Indian Snakes

I HAVE just had the opportunity of examining the cobra mentioned in my letter dated 12th inst., together with a very handsome one belonging to another snake charmer. This latter cobra also devoured a frog in the space of a minute or two after it was placed in the basket, the frog croaking audibly about half a minute after it was swallowed.

I append the description of these cobras for the benefit of those interested in such matters.

Naja tripudians.—Specimen A.—Colour above very pale olive with pair of conspicuous white, black-edged spectacles. A pair of black H-shaped marks on 12th, 13th, and 14th series (transverse) corresponding to spectacles. Posterior edges of hood above, dark olive. Blackish band 17th to 21st ventral and corresponding scales—rest of belly mottled with dark spots.

Lower anterior temporal in contact with three (3) other temporals.

Ventrals 182, sub-caudals 51, scales 23 series.

Specimen B.—Colour above, olive brown, with numerous pale olive irregular transverse bands and blotches. Belly mottled and barred with blackish. A pair of snow-white, black-edged spectacles. Interstitial skin of anterior central portion of hood pure white, scales pale olive; that of posterior portion and margins black, scales dark olive; colour of hood extending across back in strong contrast to the paler hue of the body.

A pair of white dark-edged spectacles beneath the hood, corresponding to pair above, but the white portion very much wider. Central spots below oval, black, situated on 10th, 11th, and 12th series of scales.

Scales of head pale olive, anterior margins of vertical, supraciliary and occipital shields dark olive, forming a double band across the head. Posterior margins of occipitals dark olive. A vertical infra-orbital streak of dark olive.

Lower anterior temporal in contact with three (3) other temporals. The following ventrals blackish, forming distinct bands 17th to 31st, 24th to 30th, 35th to 38th, 48th to 51st, 61st to 64th all inclusive. Beyond these there are dark bands but the ventrals composing them are not as a rule black throughout.

Ventrals 185, sub-caudals 53, scales 23

Sept. 17, 1873 E. H. PRINGLE

The use of Terms in Cryptogamic Botany

IT seems to me that there is a very perplexing want of uniformity in the names employed by different authors to indicate the reproductive organs of cryptogamic plants.

To a private student this want of formality in the nomenclature of homologous organs is very bewildering; especially when he happens to meet with a term which no botanical work or glossary within his reach explains.

In reading the Rev. M. J. Berkeley's "Introduction to Cryptogamic Botany," I have come across a term which I cannot find used in the same sense in any botanical work I have consulted.

In the division of algæ called Rhodospermeæ, he says, in speaking of the fruit, "indefinite spores in distinct nuclei."

In *Callithamnion corymbosum* he calls the expanded wall of the mother cell from whose endochrome the walls have been produced by cell division, the nucleus.

In some other genera, he calls the cluster of naked spore-threads the nucleus. In other genera the spore threads arising from a placenta, together with the conceptacles containing them are called a nucleus.

In *Wrangelliaceæ* it is stated that the nucleus is composed of pyriform spores arising from the endochromes of the terminal cells of the spore-threads.

I had first settled in my mind that nucleus was used by Mr. Berkeley as a general name in this disvision of algæ, for an indefinite cluster of spores.

On re-consideration it seemed to me that the term nucleus in the division *Gongylospermeæ* was not applied to the clusters of spores, but to the expanded wall of the mother-cell, or walls of the mother-cells, whose contents had been transformed into spores; and in the great division *Desmiospermeæ* to the spore-threads from whose cells the spores are produced. Having at length given up this supposition as untenable, it then occurred to me that "nucleus" did not mean the expanded walls of the mother-cells alone, or the clusters of spores alone, or the spore-threads alone; but was a general term applied to the fruit consisting in some cases of spores and spore-threads, in others spores, spore-threads and conceptacles, and in others of the expanded walls of the mother-cells and their contained spores.

When, however, I again read that in *Wrangelliaceæ* the nucleus is composed of radiating pyriform spores, I gave up all attempts at a solution satisfactory to myself.

Can any of your readers inform me what, in this division of algæ, is meant by the term "nucleus," and why it is only used in this division? Did the term not occur in a book written by so high an authority in Cryptogamic Botany it might be passed over as a piece of affectation on the part of the writer. D. R.

*POLARISATION OF LIGHT**

III.

WE now proceed to the consideration of the colours produced by plates of crystal when submitted to the action of polarised light. A crystal very commonly used for this purpose is selenite or sulphate of lime, which is readily split and ground into flat plates of almost any required thickness. If such a plate be placed between the polariser and analyser when crossed, it will be found that there are two positions at right angles to each other, in which, if the selenite be placed, the field will remain dark as before. The selenite is, in fact, a doubly refracting crystal, and the positions in question are those in which the plane of vibration of the ordinary ray coincides with that of the polariser (or analyser), and that of the extraordinary ray with that of the analyser (or polariser). In every other position of the selenite, and notably when it has turned through 45° from either of the positions before mentioned, or neutral positions as they may be called, light passes through, and the field becomes bright. If the thickness of the selenite be considerable, the field when bright will be colourless; but if it be inconsiderable, say not more than three millimetres, the field will be brilliantly coloured with tints depending upon the thickness of the plate.

Supposing however that, the selenite remaining fixed, the analyser be turned round, we shall find that in the first place the colour gradually fades as before; until when the analyser has been turned through 45°, all trace of colour is lost. After this, colour again begins to appear; not however the original tint, but its complementary; and in fact, there is no more sure way of producing colours complementary to one another than that here used. A general explanation of this change of colour is already furnished by our former experiments. Doubly refracting crystals generally, in the same way as Iceland spar, divide every ray, and consequently every beam of light which passes through them, into two, so that of every object seen through them, or projected through it on to a screen, two images are produced. These two, being parts of one and the same beam of light, would, if recombined, reproduce the original beam; and the same is, of course, the case with the two images. This may be rendered visible by using the double-image prism as an analyser, and throwing both images on the screen together. As the prism is turned round, it will be seen that, just as when no selenite was interposed, the images are alternately distinguished; but that when both are visible, their colours are complementary. And if the distance of the prism be so adjusted that the images overlap, it will be found that, when both are visible, the part where they overlap is always white, whatever be the thickness of the plate used.

An instructive experiment may be made by interposing an opaque object in the path of the beam of light, so that its shadow may fall upon the part of the field common to the two images. The shadow will of course intercept the light forming each of the images, and will consequently appear double. Suppose that the two images are

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* Continued from p. 169.

coloured red and green respectively; then one of the shadows will be due to the shutting off of the red light, and the other to that of the green. But in the first case the space occupied by the shadow will be still illuminated by the green light, and in the second by the red. In other words, neither of the two shadows will be black, one will be green, and the other red. If in any part of their extent the two shadows overlap, the part common to the two, being deprived of both red and green light, will be black.

But in order to explain how it comes to pass that colour is produced at all, as well as to find a more strict proof that the colours of the two images are complementary, we must have recourse to some considerations based upon the wave theory of light. And first as to the mode in which waves may be produced.

Consider a row of balls lying originally in a horizontal straight line. Let the balls start one after another and vibrate at a uniform rate up and down. At each moment some will be at a higher, others at a lower level, at regular intervals in a wave-like arrangement; the higher forming the crests, the lower the hollows of the waves. The distance from crest to crest, or from hollow to hollow, is called the wave length. The distance from crest to hollow will consequently be half a wave-length. This length will be uniform so long as the vibrations are executed at a uniform rate.

Each ball in turn will reach its highest point and form a crest; so that the crests will appear to advance from each ball to the next. In other words, the waves will advance horizontally, while the balls vibrate vertically.

If the row of balls were originally arranged in a wave form, and caused to vibrate in the same way as before, those on the crests would vibrate wholly above, and those in the hollows wholly below the middle line. When the balls originally on the crests rise to their highest points, those in the hollows will fall to their lowest positions, and the height of the wave will consequently be doubled. When the balls originally at the crests fall, those in the hollows will rise, both to the middle line; and the wave will consequently be annihilated. The first of these corresponds to a condition of things wherein the crests of the new wave motion coincide with those of the old, and the hollows with the hollows; the second to that wherein the crests of the new coincide with the hollows of the old, and *vice versâ*.

Hence, when two sets of waves are coincident, the height of the wave or extent of vibration is doubled; when one set is in advance of the other by half a wave length, the motion is annihilated. The latter phenomenon is called *interference*. When one set of waves is in advance of the other by any other fraction of a wave-length, the height of the wave, or extent of vibration, is diminished, but not wholly destroyed; in other words, partial interference takes place. The distance whereby one set of waves is in advance of another is called the *difference of phase*.

The Wave Theory of Light consists in explaining optical phenomena by vibrations and waves of the kind above described. And according to that theory the direction in which the waves move is the direction of propagation of the ray of light.

The intensity of light depends upon the extent of the vibrations or the height of the waves; the colour upon the number of vibrations executed in a given interval of time. And since throughout any uniform medium the connection of the parts and the rate of propagation may be considered to be uniform, it follows that the waves due to the slower vibrations must be longer than those due to the more rapid. Hence the colour of the light may be regarded as depending upon the wave length.

The substance to the vibrations of which light is supposed to be due, is an elastic fluid or medium pervading all space, and even permeating the interior of all bodies. A full statement of the reasons which have led philosophers to make this hypothesis would involve considerations derived from other sciences besides optics, and would be out of place here. But it may still be pointed out that one strong argument is furnished by the fact of the transmission of light from the sun and from the fixed stars through space, where no atmosphere or known gases can be conceived to exist. That the light so traversing interstellar space must be transmitted by a material substance, is a fundamental proposition of mechanical philosophy; and the hypothesis of the ether simply consists in attributing to the substance or medium the property of elasticity (a property possessed in a greater or less degree by all known bodies), without assuming anything else whatever as to its nature or relation to other substances.

In the illustrations of wave motions given above, the balls would represent successive portions or molecules of the ether; and the means whereby the motion of one molecule is transmitted to its neighbour, is the elastic cohesion attributed to the whole medium in the hypothesis above mentioned.

The difference between ordinary and polarised light has been explained above; and the mechanical contrivances devised for representing wave motion always have reference only to polarised light. But as this is the subject with which we are here concerned, the limitation in question is not of consequence. A variety of instruments have been constructed for showing the effects of compounding vibrations or waves under different circumstances. The best with which I am acquainted is that by Sir Charles Wheatstone.

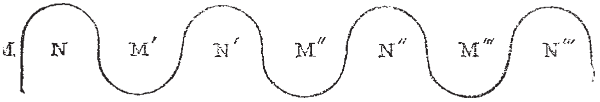
In plane polarised light, such as is produced by tourmalin plates, by double refraction in Iceland spar, &c., the vibrations are rectilinear, and are executed in one and the same plane throughout the entire length of the ray. In circularly polarised light the vibrations are all circular, and the motion is performed in the same direction. In elliptically polarised light the vibrations are all elliptical, the ellipses are all similarly placed, and the motion is in the same direction for the entire ray. These are the only known forms of polarisation, and indeed they are the only forms compatible with the usual, simplest assumption respecting the elasticity of the ether.

These general considerations being premised, we are in a position to trace the course and condition of a ray of light issuing from the lamp or other source, and traversing first the polarising Nicol's prism; secondly, the plate of doubly refracting crystal; thirdly, the analysing Nicol.

The vibrations of the ray on leaving the polariser are all restricted to a single plane. On entering the plate of doubly refracting crystal, every ray is divided into two, whose vibrations take place in planes perpendicular to one another. The angular position of these planes about the axis of the beam of light is dependent upon the angular position of the crystal plate about its centre. The two sets of rays traverse the crystal with different velocities, and therefore emerge with a difference of phase. The amount of this difference is proportional to the thickness of the plate. On entering the analyser the vibrations of each pair of rays are resolved into one plane; and are then in a condition to exhibit the phenomena of interference. If the plane of vibration of the analyser be parallel to one of those of the plate, that ray will be transmitted without change; the other will be suppressed. In any other position of the analyser those monochromatic rays (spectral components of white light whose difference of phase most nearly approaches to half a wave-length, will be most nearly suppressed; and those in which it approaches most nearly to a whole wave-length will be most completely transmitted. The amount of light suppressed increases very rapidly in the neighbourhood of the ray whose difference of phase is exactly a half wave-length; so that with plates of moderate thickness a single colour only may in general terms be considered to be suppressed. This being so, the beam emergent from the analyser will be deprived of that colour, and will in fact consist of an assemblage of all others; or in other words will be of a tint complementary to that which has been extinguished.

Next, as regards the colours of the two images, that is, the two which are formed either simultaneously by a double-image prism or successively by a Nicol in two positions at right angles to one another. In the first place it is to be remembered that the two sets of vibrations into which the selenite has divided the polarised ray are at right angles to one another; secondly, that one set is retarded behind the other through a certain absolute distance, which is the same for every ray, and consequently through a distance which is a different fraction of the wave-length for each colour; thirdly, that these two are re-combined or "resolved" in a single direction in each image by the analyser.

This being so, bend two wires in the following form:—



and place them at right angles to one another about their middle line M N M′ N′.., so that the points M of the two wires coincide, and likewise N, and so on. This will represent the condition of the vibrations as they emerge from the selenite, when the plate is of such a thickness as to cause a retardation equal to one or to any whole number of wave-lengths. Turn the wires about their middle line M N M′ N′ until they meet half way, *i.e.* in a position inclined at 45° to their original directions; this will represent the vibrations as resolved by the analyser in one image. Turn the wires about their middle line as before, but in reversed directions, until they meet in a position at right angles to the former; this will represent the vibrations as resolved by the analyser in the other image. On looking at the wires when so brought together, it will be found that in one case the crests fall upon the crests and the hollows upon the hollows, so that the vibrations combine to increase the intensity of the light. In the other case the crests fall upon the hollows and the hollows upon the crests, so that the vibrations interfere and completely neutralise one another.

The same principle would obtain if we shifted one wire along the middle line so that the points M of the two wires no longer exactly coincide. This would represent the condition of the vibrations as they emerge from the selenite when the plate is of such a thickness as to cause a retardation of a fraction of a wave-length equal to the amount of shift. And on turning the wires as before, we should find that in one image the waves partially combine, and that in the other they partially interfere. The shifting of the wires would represent either the effect of plates of different thickness upon waves of the same length, *i.e.* rays of the same colour; or that of a single plate on waves of different lengths, *i.e.* on rays of different colours. From these considerations we may conclude that the rays which are brightest in one image are least bright in the other; or, in other words, that the colours of the two images are complementary.

It has been remarked that the colour produced by a plate of selenite depends upon the thickness of the plate. In fact, the retardation increases with the thickness, and consequently, if, for a given thickness, it amounts to a half wave-length of the shortest (say violet) waves, for a greater thickness it will amount to a half of a longer (say green) wave, and so on. And if, instead of a series of plates of different thicknesses, we use a wedge-shaped plate, the entire series of phenomena due to gradually increasing retardation will be produced. This is easily seen to consist of a series of tints due to the successive extinction of each of the rays, commencing with the violet and ending with the red. And the tints will consequently have for prevailing hues the colours of the spectrum in the reverse order. This series of colours will be followed by an almost colourless interval, for which the retardation is intermediate between a half red-wave length and three half violet-wave lengths. Beyond this again the series of colours will recur; and the same succession is repeated as the wedge increases in thickness. It will, however, be observed that the colours appear fainter each time that they recur, so that when the thickness reaches a certain amount (dependent upon the nature and retarding power of the crystal) all trace of colour is lost.

It is not difficult to account for this gradual diminution in the intensity of the colours if, by means of a diagram, we examine the mode in which the waves of various lengths interfere with one another; but spectrum analysis furnishes an explanation which is perhaps more easy of general apprehension. If the light emerging from the analyser be examined by a spectroscope, it will be found, in the case of a plate giving the most vivid colour, that the spectrum presents a dark band indicating the colour which has been extinguished. On using thicker and thicker plates the band will be found to occupy positions nearer and nearer to the red end of the spectrum, until the band finally disappears in the darkness beyond the least refrangible rays that are visible to the eye. If the analyser be turned round the band will gradually lose its characteristic darkness, until, when the angle of rotation has reached 45°, the band will have disappeared altogether. The spectrum is then continuous, and when recompounded will give white light. This corresponds to the fact noticed before, that when the analyser is turned round, the colour given by a selenite plate fades and finally disappears when the angle of rotation amounts to 45° If the rotation be continued a band reappears, not, however, in its original position, but in the part of the spectrum complementary to the former.

If the thickness of the plate be further increased, two bands will be seen instead of one; with a still greater thickness there will be three bands, and so on indefinitely. The total light then of which the spectrum is deprived by the thicker plates is taken from a greater number of its parts; or in other words, the light which still remains is distributed more and more evenly over the spectrum, and consequently at each recurrence of the tints the sum total of it approaches more and more nearly to white light.

The following experiment will be found very instructive. Take two wedges of selenite or other crystal, and having crossed the polariser and analyser, place the two wedges side by side in the field of view so as to compare the tints produced by the two. Then place one over the other, first with the thick end of the one over that of the other; next with the thick end of the one over the thin end of the other. If the two plates are exactly similar, the combination in the first instance will be equivalent to a single wedge whose refracting angle is double that of a single wedge; and the number of bands produced will consequently be doubled. In the second combination the angles of the wedges will compensate one another, and the result will be equivalent to a uniform plate whose thickness is equal to the sum of the mean thicknesses of the wedges. The field will then be coloured with a uniform tint, viz., that due to a plate of the thickness in question.

By making use of the principle that the colour produced depends upon the thickness of the plate, selenites have been cut of suitable shapes and thicknesses, so as to produce coloured images of stars, flowers, butterflies, and other objects.

W. SPOTTISWOODE

(*To be continued.*)