The results were as follows; the rates of leak are given in scale divisions per hour, and are corrected to 30 inches pressure:—

Gas	Rate of Leak	Mean
Hydrogen	10·4, 10·5, 10·4, 11·2, 10·4, 11·2, 9·86, 10·1, 10·2 ...	10·5
Air	65·2, 66·6, 66·6, 60·0, 57·0, 61·5, 60·2, 63·0, 58·2, 58·3, 56·6, 56·2	62·1
Oxygen	75·0, 74·2, 71·0, 74·1	73·6
Carbon dioxide	96·0, 95·4, 94·5, 95·1, 94·1, 94·7	95·0
Cyanogen	107, 104, 106, 106	106·0
Sulphur dioxide... ...	132, 126, 134, 135	132·0
Chloroform	297, 298, 290, 327	303·0
Methyl iodide	298, 292, 310, 291	298·0
Carbon tetrachloride ..	363, 351, 344, 349	352·0

The following table gives the relative ionisations, referred to air as unity. The values of the same constants for the α and β rays formerly found are included, and also measurements of relative ionisation under Röntgen rays. These latter form part of an investigation not hitherto published.

Relative Ionisations.

Gas	Relative density	Relative Ionisation			
		α rays	β rays	γ rays	Röntgen rays
Hydrogen	0·0693	0·226	0·157	0·169	0·114
Air	1·00	1·00	1·00	1·00	1·00
Oxygen	1·11	1·16	1·21	1·17	1·39
Carbon dioxide	1·53	1·54	1·57	1·53	1·60
Cyanogen	1·86	1·94	1·86	1·71	1·05
Sulphur dioxide	2·19	2·04	2·31	2·13	7·97
Chloroform	4·32	4·44	4·89	4·88	31·9
Methyl iodide	5·05	3·51	5·18	4·80	72·0
Carbon tetrachloride ...	5·31	5·34	5·83	5·67	45·3

The determinations for the γ rays are less accurate than the former ones for the α and β rays, on account of the very much smaller rates of leak which have to be measured. I think, if this be taken into account, there is no reason to doubt that, within the limits of experimental error, the γ rays give the same values as the β rays. These values are nearly proportional to the density of the gas, except in the case of hydrogen. The law which holds in the case of Röntgen rays is totally different.

This conclusion throws some light on the nature of the β rays. The view seems to be gaining ground that these are Röntgen rays, produced by the impact of the β rays on the radium itself.[1] This theory seems to have much to recommend it. The β rays should, by analogy with the kathode rays in a vacuum tube, produce Röntgen rays when they strike a solid obstacle, and these Röntgen rays should be much more penetrating than the β rays themselves. The γ rays seem at first sight to be just what should be expected. But the present paper shows that in one respect, at all events, the γ rays behave quite differently from Röntgen rays, while, on the other hand, they resemble the α and β rays. There seems to be a possibility that they too are of a corpuscular nature, though uncharged with electricity. This would account for the absence of magnetic deflection.

I do not think that the absence of conspicuous Röntgen radiation is very hard to understand, if we consider that the current emitted in kathode rays by a square inch of intensely active radium is only 10^{-11} amperes; the current through a focus tube is of the order 10^{-2} amperes, and probably a great part of this is carried by the kathode rays.

[1] See, for instance, Madame Curie, "Thèses presentées à la Faculté des Sciences," 1903, p. 83.

THE COLORATION OF THE QUAGGAS.

It is well known that, in different districts of their range, the zebras of the type commonly known as Burchell's, but which, for reasons elsewhere given, I propose to call "quaggas," present distinct and easily determinable colour variations, sufficiently constant in character to be worthy of nominal recognition. Grant's quagga occurs in North-East Africa, Crawshay's quagga in Nyasaland, Selous's quagga in Rhodesia, and Chapman's quagga in Angola. Still further south came Burchell's quagga, and south of this again the two or more extinct types which, as Mr. Lydekker has shown, pass currently as the quagga proper.

The first and last of this category are the extremes in pattern variation. Grant's quagga may claim to rank as one of the most completely striped of existing horses. Apart from the ears, which are sometimes nearly white, and the muzzle and fetlocks, which are usually black, he is a mass of stripes from head to tail, from hoof to spine; and in sharpness of contrast between the blackness of the stripes and the whiteness of the interspaces, he rivals the Abyssinian race of Grévy's zebra and the Angolan race of the mountain species, while surpassing both in the inferior extension of the stripes to the middle line of the belly. Place him alongside Gray's quagga, with his pale stripeless limbs, underside and hind-quarters, his brown and confusedly banded body and fawn-lined neck and head, and you will hardly believe them to be the same species. Yet there is no avoidance of the conclusion, since all intermediates have been seen either as living specimens or mounted skins. And one of the chief interests centred in the existence of these intermediates lies in the progressiveness of the change this species undergoes as it passes from north to south over its geographical area. Even in British and German East Africa the pale interspaces on Grant's quagga begin to be washed with brown, and to be filled in with narrower intervening stripes. It will be difficult, perhaps impossible, to distinguish such forms from the quagga of the Mashonaland plateau. The latter, indeed, may be taken as illustrative of the first step in the change above alluded to leading from Grant's to Gray's quagga. From it may be traced a series of gradations represented by the local races named after Chapman, Wahlberg, and Burchell, in which the stripes gradually disappear and thin out upwards from the fetlocks to the shoulders and haunches, while those on the body lose their connection with the mid-ventral band, and, becoming shorter, leave the belly unstriped. Concomitantly the intervening "shadow" stripes increase in number and definition as they extend forwards towards the neck, the normal stripes themselves turn brown, and the ochre-stained ground colour deepens in hue. In the typical form of Burchell's quagga the "shadow" stripes reach the head, and the last of the complete stripes is the one that extends backwards from the stifle to the root of the tail, the hind-quarters and legs being practically, and the belly actually, stripeless. It is but a step from this to the extinct Gray's quagga, in which the stripes of the body were fused together and blended to a great extent with the brown of the intervening areas, those on the neck being exceedingly broad and broken up by paler tracts of hair.

The tendency of these modifications is to convert a striped and conspicuously parti-coloured animal into one which, even at a short distance, must have appeared to be an almost uniform brown, paling into cream on the underside, limbs and back of the haunches. What is the meaning of this change? Inferentially we may conclude it was protective in the sense of subserving concealment.

The testimony of observers in the field has established the truth that the coloration of the coat renders a zebra invisible under three conditions, namely, at a distance on the open plain in midday, at close quarters in the dusk and on moonlit nights, and in the cover afforded by thickets. The procryptic result is achieved by the cooperation of several factors. The white stripes blend with the shafts of light sifted through the foliage and branches and reflected by the leaves of the trees, and in an uncertain light or at long range they mutually counteract each other and fuse to a uniform grey. It is probable, too, that the alternate arrangement of the black and white bars contributes something to the effect produced, by imparting a blurred appearance to the body and destroying the evenness of its surface owing to the difference in light-reflecting power between hairs of these hues to which domestic horses bear witness. Moreover, the extension of the stripes to the very edge of the body and legs breaks up the continuity of the outline, and this, I believe, is the reason for the alteration in their direction on the hind-quarters and limbs, so that, except on the forehead, the whole animal is barred transversely with reference to its spinal and appendicular axes.

We have also the positive assurance of observers that the asses of the deserts of North-East Africa are perfectly adapted to their surroundings in colour, and no one can doubt that the assimilation is equally perfect in the case of the kiang and Prjevalsky's ponies[1] of Central Asia. In the matter of colouring the kiang forcibly recalls the typical quagga, despite a decided difference in the deepness of the brown pervading the upper parts in the two species. Notwithstanding this difference, there can, I think, be no question that the explanation to be given of the significance of the colours of the kiang applies with equal truth to the quagga. This explanation is the hypothesis of the counteraction of light and shade put forward by the American artist, Thayer.

It would be hard to find a better and simpler instance of this style of coloration than the kiang. The upper parts on which the light falls are of a rich ruddy hue, darker than ordinary sand, while the muzzle, the lower side of the head, the throat and the belly are creamy white. Surely no one with a knowledge of the truth enunciated by Thayer will

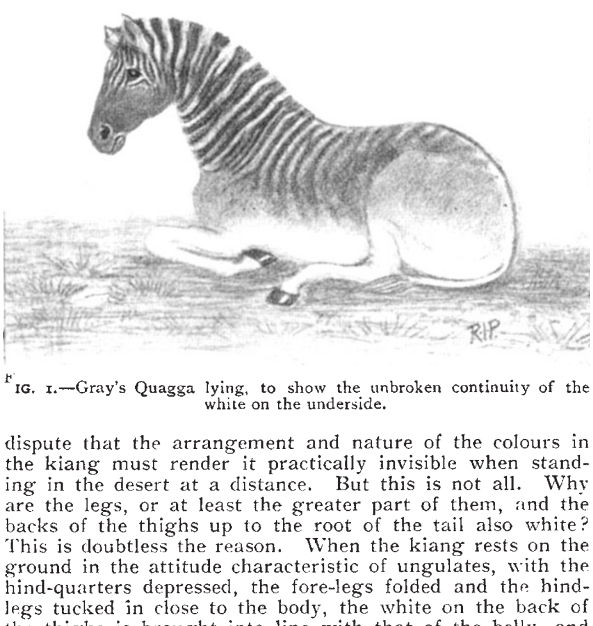

FIG. 1.—Gray's Quagga lying, to show the unbroken continuity of the white on the underside.

dispute that the arrangement and nature of the colours in the kiang must render it practically invisible when standing in the desert at a distance. But this is not all. Why are the legs, or at least the greater part of them, and the backs of the thighs up to the root of the tail also white? This is doubtless the reason. When the kiang rests on the ground in the attitude characteristic of ungulates, with the hind-quarters depressed, the fore-legs folded and the hind-legs tucked in close to the body, the white on the back of the thighs is brought into line with that of the belly, and a continuous expanse of white, obliterating the shadow, extends all along the underside from the knee to the root of the tail. So, too, with the quagga. This, then, is the meaning of the change in pattern presented by the African species as it passed southwards into Cape Colony. In correlation with the adoption of a life in the open, a new method of concealment by means of shadow counteraction was required, and was gradually perfected by the toning down of the stripes on the upper side and the suppression of those on the hind-quarters, belly and legs.

The same alignment of the white on the rump and belly may be seen in many antelopes, like gazelles, and the co-operation of the legs in increasing the underlying area of white is especially well shown in the bonte-bok.

Now the rump-patches, be it noted, only subserve the purpose here suggested when the animals that possess them are lying on the ground. This, however, is the time, as they drowsily rest or chew the cud, when concealment is of the greatest importance to ungulates, which are, for the most part, clumsy risers, and slow at getting under way. When standing and on the alert, their need for concealment, though seldom absent, is certainly less, and when they are on the run all idea of it is thrown to the winds. It is then that the rump-patches act, as Mr. Wallace suggested, as danger signals and "follow-the-leader" marks, showing the young and inexperienced which way to go, and helping the members of a herd to foregather in the dark when dispersed by the panic of a night attack.

The pattern of a zebra, in its entirety, is also believed by Mr. Wallace to have a double significance analogous to the above. It is known to be procryptic; but he holds that it acts as a badge of recognition, enabling the zebras to distinguish their own kind amongst the herds of other beasts that may be feeding in the same place. It may be so; for although seemingly contradictory, the two explanations are not mutually exclusive. The procryptic effect of the pattern is largely a matter of distance and light. At close quarters in broad daylight a zebra is conspicuous unless under cover, and the colouring is strikingly unlike that of other animals. On the other hand, it must be remembered, as I have elsewhere pointed out (NATURE, October 11, 1900), that the species, like wildebeests, zebras, spring-buck, or even ostriches, which formerly at all events fed together upon the veldt,[1] are so dissimilar in size and shape that the need for a distinctive type of coloration to prevent the postulated likelihood of specific confusion can hardly have been a sufficiently important factor in survival to have guided the evolution of the colour for the purpose supposed. And since we have evidence of the best kind that the pattern of zebras and quaggas is procryptic, it seems unnecessary to look further for its explanation. R. I. POCOCK.

1 A suspicious inconstancy about their coloration inclines me to the opinion that these ponies are the descendants of "runaways."

1 These odd friendships are a great puzzle; but perhaps the following suggestions may throw some light upon their occurrence and use. It is unlikely in the extreme that all the species concerned have their sense organs developed to an equal pitch of excellence. In one the sense of smell, in another the sense of sight, in a third the sense of hearing will be pre-eminently keen. Hence the sensory imperfections of one species will be made good by the proficiencies of the others; and each will be benefited by the association. Ostriches, for instance, in virtue of their stature and long sight, will see an enemy in open country at a much greater distance than will zebras or gnus, and will give the alarm by starting to run. Zebras, on the other hand, will scent a lion creeping up under cover long before the ostriches will see him; and by making off will warn these birds and other duller scented members of the incongruous assemblage that danger is afoot.

AGRICULTURAL NOTES.

IN the recently published number of the *Journal* of the South-eastern Agricultural College, Wye, Mr. Theobald gives an account of some injurious flea-beetles (Halticæ) which he has recently studied. He finds that the damage ascribed to the turnip "fly" (*Phyllotreta nemorum*) is very often due to related genera. A troublesome attack of the "fly" at the College farm drew attention to a new culprit, *Haltica oleracea*, and in observations made in Yorkshire, Cambridge, Huntingdon, Surrey, Kent and Devon, this species was found to be much more destructive than *P. nemorum*. The characteristics of five injurious genera are described, and observers are asked to collect and report upon these very destructive insects. Mr. Theobald's experience leads him to remark that "The present economic entomologist relies on the past economic entomologist, and so errors go on until they really seem facts. . . . John Curtis wrote the most excellent article on the turnip flea that can be imagined, and we have all copied it." Mr. Theobald's request for "serious reporting and collecting" should appeal to a wider circle than is reached by the College *Journal*. The entomologist is not the only worker who relies on the achievements of the past, nor is economic entomology the only branch of applied science that may learn something from this study of the Halticæ.

In the same number Principal Hall, until recently head of the College, summarises the results of manurial experiments on the hop, which have been carried on at various centres for from three to eight years. He concludes that the hop plant is "an all-round feeder," in this respect differing from such crops as swedes, which depend mainly on phosphates, and from potatoes, which must be liberally dressed with potassic manures. No one special manure can