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The following Paper was then read by the Author :—

COLOURS IN NATURE. By the Rev. F. A. WALKER, D.D., F.L.S.

"Scarlet and blue and purple and fine linen."

SUCH was the combination of colours ordained of God by Moses for the service of the Tabernacle at the commencement of the Jewish national history. And there have not been wanting those who, in allegorising the whole of the prescribed ritual, have professed to regard the above productions of art as symbolising the four elements in the world of Nature,—to wit, scarlet, fire; blue, water; purple, as I suppose, air, from the tint of the mountains and clouds when viewed through the medium of distance; and fine linen, earth, from flax, of which it is composed, being a product of earth. I am not prepared to endorse this interpretation as the real one, although I do not go so far as to assert that no symbolism is intended, and with regard to scarlet, at any rate, the deep dye and glaring character of sin may be hereby portrayed, as is more particularly exemplified by scarlet being one of the offerings required for the cleansing of the leper, and

having regard to such a passage of Holy Writ as Isaiah i. 18: "Though your sins be as scarlet, they shall be as white as snow; though they be red like crimson, they shall be as wool." But the special reason why I have mentioned the colours enjoined for the service of the Tabernacle is, that scarlet, blue, and purple are here spoken of in combination, and scarlet, blue, and purple are three of the colours in Nature to which I wish to draw your attention, more particularly in the case of purple, as there is without doubt great variety and discrepancy in the particular colour intended by the word purple, as employed in different writers, ages, and countries. The ordinary modern acceptation of the word purple without doubt signifies such a tint as belongs to the *Viola odorata* and the purple crocus, to the purple, moreover, of a leaden-coloured cloud when lighted up by sun-light; and this statement derives additional corroboration from the fact that a large South American butterfly, *Caligo Inachis*, is also termed Uranus, or Heaven, from its purple wings with yellow band, being supposed to resemble the purple and gold of sunset. As an entirely different colour is intended, and described in the lines,—

"The roseate hues of early dawn,
The brightness of the day,
The crimson of the sunset sky,
How fast they fade away."

So, too, the purple mountain of Killarney, exhibiting a similar appearance in the intensity of its tint to the beautiful title of Athens in classic times as the "city of the violet crown," ἰοστέφανοι Ἀθῆναι, from its environment by such purple hills as Pentelicus, Hymettus, &c., as I have seen and can personally testify.

Of quite another hue was the Tyrian purple of the ancients, that became a synonym for royal attire. For example, the purple that is mentioned, together with fine linen, in St. Luke's Gospel. We may feel assured of this from the original word in the Greek being πορφύρεος, also employed to designate the dark, dull red stone known, when Anglicised, as porphyry. Similarly, "born in the purple" became a proverbial expression for offspring born to reigning monarchs. A Byzantine prince was termed Porphyrogenitus, when born in an apartment with royal hangings of red, which was assigned for births in the imperial family, and the porphyry, or red, in which ancient missals, splendidly illuminated and richly decorated with gold or silver, were bound, was said to be of the

colour of dark bull's blood, so the better to show up the brightness of the metal. It is likewise noteworthy, with regard to the robe in which the soldiers attired our Lord before His crucifixion, St. Mark and St. John describe it as "purple," St. Matthew as "scarlet," and St. Luke speaks of it as "gorgeous." If purple and scarlet could be used by two different writers in reference to the same dress, it is clear that the purple of the ancients must have been decidedly of the colour that we should now term red. And it is highly probable that the robe in which our Lord was clad in mockery of His title as King of the Jews was a "paludamentum," or old military cloak, of the Roman soldiers, possibly scarlet, like our regimentals.

There can be no question but that the Greek πορφύρεος (from which both the Latin *purpureus* and our "purple" are derived) conveyed in its first notion, when used in the Homeric poems, the signification of dark without any particular reference to colour. Thus, in Iliad I. 482, πορφύρεον κῦμα is "a dark wave"; Iliad XVI. 391, πορφύρεον ἅλς is the dark sea; Iliad XVII. 551, πορφυρέη νεφέλη is a dark cloud. Then it came to be used more definitely of colour, as πορφύρεον αἷμα, crimson blood; πορφύρεος θάνατος, bloody death, death in battle. It is also used in other passages of garments and cloths coloured by the dye of the murex, like φοινικόεις in this respect, just as the Latin Tyrius is likewise an equivalent for *purpureus*, for the Phœnicians or Tyrians are reported to have been the first to discover and use this colour. With regard to the meaning of *purpureus* in the Latin poets, when denoting a particular colour, it signifies rosy, red, or reddish, as used of the rose in Hor., Od. III. 15, 15, "purpureus flos rosæ"; of the dawn, "Aurora," in Ov., Met., 3, 184; of blushes, "rubor oris," Ov., Trist. 4, 3, 70; of poppies, "papavera," Prop. I. 20, 38.

And likewise bright, brilliant, apart from any special tint, as of "lumen juventæ," the light of youth; of "orbes," equivalent to "oculi," the eyes, Val. Fl. 3, 178; of "colores," colours, Hor., Od. IV. 1, 10. Occasionally, but more rarely when used of the wave, it means dark,—"purpureus fluctus" thus corresponds to the Homeric πορφύρεον κῦμα. We are probably all of us familiar with the anecdote of the blind person who, when asked what he supposed the colour of scarlet to resemble, replied that he imagined it was like the sound of a trumpet,—no bad illustration, when we reflect that of all hues it is the most glaring and dazzling. And some of us may have read long ago the old-fashioned fairy-tale of Miranda, who, expressing herself tired of the perpetual verdure, had her imprudent wish suddenly

realised by all the foliage being turned to the brightest red, resulting in dazzled and aching eyes, and convincing her that no tint in Nature was so productive as the green of springtide of softness and repose, and so unattended by inconvenience. It may be remarked, *en passant*, concerning scarlet, that very few of our English wild flowers are of this colour,—the field poppy and the pimpernel, for example; but the field poppy is the only one of sufficient size and occurring in sufficient quantity to create a noticeable feature in the landscape, wherever it fills the cornfields. A much larger proportion are pink or crimson, as the foxglove, the lychnis, the bloody crane's-bill, the willow herb, the herb Robert, the lythrum, common mallow, ragged robin, clover, &c. It is very possible that the ferruginous character of the soil in places may contribute to the abundant number or to the intensity in hue of several crimson flowering plants. And similarly different chemical agencies are rendered subservient to the production every season of variations in colour in cultivated kinds. It may be observed with regard to butterflies, as a parallel to what has been above stated, that very few species indeed are entirely scarlet or red,—*Harma sangaris* of West Africa, and *Appias nero* of East Indies, furnishing two notable exceptions; but in almost every other instance the red does not constitute the only, or even the ground colour, but occurs in spots or patches.

Among birds also, and to take the parrot tribe as a serviceable example, there are more green than red kinds, though in the case of butterflies and moths there are few species entirely green like the African *Charaxes eupale* among butterflies and the "Emeralds" among British moths. And in British plants *Helleborus viridis*, or green hellebore, is one of the very few conspicuous kinds that have an apple-green flower similar in tint to an ordinary leaf. To blue, on the contrary, has been assigned a far larger place among the works of creation.

> "Blue rolls the waters, blue the sky
> Shines like an ocean hung on high."

Blue is the colour of Virgil's thundercloud:—

> "Olli cœruleus supra caput astitit imber,
> Noctem hiememque ferens."

The heavens declare the glory of God, and when we assert of any object of Nature that it is sky-blue, we are purposely ascribing to it the most lovely tint of all imaginable hues. When, in Exodus xxiv., Moses and Aaron, Nadab and Abihu,

and seventy of the elders of Israel alone out of all the congregation, saw the God of Israel, the sacred narrative proceeds to state that in that vision of the Creator of all things, the colour of blue was specially conspicuous, as, so to speak, the footstool of the God of glory. "There was under his feet, as it were, the paved work of a sapphire stone, and, as it were, the body of heaven in its clearness." We are all of us familiar with the expression "true blue" in ordinary parlance, but the very triteness of its usage may of itself be an indication that there is a deep and solemn reality underlying this idea. Is there not a tacit, though, it may be, almost unconscious, acknowledgment of the eternal verities hereby implied, that blue are the distant hills—blue by reason of their distance, which, above all objects of the visible creation, seem, by their towering summits heavenwards, by their lonely heights and unbroken solitude, apart from the life and ways of men, to speak of Him who is the unchanging Truth, and by their massiveness and enduring character to be girded about with power; and are they not in Holy Writ the favoured scenes of special manifestations of the Deity, and of communion between Himself and His creatures?

Blue is the "great and wide sea also," unchanging in outward appearance through the lapse of ages, and showing no traces of alteration as the earth does in process of time, owing to eruption, earthquake, landslip, or other geological change.

> "Time writes no wrinkle on thine azure brow,
> Such as Creation's dawn beheld, thou rollest now."

Again, certain seas (those around the Channel Isles and also the Mediterranean) are of a particularly bright blue. If we now revert to the living products of the Divine hand, we shall find abundant evidence in flowers and butterflies of blue preponderating over some, and holding its own with all colours, and especially in the case of the butterflies. Of our own English wild flowers may be quoted as examples the various kinds of violet, the scabious, pinguicula, ajuga, self-heal, gentian, harebell, and other species of campanula, *Vicia cracca*, ground ivy, speedwell, forget-me-nots, blue pimpernel, sea aster, *Scilla verna*, *Scilla nutans*, corn blue-bottle, &c.

Again,—what more lovely sight than that of a wood in early springtime, when, through the carpet of last autumn's leaves sodden, trodden down, and decaying amid the miry clay, myriads of blue spires of our wood hyacinth, the *Scilla nutans*, are struggling upwards? Do they not seem to speak to us of dull earth transmuted into a higher nature, ever as

in their direction they point heavenwards, and in their colour reflect the sky's own tint, teaching what we might be, a little bit of heaven's blue in the midst of senseless clods, and springing out of the prevailing decay?

In reviewing the butterflies, the Morphidæ of South America pre-eminently suggest themselves to all our minds. *Morpho*, a Greek word denoting form or beauty, was a Spartan title for Venus, and certainly the tribe of insects thus named, large in size, conspicuous in beauty, and numerous in the number of its species, fully deserves the appellation it has received. The title Morphidæ is regarded as including the whole tribe comprehending some fine genera, as Pavonia, Caligo, &c., that are not in many instances of a brilliant blue, but dusky. The word Morpho is reserved for such as are of a uniform azure or pearly tint, and nothing can exceed the beauty of many of those denizens of the Western tropics. Blue, unlike red, in many of these species, constitutes the ground and only colour. In the case of other kinds broad blue bands intersect a black or dark brown surface. Morphidæ are decidedly the largest in size of all the tribes of butterflies known in the Western hemisphere, several of the species equalling in stretch of wing any that occur in the Eastern also. The range of most of the kinds is confined to South America, but few extend as far north as, and a few more are peculiar to, Central America and Mexico. The beauty of many of the kinds, and the minute differences, variations, and gradations of tint are indescribable, and can only be realised by close inspection, some recalling moonlight in water, others an opal-like radiance or mother-of-pearl suffused with mauve, or a blue unsurpassed in lustre by any created object, unless it be the breast of another inhabitant of the same region, I mean a tropical humming-bird.

Several species of our own, and the Continental, African, and East Indian Lycænidæ, small and insignificant in appearance as they are in comparison with the Morpho, are, nevertheless, wholly blue, some brighter, some duller, some dark, some purplish, and others again silvery. It may be remarked that a yellow flower, when dried, preserves its colour much better than a blue one. Take the *Centaurea cyanus* (corn bluebottle) as an instance. For the first five or six days it will appear to keep almost its original tint, and then suddenly it will turn completely white. Among butterflies the contrary holds good. Place a blue Morpho, and a yellow or orange Callidryas in a glazed case in a shop-window, and the blue will retain its hue for a long period after the other insect has

become faded and bleached. To a certain extent the colouring of butterflies, as well as their size, shape, and markings, indicates the particular tribe to which they belong,—*e.g.*, the blue of many of the Morphidæ, the yellow of the Ornithoptera, the bright and various tints of the Catagrammas are peculiar to themselves, and have no parallel among other genera of butterflies. On the other hand, there is such a similarity between some species of Papilio and those of Euplœa, between one particular Diadema and a species of Danais, between the genus Euryphene and that of Romalæosoma, as a whole, that the distinctions must be sought for in the nervation of the wings, or in some other structural divergence, and not in the respective outward colouring merely.

The survey of an Oriental crowd gathered together on some public occasion, as the setting forth or return of a procession, when all the spectators attired in flowing robes have donned their best dresses to view the sight, will inevitably lead to the conclusion that blue is the Eastern's favourite colour, and worn far more extensively than orange, black, or white. The blue in question is obtained by steeping the garments in vats of indigo dye, such as may be seen at the doors of the clay-built huts of Keneh, Upper Egypt, and the garments so stained are then suspended on cords across the narrow street to dry. Now, there must be some prompting of a picturesque effect that has led the Oriental to the adoption of this colour,—possibly the contrast between it and the green palm-trees and yellow sand that form his every-day surroundings in so many places,—as his preference for it is manifestly not confined to articles of dress, but window-shutters, door-posts, palisades, &c., are similarly painted, and thus afford additional evidence of his taste in this particular.

With regard to the question how far the colour of insects is caused or modified by outward circumstances, I have had to apply for information to those who have made these and such-like matters their special study, and am credibly informed that the larvæ of certain species can be modified by varying surroundings, and the pupæ also, but independently; in other words, I conclude that we are to understand that both caterpillars and chrysalids can have their colours altered or modified by external causes, but that the chrysalids do not derive their altered tint from the caterpillar stage, but undergo a separate modification in their turn; also in no case does the effect go on into the next stage, or make any difference to the imago (as far as work has gone at present). Only in one case does larval dimorphism (green and brown)

affect a later stage, and that only the pupal, and in this case, as far as my informant can see, the larval colours cannot be produced artificially.

There is no evidence for colours being due to the presence of chemicals, although, no doubt, advantage is taken of their presence to produce certain colours; but in the vast majority of cases the colours are due to arrangements of molecules, &c., and *not* to peculiar or uncommon elements. None of these have been shown to exist in insects.

It is not believed that the fact of the insect beholding the surroundings could ever account for resemblances, but that it is a case of survival of the better-adapted variations. In certain cases colour is modified by beholding surroundings, although, in the case of larvæ, it is more probably by *feeling* the colours through the skin, and not through the eyes. But in these cases we have no *explanation* of the *origin* of colour, for it is more than doubtful whether the result can be inherited.

In the case of the changing colour of the chamæleon, trout, &c., it is obvious that the *results* cannot be transmitted, only the *power* of changing, and it is believed that it is also the same with the results arrived at in insects.

The blue sky and sea cannot account for blue in animals, for the two colours depend upon such different chemical substances, and often different optical principles. Nor is there any evidence for any colour tending to produce a similar colour in other bodies.

Those who desire more detailed information on this topic, and kindred subjects, are referred to Mr. Edward Poulton's papers in the *Proceedings of the Royal Society for* 1885 *and* 1886 on the special colour-relation between *Smerinthus ocellatus* and its food-plants, the outcome of laborious investigation, accompanied by varied experiments, modifications of colour produced and noted by feeding larvæ on leaves of different trees, and also on leaves of different sizes and shapes, as well as different kinds; also the contrivance of fastening leaves together, so that some larvæ should only see the upper surface, others only the under, and as the upper surface differs in tint from the under, a varied result is expected and, in many cases, obtained. The experiment has also been varied by feeding some larvæ which had been given a different tint artificially by removing the "bloom" from the under surface, and, to test whether the ocelli formed the impressionable part of the larvæ by investigating the effect upon colour of covering those organs with some innocuous opaque pigment.

The effects of certain food plants, about which the evidence was conflicting, were also further investigated, the periods inquired into during which the larvæ are most susceptible to the influence of the food plant, and the instances carefully watched for of individual variation among the larvæ from the same batch of eggs, and fed upon the same food. The influence of the food plant, so far as observation has been made, is not uniform, and must act during a large proportion of the whole family life to produce an effect. It is probable that effects accumulate during successive generations. The effects are partially due to pigment which is proper to the larva, and which has no immediate relation to the food plant. The changes produced in derived pigments are more complicated, and due to the predominance of one or another of vegetable colouring matters in the tissues and blood. The food in the digestive tract is a probable first cause of larval colour, and the dark dorsal line of the larva a very early marking. Where the large-leaved varieties of the willow have been used as the food plant, the tendency in the larva has usually been towards a whitish hue, and where the long but narrow and small-leaved ditto, towards yellow. Towards yellow again when the dark green upper side of *Salix viminalis* has served as food, and, on the other hand, the tendency always towards white, when the feeding has taken place on the under-sides of the same leaves, the said under-sides being, of course, hoary, as in the case of the poplar, upon which tree as well as upon many varieties of willow, and upon the apple, and cultivated and wild crab, experiments have been made. Another kind of willow, *Salix triandra*, with whitish bloom, is evidently in the direction of yellow, but ditto without the white bloom, more strongly than the last in the direction of yellow. This, of course, would indicate that the presence of white bloom on the leaf counteracts so far as it produces any effect, although it cannot counteract altogether and effectually, yellow in the larva. The parent larvæ experimented on of *Smerinthus ocellatus* were extreme white varieties, and belonged to a group which evidently inherited a very strong tendency in this direction, as was shown by the comparatively slight effect that followed the use of foods which most powerfully tend to produce white varieties. It is noteworthy to observe that the leaves of the crab produced most extreme white in the bred larva, as also in the case of the parents previously experimented on, but that *Salix rubra* and *Babylonica* produced much less effect than in the case of the parents. And Mr. Poulton's argument, drawn

out *in extenso* from these data, would, I suppose, be somewhat as follows:—The parents in each case are of the extreme white variety. One set of these, and likewise the larvæ that are their offspring in the following season, were fed on crab leaves, tending to produce and to perpetuate white, while the other set, and likewise their larvæ, in succession were fed on small-leaved varieties of the willow, that similarly tend towards yellow (small-leaved varieties having this tendency, and *Salix Babylonica*, the Eastern weeping willow, being the smallest leaved of them all). So that when a second generation of larvæ was fed on yellow producing food, the effect in the direction of white was much less manifest, although the same yellow producing food had no result whatever in the case of their progenitors, selected, as has been already noticed, from the extreme white variety. It is a highly interesting matter of observation, as it seems to me, how far, how long, and in how many individuals of a batch of caterpillars, the selected and inherited white will prevail, when the food plant, season after season, is of a yellow tendency, or, to speak more correctly, the plant with which the larval sensory surface is brought into contact, as there is considerable evidence for believing that the influence of food upon larval colour does not consist in the eating, not in the comparatively simple phytophagous influence, but through the nervous system regulating the amounts and kinds of the vegetable pigments made use of, and that of the larval pigment deposited. I am of course open to correction, if I have unintentionally misrepresented the bearing of Mr. Poulton's arguments in any particular while under the necessity of compressing the record of his experiments into small compass, and of only very partially and incompletely referring to the sundry and laborious investigations that one so talented and possessed of such power of research has conducted on behalf of science.

Such work as he has so laudably commenced ought to be conducted by many individuals at the same time in reference to a great many species of insects, with a no less great variety of food plants, and through every succeeding season, for the compass of a whole lifetime, the consequent breeding and rearing, experimenting and observing and registering should be conducted,—and notably in the tropics, as much as if not more than at home,—if anything like an adequate generalisation, only attainable, as it seems to me, by the comparison of a multitude of instances, and through long process of time is to be arrived at; for after all there are

pretty certain to be several exceptions to the rule as regards cause and effect in colour, partly, it may be, arising from incompleteness of knowledge and imperfection of experiment as yet, while only on the threshold and borderland of an almost untrodden field, and same reasons, moreover, when no results are attainable from a brood of caterpillars suddenly dying out by reason of an epidemic or otherwise.

Again, with regard to colour in animals generally,—not insects only, but all living creatures viewed as one great whole,—certain great truths are sufficiently manifest. First, the relation between colouring and light is very evident in beings which inhabit the earth and air, and in some instances, but by no means in all, and not in the same way or to the same extent in those of the water also. Many statements have been given in support of this, several of which I unhesitatingly admit, while others I accept subject to certain qualifications and reserve. It has been asserted with regard to the denizens of earth and air, that those are the most brilliant which are exposed to the sun; those of the tropics are brighter than in the regions around the North Pole, and the diurnal species than the nocturnal. But it should be borne in mind, that to institute a comparison between the tropics and the neighbourhood of the North Pole in reference to any order in Nature, is to pre-suppose two extreme cases, and the fact is ignored, that though the tropics possess a far greater number of rich and radiant-coloured birds and insects than any other part of the globe, they contain at the same time many more dull-coloured ones as well,—butterflies, at all events. And while dwelling on the subject of diurnal Lepidoptera, with which tribe I am most familiar, I may take the opportunity of mentioning that our seven British species of genus Vanessa equal in beauty any other kinds of the same family from warmer climates. Again, it has been stated, and stated truly, that birds which fly, as it were, bathed in light, do not offer the strong contrast of tone between the upper and lower side; in other words, that the breast resembles the head, or back, or wings, one or other if not all of these in colouring, I suppose. But the writer of the article that appeared several years ago in *Chambers's Journal*, and from which I am now quoting, adds, "And the wings of many butterflies are as beautifully feathered below as above." As beautifully feathered,—yes; but very differently coloured, and very differently marked. I have in my mind's eye at this moment three different species of the South American genus Catagramma, that may serve as one example out of many that I

could produce. The upper surface of each of these three butterflies, consisting of bluish green metallic bands upon a very dark, if not black ground, is so similar that they look almost like one species. The under surface in every instance presents a marked contrast to the upper as well as to the under side of the two others, being primrose in one species, pale brown in another, and stone colour, almost white, in a third. I will go further, and myself allege that the wings of some butterflies are not only as beautifully feathered, but more beautifully below than above, as I could prove from my own collection. But this does not do away with the equally true fact that all the numerous bright blue morphos which have been previously referred to in the course of this paper, have, without exception, their sides of a sober brown, and I think it cannot be disputed that the under surface of no English butterfly is equal to the upper in beauty, and also that the upper surface of the majority of the species from all over the globe surpass the under in gayness and lustre of colour. Beetles, wasps, and flies are likewise stated to have the metallic colouring of blue and green, and to possess rings equally dark all round the body. Precisely, because beetles, wasps, and flies, like birds in this respect, have the whole of their bodies equally exposed to the rays of the sun, so that if the sun's brightness produces any effect and any intensifying of colour in them at all, it must do so on every part of them alike. But the colouring of the bodies of by far the greater proportion of butterflies and moths is not worth mentioning. It is with their wings that we are concerned, and what I would assert is that the upper surface of a butterfly's wings must naturally and perforce be far more exposed to the bright sunlight than the under, for if it flaps its wings in rapid flight, even then the upper surface receives more of the sunlight, and if, on the contrary, it floats along with its wings spread out horizontally like a fan, then a portion of the upper surface is all that the sun shines on; the lower is turned towards the earth. View the same creature when it has settled. Its under surface rests against the flower, or if the wings should be closely pressed together and erect it will frequently be noticed that the weather is cloudy, or that it is the hour of declining day, and that in any case the butterfly is asleep.

Again, "one star differeth from another star in glory," and the beauty of the scarlet-and-black patches of the upper side of *Catagramma cynosura* is very diverse from that of the orange-and-blue markings of the under in that South

American butterfly. Both are lovely, and should be displayed equally in cabinet specimens, but that of the scarlet-and-black, which necessarily receives more of the sunlight, is the more gorgeous. Some butterflies have dull upper and under surfaces equally, others are beautiful on either side; some, dull on the upper, present a strikingly handsome contrast on the lower, while the greater number are far more beautiful above than below. But in those instances where each side is beautiful the colours and markings of the two sides respectively, be it noticed once more, are very different. Hence arises the question, Is the sunlight so important, after all, if the under surface that does not enjoy so much radiance is, although so different from the upper, and perchance not so gorgeous, still so beautiful? But the answer is obvious. Sunlight is not, for the most part, necessary to the production, but it is to the maintenance of colour in all organic beings, although I could exhibit instances from my own collection of the differences in colour both of the wings and body in a certain dragon-fly (*Calepteryx ludovisiana*), as caught after it had newly emerged, from other specimens that had been exposed for some days to the light and heat of the sun. Intestinal worms and larvæ found in the ground or in wood are all colourless, as also are certain little beetles in the depths of the crevasses of snowy mountains, or the eyeless reptiles and fishes inhabiting the waters of subterranean caves, in the same way that sea-kale, rhubarb, &c., are effectually blanched when growing amid darkness under an inverted pot. A gorgeous butterfly is never, it is true, brighter in tint than in the hour when it emerges from the chrysalis. It does not become brighter by disporting itself day after day in the noontide beam (for its colours are altogether differently constituted from those of the dragon-fly); but what the sun's rays do for it is this: Its first act on reaching the perfect state is to flutter towards the light, and to place itself in a position whence it can gradually unfurl, expand, and hang its wings downwards, until those wings, by reason of the warmth, gain nerve, and are no longer limp, but fully capable of an extended flight. Bright sunshine is requisite for the appearance as well as the abundance, no less of dragon-flies than of butterflies, if not even more so; and it is worth notice to observe what a difference a bright hot day makes in the rapidity and wildness of flight of a certain butterfly,—our only British swallowtail, P. Machaon, in the Cambridgeshire fens. It is also remarkable how, if but a transient cloud pass over the sun, the insects,

even if there be no rain, will all in a moment disappear, and where they betake themselves is equally past finding out. One's own shadow projected across a flower or leaf on which an insect is settled, without the slightest noise, will cause it rapidly to take wing, so dependent is it for its brief hour of enjoyment on the sun's brightness. Although, as I just now said, it becomes no brighter for many days of sunlight, it does become considerably faded in some instances between the beginning and end of the season. Observe a specimen of a painted lady butterfly that has successfully hybernated, and reappeared in the ensuing spring, and look at the difference that those humble bees ordinarily known as red tails (*Bombus lapidarius*, for example) show between spring and autumn and the period when they are found on the early blossoms of the dead nettle and the time when they haunt the flowers of the late lingering thistles,—in the former instance bright orange, and in the latter a dull rust colour. Again, birds, fishes, and insects have been correctly said to alone possess the metallic colour; while plants and zoophytes are without reflecting shades, and the mollusca to take a middle path with their hue of mother-of-pearl. But in any inquiry,—so far as inquiry can be made,—into the causes to which animal colouring is due, we must be careful to distinguish between three sorts of colour, which I will venture to term for convenience' sake uniform, metallic, and iridescent, and then to convey my meaning with regard to these three appellations.

Uniform, such as all butterflies possess, and which is evident to the most superficial observer, and seen even under a dull light, as for example the yellow of the sulphur, the crimson and blue of the peacock, the scarlet, black, and white of the red admiral.

Metallic, peculiar to certain tribes of birds and butterflies like humming-birds and morphos. In the case of *Morpho cypris*, for example, it is a shifting tint, for as that resplendent insect is viewed flat in a drawer, now one side appears bright blue, and now again the other, while the left or right wing alternately seems dark. The drawer requires to be held up and turned to and fro under a full, strong light, for the beauties of insects of this description to be thoroughly realised. It is noteworthy to observe with regard to another species of this group, *Morpho sulkowskii*, and its metallic tint, that it has the same markings in consequence, though not the same tint on both upper and under surface, owing to its wings being very transparent, presumably from the coating of scales being very thin, and that the pencilled markings on

the comparatively dull surface of the under side reflect a bright mauve on the mother-of-pearl expanse of the upper. None of this tribe can be effectively represented by a coloured illustration, inasmuch as the opaline tints of some cannot be depicted at all, while the brilliant blue of others is only represented by a dull indigo hue, and can be seen flashing like a speculum or mirror for an immense distance as the insect wings its rapid flight in its own land through the tropical sunlight. With regard to the humming-bird, when the beautiful feathers on its breast are examined under the microscope, it has been said that it is astonishing to see none of the shades the mystery of which one could penetrate. They are simply made of a dark-brown opaque substance, not unlike those of the black duck. There is, however, a remarkable arrangement,—the back of the feathers, instead of being a fringed stem, offers a series of small squares of horny substance placed point to point. These plates, of infinitesimal size, are extremely thin, brown, and, to all appearance, exactly alike, whatever may be the reflection they give. They have been described as so many little mirrors, but that comparison is not correct, for then they would only give back light without colouring it. Neither do they act by decomposing the rays which pass through them, for then they would not lose their iris tints under the microscope. It is to metals alone that the metallic plumage of the humming-bird can be compared; the effects of the plates in a feather are like tempered steel or crystallised bismuth. Certain specimens emit colours very variable under different angles, the same scarlet feathers seeming, when turned to ninety degrees, a beautiful emerald green. The same process which nature has followed in the humming-bird is also found in the wing of the butterfly. It is covered with microscopic scales, which play the part of the feathers, arranged like the tiles of a house, and taking the most elegant forms. They also lose their colour under magnifying power, and the quality of reflection shows that the phenomena are the same as in feathers. There is, however, a difference in the extent of the chromatic scale. Whilst the humming-bird partakes in its colours of the whole of the spectrum, from the violet to the red, passing through green, those of the butterfly prefer the more refrangible ones from green to violet, passing through blue.

As regards iridescent hues, a brief statement will suffice. On the upper surface of the wings of certain Swiss species of the genus *Erebia*, that are of a dark reddish brown, as a rule, I have noticed the play of a greenish and also a purplish tint

when the specimens have been in fresh and good condition; but my belief is that this appearance is very transient, and does not long survive their capture and transference to cabinet drawers. I do not pretend to say what occasions the combination of green and purple, but it is possibly worth while to notice that short iridescent hairs of somewhat the same tints clothe the back of the doris or sea-mouse as it appears cast up upon the beach, and this consideration leads us to the question of colour in another order of organic beings —namely, fishes. In these the action of light is apparent. The part of the body turned towards the light is always paler than that which is undermost. Fishes which live on the side, as the sole and turbot, have the left side, which answers to the back, of a dark tint, whilst the other side is white. Nevertheless, it would appear that the fishes of the richest shade, in distinction to the beings inhabiting the earth and the air, exist where the light is more tempered, and that some kinds found both on the shores as well as in depths requiring the drag-net, are of a bright red purple in the latter regions, and of an insignificant yellow-brown in the former. Other bright objects of the deep, such as certain species of sea anemone, and the like, only occur at a considerable depth below the surface water, so that they cannot be observed at all in their natural habitat, except in some sea caves which the tide fills to a considerable height, only receding from the entrance sufficiently to allow of ingress two or three times a year, whereby I obtained a sight of these numerous and marvellous creatures studding the rocky walls. I shall take occasion to advert to these marine caverns again, so before quitting this part of the subject would merely remark that those who bring up gold fish know well that to have them finely coloured they must place them in a shaded vase where aquatic plants hide them from the extreme solar heat, and that under a hot July sun they lose their beauty. Similarly on a summer's day common carp and roach, &c., will betake themselves to the shelter of the expanded leaves of the water-lilies in our ponds. A great deal of what has been above stated tends to show that it is vain to say that an animal is beautiful in shape or in colouring, in order to please the human eye; and Wallace testifies to the same truth in the second volume of his *Malay Archipelago*, wherein on obtaining a specimen of the king bird of paradise, he states :—

"I knew how few Europeans had ever beheld the perfect little organism I now gazed upon, and how very imperfectly it was still known in Europe.

"The remote island, in which I found myself situated, in an almost unvisited sea; the wild, luxuriant tropical forest, which stretched far away on every side; the rude, uncultured savages who gathered round me,—all had their influence in determining the emotions with which I gazed upon this 'thing of beauty.'

"I thought of the long ages of the past during which the successive generations of this little creature had run their course, year by year being born, and living and dying amid these gloomy woods, with no intelligent eye to gaze upon their loveliness; to all appearance such a wanton waste of beauty. Such ideas excite a feeling of melancholy. This consideration must surely tell us that all living things were *not* made for man. Many of them have no relation to him. The cycle of their existence has gone on independently of his, and is disturbed or broken by every advance in man's intellectual development." And more to the same purport.

One object for which the birds of paradise are endowed with beauty of plumage,—beauty, be it remarked, entirely confined to the cock birds,—is, without doubt, the delight of the hens, when their mates, in the case of the great birds of paradise, for example, shake out their saffron feathers like a fountain.

To quote from Wallace again on this subject:—

"The birds had now commenced what the people here call their 'sácaleli,' or dancing parties, in certain trees in the forest, which are not fruit-trees, as I at first imagined, but which have an immense head of spreading branches and large but scattered leaves, giving a clear space for the birds to play and exhibit their plumes. On one of these trees a dozen or twenty full-plumaged male birds assemble together, raise up their wings, stretch out their necks, and elevate their exquisite plumes, keeping them in a continual vibration. Between whiles they fly across from branch to branch in great excitement, so that the whole tree is filled with waving plumes in every variety of attitude and motion."

I find it difficult to reconcile the different experiences of Wallace and Kingsley on the subject of colour in the flora of the tropics as affecting the general scenery. It is true that Kingsley visited the West Indies and Wallace the Malay Archipelago, but the latter was also familiar with the New World, having previously visited the Amazon, or some of the tributary branches of that mighty river.

The discrepancy had best be given in their own words. Wallace says:—

"Persons who have formed the usual ideas of the vegetation

of the tropics, who picture to themselves the abundance and brilliancy of the flowers and the magnificent appearance of hundreds of forest trees covered with masses of coloured blossoms, will be surprised to hear that though vegetation in Aru is highly luxuriant and varied, and would afford abundance of fine and curious plants to adorn our hot-houses, yet bright and showy flowers are, as a general rule, altogether absent, or so very scarce as to produce no effect whatever on the general scenery.

"It is true that Aru seemed to me exceptionally poor in flowers, but this is only an exaggeration of a general tropical feature, for my whole experience in the equatorial regions of the West and the East has convinced me that in the most luxuriant parts of the tropics flowers are less abundant, on the average less showy, and are far less effective in adding colour to the landscape than in temperate climates. I have never seen in the tropics such brilliant masses of colour as even England can show in her furze-clad commons, her heathery mountain sides, her glades of wild hyacinths, her fields of poppies, her meadows of buttercups and orchises,—carpets of yellow, purple, azure blue, and fiery crimson, which the tropics can rarely exhibit. We have smaller masses of colour in our hawthorn and crab-trees, our holly and mountain ash, our broom, foxgloves, primroses, and purple vetches, which clothe with gay colours the whole length and breadth of our land.

"It is very easy to see what has led to this erroneous view of the nature of tropical vegetation. In our hot-houses, and at our flower shows, we gather together the finest flowering plants from the most distant regions of the earth, and exhibit them in a proximity to each other which never occurs in nature. A hundred distinct plants, all with bright, or strange, or gorgeous flowers, make a wonderful show when brought together; but perhaps no two of these plants could be seen together in a state of nature, each inhabiting a distant region or a different station. Again, all moderately warm extra-European countries are mixed up with the tropics in general estimation, and a vague idea is formed that whatever is pre-eminently beautiful *must* come from the hottest parts of the earth. But the fact is quite the contrary. Rhododendrons and azaleas are plants of temperate regions, the grandest lilies are from temperate Japan, and a large proportion of our most showy flowering plants are natives of the Himalayas, of the Cape, of the United States, of Chili, or of China and Japan, all temperate regions," &c.

Now Mr. Kingsley's contrary view, as told in his *Christmas in the West Indies*. His whole description of the unspeakable marvels of a tropical forest extends over many pages, but I will select a few passages descriptive of flowering shrubs :—

"Beyond it [namely, a coco-palm], again, blaze great orange and yellow flowers, with long stamens, and pistils curving upwards out of them. They belong to a twining, scrambling bush, with finely-pinnated mimosa leaves. That is the 'flower fence,' so often heard of in past years, and round it hurries to and fro a great orange butterfly, larger seemingly than any English kind. Next to it is a row of hibiscus shrubs with broad crimson flowers. Over the low roof rises a tall tree, which looks like a walnut, but is not one; it is the *poui* of the Indians, and will be covered slowly with brilliant saffron flowers."

And again: "And yet, where the fire passed six months ago, all is now a fresh, impenetrable undergrowth of green creepers, covering the land, climbing up and shrouding the charred stumps. Young palms, like Prince of Wales's feathers, breaking up, six or eight feet high, among a wilderness of sensitive plants, scarlet-flowered dwarf Balisiers, climbing fern, convolvuluses of every hue, and an endless variety of outlandish leaves, over which flutter troops of butterflies."

Again: "Oh that we could show you the view in front. The lawn, with its flowering shrubs, tiny specimens of which we admire in hot-houses at home; the grass as green (for it is now the end of the rainy season) as that of England in May, winding away into the cool shade of strange evergreens; the yellow cocoa-nut palms on the nearest spur of hill throwing back the tender blue of the higher mountains; the large central group of trees,—Saman, Sandbox, and Fig,—with the bright ostrich plumes of a climbing palm towering through the mimosa-like foliage of the Saman and Erythrinas (*Bois immortelles*, as they call them here), their all but leafless boughs now blazing against the blue sky with vermilion flowers, trees of red coral, sixty feet in height."

Again: "One tall coolie ship at anchor seen above green cane fields and coolie gardens, gay with yellow Croton, and purple Dracæna, and crimson Poinsettia, and the grand leaves of the grandest of all plants,—the Banana,—food of Paradise."

And yet once more: "Under the perpetual shade of the evergreens haunt Heliconias and other delicate butterflies

who seem to dread the glare outside, and flutter gently from leaf to leaf, their colouring,—which is usually black, with markings of orange, crimson, or blue,—coming into strongest contrast with the uniform green of leaf and grass." And so forth.

In the second paper on Oriental Entomology that I had the honour of reading before a meeting of this Society, mention was made of the similarity of insects to vegetation constituting a protective resemblance in the case of butterflies, as also the means whereby other orders of insects were enabled to seize their prey unawares. To give an illustration of my meaning which I did not, I think, touch upon:—A spider coiled up at the bottom of a flower will precisely counterfeit the green axil of the flower-bud. And so, too, with animals. The stripes of the tiger are often deceptive, like the tint of the bamboos and canes wherein he makes his lair; the hue of the lion's hide resembles the sand of the desert on which he stalks. The ptarmigan in winter and the Arctic hare at the same season are white as the surrounding snows, the better to elude their natural enemies, while the Polar bear depends upon that self-same hue the more easily to surprise the unwary seal; and the ermine and Arctic fox are likewise clad in white fur at that time of year, the more readily to seize their prey. It has also been observed that hares, rabbits, stags, and goats possess the most favourable shade for concealing them in the depths of the forest or in the fields. And that when the most suitable colour for the riflemen at the first enrolment of the volunteer corps was discussed, it was supposed to be green, but, contrary to expectation, that which escaped the eyes of the enemy was the fawn colour of the doe, when soldiers dressed in different shades were placed in woods and plains to try which offered the best concealment. The birds which prey upon the smaller tribes, and carnivorous fishes like the shark, are clothed in dead colours, so as to be the least seen by their victims; and it was for no unmeaning fancy that the negroes of the Soudan were depicted in the paintings of the old Egyptian tombs clad in the yellow skins of the leopard or the panther. Nor can I wonder that the *Kallima*, or Indian leaf butterfly, manages so successfully, after it has settled, to elude the birds, when I myself once made with outstretched hand for an autumnal leaf standing upright on end in the mud of a Cambridgeshire lane,—as it exactly presented a superficial resemblance to the lemon colour and dull violet patches of the under side of the wings of a South American butterfly (genus *Callidryas*).

The causes of animal colouring are very various. Some living creatures have it in themselves, owing to molecular arrangements, the particular tint varying, one may conceive, according to the position, quantity, and closeness of the molecules, but the brightest colours are not, as a rule, bound up with the tissues; sometimes they arise from a phenomenon like that by which the soap bubble shows its prismatic hues. Then there is the special matter called pigment united with the organic substance, as, for example, the brilliant paint carmine is the pigment of the cochineal insect, and the red colour of blood which may be collected in crystals is separate from the other particles to which it is united.

A great deal has been already stated relative to the colour of butterflies in this paper, but I have hitherto omitted to notice that a numerous genus of South American butterflies (*Ithomia*) have their wings entirely free from colouring matter and any scales whatever, and as transparent as those of flies; another tribe (*Hetæra*) has also the whole of the wings transparent, with the exception of a rose-coloured spot close to the base of the lower wing, so that the insect has been aptly described by Mr. Bates to resemble a wandering rose petal in its flight as the transparent part is unnoticed while it is on the wing. Others again as the *Acræidæ* of Africa and Madagascar have the coloured scales over the whole of the surface, with the exception of the tips of the upper wings; and as I have dwelt on those butterflies which possessed an under side as beautiful as, but completely different from, the upper, I may now mention that some species of the South American genus Lycoreæ, for example, have on their under side a similarity to the upper surface, but at the same time a very faint reproduction of its orange, yellow, and tawny tints and markings, possibly because the under surface possesses a more sparse and scanty arrangement of molecules, or because the thinness of the wings produces a reflection of the vivid hues and markings that grace the other side.

To resume, not only do butterflies, when rudely and hastily caught, leave powder on the hands of their captor; but birds like the white cockatoo leave white powder on the hands, and an African traveller was astonished on a rainy day at seeing his hands reddened by the damp plumage of the bird that he had killed. When the particles are scattered they scarcely influence the tint, but when close together the effect is very conspicuous, as, for instance, the abundance of brown pigment that may be seen to underlie the skin of a negro after it has been raised by a burn, gives rise to his sable colour. Colour

likewise results not from a flat surface, but from the different depths of layers in the flesh. The varying rose and lily tints proceed from the more or less free circulation of the blood; the bluish tint well known to painters, proceeds from the vesicles when seen under the skin, and similarly blue veins present a false appearance, because the blood is red; it is the skin that thus dyes what lies beneath it; and blue eyes owe their shade to the brown pigment that lines the other side of the iris. Fishes, on the other hand, owe their lustre,—causing the contents of the fishing-net to resemble an immense opal,—not to the scales but to thin layers below the scales and under the skin and round the blood-vessels, that look like so many threads of silver running through the flesh. Of these plates or layers, with the addition of glass and glue, false pearls are manufactured. The exceptional brightness of colouring displayed by male animals during the spring season, and at nesting time, far exceeding their hue at any other period of the year, is well known; to quote a few examples out of many, that of the yellow-hammer among birds, of the common newt among reptiles, and of the stickleback among fishes.

Whiteness, be it remarked, is never a sign of strength, even if the said whiteness results from constitutional variety, as much as from age or illness. Hoar hairs sometimes result from sudden fright, or dangerous fever, or long continuance of severe headaches, as well as from advanced years; but from whatever cause, it is always a sign of decrepitude. And there are albino varieties of the cat, the rat, the guinea-pig, the mouse, the crow, &c., as well as of human beings; but this peculiarity is almost invariably accompanied with some constitutional defect, that of red eyes in nearly if not quite all the creatures above mentioned. White cats, morever, are said to be always deaf.

And human albinoes, such as I saw, too, very many years ago in the streets of London, are reported to lack vigour of intellect, and certainly presented a pitiable appearance with their red, raw, and inflamed eyes, seemingly unable to bear the daylight. Similarly, the white varieties of the common orchis, and hyacinth, &c., are never of such vigorous growth, or so free for blossoming, as the ordinary types, while they certainly are far rarer. Age replaces the colouring matter in the hair (when it turns white) with small air-bubbles, and so, too, the brilliant white of feathers is due to the air which fills them; and the plumage of domestic poultry often turns whiter at each successive moult, just as much as the hair of human beings or the coats of horses at the approach of age. It would be

interesting if it could be conclusively shown that the frequently different colours of the beard and whiskers to that of the hair could be traced in any degree to the fact that the former are exposed to the full light when the latter is for the most part covered by the hat; for if my observation is correct, the hair may be dark, and the beard of a lighter tint; or again the hair may be light and sandy, and the beard of a more reddish tint, or the hair and beard may be alike dark, or the hair and beard alike light, and alike red; but what one does not, at any rate, commonly see is the beard darker than the hair, or the hair redder than the beard; so that the fiery tint may, to some extent, be caused by the unimpeded action of the sun, which likewise develops red patches of pigment, whatever the chemical nature of that pigment be, in the complexion. One must not, at the same time, forget that a good deal of the perception of colour is purely relative to the individual, and may present a very different appearance to a different order of created beings, as man has no inherent dislike to bright red or scarlet, such as the bull and turkey-cock invariably exhibit, and the glass-stained bright yellow to our eyes would appear, from Sir John Lubbock's experiments, to be correspondingly dark to the vision of the ants, which immediately began removing their eggs to a spot beneath the said glass. And the first instinct of these creatures, when their nest is disturbed, is to seize and carry off their young to some dark and inner part of the nest as yet untouched, and to preclude them from curious observation, so that if the same tint affects the optic nerves of human beings and of ants in so contrary a manner, either the ants or we, or both, must be colour blind. Animals indeed are far more powerfully affected by colour, or more strictly speaking, by the want of colour than by the time of day, just as I have noticed domestic fowls go to roost at four or five in the afternoon on the approach of the dusk of a winter's evening, and similarly to seek their perches while the earth, in full daylight, was temporarily darkened by an eclipse. If the power of the eyes of several flies be as that of a magnifying lens consisting of many facets, why may not also subtle gradations of colour, such as the human eye could never distinguish, be thoroughly perceived by these lower creatures, just as there is reason for supposing that their sense of hearing and that of smell are far keener than those possessed by man? I should be glad, in conclusion, to mention a few instances of colours in nature that I have witnessed, and which may not, perhaps, have come under the

observation of all present. One is that of phosphorescent animals, that of the luminous centipede, for example, of our gardens and lawns, whose light is of a pale yellow, not green like that emitted by the glowworm. Another instance that may be quoted is that of the phosphorescent sparkles of the Mediterranean resembling the light of the moon, caused by the numerous mollusca of the family of salpidæ and termed by the French "*une mer de lait.*" Another lovely spectacle was the appearance of a perfect flotilla of Medusæ-like fairy umbrellas about two feet beneath our boat towards the close of day on Loch Sweyn in the western Highlands, and these also are to some extent phosphorescent. Again, as distance causes the mountains to appear blue, so depth and profundity would seem to have the effect of making living objects far beneath the waves look blue likewise, as the sardines, silvery when brought to the surface, resemble flashes of blue light when seen deep down in the clear depths in the Bay of Naples from the rocks near Sorrento. The grotto Azurra at Capri still remains one of the few spots unvisited by me in that region; but I have seen similar effects of light and shade in several sea caves beneath the cliffs of Sorrento, where rocky walls above the water and boulders far beneath the tide alike show themselves of a chastened and beautiful blue. The Gonliot caves again in the island of Sark are places that for reasons previously recorded in this paper very few have visited. How shall I attempt to describe the sides of the largest cavern where the tide rises to a height of forty-one feet, completely covered with a large species of barnacle, red and green sea anemones such as are ordinarily known as strawberries, bright orange sponges, &c.; or those of another cave completely covered in parts with clusters of the tubularia, expanding their delicate arms and feathery mouths; on others with bright yellow and orange actinias of large size and in great numbers, true flowers of the deep, resembling in their shape large alamanda blossoms, some expanded, others closed. Here and there the sea slug crawling, from which the dye is obtained; brought home and placed in a basin of water it died in the night staining the water with a deep crimson. It is one of the very few places and it was one of the very few times in the year where submarine treasures and richness of colouring are revealed to the eye.

I am also in a position to state my own experience of the real tints of that much misrepresented reptile the chamæleon, having captured and received specimens of this creature at Beyrout, on the Jordan, and in Nubia. It possesses, pro-

perly speaking, only two colours, bright apple green with some yellow spots on the side of the body, and a dusky olive tint approaching to black; the former when enjoying open air and sunlight, and the latter when shut up in a box or when poked and teased, on which occasion it puffs out its cheeks and hisses by way of manifesting its displeasure. The effect of feeding the *Lacerta viridis* (Jersey green lizard), also of a bright green when in a state of nature, entirely with milk,—which is not its natural food,—renders its skin likewise very dull in captivity.

How shall I tell of the *Leucojum roseum*, the tiny snow-drop of Corsica, with flower no larger and stalk no longer than that of a violet, with just such a suspicion of pink as may be beheld within the lip of a delicate shell, which I gathered on a November's morning on the short turf above the sea beach at Ajaccio, and which, I have since been told, is to be gathered nowhere else; or how describe flowers beautiful in themselves, rendered more lovely still in consequence of their local surroundings, as the furze thickets of Guernsey, aptly termed "The Field of the Cloth of Gold," that cover the cliffs above and present a lively contrast to the bright blue waters of Moulin Houet Bay; or the sulphur anemone and blue gentian surrounded by perpetual snow as they flourish on the borders of a little blue tarn just beneath the summit of the Great St. Bernard; or the snowy tressed acacia in the suburbs of Constantinople, or those of Smyrna, prettier even than its wont when viewed against the medium of a deep-blue eastern sky or the masses of mauve blossom of the *Paulownia imperialis*,—each flower as large as that of a foxglove, and forming part of a spike and growing on a tree of the dimensions of an English horse-chestnut,—which crown the steep slopes that skirt the Bosphorus; or that gem of beauty, a crimson primula, flowering on the very verge of the Mer de Glace.

Where shall I behold

> "Heaven's deathless blue and Earth's eternal green,"

as where the snow-streaked summits of the mighty range of the Lebanon, standing out against the western sky, have their bases carpeted with miles upon miles of young and verdant wheat, waving in the springtide hour, and alternating, like some textile fabric, with the deep red soil?

How can I adequately picture the inimitable blue and green of the ice as seen twenty and thirty feet within the narrow depths of an Alpine crevasse, and all the bluer and all the

greener because of the dazzling fields of snow that shroud the glacier's surface? Or how describe the glaciers themselves, with their billows seemingly all on a sudden congealed, some more snowy than others because more free from the grimy moraine that is rolled down and ground at the same time by their ceaseless action, but all picturesque? How can I do justice to the reddened mountain peaks of Switzerland, reddened in two ways—by the rose of the Alps that clothes their steep sides, and, secondly, as often as those heights of snow blush with a brilliant rose colour beneath the glory of the springing or that of the declining day.

We are familiar with the lines,—

> "Where Afric's sunny fountains
> Roll down their golden sands."

And if the term "golden" be understood as applying to the colour only, and not to the metalliferous deposit of those sands, no more suitable appellation could be derived, for nowhere have I ever seen softer, purer, and more golden sands than those forming the drifts which skirt the Libyan banks of the Nile, while partially covering its temples and its tombs. Last, but not least, in point of rarity, I have once in my life seen red snow as it is called, but really consisting of the particles of a very elementary species of lichen, the *Protococcus nivalis*, which grows in high latitudes on the surface of the snowfells, while ascending the great St. Bernard. I may add, in conclusion, that in the compilation of this paper,—which contains too varied facts and results to be the outcome of one person's experience alone, in addition to the record of unscientific travel and observation,—I have been largely indebted to an article in *Chambers's Journal*, Wallace's *Malay Archipelago*, Kingsley's *Christmas in the West Indies*, as well as to Mr. Poulton's scientific papers in the *Proceedings of the Royal Society*.

The CHAIRMAN (H. Cadman Jones, Esq.).—I am sure all present will join in according a vote of thanks to Dr. Walker for his paper. I will now ask the Honorary Secretary to read the communications received in regard thereto.

Captain FRANCIS PETRIE, F.G.S.—The first communication is from Mr. H. E. Cox, F.E.S., who writes :—

"In reading Dr. Walker's interesting paper on 'Colours in Nature,' one cannot but be struck by his reference to the prevalence of blue. I think this can scarcely be considered to extend further than the sky and the sea. The indigo blue, which, no doubt, is the favourite colour in the East, not only in Egypt, but still more in China and Japan, is favoured, I imagine, not so much from the 'prompting of a picturesque effect,' as from the facility with which indigo dye can be obtained in those regions compared with the dyes for orange or black.

"In insects I do not think that blue can be called a prevalent colour; certainly among the coleoptera it is not so.

"I can scarcely agree with Dr. Walker in supposing that the usually brighter upper side of the wings of butterflies is due to more exposure to sunlight. I think that I have seen the "white admiral" butterfly sitting on a bush, alternately raising and lowering its wings, and showing a dull black and white upper side and a bright red and white under side. The fritillaries, again, are much brighter on the under side (adorned, as many of them are, with silvery spots), than anything the upper side can show.

"Concerning the iridescence and variable colouring exhibited by some insects, I would observe that, so far as my experience goes, the variable colouring in beetles appears to be confined to red and green. Of this there is a notable example in a Carabus found in Spain, the elytra of which appear, when viewed from one direction, to be of an intense coppery red, and, when seen from another point, they become a vivid emerald green. In some of the cetonidæ there is a peculiarly bright polished appearance, giving the insect an aspect of having been covered with liquid."

Mr. F. P. Pascoe, F.L.S., writes:—

"I have read Dr. Walker's interesting paper, and I can only suggest that the alleged fondness of insects for blue flowers might have been mentioned, as well as Sir J. Lubbock's experiments with regard to colours in relation to ants. I can confirm Wallace's account of the absence, or rather the scarcity of flowers in the forests of the Amazon and other tropical parts of South America. Kingsley is also right. In the West Indies, especially in the smaller islands, cultivation has displaced much of the arboreal vegetation, but I doubt if in any of them anything like the Brazilian forests ever existed. Darwin was 'most affected by the emotions of the

sublime' in those forests (*Life*, iii., p. 55). Dr. Walker's account of the two colours of the chameleon agrees with what I have seen of them in Asia Minor and in Algeria."

The Rev. THEODORE WOOD, F.E.S., writes :—

"Page 86, near end.—The blue of the *Morpho* is due to iridescence; hence, probably, the stability of the colour when exposed to sunlight.

"None of our British moths are blue, and very few of them have any trace of blue about them. I do not know enough of exotic species to state whether this rule holds good among them also; but it is certainly a striking fact as regards those of our own country. Possibly blue is a colour depending more upon sunlight for its development than other hues; red, yellow, and green are all common enough among moths, although the last of these fades so rapidly that it is often only visible in recently-emerged specimens.

"Page 87, near end.—Larvæ of *Arctia caja* fed from birth upon black currant are said to produce very dark *imagines*. Specimens of *Vanessa urticæ* and *Polychloros*, reared under blue or yellow glass, are also said to be pale and faded in appearance. In these cases the alteration in hue in the imago would be due to influences affecting the earlier stages only; but the second, of course, cannot occur in nature."

A discussion, of a conversational character, then ensued on various minor points in the paper, in which Major T. A. Freeman, M.A., Oxon., the Revs. Dr. Irving, F.G.S., and Dr. F. A. Walker, F.L.S., and others took part.

The meeting was then adjourned.