

I append a short proof, out of several which may be given. We have to show that

$$(w_2 + w_3)^{2n-1} + (w_4 + w_5)^{2n-1} \equiv 1 \pmod{2n-1}$$

when, and when only $2n-1$ is prime.

Let w_2, w_3, w_4, w_5 be the unreal roots of $x^5 + 1 \equiv 0$ and $2n-1 =$ any odd prime, then we may say

$$\begin{aligned} & \left(\frac{1 + \sqrt[5]{5}}{2} \right)^p + \left(\frac{1 - \sqrt[5]{5}}{2} \right)^p \equiv 1 \pmod{p} \\ & = \left\{ \frac{1 + \frac{p}{2} + \frac{(\sqrt[5]{5})^p}{2} \right\} + \left\{ \frac{1 - \frac{p}{2} - \frac{(\sqrt[5]{5})^p}{2} \right\} \equiv 1 \pmod{p} \text{ where } p \\ & \text{is any odd prime.} \\ & = \frac{2 + \frac{p}{2} \cdot m}{2^p} \equiv 1 \pmod{p} \text{ or } \frac{1 + \frac{p}{2} \cdot m}{2^{p-1}} \equiv 1 \pmod{p}. \end{aligned}$$

Now, by Fermat's theorem $2^{p-1} - 1 = p \cdot n$ when, and when only p is prime. Thus

$$p \cdot m - p \cdot n \equiv 0 \pmod{p}$$

which proves the theorem for any odd prime.

It is also true for $p=2$, since by ordinary work

$$\frac{1 + 2\sqrt[5]{5} + 5}{4} + \frac{1 - 2\sqrt[5]{5} + 5}{4} = 3 \equiv 1 \pmod{2}.$$

Thus the theorem is universally true for all primes.

It is remarkable that the second factor of the prime series given above is also a function of the prime p , viz.:

$$1 + \frac{p-3}{2!} + \frac{p-4}{3!} \cdot \frac{p-5}{2} + \frac{p-5}{4!} \cdot \frac{p-6}{3} \cdot \frac{p-7}{2} + \dots$$

ex. gr. the 4th term of the prime series is 29, thus

$$29 - 1 = 7 \left\{ 1 + \frac{7-3}{2!} + \frac{7-4}{3!} \cdot \frac{7-5}{2} \right\} = 7 \{1 + 2 + 1\} = 28.$$

As this communication is somewhat long, I reserve the proof of this.

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April 28.

The Effect of Sunlight on the Tints of Birds' Eggs.

THE beautiful and delicate colours observed on the eggs of birds are not very fast to light, more especially when they belong to the lighter class of colours. Egg-collections should be carefully protected from the light by some covering over the case, when they are not being inspected; otherwise much of their beauty of tint becomes lost in course of time. It is gratifying to notice that in museums and natural history collections this precaution of protecting egg-cases with covers is now almost universally observed. In many instances some of the finest and most characteristic tints of several eggs disappear on exposure to much sunlight. A common example may be found in the beautiful pale blue of the starling's egg (*Sturnus vulgaris*). This, on exposure to sunlight for a few days, loses its clear blueness of tone, and becomes purplish, approaching more to the slate tint. Such is also the case with most of the greenish-blue eggs, like those of many sea-birds, the common guillemot's (*Uria troile*), for instance, the beauty of which largely depends on the clear freshness of its blue tints. The writer, some time ago, made some experiments on the fastness to sunlight of those egg-tints. The method employed was a very simple one, and may be briefly described as follows. Various birds' eggs were selected for experiment, those having decided and well-marked colours being preferred. These shells were halved lengthwise, care being taken before the operation to divide it so that each half should, as nearly as possible, present the same amount of colouring. One half was kept from the light for future comparison, while the other half was exposed in a glass case to direct sunshine. After various exposures, amounting to one hundred hours' sunshine, each exposed half was then compared with its unexposed counterpart, and the changes in hue carefully noted. Little change was visible in the darker coloured eggs of the olive-brown or chocolate depth, but in the lighter tints, especially among the blues and green-blues, the changes became more marked. Among the darker shades of eggs was the common curlew's or whaup (*Numenius arquata*), with its dull olive-green spotted with deep shades of brown; and also the lapwing (*Vanellus cistatus*), which closely resembles in

general appearance that of the curlew. Such deeply-coloured eggs are little altered on exposure to light, unless after very long exposure, when they lose some of their rich warmth of tone, and become a trifle clearer in their ground tints, making them look somewhat bleached. Many sea-birds' eggs have a bluish-green colour—sea-green it might be called—which, when new and unexposed, is rich and beautiful. This clear tint, however, is lost on exposure, and it assumes a more dingy slate hue. Some of their eggs have a network of white chalk-like incrustation streaked over the bluish ground tint. This may be seen on the egg of the common cormorant (*Phalacrocorax carbo*). If such shells be exposed for several days to sunlight, and afterwards the white incrustation removed with a knife, the difference produced on the ground tint by exposure becomes at once apparent. The exposed parts will be found of a slaty, duller hue, more approaching a stone-grey tint; while the unexposed parts, protected by the incrustation, will reveal the original sea-green tint in all its freshness. Another example is the fair blue egg of the common thrush or mavis (*Turdus musicus*). This egg when newly laid is of soft light blue of a fine shade, but on exposure it loses much of this clearness of tint, and becomes dull and purplish, tending more to a leaden hue. Many similar examples might be given of beautiful shades of blue and blue-green tinted eggs which all tend to become redder and duller on exposure. The red blotched egg of the fieldfare (*Turdus pilaris*) fades in this manner, and the red markings assume a lighter rusty-brown hue. The ring ouzel (*Turdus torquatus*) so well known for its predatory visits to the strawberry-beds, has an egg closely resembling the fieldfare's, both in ground tint and markings, which undergoes the same changes in every respect. One of the commonest eggs is that of the blackbird; it also loses its greenish hue and becomes more of a stone-grey, while its varied markings lose considerably in depth. In the beautiful eggs of the yellow hammer (*Emberiza citrinella*), so curiously veined and mottled with dark red-brown over a pale ground, little or no fading was visible after exposure. Its markings may thus be considered fast to light. There are but few coloured eggs which show no appreciable change after so severe an exposure test as 100 hours' direct sunlight. A good example of a fairly fast-coloured egg is that of the favourite songster the skylark (*Alauda arvensis*). Its eggs vary considerably in colour, but they are always of an indescribable hue, sometimes an ashy brown, or a dark purplish grey, other times more of a greenish tinge. These stand the light very well. The specimens tested looked only a trifle bleached, but those having the greener tinge fade more. One of the prettiest of blue eggs is that of the common hedge-sparrow. The loss of its clear blue tint to a purplish blue drab was most marked. To illustrate the unstable nature of egg-colouring in comparison with colours of different origin, various other colours resembling in tint those of the eggs were exposed in a similar manner. These were "distemper" colours, and water colours, painted on paper, and coal-tar colours dyed on wool. The distemper colours were perfectly fast to light; their colour constituents all being of mineral origin. The water colours examined were both of mineral and vegetable origin; those belonging to the latter faded very considerably. The coal-tar colours selected were mostly of the bluish cast, corresponding to many of the egg tints. The summary of the results obtained might be tabulated as follows:—

Colours examined.	Result after 100 hours' exposure.
Distemper colours...	100 per cent. fast.
Water colours ...	60 " "
Coal-tar colours ...	30 " "
Egg-shell colours ...	20 " "

The above results, along with the few common examples which have just been given, readily show that eggs lose much of their delicate and characteristic beauty of tint on being too freely exposed to sunlight.

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Physiological Specific Characters.

PROF. R. MELDOLA, in his very suggestive presidential address to the Entomological Society, remarks (*Trans. Ent. Soc. for 1896, Pt. v. p. lxxviii.*)—"At any rate, it appears to me inconceivable that any change of environment requiring a modification of structure of sufficient magnitude to rank as diagnostic in the systematic sense, should not also be accompanied by a

greater or less amount of physiological readjustment." But in a foot-note on the very same page, in which he discusses the present writer's statement that specific characters are essentially physiological, he says:—"There must be so much in common in the physiological processes of allied species, that well-marked physiological differences cannot, without further evidence, be regarded as the universal characteristic of specific differences." These two statements are surely somewhat contradictory, and as the proposition I made appears to me to be a fundamental one, I desire to offer some explanatory remarks, especially as few critics will probably trouble themselves to look at the original paper.

I think Prof. Meldola, throughout his address, uses the term "physiological" in too narrow a sense. Morphology, as I understand it, has to do with form, physiology with function. My contention was exactly that of Dr. Wallace, that specific characters have to do with function—are functional, or else coincide with those that are functional. They may be internal or external; an internal process is no more "physiological" than an external one.

But I pointed out, that the very same morphological characters may be specific in one form, varietal in another. The reason why they are specific in the one case is, that they have a physiological as well as morphological significance; they are variable in the other, because they have little or no functional value, although under new environment they may come to have such value, and then through selection become specific.

A dead insect appears equally important in all its parts; function no longer exists, and they are reduced to a common level. But how different is the living creature! Each part now has a special significance; it is a tool, and some tools are more important—more useful—than others. Just in proportion to their value are they elaborated, and kept to one pattern, or, sometimes, to a choice of two or more patterns, as in dimorphic or trimorphic species. Those who claim that specific characters exist without any reason, have got to explain why it is that the very same characters are constant in one form and variable in another; or sometimes even constant in one part of the range of a species, and utterly variable in another part.

Therefore, taking up the first-quoted sentence from Prof. Meldola, I would object that environment never does "require a modification of structure" which has not also a physiological meaning. It is not necessary, of course, that there should be a functional change in *kind*, it must very often be simply a change in *degree*.

In another part of my paper quoted (*Proc. Phila. Acad.*, 1896, p. 45) I express more nearly what Prof. Meldola seems to have intended, but I use the term "constitutional," thus:—

"Furthermore, it is apparent that the earliest distinctions between species are at least often of a very subtle character, so that the workings of natural selection during the actual process of segregation are anything but easy to observe. And this need not surprise us when we reflect that among ourselves constitutional characters, not easily identified by any coincident structural features, play so large a part in determining our ability to reach manhood and beget offspring."

It must not be forgotten that in describing a new species, we always include *more* than the actual specific characters, although, as Prof. Meldola excellently points out, we always miss a large proportion of the latter. Generic, subgeneric, and sectional characters are built upon the specific characters of former ages, but they need not now possess a special function. They are, however, the groundwork on which new specific characters are built, and they constitute, in a sense, part of the environment which directs the moulding of those characters. It is when they come too directly in conflict with the external environment that the species becomes extinct. Thus species come to be judged by their ancestors.

A good instance of the correlation of function with structure is afforded by the wings of bees. These insects are classified largely on apparently trivial differences in the venation of the wings. But those who observe them in nature see that with these differences go differences in flight, and it is obvious that there must also exist important differences in the muscles of the thorax, so subtle that at present we know little or nothing about them. Even the psychological characters of these bees must differ. We do not yet know enough about the principles of insect flight to say exactly what influence slight changes in venation would have, but the influence need not be doubted. Recently, I discovered a new genus (*Phileremulus*) of bees with

very peculiar venation, and its flight also was peculiar, rapid zigzags just above the surface of the ground, making it impossible to catch it in a net. Many bees can be caught by sweeping; *Centris*, with its hovering pendulum-like swing over the flowers it visits, must be caught by a rapid stroke, or it darts suddenly away.

Prof. Meldola, in his address, has ably shown the need for more subtle observations on the specific characters of insects, and if his suggestive remarks do not stir some of our entomologists up to new ways of work, it can only be because entomology, like astrology, has ceased to have any physiological significance—a thing no entomologist will be willing to admit!

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AN ARCHÆOLOGICAL SURVEY OF THE BRITISH ISLANDS.

THOSE who are interested in the preservation and examination of ancient monuments should read the plea for "An Archæological Survey of the United Kingdom," which formed the subject of Dr. David Murray's presidential address to the Archæological Society of Glasgow, and which is reprinted in a convenient form by James MacLehose and Sons, of Glasgow.

This is a succinct account of the existing laws relative to antiquities, and of the "rights" or otherwise of the public. "Government spends large sums of money every year upon the preservation and protection of our records, the reproduction of fading charters, &c., but it does not regard the monuments which illustrate or supplement these records. Archæologists have raised the veil that shrouds the first epochs of man's life upon the earth, and have given us a glimpse of prehistoric times, but Government does nothing to collect or preserve the material which is essential for such investigations. The editing and interpretation of our Runic monuments we owe to Prof. George Stephens, of Copenhagen. For a record of the Roman inscriptions in this country we have to look to Germany or to Canada. Inscriptions and sculptures are of the same character as written monuments, and it is surely just as important that these should be carefully collected and accurately transcribed and photographed as that we should have new editions of the Chronicles of the Picts and Scots, or of the Exchequer Rolls of Scotland.

"The quaternary period is common ground to the geologist and the archæologist, the physical characters are dealt with in the Geological Survey. But why should the systematic survey stop at this point, or be limited to the requirements of geological science? The monuments which are witnesses to man's presence, his life and labour, are surely as worthy to be collected and preserved as the fossil remains of extinct fauna and flora.

"The monuments of the past are not indeed wholly neglected by Government, for if an object be in itself artistic, in the opinion of the Science and Art Department, it has the sedulous care of that Department, and no money is grudged for its protection and reproduction. The Ardagh chalice, for instance, is of this description; but a Roman altar or a centurial stone, no matter how valuable it may be historically, is passed by. Can anything be more inconsistent? To limit ourselves to the artistic side of man's nature will give but a partial view. We wish to know his life as a whole, his surroundings, his pursuits, and manner of living—everything, in fact, that enables us to trace the growth and development of culture and civilisation. For this purpose the unsigned and unwritten records of the past must be systematically ascertained, protected, and preserved, and, if need be, copied or reproduced. To do this effectually Government assistance is essential as a first step. It is a work that has been too long neglected, and should be no longer delayed. Let us at once and for ever wipe away the reproach that England is the only country in Europe