the literature of paleontology, and it is a pleasure for the writer to add a new item to the information already given by Mudge and Marsh, many years ago, concerning vertebrate footprints of the Coal Measures of Kansas.

The literature has been summarized and a description of a large slab of limestone from Osage County, Kansas, bearing footprints has been given by Moodie in his monographic work on the Coal Measures Amphibia of North America. No new information concerning vertebrate footprints in the Coal Measures of Kansas has been published since that work appeared in 1916. The new discovery is thus all the more interesting, and especially so since a huge type of Coal Measures vertebrate, otherwise unknown, is indicated by these tracks. Moodie has likewise described, in the above-mentioned work and elsewhere, skeletal remains of a large labyrinthodont (?) but of a size insufficient to have made the tracks described herewith.

The present discovery relates to a series of eight footprints discovered by the sons of Dr. George Coghill and turned over to the writer for excavation and description. They were discovered in a heavy sandstone, a formation extending generally over eastern Kansas, lying just above the Weston Shales, exposed in a high cliff near the Dightman bridge over the Wakarusa Creek, some five miles southeast of Lawrence, Kansas. The series of tracks extended for a distance of twenty-five feet in a direct line, but several tracks of the series are evidently missing as they average about two feet six inches apart, and wider spaces occur in two places.

The tracks vary slightly in size, due doubtless to the plasticity of the matrix when the imprints were made. They have an average of six inches in breadth, by from six to seven inches in length, and both the front and the hind feet appear to be represented, as two of the imprints distinctly show the presence of four toes, while three of them show five toes.

One impression seems to indicate that the hind foot was placed over the impression of the front foot. These footprints, if properly interpreted, indicate the largest Coal Measures vertebrate so far known. A more detailed account, with photographs, will appear in a later paper on the subject.

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LIESEGANG RING FORMATION

RECENTLY, I advanced a theory to explain Liesegang's rings. [1] Unaccepted theories were not discussed. [2] Bradford [3] objects to my theory, and to the omission of literature.

That I am unaware of some work on banded precipitates is possibly correct. However, I disagree with the chemical analysis [4] on which his adsorption theory is built. I agree with him that bands of lead chromate can be obtained in gelatine, also with silver nitrate in the gelatine and bichromate in aqueous solution. Further, I think that banding is the normal formation of precipitates, and may occur in any solution. The function of the gel is to fix—relatively—one of the ions, and render banding visible. Ordinarily the reaction between the ions is so violent and the field of the reaction so stormy that bands are destroyed. In my theory, *relatively fixed* was used, except in one place, and the discussion shows that an absolutely fixed state was not intended. In fact an absolutely fixed state of one ion, or a relatively fixed state of both ions —as in superimposed gelatine layers of $AgNO_3$ and $K_2Cr_2O_7$—tends to prevent banding. Bradford states that the ionic attraction of silver and chromate is insufficient to explain banding in gelatine and not in agar. However, silver chromate bands form in agar quite readily, and revision of the theory is unnecessary to explain banding in this gel. I agree with him that bands of lead chromate can be obtained in gelatine with proper concentrations of lead acetate and potassium bichromate. Direct reversal of the solutions, however, without change of concentrations is not a reliable method.

Band formation is beautifully illustrated in the growth rings of trees. Rings in gels are formed similarly.

[1] SCIENCE, July 22, 1921.

[2] Bancroft, "Applied Colloid Chemistry," 1921, p. 259.

[3] SCIENCE, Nov. 11, 1921, p. 463.

[4] *Biochemical Journal*, 1916, X, p. 173.

To quote briefly without essential change from my previous paper:

In a gelatine solution containing bichromate, when silver nitrate is added, concentric rings are formed because the ion in the gelatine is relatively fixed. The silver ion wanders out and forms a ring by precipitation. A region on the chromate side of the ring is freed from the chromate ion, and a corresponding region on the silver side is freed from the silver ion. Growth stops until the silver again wanders out through the precipitate, and comes within range of the chromate ion when the process is repeated. The essentials of this interrupted growth theory are given in the previous article. Holmes' [5] theory closely resembles mine. Bradford's assumes unnecessary facts to explain the phenomenon. Later, I expect to give a more detailed account of this common phenomenon.

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SPECIAL ARTICLES

THE IDENTITY OF CERTAIN YELLOW PIGMENTS IN PLANTS AND ANIMALS

LITTLE attention seems to be paid, from the physiological standpoint, to the fact that the yellow pigments in certain animal organs have been shown to be chemically identical with the yellow pigments common in plants.

Some cases of the identity of lipochromes (yellow pigments of animals) with carotinoids (carotin, xanthophyll, lycopersicin, and fucoxanthin of plants) have been known for several years,[1] and the list has recently been greatly extended. The lipochromes of the following animal tissues are now known to be either chemically identical or isomeric with carotinoids—the ear lobes, beaks, shanks, body fat and blood serum of fowls, and the yolks of their eggs;[2] and the fat of the body, blood serum, corpus luteum and milk of the cow.[3] It seems probable that the same is true of the nerve cells of some animals and of the blood plasma and body fat of the human body.[4] These pigments are not synthesized by the animals, but are merely taken up from their food.

It is well known that carotin ($C_{40}H_{56}$) is a highly unsaturated hydrocarbon. It has been shown[5] that part of the unsaturated linkage of its molecule is of a type that can be easily satisfied by direct addition of oxygen. Xanthophyll is carotin dioxide ($C_{40}H_{56}O_2$). Lycopersicin has the same empirical formula as carotin. Fucoxanthin ($C_{40}H_{54}O_6$) contains more oxygen than the others. The first two of these pigments are widely distributed in plants. Not only do they always accompany chlorophyll, but they are also found in flowers, fruits, seeds, and subterranean organs, and also in fungi.[6]

The physiological significance of the carotinoids has, of course, not been wholly neglected. It is commonly pointed out[7] that the tendency of carotin to unite with oxygen may be significant in connection with photosynthesis, which is a reduction process. Steenbock[8] has suggested that the fat-soluble vitamine is identical with some of the carotinoids, while Palmer[9] has cited cases that seem to cast doubt on this view. Years ago Schunck[10] suggested the question as to whether xanthophyll, being present in connection with both chlorophyll and haemoglobin, may not be of physiological importance in both cases.

Emphasis is commonly laid on the chemical similarity between the chlorophyll molecule and the hæmoglobin molecule, though similarity of function between the chlorophyll of plants and the haemoglobin of animals does not seem to have been definitely shown. An examination of half a dozen recent and standard works deal-

1 Proc. Roy. Soc. London, 72: 165. 1903. Z. Physiol. Chem., 74: 214. 1911-12.

2 Jour. Biol. Chem., 23: 261-279. 1915.

3 Ibid., 17: 191-263. 1914.

4 Jour. Amer. Med. Assn., 74: 32-33. 1920.

5 Holmes. *Journal American Chemical Society*, 1918, XL, p. 1187.

6 Thatcher. The Chemistry of Plant Life. 1921.

7 Palladin's Plant Physiol. Livingston. p. 19.

8 Sci. N. S., 50: 352-353. 1919.

9 Sci. N. S., 50: 501-502, 1919, and Jour. Biol. Chem., 46: 559-577, 1921.

10 Proc. Roy. Soc., London, 72: 176. 1903.