

THE COLOURS OF FLOWERS, AS ILLUSTRATED BY THE BRITISH FLORA¹

III.—*Variation and Retrogression*

SO far we have spoken for the most part as though every flower were of one unvaried hue throughout. We must now add a few considerations on the subject of the spots and lines which so often variegates the petals in certain species. In this connection a hint of Mr. Wallace is full of meaning. Everywhere in nature, he points out, spots and eyes of colour appear on the most highly-modified parts, and this rule applies most noticeably to the case of petals. Simple regular flowers, like the buttercups and roses, hardly ever have any spots or lines; but in very modified forms like the labiates and the orchids they are extremely common.

Structurally speaking, the spots and lines seem to be the direct result of high modification; but functionally, they act as honey-guides, and for this purpose they have no doubt undergone special selection by the proper insects. The case is just analogous to that of the peacock's plumes or the wings of butterflies. In either instance, the spots and eye-marks tend to appear on the most highly-modified surfaces; but they are perpetuated and intensified by special selective action. Lines are comparatively rare on regular flowers, but they tend to appear as soon as the flower becomes even slightly bilateral, and they point directly towards the nectaries. Hence they cannot be mere purposeless products of special modification; they clearly subserve a function in the economy of the plant, and that function is the direction of the insect towards the proper place for effecting the fertilisation of the ovary. In the common rhododendron, the connection can be most readily observed with the naked eye, and the honey tested by the tongue. In this case, one lobe of the corolla secretes a very large drop of nectar in a fold near its base, and the lines of dark spots appear on this lobe alone, pointing directly towards the nectariferous surface.

The *Geraniaceæ* afford an excellent illustration of the general principle. They are on the whole a comparatively high family of polypetals, for their ovary tends to become compound and very complicated, and they have many advanced devices for the dispersion of their seeds. *Oxalis corniculata*, our simplest English form, is pale yellow: *O. acetosella* is white, with a yellow base, and its veins are delicately tinged with lilac. The flowers of *Erodium* and *Geranium*, which are much more advanced, are generally pink or purplish, often marked with paler or darker lines. For the most part, however, these regular forms are fairly uniform in hue; but the South African *Pelargonium*, cultivated in gardens and hot-houses, are slightly bilateral, the two upper petals standing off from the three lower ones; and these two become at once marked with dark lines, which are in some cases scarcely visible, and in others fairly pronounced. From this simple beginning one can trace a gradual progress in heterogeneity of colouring, till at last the most developed bilateral *Pelargoniums* have the two upper petals of quite a different hue from the three lower ones, besides being deeply marked with belts and spots of dappled colour. In the allied *Tropæolum* or Indian cress (Fig. 21) this tendency is carried still further. Here, the calyx is prolonged into a deep spur, containing the honey, inaccessible to any but a few large insects; and towards this spur all the lines on the petals converge.

In most regular flowers, the lines are mere intensifications (or diminutions) of the general colouration along the veins or ribs of the corolla; and they point towards the base or claw of the petal, where the honey is usually secreted. But in irregular flowers, we often get a higher modification of colour, so that one region of the petal is yellow or white, while another is pink or blue; and these

regions often run transversely, not longitudinally. Such modifications usually affect the most highly-altered parts of the irregular flower.

The common wild pansy, *Viola tricolor*, affords a good example of complex variegation. Its flowers are purple, white, or yellow; or have these pigments variously intermixed. The two upper pairs of petals are usually the most coloured; the lower one is broadest, and generally yellow at the base, with dark lines leading towards the spur. *Viola palustris* exhibits the same tendency in a less degree; it is pale blue, with purple streaks. The whole family is immensely interesting from the present point of view, and should be closely observed by the student at first hand.

Among regular *Corollifloræ*, variegation is not very common, though it occurs much oftener than in the polypetalous classes, especially at the throat of the tube, as in the forget-me-nots (*Myosotis*); but in irregular *Corollifloræ* it is exceedingly frequent. The *Lentibulaceæ* and other small families afford several examples. In the great order of *Labiataæ*, the highly modified lower lip is very often spotted, especially where it is most developed. This is the case in *Stachys silvatica*, *Lamium purpureum*, *Galeopsis tetrahit*, *Calamintha acinos*, *Nepeta cataria*, *N. glechoma*, *Ajuga reptans*, *Scutellaria galericulata*, and many other species. Several exotic kinds show the same tendency in a more marked degree.

The *Scrophularineæ*, however, form perhaps the best example of any. We have noticed already that comparatively few of these are as blue or as purple as might be expected from their high organisation. The explanation is that they have mostly got beyond the monochromatic stage altogether, and reached the level of intense variegation. They are, in fact, a family with profoundly modified flowers, most of which are very specially adapted to very exceptional modes of insect fertilisation. The *Veronicas* alone among our English genera are simply blue, with white or pink lines; the others are mostly spotted or dappled. *Antirrhinum majus* is purple, sometimes crimson or white, with the curiously closed throat a bright yellow. *Linaria cymbalaria* is blue or lilac, with white patches, and the palate a delicate primrose. *L. spuria* is yellow, with a purple throat. *L. minor* is purple, with a white lower lip and yellow palate. The very strange flowers of *Scrophularia* have a curious, indescribable mixture of brown, green, dingy purple, and buff. *Sibthorpia* is pink, with the two smaller lobes of the corolla yellow. *Digitalis purpurea*, the foxglove, is purple, spotted with red and white. *Euphrasia*, eye-bright, is white or lilac, with purple veins, and the middle lobe of the lower lip yellow. *Melampyrum arvense* is red, with pink lips and a purple throat. As a rule, the spots or patches of intrusive colour are developed transversely near the palate or around the throat. Purple, red, or blue appear to be the prevalent ground-tones, with white and yellow introduced as contrasted tints.

Among Monocotyledons, such plants as the highly modified *Iris* genus show similar results. Our own *I. fœtidissima* has blue sepals, with yellow petals and spatulate stigmas, all much veined. The *Orchidaceæ* exhibit the same tendency far more markedly. *Orchis mascula*, *O. maculata*, *O. laxiflora*, and many other British species have the lip spotted (Fig. 22). In *O. militaris* and *O. hircina*, the variegation is even more conspicuous. In *O. ustulata*, the spots on the lip are raised. The problematical bee-orchid, *Ophrys apifera*, is singularly dappled on the lip and disk, and has the sepals different in colour from the rest of the flower. *Aceras anthropophora*, the man-orchid, has green sepals and petals, edged with red, and a yellow lip, pink fringed. *Cypripedium calceolus*, the lady's slipper, *Cephalanthera grandiflora*, white helleborine, and most other British species, are similarly very diversified in colour. As to the exotic species, some of them are more peculiarly tinted and blended with half a dozen dif-

¹ Continued from p. 326.

ferent hues than any other forms of flowers in the whole world.

On the other hand, primitive yellow flowers of the earliest type never have any lines or spots whatsoever.

Besides the complications introduced by variegation, we have also to consider those introduced by retrogression. Flowers which have reached a given stage in the progressive scale of colouration often show a tendency to fall back to a lower stage. When this tendency is of the nature of a mere temporary reversion (that is to say, when it affects only a few individuals, or a casual variety), it may conveniently be described as Relapse. When, however, it affects a whole species, and becomes fixed in the species by a new and presumably lower adaptation, it may best be styled Retrogression.

Primary yellow flowers, like the buttercups and potentillas, show little or no tendency to vary in colour in a state of nature. They have never passed through any earlier stage to which they can revert; and they are not likely to strike out a new hue for themselves.

Some white flowers, on the other hand, show a decided tendency occasionally to revert to yellow, especially in the simpler orders. *Erysimum orientale* varies from white to pale primrose. *Raphanus raphanistrum*, as already noted, is usually even lilac, often white, and on the sea-shore yellow. The white cistuses often revert to a pale sallow tinge. In some roses, the throat becomes yellow in certain specimens. Stitchwort occurs yellow near Exeter. In

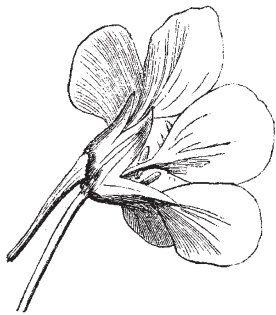


FIG. 21.—Flower of Indian Cress, orange with dark lines: the honey-guides point directly towards the long spur.

several other cases, stray yellow specimens of normally white species are not uncommon.

Pink and red flowers almost invariably revert in many individuals to white. A few typical instances must suffice. All the British roses are reddish pink or white. So are *Saponaria officinalis*, and many pinks. *Malva moschata* runs from rose-coloured to white; *M. rotundifolia* from pale lilac-pink to whitish. *Erodium cicutarium* has rosy or white petals; all the geraniums occasionally produce very pale flowers. White varieties of heaths are frequent in the wild state. Where the red or purple is very deeply engrained, however, as in labiates, reversion to white occurs less commonly. But almost all pink or red flowers become white with the greatest readiness under cultivation.

Blue flowers in nearly every case produce abundant red, pink, and white varieties in a state of nature. It would seem, indeed, as though this highest development of colour had not yet had time thoroughly to fix itself in the constitution of most species. Hence individual reversion is here almost universal as an occasional incident in every species. The columbine (*Aquilegia vulgaris*) is blue or dull purple, sometimes red or white. The larkspur (*Delphinium ajacis*) often declines from blue to pink or white. The monkshood (*Aconitum napellus*) is an extremely deep blue, very rarely white. White violets everybody knows well. The rampions (*Phyteuma*) vary from blue to white; so do many of the campanulas.

Gentiana campestris is sometimes white. In most *Boraginæ*—for example, in borage, viper's bugloss, and forget-me-not—pink and white varieties are common. Pink and white *Veronicas* also occur in abundance among normally blue species. *Prunella vulgaris* occasionally produces rosy or white blossoms. White wild hyacinths are often gathered. Many other cases will suggest themselves to every practical botanist.

Blue flowers, however, very seldom revert to yellow. As a rule, the blue goes back only as far as those shades from which it has more recently been developed. This



FIG. 22.—Spotted Orchid, purple with white patches: type of highly developed bilateral monocotyledons.

is, perhaps, the true rationale of De Candolle's law of xanthic and cyanic types.

With the light thus cast upon the question to guide us, we may pass on to the general consideration of Retrogression in colours. Certain species of advanced families have apparently found it advantageous in certain circumstances to revert to colours lower in the scale than the normal hue of their congeners. The reasons for such Retrogression are often easy enough to understand.

We may take the evening campion (*Lychnis vespertina*) as a good example. This white flower, as we saw, is evi-

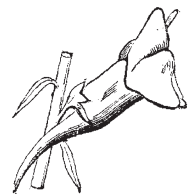
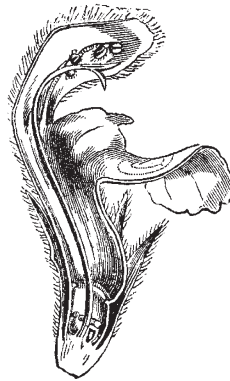


FIG. 23.—Section of Deadnettle, retrogressionary white, with dark spots on lip. FIG. 24.—Common Toadflax, yellow, with the lip orange, acting as guide to the honey concealed in the long spur.

dently descended from the red day campion (*Lychnis diurnia*), because it is still often pale pink, especially towards the centre, verging into white at the edge. But it has found it convenient to attract moths and be fertilised by them; and so it has lost its pinkness, because white is naturally the colour best seen by crepuscular insects in the dusky light of evening. Sir John Lubbock notes that such evening flowers never have any spots or lines as honey-guides on the petals.

The evening primrose (*Oenothera biennis*) is another

excellent instance of the same sort. It belongs to the family of the *Onagraceæ*, which are highly evolved poly-petalous plants, with the petals reduced to four or two in number, and placed above instead of below the ovary. We should thus naturally expect them to be pink or lilac, and this is actually the case with most of our native species. Why, then, is the evening primrose yellow? Because it is a night-flowering plant, fragrant in the evening, and its pale yellow colour makes it easily recognisable by moths. In this case, however, two points mark it off at once from the really primitive yellow flowers. In the first place, it has not the bright golden petals of the buttercup, but is rather more of a primrose tint; and this is a common distinguishing trait of the later acquired yellows. In the second place, it belongs to a genus in which red and purple flowers are common, whereas the buttercups are almost all yellow or white-yellow, and the potentillas mostly yellow or white. In short, primitive yellow flowers are usually golden, and belong to mainly



16. 25.—Corn bluebottle, high: blue, highest type of Cynaroid composite.

yellow groups: reverted yellow flowers are often primrose orange, or dull buff, and occur sporadically among blue, red, or purple groups.

There are other cases less immediately apparent than these. For instance, *Lamium galeobdolon*, a common English labiate, belonging to a usually purple or blue family, is bright yellow. But we can form some idea of how such changes take place if we look at the pansy, which we have seen reason to believe is normally violet-purple, but which usually has a yellow patch on the lowest petal. In the pansy's var. *lutea*, the yellow extends over the whole flower, no doubt because this incipient form has succeeded in attracting some special insect, or else grows in situations where yellow proves more conspicuous to bees than blue or purple. So, again, another English labiate, *Galeopsis tetrahit*, the hemp-nettle, has a pale purple or white corolla, sometimes with a tinge of yellow in the throat; and in the var. *versicolor*, the yellow spreads all over the flower, except a purple patch on th

lower lip. In *G. ochroleuca*, the whole corolla has become pure yellow. In this way, one can understand the occurrence of such a flower as *Lamium galeobdolon*, especially since an allied species, *L. album* (Fig. 23), is white, and all the genus is extremely variable in colour. Indeed, it is to be noted that the yellow labiates do not commonly occur among the less developed thymes, mints, and marjorams, but among the extremely specialised *Stachydeæ*, which have very modified flowers, and usually variegated or spotted lips. They seem to be essentially reversionary forms from purple or blue species, spotted with yellow.

Another hint of Retrogression is given us by flowers like our English balsams, *Impatiens noli-me-tangere* and *I. fulva*, in the fact that their yellow is generally dappled with numerous spots of deeper colour. The balsams are highly modified irregular *Geraniaceæ*, sepals and petals being both coloured; and at first sight it seems curious that our species should be yellow, while the simpler *Geraniums* and *Erodiums* are pink or red. But the genus as a whole contains many red and variegated species, and alters in colour with much plasticity in the hands of gardeners. *I. noli-me-tangere* is pale yellow, spotted with red; *I. fulva* is orange, dappled with deep brown. Both are almost certainly products of retrogressive selection.

In the *Primulaceæ*, we find similar instances. *Hottonia palustris*, a less developed form, is rosy lilac. *Cyclamen europæum* is white or rose-coloured. *Trientalis europæa* is white or pale pink, with a yellow ring. From such a stage as this, it is easy to get at our primroses, cowslips,

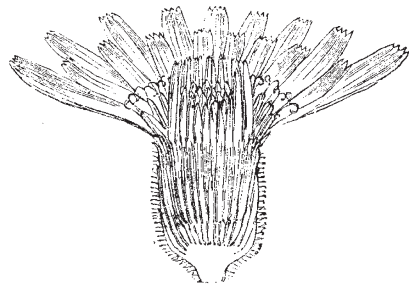


FIG. 26.—Section of Ligulate Composite, all the florets retrogressionary yellow.

and oxlips, which have pale yellow corollas, with orange spots at the throat. Indeed, one English species, *Primula farinosa*, is pale-lilac, with a yellow centre: and this might easily, under special circumstances, become pale primrose all over. The cultivated varieties of the cowslip, called Polyanthuses, readily assume various tints of orange, red, and pink, always at the edge, the deep yellow of the throat remaining unchanged.

The colours of many *Scrophularineæ* may be explained in the same way. Perhaps the yellow of the mulleins is primitive; but as some species are white or purple, it is just as likely to be retrogressive. In *Linaria*, we may almost be sure that retrogression has taken place; for we can trace a regular gradation from lilac flowers with a yellow palate, like *L. cymbalaria*, to pale yellow flowers, like *L. vulgaris*, which has the mass of the corolla primrose, and the palate orange (Fig. 24). *Mimulus luteus* is also yellow, but it is usually marked inside with small purple spots, and sometimes has a large pink or red patch upon each lobe. In *Melampyrum cristatum*, the yellow corolla is variegated with purple: in *M. pratense*, it has the lip deeper in hue. All these genera include many purple and variegated species; and the yellow members almost always bear evident marks of being descended from polychromatic ancestors.

The case of the yellow *Compositæ*, especially the *Ligulate*, is more difficult to decide. It would seem as though these plants, which have all their florets ligulate, must be more highly developed than the *Corymbifera*, which have

only the ray-florets ligulate, or than the *Cynaroidæ*, which have no ligulate florets at all. Hence we should naturally expect them to be blue or purple, whereas they are for the most part yellow of a very primitive golden type, while the ray-florets of the Corymbifers are usually white or pink, and all the florets of the Cynaroids are usually purple. The following hypothetical explanation is suggested as a possible way out of this difficulty.

The primitive ancestral composite had reached the stage of blue or purple flowers while it was still at a level of development corresponding to that of the scabious or *Jasione*. The universality of such colours among the closely allied *Dipsacæ*, *Valerianæ*, *Lobeliacæ*, and *Campanulacæ*, adds strength to this supposition. The central and most primitive group of composites, the Cynaroids, has kept up the original colouration to the present day; it includes most of the largest forms, such as the artichoke, and it depends most of any for fertilisation upon the higher insects. All our British species (except the degenerate *Carlina*) are purple, sometimes reverting to pale pink or white, while *Centaurea cyanus* (Fig. 25), our most advanced representative of the tribe, rises even to bright blue.

Next to the Cynaroids in order of development come the Corymbifers, some of which have begun to develop outer ligulate rays. Here the least evolved type, *Eupatorium*, with few and relatively large florets, is usually purple or white, never yellow. But as the florets grew smaller, and began to bid for the favour of many miscellaneous small insects, reversion to yellow became general. In a few cases here and there we still find purple or white central florets, as in *Petasites vulgaris*, the butter-bur; but even then we get closely related forms, like *Tussilago farfara*, colts-foot, which have declined to yellow. The smallest and most debased species, such as *Solidago virga-aurea*, golden rod, *Tanacetum vulgare*, tansy, and *Senecio vulgaris*, groundsel, have all their florets yellow and similar; unless, indeed, like *Gnaphalium* and *Filago*, cud-weed, *Artemisia absinthium*, wormwood, or *Xanthium strumarium*, burweed, they have declined as far as colourless or green florets, in which case they must be considered under our next head, that of Degeneration. On the other hand, the larger and better types of Corymbifers began a fresh progressive development of their own. In many *Senecios*, *Inulas*, *Chrysanthemums*, they produced yellow ray florets, similar in colour to those of the disk. In *Chrysanthemum leucanthemum*, *Anthemis cotula*, *Matricaria inodora*, &c., these rays, under the influence of a different type of insect selection, became white. In the daisy they begin show signs of pink, and in the *Asters*, *Cinerarias*, &c., they become lilac, purple, and blue. Complicated as these changes seem, they must yet have taken place two or three times separately in various groups of Corymbifers, for example, in the *Asteroidæ*, the *Anthemidæ*, and the *Senecionidæ*.

The Ligulates were again developed from yellow-rayed Corymbifers by the conversion of all the disk florets into rays. Appealing for the most part to very large and varied classes of miscellaneous insects, they have usually kept their yellow colour (Fig. 26); but in a few cases a fresh progressive development has been set up, producing the violet-blue or purple florets of the salsify (*Tragopogon porrifolius*), the deep blue *Sonchus alpinus*, and the bright mauve succory, *Cichorium intybus*. As a whole, however, the Ligulates are characterised by what seems a primitive golden yellow, only occasionally rising to orange-red or primrose in a few hawkweeds.

That this hypothetical explanation may be the true one seems more probable when we examine the somewhat similar case of the *Stellatæ*. Here it seems pretty clear that mere dwarfing of the flowers, by throwing them back upon earlier types of insect fertilisation, has a tendency to produce retrogression in colour. Even in the more closely allied *Dipsacæ*, *Valerianæ*, and *Campanulacæ*,

we see a step taken in the same direction, for while the large-flowered *Campanulas* and *Scabiosas* are bright blue, the smaller flowered teasel (*Dipsacus silvestris*) is pale lilac, the *Valerianas* are almost white, and the *Valerianellas* are often all but colourless. In the *Stellatæ*, the same tendency is carried even further. As a whole, these small creeping weeds of the temperate regions form a divergent group of the tropical *Rubiaceæ* (including *Cinchoniaceæ*), from which they are clearly derived as a degraded or dwarfed sub-order. Now, the tropical *Rubiaceæ* have tubular blossoms with long throats, and as a rule with five lobes to the corolla; but many of the *Stellatæ* have lost the tube and one corolla lobe. *Sherardia arvensis*, which has departed least of our British species from the norma of the race, has a distinct tube to the corolla, and is blue or pink. *Asperula*, which approaches nearer to the retrograde *Galiums*, has one pale lilac species and one white. The *Galiums* have no corolla-tube at all, and most of them are white; but two British species, *G. verum* and *G. cruciata*, are yellow, and one of these has become practically bi-sexual—a common mark of Retrogression. *Rubia peregrina* is even green. This clearly marked instance of Retrogression from blue through lilac and white to yellow makes the case of the Composites easier to understand. No doubt the dwarfed northern *Stellatæ* have found that they succeeded better by adapting themselves to the numerous small insects of the fields and hedgerows, and therefore have fallen back upon the neutral colours, white and yellow.

After so many instances of more or less probable Retrogression, it will not surprise us to learn that in an immense number of other cases there is good reason to suspect some small amount of dwarfing or even Degeneration. It may have struck the reader, for example, when we were dealing with the Crucifers, that many of the smaller white forms were apparently lower in type than large and brilliant yellow flowers like the charlocks. That is quite true; but then, many of these small types are demonstrably dwarfed and slightly degraded, as, for example, *Cardamine hirsuta*, which has usually only four stamens instead of six, thus losing the most characteristic mark of its family. In *Senebiera didyma*, the petals have generally become quite obsolete; in some species of *Lepidium*, *Arabis*, *Draba*, &c., they are inconspicuous and often wanting. So in the smaller *Alsineæ* there are many signs of Degeneration. The normal forms of *Caryophyllacæ* have two whorls of five stamens each; but these little creeping or weedy forms have often only one whorl, as in *Holosteum*, some *Cerastiums*, the smaller *Stellarias*, *Spergula*, *Polycarpon*, &c. In *Sagina*, *Cherleria*, and other very small types, the petals are often or always wanting. Indeed, most botanists will probably allow that nearly all our minute-flowered species, such as *Montia fontana*, *Claytonia perfoliata*, *Elatine hexandra*, *Radiola Millegrana*, *Circæa lutetiana*, *Ludwigia palustris*, *Peplis Portula*, *Tillæa muscosa*, *Myriophyllum spicatum*, *Hippurus vulgaris*, *Centunculus minimus*, and *Cicendia pusilla*, are distinctly degenerate forms. Though obviously descended from petaliferous ancestors, and closely allied with petaliferous genera or species, many of them have lost their petals altogether, while others have them extremely reduced in size. In several cases, too, the number of sepals, petals, or stamens has been lessened, and the plant as a whole has suffered structural degradations. Most of these dwarfed and degenerate flowers, if they have petals at all, have them white or very pale pink.

Readers of Sir John Lubbock's admirable little book on "British Wild-Flowers in Relation to Insects" will readily understand the reason for this change. They will remember that white flowers, as a rule, appeal to an exceptionally large circle of insect visitors, mostly of small and low grades. Hence, some among these very small flowers may often succeed, in certain positions, better than larger ones. Moreover, they will recollect that in

numerous instances the larger blossoms of each family are so exclusively adapted to insect fertilisation that they cannot fertilise themselves; while among the smaller blossoms alternative devices for self-fertilisation commonly come into play after the flower has been open for some time, if it has not first been cross-fertilised. Structural considerations show us that in most of such instances the larger and purely entomophilous flowers are the more primitive, while the smaller and occasionally self-fertilising flowers are derivative and degraded, having usually lost some of their parts. Hence, in tracing the progressive law of colouration in the families generally, it is necessary, for the most part, to consider only the larger and more typical species, setting aside most of the smaller as products of degeneration.

GRANT ALLEN

(To be continued.)

NOTE ON THE HISTORY OF OPTICAL GLASS

M. FEIL has been good enough to send us the following interesting particulars of the life of Pierre Louis Guinaud:—

Pierre Louis Guinaud was born at Bresset in the canton of Neuchatel, Switzerland, in 1742, and died in 1821. He was nearly sixteen years old when Herschel visited Switzerland, and with Alschneider made some telescopic experiments on the Tête Doran. Young Guinaud, who acted as shepherd by day, and at night worked in a bell manufactory, occasionally was present at the meetings of these gentlemen, and attracted their attention and good will by many services.

His curiosity was greatly aroused, and after having been allowed to look through the telescope, he asked Herschel to dismount the instrument, as he wished to see how it was made; doubtless struck by his wonderful intelligence, the illustrious *savant* showed him the details of its construction.

The following year this gentlemen returned to Switzerland with Dollond and Faraday. Young Guinaud must have utilised the intervening time, for he showed Herschel, whom he was able to call his benefactor, a telescope which he himself had made, the mirror being of bell-metal. Imperfect as such an instrument must necessarily have been, it proved his strength of will and aptitude for optics.

He had pondered over the subject and asked why large object-glasses had not been made? There are no glasses in existence suitable to make them," was the answer. "Make some, if you can," said Alschneider. "I will make some," replied Guinaud. But he required money. He set to work, and, being a clever workman, soon invented the bells of repeaters, which proved very lucrative. All that he earned was devoted to the establishment of small glass-works. What power of research and perseverance must this man have possessed, who, without any other resource but his genius, started the most difficult branch of glass making, in order to solve a problem which was incomprehensible to Faraday and Dargitères? For ten years everything was devoted to his work. One casting failed, and was thrown into the torrent which flowed at the foot of the mountain on which he had built his factory. He had chosen the highest and most inaccessible point, having to defend himself against the ignorance of his neighbours, who treated him as a sorcerer, and several times his place was sacked. He utilised a stream of water in order to work a hydraulic wheel for the pulverisation of these materials, the sawing and working up of these blocks of glass. Nevertheless, the attention of the scientific world was already drawn to the modest worker. Alschneider had become his friend. About 1806 he sold a disc of six inches to Lerebours, and at nearly the same time he sent an eight-inch to Dollond; the problem was

solved. He furnished Panchoni and Lerebour with discs of twelve inches. The twelve-inch object-glass belonging to Causham was bought for 2,500 francs by Faraday. Alschneider begged him to go to Munich and associate himself with Fraunhofer. But at the end of about three years the desire to see his mountains again took possession of him, and he renounced all his advantages and returned to continue his work alone. France offered him a pension from the state, a secret patent for fifteen years, and a factory fully established; but he refused to accede to the offers of the minister of Vitellius, and died in 1821. After his death his son, Henri Guinaud, who had always lived in France from the age of fifteen, was put into communication by Lerebours with MM. Bontemps and Thibaudau, proprietors of the glass-works at Choisy-le-Roi. He had seen several experiments during the journeys he had taken with his father. He taught these gentlemen all he knew of his father's processes, but, obliged by penury to quit them, he returned to Paris, and founded, with his son-in-law, M. Feil, my father, a small glass-work in the Rue Mouffetard. This was in 1832.

In 1838 Henri Guinaud received the gold medal of the Academy of Sciences, in 1839 the great prize in astronomy, one part of which was given to M. Bontemps. He presented to the Academy of Sciences a disc of eighteen inches diameter. I succeeded him in 1848, and was his pupil for six years. He died in 1851, carrying with him the regrets of all scientific men, who, like the Aragos, Gambays, Théyards, and Dumas, had appreciated his cleverness and his talents, and who were his friends and protectors.

NOTES

THE French Association for the Advancement of Science meets this year at La Rochelle, on the 24th inst., for its eleventh session. M. Janssen is the President elect. Two lectures are to be delivered, one by M. Bouquet de la Grye, on the deep water harbour of La Rochelle; the other by M. Hospitalier, on the electric light. There will be excursions to the places where oysters and mussels are cultivated. Deep-sea dredging will take place on board the *Ardisnade*, under the direction of Prof. Giard, of Lille. A reduction of 50 per cent. will be granted on the French railways to the members of the Association. Among foreign *savants* expected to attend the meeting are Prof. Hennessy of Dublin, Prof. van Beneden of Louvain, with several other Belgians, Prof. Baehr of Delft, and two other Dutch *savants*, Signor Denza, of Moncalieri Observatory, and two other Italians, Chevalier di Silva, Royal Architect, from Lisbon, Prof. Vittanova of Madrid, and M. de Lorient of Geneva. Among the subjects of papers we note briefly the following:—The Channel Tunnel; American glaciers; transformation of work into heat, and reciprocally; marbles of Italian quarries; employment of portable railways in the war in Tunis; geodetic works in Italy; the salubrity of collective dwellings; aerodynamics and solar heat; the topoveloce; a new gyroscopic box; a geometrical generation of Fraunhofer's lines; theory of vowels; isotherms on mountains; registering capillary electrometer; new pressure-anemograph; best coloured signals for beacons, &c.; sulphurous acid in Lille atmosphere; aerial navigation; photometry for light of different colours; severe winters; distribution of the atmosphere in the two hemispheres; ammoniacal fermentation; determination of salicylic acid in alimentary substances; action of oxalic acid on polyatomic alcohols; formation of alkaloids in protoplasm; bases of the quinoleic series; electro-therapeutic treatment of vomiting; double consciousness; teas of commerce; anaesthesia in croup; anthropology of evolution; the cause of goitre; intestinal parasites of oysters; thermal waters in the