvement of the former cannot be alleged in the case of poetry, which may be called the exclusive province of the imagination—that in times, when reason had been but little cultivated, brilliant instances of poetic genius have appeared, and that Homer himself, the great father of poetry, flourished in the very infancy of reason." But it is to be remembered, that Homer, and the others, who shone forth amidst the obscurity of rudeness, were indebted to their strength of reason and accuracy of judgment, no less than the vigour of their imagination. The works of Homer in particular abound with sentiments and reflections replete with understanding and wisdom; the numerous speeches with which his poems are interspersed, display the reasoning faculty, in a degree of excellence not unworthy the most experienced philosopher; and if we consider the times in which he lived, the knowledge and learning which appears throughout his writings, has highly deserved that admiration with which it has been received by posterity. Horace says, "that wisdom is the origin and source of all good writing," and wisdom is not the endowment of nature, but the effect of long and patient study, of continued exercise and unremitting perseverance. If the necessity of improving and consolidating the understanding was so great in the times of Horace, as this and several passages of his works declare, it must be allowed, that among all the disadvantages under which tragic and epic poetry labours at the present day, it would be a most presumptuous attempt, even in a mind of the greatest natural abilities, to undertake such a pursuit as will almost necessarily bring him into competition with the ancients, were not these circumstances, in which he is unavoidably inferior, counterbalanced by the opportunities of a more comprehensive education. And if in the review of modern literature, we should find any, who, though uneducated and uninstructed, with their reason undirected and their knowledge not much extended beyond the informations of sense, have by the sole force of native talent raised themselves to an eminence inaccessible to others though possessed of all the artificial aids that the most elaborate cultivation can bestow, we are hence not to conclude that learning is of no utility, and improvement of the reason superfluous, but rather to reflect, how much more decisive would be the victory of the one, how much more complete the defeat of the other, if these extraneous advantages had been equally withheld or equally communicated. But it has been the universal opinion of mankind in every age, that education is necessary for the perfection of the faculties, and reason seems to be the only one (if perhaps we except memory,) that discipline can improve or exercise strengthen. In our infancy the reasoning power makes no appearance, the mind has then no opportunity of comparison, being distracted by the multitude and variety of objects; even those which his more experienced eye afterward contemplates with indifference, being adorned with the fresh and glossy complexion of novelty. His mind is as yet occupied only by individual and unconnected ideas, and the world presents to him an uneven appearance, composed of innumerable detached and irregular surfaces, which perplex him by the confused and scattered manner, in which they reflect their light to his intellectual eye. Even for a considerable time after the reasoning power has begun to unfold itself, his apprehension continues wavering and his judgment feeble, he examines with the uneasiness natural to incapacity, and pronounces with hesitation and reluctance. Nor is it to be imagined that time alone would be a sufficient remedy for this imperfection, in an undirected mind this distraction of thought usually subsides into listlessness and indifference; the wonder caused by the novelty is gone, but it is not succeeded by cool deliberation, they are satisfied with the confused notions casually caught up while the objects attracted their attention, and at the same time derive no profit from their experience, for along with this cold disregard for every thing that is familiar, they still retain a restless and insatiate curiosity. Of the truth of this we may have abundant proof in the illiterate of every country, who evince complete insensibility and disregard to familiar objects, even though they have the strongest claims to their attention, and at the same time are anxiously inquisitive with regard to every thing that has the recommendation of novelty. And * there are many even among those, who may

* Reid App. to Home's Sketches, Vol. III.

be called learned, that from the habit they have acquired of submitting their opinions to the authority of others, or from some other principle, that operates more powerfully than the love of truth, suffer their judgment to be carried along to the end of their days, either by the authority of a leader, or of a party, or of a multitude, or by their own passions. Such persons, however learned, however acute, may be said to be children all their lives.

Having thus seen that the improvement of the reasoning faculty is indispensably necessary to all those who would aim at excellence in any department of polite literature, even in poetry with which it is apparently least connected, we are now to examine what description of study is best adapted for this purpose, what mode of instruction might correct the judgment without encumbering or retarding the fancy, might confirm the strength and sagacity of the reason in its pursuit, and enlarge the field of the imagination by its possession. And first, for the discipline of the understanding no study has ever been thought so proper as that of mathematics, almost all the ablest writers on the subjects of education and human faculties have recommended it, and their opinion has been sanctioned by the approbation of those learned and enlightened men of every country, to whom has been committed the superintendance of academic instruction. Quinctilian expressly inculcates the advantage of mathematical learning to an orator; and Locke says that he would have all children learn mathematics, "not, says he, to make them mathematicians, but to make them reasonable creatures;" to which opinion Dr. Reid agrees, for two reasons. First, "because there is no other branch of science, which gives such scope to long and accurate trains of reasoning," by which the mind will be gradually restrained from its natural tendency to run into extraneous matter, and insensibly acquire the habit of persevering pursuit and steady application. Secondly, Because in mathematics there is no room for authority, or prejudice of any kind which may give a false bias to the understanding." It may indeed be urged with some appearance of plausibility, that as one of the chief requisites for a poetical character is a susceptibility of the attractions of novelty, any mode of discipline which tends to remove that, must be vitally injurious to the cause of poetry. But we are to remark, that novelty in itself does not constitute an object fit for the taste or imagination to dwell on; it is not a quality of the thing itself, properly speaking, but merely relative to the observer, and therefore, unless it be united to the inherent and permanent qualities of beauty or sublimity, it can have but little claim on the poet's attention. No one ever asserted that novelty alone was sufficient to render poems, pictures or other representations agreeable, and it would be difficult, if not impossible, to assign a reason, why that which is thus universally rejected as a foundation for the secondary, should be admitted as a constituent and original cause of the primary pleasures of the imagination. Addison, indeed, and Akenside after him, have enumerated novelty among the sources of the primary pleasures of the imagination, but Addison lived in the infancy of criticism when the philosophy of taste was as yet unknown, and Akenside, in the revisal of his celebrated poem, has omitted it altogether, comprehending all in that twofold division sanctioned by the authorities of Burke and Alison. The real value of novelty Dr. Reid has thus happily expressed. "When novelty is altogether separated from the consideration of worth and utility, it makes but a slight impression upon a truly correct taste. Every discovery in nature, in the arts and sciences has a real value, and gives a rational pleasure to a good taste. But things that have no other recommendation but novelty, are fit only to entertain children, or those who are distressed from a vacuity of thought. This quality of objects may therefore be compared to a cypher in arithmetic, which adds greatly to the value of significant figures, but when put by itself, signifies nothing at all."

Mathematical studies, therefore, though they in a great measure remove that sensibility to novelty which is generally supposed essential to a poetical character, are not on that account alone to be considered inimical to the imagination. The exercise and improvement of reason, whatever effect it may have in regulating and directing the passions, neither seeks nor tends entirely to suppress them. In the present state of criticism, we should be much more inclined to doubt the soundness of a man's taste, than admire the delicacy of his feeling, who could exspatiate with rapture on the charms of a prospect in general, without being able to point out those particular objects which had principally contributed to call forth his admiration. No one will say, that the study of philosophical criticism is a pursuit calculated to injure the imagination; to say that a man can attain to a high rank in poetical reputation, without learning what to avoid or what to imitate, or why the former should be rejected, and the latter adopted, would be absurdity too gross for refutation. In order to succeed in a composition of your own, you must have investigated the principles, and searched into human nature for the causes of that success in others; you should not be content with a few fruits, that chance might present or desultory observation procure, you should endeavour to get possession of the parent stock, from which all the scions shoot forth, and from which issues the vital principle that is necessary for the preservation, the beauty and the strength of the whole body. This tâste which is thus necessary for a poet is nothing else but a refined judgment; they are not two distinct powers of the mind, but different species of the same faculty; that, which when employed on scientific subjects is called reason, in matters of critical enquiry, will receive the appellation of taste; the objects with which the mind is engaged vary, but it is the same understanding that is exercised in both cases. "If then," it may be urged, "these two are really not essentially different from each other; if it be the same judgment that is exercised in both enquiries, where is the occasion for mathematical study of which a poet or orator can never make any direct use in his works; will not the perusal of works on taste and criticism be sufficient to give him that strength of conception and justness of thought, which is so much insisted on, as being requisite for all men?" To this it may be answered, that at the period best adapted for the strengthening of the faculties, the mind scarcely knows any other evidence but that of sense, and is perplexed and confused at the simplest abstract question; any attempt therefore to turn the mind immediately, and without preparation, to a study abounding in minute and subtle distinctions, where the medii termini are perhaps never intuitively connected with the extremes, or with each other, must be attended with extreme labour and difficulty. The conclusions, never drawn with demonstrative force, would to such a mind appear entirely unsatisfactory, nay, without a previous acquaintance with logic, he would be unable, from the diffuse style in which such compositions are generally written, to comprehend the tendency of the argument, or perceive whether the induction be fairly made from the particular instances previously laid down as the foundations of a theory. It has been remarked, as a signal instance of the wisdom and benevolence of the DEITY, that darkness comes not on us suddenly; we are prepared for the change by the gradual decrease of light, until at length the moon almost imperceptibly resumes her station in the heavens. In such gradation should we arrange the succession of studies for the enlightening of the mental eye, we should not plunge it at once from the lustre of sensitive knowledge into the obscure mazes of metaphysical criticism, we should first indulge it in the contemplation of the splendor of mathematical demonstration, then let it enjoy the milder and less irresistible light of philosophical reasoning, and last of all commit it to those more attenuated beams, that enliven the regions of taste and criticism. "The truth is," says Addison, "there is nothing more absurd, than for a man to set up for a critic, without a good insight into all the parts of learning, whereas many of those, who have endeavoured to signalise themselves by works of this nature among our English writers, are not only deficient in the abovementioned particulars, but plainly discover by the phrases they make use of, and by their confused way of thinking, that they are not acquainted with the most obvious and ordinary systems of arts and sciences." Here we have pointed out to us by the first great critic of our nation, the fundamental cause of the errors of his predecessors; he refers it entirely to their "want of a good insight into all the parts of learning." And if the opinion of such a man as Addison wanted any support on such a subject as criticism, the distinguished success with which it has been prosecuted of late by men conspicuous for their scientific acquirements, is the strongest and most satisfactory corroboration of his judgment. And the same elegant and ingenious author observes, that "it is not sufficient for a man who sets up for a taste in criticism, to have perused the Ancient and Modern Classics with attention, unless he has also a clear and logical head. Aristotle, who was the best critic, was also one of the best logicians that ever appeared in the world." Though fully conscious of the advantages resulting from the study of logic, I should have hesitated to mention it as useful for the acquisition of a just and delicate taste, were I not thus sheltered by the authority of the most elegant of critics. At the present day, the prejudice against that art runs so high that the very mention of it, when treating of polite literature, is in danger of being accounted absurd and pedantic; and to enter into a formal vindication of it, and a detailed exposition of the benefits accruing from its cultivation, would (beside that it would extend this little essay much beyond the intended limits) be only transcribing the eulogiums of several, distinguished not only for their scientific knowledge, but more elegant and refined literature. It will, however, perhaps not be superfluous to mention one instance, where logic seems of the utmost importance to the poet and the critic. The chief requisites for a truly noble and sublime style, are energy of thought and justness of sentiment, such as when clad in the plainest garb, will display sufficient internal marks of an inherent and unalienable dignity. For this purpose Longinus advises us to examine splendid passages of the poets and orators, "lest they should possess only that semblance of majesty, which is often produced by a profusion of figurative expression and rhetorical ornament, when on the contrary, if more accurately inspected, they would be found empty and superficial, and meriting the contempt rather than the approbation of every sound and genuine critic."* Quinctilian also tells that there are some who pay more attention to elegance of expression, and brilliancy of metaphor, than to real strength of conception, correctness of opinion, and weight of argument.† Pope has said, that a little learning is a dangerous thing, and his own Essay on Man is a memorable and lasting instance of the truth of his observation. Had he possessed that logical acumen which seems to be so much despised, he would not have been seduced by the artful sophistry of Bolingbroke into a defence and illustration of the doctrine of fatalism. That he was seduced, is evident, both from the conduct of Bolingbroke, who is said to have ridiculed him, among his confidential friends, for having adopted principles, of which he did not perceive the tendency, and also from that ardor of delight and profusion of gratitude, with which Pope accepted and acknowledged the gratuitous defence set up by Warburton.

That Pope was thus deceived by the specious arguments of his insidious preceptor, cannot be attributed to a natural defect in the discursive faculty, on the contrary the manner in which he treats this very subject is a sufficient proof that he possessed it in a very high degree: nor can we imagine that he adopted these dogmas immediately and without ex-

* Μη τινα μεγεθους εχοι φαντασιαν ταυτην ἡ πολυ προσκειται το εικη προσαναπλαττομενον, αναπτυσσομενα δε αλλως ευρισκοιτο χαυνα, ὧν τη θαυμαζειν το περιφρονειν ευγενεστερον.

† Sunt qui neglecto rerum pondere et viribus sententiarum, si vel inania verba in hos modos depravaverint, summos se judicent artifices, ideoque non desinunt eos nectere.

amination, that trembling sensibility which he always manifested with regard to his literary reputation, will not allow us to suppose it; it remains then that we account for it by his ignorance of that art, which professes to unfold the most complicated chain of fallacy, and guide the mind in safety through the labyrinth of ingenious sophistry. Here then we see an important advantage to be derived to the poet from the study of the art of reasoning; and the same instance is sufficient to prove its still more indispensable necessity to the critic. "The Essay on Man" says Johnson *, "abounded in splendid amplifications and sparkling sentences, which were read and admired, with no great attention to their ultimate purpose; it's flowers caught the eye, which did not see what the gay foliage concealed, and for a time flourished in the sunshine of universal approbation. So little was any evil tendency discovered, that, as innocence is unsuspicious, many read it for a manual of piety." Here was that semblance of majesty, against which Longinus advises the critic to be so cautious, and with such dexterity and elegance was the counterfeit wrought, that it was received as genuine by the universal English nation; and for the discovery of the imposture, the world was indebted, not to any of the wits and more refined critics of the day, but to a professed writer on the subject of logic.

Thus have we seen that subjects of a lighter and more elegant turn are capable of being treated with encreased per-

* Life of Pope.

spicacity in consequence of the rectification of the taste and correction of the judgment by the partial pursuit of abstruse enquiry. And in like manner by a still more minute and philosophical research into these matters, will the mind be disciplined for the discussion of those graver and more serious subjects, suited to the occupation of contemplative sagacity; subjects which necessarily diverge from the line of classical elegance and simplicity, less engaging, more important, less capricious, and more profound. The quantity of scientific knowledge likely to be advantageously instrumental in the prosecution of less rigorous studies, should be in some measure proportionate to the weight of those studies themselves; and it should be regulated by ascertaining, whether the reason, or the imagination, be likely to gain the ascendancy, and determined by the degree of the ascendancy which either may be presumed to obtain. The wild and irregular charms of the Minstrel's lay, the melting pathos of the bard of Wyoming, the plaintive simplicity of the "Deserted village," and the elegant voluptuousness of Moore, could receive but little benefit from mathematical enquiry, or logical discipline. In such compositions, habits of close and accurate reasoning may save the writer from impropriety of thought or pruriency of expression, and may enable him to determine justly what sort of dress and ornament would best become the features and complexion of his characters; but that characteristic beauty which runs through the minutest parts of the writers above-mentioned, and constitutes their specific difference, can neither be acquired or communicated. Nearly the same may be said of the writers of comedy, and what is called by * Dr. Beattie the comic Epopee; in these cases the characters, manners, and even in some degree the language, are more immediately derived from observation and acquaintance with the world, and † the constitution of society at present is particularly favourable for these kinds of writing. For the archetypes of Squire Western or Sir Anthony Absolute, of Tom Jones and Charles Surface, of Blifil and Joseph Surface, of Dr. Primrose and Parson Adams, of Partridge and Hugh Strap, we have only to look among our acquaintances; and he must be very secluded from the world, who could not point out real characters, such as might be fairly supposed to have sat for the pictures. The chief use therefore that seems to be in the preparatory exercise of the reason for such writing, is in accustoming the mind to determine the degree of abstraction necessary for the formation of a genus, and also in enabling it to make a judicious selection of such circumstances as may be found in different individuals of the same character. The character of Tom Pipes may be considered as a fair general representative of British seamen, and yet there certainly was no one seaman that ever corresponded perfectly to the archetype; it is a combination of all those peculiarities incident to that mode of life, each of which may be

* Essay on Poetry, and Music.

† Beattie's Essay on Laughter and Ludicrous Composition.

supposed to be found individually in different persons. If therefore for the classification of natural objects by philosophical abstraction, there be an indispensable necessity for sound judgment and accurate discrimination, the occasion for it in this poetical abstraction must, from the superior difficulty of the operation, be immediately acknowledged. In philosophical abstraction you are required only to omit peculiarities, here it would be a vice not only to add an idea that was not to be found in any, but to retain what was not to be found in all; whereas, in the other case, you are expected not only to omit, but to retain some singularities, and even to add, as far as possibility will allow, whatever seems necessary for the perfection of the generic character. In the one mode you diminish from real existence, in the other you both diminish in one respect, and encrease in another; in the former the genus is partial and incomplete, in the latter it is exaggerated and redundant. In philosophical abstraction you have but one, and that apparently a simple rule to follow, that is, to leave out all differences whatsoever: in the other you leave out differences not merely as such, but because they are accidental to that particular character you intend to delineate; it is requisite not only that the individuals of the species described should differ from each other in these qualities, but agree with individuals of other classes in the same points. Thus in drawing the character of Pipes, a trait was not to be omitted, merely because it was not universally found in all seamen, but because it might be found in other persons of any other assignable profession, and consequently could not be retained in a representation which was intended to be characteristic. But this, which in itself appears to be a more delicate operation than that required in the former case, is only the beginning; then follow the collection of all the characteristic features really existing among the different individuals of the class, and the addition of such farther decorations as seem consistent with verisimilitude. When Augustus Cæsar committed the imperfect Æneid to the hands of some of the greatest geniuses of his day, he allowed them only to correct by retrenching what was redundant, he did not suffer them to add a single line, or even to complete a broken one; how much would the difficulty have been augmented, had he commanded them to give distinct characters to the "fortis Gyas fortisque Cleanthus," and raise each of them to the elevated rank of poetical genera? If from the consideration of these lighter species of composition, we now turn to others of a more sublime and dignified nature, it will appear evident at first sight, that for such productions as Paradise Lost, the Essay on Man, the Pleasures of Imagination, or the Anti Lucretius, the judgment cannot be too correct, the understanding too assiduously cultivated. Here it is necessary for the soul to put forth all its energies, and nothing that appears, even in the slightest degree, likely to contribute to its strength or support, should be neglected. The old alchymists pretended to extract gold from every sort of metallic substance; it should be the endeavour of the poet who undertakes such exalted subjects as we are considering, to effect that which they professed to perform. In such an arduous contest, it is not enough to have the natural strength and vigour of an Achilles, one should like him be arrayed in impenetrable armour, and provided with weapons not liable to be broken by violence or impaired by time; to persons of ordinary strength and stature they might be rather an incumbrance than an assistance, but when possessed by one of superior powers and unusual dimensions, they will be not so much an addition to his natural frame as a part of it, " they will be as wings to him," according to the expression of the Grecian bard.

Few, who consider, with even passing attention, the religious and political controversies of former times, as well as of the present day, but will be inclined to acknowledge the manifest and extensive advantages resulting from a dexterous and scientific management of subjects unconnected with scientific investigation. Scientific knowledge, to a very considerable amount, is necessary to predispose the mind to a systematic and sagacious enquiry into subjects of profound and tediously protracted controversy. And so great is the necessity for it in this particular case, that it is universally admitted, the cause of truth has never suffered more real detriment than from the hasty and precipitate zeal of superficial theologians. It was a saying of the celebrated Ganganelli, that he could tell, from the perusal of a work on any argumentative subject, whether the author was a mathematician or not, and without doubt there will be a considerable fund of internal evidence, whence a decision may in general be formed as to the author's habits of abstruse speculation. It is the peculiar glory of the Church of England, that beside giving the most able and irrefragable defence of those tenets in which she differs from other Christian societies, she has, in every age since the Reformation, produced hosts of zealous and enlightened men, who have stood forth the champions and protectors of Christianity in general, and successfully exerted themselves in overturning whatever had even the slightest or most remote tendency to weaken the stability of the true faith: every Hobbes has had his Cumberland; every Spinoza his Clarke, and every Tyndal his Conybeare; nor is it only over the malicious cavils and artful sophistry of professed enemies, that the Protestant Church has to exult, the more venial errors of sincere but ill-judging Christians have not been suffered to pass unnoticed or uncorrected. Now almost all those, by whom such inestimable service has been performed, were of the great theological school of the seventeenth century, all of them carefully disciplined in scientific reasoning, almost all considerable mathematicians, acute metaphysicians, and carrying their estimation of logic so far, as to use it technically and with the most complete success, in their arguments and refutations. Cumberland appears to have been not only one of the clearest and most forcible reasoners, but one of the deepest philosophers of his time; no sort of learning seems to have escaped him, and it is surprising to observe with what dexterity and effect he turns subjects apparently the most unconnected and remote into the happiest and most striking illustrations of his arguments. Had Barrow been known to the world only as the author of Geometrical and Optical Lectures, and a cultivator of the method of indivisibles, he would be entitled to a high rank among the learned men of his country; but by directing the resources of his strong and highly improved understanding to the elucidation of the doctrines of Christianity, he has established for himself still more extensive claims to the gratitude and admiration of England. Clarke would have been still regarded with veneration as the friend of Newton, the partaker in his studies, and explainer of his system, had it not been considered that the best proof of his mathematical abilities was his demonstration of the Being and attributes of the DEITY. And the present age has to boast of men of our own country and university, who have shewn the fruits of their more abstract speculations in masterly and scientific works on questions of the highest moment and most entangled complexity, in discourses that display the discursive faculty employed in the most exquisite perfection on the most difficult and important doctrines of the Christian religion. How great the utility of close and accurate reasoning is to the eloquence of the Bar or the Senate, is too obvious to require a detailed and minute exposition; it is well known that several of those great men, who are now in the highest reputation for forensic talent, had in the early part of their lives, and during their course of academic education, been distinguished for their abilities in severer studies. The great Athenian orator derives a considerable share of his renown, from a strict attention to cleanness of arrangement and strength of reasoning, even in the full career of his rapid and impetuous eloquence; in the very "whirlwind of his passion" his presence of mind never forsakes him, he keeps his eye steadily fixed on the course through which he is to direct his own argument, and marks attentively the obstacles which his rivals or enemies may have opposed to his progress. And to account for this happy union of emotion and calmness, of transport and deliberation, we are told that he was a pupil of that school over whose gate it was written, that no one ignorant of geometry should enter. Servius Sulpicius, according to Cicero, was the greatest orator among those distinguished for legal knowledge, and the most distinguished for legal knowledge among the eminent orators; though there were many experienced civilians and acute pleaders at the time, he was the only one who understood Law as an art, who had regularly digested and methodised it, who had reduced it to settled principles, and given it a scientific appearance.— "This" says the orator, * "he would never have effected by the knowledge of law alone, had he not also learned that Art, which teaches to distribute an entire subject into it's parts, to explain what was unknown by definitions, and elu-

* Cicero—Brut.

cidate what was obscure by a full and clear interpretation, to discern whatever is equivocal or ambiguous, and point out the inaccuracy to others; and which, finally, supplies you with a rule to distinguish between truth and falsehood, and perceive what consequences may, and what may not, be fairly deduced from certain premises."

Hitherto we have considered the sciences only as they tend to strengthen the reason and correct the judgment, to produce a condensation both of thought and of expression, to give perspicacity in detecting error, clearness in arranging the confutation of an adversary's opinion, and accuracy in methodising the statement of one's own. But they are also of no unimportant serv'ce to the Imagination, and will enable the possessor of them, to display a vast variety of illustrations and similitudes, which he cannot be censured for having borrowed from the ancients, because they depend on ideas with which they were unacquainted. "The imagination," says Burke, * "is incapable of producing any thing absolutely new, it can only vary the disposition of those ideas which it has received from the senses;" That the imagination has no creative power, properly speaking, is immediately apparent, but that the exercise of it's combining faculty is limited to ideas of sensation, is as erroneous as the former assertion is incontrovertible; the imagination derives a great, and at the present day, should derive much the greatest supply, from reflection. We have already seen that nature,

* Introduction to Sublime and Beautiful.

as it presents itself to the senses, preserves a constant uniformity; this source of association therefore, great and extensive as it is, must naturally be liable to exhaustion, and it appears at present to be strained very nearly to its limit. But in the other case there is no asssignable boundary; every encrease of knowledge serves to shew us still more sensibly than we were before aware of, how much still remains to be discovered. This difference between the two is beautifully expressed by Akenside—

> "Soon feeble grows
> Their impulse on the sense, while the pall'd eye
> In vain expects it's tribute, asks in vain
> Where are the ornaments it once admired.
> Not so the Moral species, nor the Powers
> Of Passion and of Thought; the ambitious mind,
> With objects boundless as it's own desires,
> Can there converse, by those unfading forms
> Touched and awakened."

In almost every department of philosophy, natural philosophy in particular, and in every branch of natural history, the moderns have an evident and great advantage over their predecessors. Hence are derived an endless multitude of ideas unknown to antiquity, and various opportunities of tracing out new and unexpected similitudes; and whoever is acquainted with the doctrine of combinations must perceive, that the sphere of the imagination is encreased in a much greater proportion than the actual number of additional notions acquired by the enlargement of literary knowledge.

It may be said, that the mind may be overpowered with the weight of knowledge, if encreased beyond a certain limit, and the imagination will be perplexed by the number of ideas and consequent difficulty of choice; thus their multiplicity will prevent their use, and the disappointed scholar will too late find the natural vivacity of his fancy deadened, his original perspicacity clouded and obscured, and will lament the loss of that time, which might have been more advantageously employed in the contemplation of the beauty and sublimity of the sensible creation. It may appear a confirmation of this, that the thoughts and sentiments of persons in a state of comparative rudeness, where there is little information beyond that of sense, are generally considered bolder and more poetical than those of other persons; and that the effusions of youthful poets are supposed to shew an exuberant redundancy of imagery, that is usually much diminished in the days of improved reason and accumulated knowledge. As to the first, however, we should not ascribe it so much to a more vivid force of imagination, as the poverty of language invariably attending imperfect civilisation. All languages are in some degree metaphorical, it would be impossible to have distinct appropriate signs for every object of thought, therefore we are constrained to borrow the names properly applied to more familiar ideas, and extend them to others with which we are not so long or so intimately acquainted. And if in such a copious language as that of our's, there be few words that are not used in a variety of significations, what a complicated heap of metaphor must that tongue be, which does not consist of the twentieth part of our vocabulary? Besides, though the language abound thus in metaphor, it by no means follows that it is, therefore, more poetical or sublime; the style is generally very unequal; if one passage is somewhat beyond the level of ordinary poetry among us, the next is as much below it. We know that in natural objects, a country abounding in sudden declivities and steep ascents, strikes the eye as much more picturesque, and perhaps more elevated, than a tract of as great height in reality, but less diversified in it's appearance.

If this be so in the primary objects of the imagination, (and I believe every one accustomed to the observation of nature will assent to it) it may, by an easy, and apparently just analogy, be transferred to the secondary. As accuracy of proportion, therefore, diminishes the visible height of an object, so a composition, the symmetry of whose parts is regulated by an accurate taste, will not impress upon the imagination at first view, those ideas of sublimity and boldness, that are so powerfully excited by the perusal of the wild productions of untutored fancy. The second opinion above mentioned, that the early poems of men possessed of real poetical talent, abound in a gay luxuriancy of thought, unequalled in their maturer works, is also very questionable. On the contrary, I believe it will be found, by examining the juvenile pieces of our own celebrated poets, that a poverty of idea prevails uniformly among them. They even seem conscious of their own defect, for whenever they seize upon a favourable or happy idea, they seem unwilling ever to let it escape, and it is compelled to drag it's way through twenty or perhaps thirty lines. Roscommon says of the French poetry, compared with the English,

> "The sterling bullion of one English line,
> Drawn to French wire, would in whole pages shine."

and some old critic, (Lucian, I believe) speaking of that passage in the Odyssey, which has been so admirably translated by Pope, and begins thus;

> "With many a weary step, and many a groan,
> Up a high hill he heaves a huge round stone."
>
> Mart.

says, "if it were Apollonius or Callimachus that attempted this description, how many verses would they have employed in tracing the ascent of the stone, and how many more would they have found necessary to conduct it down the eminence, whither it had been moved with such tedious labour, as well of the poet, as the criminal." Such a difference as is here pointed out between French and English poetry in general, or between the sublime conciseness of Homer, and the minute and feeble refinements of Apollonius, may be observed between the compositions of the same poet in youth and in maturity, between the full grown majesty of the author of the Æneid, and the crude imbecility of that Virgil,

"Qui modo Culicem fleverat ore rudi." Mart.

If then we are to conclude that the productions of a poet are thus improved by time, not only in correctness but in imagination, (and such a conclusion may be drawn without much apprehension of error) and if it cannot be attributed to an encrease in the warmth of his feelings, or in his sensibility with regard to the beauties of external Nature, the only remaining method of accounting for it is to ascribe it altogether to the augmentation of his intellectual wealth by the rich and varied offerings that philosophy presents.

The sciences assist the imagination not only by encreasing the opportunities of combination, but also in a manner still more important for the purposes of poetry, by raising a susceptible mind to such a fervor of enthusiasm as can scarcely ever be excited by the impulse of unassisted sense. "Every * accession of knowledge in itself is pleasant, and affecting. Even mathematical truths, which have the least intercourse with human passions, are not received with cold indifference when considered as purely speculative, without any attention to their use or application; we are delighted with them, nay sometimes even transported by what metaphysical critics call the beauty of theorem."

* Leland on Eloquence, p. 3.

"For man loves knowledge, and the beams of truth
More welcome touch his understanding's eye,
Than all the blandishments of sound his ear,
Than all of taste his tongue. Nor ever yet
The melting rainbow's vernal tinctured hues
To me have shewn so pleasing, as when first
The hand of Science pointed out the path,
In which the sun-beams, gleaming from the west,
Fall on the wat'ry cloud, whose darksome veil
Involves the Orient, and that trickling shower,
Piercing thro' every crystalline convex
Of clustering dew-drops to their flight opposed,
Recoil at length, where, concave all behind,
The internal surface of each glassy orb
Repels their forward passage into air,
That thence direct they seek the radiant goal,
From which their course began; and as they strike
In different lines the gazer's obvious eye,
Assume a different lustre, through the breed
Of colours changing from the splendid rose
To the pale violet's dejected hue."

AKENSIDE.*

Thus even in questions of a nature completely abstracted and mathematical, the mind is capable of enjoying a pure and serene satisfaction. It is true that at first the difficulty attending the investigation will preponderate over any gratification that the beauty or utility of the conclusion is naturally calculated to produce, but his susceptibility of emotion will

* I have taken the liberty of inserting this passage at full length, not only on account of the force with which the beginning of it bears upon the argument, but also because the remainder of it may be considered as a fair specimen of the manner in which subjects so decidedly mathematical should be treated by a poet.

encrease with his skill, and attractions hitherto unobserved or unheeded will every moment present themselves to his notice. And when his judgment has thus become more exact and refined, those difficulties, which at first were attended with trouble and uneasiness, will now constitute no inconsiderable portion of his pleasure; they will be to him so many testimonies of the skill, the sagacity and invention of his author, will transport him with admiration of his genius, and excite in him a reverence for every relic connected with his memory. Thus will the young philosopher be amply repaid for the obstacles that impeded his progress, by the enjoyment of a pure delight, more tranquil, indeed, but not less satisfactory than that rapidity of impulse with which we are sometimes hurried along by the more commanding features of the material creation. But when the soul is led along to take a more distinct survey of the earth, to observe its various climes, each amply supplied with those productions best suited to the nature of the country, and the accommodation of its inhabitants; when it beholds the numberless tribes of animals that people the distant regions of the earth, the pathless ocean, and the purer element that surrounds us; when it discovers the myriads of inhabitants on every leaf of every plant, and remarks the perfect constitution and regular form with which each of them has been gifted; the young philosopher seems then to have acquired a new sense, he has every where an opportunity of tracing out beauties imperceptible to most observers of nature, and in the contemplation even of objects most familiar to him before, he feels—

> "that kind access of joy,
> Which spring on each fair object, while we trace
> Through all its fabric, wisdom's artful aim
> Disposing every part, and gaining still,
> By means proportioned, her benignant end."

He is now to enjoy a still more sublime delight; the first wish of Virgil, (whom no one will call cold to the sensible beauties of nature) was—

> "Me vero primum dulces ante omnia Musæ,
> Quarum sacra fero ingenti percussus amore,
> Accipiant, cælique vias et sidera monstrent,
> Quid tantum properent Oceano se tingere soles
> Hyberni, vel quæ tardis mora noctibus obsit,
> Unde tremor terris, quâ vi maria alta tumescant
> Objicibus ruptis, rursusque in seipsa residant."

What Virgil wished for in vain, the poet of the present day has an opportunity of acquiring with ease, and displaying with effect. Under the guidance of Newton, he may range through the solar system, and survey the planets, still obedient to the laws of truth, returning to retrace the paths allotted to them, pursue the devious comet, "that goeth so far, and no farther," and perceive the majestic sovereign of the system in conscious dignity still remaining immoveable. If at length his mind should traverse, with Herschel, the full orb of being, he will catch a glimpse of that glory, which no finite intelligence is capable of comprehending, he will see, in prospect, millions of systems, rising before him, but they only conceal from him the thousands of millions that lie beyond; and when innumerable suns, not one of whose rays is permitted ever to enlighten the corporeal eye of man, blaze out upon him, his keen conception will be dazzled by an excess of lustre, and he will sink into that delirium of joy, that, if ever there be a moment of poetical inspiration, is best calculated to produce it. When he compares this sublime assemblage, with that scene (however splendid it may be) that presents itself to the natural eye, he will cry out with Akenside—

> " Who, that from Alpine heights, his labouring eye
> Shoots round the wide horizon, to survey
> The Nile, or Ganges, rolling his bright wave
> Through mountains, plains, through empires black with shade,
> And continents of sand, will turn his gaze,
> And mark the wand'rings of a scanty rill
> That murmurs at his feet?"

Thus have I feebly endeavoured to point out the advantages that may be derived both to the reason and the imagination, from scientific pursuits; it must, however, be remarked, that for the former all the branches of science are not equally useful; and for the latter, no science whatsoever, except, perhaps, moral philosophy, should be cultivated to its fullest extent, and pursued through all its varieties of minuteness. In the abstract mathematics, the mind, for the purpose of discipline, has not so much occasion for the conclusion as the premises; in this intellectual chace, it is not the possession of the prey, but the invigoration of our own powers, that should be the primary object. It is evident to every one that this end is not so happily attained by the analytic methods so much in use at present, as by the ancient geometry. For the youth who is destined to be a mere mathematician, algebra offers, in general, an easy and compendious mode of advancing in knowledge, but his knowledge is not philosophy, it is not (to borrow a logical definition) "acquired by the sole force of reason." Were it necessary to insist on this, it would be easy to illustrate it by a comparison of the truths contained in the 2d book of Euclid, as treated by that geometer, and as they would be by an analyst, or by remarking the difference between a demonstration, as it is handled by Hamilton, and by Emerson or L'Hospital; and perhaps still more strongly by observing, that mere characters, of whose meaning no one has or ever can have any conception, (they being supposed the marks of inconsistent notions, as the very name, "impossible quantity," denotes,) are as proper objects of analytical computation, except in the mechanical difficulty of managing them, as real and adequate ideas.

Again it may be prejudicial to the imagination to enter with minute accuracy into any scientific enquiry. He who has been too long habituated to the consideration of abstruse metaphysical enquiries, the patient investigation of mathematical relation, or the examination of the individual and peculiar qualities of natural objects, rather than those which admit of comparison with others, can have but faint conceptions of that vivid glow of feeling, which animates him who has been principally conversant with more elegant and refined pursuits. That enthusiastic emotion which the latter delights to indulge in is a stranger to the breast of the mathematician, and if it should occasionally intrude, it is treated with suspicion, and considered, perhaps, dangerous, certainly unnecessary and extravagant. In the works of the more eminent poets and orators, we occasionally find those noble darings of the soul, which are subject to no critical control; they acknowledge no judge but the fervid spirit that gave them birth, and elude the force of those laws which compress the more terrestrial particles of composition into system and subordination, but are insufficient to restrain the aerial subtlety of the "divinæ particula auræ." He who wishes to scrutinise such passages with metaphysical accuracy may pronounce them contrary to the dictates of sovereign reason; but though he thinks himself justified in expressing partial disapprobation at the indiscretion or temerity evinced in the attempt, he cannot refuse, like the Lacedemonians of old, the tribute due to transcendent prowess and distinguished success. Such efforts no preparatory discipline can enable us to make; such fruits no cultivation can bring forth, they must be the spontaneous offerings of a luxuriant soil, and in a cold climate would decay even in the hot-beds of the most elaborate education. When Homer, in endeavouring to raise to the highest pitch our conception of the honors of a battle, says, Δεισε δ᾽ ἐνερθεν ἀναξ ἐνερῶν Ἀΐδωνεως, &c. he falls into one of those errors, which made Plato say, that as he raises his men to the dignity of gods, so he degrades his deities to the condition of men, of those very creatures, whom he has called the most miserable of animals; yet none of his poetical readers would wish to have it expunged from the passage, of which it is so grand an ornament. When Demosthenes broke forth into his celebrated oath, Ὀυ μα τȣς ἐν Μαραθωνι, &c. or Burke into his eulogium on the Queen of France, and lamentation for the extinction of chivalry, it is hardly possible that they could have produced such towering sublimity by study or deliberation, passion and native genius alone could have effected it.

It will not be improper therefore to mark particularly those circumstances in which a peculiar opposition seems to subsist between the two pursuits. The first cannot be expressed better than in the words of Lord Bacon; in the preface to the Novum Organum, he has these words (In Philosophiâ) " Mens rebus morigera sit, nec impotenter rebus insultet," and the same great man elsewhere * says, " Poesis animum erigit et in sublime rapit, rerum similia ad animi desideria accommodando, non animum rebus (quod ratio facit et historia) submittendo." The second is nearly the same as Locke

* De Augm. Scient.

draws between wit and judgment, the one consists more in forming pleasant pictures to amuse the fancy, by assembling those ideas that have the least resemblance, the other on the contrary is exercised in separating those that have the least difference. This distinction, however, is not to be considered complete. For although it must be confessed, that as imitation is the principal object of poetry, that faculty whose province is the discovery of similitudes claims the chief attention; still it is requisite that we should examine, whether the coincidence be perfect or not, and if not, determine accurately the extent of their parallelism, and precisely mark out the points where they begin to diverge. To have a confused general perception of the resemblance is by no means sufficient, if those features of the picture which are evidently unlike their archetypes be as strongly delineated and highly coloured, as those in which the mind is delighted with the correspondence. Thirdly, a philosophical talent requires the most obstinate patience, and caution approaching to timidity; " a philosopher," says Bacon, " must always be suspicious of his own natural disposition, and be continually on the watch, lest it lead him into error;" it is incumbent on him as much as possible to stop the natural current of his ideas, and fix his thoughts immutably on one subject; whereas a poet succeeds best by giving loose reins to his imagination, by following the impulse of passion, and indulging himself in that train of thought into which the mind is almost imperceptibly led by the observation of some particular objects. Even where there is no apparent object for reflection, in the movements of unrestrained reverie, the suggestions of the muse are often most propitious: Cowper seems to hint that no inconsiderable portion of his beautiful poem, the Task, was composed during the listless musings that attend a single person, when he has taken his solitary seat by an evening fire. To these we might perhaps add the circumstances, which Bacon, in the first, third and fourth instances of what he calls idola tribus, enumerates as prejudicial to the interests of philosophy.

If we should now proceed to examine all those less important differences that arise from the peculiar modes of philosophical and polite composition, it would not only extend this essay to an improper length, but perhaps subject the writer to the necessity of intruding himself into ground already pre-occupied by formal treatises on the subject. Unequal as he is to enter on questions of delicate criticism, and too conscious of his own inability to venture into a competition with others of character deservedly high, he has retrenched several parts that might be claimed as their exclusive property. And where the subject is of long continuance, and almost invites discussion from its nature, it is almost impossible to advance any thing valuable or important without incurring the danger of repetition. Thus an objection has been urged by Locke, and renewed with redoubled force by Warburton, that all figurative language is an abuse of words, that whatever exceeds the strict bounds of logical and metaphysical accuracy is arbitrary and capricious, and therefore to be avoided as a vice, particularly in philosophical and serious composition. This opinion they both seem to have formed from a mistake of a censure passed by Lord Bacon, on the old philosophers, for ornamenting their pieces with the graces and elegances of rhetoric. " Auctoribus ipsis suspecta," says he, " ideoque artificiis quibusdam munita fecere. But this is not meant as a reprehension of an ornamented style in general, but founded solely on the imperfect state of science among them; for so artful and ingenious was their method of treating their subjects, that they succeeded in deceiving the world into an opinion, that every science, which had received the polish of their hands, was cultivated to the utmost possible degree of perfection. The charge itself has been ably refuted by Dr. Leland, in his Essay on Eloquence, and to mention any thing here on the subject would be only to transcribe his ingenious work. And though modern philosophers appear in general to neglect the beauty of their language, or elegance in arranging the parts of the question they consider, yet we have a sufficient number to serve as instances how much might be done in this way. In metaphysics the style and the matter of Stewart are equally topics for praise and admiration; and the fragment of the Latin imitation of Locke, by Mr. Gray, shews of what an exquisite degree of poetical beauty the subject is susceptible. The lectures of Davy will be long remembered in this city for their eloquence and perspicuity, and the Anti-Lucretius of Polignac abounds in harmonious lines and happy expressions, though occasionally it deserves the censure of Voltaire for the use of terms technically scientific.

Such are the opinions that have suggested themselves to the author of this little essay on the question proposed by the academy: he has purposely contracted it, in some places, for the reasons mentioned above, and in others, the pressure of ill health, and the necessary avocations of a more extended and difficult pursuit have prevented him from paying that attention, which the importance of the topic required. Imperfect as it is, he would not have ventured to obtrude himself on the notice of the academy, were he not confident that they would be disposed to look with indulgence, on even a feeble endeavour to point out some of the advantages resulting from a combination of those studies, which have been jointly and equally cherished in this country by their fostering care. They have generously and successfully undertaken the erection of a temple to learning, where the strength and solidity of science is combined with the light and graceful elegance of polite literature, and cannot therefore be displeased at the officiousness of him, who would wish "to * partake in the work, though not in the inscription, content to assist in the preparation of that cement, which is intended to unite the various and diversified materials employed in the construction of the edifice itself."

ACADEMICUS.

* Lucian Συγγραφειν.

ESSAY

ON THE

INFLUENCE OF FICTITIOUS HISTORY

ON

MODERN MANNERS.

" Of power to cheat the eye with blear illusion,
And give it false presentments . . . . .
I, under fair pretence of friendly ends,
And well placed words of glozing courtesy,
Baited with reasons not unplausible,
Wind me into the easy-hearted man,
And hug him into snares. MILTON'S COMUS.

AT a period when so many works of imagination issue from the press every, day giving birth to some new fiction, it appears particularly seasonable, that a question, relative to the influence such productions may have on the manners of the present age, should be instituted by an academy, whose object has ever been the investigation of truth, and the advancement of science; and at the same time that I presume to offer my sentiments upon the subject proposed, to the notice of the academy, I would bespeak its indulgence—that "χαρις μικροισι," which only the wise, and the learned, are capable of affording.

The power which fiction, from the remotest antiquity, has usurped over the human mind, must be evident even to him who is but little acquainted with the history of mankind—but accurately to ascertain *how much* is to be ascribed to *it*, rather than to other co-existent and powerful causes, is a task that involves in it considerable difficulty, a difficulty that will be found to apply even to those times, when the influence of fiction must have been most felt; when it was sought for with the greatest avidity, and received with the most universal delight.

Before I enter on the more immediate subject of this essay, which relates merely to modern times, it will be agreeable, and I hope, will not be considered unnecessary, to take a brief view of the origin of fiction, and of its influence upon the manners and morals of the Greeks and Romans; should it be thought that, in so doing, I depart somewhat from the subject proposed, I desire to shield myself under the authority of Dr. Johnson, who says, "To judge rightly of the *present*, we must oppose it to the *past*, for all judgment is comparative." *

* Rasselas.

In the early heroic times, the warrior was accustomed to be roused by the songs of the bards, which reminded him of the heroic actions of his ancestors, and which, set to music, were impressed upon his memory, and were continually on his lips, whether he joined the choruses of his countrymen, or was in secret stimulated by them to deeds of fame. Thus Homer has introduced Achilles, sitting on the shore, and singing to his lyre.

> " Τὸν δ' εὗρον φρενα τερπόμενον φορμιγγι λιγείη,
> Καλη, δαιδαλέη, επι δ'ἀργύρεος ζυγος ηεν
> Τὴν ἄρετ' ἐξ ενάρων, πτολιν Ἠετιωνος ὀλέσσας·
> Τη ὅγε θυμὸν ετερπεν, αειδε δ'ἄρα κλέα ανδρῶν." IL. IX.

And in a later age, we find Tyrtæus animating the Spartans, and leading them to battle, by the divine influence of his poetry, in which he sung the renown of ancient warriors, and set before them the rewards of valour; victory, and its attendants, glory and honour. We also find Solon employing the same means to excite the Athenians to make war upon the Megareans; a subject, the bare mention of which, in sober prose, and stripped of the embellishments of fiction, would have incurred the penalty of death.

But the poets, as they proceeded to study nature more intimately, and to seek the most powerful causes of things, finding that the relation of human actions merely, however illustrious, was insufficient for their purpose, sought the intervention of supernatural agency. Men of such a profession as theirs had little to do with the reason and sober judgment of their hearers. The imagination, and the passions, were to be wrought upon, for " there is something in the mind of man, sublime and elevated, which prompts it to overlook all obvious and familiar appearance, and to feign to itself, other, and more extraordinary." * Accordingly, the actions of several persons are attributed to *one*, and those actions adorned with every circumstance that could make them interesting, or excite to emulation; and that the glory resulting from them might never be forgotten, or their benefits lost to mankind, the hero that achieved them is exalted into the assembly of the divinities, to watch over his favoured votaries; to infuse into their hearts his undaunted spirit, and to give strength and energy to their bodies. It cannot be doubted that to the fictions of the poets may be ascribed, in a great degree, the undaunted, and warlike spirit of the first ages.

Equally striking are the effects of those fictions upon their morals. The poets, ignorant of the true God, and of the Unity of the Divine perfections, divided amongst a number of separate beings, what they imagined were attributes of deity; † and in the creation of such imaginary beings, hav-

* Hurd's Dissertations.

† The Pelasgians (according to Herodotus,) sacrificed and prayed to gods to whom they gave no name, or distinguishing appellation, it was therefore the poets that introduced the belief of those numerous deities, and their names.

MITFORD's Grecian History, vol. i. p. 88.

ing no other standard to direct their fancies, were obliged to enlarge the idea of some human creature, and at the same time that they magnified his virtues, could not avoid magnifying also his vices. Hence, we are presented with the most disgusting representations of every kind of vice in the actions of the heathen divinities. It is not the furies with their snakes, or the abominable harpies that excite our abhorrence; no, it is the great God, that wields the thunder-bolt, and at whose nod the earth trembles! when we behold him, exerting his omnipotence for the purpose of gratifying the most disgraceful passions, and for the perpetration of the most shocking crimes;—it is the goddess of beauty, whose magical charms awaken love and admiration in the bosoms of gods and men; when we behold her, instead of presenting those modest charms, and that chaste deportment, which give to beauty its highest perfection, displaying the wanton and indelicate manners of an abandoned courtesan. We may learn from a passage in Terence, how great encouragement to dissoluteness those fictions were, in which was depicted the immoral conduct of the gods: for we find a young man declaring with what greater willingness he was induced to commit a crime, when accidentally reminded, that he was authorised by the example of the great God himself.

"At quem Deum? qui templa cœli summa sonitu concutit.
Ego homuncio hoc non facerem? ego illud vero ita feci, ac lubens."

The scenes that were exhibited in the temples at the celebration of some of the festivals, and the orgies of Bacchus, are instances of the same kind, that cannot be thought of without horror.

It is remarkable that the Roman people were eminent for their virtue and chastity, until the time that Greece was subdued by their arms. Five hundred years had elapsed, from the foundation of their city, before a divorce was known at Rome; but as soon as this event took place, which was about the time the Romans began to have intercourse with the Greeks, the change in their manners is apparent, and this change may be very well referred, at least in a considerable degree, to the introduction of the fictions of the Grecian Mythology, so that in this respect, as much as in the arts, may it be said, " Græcia capta ferum victorem cepit."

Those law-givers, who annexed such severe punishments to the breach of the conjugal vow, certainly adopted at the same time the most effectual method of preventing it, by erecting temples to chastity. Agreeably to this, we find Numa, in order to make his people honest, transforming Bona Fides into a goddess, and building a temple to her worship; and perhaps it was owing to the want of such a device, in the Grecian law-givers, that Greek knavery forms such a contrast to Roman honesty; and if we enquire into the causes that made the Romans excel every other nation in the art and practice of war, we cannot avoid ascribing much importance to the belief, that they were the children of Mars, and under his peculiar protection.

With respect to prose compositions, that rank under the class of fiction, there is reason to think that, generally speaking, they were unknown to the Greeks and Romans; however, we hear of the Milesian, Ionian, and Sybaritic Tales, and although they have perished, we know them to have been of a licentious and immoral nature; we know also, that these people were remarkable for effeminacy and immorality above all the other inhabitants of Greece or Italy. There is therefore *here* presumptive evidence, that their manners and morals were much influenced by fictitious writings, and vice versâ.

That the fictions of the poets contributed very much to that taste and refinement which characterised the Greeks more than any people that ever existed, cannot, I think, be denied, especially when we consider that it is only in proportion to his acquaintance with the writings in which these fictions are found, that we are accustomed to give any man the reputation of a refined and elegant scholar. It must be admitted that there were other causes beside these, for the superior elegance of the Greeks, but nothing could be devised more likely to produce it, than the machinery of the poets. In a rich and beautiful country, on which nature had profusely lavished her charms, it was impossible to turn where some poetical fancy was not presented to the mind: every meadow, and every grove abounded in its satyrs, and hamadryads, and every fountain and river had its appropriate nymph or deity; a rosy-fingered goddess unbarred every morning the gates of the east, and they were closed in the evening by another more sombre, but not less interesting deity; in short, no spot could be visited, that was incapable of presenting to the view the most attractive and exquisite imagery.*

But the Greeks, as is always the case, with their independance, lost also their mental superiority among the nations, and their genius and energies were left buried among the ruins of their country.

If we again turn our eyes toward Italy, we shall find that the subjugation of the Greeks changed as well the manners, as the morals, of their conquerors. The rough and brutal manners of the old Roman were, by degrees, lost in the refinement and elegance of the Greek. The Grecian writers exclusively occupied the attention of the Roman student, and their greatest geniuses aspired only to the glory of imitating them. For several ages, the Latin language had been adopted by the learned in every nation of Europe; but it was destined to undergo the fate of the Greek. About the beginning of the eighth century, the Arabians entering Spain, and establishing the seat of their empire at Cordova, changed the language of the country.

* See L'Introduction au Voyage du Jeune Anacharsis.

This period, the darkest of the European annals, was the time when Arabian literature was in its most flourishing state.

"The Saracens," (to use the words of Mr. Gibbon,) confident in the riches of their native tongue, and disdaining the study of any foreign idiom, deprived themselves of the principal benefit of a familiar intercourse with Greece and Rome, the knowledge of antiquity, purity of taste, and freedom of thought; so that there is no example of a poet, orator, or even historian, being taught to speak the language of the Saracens. Cordova, with a few adjacent towns, gave birth to more than three hundred writers, and a library was formed, that consisted of 600,000 volumes."* The effect of all this on the Europeans was what might have been with reason expected. A manuscript cited by Du Cange acquaints us, that the Spaniards, soon after the irruption of the Saracens, neglected the study of Latin, and captivated by the novelty of the oriental tales imported by the Saracens, suddenly adopted a pomp of stile, and an affected elevation of diction; and the ideal tales of these eastern invaders, recommended by a brilliancy of description, a variety of imagery and an exuberance of invention, were eagerly caught up, and universally diffused.† These tales passed over from Spain into France and Italy, and from thence to the north: and when the Europeans afterwards flocked in such numbers

* Roman Empire, vol. x.

† Warton's first Dissertation, Hist. English Poetry, vol. i.

around the standard of the cross, and "legions of poets" accompanied the armies to the Holy Land, religion and superstition, with their saints and dæmons, in those heterogeneous compositions, were engrafted with the eastern ideas of magic and dragons, and in course of time with the Gothic ideas of female excellence, and phantastic honour—to which may be added, the ideas of magnificence derived also from the east, the vast distance from whence, gave the greater force and credibility to their fictions.

Thus we find the Arabians uniting with the Scandinavians in forming a new and irregular species of composition, which was to be as various in its effects, as the characters and manners of the nations it embraced; and if, in taking this retrospect, we find that the purity of style, and delicacy of taste of the classic authors was thus for a season entirely lost, we shall have less reason to regret it when we reflect that a too servile imitation of those exquisite models, had they been more diffused, might have fettered genius, and restrained the sublime flights of untutored imagination; we may even presume that the empire of literature has on this account been extended and enlarged. *

* Mr. Warton very ingeniously reconciles his own hypothesis, namely, that the Arabians were the authors of romantic fiction in Europe, with that of the Bishop of Dromore, who derives it from the ancient songs of the Gothic bards and scalds; and with the testimony of Mons. Mallet, the Danish historian, who is of the same opinion. Mr. Warton brings forward many proofs of the eastern origin of some of the Scandinavian tribes: first, that they are said to have emigrated with their leader Odin, imme-

Having, as briefly as possible, considered the effects of fiction in general, upon the manners of the ancient Greeks and Romans; I come now to more modern times, and to enquire what influence is to be ascribed to those particular productions which rank under the denomination of romances and novels. I have already glanced at their origin, which is plainly oriental.

The term romance has been traced by Monsieur Huet to the Provençal Troubadours, who composed their songs in a language that was a mixture of Latin and Gallic, and on this account called romanz or romance; but although the bishop wrote expressly on the origin of that particular species of composition, to which they give the name, he has entirely relinquished the most important part of his subject (which would have been the romances of chivalry) contenting himself with giving a dry detail of the poems of the Provençal Troubadours, to which the others have hardly any other relation, than similarity of name.* From Mons. Huet, we obtain

diately after the overthrow of Mithridates, from the region of Asia, now called Georgia, and to have settled in Norway and Denmark: And secondly, the remarkable, and conspicuous similarity between many of the customs of the Asiatics, of the Georgians in particular, and those of the inhabitants of the north, even at this day.

WARTON'S Hist. of English Poetry, vol. i.

* Mr. Warton is of opinion, that there were two sorts of French troubadours, that are not sufficiently distinguished: that the poetry of the first consisted of satires, moral fables, allegories, and sentimental sonnets; and that the latter class composed metrical romances, which formed a distinct species, and ought to be considered sepa-

little else than a list of these poems, and the names of some Greek authors, who flourished in the decline of the Roman Empire, amongst whom the most remarkable is Heliodorus, Bishop of Trica, who was deprived of his bishopric, for being the author of Theagenes and Chariclea, which was then supposed to have baneful effects upon the manners of youth, though it is not at present considered as having such a tendency.

The earliest specimens we have of romance, as it existed for a long period in Europe, are the histories of Arthur and Charlemagne, compiled, as is supposed, from ancient legends, by Geoffry of Monmouth, and Turpin, the monk, in the eleventh century, though some imagine them to be as old as the eighth. The high veneration in which these histories were held, and the enthusiasm which a bare recital of them was calculated in particular circumstances to produce, is demonstrated by a fact recorded in our own annals of the Minstrel Taillifer, who, at the battle of Hastings, advanced before William's army, singing the songs of Charlemagne and Roland.

These histories gave birth to innumerable others, but it was chivalry, and the croisades, that afforded the most abundant materials and encouragement to fictitious history.

rately; they seem to have commenced at a later period, and not until after the croisades had effected a great change in the manners and ideas of the western world.

Hist. English Poetry.

The institution of chivalry was founded originally in principles of humanity and justice. When the different kingdoms of Europe were broken and divided into several smaller states; and when the weakness of the law had enabled the more powerful baron, without any risk to himself, to do violence to those whom age, profession, or sex, had rendered incapable of resisting him;—some kind of protection was required, more ready in its application, and more permanent in its effects, than what could be derived from the casual exertions of a neighbouring chieftain, however virtuous, or however courageous.

To redress some of the grievances that would naturally arise from such a state of society, was the object of the institution; an object worthy of admiration! nor can we avoid attributing a considerable degree of ingenuity to a scheme that was calculated to keep alive the martial spirit of the times, (which was then of the highest importance,) by the exercise of virtues, in all other cases so incompatible with it. For it was not merely the martial spirit that was cherished by this means; "Les preceptes," says Mons. de la Curne de Ste. Palaye, * "renfermès dans le serment de la Chevalerie, sont le germe de toute la morale repandue dans les Ouvrages de nos Poëtes, et de nos Romanciers:" And by paying some regard to those circumstances, we shall be tolerably well able to estimate the reciprocal importance of chivalry and ro-

* Memoires de l'Academie des Inscriptions, &c, Tom. xx.

mance. Chivalry was certainly the parent of romance; but the refinement and sentiments then new to the European world, which the institution of chivalry introduced, must have been necessarily confined to courts, and to the higher orders, for a much longer period than was actually the case, had not romance, in a manner, multiplied the number of knights, and presented as in a mirror, to all classes of society, the resemblance of what was acting in courts, and in camps, heightened generally by the enthusiasm of unfettered genius. The fact that it was to the old romances we are indebted for the most perfect information which has been afforded to us on the subject of chivalry, by Mons. de Ste. Palaye, who acknowledges that he derived it from them, is sufficient to make us view those productions in a light much less ridiculous than we have been accustomed to do; in the same manner as the exhibition of a lady and gentleman dressed according to the costume of those times would be highly interesting, notwithstanding the smile they might excite.

The truth and reality of the representations of the romance writers is also proved by a curious document preserved by Montfaucon,* which informs us that many of the romances of the fourteenth century owed their origin to a register which every knight was obliged to make of his yearly adventures, and to place in some castle: nor is this proof invalidated by

* Monumens de la Monarchie Française.

the enchanters, dragons, and other absurdities that were intermingled with the adventures; it is rather confirmed by them, as such was the popular belief of the times. In another point of view, the early romances must be considered important; they were the first productions written in the vernacular tongue, and were what first made learning popular. The Provençal writers led the way, by writing in a language intelligible to the ladies and common people: It was from them Dante formed his idea of writing his Inferno in Italian, and not, as he had originally intended, in Latin: To which circumstance may be traced the perfection of the Italian and of the other European languages.

Candour thus obliges us to regard the romances, as favourable to the progress of literature; at the same time it must be admitted, that they were made use of by the monks, the authors of most of them, to cherish a spirit of superstition and fanaticism, very inimical to it. Mons. de Ste. Palaye, further informs us that the object of the writers of romances was to excite to emulation; and had they been actuated by a spirit of genuine christianity, we might have seen the most beneficial consequences resulting from their influence;—but in all their compositions there was such a mixture of profaneness and immorality with religion, as could not fail of having the most injurious tendency: They inculcated beside, the ridiculous punctilio of defending women, even on occasions the most dishonourable—We must therefore differ from a learned and judicious critic, * who considers those romances as compositions of the "truly moral and heroic kind;" had this been the case, they would not surely have excited the complaints, invectives, and sermons of the most excellent and zealous men in Europe. Beside, if we consider the grossness of the manners of those times, it is highly improbable that such writings would have been so eagerly caught up, and so universally admired, had they not been accommodated to the depraved taste of the readers. †

I might have thought it necessary, perhaps, to give further proofs of the dangerous consequences resulting from the old romances, and of the power which they possessed over the minds of persons of all descriptions, had not the great Cervantes, in his admirable Don Quixotte, exhausted every thing that could, or need, be said upon the subject; and demonstrated, by the success of his work, that no other mode of attack, than that which he adopted, would have been attended with equal success. It is remarkable that Cervantes had been anticipated by Chaucer, in his attempt to ridicule these productions, and also, in his manner of doing so. I shall be excused for quoting a passage from the Letters of Bishop Hurd, in which he makes us acquainted with the motives that induced our venerable poet to compose a Tale (the Rhyme of Sir Thopas,) at a period, when the manners of romance were almost realised. "We are to observe," says his lordship, "that this is Chaucer's own Tale, and that

* Dr. Blair. † Don. G. Mayan's Life of Cervantes.

in the progress of it, the good sense of the host is made to break in upon him, and interrupt him. Chaucer approves his disgust, and changing his note, tells the simple tale of Meliboeus, *a moral tale, vertuous*, as he terms it, to shew what sort of fictions were most expressive of real life, and most proper to be put into the hands of the people. It is further to be noted, that the *Boke* of the Giant Oliphant, and Chyle, Thopas, was not a fiction of his own, but a story of antique frame, and very celebrated in the days of chivalry: so that nothing could better suit the author's design of discrediting the old romances, than the choice of this venerable legend, for the vehicle of his satire upon them." He adds, "the ridicule Chaucer bestowed upon them, hastened the fall of both chivalry and romance." *

The character, which truth has made it necessary to give of the old romances, will not apply to the more modern ones of Sir Philip Sidney, &c. &c. and of "Scudery dont la fertile plume, peut tous les mois sans peine, enfanter un volume." † They, however, revived the "*Old Court of Love*," and the mode of spiritualising and abstracting the passion, which had such an effect upon the manners of the French people, as has never been effaced; and if we consider the character, with regard to love, of a nation which was so very much engrossed with those subjects; ‡ we must conclude that their tendency is very unfavourable to virtue.

* Hurd's Letters on Chivalry and Romance. † Boileau.

‡ L'Academie Française traita dans ces premieres seances plusieurs sujets qui concernoient l'amour, l'on vit encore dans l'hotel de Longueville, les personnes les plus qua-

Though the form that fictitious writing has assumed within the last century, is doubtless of a very different kind from all that we have hitherto been considering, and though several causes now unite to prevent romances and novels from being so influential on manners, as in the infancy of society;—yet, when we reflect that they are in the hands of every one, without distinction of age, sex, or condition, we can scarcely avoid attributing to them a considerable degree of importance. We observe that people generally catch the manners of those they associate with; that the artisan is distinguishable from the man of fashion; and the scholar, from both—such are the effects of different associations: from the general laws of which it is not to be expected that the readers of fictitious history should be exempted: the manners of these, no doubt, are influenced by those of the imaginary society they keep, and with which they are delighted. It remains for me to seek out, if possible, how far this influence extends.

Two causes combine to diminish the influence of fictitious history: first, the present advanced state of civilisation; and, secondly, the sort of writing now denominated fictitious. With regard to the first, it is pretty certain that fiction, properly so called, can only be conceived to operate powerfully

lifiés et les plus spirituelles du siecle de Louis quatorze se disputer a qui commenteroit et raffineroit le mieux sur la delicatesse du coeur, et des sentimens, a qui feroit sur ce chapitre, les distinctions les plus subtiles.

Memoires de l'Academie des Inscriptions, Tom. xx.

upon an unenlightened, and unpolished people; and that of course, the most effectual remedy to oppose to it, is cultivation and refinement: in these the last century, has witnessed extraordinary advances, of which we need no greater proof, than the encreasing discredit into which superstitious stories have fallen; our mothers, and our aunts may remember when cows were elf-struck, and when the sudden appearance of a witch or ghost was dreaded on every occasion, but such notions make no part of the present vulgar creed; they have been buried with the dead, and would never again, perhaps, have been summoned up to light, were it not for the Gothic propensity of some of our modern writers, to rake up all the antiquated stuff of the darkest ages, as if they thought it a pity it should sink into oblivion.

A high state of civilisation is a preventive of the power of fiction, in another respect also. Commerce, and much intercourse with the world, will, by degrees, efface those strong and marked characters, by which, nations, at various periods are distinguished; and the existence of which, is essentially necessary, in order that a particular cause may act with the greatest possible energy. Thus, the spirit of war, combined with that of gallantry, formed the distinguishing features of the middle ages; whence, it is easy to be conceived, that at this period, the reading of romances would greatly inflame those passions, which we know to have been the fact; but, as an attempt to pourtray the character of the present times would be difficult indeed, so, it would be equally difficult to conceive how any new effect could be wrought upon Europeans, by means of fiction, unless we might perhaps except the Spanish nation, which has been so recently converted by one species of fiction, from the absurdities introduced by another; taking also into account, the prejudice and ignorance which the policy of the Inquisition has obliged them to retain. With regard to the French, we know they have been always remarkable for their politeness and gallantry; we know also, that it was by the French, the romantic mode of fabling had been earliest and most cultivated; that it never was lost from among them; and that they continued superior to all other nations in that deparment of literature. Their constant reading of this kind of books is sufficient to account for that extraordinary attachment and devotedness to the fair sex, for which Frenchmen have been remarkable, beyond their neighbours, and which continued to the time of the revolution; since that period, French manners form a striking contrast to what they formerly were, and we have reason to suppose, that as the manners have been in some degree changed, so has their fondness for those compositions, by which they were cherished.

The same observation holds, with regard to individuals. Cultivation, improvement, and a desire for truth, will proportionably diminish the effects of fictitious writing. When the mind has been previously enlarged and invigorated by being exercised with truth, and by habits of thinking and judging, the illusions of fancy may amuse for a moment, they may even sometimes transport, but they can gain no ascendency. It is therefore for the *young* and *inexperienced*, for the *ignorant* and the *idle*, that we are interested in the present enquiry. Nor is it so much to the higher classes of society that we are to look for the ill effects of fictitious history—as it cannot be supposed that much additional injury can be sustained by persons who read of follies, dissipation, or vices, with which they are perpetually conversant. It is the middle and lower classes that suffer most by publications, through the medium of which, they are introduced to manners they would otherwise have remained strangers to. If it were not for the circulating libraries of the neighbouring towns; the daughters of farmers might remain contented and happy in the humble circle of domestic enjoyment, which Providence had allotted them; but the comparison they are taught to make between their own homely occupations, and the brilliant glare of fashion's fascinating pursuits, frequently leads to the most lamentable consequences, which every day's experience too sadly proves. Hence—deluded by the seducer, who held out the hope of treading those paths which fancy had learned to delight in—the simple girl, after having forsaken her aged parents and her home, finds every thing too true that she had anticipated in the scenes of dissipation, except the ideal happiness supposed to be inseparably connected with them. Another cause which diminishes the influence of fictitious histories in the present day is, that the *number* of them is really considerably less now than formerly—for the term, "fictitious," can scarcely, with propriety of speech, be applied to novels: "To catch the manners, living, as they rise," seems to be the principal aim of the novelist: and—though they may be productive (if I may use the expression) of fictitious consequences, by teaching the young to assume characters not their own—yet portraits of vice, or of virtue, merely, however highly coloured, can hardly be deemed fictitious, and such must the characters drawn in novels be considered; all of them—the faultless, or the "monstrum non una virtute redemptum" excepted—having their archetypes in real life. In order then, to estimate aright the consequences arising from the universal avidity with which the innumerable swarms of novels are read, that have already issued, and are daily issuing from all the presses of Europe, we should regard them, not in the light of fictions, which, by giving false views of things, might unfit the inexperienced mind for the sober business of life, or hurry it into the vagaries of romantic enthusiasm; but of being *too faithful* transcripts of all the follies and vices of a luxurious and corrupted age; and the medium for conveying to the unwary minds, the poison of infidelity, and of contempt for whatever is truly estimable in religion or morals.

From the very extensive circulation which novels are known to have, some persons of great talents and virtue have been of opinion that they might be made of infinite use; and some have, even themselves condescended to become novel writers;

but, as their object was more to instruct than to please, or rather to make the latter entirely subservient to the former, their works are not read, or at most are only read by people of taste and information. Such is the fate of Johnson's Rasselas, and of Guadentio di Lucca, a work ascribed to one of the most illustrious philosophers;* nor will this appear surprising, when we consider that the readers of novels are usually the most illiterate part of the community. It is not to be denied that such a form of writing might be made the vehicle of wholesome moral instruction, which to a certain class of readers would not perhaps be unpalatable: but to suppose that any extensive benefit would follow from such a plan is to attribute to the generality of readers, a talent for selection and discrimination, that exclusively belongs to cultivated intellect.

It is not enough, that a novel abounds in moral sentiments; the whole story should be so constituted, as to convey an important lesson: but if every page have introduced us into the company of vicious characters; if we have been induced, in our progress through the book, to smile at vice, or to sympathise with the feelings of the libertine—can the useful moral thrown into the *last page*, or into the *last line* be able to obliterate the bad impressions of all that went before? unquestionably not.—In order, therefore, to make novels useful, care should be taken to mark vice and folly with abhorrence and contempt, and to paint with all the clearness of which language is susceptible, the disgrace and

* Bishop Berkeley.

infamy that should ever be represented as inseparable from immorality and vice—so clearly, that the most careless reader could not avoid seeing the connection. If such a rule is necessary, in order to make novels a medium of usefulness to the community, what must be the consequence, when that rule is always inverted?—which, with very few exceptions, we know to be the fact. The truth is, that emolument is the chief object about which novel writers are concerned. If this result from their works, every wish is fully gratified, and every end which had been proposed, attained.

I have, indeed, supposed it possible, that novels might be made productive of beneficial effects: but to multiply them, in the hope of such a result, I am fully of opinion, would prove a Utopian scheme; for * when the mind is much habituated to, or much conversant with fiction, however innocent or moral, it is unfitted for the reception of *historic truth*; in this exercise, the imagination alone is employed, whilst the mind or reasoning faculty remains perfectly inactive and useless.

Though it is pretty obvious that most of the evils that ensue from the constant reading of fictitious history, apply to the female, rather than to the male sex, yet, if it can ap-

* This reason will equally apply to the methods which have been latterly adopted in order to *cheat* the rising generation into learning, which is to be effected, according to the modern plan, by means of fictitious histories, which have been multiplied to an amount, which must be alarming to those that are really interested for true learning and science.

pear, that from the same source, the heart may be corrupted, the principles undermined, or the imagination defiled, then they apply equally to both sexes. Women, however, seem to be especially interested in the present enquiry, because they are more generally devoted to novel reading, than men; and because their habits of life, and education, instead of being calculated to correct the defects of a more flexible temperament, seem as if they were intended to encourage them. Hence, imagination, which, if properly regulated, would be a very great source of pleasure, becomes rather productive of misery and misfortune; and, of all the means that were ever invented, in order to strengthen the imagination, in opposition to the reasoning faculty, to weaken or destroy the moral as well as the intellectual sense, and to engender all the innumerable evils that must follow of course, novels have been most successful.

This leads me to endeavour to seek out *some* of the reasons which may be assigned in proof of the foregoing assertion. To unfold *all* their consequences, would require, indeed,

"A master's hand, and prophet's fire!"

For greater clearness, modern novels may be divided into the two classes of *humourous*, and *sentimental*. The former generally exhibit human nature in its degraded state; they attempt to paint the worst feelings of the human heart; to introduce the reader to the dregs of society, and into every haunt of vice. By means of these, the young man—" cereus in vitium flecti," before he has yet left the paternal mansion, is fully initiated into the manners and language of hostlers, rakes, bullies, gaming tables, &c. &c.—in short, he is made to "see with the eyes" of Fielding and Smollet, many things which his own shallow observation would never perhaps have noted. The parting advice, and warning voice of affectionate parents, cannot be supposed to produce any great effects upon one who has already learned, that vice is not, either in *itself*, or its *consequences*, what their prejudices have taught them to believe: on the contrary, he is *certain* that a man's being a spendthrift, a gamester, and a debauchee, does not prevent him from being well received in society, or from obtaining the beauteous and virtuous object of his affections, and he is prepared to regard sedate manners, and cautious conduct, only as the mask which is to conceal the hypocrisy and villainy of a *Blifil*.

Every candid person must acknowledge, that this is the view of things presented by the perusal of Tom Jones; which, as it unquestionably holds the highest place amongst this species of composition, is not improperly noticed here.

The biographer of Fielding, in his observations upon that author's principal work, in the few words which he uses to describe the character of the hero, happens to point out the moral of the book, as plainly, as if he had done so intentionally. "Tom Jones," says he, "as much a libertine as he is, engages all *sensible hearts*, by his *candour*, *generosity*, *humanity*, his *gratitude* to his benefactor, his *tender compas-*

sion, and readiness to relieve the distressed." * So then, according to this writer, true libertinism is a *term* which may comprehend in it the virtues " generosity, candour, humanity, gratitude, tender compassion," &c. &c. or at least, not exclude them. This is new logic, but certainly not what Mr. Locke, or any of his disciples would countenance. It is, however, the *logic of libertinism*, and may serve to shew us the advances which the modern writers have made in the subject of Ethics. But to be serious;—is it possible that on the least reflection, any one can think that the virtues ascribed to Tom Jones could belong to, or be at all compatible with his character? I will not suppose that one " *sensible heart*" will reply to this question in the affirmative, and therefore do not hesitate to declare positively, that they *cannot?* but in doing so, I still adhere to the old-fashioned interpretation of words and things: for instance,—I consider with *Johnson*, a libertine to be " a man who lives without restraint or law, who pays no regard to the precepts of religion;" I consider libertinism and irreligion to be so closely allied, as to regard them nearly as synonymous terms; and therefore, cannot comprehend the meaning of the "*humanity*," that is exercised in degrading and ruining that sex, of which man should be the protector and guardian; or of the " *generosity*" that " robs of that which not enriches *him*, but makes *her* poor indeed." All the other virtues, supposed not to be

* See last edition of Fielding's works, vol. i. p. 101.

excluded from meaning of the term *libertinism*, might in the same manner be shewn to be equally incompatible with it: but perhaps it is sufficient to ask in the words of the gospel, "do men gather grapes of thorns, or figs of thistles? A good tree cannot bring forth evil fruit; neither can a corrupt tree bring forth good fruit."

On the other hand, to introduce profligate characters, for the purpose of exposing them to shame and ridicule, is a dangerous experiment. As Swift's "directions to servants" are said to have spoiled more good servants than corrected bad ones, by teaching tricks, which otherwise would not have been thought of; so, the high-coloured pictures of vice and folly drawn in novels, leave on the inexperienced mind, such copies of their reality, as the good moral of the work is but ill calculated to efface.

It is rather a curious circumstance, and worthy to be noted, that notwithstanding the manifest evil tendency of the novels of Fielding, he professes most solemnly, that "to recommend goodness, and innocence, has been his sincere desire," and he "hopes that nothing will be found in the whole course of his work, prejudicial to the cause of virtue and religion, nothing inconsistent with the strictest rules of decency, or which can offend the chastest eye on the perusal." In these his *pious desires*, as well as in the method he adopted to put them into execution, he has been followed universally by the multitude of novel writers who have succeeded him, from Marmontel, to G. M. Lewis, author of the Monk,* and who, although they have fallen infinitely short of him in genius and talents, have certainly much surpassed him in the method of conveying sentiments of virtue and religion to inexperienced minds!

Before I take my leave of this class, I cannot help expressing some regret, that the species of fictitious history, which, as it has been employed by Cervantes, appears to be the safest, or least injurious method of entertaining by fiction, has been almost entirely occupied by writers of the basest principles, and loosest morals. For in other hands we have sometimes seen that humour may possibly be accompanied by decency and morality; that relaxation, if necessary, may be afforded to the mind, without causing debility, and amusement without depravity; and that the fancy may be delighted, without any dangerous lesson being conveyed to the heart.

In entering upon that part of the subject, which involves the consideration of sentimental novels, I am so impressed with the conviction of the numerous evils that result from them, that I am led to say, in the words of Tasso, to those who have as yet escaped from their dangerous influence,

> " Guarda, che mal fato,
> O giuvenal vaghezza, non ti meni
> Al magazino de le ciancie, ah fuggi!
> Fuggi quel' incantato allogiamento.
> Quivi habitan le Maghe, che incantando
> Far traveder; e traudir ciascuno."

* See particularly in proof of this, " Pursuits of Literature;" Dial. iv, p. 240.

To place every thing that is important in a wrong point of view; to corrupt the taste, and undermine the morals, is the business of these *enchanters*, in which, under pretence of doing the reverse, they have been, unhappily, most successful. At first sight indeed, it is not easy to discover, that false views of life and manners are presented, when the professed object is to paint them with accuracy; that the taste can be corrupted by writers versed in polite literature, and who all aim at expressing their thoughts in language the most pathetic or sublime; or that the morals can be undermined by not only cherishing the tender and sentimental affections, but working them up to a degree of the most exquisite sensibility.—Paradoxical as all this may appear to some, it is nevertheless true, nor can any solitary instance which may be adduced to prove the contrary, weaken the evidence of countless multitudes. Even Richardson himself, who was more anxious to inculcate principles of morality than most of his imitators, might plead guilty to this indictment; for in Clarissa, and Pamela, he has not only placed his principal characters in situations the most improbable, and unnatural, but in doing so, has unfolded scenes, totally inconsistent with morality, or even with common decency; and has given such a degree of importance to vice, by making it the whole aim and occupation of his male characters—the business in which ingenuity, talents, and money are all employed and consumed as can hardly fail to make an impression upon youthful fancies, unfavourable to virtue. In the love of

Pamela for the abandoned seducer, there is something greatly repugnant to delicacy, besides its being a precedent, which in some degree authorises a virtuous young woman to hold a parley with a seducer, an incident which has been greatly improved upon in the more modern novels.

But after all those objections, and many more that might be urged, perhaps there is more danger to be comprehended from many writers, who have taken care to avoid all appearance of grossness, or indelicacy, but who, (in the words of an excellent writer) * "have made the least refined affections of humanity lose their indelicate nature in the eyes of many, when dignified by the epithet of *sentimental*, and have made a softened appellation give a gracefulness to moral deformity."

There is not any more natural way of accounting for the greatly increased multiplication of those *trials* that are the disgrace of our daily newspapers, than the light manner in which the breach of the seventh commandment is treated in novels; considered in this point of view, the *Julies*, and *Delphines* of Frances, have greatly afforded to the moralist subjects for animadversion: and even one of our own country women has thought proper to make the hero of her tale, (who is the person for whose feelings, and affections, the young, the tender, and perhaps the virtuous, are to be interested, and to sympathise with,) guilty of a *crime*, in

* Vicesimus Knox.

many countries subject to the punishment of a cruel death, and which is, in *all*, attended with infamy.

Since then, a novel is *the only place*, where the violator of the most sacred laws of God, and of his country, can boast of his deeds in levity of language and jocularity of spirit, and where his father, whilst he mildly blames him for what he would term indiscretions, can remind him of his "innate rectitude" and of his "splendid virtues;" I would earnestly wish, that they, whose manners are yet uncontaminated, would look with a jealous, and guarded eye, upon what are apparently so inviting—"Latet Anguis in herbâ."

But it is not the levity, merely, with which these breaches of the moral law are treated, that should make novels be regarded as tending to encrease the corruption of manners:—*false ideas* respecting all those things in which consist the true happiness and honour of a woman, are to be drawn from them. The man who is so fortunate as to enjoy the luxury of finding his home always peaceful and happy, will be best able to judge whether the qualities that make the greatest figure in the world, or excite the most admiration and notice, are really the most valuable, or are what have chiefly contributed to make his situation enviable. *He* will undoubtedly judge the contrary to be true; but it can hardly be expected, that any girl, who has been much addicted to novel reading, will cordially agree with him in this opinion: for *her* heroines are never suffered to appear without making conquests, or without receiving the perpetual incense of flattery: they are ever to be found in ball-rooms, and at masquerades, where they, of course, meet with the most excellent, superlatively wise, and accomplished husbands, whom, notwithstanding, these discerning fair-ones do not unfrequently select from a knot of illiterate rakes. Nor should we forget the uncommon share of personal beauty, that seldom fails to accompany their other perfections, which, beside teaching a young lady to set an immoderate value upon it, causes her to form in her mind inseparable associations between personal graces and moral and intellectual endowments—associations which are as likely to be injurious to happiness and good morals, as they are inconsistent with truth and experience.*

Many other evils arising from fictitious history (considered in this point of view) might be enumerated, but as they have been already touched upon by so able and elegant a writer as Professor Stewart, I will content myself, for the most part, with referring to his chapters "on the influence of imagination upon human character and happiness," † but shall be

* How very different in this respect, the impression is, which authentic, and fictitious history is calculated to produce, may be agreeably illustrated by a reference to Lord Clarendon's History of his own Life, vol. i. and iii. where, in the character of Lord Falkland, he has finely contrasted the disadvantages of his person with the excellencies of his mind; and in that of Sir Charles Cavendish, he has afforded a lesson, admirably calculated to counteract the prejudices in favour of these false associations.

† Philosophy of the human mind.

excused for adopting his words here, in order to shew that the mind which has been accustomed to high wrought scenes of distress, and which is made " tremblingly alive" to the representation of fictitious sorrows, will be incapable of affording that useful and active sympathy, which it is necessary to exert, in order to relieve the less shining miseries of real life. " Exhibitions of fictitious distress tend to strengthen those passive impressions which counteract beneficence. The scenes into which the novelist introduces us, are, in general, perfectly unlike those which occur in the world. As his object is to please, he removes from his descriptions every circumstance that is disgusting, and presents us with histories of elegant and dignified distress. It is not such scenes that human life exhibits. We have to act with the mean, the illiterate, the vulgar, and the profligate. The perusal of fictitious history has a tendency to encrease that disgust which we naturally feel at the concomitants of distress, and to cultivate a false refinement of taste, inconsistent with our condition, as members of society;—nay, it is possible for this refinement to be carried so far, as to withdraw a man from the duties of life, and even from the sight of those distresses which he might alleviate; and accordingly many are to be found, who, if the situations of romance were realised, would not fail to display the virtues of their favourite characters, whose sense of duty is not sufficiently strong to engage them in the humble and private scenes of human misery."

It may appear strange to some, that amongst all the ills which are supposed to result from novels, I have omitted the mention of *romantic love*, the subject with which they all *begin*, *proceed*, and *end*. The truth is, I have not forgotten it, but I have been obliged to remember that it is the effect of fictitious history upon *modern manners*, I am desirous to elicit: upon which *love*, if he were to appear in his own shape, or under the more attractive form *of his mother*, would find that he had lost his power: and would be obliged to assume the semblance of old Plutus, or of the blind goddess, before his arrows (though sharpened upon the most bloody whetstone) could be able to produce a single scar.

Although much more might be offered upon this subject, yet from what has been said, I believe it is pretty clear that novels hold no trifling rank among the various sources to which the acknowledged corruption of modern manners might be ascribed. With respect to the consideration whether they affect the taste and literature of the times, it is obvious, that for the most part, an intoxicating spirit of levity, and an excessive love of ornament, have in modern compositions, occupied the place of sound judgment and classical purity; and that the desire after novelty usually prevails over every other consideration. Hence, the modern poet disclaims those rules of art, that have for so many ages given strength and stability to the production of genius; and hence, even the historic page assumes a form assimilated to fiction, or actually partaking of it. To ascribe all this to the multiplication of fictitious history, would be going rather too far, as the true cause must be sought in the excessive refinement and luxury of the times,

But if it be granted, that fictitious history,—a species of composition which has been occupied by writers of various denominations often ignorant and often depraved; a species of composition calculated to interest the imagination, engage the sympathy, and stimulate the passions of youth, at that period of life, which generally decides the moral and literary character; if it be granted that it has contributed to the corruption of morals, then, the connection is so close between them, that no farther argument can be required to prove that they equally affect taste and manners.

I am well aware that it may be deemed illiberal to lay so heavy a charge against a species of writing which has employed the pens of many persons of talents and taste, as well as of those that have no pretensions to either; and undoubtedly it would be so, if the number of the former bore any reasonable proportion to that of the latter: but where a few names may be brought forward, who have expressed the inspirations of nature, in propriety of language, innumerable are they that have done outrage to truth and decorum, or else have mingled with their talents, qualities, which have only served to render them more dangerous. How small is the number of those that have been able or willing to discriminate the exact boundaries, beyond which (however trifling the distance) *wit* degenerates into licentiousness; *reason* and *propriety* into extravagance.

But enough has been said by *me* upon this subject. I would wish, however, before I take my leave of it entirely, to suggest what appears to be the most likely means of correcting these evils. It is, to give our youth, of both sexes, a virtuous and religious education; to make *truth* the prime object of all these pursuits; to direct their views to *realities* instead of *shadows*; to engage them in those studies which have a tendency to enlarge and elevate the mind, and strengthen and rectify the judgment as well as to rectify the taste; which accustoms the mind to habits of industry and labour, and gives in return a pleasure, far more exquisite than that which is the meed of idleness or indolence.

In these times, pains have been taken by the *learned*, to remove all difficulties out of the way of the *learner*, and to prevent in future, the necessity on his part, of any great exertions for the attainment of knowledge: but whilst it is to be doubted, whether this mode of *making learning easy* will eventually encrease the number of *good scholars*, some beneficial consequences, may, it is hoped, follow from what entirely does away the necessity of any extraordinary means, in order to relax the mind after severe and intense application—the excuse which is offered by many, who indulge themselves in the free perusal of fictitious history.

—Nugæ seria ducent in mala.

AN

ESSAY

ON THE

INFLUENCE OF HABIT,

CONSIDERED IN CONJUNCTION WITH

THE LOVE OF NOVELTY.

Hæc placuit semel; hæc decies repetita placebit.

THE influence of habit and the love of novelty are principles of so general, yet so opposite a nature, and intended to promote such different purposes, that if they were incompatible, one half of the business of life would be left unaccomplished. Could we suppose a being under the government of habit alone, his actions would be confined within the narrow circle that comprises the necessities of his nature; and the preservation of his existence, by eating, drinking and sleeping, would be almost his only achievement. On the contrary, a being, destitute of every moving principle but a love of novelty, would be active, energetic and enterprising, but as useless and unprofitable as the other. He would attempt every thing, and accomplish nothing—for ever be labouring, but labouring in vain. Of all our common and daily acts, how small is the number that could at all be performed without many attempts and long practice. What pains and exertion did it cost us to acquire the use of our limbs and the power of locomotion, the faculty of speech, and the exercise of the simplest of our arts and attainments.

Had our nature been endowed with the other affections and governed by habit, yet destitute of the love of novelty, we should merely enjoy a barren and grovelling existence, unimproved by progressive change, unembellished by science, and perhaps unexalted by virtue. On the contrary, if this passion were added to the rest, and that our then busy curious and aspiring spirit were deprived of the discipline of habit, our circumstances would be little altered for the better; for science would be still unattainable, and virtue consist of little more than a name—virtuous inclinations unproductive of virtuous conduct.

Wisely then have these two equal and opposite principles been interwoven with the first rudiments of our nature. They unfold themselves with our earliest desires, they govern us with the force of original laws through life, and reluctantly in death we are torn from that system of actions, affections, and pleasures endeared to us by the one; while the other invites us to a state of being in the last degree new, strange and inscrutable.

This change, awful and mysterious as it is, differs but in degree from *that* we have all experienced, but the recollection of which we are not permitted to retain. Perhaps the infant, satisfied with the mere sense of existence, would, if endued with the power of volition, be as unwilling to burst from the confinement and darkness of the womb, though to enjoy the delights of his destined residence, as the departing spirit to enter upon that scene for which it is, perhaps, no less suitably provided by nature. Each may cling with equal obstinacy to its chains and its dungeon; ignorant of its dormant faculties, and incapable of conjecturing its future perceptions and enjoyments, submissive only to the influence of habit and averse to the desire of unexperienced felicity.

When we say that these principles are interwoven with the first *rudiments* of our nature, it is implied that like the other affections they must be gradually developed; and it would be superfluous to remark that an action must be performed more than once before it becomes a habit; or that we must be acquainted with more objects than one before the love of novelty can operate. The propensity is not less an original law of our frame, because it must necessarily be dormant till roused by appropriate occasions. It will therefore be curious to trace the first movements of these principles in the mind.

It is obvious that the infant acquires habits before it is affected by a desire of novelty. Its first act is a scream. Its collapsed lungs are suddenly inflated by the atmosphere of the new world it has entered; the blood is forced into another system of vessels hitherto unoccupied, but now become necessary to its different state of existence. From warmth it plunges into an ocean of cold, and from darkness into an atmosphere of light. Its amazement, if capable of such an affection, must be lost in the universal pain it endures. No wonder its first act should be a cry of misery; or that on every recurrence of pain, it should repeat the expression pain had first taught it. This is our earliest habit; and reason must in most of us have made some advance before we can overcome the propensity of lamenting by outcries and tears, whatever anguish we suffer, whether corporeal or mental.

Life is a mingled draught from the beginning; and if the first habit of the infant flows from a source of pain, the second is derived from a more pleasurable origin. The former owes its birth to the sense of feeling, the latter to that of smell. It is agreed that the child is attracted to the breast by the fragrance of the milk. The organ of taste soon shares in the delight; and we can well conceive, though we cannot recollect, the first felicity we enjoyed, when two dormant senses were at once awakened by the complicated perception of so delicate an odour, and delicious a taste. Untaught and unpractised, the infant draws its nourishment from the fountain of life;—soon and frequently it seeks a repetition of its enjoyment—its diminutive frame requires an incessant supply, and it is not strange that so agreeable a habit should be speedily established. It is only interrupted by sleep, and continues till a different habit is induced by the use of other food; nor should we omit to observe, in this trivial circumstance, the superior strength of the influence of habit over the love of novelty. The child long prefers its first and most natural diet to every other. Grosser food becomes more suitable to his encreasing strength, and in time he would perhaps spontaneously reject the former. But it is with reluctance he first enters on his *novel* diet; and its *novelty* has long ceased, and the habit of resorting to it long been confirmed before he is willing to relinquish altogether the enjoyment of his earliest luxury.

Perhaps the love of novelty first discovers itself in the desire of changing the position of the limbs. During its waking moments the infant is seldom still; it stretches out its hands and feet in so many directions, and so early after birth, as to leave no doubt of its having acquired the practice of exercising the muscles to the utmost of its power even in the womb. Perhaps this affection is the great incentive to its subsequent corporeal exertions, and becomes a necessary counterpoise to the apprehensions that might otherwise restrain them. In vain would the mother expect that a desire to give her pleasure should animate the exertions of a being, as yet so destitute of sympathy. It is the delight arising from new situations which carries it through its progressive improvements; and incited by the love of novelty, it at first learns to creep—then to stand erect, unsteadily balancing its frame—next with assistance ventures to put itself in motion; until grown more independent, it afterward confides its movements to its own tottering limbs, and at length attains the power of walking with firmness, and running with agility. But here other passions become his assistants, and as he advances in life, the pride of emulation to equal his competitors aids his maturer exertions, and the more active and athletic exercises follow each other in quick succession. But from first to last, habit is the grand auxiliary, and perfects the work begun by its precursor.

As the sense of smelling is the first to receive an agreeable impression, it is perhaps the first to require novelty and variety in its gratifications. The magazine of fragrant odours is however soon exhausted; and it is only in our early days that we delight to run from flower to flower. After we have become familiar with all the sweets of the garden, we are less anxious to seek a succession of agreeable scents, than to avoid those that are offensive. Mahomet is a singular instance of preserving to the last a passion for perfumes. Two sensual enjoyments were required by his nature, and therefore permitted by the religion he established. This delicate gratification was *one*—and as it was necessary to his happiness, perhaps in him it was accompanied, through life, with a love of variety—which differs but in a shade from the love of novelty.

The latter can, perhaps, be gratified but once by the same object; but when it can be no longer considered as altogether new, it may still bear a comparison in point of novelty with other objects of a similar nature; it may gain or lose this quality, as we become more or less accustomed to it; and if it were possible that we should sojourn so long upon earth, as that nature could not offer, nor imagination suggest to us an object with which we were not familiar, the love of novelty would then have degenerated into a love of variety.

The sense of *Taste* enjoys a much larger scope than that of *Smell*, and bestows on the principles we are considering, not only a wider range, but much greater strength, on account of its more intimate connexion with the appetites of hunger and thirst.

As long as this sense is only acquainted with the flavour of milk, however diversified in its mode of preparation, it allows little room for the love of novelty and variety; but sweetmeats in various forms, and fruits of various relish, are presented to the inexperienced palate, and soon give birth to new desires. Little is it thought that in the prudent or improper gratification of this sense, begins the education of the child. To indulge him in these things without restriction, or to reward his good conduct by such paltry objects of ambition, and establish in their favour a distinction to which they are but little entitled beyond his ordinary food, is to make him in infancy, what he may continue to old age, an epicure and glutton. But more obvious absurdities are every day in use, and we see the foundation laid for habitual inebriety, by vitiating the long-reluctant organ of taste with undiluted wines; or, as practised among the inferior classes of society, with still more powerful and deleterious potions.

The alarming progress of this most vile and ruinous of habits, surprises the unreflecting and shocks the contemplative mind. But when we witness its depredations, overwhelming every barrier opposed to it by superiority of intellect, elegance of taste, pride of learning and elevation of genius, the most reflecting mind is most shocked and surprised. All prior expectations give way before the almost incredible, but too authentic, history of the unfortunate Dermody. Born, it is true, in an humble condition, yet qualified by transcendant talents and uncommon acquirements to arrive at the highest, we should perhaps have beheld without wonder or envy his encreasing lustre, as a poet, philosopher, or statesman. In our own times we have seen more than one advanced to offices of dignity and emolument, by means of qualifications, such as this ill-fated young man possessed, in a much superior degree—great natural talents, extensive knowledge of languages, and a thirst for general information prompted and governed by a passion for the muses, to which it was subservient. But see the destructive effects of one pernicious habit. A worthless father infected his infant mind with the mania of intemperance. It signifies little whether he adulterated his taste and corrupted his appetite by administering the poison; or depraved his understanding by the force of example. For such is the power of sympathy, that the example of those we are taught by nature to respect, operates irresistibly upon us, and their habits insensibly become ours. While yet a schoolboy, intoxication had its charms for him; and though familiar and delighted with the classics, and enriched with a store of scholastic knowledge, these elegant enjoyments were not sufficient to exclude this degrading passion: and the wit that was inspired by his genius, and invigorated by his learning, was lavished on the meanest associates, amidst the lowest debauchery. The habit was confirmed: strong in childhood, inveterate in youth, hopeless in manhood. Yet in every stage those numerous and illustrious patrons, whose protection his extraordinary genius had procured him, endeavoured by advice, exhortation, and threats, to rescue him from the perdition toward which he was hurrying. But in vain: vice was added to vice, depravity to depravity, outrage to outrage; until at length forsaken and abandoned by his disappointed admirers and indignant friends, by turns an importunate beggar and desponding recluse, now rioting in vile and extravagant excesses, now sunk in abject contempt and misery, at the early age of seven and twenty he died of a lingering disease, the victim of one ungovernable habit, that debased a noble and generous mind, a cultivated intellect and exalted genius, those strongest evidences of our immortal nature, to that grovelling level at which man ceases to be honoured with the epithet of HUMAN, and ranks in the estimation of society with the Brute.

Those senses which we have hitherto considered, are nearly perfect from the beginning; but the organ of SIGHT requires long practice before it is fitted to perform its office with effect. It is first attracted by the light, next by glittering and bright-coloured objects, then by whatever is near it, and at last is competent to judge of distances and magnitudes.

The celebrated Berkeley in his "new Theory of Vision," which is commended by the wisest and ablest of our natural, moral and political enquirers, as "one of the finest examples of philosophical analysis that is to be found either in our own or in any other language, leaves no doubt in the mind that "the judgment we make of the distance of an object viewed with both eyes is the result of EXPERIENCE; and on this subject the following passages are deserving of particular attention.

"The judgments we make of greatness, do, in like manner as those of distance, depend on the disposition of the eye; also on the figure, number and situation of objects, and other circumstances that have been observed to attend great or small *tangible* magnitudes. Thus, for instance, the very same quantity of *visible* extension, which in the figure of a tower doth suggest the idea of great magnitude, shall in the figure of a man suggest the idea of much smaller magnitude. That this is owing to the EXPERIENCE we have had of the usual bigness of a tower or a man, no one I suppose need be told." (Section 57.) " Of visible points we see at all times an equal number. It is every whit as great when our view is contracted and bounded by near objects, as when it is extended to larger and remoter. For it being impossible that one *minimum visibile* should obscure or keep out of sight more than one other, it is a plain consequence that when my view is on all sides bounded by the walls of my study, I see just as many visible points, as I could, in case that by the removal of the study walls and all other obstructions, I had a full prospect of the circumjacent fields, mountains, sea, and firmament: for so long as I am shut up within the walls, by their interposition every point of the external objects is covered from my view: but each point that is seen, being able to cover or exclude from sight one only other corresponding point, it follows that while my sight is confined to those narrow walls, I see as many points or *minima visibilia* as I should, were those walls away, by looking on all the external objects, whose prospect is intercepted by them. Whenever therefore we are said to have a greater prospect at one time than another, this must be understood with relation, not to the proper and immediate, but the secondary and mediate objects of vision, which properly belong to the touch." (Section 82.)

Adam Smith, the elegant eulogist of Berkeley, elucidates his theory in his Essay on the External Senses; and his exquisite illustrations are well entitled to the applauses he bestows on his predecessor. He has added many improvements of his own, to the merit of which he modestly disclaims any title; but he gives us the following perspicuous views in one of his most distinguished illustrations.

"It is because almost our whole attention is employed, not upon the *visible* and representing, but upon the *tangible* and represented objects, that in our imaginations we are apt to ascribe to the former, a degree of magnitude which does not belong to them, but which belongs altogether to the latter. If you shut one eye, and hold immediately before the other a small circle of plain glass of not more than half an inch in diameter, you may see through that circle, the most extensive prospect, lawns and woods, and arms of the sea, and distant mountains. You are apt to imagine that the landscape which is thus presented to you—that the *visible* picture which you thus see—is immensely great and extensive. The *tangible* objects which this picture represents undoubtedly are so. But the *visible* picture which represents them can be no greater than the little visible circle, through which you see it. If while you are looking through this circle, you could conceive a fairy hand and a fairy pencil, to come between your eye and the glass, that pencil could delineate on that little glass the outline of all those extensive lawns and woods, and arms of the sea, and distant mountains, in the full and exact dimensions with which they are really seen by the eye." (Page 222.)

Adopting these views, we may conclude that previous to all EXPERIENCE, a new-born child can only perceive at first a circle of light of the dimensions of its pupil. It is perhaps the first object (if it is entitled to that name) which it beholds. It appears to it most probably, not on the retina, where the rays of light form its resemblance, and create a sensation; but where the circle actually exists, the aperture of the eye. Afterward the walls and furniture and inmates of its apartment, or the scenery and animation of an extensive prospect, reduced to an almost imperceptible miniature, occupy the same narrow field of view: one object indistinguishable, on account of its minuteness from another, but forming altogether an intermingled mass of brilliant colours. This variegated tissue is changed to one dull unvaried colour, when an object approaches so near as to occupy the field of view to the exclusion of other objects. Distance is as yet imperceptible to the eye, and inconceivable by the mind. The hand must be often extended and withdrawn, placed before the eye and on different parts of the body, contemplated in different positions and at different distances, before the infant ascertains that the hand which it beholds is *that* which a repetition of the sensations of feeling had previously taught it to regard as part of its frame. This is the first step in the complicated process by which it acquires the HABIT of judging of distances: for the hand is the first measure it uses, and it must be familiar with the instrument before it can employ it with effect.

In time he discovers that the space where his hand moves with freedom is destitute of objects; and thus ascertains that those which he beholds and cannot touch, lie beyond the extent of his arm. At this period it is probable that the field of vision has encreased to the dimensions of a circle about four or five inches in diameter, which enlarges to twenty or thirty when he attends to the space which both of his arms can describe or encompass, while all the objects in view appear painted within its area much larger than at first, much smaller than afterward, and nearly within reach of the hand. The eye of man is fitted by the Wisdom of Nature to behold commodiously at a single glance all objects that present themselves within a cone whose sides form an angle of about sixty degrees, and whose apex is the eye. This cone embraces but one-sixth of the horizon; yet so quick is the motion of the eye, that we believe we see a hemisphere at once, which we only take in by successive glances. For the convenience of beholding the greatest possible number of objects, it is established, either necessarily, or arbitrarily, that the more remote an object is situated, the smaller it appears; otherwise a multitude of those which under our present circumstances we are capable of perceiving, would be concealed from us by the intervention of that single object which happened to be nearest. This is not the place to enquire by what means this law is carried into effect. It is sufficient to know that the nearer we suppose an object to be placed, the smaller we judge it to be; and a castle of a hundred feet in altitude at the horizon, will appear scarce an inch to the infant that believes it to exist almost within reach of its hand. Thus we can readily conceive that the more distant an object really is, the smaller it must ever appear; and the nearer we judge it to be, without actually knowing the truth, the smaller we must also suppose it. Of this diminutive size, and bearing a just proportion to each other, as in a painting accurately executed according to the rules of perspective, all objects within the field of vision must probably appear to a child at the period alluded to; no prominence observable; but the whole consisting of a flat plane diversified by shades and colours. Though it may be doubtful whether this picture does not very early assume the form of a concave hemisphere; similar in every respect, but in magnitude, to the area comprehended by more perfect vision, but so confined as to appear within tangible distance of the hand of the infant. The visual powers command an equal extent in all directions; and if, as a necessary consequence, the boundary of vision presents to the adult an immense sphere, it must in like manner present a sphere of reduced dimensions to the infant, whose powers of vision likewise extend in all directions, but only, in his conception, to the distance of a few inches.

Nearly at the distance which the infant has first learned to assign to objects, is in all probability established the barrier between distinct and indistinct vision: all things within it appearing larger than they actually are, and encreasing in size and indistinctness as they approach the eye; and all beyond it diminishing in size the farther they recede from it, till they are also involved in obscurity and at length lost to sight. A pin not an inch long, if brought close to the pupil, appears to encrease in dimensions to six; and if gradually removed from distance to distance, reduces its size till it totally vanishes, being seen in its true dimensions but once in its progress which takes place at the barrier in question.

Beyond this boundary, the eye of the infant has not yet learned to penetrate. It must previously become so intimately acquainted with at least one particular object, that it will recognise it at a moderate distance; or, to speak more consonantly with the sensations of the child, it must be able to recognise it for the same object, although at one time it appears large, and at another small. The first step in the acquisition of this knowledge is the discovery, that the visible and tangible object is the same. One of the earliest occupations of the infant is to press with its hand the bosom of its mother. The prominency which is familiar to the touch, cannot long be concealed from the eye. The gradual brightness and shading soon become signs of the figure of the object; and the sight, under the tuition of the feeling, learns to distinguish the round and the angular from the coloured flatness peculiar to its own powers of perception. In his progress he insensibly becomes acquainted with the features of his mother—rejoices to behold them softened into smiles—and gives the first proof of his sympathy, that grand foundation of our moral attributes, by a respondent smile. At rest in his cradle he follows the countenance, now become so interesting to him, with an attentive eye. It lessens as it recedes; it enlarges as it advances; and perhaps with the delight of a philosopher at the discovery of a new truth, he for the first time ascertains in those different situations, the identity of the object. But still he can have no notion of that distance which occasions the change. He must himself be borne from his mother, and again advanced toward her; he must be conscious of having been in motion—and possibly that consciousness may not arise until his own powers of locomotion have first been exerted—he must have acquired some idea, however faint, of the space he has traversed, before he can possess the most imperfect notion of distance; and even that idea must have become habitual, long before he recognises it as the cause of the diminution of objects. But that recognition once made, and ripened by time into HABIT, we forget appearances, and attend only to the real object and the real distance.

A variety of objects, subjected to the same process, lend their assistance in strengthening and perpetuating the habit: and with the exercise of the habit the power encreases of judging correctly of distances. If the infant has traversed no greater space than the length of his chamber, he cannot entertain a conception that the universe is more extensive; and whatever prospect its windows may command, the manifold objects between his eye and the horizon will appear at the distance of fifteen or twenty feet from his eye, if such be the limits of his knowledge of space. In proportion as *that* knowledge advances by means of experience, his horizon recedes—his circuit of vision enlarges, and objects encrease their dimensions—known objects become a standard to judge of unknown—and the human figure is perhaps the first and the most useful which he employs to that end. A man on the battlements of a distant tower, serves by comparison to measure at once its magnitude and its distance—a full grown oak, the elevation and extent of the hill on which it flourishes. For a long period, the remotest mountains in the prospect are regarded by the child as the boundary of the world. His field of vision then extends to the terrestrial horizon. A solid vault of blue, studded with diminutive stars, appears to rest on the flat earth as on a foundation; and many a year has he numbered before his encreasing knowledge countervails the habit of his perceptions, and lends his imagination wings to rise through a yielding firmament, and discover through a vista extending millions of miles, innumerable suns which he had been taught to call stars, millions of miles in circumference, and multiplied millions asunder: while Reason and Fancy unite with Philosophy in peopling the invisible void with systems of habitable orbs, as infinite in number as the suns round which they revolve.

Thus instructed by the most confined and local of the senses, the most unrestricted and expansive becomes perfect. And a circle scarcely one-tenth of an inch in diameter, whose sphere of vision is at first not more extensive than that circle, in the progress of time acquires, by force of habit, the astonishing power of comprehending within its diminutive sphere the stupendous universe.

The first steps of this process, naturally as they follow each other, will never, if controverted, admit of demonstration; for we can scarcely hope, that in contradiction to those laws which have hitherto governed the infancy of man, his mind will ever be endued with the faculty of recollecting every impression it received from the first dawn of its existence; and until there is an instance of such an event, we may conjecture, but we cannot know. Yet the concluding steps of the process are so far advanced beyond the regions of mere probability, that their certainty in no small degree confirms the credibility of those that precede them, not only by their reciprocal harmony, but their united accordance with reason. Still it must be confessed that we have facts within our knowledge, which seem to refute the doctrine altogether. In Cheselden's invaluable case, referred to by almost every writer on the subject of vision, the young man couched for cataract at first perceived objects of a much larger size than they really were; when according to the above principles, we would rather expect them to appear much smaller, and reduced to a scale as diminutive as their picture on the retina. But we must recollect that the patient was not an infant—that he was acquainted by the touch with the dimensions of objects—and that the idea of space had long been familiar to him. We must also recollect that like others affected with the same species of blindness, he could distinguish light from darkness, and even discern two or three colours. It is therefore probable, that immediately after birth, he perceived a dim circle of light of the diameter of his pupil; and that as he enlarged his notion of space, the circle of light encreased its dimensions; but without extending to the degree of magnitude, during his blindness, which it attained after he acquired the use of his sight. It is therefore natural to suppose, that the first objects he perceived would appear to him at least as large as to others, if there was no other peculiarity in his sensations. But according to Cheselden he conceived that all the objects he saw were as close to his eye, as those which he touched, were to his hand. No wonder then that every object should appear larger to him than to others, when (subtending an equal superficies to both) he esteemed it to be in contact with his eye, and they perceived it at its proper distance.

These considerations perhaps afford a sufficient explanation of the variance between the actual circumstances of this young man, and those we would previously be inclined to expect. He had a manifest advantage over the infant who is totally destitute of all idea of space. He therefore acquired more speedily the art of seeing. And upon the whole it may be considered, that the peculiarities of his case yield a strong confirmation of the doctrine, they seem on a superficial view to subvert.

This topic has perhaps detained us too long; but as it forms so curious and important a part of the history of our habits, it was necessary to render it at least intelligible, and I confess I had not the art of accomplishing this in fewer words.

We have seen that no object would appear as it exists, and that therefore vision would be comparatively useless to us, if it were not for the habit of mentally converting visible into tangible objects. The organ of sight would be for ever imperfect without this exercise of the mind. It was not requisite to consider what assistance is contributed to this effect by the love of novelty, in investigating the mere improvement of the organ of vision; though doubtless it operates in no small degree in promoting that intellectual exercise, so necessary to its perfection. But it claims an important share of our attention, when we direct our enquiries to the affections of the mind, as moved and influenced by the objects of sight.

We have hitherto sketched a history of the combined influence of habit and the love of novelty, as they affect us from their birth to their maturity, in relation to the objects of those senses we have already discussed; but it would be tedious in every part of the subject to advert to minutiæ that cannot have escaped the most heedless observer. The eagerness with which infants relinquish one glittering object for another more novel, must have forced itself on every one's notice. Nor are those circumstances less obvious, which evince the full growth of this passion in the mind; and we cannot look back without strong feelings of interest, to the first instance of our absolute submission to its powerful influence. There is no one that does not cherish the recollection of the solicitude he felt, in expectation of the first change of scene he enjoyed. With what ardour does the young rustic desire to visit the neighbouring town, of which he has heard such exaggerated tales; and how much does the gratification of his curiosity add to its vigour. The distant capital invites him to a feast still more splendid; and if his appetite is not palled by the banquet, this impulse may render it still more insatiable after novelty. On the other hand the child bred up in cities, and breathing their unwholesome atmosphere, feels as if he were imprisoned in an uncongenial element, and secluded from enjoyments for which he was constituted by nature. He longs to breathe in freedom the pure air of the country. His imagination carries him to every green and luxuriant spot in the prospect, of which, through interposing roofs and towers, he can obtain a glimpse; and he entertains the ambition of climbing the mountains which bound his horizon, from whose summit he fancies he shall behold a fathomless abyss, or a dreary ocean, constituting the last verge of nature. The love of novelty thus finds a firmer footing in the mind. Indulgence strengthens this passion, as it strengthens every other. If it ripens into habit, it becomes necessary to the existence with which it is interwoven. Excursion after excursion, scene after scene, at once gratify the mind, and stimulate it to fresh gratifications. And by this process, a basis is laid for an insatiable thirst of novelty, such as led Park over the terrible desarts, or through the more terrible population, of Africa; or instigated Columbus to the glory of contending with the unknown tempests of the desolate Atlantic then deemed unnavigable.

This affection, with Sensibility for its partner, delights to traverse those regions consecrated by the memory of illustrious nations, which have long since perished from the earth; or the deeds of magnanimous individuals, who by their example, as with an inheritance have enriched posterity for ever. With similar and equal interest we dwell upon the reliques of the days of our forefathers—their grand and gloomy castles, convenient only for defence, awaken all the sympathy our nature still retains for the boisterous and heroic age of chivalry. Taste is generated by objects like these, and the sentiments they inspire. A Burke or an Alison leads us through the gardens and wildernesses of nature—and whether we trace some inviting stream, through cultivated meadows and wooded dells, to the barren mountains that form its cradle; or hang over its frightful cataracts from a rock seemingly consolidated with the foundations of the earth—whether we revel in the smiles or shrink aghast at the frowns of nature—we every where confess the footsteps of God. The sources of beauty and sublimity are opened to us; and thenceforth an inexhaustible fountain of enjoyment flows beneath our feet.

Such a share has the Love of Novelty in enhancing the value of the objects of sight. Nor is this all—associated with Observation and Sagacity, it explores new fields of knowledge, and opens new springs of felicity, not less valuable to the intellect, than those already mentioned, to the heart. We walk with the ingenious and discerning Werner, and the profound and speculative Hutton, amidst rocks of adamantine hardness, whose various strata resemble the gradual and successive deposit of the waters; and without a blind unqualified and implicit adherence to either of these philosophers, we acknowledge but doubtingly that a force less than of fire could scarcely have produced the change. The disintegration of these rocks seems to supply the sandy bed of the neighbouring torrent; and if we pursue its course to the sea, we learn that "the capacious bed of waters" owes its formation to the same materials. It appears as if the lofty mountains and solid plains were carried by a slow but unceasing progress into the abyss of the ocean; and we look round us, with inquisitive eyes, to discover if the dry land we inhabit has ever been subjected to the same astonishing revolution. We pursue the novelties that invite us; and fancy that we are taught in every page of the volume of nature, that twice this earth was in the bosom of the waters, and as often heaved above them by the force of subterranean fires, which liquefied or baked it into the manifold forms that diversify its surface. We shrink from so incredible a creed, but rocks of enormous magnitude excite our attention; and the vertical strata of their masses, which seem to have been once horizontal, compel us to acknowledge that the power which heaved them upright must have been adequate to events the most tremendous; and reluctantly we admit the conviction, that wherever we tread, it is on the wrecks of former worlds.

Thus we see how the profoundest enquiries become food for the appetite of novelty. It cannot be satiated, any more than the sense of vision, by terrestrial prospects. It expatiates at large in the immensity of the heavens. It weighs and measures the planets, their distance, and velocity; and ascertains with Newton, the laws that speed, yet confine them in their orbits. It adds new powers to the eye by the telescope, and opens to us deeper and deeper profundities of space. We discover with Herschel, that the nebulous brightness of the milky-way consists of multitudes of stars thickly sown in stratum over stratum; and which seem more closely to approach each other in proportion to their remoteness from us —that the stars of our firmament, however distant from each other, are but a part of the one congeries—that our sun is an individual among them, and that those in his vicinage naturally appear to our eyes the farthest asunder. Prodigious contemplation!—yet how trivial to that which succeeds. In various parts of the heavens, and still more distant than the most distant star of the galaxy, other nebulous spots appear. We look through the telescope, and stars become visible as numerous as those which heretofore constituted to us the universe. At the same time a profounder space is unfolded, and other nebulæ whose stars still remain undistinguishable, are revealed to view. Two thousand five hundred, has Herschel numbered, of these Universes; for Universes we must call them in spite of, the solecism. Human language is alike incompetent to express the Creation and the Creator.

Sublime and ineffable as are the sentiments which arise from these amazing contemplations, they but inflame the lust of knowledge. System after system bursts with increasing grandeur on the indefatigable mind. We reason—we compare—we generalise—we simplify. Science fixes her firm foot on the orb of the sun, and sees, around her, circumvolving planets, satellites, and comets. Their motion more rapid beyond comparison than the whirlwind is to the eye imperceptible at the distance even of the nighest. How then could we hope to discern the motion of the stars hitherto supposed to be fixed? Yet Halley suspected and Herschel has discovered that they actually move, and almost ascertained even the direction of their course.* But thousands of years must elapse before such a general change can occur as to alter materially to our senses their relative positions. Some nebula infinitely remote, and whose motion must be less perceptible in proportion to its distance, may offer itself as an object sufficiently fixed for measuring the movement of the nearer heavens. But what is the length of human life—the duration of nations—the existence of the earth itself, to accomplish such a task? At those incalculable distances, it is possible that many millions of miles, nay many millions of diameters even of the solar system, may not occupy to our

* See Herschel's Papers on the Motion of the Sun and Solar System in the Transactions of the Royal Society, for the years 1783 and 1805.

eye a space equal to the hundredth part of an inch; and though that mighty longitude were traversed by the heavenly bodies with the velocity of light—to us, though observed for ages, or perhaps for ever, the amazing tale of their travels might still remain undivulged.

But the acquisition of facts only prompts us to the acquisition of facts yet unknown. The love of novelty ripens into an appetite for knowledge; and we hunger and thirst to riot without stint in the feast of reason, among new objects, new facts, new truths, in endless variety. And scarcely have we learned that the magnitude of our sun may surpass that of all the heavenly bodies united, which roll around him as their centre, and that he and his attendant worlds are advancing together through space, than our imagination transports us into the centre of all nature: and there it frames a mighty orb, equal in mass to the thousands of universes that are attracted by its gravity, and róll in majestic splendour around this heaven of heavens—" this throne itself of God."

Magnificent as this scheme may appear, it must still fall short of the works of the Creator. What He has achieved, it is not for man in the utmost stretch of his imagination to conceive.

In the several instances to which we have had occasion to recur, we find that the love of novelty becomes gradually exalted into a much nobler passion. Nor in any of them can we discover that this desire exists without a preconceived object. The victim of lassitude and ennui may indeed pant after novelty for its own sake; but he is a singular instance. The infant does not throw away his rattle until some other attraction presents itself; the boy does not long for a glimpse of the metropolis until he has heard of its splendours. It is the same in manhood. Johnson did not seek the Hebrides until he had warmed his imagination with the view of primitive and uncultivated society which he expected to enjoy there. The fancy of Columbus dwelt only on a new track through the ocean, when he discovered a new world. And the galaxy and nebulæ were already in the eye of Herschel before he ascertained them to be clusters of stars, and found a new universe in every assemblage.

Every organ of sense is long under the tuition of habit, and by its means attains no small degree of perfection, before the mind is affected by a desire of novelty with respect to the objects of that particular sense.

Hearing, for example, must long be exercised, before it arrives at the power of distinguishing the variety of noises, that first excite its attention, and the multiplicity of sounds conveyed in the simplest air of music, or the narrowest compass of language. Pleasing sounds, by being new, are rendered more pleasing; but until the ear is habitually acquainted with some arrangement of sounds, it can scarcely be subservient to the love of novelty; because the imagination cannot form a preconception of a simple sound to which the mind is a stranger; and we have seen that without some preconception of the object, this affection does not arise. But when the ear becomes familiar with different arrangements of sound, the imagination can readily conceive the formation of other arrangements, and naturally gives birth to a desire for new harmonies in music, new expressions of language, and at length pants after new efforts of eloquence, new flights of the muse, and all that science can perform by the power of diction.

Vast as is the empire of the eye, the dominion of the ear is far more extensive; and though the former is more useful to man as an animal, the other is more necessary to him as a reasonable creature. It is the great inlet of his knowledge—the gate which opens to him the intellect of others, throws down the barriers which would confine his mind to the scanty produce of its own conceptions, and gives it a passage to the collective understanding of mankind. Without it, language could never have been invented—without language, general ideas could have no existence—and without general ideas, where would be that knowledge which stamps on man his exalted character of a reasonable being?

No wonder then that this refined and delicate organ should be slow in arriving at perfection. To distinguish accurately every vibration of air, from an infinite number of other vibrations, whose impulse conveys to the auditory nerves all the involutions of sound employed in music or language, seems a power more than miraculous. It is according to the course of nature, and we pass it by without consideration—

it may be said, without notice—yet in the records of those marvels which have contradicted that course, is there one more astonishing than this which floats with the stream? How exquisite must be the construction of the organ, how accurate its perceptions, how attentive the mind, how incessant the habit of observing and discriminating, to endue this wonderful faculty with all its perfection. And during the process, how ardent must be that love of novelty which promotes those exertions, how early its birth, how prodigious its growth, when it rushes unconscious from the sound to the sense, from the diction to the subject, from detail to reasoning, and as it advances in its progress, becomes first a love of knowledge, and then a love of truth, the acme of its character.

It is strange to reflect that the foundation from which has arisen the proudest superstructure of human attainments, may have been an idle fairy tale or absurd romance! It is not the knowledge we receive by compulsion, in schools and colleges, that takes the fastest hold of the mind; but that which we acquire voluntarily, and pursue with avidity. Infant curiosity awakened by a Persian or Arabian tale, the less marvellous stories of Monsieur Berquin and Madame Genlis, or the invaluable and more fascinating compositions of Miss Edgeworth, to whom society will perhaps be indebted for the virtues of future generations, soon demands more solid nourishment. Fiction and fancy give place to truth and reason. The unrestricted intellect traverses with rapid strides the frequented regions of knowledge—makes excursions of its own in the unfrequented; and leaves far behind the limited endeavours of the trammelled mind. A regular plan of education is no doubt indispensable; but the boy greedy of intellectual pleasure will overleap its fences; while the pedantry that would confine him within them, defeats its own views. Require of him his allotted task; but allow him beside, his choice of reading, whether solid or light, and he will derive advantage from both. Chain him to his galley, and he will be but a galley-slave—his exertions as languid, his progress as circumscribed, his disgust as inveterate. It is in your power to choose the first book that is put into his hands—if it is suited to his age, and adequate to captivate his attention, you may leave him in a great measure to himself—advise him when he asks for advice; but it is scarcely necessary to obtrude it when he does not solicit it. The amusing tale will be followed by the instructive history—science will tread on the heels of science—he will find his way from volume to volume with little need of a guide—all he wants is books and instruments—and these it is your business to supply as he demands them, if you would not impede him in his road to universal knowledge. The habit of study, and the passion of grasping at truths yet unknown to himself or to others, will be sufficient incentives to his progress, and supports of his toils.

As a necessary companion and minister to the sense of hearing, and equally a medium of communication between reasonable beings, the faculty of speech was bestowed on man; and it deserves the highest cultivation of which it is susceptible. The power of delivering the thoughts in easy unaffected perspicuous animated language, is in every condition of life a pleasing accomplishment; but in the higher ranks and more public avocations of society, it is an indispensable requisite. In these free countries where popular discussions have such mighty sway, this popular talent is of the utmost moment; and its acquisition is the surest means of attaining the highest summit of political ambition. But it cannot be acquired without the aid of habit, early and unremitting. At the outset of life we imagine that nothing more is necessary to the expression of our thoughts, than to possess a valuable and abundant store. Accordingly we shut ourselves up in our studies—we devote ourselves to our books—we heap fact upon fact, and truth upon truth, and the indefatigable student at length becomes a magazine of science. Then triumphing in his acquisitions he enters into society; and when the wished for opportunity occurs for the display of his learning, he finds to his astonishment that he wants the only means to give it utterance—words. He opens his ears and learns to his mortification, that the shallowest talker, who deals only in common-place, exceeds him in the art of conversation and the powers of amusing—that the stranger to books who owes all his information to accidental intercourse with the learned, can shine with more lustre than himself, even in the field of literature; and too late he acknowledges, that the labours of his life have been unavailing, since he cannot impart their result; and that science and philosophy are but useless appendages, without the habit of conversing, and the talent of expressing our thoughts.

It is true that writing affords the unconversable student a ready instrument of developing his opinions, whose sphere of action and influence is much more extensive. But habit is as necessary to the perfection of this art as of the former. The practice of composing should be early encouraged among those to whom it can be useful; and there are few persons above the inferior classes of society, to whom it may not be of the most eminent service. The multitude will derive sufficient advantage from the mere mechanical use of the pen; and the lowest individual in the state should not be left in ignorance of the art. This would be a benefit more to be desired than expected, were it not that the simple but incomparable inventions of Lancaster promise to disseminate the invaluable blessings of education among every rank in society, before another generation passes away. But the more exalted skill of elegant composition should not be neglected, or left to chance among the superior classes. It were wise to afford to every boy an opportunity of discovering the extent of his capacity for this accomplishment; and if the result be favourable, the ambition to excel, and the practice which generates excellence, will spontaneously follow. In our early years the splendid efforts of the muse are more suited to our taste, and more evident to our understanding than the simpler beauties of prose—the young are prone to imitate what most they admire—and our infant genius, like the genius of infant society, effuses itself in poetry. It is an art to which we are under much higher obligations than is commonly supposed; and a little reflection will convince us, that we owe to some ambitious poet of remote antiquity, the invention of alphabetical writing. Facts, opinions, and laws, he might have promulged, by means of hieroglyphics; but he could not record his verses, till he had discovered the power of registering the harmonious and evanescent arrangement of sounds.

Whether it is politic to encourage a poetical taste, is however to be questioned. It seduces the unfortunate possessor from his proper business—the employment, from whose profits he is to derive his sustenance.—It diverts his industry into a channel that enriches his mind, but where worldly wealth seldom flows. It inspires him with that contempt for gold, which perhaps may console him under the privation, of which it is eminently the cause. It promotes a cultivation of the understanding, a melioration of the disposition, a poignancy of feeling, an ardour of virtuous sentiment, and a romantic nobleness of heart—in vulgar times it accomplishes him for the days of chivalry—and it will not be difficult for common understandings to decide, how far that taste is to be coveted, which unfits a man for the present state of things, even though it may qualify him for a better.

In our investigation of the influence of habit and the love of novelty, as they operate in the improvement of the organs of sense, and affect the mind in its relation to sensible objects, we cannot overlook their alternate operation, and the quick advances toward perfection, which are the consequence of this arrangement. Every act and object is fresh and new to the infant; and it is satiated with novelty before the desire can arise. The very performance of an act creates an inclination to repeat it; and the influence of habit is the first to affect us. It grows stronger with every repetition, and does not require any support from novelty, where there is little or no exercise of the will; as for instance, in imbibing an awkwardness of manner; practising peculiar and unmeaning gesticulations, or resorting to those preposterous, but innocent enjoyments, the most common of which is the use of that nauseous weed, which is so providentially harmless to the individual, and productive to the state. These habits require no charm of novelty to render them permanent; for in time they become as independent of the will, as the return of hunger at the accustomed hour, the process of digestion, or the pulsation of the arteries.

But where the will exercises a control, the habit grows stronger only so long as it preserves any character of novelty. When an object or action is for the first time presented, those which were familiar lose in some degree their attractions, and the mind devotes itself with ardour to the new. But when the delicate essence of novelty is totally dissipated, all the relish of attraction evaporates with it. We may however remark that habit is sooner deprived of its influence, and the intercurrence of novelty longer required to engage our attention, when we are passive, than when we are active. Even the most exquisite singers and facetious of story-tellers are seldom sensible of the tedium of repeating the same songs, and recapitulating the same stories, so soon as the politest of their auditors; whose amenity is sometimes subjected to no trifling test of endurance, if the air be not varied by some lively touches of Pathos, or the anecdote by some unexpected effusion of humour: or in fine, unless some additional auditor is present; when a new sense of sympathy with the interest he feels, may postpone for the time the impatience of lassitude. Old Homer's rule of the twice-told tale has never been reversed; nor do the annals of song afford an exception; unless it is, perhaps, to be found in such ever-varying and fascinating modulations as are disclosed in the notes of "*Lungi dal caro bene*," and Viola's still more affecting appeal to the heart of Orsino, "*She never told her love*." * These have the privilege, if it is possessed by music, of feasting "the ravished ear" to excess, but never to satiety.

The influence of habit is commonly exercised in matters of a general nature, while the love of novelty deals in particulars. A taste for reading may become an indispensable habit: we may even with pleasure confine our studies to one

* The former by Sarti, the latter by Haydn.

science, but can seldom restrict them to one book. The same work does not often invite to a second perusal; at least until the subject is partially forgotten, and therefore in some degree new. We may acquire an habitual necessity of frequenting the theatre; but the same dramatic representation will afford but a meagre amusement, unless its attractions be revived by a change of performers, or some similar novelty.

Yet in our most constant and permanent habits, the simplest variation suffices to render them agreeable. A person will pace the same streets or travel the same road, day after day and year after year, without the slightest disgust; scarcely adverting to the objects which he has so often beheld, and finding perhaps all the novelty that enlivens his way, in his own meditations. Or even if "he whistles as he goes, for *want* of *thought*," the scenes he has traversed a thousand times, may every time display a thousand minute varieties that exclude the approach of chagrin and ennui. The same landscape is not the *same*, in sunshine, and in twilight—when the heavens are blue and serene, or enveloped in a curtain of clouds—in a calm when the aspen scarce moves, and in a breeze which sways with its breath the fields and the forests.

Thus the perpetual recurrence of novelty is in some degree necessary to preserve the existence of such of the habits as have not renounced the control of the will; even those which have been of the longest continuance. And from this curious circumstance we learn how closely these principles of action are united, and the difficulty of separating the consideration of their effects.

Can this operation of *novelty* be a law of our nature, interwoven with our frame; or has the *habit* of thus being affected, arisen from the pleasure we derived from every object, when the world was new to us, and the consequent stimulation to similar enjoyments?

Be this as it may, the dominion of habit is not superficial. Its sway can be traced in the depths of our constitution; and its power over the functions of the frame would lead us to regard it as a primitive law of our nature.

Labour of body and exertion of mind, those great promoters of sleep, no longer produce their effects on a patient familiar with laudanum. The drops must be administered before rest can be hoped for. The epicure, accustomed to spicy condiments with his food, cannot digest it without them; and the stimuli of the natural secretions, cease to be stimuli, to intestines enervated by the use of cathartics.

If these internal actions so little within the dominion of the will, are still subjected to the government of Habit, we need not be surprised that this law of our constitution should predominate in our voluntary actions. Every muscle in the frame performs its office with ease, or difficulty, according as it has been exercised; and dexterity, grace and skill are the fruits of repeated practice. The smith toils throughout the day with a sledge, which a ploughman, as robust, could not wield for an hour. A skilful rider will "turn and wind a fiery pegasus" that a novice in horsemanship dares not venture to mount. The seaman will climb unconcernedly to a height, where landsmen cannot see him without terror; and confiding in the habitual strength of his hands, suspend himself over the waves into which one less practised would drop in despair.

It is this effect of habit, in improving manual operations, that has rendered the division of labour of so much importance to a commercial country. But the wealth it creates, is not altogether a compensation for the expenditure of health, activity, and intellect, that are given in exchange. Low must be his bodily strength, and mean his understanding, who is destitute of all thought or employment, but cutting off inches of wire or sharpening them into points. In the northern parts of Ireland a different system exists—there is *there* a population not to be exceeded for intelligence in any part of the globe; and this blessing is chiefly to be ascribed to the prevalence of exercising two different trades, the one an active, the other a sedentary occupation. The weaver, it is true, might be a much better weaver, if he confined his attention to the shuttle, and relinquished the spade and the plough; and the farmer excel as a farmer, if he never sat down to the loom. But the individual is stronger and healthier, more intelligent and happy; and if the country has less wealth, it is more nobly enriched in the vigour, intellect and energy of a people who are competent and ambitious to be her defenders.

In the more learned and illustrious avocations of life, it is only industry and talents that can bestow celebrity. But knowledge the most profound, and genius the most exalted, would be useless to the possessor on the most critical occasions, were it not for the power of habit. It is by constantly calling them into exercise, that they become as ready instruments in his hand, as a tool in the mechanic's. The experienced physician has scarcely ascertained the symptoms, until the hidden seat of the disease discovers itself to his sagacity, and his judgment as instantly decides on the appropriate remedy. The legal practitioner as speedily developes the rights of contending parties, and evolves the intricate avenue to justice—with confidence and fluency he stigmatises the conduct of one individual, and justifies that of another—and with the same astuteness and presence of mind, eviscerates truth from an evasive witness; or replies to the arguments, and retorts on the wit, of a dextrous adversary. The parliamentary orator is no less indebted to habit, for the skill with which he brands his opponents without breach of decorum;—the pertinacity of hollow argument, with which he upholds the cause of corruption; or the lightening of eloquence, with whose flashes he confounds its abettors.

What a variety of habits is necessary to form the commander of armies. To discern at a glance the strong and weak points of a country—to calculate the sum of its resources—to combine extensive and even remote operations—to move in all its involutions and dependencies the vast machine of battle,—to exercise invincible patience—infallible foresight—prompt and unerring decision—vigilant and unremitting presence of mind—rapid and overwhelming activity,—to perceive the opportunity of attack—the means of retreat—the moment of victory. To be careless of ease—insensible to danger—enamoured of heroism—wedded to glory. These are not virtues to be obtained by occasional or uncertain exertion: but like all other virtues, they cannot be confided in, until they are practised as if by instinct; and interlaced with the very fibres of the constitution, by the power of habit. Let us turn our eyes on the two arbiters of the world—with what gigantic strides have their minds advanced in their tremendous science, from the bridge of Lodi to the field of Mojaysk; from the modest dawning of Assye, to the noontide splendour of the Arapiles.*

It is not among ministers or statesmen I would seek for an illustration of the advantages that flow from the power of habit. The routine of office—the wiles of diplomacy—and

* The language of Metaphor is exhausted in following the achievements of Lord Wellington. The glories of Vittoria have since been added to his fame, "*Like a new morning risen on mid-day.*"—Another interval has elapsed—the days of Roncevalles! St. Jean De Luz! Bayonne! Orthes! Toulouse! have followed each other in rapid succession—we can but name them and be silent.—At the time of writing this essay there were two names alone of moment in the world—Napoleon and Wellington. What changes have a few short months produced—how many heroes have arisen to Europe—how many entitled to rank as her arbiters. Yet he who first inspired their triumphant exertions still maintains his proud pre-eminence; while of his mighty competitor, we are reduced to exclaim, like Ossian, at the grave of the warrior, "With three strides all thy possessions are compassed, Oh thou that wast so great before!"

the polished arts of protraction and deception may derive their most striking effect from long and studied exercise; but a minister may possess all these virtues in perfection, yet fail of being esteemed a blessing to his country. His opinions are of more consequence than his operative skill; and are more likely to affect the permanent interests of society. But the influence of habit on opinion has seldom a favourable tendency. Prejudices do not often lean to the side of reason, truth or justice—and the body of a Fakir is not more cramped by his favourite posture, than is the mind by a weak and predominant tenet.

It is a melancholy amusement to reflect on the prodigious absurdities in politics and religion, which in all ages of the world have been adopted by the mass of mankind, and, in some countries, with the full acquiescence of the select and the studious. Indeed the ignorant would perhaps always content themselves with the suggestions of common sense; but these are too often forgotten in the lucubrations of the learned. Excessive refinements of reasoning have introduced many a doctrine irreconcileable with common sense; and the ignorant bow with deference to the tuition of the learned, if their mind happens to be unoccupied. But the opinions which they once imbibe from their teachers, they hold more tenaciously, in proportion as they are absurd. They acquire a habit of regarding them as sacred; and the habit grows older and stronger, and at length bids defiance to the united powers of reason and common sense. Why should we exclaim against the opinions of the vulgar—the grossest they entertain, were perhaps a few centuries back, engendered by the most learned and eminent of the day.

But it is not the vulgar alone that are slaves of this habit. Men of high rank, and some education, submit with the multitude to the shackles of prejudice; and the more important the question and the deeper it concerns us, the less are we disposed to investigate its merits, or examine the opinions we harbour on the subject. It is true, a spirit of enquiry is universally spreading; and its progress is proportioned to the process it adopts. Human reason, after an excursion of thousands of years, has been brought back to common sense. This has been effected, in the science of the material world, by Bacon—and under the guidance of his precepts, by Reid, in the immaterial. Knowledge is encreasing in every class of society; and flows from innumerable sources, fertilising every corner of every land. It has been truly remarked, that when sovereigns become philosophers, or philosophers sovereigns, the people will then be happily governed. But if the people become philosophers, their governors must of necessity become philosophers also. When the whole mass of society was buried in ignorance, a trivial superiority in knowledge sufficed to direct or control it. But those times are passed away; and as science encreases (and God seems to have provided that henceforth it shall for ever encrease) the governors must at least keep pace with the governed. The mists of prejudice will spontaneously disperse before the radiance of knowledge—politics will become the science of creating and perpetuating the happiness of nations—christianity will every where reassume the pure robe of her Author, and unite all her children in the bonds of *his* charity. The powers of the intellect will augment with the habits of exertion; and the supremacy of virtue extend with the practice of goodness. It may be a weak, but it is an innocent enthusiasm, that anticipates that distant day, when man, having gradually ennobled his nature, and ripened the perfection of which he seems susceptible, shall triumph over every moral evil; when enmity shall cease between factions and states; and the empire of virtue, peace, and happiness, no longer be visionary.

The generality of men are averse to the adoption of new tenets; and perhaps this constitution of our nature may answer the wisest purposes. For it is better that we should be tenacious even of a weak or absurd notion than flippant in relinquishing just and long established opinions—the fruit of industrious examination, and conscientious reflection—through the simple gratification of the love of novelty. But when this affection is employed in the pursuit of knowledge; and mature investigation has discovered a truth subversive of a doctrine to which long habit has attached us; it is then we should overcome this propensity of our nature; nor suffer a disposition which was intended for the support of truth and virtue, to degenerate into an auxiliary of folly and falsehood.

But if the simple love of novelty has little place in the regulation of our opinions, much less does it sway us in the exercise of our moral capacity. Virtue is never adopted for the sake of any novel sensation which may attend it. Its strength, its continuance, its very existence, depends on habit. Novelty bestows no beauty on the attractions of goodness—the longer we are acquainted with them, the more we feel their power. The first act of virtue may indeed be accompanied with emotions, never afterward experienced. But her dominion is not complete, until her precepts are obeyed spontaneously and without a struggle.—Tumultuous feelings make room for a complacency bordering on delight, which encreases with each successive act of virtue, and if elevated to its highest degree would be perhaps supreme felicity.

Vice, no less than virtue, is the child of habit. Within her domains, it is true, she may be intoxicated by the fascinations of novelty; but the superior novelty of virtue has no talisman to dissolve the enchantments of habit. The first act of vice is preceded by apprehension, and attended by remorse—repeated acts may blunt these stings of conscience; but the mind at last consigns itself to a hopeless state of depravity and wretchedness—a struggle may yet retrieve its liberty: but the same power, the power of habit, which renders virtue superior to the whispers of seduction, renders vice as insensible to the clamours of duty, and extinguishes every capacity in man, but such as fits him for irretrievable misery.

Conscious of this indissoluble law of our constitution, how anxiously should we direct its operation to our final advantage. Endued as we are with appetites and passions, which within a certain compass are necessary to the preservation of the individual, the propagation of the species, and the happiness of society, but when let loose and abandoned to the violence of their career, are as destructive in their fury, as they are beneficent under the restraints of conscience and reason—so endued—with what solicitude should we acquire the habit of confining, within their appointed limits, these dubious directors, which waft us round the circle of virtuous enjoyment, or hurry us into the regions of turpitude and misery, the operant causes of much natural good---the indisputable authors of all moral evil.

Our infancy is assailed by a host of rebellious passions, which will accompany us through life, if not early subdued, and constantly restrained, by force of habit. That sensibility to pain, which indicates itself by tears and cries, and is necessary to the preservation of so tender a creature, soon becomes confirmed peevishness, petulance and rancour. That passion, which was intended in the progress of life to promote our welfare by steadiness and perseverance in our pursuits and labours, may in its very outset deviate into stubbornness and obstinacy. That emulation, which might one day raise us above our fellows, may be transformed at its birth into a pitiful or malignant envy. That pride, which has been provided to dignify the lofty nature of man, may sink into silly vanity, or swell into overweening arrogance. And that provident apprehension of insurmountable danger, which by rendering us circumspect and prudent is necessary to the preservation of our frail existence, and even to the successful exertions of heroic courage, may degenerate into pusillanimous cowardice and contemptible dastardy, and all the despicable crimes that follow in their train,---duplicity, falsehood, meanness and treachery.

These are the vices of infancy, and they may debase and torture every successive stage of life. Those of youth are intemperance and incontinency. Forced away by the extravagance of his passions, strengthened perhaps by an unmeaning ambition, the self-immolated victim sacrifices his health, his prosperity, his virtue, and his happiness---at the board, or in the bed---of debauchery. He forgets the charm of the temperate and chearful meal,---and he has never known the refined and exquisite intercourse of virtue and love—that fond hope, the first to be formed and the last resigned, by the warm imagination, pure heart, and cultivated intellect. Habit rivets his fetters,—he grows old in a tavern or a brothel—the inroads of vice are traced within and without—he possesses the features and the feelings of a satyr—and having devoted his life to the vain pursuit of happiness, he remains to the last unacquainted with its nature, and incapacitated for its enjoyment.

But there is something more to be observed than the mere restraint of our passions. This probationary life abounds with temptations, and we ought not to create them for ourselves. We should prudently consider how we are constituted by nature, and not submit ourselves to trials too strong for our virtue. Indifference or Apathy may walk over the burning ploughshares, which Sensibility and Ardour cannot approach with safety. That the earth shall be peopled, and its inhabitants happy, rather than the wealth should encrease and the pride be fostered, of families or individuals, is the manifest design of Providence. He has therefore planted in man and woman the strongest, and, in civilised life, the most delicate of passions. It is the fashion to ridicule it as absurd and romantic; and the generality of marriages are contracted with a determined disregard of this necessary party. It is painful to reflect on the consequences daily obtruded upon us. Love avenges too often the slights he receives; and the devotee of rank or fortune, finds too late, that neither can supply the place of affection. A habit of propriety, or reverence for religion, may be safeguards in the hour of trial—but without them, what becomes of the deluded tempter of her own virtue; who in rebelling against the natural institutions of the Author of her being, yields voluntarily to a life of struggles; and sacrifices the finest feelings with which he has hallowed our nature, to anguish and despondence, or to shame and misery.

It is true, congenial minds may not always meet, or if they meet, cannot always be united---but it is ever in our power to shun a discordant union; and how much happier than a state like this and all its hazards, is the tranquil tenor of an honorable celibacy.

Ambition is said to be the vice of manhood, and avarice of old age. They have perhaps attained their excess at those periods, but their seeds have been sown much earlier. The intrigues of the courtier have probably their origin in the manœuvres of the schoolboy—the covetousness of decrepitude, in the selfishness of childhood—and all the evils of the gambling table, in the trivial but pernicious games of chance, to which children are sometimes allowed to devote themselves, in dereliction of more manly, energetic, and generous sports.

But if the germs of vice take an early root in the heart, so do also those of virtue. Nor those only which consist in self-control, and the government of the passions, but the positive and more amiable virtues of veracity, generosity, courage, magnanimity, that philanthropy to which all mankind, that charity to which all creatures are dear. These two extensive principles of benevolence have their source in the narrow circle of domestic affection. Even veracity is practised as a duty, long before the mind can have a distinct conception of truth—courage developes itself in the infant—magnanimity in the schoolboy. It is almost three thousand years since the days of Homer. In the course of that period, how many heroes have sprung from the inspiration of his verses. Every passage teems with greatness; and *one* might be selected that seems the very matrix of heroism. From the youthful eye, how many tears have flowed over the tenderness and magnanimity of Andromache and Hector. How many have wept for the glory of a fate like his, and lived to deserve it.

A sense of piety is early implanted by the example of religious parents. But it has not struck its roots deeply and immoveably in the mind, until we have experienced our continual dependance on the Author of our being for its momentary preservation—until perilous escapes assure us of his providential protection,—until despairing of our usual supply, we unexpectedly receive our daily bread; and, though by natural means, acknowledge that we owe it, nevertheless, to his bounty,—until we are sensible that all the inhabitants of the earth are equally his pensioners,—until we regard with grateful wonder, the goodness that inspired, and the wisdom that contrived the marvellous, yet natural arrangements, by which he feeds us. Then, and not until then, when these views and feelings are interwoven in our minds by the unremitting and invincible force of habit, we may be satisfied that we have laid the true foundations of our happiness.

But speculation is not sufficient to erect the edifice. Temptations solicit and must be subdued, disappointments harass and must be disregarded, afflictions overtake and must be endured. But these habits are not often acquired in the outset of life. We must long be familiar with temptation, disappointment and affliction, before we attain the habitual power of rising superior to them. It would be curious to trace the common progress of the mind, among the intermingled virtues and vices of the still semi-barbarous state of *civilised* society. Golden dreams of prosperity tincture with an honourable ambition, the hopes of youth. Romantic visions of sympathetic affection and impassioned felicity brighten his distant prospects. His sanguine expectations waft him to an elysium where

> ———————Love lights
> His constant lamp, and waves his purple wings,
> Reigns there and revels—not in the bought smile
> Of Harlots——loveless, joyless, unendeared
> Casual fruition!

These are the virtuous and honourable views of most persons in entering upon life; but the allurements of pleasure, and incentives of passion too often hurry them from the path they had deliberately chosen. But they soon find that intemperance, extravagance, and debauchery, are at once crimes, and punishments; that there are pleasures which can only be purchased at the expence of the happiness of others; but that the generated Misery grapples, with redoubled strength, its selfish Author—that Vice and Folly are unfailing founders of the school of Adversity; and that this Preceptor is in its turn the best promoter of Virtue; under his discipline they learn to retrieve their former principles, they listen to the hints of Conscience, and the precepts of Reason, and are taught by them that present Enjoyment is too surely a passport to Misery; and that Self-denial, Labour, and Pain, spin the clue, that unravels the way to genuine Happiness.

Fortunate is the individual who has passed through the ordeal of youth, and enters on the threshold of manhood, impressed with this conviction, and purified from the adhesion of any habitual depravity. But doubly fortunate is he, who, resolute to withstand the strongest and keenest emotions of his nature, except within the bounds of legitimate gratification, finds early the hallowed opportunity, so ardently wished for by every mind that possesses a spark of sensibility or virtue. The present state of the world cannot admit of extending this happy allotment to all, yet the excluded wretch finds consolation at last, even among the dregs of disappointment. His mind gathers strength from the pangs of defeated hope; he compares his anguish, seated as it is in the imagination, with the substantial miseries of others; he perceives that fortitude can subdue the former, but can only endure the latter; he covets the repose of indifference; he shrinks from the perturbations of suspense, and even from the tumults of joy; he sinks into the listless seat of resignation; and if Philosophy places herself beside him, cold and dispassionate as are her attractions, he will not be without a mistress that can awaken him from his apathy, and indulge him in pleasures unmingled with regret or satiety.

It is in these torpid enjoyments, this delicious tranquility that consists perhaps the happiness of old age, the turmoils of the world no longer possessing any interest, nor the emotions of passion any power. The memory feels no pain in looking back even on afflictions—the imagination no pleasure in the foretaste of any earthly delight. Peace, quiescence and comfort take possession of the mind—and joy, rapture and extacy are for ever excluded, unless their sunbeams find admission through a vista that opens beyond the grave.

The moral progress of mankind differs little from that of an individual; and many of the difficulties occurring in the consideration of God's moral government, find an easy solution in the nature he has bestowed on man, and the powers and privileges with which he has endowed him: ordaining as one of his original laws, that the constitution he has established for this peculiar being, shall not under any circumstances, however cogent they might appear to a superficial inquirer, be infringed or violated, even by divine control, restraint or interference.

The constitution of man comprehends those appetites and passions so necessary, in their allotted uses, to the happiness and very existence of the species, yet in their abuse so pernicious and destructive. It also comprehends the faculties of conscience and reason—the one to check the wild career of passion, at the moment, by an instinctive communication, that to proceed is criminal,—the other, to look into futurity, to measure effects and discover consequences; to admonish us of the perils, sure though remote, of imprudence and guilt; and in fine, to elevate the nature of man, by rendering him conversant with truth and virtue. And last of all, in the human constitution is revealed that most disputed of his faculties, yet the most absolute and inviolate in the eye of its Author—free-will. By this, man has the high prerogative of submitting, according to his inclinations, to the government of his appetites and passions, or of his conscience and reason. By this he becomes a moral and accountable creature, is capable of vice or virtue, and obnoxious to punishment or reward.

Let us close for a moment the volume of history, and consider what would be the probable conduct of creatures so constituted, from their creation to the consummation of all things. It is evident that the impulse of the passions would be at first omnipotent. Conscience in its infancy is rather a capacity than a power. We must witness oppression and sympathise with the injured, before this faculty is developed: we must meditate injustice, we must become in imagination a spectator of our offence,* we must feel that spectator's sympathy for the offended, and then for the first time Conscience finds employment. Reason is later in its exercise; it must have witnessed sure and inevitable, though distant consequences, it must have learned that present pain may end in future pleasure; and the happiness of a moment, in the misery of years. Then, and not until then, does

* See Smith's Theory of Moral Sentiments.

reason become a restraint upon the passions. It is therefore no wonder, if man in his freedom should yield himself a slave to his appetites, and that his first step should be in vice. Unassisted by reason and conscience, may we enquire with decorum what other barrier could be placed by the Deity for the protection of his innocence, without infringing on the established constitution of his nature. Perhaps we might rationally say, some positive command to abstain from an act in itself indifferent; but which, while obeyed, would defend the approach of all transgression intrinsically evil. Such a prohibition ought fully to counterpoise the force of the passions; but if once disobeyed, a recoil must ensue proportioned to the restraint. Crime would naturally follow crime, example become infectious, and habits of wickedness spread such corruption, that the business of life would be violence, murder, and lust, in all their most ferocious and detestable forms.

In this state of things Conscience would find sufficient food for its growth; and add to the anguish of vice without sapping its power. Nor would Reason want employment, in reflecting on miseries, which multiply in proportion to crimes. But half of the argument would lie beyond its grasp, it could know nothing of the blessings that wait on the virtues. In defiance of reason and conscience, the passions in all their pollutions and horrors would therefore reign paramount. The nature of man could afford no resource; and the earth must remain a mass of encreasing corruption, unless Providence order the adequate remedy.

A remedy were easily found, if the counsels of God permitted the violation of his prior establishments. "Let reason subdue the passions" were as easily said as "Let there be light." But the law which ordained the freedom of will, would then fall a sacrifice, that basis of virtue and vice, of man's moral subjection, and God's moral government.

It would be more suitable to the operations of Providence to dispense with a law less essential to the government of his rational creation, and to select from mankind a virtuous few, if yet such a remnant remained. Through these organs, denouncing his vengeance, working on their fears, and appealing to their reason, men might be possibly drawn from their sins and restored to a sense of gratitude and duty. But if all these efforts should fail, and humankind sink brutalised in one abyss of depravity.—If amendment were hopeless, and example and habit should spread a contagion, daily encreasing, and for ever incurable, it were mercy to all future generations of men to cut off the pestilence, even by the terrible remedy of destroying the infected. As individuals, they must naturally perish in a few years, bequeathing their inveterate distempers to their children: as a multitude or a race, their fate is more horrible; but they do not transmit a perpetual inheritance, to beings created to be pure and happy, of abominable vice and hideous misery.

It is natural to suppose that the impression of these awful judgments on the surviving few, must at least deter them from the most enormous crimes of their vile progenitors; but their jaundiced eye would scarcely discriminate between lesser offences and virtues: and the corruption of the extinguished generation would still entail some portion of its poison on the succeeding. Want of temperance, of filial piety, of chastity would soon be apparent; and more atrocious vices, in time might renew such inveterate and irremediable habits, as could only be destroyed with the communities they afflicted. Reason however would have ampler exercise, and would not always yield the triumph to the passions. But reason itself would naturally stray from truth; and, as yet, an unskilful guide, would lead mankind into a thousand pernicious errors and absurdities.

Reflecting on the mixture of good and evil, the human understanding perversely hunting after subtilties, would naturally overlook the effect of the passions, and ascribe the existence of vice and misery to an imaginary Principle of evil, contending for ever with God the Principle of good, and almost sharing with him his omnipotence. To this phantastic Being the apprehensions of men would unavoidably lead them to bow in adoration. They would gradually multiply him into as many divinities, as they fancied there were objects of dread: and all trace of God himself would be lost in a similar distribution of his attributes, among as many objects of benevolence and power. Reason itself would acquiesce in the propriety of consecrating to these objects of hope and terror, all that was most dear and precious to their votaries; and the sacrifice of their flocks would soon be succeeded by the immolation of their children.

At such a crisis, if no remedy were to be found in human resources, and that the intervention of the Supreme Being became a matter of necessity, with our experience of his counsels, there is little presumption in conjecturing what course his wisdom would be likely to adopt, and how far it would be seconded by human conduct. If previous to its execution, the scheme were submitted to our judgment, should we not think it adequate to the end proposed, if God should raise up a nation consecrated to his service and instructed in his laws, confessing his hand in its miraculous origin, its miraculous education, its miraculous establishment, attached to his parental care by reiterated deliverances and unceasing blessings so long as it deserved his favour; and recalled to its allegiance by the severity of parental castigations, whenever it departed from the knowledge he revealed and the obedience he required.

Such a nation, though surrounded with the absurdities of Polytheism, which plunged the rest of mankind in folly and iniquity, would still, in the main, preserve consistent notions of the one true God, his power and providence. Time and habit would engraft them in the understanding, and miraculous intervention be no longer necessary. But man is prone to change; and the solemnities and circumstances prescribed as a barrier to separate the favoured nation from the corruptions of the earth, would in time be regarded as the essentials of religion. It would therefore be necessary to re-establish it upon its true and only basis, the Love of God and Man. And if civilisation and science had already awakened the other nations to a suspicion of the errors that obscured their understanding, the season must then have arrived for revealing to all mankind, "The Unknown God."

These important objects could hardly be accomplished without the aid of miracles; and the manifest assent of the Deity to the promulgated doctrines. After so long an interval, they would carry accumulated force; and if the former series was of a nature to ratify his tremendous power, by its public exertion in favour of the only people who believed in his name; the latter series ought to be adapted to announce his good will to all the inhabitants of the earth; and by the exercise of particular instances of omnipotent benevolence, convince mankind of his unremitting and universal Providence, that shields them through the warfare of life, and makes death itself but the gate of immortality.

Should these miracles be submitted to the inquisition of the senses, those grand and only inlets of our knowledge—should the doctrines they were brought to sustain be further supported by ancient predictions marvellously verified—should events be then foretold which were afterward fulfilled in all their parts, or so far accomplished as that successive generations might witness their progressive completion—

should the very actors and witnesses of these transactions have instituted ceremonies that have descended without interruption through the lapse of ages—should they have unfolded their simple doctrines, and detailed the extraordinary acts they performed or witnessed, in unadorned compositions, some of them intended as a lasting record, and others for mere temporary purposes, yet all of them transmitted to posterity, and found to be a reciprocal voucher and confirmation of their mutual truth—should all this accumulated evidence be offered to our deliberate consideration, it seems sufficient to command our assent. But it is not calculated to command that assent, without that deliberate consideration. It does not bring intuitive conviction, like an axiom; but puts our reasoning powers into motion, and appeals to the improved and ripened judgment. Were it intended by our great moral Governor, that, unlike every other evidence, we should believe this, without enquiry or investigation, he would have left no room for doubt or hesitation; but by a miraculous compulsion have rendered mankind believers, and thus have invaded their great privilege of free will: or have established such a universal system of miracles, as would force intuitive conviction on every individual, and thus have suppressed the exercise of his reason (the grand characteristic of the species) in matters best entitled to its most strenuous exertion.

It seems pleasing to God to observe the gradual development, rapid growth and gigantic strides of this wonderful faculty; and while he presents it with facts sufficient to awaken its powers, or convey a hint of the discoveries it may reach, he appears most scrupulously to abstain from stifling its efforts by an overwhelming pressure of incontrovertible testimony. He suffers it to err and detect its errors—to build hypotheses and then to overturn them, and perhaps amidst the ruins to discover the hidden foundations of truth—to acquire strength in its progress from the birth to the maturity of its possessor—from the birth to the maturity of the species —unassisted unbiassed, and uncontrolled by his interference.

We may therefore expect that in his revelations to man, however authenticated by miracles, he will always leave room for the exercise of this power. Nor should we be astonished, if his instruments be human, to detect human doctrines sometimes mingled with divine. Much less have we any grounds to suppose, if an unauthorised host of expositors and disputants misapprehend his promulgations, and preach their own follies in his name, that he will miraculously reform their reason, or control their free will. And least of all if in support of their impious absurdities, they weaken and corrupt his doctrines by interpolations, forgeries, frauds, and false miracles, that his divine intervention will interrupt their career, by a preternatural obstacle, when he has previously provided a sufficient impediment, in the Reason he has given us.

Much has already been done by this natural guide, in detecting and exposing the silly and criminal inventions of men. But it also is true, her instructions have not been universally adopted; and multitudes are content to continue the slaves of example and habit, and abandon themselves in the vigour and manhood of their understandings to a system of errors, fit only to impose on the credulity of childhood, or the inanity of dotage.

This perversion of intellect could scarcely have arisen, were it not for a term of fearful importance among the abettors of human degradation. They have not invented the word—but they have distorted its meaning. Faith may be sometimes interpreted simply "belief"—sometimes "reliance on God," and perhaps it sometimes is used in this double capacity: but never except in the glossaries of ignorance, superstition, or enthusiasm, does it signify "an assent to a conclusion unsupported by premises"—nor can it be supposed by a sane understanding, that God is best pleased with his creatures, when they most firmly *believe* without evidence, what the faculties he bestowed declare most *incredible*. On the contrary, it is manifest, that if it is in the power of human beings to acquire the favour of God, it must be by the exercise of that towering faculty, which keeps the passions in subjection, enlarges the dominion of the intellect, and in unfolding the immensity of nature, elevates the mind to a conception of its stupendous Author.

As the reason of man advances toward perfection, the improvement of the physical and moral world must necessarily advance with equal strides. Every addition of knowledge is an addition of power; and the acquisition of an unknown truth is a step to other truths still more recondite. Science has already accomplished prodigious things, and how far she may diffuse her sway, is at present inconceivable. As civilization extends, the very earth learns to assume another aspect;—as the moral sentiment prevails, the encreased refinement of ociety becomes more prominently manifest. Vice abandons her grossness, or she would not be endured; and if her seductions are more dangerous in the garb of delicacy, the triumphant progress of virtue is but the more conspicuous. Remote is the period, but we may hope that it will one day arrive, when under the cultivation of man, his habitation shall become a second paradise; and as the self-same Reason that unlocks the secrets of Nature, and almost puts her operations in his power, also commits to his hand the control of his passions and the direction of his will,—at that propitious period, he will gradually have become a Being qualified for his renovated residence; vice and misery, war, pestilence and famine, will be perhaps unknown, except in the salutary records of their ravages; and the easy yoke of virtue and religion, will be no longer a burden or restraint, but,—accompanied by the anticipation of consequences, and the power of habit,—will become undeferred and present felicity.

In this discussion of the moral progress of man, we have almost lost sight of the love of novelty; so trivial is its influence, compared with that of habit, in propagating the virtues and vices. Yet it is not without its operation; and the mode in which it acts ought not to be omitted. Novelty is one of the moving springs of those feelings, which occasion actions, that afterwards become habitual. The more seldom we have witnessed misery, the more intense is our compassion; but it is a chance whether the pain we feel excites our aversion to the object, or impells us to relieve him. In either case, the keen sense of pity grows more obtuse as it finds occasion for exercise; but every occasion tends to establish the habit of turning with disgust from the appearance of wretchedness, or hastening to its aid with consolation and succour. Exercise diminishes the force of impressions, but strengthens the power of habit. This is not owing to two distinct laws, as might be imagined, but to one and the same. For every habit to which we are subject, whether intellectual or corporeal, gradually loses the power of exciting attention; so that a certain train of thought or action, which in the commencement, could not take place without making a lively impression, in consequence of the exertion it required, or the sense of novelty it occasioned, afterwards occurs so spontaneously and in course, particularly when the habit is strongest, as often to escape observation altogether. Just as opium or any other medicine or condiment in constant use, gradually loses its effects on the constitution, unless its quantity be encreased or its form altered; so pity, grief, hatred and love itself, cease in time to create their wonted sensations; unless the object of these passions has the happy art of adding to the stimulus, by the mixture of some novel ingredient.

But with or without the excitement, the habit progressively strengthens; while the organs become more and more insensible of its existence. For example: poison itself taken into the stomach in quantities too small to injure the health, and gradually augmented, affects the constitution as little as its ordinary food; and habit renders that viscus so familiarised to its effects, that it would require a great and sudden increase of the quantity, to destroy its powers or endanger life. In like manner the muscles, inured to any particular action, as sweeping the strings, or gliding over the keys of a musical instrument, discharge their functions unbidden, and with the rapidity of lightening. And this surprising volubility of execution excites no attention, nor requires the slightest exertion of will, unless interrupted by some novel occurrence. as when a person accustomed to perform alone, undertakes to play in concert; or excelling on one instrument only, attempts to thrum on another. It is not otherwise with the passions. The emotions of love gradually subside. The mind habituated to their impressions no longer swells into tumult; yet all the tender offices of affection follow each other spontaneously and unobserved, because they have become too natural to require the interference of the attention or will. But when some unexpected proof of sensibility and fondness touches a responsive string, we feel it with the force of a first impression; and it is an ungrateful heart that can forbear to exclaim with Moore,

> "Give smiles to those who love you less,
> "But keep your tears for me."

Our rational and moral faculties obey the same law; and an absurd opinion is cherished through life as an incontrovertible truth, and a shameful vice as an amiable failing, until they are pushed to a novel and unusual extremity; and then they give an alarm to reason or conscience, and the true nature of each stands revealed; though habit perhaps will continue to cling to them both, in spite of conviction.

Such are the powers of habit and the effects of novelty. Their conjoined operation in man has been wisely contrived; and each has most influence, at that season of life, when most it is requisite. In early infancy the love of novelty, so necessary to excite the energies and develope the understanding, greatly preponderates: and no habit is formed that may not be abandoned at will. In youth this affection long finds employment; but in time the two principles begin to balance each other: the desire for new objects grows gradually weaker; unless indeed a thirst of knowledge is excited, and this is insatiable: and habits of virtue and vice now strike their roots, but as yet not so deep but they may be eradicated. In manhood the counterpoise at length is complete. The passion for novelty finds exercise in pursuit of knowledge and truth. The habits become fixed, and virtue or vice is establised on foundations of adamant. Old age comes at last, and habit reigns paramount. The knowledge already acquired is considered the ne plus ultrà of human attainments; and innòvations in philosophy, religion, or politics, are regarded with horror. Before this period of life, Vice has most commonly cut off her votaries. The hoary profligate is an object as rare as disgusting. But even the young and the gay, the thoughtless and giddy, the dissipated and the vicious, unite to pay homage to the burden of years adorned by virtue, and enjoying or prepared to enjoy the rewards of the virtuous.

On a view of the whole of our subject, we well may conclude that it should be the constant solicitude and ardent ambition of rational beings to improve the LOVE of NOVELTY into a desire after KNOWLEDGE and TRUTH, and the INFLUENCE of HABIT into the PRACTICE of VIRTUE and PIETY.

CONTENTS.

AN

ESSAY

ON

THE INVENTION

OF

ALPHABETIC WRITING.

Read, May 8th, 1815.

THE difficulty of accounting for the invention of Alphabetic Writing, and the impossibility of tracing any connexion between letters, which are the representatives of sounds, and hieroglyphics which are resemblances of things, has induced men of extraordinary erudition and talents, to ascribe the gift to a direct revelation from heaven. And when we consider the prodigious sagacity, the wonderful powers of discrimination, the profundity of thought. and the almost infinite comprehension requisite to analyse words into their component parts—sounds appearing simple, into sounds still more simple—to discover that the multitude of words in a language are composed of a very small number of sounds—to ascertain precisely this small number, and to annex a mark to each, we shall not be astonished that the eminent men to whom I have alluded, should deem the human mind incapable of such an effort, and esteem it necessary to cut the knot by a miraculous intervention of the Deity.

Hartley conjectures that the communication was first made to Moses, on the delivery, at mount Sinai, of the two tables which the sacred historian declares to have been written by the finger of God;* and Wakefield (who, still less than Hartley, can be suspected of weakness or credulity) supports a similar opinion by very convincing arguments,† without adverting, however, to the particular occasion on which the revelation was made to the Hebrews, or even referring to the discussion of Hartley on the subject. But so great are the achievements, so extensive the dominion attempted and attained by the mind of man, that I am more inclined to solve the difficulty in a natural way, by ascribing the discovery to those exertions which have hitherto found a specific for every want, as soon as the want was felt, rather than assume, without manifest necessity, a departure from the course of nature, and those laws by which Providence visibly governs the world.

It may be said that when alphabetic writing was first adopted, there was not such a want of the means of re-

* Hartley on Man, 1st v. 308. octavo edition.

† Second Appendix to Gilbert Wakefield's Life.

cording events, opinions, and laws, as would spur the human mind to the exertions requisite to this great discovery. Mankind must have been in possession of Picture-writing, Hieroglyphics, or that improvement upon them which exists at present among the Chinese, and these were sufficient for all their purposes. They are, it is true, greatly inferior to the alphabetic mode of writing; but as the former could never improve into the latter—as they are each perfectly distinct and unconnected in their kinds—as one represents things and ideas, and the other neither things nor ideas in the first instance, but sounds, how could the former mode be abandoned, and the latter adopted, when the one though inconvenient seemed fitted to all the wants of the writer; and the other was not only untried, but was even of such a nature, as that no sagacity could conjecture its utility until subjected to reiterated trial?

It has been ascertained that the nations bordering on China, and which speak a different language, can read and understand the Chinese when written, though they cannot comprehend a word of it when spoken;* and in perusing a Chinese work, it is their own language they pronounce, and not that of China; and this because the characters represent things and ideas—not sounds. We should therefore be inclined to suppose that two natives of China might

* Staunton's Account of the Embassy to China.—Vol. 3. p. 420. 2d. edit.

use different words, provided their meaning was similar, in reading the same passage. For example; one man, according as his style was familiar, formal or easy, compressed or diffuse, might read certain characters thus:—" The deeds of talented men weigh more than the precepts of wise ones."—Another:—" Genius that acts, is of more importance than Wisdom that declaims."—A third:—" The actions of the able are superior in value even to the words of the wise."—And there can be little doubt but that this was the case in the infancy of their written language. It has now, however, arrived at the highest perfection of which, perhaps, it is susceptible.—The prodigious number of its words, for each of which there is a separate character, comprehends a multitude of synonimes.—Most of the words are monosyllables; and as each is designated by a distinct character, the sound is as perfectly ascertained as if it was intentionally represented; and the only inconvenience, (but which is almost an insurmountable one), is the incredible number of characters that become necessary, when every word must have its own peculiar representative.

There was a time, however, among the Chinese, Egyptians, and other nations, using similar symbols, when the art of writing was yet in its infancy, and its progress in improvement but little advanced.—At such a period, the characters must have been confined in the strictest sense to the representation of things and ideas only; and in pronouncing them, any word might be used in the place of one which was synonimous. The meaning might still be certain, though not so precise as if sounds had been represented by those characters; yet there could not be that strong necessity for the signs of sounds, which would be sufficient to instigate the mind to labour after so profound and recondite a discovery. What then, it may be asked, could create this strong necessity?—I reply, in a word, Poetry—and Poetry alone.

Circumstances may be picturesque and ideas poetical, but they do not constitute poetry, unless they are clad in the language of the Muses. The harmonious flow of sounds is the very essence of a poem; and to fix and consolidate their volatile and evanescent nature, to give them stability and render them permanent, can only be accomplished by marks which represent them; and not by the symbols of ideas, or the pictures of things. Hieroglyphics, or the improved characters to which Hieroglyphics in the first instance gave birth, could never have become the record of an Iliad or Æneid.—An alphabet was necessary to preserve them for succeeding ages.—Nay, without an alphabet, they would perhaps have perished during the very life of the poet who produced them; or possibly the most admired of his episodes would have continued their ephemeral existence, only so long as his memory could retain them. Let us then imagine a Homer, a Virgil, or a Milton, carried away by his sublime conceptions and the melody by which he gave them utterance—satisfied that they were worthy to excite emotions of delight and wonder in the latest posterity, yet persuaded that they were destined to vanish from existence, even at the moment they flowed from his lips—let us imagine those circumstances, and we shall have no difficulty in conceiving how an enthusiastic individual impressed with these emotions would exert every power of his intellect, to preserve from annihilation compositions which ought to be immortal. The motive would be sufficient for any labour of invention however surprising; and it may not be an uninteresting employment to discover, if possible, the progressive steps by which the task might have been accomplished.

Whether the inventor was of India, Chaldea, Phœnicia, or Egypt, he has not succeeded in transmitting to our days the verses which he intended to immortalise; or even a name that might justly rank, among the most illustrious of mankind, beyond that of Homer himself. Yet in the place of those works, for whose celebrity he perhaps alone was interested, he has bestowed upon us a gift of more value and interest than an hundred Iliads.—Not that it perpetuates those divine compositions which have humanised man, ameliorated his nature, and elevated his character with the traits of nobleness and magnanimity;—not that it has enabled him to record with unequivocal precision his observations and sentiments, and to argue, discuss, and ascertain with preeminent accuracy, every shade of probability, and limitation of truth within the cognisance of his faculties.—Not that it facilitates his progress in natural, moral, or intellectual philosophy, and the discovery of those simple and admirable laws by which the earth and the universe, matter and mind are so wonderfully governed—but because this extraordinary gift, which I am almost tempted to call divine, even while I am proving it to be human, opens at once the doors of knowledge to all mankind:—roots up the labyrinths of darkness that surrounded every temple of science; and admits, not the philosopher, and the legislator only; but the citizen, the mechanic, the rustic, and the labourer—nay the whole mass of society, civilised or dawning into civilisation, within those portals, from which, without its simple but powerful assistance, it must have been helplessly and hopelessly excluded.

How little did the original inventor conceive the inherent powers of his invention, destined to be one day multiplied ten thousand fold, by the less profound, but no less important, discovery of Printing.—Little did he imagine that he had set a force in operation, which was to overturn ignorance and barbarism in every class of society, and we may venture to predict, in every horde of the species, however at present degraded, and pour over the surface of the globe in irresistible streams, the blessings of knowledge, liberty, and happiness.

But let us turn from the sublime effects to the lowly instrument and unconscious prime-mover. Let us endeavour to analyse the process, by which a human being might have contrived an arrangement, which collectively regarded, might not unreasonably be deemed beyond the reach of human ingenuity, yet when elucidated by the analysis which shall be immediately explained, the invention, it is believed, will appear not merely a matter of possibility, but an event of natural occurrence.

Let us begin the investigation by tracing, if we can, the mode of proceeding which might have been adopted by any of our great epic poets, if he had not the means of recording his verses, yet was anxiously bent on transmitting them to posterity. Let us suppose Homer, Virgil, or Milton, labouring under this predicament, and endeavouring distinctly to note down the successive sounds which compose the first verses of the Iliad, Æneid, or Paradise Lost. Let us select one of this immortal triumvirate; and as the Latin Language is more uniform in its sounds than the English, and the Roman letter more convenient than the Greek for combining two or more characters into one, as will be found serviceable in explaining the process of the invention, let the Roman Poet on the present occasion be our guide.

Having composed and committed to memory the four first lines of the Æneid, he would have no difficulty in dividing the words into syllables as he pronounced them.

Ar-ma vi-rum-que ca-no, Tro-jæ qui pri-mus ab o-ris
1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15.

I-ta-li-am, fa-to pro-fu-gus, La-vi-na-que ve-nit
16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30.

Li-to-ra: mul-tum il-le et ter-ris jac-ta-tus et al-to,
31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46.

Vi su-pe-rum, sæ-væ me-mo-rem Ju-no-nis ob i-ram.*
47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61.

* Numbers are placed under the several syllables that the reader may trace them in the subsequent tables.

But as every syllable would seem a simple sound, he would be under the necessity of noting each by a separate character. In the lines just quoted he would find sixty-one syllables; but as thirteen of them are repetitions, forty-eight characters would suffice to designate them. Having sufficiently familiarised himself with these characters, so as to recollect the sound by the sign, and the sign by the sound, he would naturally group together those signs which represented sounds bearing the slightest degree of resemblance to each other. In this process he would find his forty-eight characters arrange themselves in five columns, perhaps in the order in which I shall represent them. He might have chosen different configurations, straight or curved, simple or complicated, for *his* characters; but I shall select for *mine* such as will remind my reader of the sounds which they are intended to represent.

1.	ÆR.	3. 26. 47.	VI.	4. 50.	RUM.	5. 28.	QUE.	7. 57.	NO.
2.	MA.	10.	QUI.	12.	MUS.	9.	Æ.	8.	TRO.
6.	CA.	11.	PRI.	23.	FU.	29. 52.	VE.	14.	O.
13.	ÆB.	15. 40.	RIS.	24.	GUS.	37.	LE.	21. 32. 46.	TO.
17. 42.	TA.	16. 60.	I.	34.	ML.	38. 44.	ET.	22.	PRO.
19.	AM.	18. 31.	LI.	35.	TM.	39.	TER.	54.	MO.
20.	FA.	30.	NT.	48.	SU.	49.	PE.	59.	OB.
25.	LA.	36	IL.	43.	TUS.	51.	SÆ.		
27.	NA.	58	NS.	56.	JU.	53.	ME.		
33.	RA.					55.	REM.		
41.	ȦC.								
45.	AL.								
61.	RAM.								

It is scarcely necessary to observe that in forming this arrangement he would naturally place, as I have done, the characters in the order in which the sounds occurred in the verses he was endeavouring to analyse.—For example, he would place *Ar* in the first column of the table;—*ma* in the same column, *vi* in the second column, *rum* in the third, *que* in the fourth, *ca* in the first again, and *no* in the fifth; and the prevailing sounds in the respective columns would not be in the order of our vowels, but thus:—a. i. u. e. o. and with respect to the situation of the characters in each column, they would be nearer the top or bottom in proportion as the sounds they represented were near the beginning or end of the verses submitted to this process. I have only to add that a person accustomed to pronounce the Latin language after the English fashion, may object to my arranging together sounds so dissimilar as *vi* and *ris*, *fu* and *mus*; but there are strong grounds to believe that they were not so pronounced by Virgil. The Italians, the French, the Spanish, the Portuguese;—in fact all those nations whose languages are derived to any extent from the Latin, for the most part agree in pronouncing *a* as in *all*, *i* as in *ill*, *o* as in *ore*, and *u* as in *pure*; *e* sometimes as in *revere*, and sometimes as in *revery;* and their evidence on this point has the force of four witnesses, testifying and coroborating the testimony of each other, that the Romans, from whom they derive their languages, transmitted to them also this mode of pronouncing them.

But to return to Virgil, and the task we have assigned him :—In separately studying the columns, as above arranged, he would perceive several sounds very closely resembling each other, yet at the same time distinctly different. I allude to the syllables which rhyme to each other, such as *ma, ca, fa, la;—no, to, pro, mó,* &c. He would clearly discover the simple sound *a* or *o* which he could distinctly pronounce, pervading all those rhymes; and he would at the same time ascertain that it was in every instance combined with another and different sound, which he could not separately articulate, but which, like an invisible elastic fluid in a chemical investigation, would satisfy him of its presence by its effects.

Now for the first time he would entertain sanguine hopes of success; and in the ardour of discovery he might possibly hasten to dissect, and assign distinct characters to the sounds in his several columns: or perhaps he would more systematically make a new arrangement of those columns, placing together in separate groups the several rhymes, for the purpose of entering on a more minute comparison of their component sounds. If such was a necessary step in the process, the following table may exhibit his new arrangement.

1	AR.	3. 26. 47.	VI.	4. 50.	RUM.	5. 28.	QUE.	7. 57.	NO.
		10.	QU.	35.	TUM.	9.	Æ.	8.	RO.
2.	MA.	11.	PRI.			29. 52.	VE.	14.	O.
6.	CA.	16. 60.	I.	12.	MUS.	37.	LE.	21. 32. 46.	TO.
17. 42.	TA.	18. 31.	LI.	24.	GUS.	49.	PE.	22.	PRO.
20.	FA.			43.	TUS.	51.	SÆ.	54.	MO.
25.	LA.	15. 40.	RIS.			53.	ME.		
27.	NA.	58.	NIS.	23.	FU.			59.	OB.
33.	RA.			48.	SU.	38. 44.	ET.		
		30.	NT.	56.	LU.				
13.	AB.					39.	ER.		
		36.	IL.	34.	MI.				
19.	AM.					55.	REM.		
61.	RAM.								
41.	AC.								
45.	AL.								

In considering the first of the five columns in this table, he would scarcely in his early essays be able to ascertain whether the sound *Ar* at the head of the column were simple or compound, not having another sound of sufficient resemblance with which to compare it. He would therefore proceed to the next sound *ma* and would find ample scope for his sagacity, in comparing it with the six succeeding sounds: *ca*, *ta*, *fa*, *la*, *na*, *ra*; and surely it would not require the inspiration of heaven to enable him to discover on comparing them, that the sound *a* existed in each, combined with another sound which could not be articulated without it. These indistinct sounds his mind could, however, embrace and discriminate. To make sure of his discovery he would affix a character to each, as well as to the articulate sound with which it was combined; and the first fruits of his labour would be the letters *a*, *m*, *c*, *t*, *f*, *l*, *n*, *r*. The discovery of the last mentioned letter would enable him to return to the analysis of the sound which he passed over at first; and as he had succeeded in finding that *ra* was composed of the sounds indicated by an *r* and an *a*, he would readily perceive that *Ar*, the first syllable of Arma, was but a transposition of the same sounds in the order *a. r.*

This minute circumstance can be but little interesting at present; yet no doubt it was of the highest importance to the inventor of the alphabet; for it furnished him with a test to discover whether a sound were simple or compound. In attempting to repeat in every possible way, any one of those sounds that have since been called vowels, it still remains the same, and cannot be inverted. It is therefore a simple sound. But combine it with another and the compound admits of an easy inversion: *ma* becomes *am*, *la*, becomes *al*, *&c.* After this discovery, the only difficulty that could occur, in considering the first column, would be the analysis of syllables composed of three sounds. The first that presents itself is *ram*, the last syllable of *iram*, and this is no longer a difficulty. It has already been analysed; and the sounds of which it is composed, arranged in the incipient alphabet under the characters *r*, *a*, *m*.

The same simple procedure would unravel the mysteries of the remaining four columns. To every sound he would affix its appropriate mark; and to every mark he would assign but the power of representing one sound. No dipthongs would enter into his system.—They appear it is true in the verses selected from Virgil. But the Romans did not invent their own alphabet; they borrowed it from the Greeks, as the Greeks borrowed theirs from the Phœnicians; who, it may be said, are indebted for their alphabet to the Hebrews, as the old Hebrew or Samaritan characters are nearly the same as the Phœnician. It may still, however, be considered a disputable point, whether these people did not communicate their alphabet to the Hebrews, as well as to the Greeks. But the original inventor of the alphabet, whatever was his country, would naturally mark every sound in his language by a single character; and those which are distinguished at present by the dipthongs æ and œ he would indicate simply by the character e.

It is remarkable that the analysis of the four first verses of the Æneid would have furnished its author, not only with all the vowels, but with fourteen consonants; a number almost equal to that which exists in the modern alphabet. Were the same process to be exercised on the succeeding verses, the deficiency no doubt would soon be supplied, and all the Latin characters appear in perfect array. Those elicited by the process we have just been supposing, would naturally occupy the following order, if taken as they appear in the last arrangement of the columns, beginning with the first and terminating with the fifth.

1 A.	14 I.	
2 M.	15 P.	
3 C.	16 S.	
4 T.	17 G.	
5 F.	18 E.	
6 L.	19 O.	
7 N.		
8 R.	20 *D.*	
9 B.	21 *H.*	
10 J.	22 *K.*	
11 V.	23 *W.*	Deficient.
12 Q.	24 *X.*	
13 U.	25 *Y.*	
	26 *Z.*	

And a glance of the eye will convince us that even these without any addition constitute an alphabet very nearly perfect: for with respect to the characters deficient, *d* is but the softened sound of *t*.—*h* but an aspiration.—*k* has the same power as *c* hard.—*w* is not necessary in Latin, or the languages originating from it.—*x* is a compound of *c s.*—*y* differs little in its powers from *i.*—And *z* is but a softened *s.*

Every step the inventor advances, the easier he finds the succeeding. Having travelled through the analysis of the two first columns, he has already discovered three vowels and thirteen consonants; in the remaining three columns he has only two vowels and one consonant to add to his possessions, for all the other sounds, whether simple or complex to be found in those columns, have already been examined and arranged in his alphabet.

At this stage of the process, we cannot but reflect on the astonishment he must have experienced, on thus discovering the paucity of simple sounds existing in the complicated variety of a language. Sixty-one syllables, containing forty-eight distinct sounds, are reduced and simplified into nineteen; and these nineteen are found in prosecuting the investigation, to be nearly sufficient to represent the entire of a language. He might have previously reasoned himself into a conjecture that the simple sounds were much fewer in number than the compound; but until the completion of the experiment, the most sanguine imagination could never have approached within many degrees of the truth.

Thus might a single individual have brought to perfection this wonderful discovery. Indeed we are almost compelled to admit from its nature, that it could only have been achieved by a single individual. Any progress one man might make before his ideas were completely developed could not possibly tend to assist any other. It is then natural to presume that we owe to the self-same mind, the conception of the plan; every stage of the process; and its perfect and final accomplishment, in so far at least as the compass extended of the sounds which he had occasion to represent: and from this original invention, it can scarcely be doubted, were copied all the alphabets entitled to the name, which ever existed.

Astle, it is true, whose laborious and extensive researches on the subject entitle his opinion to the utmost attention and deference, asserts that several of the Asiatic alphabets, which differ in the names, number, and power of the characters from the Phœnician, and those of which it was the source, must have been altogether of a separate and underived origin; and that it is most liberal as well as rational to suppose that different men at different times thought of making marks for sounds, instead of marks for things.* But strong as are the facts which he adduces, I am unable to divest myself of the opinion that the author of any alphabet, posterior to that originally invented, must have been previously acquainted either with it or some other derived from it; and that where no traces of similitude are

* See the 4th chapter of Astle on the Origin and Progress of Writing.

observable, that he adopted at least the principle on which those prior alphabets were formed;—rejecting their characters, either on account of some difficulty in applying them to a language requiring very different powers to designate its sounds; or perhaps from the vanity of encountering greater difficulties, and a wish to be considered an original inventor. Yet any man's ambition ought to be sufficiently gratified by the mere act of bestowing so inappreciable a gift upon his nation. What would not the Chinese owe to the individual, who could persuade their government to encourage the use of our characters, in place of that cumbersome and unmanageable machinery, which, if not the sole, has been the principal obstacle to their progress in the fine arts, literature, and science, the cultivation of the mind, and the intellectual embellishment of society.

It may be said that what has been done once may be done again. But so many circumstances must have concurred in the discovery of alphabetic writing, even in the simplified view we have been considering, that it seems to present, at least, one obstacle to the general application of the remark. If there be any plausibility in the process I have detailed, we can scarcely suppose that a plurality of individuals could have arisen in different ages and nations, qualified for the accomplishment of such a task:—all of them poets—all producing poems worthy, at least in their own estimation, of descending to after ages—all eager and enthusiastic to find a certain and permanent record for their verses:—

all, thus prompted to the undertaking, in possesion at the same time of the means of carrying it into execution:—a comprehension which could survey the intricate mazes of a language, and suspect that the whole might be reduced to a few simple sounds—a judgment that could decide on the possibility of designating those sounds, which inferior powers of discrimination would deem as difficult to delineate as pictures of odours, and tastes, and internal sensations:—a sagacity and genius fit to discover seeming impossibilities to be possible—and an indefatigable and pertinacious perseverance, *that* most efficient attribute of great minds, which demonstrates the possibility of an enterprise by its actual performance.

If this combination of circumstances, motives and qualifications must have concurred in the production of alphabetic writing, is it probable that such a conjunction should occur more than once? I admit that it is possible—but to my understanding, it is equally possible that a knowledge of the circulation of the blood, and the laws of gravitation, might also be discovered in different countries and times; and that Harveys and Newtons are to be esteemed but common productions of nature.

If it be admitted that the elementary alphabet may have owed its birth to poetry, it must also be confessed that the syllabic alphabets of the Ethiopians and Tartars* must have

* See Goguet's origin of Laws, Arts and Sciences.—Vol. 1st. p. 178. And Rees's Encyclopedia. Article Alphabet.

had a similar origin. It might therefore be supposed that long after the invention of a syllabic alphabet, it might have served as a step to the invention of the other. But this conjecture, though a natural one, seems not to be well founded. The powerful mind that invented alphabetic writing could have derived but little assistance from so weak an auxiliary—It would have been but an impediment to his progress; and by furnishing him with the means, however operose and unwieldy, of transmitting his verses to posterity, would have deprived him of the strongest incentive to the attempt.

This, however, must remain a doubtful question: but it is easy to perceive that in refining on the discovery of the original inventor, other ingenious persons may have contributed additional letters if other sounds should be detected which he had omitted to note; or adopting the principle and rejecting the characters, applied a new set of those arbitrary signs to represent some other language with which they harmonised better; while others may have formed a new arrangement of the original characters, in support of some system, or for the purpose of more easily instructing the ignorant. Yet when we look over the generality of alphabets, nothing like system or arrangement appears. Vowels and consonants, liquids and mutes—the representatives of every sort of sound, whether labial, dental, palatine, or nasal, are hustled together, without distinction or order, apparently as they issued at first from the brain that conceived them. Nor would this be an unimportant observation, were we fortunate enough to possess many of the writings of the primitive times: because it would furnish a test for discovering the most ancient production in which alphabetic writing was used, if it happened that such a production were still in existence. For if on an analysis of the first lines of the work into their elementary sounds, by the process which I have endeavoured to describe, the characters representing those sounds should arrange themselves in the order of the alphabet—I mean the alphabet of the language in which the work was composed—little doubt could remain, that alphabetic writing was used for the first time in recording that very composition; and was invented in the anxiety of its author, to snatch from dissolution the perishable sounds of which it consisted.

Such an expectation is not now to be entertained; and even if it might, the investigation could scarcely be desirable except to a mere antiquarian. A similar remark, perhaps, may be made upon the discussion that has already detained us so long.—I have nothing to say in its defence.—It examines a question of mere idle curiosity; and is scarcely interesting even to a few.—It is useless and unnecessary to any purpose or end—unless, indeed, it may be supposed of advantage, to open a more favourable view of the powers of the human mind, and that it shall be considered, not altogether fruitless or unserviceable to convince the unprejudiced, even by a single instance, that the best and only mode of overcoming similar difficulties, is to persuade ourselves that they are not insurmountable; and to encounter them by patient discrimination, and gradual, slow, and circumspect induction.—satisfied that it is unphilosophic, inconsiderate, and puerile to disentangle every perplexity, by resorting to miraculous interposition, where a little sagacity will reduce the achievement to the exertions of that reason, and those energies with which the Creator in his munificence has endowed mankind.