

[Footnote: See Pl. XXVII, No. 5.]

418.

A leaf always turns its upper side towards the sky so that it may the better receive, on all its surface, the dew which drops gently from the atmosphere. And these leaves are so distributed on the plant as that one shall cover the other as little as possible, but shall lie alternately one above another as may be seen in the ivy which covers the walls. And this alternation serves two ends; that is, to leave intervals by which the air and sun may penetrate between them. The 2nd reason is that the drops which fall from the first leaf may fall onto the fourth or--in other trees--onto the sixth.

419.

Every shoot and every fruit is produced above the insertion [in the axil] of its leaf which serves it as a mother, giving it water from the rain and moisture from the dew which falls at night from above, and often it protects them against the too great heat of the rays of the sun.

LIGHT ON BRANCHES AND LEAVES (420--422).

420.

That part of the body will be most illuminated which is hit by the luminous ray coming between right angles.

[Footnote: See Pl. XXVIII, No. 1.]

421.

Young plants have more transparent leaves and a more lustrous bark than old ones; and particularly the walnut is lighter coloured in May than in September.

422.

OF THE ACCIDENTS OF COLOURING IN TREES.

The accidents of colour in the foliage of trees are 4. That is: shadow, light, lustre [reflected light] and transparency.

OF THE VISIBILITY OF THESE ACCIDENTS.

These accidents of colour in the foliage of trees become confused at a great distance and that which has most breadth [whether light or shade, &c.] will be most conspicuous.

The proportions of light and shade in a leaf (423-426).

423.

OF THE SHADOWS OF A LEAF.

Sometimes a leaf has three accidents [of light] that is: shade, lustre [reflected light] and transparency [transmitted light]. Thus, if the light were at n as regards the leaf s , and the eye at m , it would see a in full light, b in shadow and c transparent.

424.

A leaf with a concave surface seen from the under side and up-side-down will sometimes show itself as half in shade, and half transparent. Thus, if $o p$ is the leaf and the light m and the eye n , this will see o in shadow because the light does not fall upon it between equal angles, neither on the upper nor the under side, and p is lighted on the upper side and the light is transmitted to its under side. [Footnote: See Pl. XXVIII, No. 2, the upper sketch on the page. In the original they are drawn in red chalk.]

425.

Although those leaves which have a polished surface are to a great extent of the same colour on the right side and on the reverse, it may happen that the side which is turned towards the atmosphere will have something of the colour of the atmosphere; and it will seem to have more of this colour of the atmosphere in proportion as the eye is nearer to it and sees it more foreshortened. And, without exception the shadows show as darker on the upper side than on the lower, from the contrast offered by the high lights which limit the shadows.

The under side of the leaf, although its colour may be in itself the same as that of the upper side, shows a still finer colour--a colour that is green verging on yellow--and this happens when the leaf is placed between

426.

the eye and the light which falls upon it from the opposite side.

And its shadows are in the same positions as those were of the opposite side. Therefore, O Painter! when you do trees close at hand, remember that if the eye is almost under the tree you will see its leaves [some] on the upper and [some] on the under side, and the upper side will be bluer in proportion as they are seen more foreshortened, and the same leaf sometimes shows part of the right side and part of the under side, whence you must make it of two

colours.

Of the transparency of leaves (427-429).

427.

The shadows in transparent leaves seen from the under side are the same shadows as there are on the right side of this leaf, they will show through to the underside together with lights, but the lustre [reflected light] can never show through.

428.

When one green has another [green] behind it, the lustre on the leaves and their transparent [lights] show more strongly than in those which are [seen] against the brightness of the atmosphere.

And if the sun illuminates the leaves without their coming between it and the eye and without the eye facing the sun, then the reflected lights and the transparent lights are very strong.

It is very effective to show some branches which are low down and dark and so set off the illuminated greens which are at some distance from the dark greens seen below. That part is darkest which is nearest to the eye or which is farthest from the luminous atmosphere.

429.

Never paint leaves transparent to the sun, because they are confused; and this is because on the transparency of one leaf will be seen the shadow of another leaf which is above it. This shadow has a distinct outline and a certain depth of shade and sometimes is [as much as] half or a third of the leaf which is shaded; and consequently such an arrangement is very confused and the imitation of it should be avoided.

The light shines least through a leaf when it falls upon it at an acute angle.

The gradations of shade and colour in leaves (430-434).

430.

The shadows of plants are never black, for where the atmosphere penetrates there can never be utter darkness.

431.

If the light comes from m and the eye is at n the eye will see the colour of the leaves a b all affected by the colour of m --that is of the atmosphere; and b c will be seen from the under

side as transparent, with a beautiful green colour verging on yellow.

If m is the luminous body lighting up the leaf s all the eyes that see the under side of this leaf will see it of a beautiful light green, being transparent.

In very many cases the positions of the leaves will be without shadow [or in full light], and their under side will be transparent and the right side lustrous [reflecting light].

432.

The willow and other similar trees, which have their boughs lopped every 3 or 4 years, put forth very straight branches, and their shadow is about the middle where these boughs spring; and towards the extreme ends they cast but little shade from having small leaves and few and slender branches. Hence the boughs which rise towards the sky will have but little shade and little relief; and the branches which are at an angle from the horizon, downwards, spring from the dark part of the shadow and grow thinner by degrees up to their ends, and these will be in strong relief, being in gradations of light against a background of shadow.

That tree will have the least shadow which has the fewest branches and few leaves.

433.

OF DARK LEAVES IN FRONT OF TRANSPARENT ONES.

When the leaves are interposed between the light and the eye, then that which is nearest to the eye will be the darkest, and the most distant will be the lightest, not being seen against the atmosphere; and this is seen in the leaves which are away from the centre of the tree, that is towards the light.

[Footnote: See Pl. XXVIII, No. 2, the lower sketch.]

434.

OF THE LIGHTS ON DARK LEAVES.

The lights on such leaves which are darkest, will be most near to the colour of the atmosphere that is reflected in them. And the cause of this is that the light on the illuminated portion mingles with the dark hue to compose a blue colour; and this light is produced by the blueness of the atmosphere which is reflected in the smooth surface of these leaves and adds to the blue hue which this light usually produces when it falls on dark objects.

OF THE LIGHTS ON LEAVES OF A YELLOWISH GREEN.

But leaves of a green verging on yellow when they reflect the atmosphere do not produce a reflection verging on blue, inasmuch as every thing which appears in a mirror takes some colour from that mirror, hence the blue of the atmosphere being reflected in the yellow of the leaf appears green, because blue and yellow mixed together make a very fine green colour, therefore the lustre of light leaves verging on yellow will be greenish yellow.

A classification of trees according to their colours.

435.

The trees in a landscape are of various kinds of green, inasmuch as some verge towards blackness, as firs, pines, cypresses, laurels, box and the like. Some tend to yellow such as walnuts, and pears, vines and verdure. Some are both yellowish and dark as chesnuts, holm-oak. Some turn red in autumn as the service-tree, pomegranate, vine, and cherry; and some are whitish as the willow, olive, reeds and the like. Trees are of various forms ...

The proportions of light and shade in trees (436-440).

436.

OF A GENERALLY DISTRIBUTED LIGHT AS LIGHTING UP TREES.

That part of the trees will be seen to lie in the least dark shadow which is farthest from the earth.

To prove it let a p be the tree, n b c the illuminated hemisphere [the sky], the under portion of the tree faces the earth p c, that is on the side o, and it faces a small part of the hemisphere at c d. But the highest part of the convexity a faces the greatest part of the hemisphere, that is b c. For this reason--and because it does not face the darkness of the earth--it is in fuller light. But if the tree has dense foliage, as the laurel, arbutus, box or holm oak, it will be different; because, although a does not face the earth, it faces the dark [green] of the leaves cut up by many shadows, and this darkness is reflected onto the under sides of the leaves immediately above. Thus these trees have their darkest shadows nearest to the middle of the tree.

437.

OF THE SHADOWS OF VERDURE.

The shadows of verdure are always somewhat blue, and so is every shadow of every object; and they assume this hue more in proportion as they are remote from the eye, and less in proportion as they are nearer. The leaves which reflect the blue of the atmosphere always present themselves to the eye edgewise.

OF THE ILLUMINATED PART OF VERDURE AND OF MOUNTAINS.

The illuminated portion, at a great distance, will appear most nearly of its natural colour where the strongest light falls upon it.

438.

OF TREES THAT ARE LIGHTED BY THE SUN AND BY THE ATMOSPHERE.

In trees that are illuminated [both] by the sun and the atmosphere and that have leaves of a dark colour, one side will be illuminated by the atmosphere [only] and in consequence of this light will tend to blueness, while on the other side they will be illuminated by the atmosphere and the sun; and the side which the eye sees illuminated by the sun will reflect light.

439.

OF DEPICTING A FOREST SCENE.

The trees and plants which are most thickly branched with slender branches ought to have less dark shadow than those trees and plants which, having broader leaves, will cast more shadow.

440.

ON PAINTING.

In the position of the eye which sees that portion of a tree illuminated which turns towards the light, one tree will never be seen to be illuminated equally with the other. To prove this, let the eye be c which sees the two trees b d which are illuminated by the sun a; I say that this eye c will not see the light in the same proportion to the shade, in one tree as in the other. Because, the tree which is nearest to the sun will display so much the stronger shadow than the more distant one, in proportion as one tree is nearer to the rays of the sun that converge to the eye than the other; &c.

You see that the eye c sees nothing of the tree d but shadow, while the same eye c sees the tree b half in light and half in shade.

When a tree is seen from below, the eye sees the top of it as placed within the circle made by its boughs[23].

Remember, O Painter! that the variety of depth of shade in any one particular species of tree is in proportion to the rarity or density of their branches.

[Footnote: The two lower sketches on the left of Pl XXVIII, No. 3, refer to lines 21-23. The upper sketch has apparently been effaced by Leonardo himself.]

The distribution of light and shade with reference to the position of the spectator (441-443).

441.

The shadows of trees placed in a landscape do not display themselves in the same position in the trees on the right hand and those on the left; still more so if the sun is to the right or left. As is proved by the 4th which says: Opaque bodies placed between the light and the eye display themselves entirely in shadow; and by the 5th: The eye when placed between the opaque body and the light sees the opaque body entirely illuminated. And by the 6th: When the eye and the opaque body are placed between darkness and light, it will be seen half in shadow and half in light.

[Footnote: See the figure on the right hand side of Pl. XXVIII, No. 3. The first five lines of the text are written below the diagram and above it are the last eight lines of the text, given as No. 461.]

442.

OF THE HERBS OF THE FIELD.

Of the plants which take a shadow from the plants which spring among them, those which are on this side [in front] of the shadow have the stems lighted up on a background of shadow, and the plants on which the shadows fall have their stems dark on a light background; that is on the background beyond the shadow.

OF TREES WHICH ARE BETWEEN THE EYE AND THE LIGHT.

Of the trees which are between the eye and the light the part in front will be light; but this light will be broken by the ramifications of transparent leaves--being seen from the under side--and lustrous leaves--being seen from the upper side; and the background below and behind will be dark green, being in shadow from the front portion of the said tree. This occurs in trees placed above the eye.

443.

FROM WHENCE TO DEPICT A LANDSCAPE

Landscapes should be represented so that the trees may be half in light and half in shadow; but it is better to do them when the sun is covered with clouds, for then the trees are lighted by the general light of the sky, and the general darkness of the earth. And

then they are darkest in certain parts in proportion as those parts are nearest to the middle of the tree and to the earth.

The effects of morning light (444-448).

444.

OF TREES TO THE SOUTH.

When the sun is in the east the trees to the South and to the North have almost as much light as shadow. But a greater share of light in proportion as they lie to the West and a greater share of shadow in proportion as they lie to the East.

OF MEADOWS.

If the sun is in the East the verdure of the meadows and of other small plants is of a most beautiful green from being transparent to the sun; this does not occur in the meadows to the West, and in those to the South and North the grass is of a moderately brilliant green.

445.

OF THE 4 POINTS OF THE COMPASS [IN LANDSCAPES].

When the sun is in the East all the portions of plants lighted by it are of a most lively verdure, and this happens because the leaves lighted by the sun within the half of the horizon that is the Eastern half, are transparent; and within the Western semicircle the verdure is of a dull hue and the moist air is turbid and of the colour of grey ashes, not being transparent like that in the East, which is quite clear and all the more so in proportion as it is moister.

The shadows of the trees to the East cover a large portion of them and are darker in proportion as the foliage of the trees is thicker.

446.

OF TREES IN THE EAST.

When the sun is in the East the trees seen towards the East will have the light which surrounds them all round their shadows, excepting on the side towards the earth; unless the tree has been pruned [below] in the past year. And the trees to the South and North will be half in shade and half in light, and more or less in shade or in light in proportion as they are more or less to the East or to the West.

The [position of] the eye above or below varies the shadows and lights in trees, inasmuch as the eye placed above sees the tree with

the little shadow, and the eye placed below with a great deal of shadow.

The colour of the green in plants varies as much as their species.

447.

OF THE SHADOWS IN TREES.

The sun being in the East [to the right], the trees to the West [or left] of the eye will show in small relief and almost imperceptible gradations, because the atmosphere which lies between the eye and those trees is very dense [Footnote 7: per la 7a di questo. This possibly referred to something written on the seventh page of this note book marked G. Unfortunately it has been cut out and lost.], see the 7th of this--and they have no shade; for though a shadow exists in every detail of the ramification, it results that the images of the shade and light that reach the eye are confused and mingled together and cannot be perceived on account of their minuteness. And the principal lights are in the middle of the trees, and the shadows to wards the edges; and their separation is shown by the shadows of the intervals between the trees; but when the forests are thick with trees the thin edges are but little seen.

448.

OF TREES TO THE EAST.

When the sun is in the East the trees are darker towards the middle while their edges are light.

The effects of midday light.

449.

OBJECTS IN HIGH LIGHT SHOW BUT LITTLE, BUT BETWEEN LIGHT AND SHADOW

THEY STAND OUT WELL.

To represent a landscape choose that the sun shall be at noon and look towards the West or East and then draw. And if you turn towards the North, every object placed on that side will have no shadow, particularly those which are nearest to the [direction of the] shadow of your head. And if you turn towards the South every object on that side will be wholly in shadow. All the trees which are towards the sun and have the atmosphere for their background are dark, and the other trees which lie against that darkness will be black [very dark] in the middle and lighter towards the edges.

The appearance of trees in the distance (450. 451).

450.

OF THE SPACES [SHOWING THE SKY] IN TREES THEMSELVES.

The spaces between the parts in the mass of trees, and the spaces between the trees in the air, are, at great distances, invisible to the eye; for, where it is an effort [even] to see the whole it is most difficult to discern the parts.--But a confused mixture is the result, partaking chiefly of the [hue] which predominates. The spaces between the leaves consist of particles of illuminated air which are very much smaller than the tree and are lost sight of sooner than the tree; but it does not therefore follow that they are not there. Hence, necessarily, a compounded [effect] is produced of the sky and of the shadows of the tree in shade, which both together strike the eye which sees them.

OF TREES WHICH CONCEAL THESE SPACES IN ONE ANOTHER.

That part of a tree will show the fewest spaces, behind which a large number of trees are standing between the tree and the air [sky]; thus in the tree a the spaces are not concealed nor in b, as there is no tree behind. But in c only half shows the spaces filled up by the tree d, and part of the tree d is filled up by the tree e and a little farther on all the spaces in the mass of the trees are lost, and only that at the side remains.

451.

OF TREES.

What outlines are seen in trees at a distance against the sky which serves as their background?

The outlines of the ramification of trees, where they lie against the illuminated sky, display a form which more nearly approaches the spherical on proportion as they are remote, and the nearer they are the less they appear in this spherical form; as in the first tree a which, being near to the eye, displays the true form of its ramification; but this shows less in b and is altogether lost in c, where not merely the branches of the tree cannot be seen but the whole tree is distinguished with difficulty. Every object in shadow, of whatever form it may be, at a great distance appears to be spherical. And this occurs because, if it is a square body, at a very short distance it loses its angles, and a little farther off it loses still more of its smaller sides which remain. And thus before the whole is lost [to sight] the parts are lost, being smaller than the whole; as a man, who in such a distant position loses his legs, arms and head before [the mass of] his body, then the outlines of length are lost before those of breadth, and where they have become equal it would be a square if the angles remained; but as they are lost it is round.

[Footnote: The sketch No. 4, Pl. XXVIII, belongs to this passage.]

The cast shadow of trees (452. 453).

452.

The image of the shadow of any object of uniform breadth can never be [exactly] the same as that of the body which casts it.

[Footnote: See Pl. XXVIII, No. 5.]

Light and shade on groups of trees (453-457).

453.

All trees seen against the sun are dark towards the middle and this shadow will be of the shape of the tree when apart from others.

The shadows cast by trees on which the sun shines are as dark as those of the middle of the tree.

The shadow cast by a tree is never less than the mass of the tree but becomes taller in proportion as the spot on which it falls, slopes towards the centre of the world.

The shadow will be densest in the middle of the tree when the tree has the fewest branches.

[Footnote: The three diagrams which accompany this text are placed, in the original, before lines 7-11. At the spots marked B Leonardo wrote Albero (tree). At A is the word Sole (sun), at C Monte (mountain) at D piano (plain) and at E cima (summit).]

Every branch participates of the central shadow of every other branch and consequently [of that] of the whole tree.

The form of any shadow from a branch or tree is circumscribed by the light which falls from the side whence the light comes; and this illumination gives the shape of the shadow, and this may be of the distance of a mile from the side where the sun is.

If it happens that a cloud should anywhere overshadow some part of a hill the [shadow of the] trees there will change less than in the plains; for these trees on the hills have their branches thicker, because they grow less high each year than in the plains. Therefore as these branches are dark by nature and being so full of shade, the shadow of the clouds cannot darken them any more; but the open spaces between the trees, which have no strong shadow change very much in tone and particularly those which vary from green; that is ploughed lands or fallen mountains or barren lands or rocks. Where the trees are against the atmosphere they appear all the same colour--if indeed they are not very close together or very thickly covered with leaves like the fir and similar trees. When you see the

trees from the side from which the sun lights them, you will see them almost all of the same tone, and the shadows in them will be hidden by the leaves in the light, which come between your eye and those shadows.

TREES AT A SHORT DISTANCE.

[Footnote 29: The heading *alberi vicini* (trees at a short distance) is in the original manuscript written in the margin.] When the trees are situated between the sun and the eye, beyond the shadow which spreads from their centre, the green of their leaves will be seen transparent; but this transparency will be broken in many places by the leaves and boughs in shadow which will come between you and them, or, in their upper portions, they will be accompanied by many lights reflected from the leaves.

454.

The trees of the landscape stand out but little from each other; because their illuminated portions come against the illuminated portions of those beyond and differ little from them in light and shade.

455.

Of trees seen from below and against the light, one beyond the other

and near together. The topmost part of the first will be in great part transparent and light, and will stand out against the dark portion of the second tree. And thus it will be with all in succession that are placed under the same conditions.

Let *s* be the light, and *r* the eye, *c d n* the first tree, *a b c* the second. Then I say that *r*, the eye, will see the portion *c f* in great part transparent and lighted by the light *s* which falls upon it from the opposite side, and it will see it, on a dark ground *b c* because that is the dark part and shadow of the tree *a b c*.

But if the eye is placed at *t* it will see *o p* dark on the light background *n g*.

Of the transparent and shadowy parts of trees, that which is nearest to you is the darkest.

456.

That part of a tree which has shadow for background, is all of one tone, and wherever the trees or branches are thickest they will be darkest, because there are no little intervals of air. But where the boughs lie against a background of other boughs, the brighter parts are seen lightest and the leaves lustrous from the sunlight falling on them.

457.

In the composition of leafy trees be careful not to repeat too often the same colour of one tree against the same colour of another [behind it]; but vary it with a lighter, or a darker, or a stronger green.

On the treatment of light for landscapes (458-464).

458.

The landscape has a finer azure [tone] when, in fine weather the sun is at noon than at any other time of the day, because the air is purified of moisture; and looking at it under that aspect you will see the trees of a beautiful green at the outside and the shadows dark towards the middle; and in the remoter distance the atmosphere which comes between you and them looks more beautiful when there is something dark beyond. And still the azure is most beautiful. The objects seen from the side on which the sun shines will not show you their shadows. But, if you are lower than the sun, you can see what is not seen by the sun and that will be all in shade. The leaves of the trees, which come between you and the sun are of two principal colours which are a splendid lustre of green, and the reflection of the atmosphere which lights up the objects which cannot be seen by the sun, and the shaded portions which only face the earth, and the

darkest which are surrounded by something that is not dark. The trees in the landscape which are between you and the sun are far more beautiful than those you see when you are between the sun and them; and this is so because those which face the sun show their leaves as transparent towards the ends of their branches, and those that are not transparent--that is at the ends--reflect the light; and the shadows are dark because they are not concealed by any thing.

The trees, when you place yourself between them and the sun, will only display to you their light and natural colour, which, in itself, is not very strong, and besides this some reflected lights which, being against a background which does not differ very much from themselves in tone, are not conspicuous; and if you are lower down than they are situated, they may also show those portions on which the light of the sun does not fall and these will be dark.

In the Wind.

But, if you are on the side whence the wind blows, you will see the trees look very much lighter than on the other sides, and this happens because the wind turns up the under side of the leaves, which, in all trees, is much whiter than the upper sides; and, more especially, will they be very light indeed if the wind blows from the quarter where the sun is, and if you have your back turned to it.

[Footnote: At S, in the original is the word Sole (sun) and at N parte di nuvolo (the side of the clouds).]

459.

When the sun is covered by clouds, objects are less conspicuous, because there is little difference between the light and shade of the trees and of the buildings being illuminated by the brightness of the atmosphere which surrounds the objects in such a way that the shadows are few, and these few fade away so that their outline is lost in haze.

460.

OF TREES AND LIGHTS ON THEM.

The best method of practice in representing country scenes, or I should say landscapes with their trees, is to choose them so that the sun is covered with clouds so that the landscape receives an universal light and not the direct light of the sun, which makes the shadows sharp and too strongly different from the lights.

461.

OF PAINTING.

In landscapes which represent [a scene in] winter. The mountains should not be shown blue, as we see in the mountains in the summer. And this is proved [Footnote 5. 6.: Per la 4a di questo. It is impossible to ascertain what this quotation refers to. Questo certainly does not mean the MS. in hand, nor any other now known to us. The same remark applies to the phrase in line 15: per la 2a di questo.] in the 4th of this which says: Among mountains seen from a great distance those will look of the bluest colour which are in themselves the darkest; hence, when the trees are stripped of their leaves, they will show a bluer tinge which will be in itself darker; therefore, when the trees have lost their leaves they will look of a gray colour, while, with their leaves, they are green, and in proportion as the green is darker than the grey hue the green will be of a bluer tinge than the gray. Also by the 2nd of this: The shadows of trees covered with leaves are darker than the shadows of those trees which have lost their leaves in proportion as the trees covered with leaves are denser than those without leaves--and thus my meaning is proved.

The definition of the blue colour of the atmosphere explains why the landscape is bluer in the summer than in the winter.

462.

OF PAINTING IN A LANDSCAPE.

If the slope of a hill comes between the eye and the horizon, sloping towards the eye, while the eye is opposite the middle of the height of this slope, then that hill will increase in darkness throughout its length. This is proved by the 7th of this which says that a tree looks darkest when it is seen from below; the proposition is verified, since this hill will, on its upper half show all its trees as much from the side which is lighted by the light of the sky, as from that which is in shade from the darkness of the earth; whence it must result that these trees are of a medium darkness. And from this [middle] spot towards the base of the hill, these trees will be lighter by degrees by the converse of the 7th and by the said 7th: For trees so placed, the nearer they are to the summit of the hill the darker they necessarily become. But this darkness is not in proportion to the distance, by the 8th of this which says: That object shows darkest which is [seen] in the clearest atmosphere; and by the 10th: That shows darkest which stands out against a lighter background.

[Footnote: The quotation in this passage again cannot be verified.]

463.

OF LANDSCAPES.

The colours of the shadows in mountains at a great distance take a

most lovely blue, much purer than their illuminated portions. And from this it follows that when the rock of a mountain is reddish the illuminated portions are violet (?) and the more they are lighted the more they display their proper colour.

464.

A place is most luminous when it is most remote from mountains.

On the treatment of light for views of towns (465-469).

465.

OF LIGHT AND SHADOW IN A TOWN.

When the sun is in the East and the eye is above the centre of a town, the eye will see the Southern part of the town with its roofs half in shade and half in light, and the same towards the North; the Eastern side will be all in shadow and the Western will be all in light.

466.

Of the houses of a town, in which the divisions between the houses may be distinguished by the light which fall on the mist at the bottom. If the eye is above the houses the light seen in the space

that is between one house and the next sinks by degrees into thicker mist; and yet, being less transparent, it appears whiter; and if the houses are some higher than the others, since the true [colour] is always more discernible through the thinner atmosphere, the houses will look darker in proportion as they are higher up. Let n o p q represent the various density of the atmosphere thick with moisture, a being the eye, the house b c will look lightest at the bottom, because it is in a thicker atmosphere; the lines c d f will appear equally light, for although f is more distant than c, it is raised into a thinner atmosphere, if the houses b e are of the same height, because they cross a brightness which is varied by mist, but this is only because the line of the eye which starts from above ends by piercing a lower and denser atmosphere at d than at b. Thus the line a f is lower at f than at c; and the house f will be seen darker at e from the line e k as far as m, than the tops of the houses standing in front of it.

467.

OF TOWNS OR OTHER BUILDINGS SEEN IN THE EVENING OR THE MORNING THROUGH THE MIST.

Of buildings seen at a great distance in the evening or the morning, as in mist or dense atmosphere, only those portions are seen in brightness which are lighted up by the sun which is near the horizon; and those portions which are not lighted up by the sun

remain almost of the same colour and medium tone as the mist.

WHY OBJECTS WHICH ARE HIGH UP AND AT A DISTANCE ARE DARKER THAN THE

LOWER ONES, EVEN IF THE MIST IS UNIFORMLY DENSE.

Of objects standing in a mist or other dense atmosphere, whether from vapour or smoke or distance, those will be most visible which are the highest. And among objects of equal height that will be the darkest [strongest] which has for background the deepest mist. Thus the eye h looking at a b c, towers of equal height, one with another, sees c the top of the first tower at r, at two degrees of depth in the mist; and sees the height of the middle tower b through one single degree of mist. Therefore the top of the tower c appears stronger than the top of the tower b, &c.

468.

OF THE SMOKE OF A TOWN.

Smoke is seen better and more distinctly on the Eastern side than on the Western when the sun is in the East; and this arises from two causes; the first is that the sun, with its rays, shines through the particles of the smoke and lights them up and makes them visible. The second is that the roofs of the houses seen in the East at this time are in shadow, because their obliquity does not allow of their

being illuminated by the sun. And the same thing occurs with dust; and both one and the other look the lighter in proportion as they are denser, and they are densest towards the middle.

469.

OF SMOKE AND DUST.

If the sun is in the East the smoke of cities will not be visible in the West, because on that side it is not seen penetrated by the solar rays, nor on a dark background; since the roofs of the houses turn the same side to the eye as they turn towards the sun, and on this light background the smoke is not very visible.

But dust, under the same aspect, will look darker than smoke being of denser material than smoke which is moist.

The effect of wind on trees (470-473).

470.

OF REPRESENTING WIND.

In representing wind, besides the bending of the boughs and the reversing of their leaves towards the quarter whence the wind comes, you should also represent them amid clouds of fine dust mingled with

the troubled air.

471.

Describe landscapes with the wind, and the water, and the setting and rising of the sun.

THE WIND.

All the leaves which hung towards the earth by the bending of the shoots with their branches, are turned up side down by the gusts of wind, and here their perspective is reversed; for, if the tree is between you and the quarter of the wind, the leaves which are towards you remain in their natural aspect, while those on the opposite side which ought to have their points in a contrary direction have, by being turned over, their points turned towards you.

472.

Trees struck by the force of the wind bend to the side towards which the wind is blowing; and the wind being past they bend in the contrary direction, that is in reverse motion.

473.

That portion of a tree which is farthest from the force which strikes it is the most injured by the blow because it bears most strain; thus nature has foreseen this case by thickening them in that part where they can be most hurt; and most in such trees as grow to great heights, as pines and the like. [Footnote: Compare the sketch drawn with a pen and washed with Indian ink on Pl. XL, No. 1. In the Vatican copy we find, under a section entitled 'del fumo', the following remark: Era sotto di questo capitolo un rompimento di montagna, per dentro delle quali rotture scherzaua fiamme di fuoco, disegnate di penna et ombrate d'acquarella, da uedere cosa mirabile et uiua (Ed. MANZI, p. 235. Ed. LUDWIG, Vol. I, 460). This appears to refer to the left hand portion of the drawing here given from the Windsor collection, and from this it must be inferred, that the leaf as it now exists in the library of the Queen of England, was already separated from the original MS. at the time when the Vatican copy was made.]

Light and shade on clouds (474-477).

474.

Describe how the clouds are formed and how they dissolve, and what cause raises vapour.

475.

The shadows in clouds are lighter in proportion as they are nearer to the horizon.

[Footnote: The drawing belonging to this was in black chalk and is totally effaced.]

476.

When clouds come between the sun and the eye all the upper edges of their round forms are light, and towards the middle they are dark, and this happens because towards the top these edges have the sun above them while you are below them; and the same thing happens with the position of the branches of trees; and again the clouds, like the trees, being somewhat transparent, are lighted up in part, and at the edges they show thinner.

But, when the eye is between the cloud and the sun, the cloud has the contrary effect to the former, for the edges of its mass are dark and it is light towards the middle; and this happens because you see the same side as faces the sun, and because the edges have some transparency and reveal to the eye that portion which is hidden beyond them, and which, as it does not catch the sunlight like that portion turned towards it, is necessarily somewhat darker. Again, it may be that you see the details of these rounded masses from the lower side, while the sun shines on the upper side and as they are not so situated as to reflect the light of the sun, as in the first

instance they remain dark.

The black clouds which are often seen higher up than those which are illuminated by the sun are shaded by other clouds, lying between them and the sun.

Again, the rounded forms of the clouds that face the sun, show their edges dark because they lie against the light background; and to see that this is true, you may look at the top of any cloud that is wholly light because it lies against the blue of the atmosphere, which is darker than the cloud.

[Footnote: A drawing in red chalk from the Windsor collection (see Pl. XXIX), representing a landscape with storm-clouds, may serve to illustrate this section as well as the following one.]

477.

OF CLOUDS, SMOKE AND DUST AND THE FLAMES OF A FURNACE OR OF A BURNING KILN.

The clouds do not show their rounded forms excepting on the sides which face the sun; on the others the roundness is imperceptible because they are in the shade. [Footnote: The text of this chapter is given in facsimile on Pls. XXXVI and XXXVII. The two halves of the leaf form but one in the original. On the margin close to lines

4 and 5 is the note: rossore d'aria inverso l'orizzonte--(of the redness of the atmosphere near the horizon). The sketches on the lower portion of the page will be spoken of in No. 668.]

If the sun is in the East and the clouds in the West, the eye placed between the sun and the clouds sees the edges of the rounded forms composing these clouds as dark, and the portions which are surrounded by this dark [edge] are light. And this occurs because the edges of the rounded forms of these clouds are turned towards the upper or lateral sky, which is reflected in them.

Both the cloud and the tree display no roundness at all on their shaded side.

On images reflected in water.

478.

Painters often deceive themselves, by representing water in which they make the water reflect the objects seen by the man. But the water reflects the object from one side and the man sees it from the other; and it often happens that the painter sees an object from below, and thus one and the same object is seen from hind part before and upside down, because the water shows the image of the object in one way, and the eye sees it in another.

Of rainbows and rain (479. 480).

479.

The colours in the middle of the rainbow mingle together.

The bow in itself is not in the rain nor in the eye that sees it; though it is generated by the rain, the sun, and the eye. The rainbow is always seen by the eye that is between the rain and the body of the sun; hence if the sun is in the East and the rain is in the West it will appear on the rain in the West.

480.

When the air is condensed into rain it would produce a vacuum if the rest of the air did not prevent this by filling its place, as it does with a violent rush; and this is the wind which rises in the summer time, accompanied by heavy rain.

Of flower seeds.

481.

All the flowers which turn towards the sun perfect their seeds; but not the others; that is to say those which get only the reflection of the sun.

IX.

The Practice of Painting.

It is hardly necessary to offer any excuses for the division carried out in the arrangement of the text into practical suggestions and theoretical enquiries. It was evidently intended by Leonardo himself as we conclude from incidental remarks in the MSS. (for instance No 110). The fact that this arrangement was never carried out either in the old MS. copies or in any edition since, is easily accounted for by the general disorder which results from the provisional distribution of the various chapters in the old copies. We have every reason to believe that the earliest copyists, in distributing the materials collected by them, did not in the least consider the order in which the original MS. lay before them.

It is evident that almost all the chapters which refer to the calling and life of the painter--and which are here brought together in the first section (Nos. 482-508)--may be referred to two distinct periods in Leonardo's life; most of them can be dated as belonging to the year 1492 or to 1515. At about this later time Leonardo may have formed the project of completing his Libro della Pittura, after an interval of some years, as it would seem, during which his interest in the subject had fallen somewhat into the background.

In the second section, which treats first of the artist's studio, the construction of a suitable window forms the object of careful investigations; the special importance attached to this by Leonardo is sufficiently obvious. His theory of the incidence of light which was fully discussed in a former part of this work, was to him by no means of mere abstract value, but, being deduced, as he says, from experience (or experiment) was required to prove its utility in practice. Connected with this we find suggestions for the choice of a light with practical hints as to sketching a picture and some other precepts of a practical character which must come under consideration in the course of completing the painting. In all this I have followed the same principle of arrangement in the text as was carried out in the Theory of Painting, thus the suggestions for the Perspective of a picture, (Nos. 536-569), are followed by the theory of light and shade for the practical method of optics (Nos. 548--566) and this by the practical precepts or the treatment of aerial perspective (567--570).

In the passage on Portrait and Figure Painting the principles of painting as applied to a bust and head are separated and placed first, since the advice to figure painters must have some connection with the principles of the treatment of composition by which they are followed.

But this arrangement of the text made it seem advisable not to pick

out the practical precepts as to the representation of trees and landscape from the close connection in which they were originally placed--unlike the rest of the practical precepts--with the theory of this branch of the subject. They must therefore be sought under the section entitled Botany for Painters.

As a supplement to the Libro di Pittura I have here added those texts which treat of the Painter's materials,--as chalk, drawing paper, colours and their preparation, of the management of oils and varnishes; in the appendix are some notes on chemical substances. Possibly some of these, if not all, may have stood in connection with the preparation of colours. It is in the very nature of things that Leonardo's incidental indications as to colours and the like should be now-a-days extremely obscure and could only be explained by professional experts--by them even in but few instances. It might therefore have seemed advisable to reproduce exactly the original text without offering any translation. The rendering here given is merely an attempt to suggest what Leonardo's meaning may have been.

LOMAZZO tells us in his Trattato dell'arte della Pittura, Scultura ed Architettura (Milano 1584, libro II, Cap. XIV): "Va discorrendo ed argomentando Leonardo Vinci in un suo libro letto da me (?) questi anni passati, ch'egli scrisse di mano stanca ai prieghi di LUDOVICO SFORZA duca di Milano, in determinazione di questa questione, se e piu nobile la pittura o la scultura; dicendo che quanto piu un'arte porta seco fatica di corpo, e sudore, tanto piu e

vile, e men pregiata". But the existence of any book specially written for Lodovico il Moro on the superiority of Painting over sculpture is perhaps mythical. The various passages in praise of Painting as compared not merely with Sculpture but with Poetry, are scattered among MSS. of very different dates.

Besides, the way, in which the subject is discussed appears not to support the supposition, that these texts were prepared at a special request of the Duke.

I.

MORAL PRECEPTS FOR THE STUDENT OF PAINTING.

How to ascertain the dispositions for an artistic career.

482.

A WARNING CONCERNING YOUTHS WISHING TO BE PAINTERS.

Many are they who have a taste and love for drawing, but no talent; and this will be discernible in boys who are not diligent and never finish their drawings with shading.

The course of instruction for an artist (483-485).

483.

The youth should first learn perspective, then the proportions of objects. Then he may copy from some good master, to accustom himself to fine forms. Then from nature, to confirm by practice the rules he has learnt. Then see for a time the works of various masters. Then get the habit of putting his art into practice and work.

[Footnote: The Vatican copy and numerous abridgements all place this chapter at the beginning of the Trattato, and in consequence DUFRESNE and all subsequent editors have done the same. In the Vatican copy however all the general considerations on the relation of painting to the other arts are placed first, as introductory.]

484.

OF THE ORDER OF LEARNING TO DRAW.

First draw from drawings by good masters done from works of art and from nature, and not from memory; then from plastic work, with the guidance of the drawing done from it; and then from good natural models and this you must put into practice.

485.

PRECEPTS FOR DRAWING.

The artist ought first to exercise his hand by copying drawings from the hand of a good master. And having acquired that practice, under the criticism of his master, he should next practise drawing objects in relief of a good style, following the rules which will presently be given.

The study of the antique (486. 487).

486.

OF DRAWING.

Which is best, to draw from nature or from the antique? and which is more difficult to do outlines or light and shade?

487.

It is better to imitate [copy] the antique than modern work.

[Footnote 486, 487: These are the only two passages in which Leonardo alludes to the importance of antique art in the training of an artist. The question asked in No. 486 remains unanswered by him and it seems to me very doubtful whether the opinion stated in No. 487 is to be regarded as a reply to it. This opinion stands in the MS. in a connection--as will be explained later on--which seems to

require us to limit its application to a single special case. At any rate we may suspect that when Leonardo put the question, he felt some hesitation as to the answer. Among his very numerous drawings I have not been able to find a single study from the antique, though a drawing in black chalk, at Windsor, of a man on horseback (Pl. LXXIII) may perhaps be a reminiscence of the statue of Marcus Aurelius at Rome. It seems to me that the drapery in a pen and ink drawing of a bust, also at Windsor, has been borrowed from an antique model (Pl. XXX). G. G. Rossi has, I believe, correctly interpreted Leonardo's feeling towards the antique in the following note on this passage in manzi's edition, p. 501: "Sappiamo dalla storia, che i valorosi artisti Toscani dell'età dell'oro dell'arte studiarono sugli antichi marmi raccolti dal Magnifico LORENZO DE' MEDICI. Pare che il Vinci a tali monumenti non si accostasse. Quest'uomo sempre riconosce per maestra la natura, e questo principio lo stringeva alla sola imitazione di essa"--Compare No. 10, 26--28 footnote.]

The necessity of anatomical knowledge (488. 489).

488.

OF PAINTING.

It is indispensable to a Painter who would be thoroughly familiar with the limbs in all the positions and actions of which they are

capable, in the nude, to know the anatomy of the sinews, bones, muscles and tendons so that, in their various movements and exertions, he may know which nerve or muscle is the cause of each movement and show those only as prominent and thickened, and not the others all over [the limb], as many do who, to seem great draughtsmen, draw their nude figures looking like wood, devoid of grace; so that you would think you were looking at a sack of walnuts rather than the human form, or a bundle of radishes rather than the muscles of figures.

489.

HOW IT IS NECESSARY TO A PAINTER THAT HE SHOULD KNOW THE INTRINSIC

FORMS [STRUCTURE] OF MAN.

The painter who is familiar with the nature of the sinews, muscles, and tendons, will know very well, in giving movement to a limb, how many and which sinews cause it; and which muscle, by swelling, causes the contraction of that sinew; and which sinews, expanded into the thinnest cartilage, surround and support the said muscle. Thus he will variously and constantly demonstrate the different muscles by means of the various attitudes of his figures, and will not do, as many who, in a variety of movements, still display the very same things [modelling] in the arms, back, breast and legs. And these things are not to be regarded as minor faults.

How to acquire practice.

490.

OF STUDY AND THE ORDER OF STUDY.

I say that first you ought to learn the limbs and their mechanism, and having this knowledge, their actions should come next, according to the circumstances in which they occur in man. And thirdly to compose subjects, the studies for which should be taken from natural actions and made from time to time, as circumstances allow; and pay attention to them in the streets and piazze and fields, and note them down with a brief indication of the forms; [Footnote 5: Lines 5-7 explained by the lower portion of the sketch No. 1 on Pl. XXXI.] thus for a head make an o, and for an arm a straight or a bent line, and the same for the legs and the body, [Footnote 7: Lines 5-7 explained by the lower portion of the sketch No. 1 on Pl. XXXI.] and when you return home work out these notes in a complete form. The Adversary says that to acquire practice and do a great deal of work it is better that the first period of study should be employed in drawing various compositions done on paper or on walls by divers masters, and that in this way practice is rapidly gained, and good methods; to which I reply that the method will be good, if it is based on works of good composition and by skilled masters. But since such masters are so rare that there are but few of them to be found,

it is a surer way to go to natural objects, than to those which are imitated from nature with great deterioration, and so form bad methods; for he who can go to the fountain does not go to the water-jar.

[Footnote: This passage has been published by Dr. M. JORDAN, Das Malerbuck des L. da Vinci, p. 89; his reading however varies slightly from mine.]

Industry and thoroughness the first conditions (491-493.)

491.

WHAT RULES SHOULD BE GIVEN TO BOYS LEARNING TO PAINT.

We know for certain that sight is one of the most rapid actions we can perform. In an instant we see an infinite number of forms, still we only take in thoroughly one object at a time. Supposing that you, Reader, were to glance rapidly at the whole of this written page, you would instantly perceive that it was covered with various letters; but you could not, in the time, recognise what the letters were, nor what they were meant to tell. Hence you would need to see them word by word, line by line to be able to understand the letters. Again, if you wish to go to the top of a building you must go up step by step; otherwise it will be impossible that you should reach the top. Thus I say to you, whom nature prompts to pursue this

art, if you wish to have a sound knowledge of the forms of objects begin with the details of them, and do not go on to the second [step] till you have the first well fixed in memory and in practice. And if you do otherwise you will throw away your time, or certainly greatly prolong your studies. And remember to acquire diligence rather than rapidity.

492.

HOW THAT DILIGENCE [ACCURACY] SHOULD FIRST BE LEARNT RATHER THAN
RAPID EXECUTION.

If you, who draw, desire to study well and to good purpose, always go slowly to work in your drawing; and discriminate in the lights, which have the highest degree of brightness, and to what extent and likewise in the shadows, which are those that are darker than the others and in what way they intermingle; then their masses and the relative proportions of one to the other. And note in their outlines, which way they tend; and which part of the lines is curved to one side or the other, and where they are more or less conspicuous and consequently broad or fine; and finally, that your light and shade blend without strokes and borders [but] looking like smoke. And when you have thus schooled your hand and your judgment by such diligence, you will acquire rapidity before you are aware.