A Few Important References.

[1] Frye, T. C. "Development of the pollen in some *Asclepiadaceæ*." *Bot. Gaz.*, **32**, 325, 1901.

[2] Willis, J. C. Cambridge Biological Series: "Flowering Plants and Ferns," 1925.

[3] Coulter and Chamberlain. *Morphology of Angiosperm*, **2**.

The Physics of Olfaction.

NUMEROUS workers since Liégois and Prevost have tried to formulate a physical basis for smell, Teudt's (1919) electronic theory being one of the most recent. It is unlikely that a satisfactory theory would be derived from a consideration of physics alone, owing to the psychological and other factors intimately bound up with the oldest and most neglected of our senses. However, it is not correct to say that no physics of olfaction exists at all.

In 1904 Berthelot suggested that the lower limit of the number of molecules perceptible by smell lay between 10^8 and 10^{11}. Zwaardemaker and Heyninx arrived independently at a figure of the order of 10^9. Lord Rayleigh, following Töpler and Boltzmann, equated the energy of minimal stimuli of sound and light at about 40 ergs, which, in the case of sound, can be expressed as a change of compression of the order of 10^{-10} atmospheres. Assuming an olfactory inspiration of about 1 cubic inch, this figure is of the same order as the smallest number of odorous molecules which require to be drawn into the nasal passage to excite the sense of smell, as I have shown in the *Perfumery and Essential Oil Record*, **17**, 1926, p. 176.

The quantity of odorous material perceptible to the nose may be inconceivably small when expressed in fractions of a milligram, yet be numerically large if regarded as a number of molecules. The molecules in a cubic inch of ordinary air would form a line many times longer than the circumference of the earth, if they were placed side by side, but a number of molecules perceptible by smell could be strung along a length of less than a meter. For comparison with the intensity of sound stimuli, it may be of interest to mention that a crowd of a hundred thousand persons would need to shout for an appreciable period to emit as much sound energy as would equal the heat in a cup of tea.

Tyndall suggested a theory of odour based upon the heat absorbed by odorous substances. Grijns in 1919, and the writer more recently, have shown that the heat absorption of essential oils can be referred almost entirely to an adventitious content of water. A physical investigation of odorous substances at the concentrations at which they are perceptible to the nose would require very delicate apparatus, as it would be necessary to deal with partial pressures of considerably less than a millionth of an atmosphere.

HUGH NICOL.

Rothamsted Experimental Station,
Harpenden,
February 6, 1934.

On the Development of the Intervertebral Ligament in Teleostean Fishes.

MACBRIDE[1] in summarising the observation of Ramanujam[3] on the development of the vertebral column of herring, states with reference to the formation of the intervertebral ligament that "the notochordal tissue intervening between the chorda centra projects as a series of gelatinous pads which are ultimately transformed into intervertebral ligaments". The various species of teleostean fishes that I have studied so far present, however, a different story altogether.

The sclerotomic cells aggregate round the notochord as perichordal sheath; soon after this, the perichordal sheath of the vertebral portions becomes osseous, while the intervertebral portions remain still membraneous (Fig. 1). Outside these membraneous intervertebral portions of the perichordal sheath, migratory connective tissue cells become arranged side by side into three bands and these enter the membraneous portions of the perichordal sheath (Fig. 2). I [2(a) & 2(b)] have shown how such migratory connective tissue cells enter through the intervertebral portions of the vertebral columns both in Urodela and Anura in order to form ophisthocœlous and procœlous vertebræ respectively. The middle band of the connective tissue cells situated at the intervertebral portions of the teleostean fishes, contributes to the formation of the intervertebral ligaments, whereas the two lateral bands of the connective tissue cells which ultimately become cartilaginous give rise to the formation of the two surfaces of the centrum. This sort of formation of the intervertebral ligaments

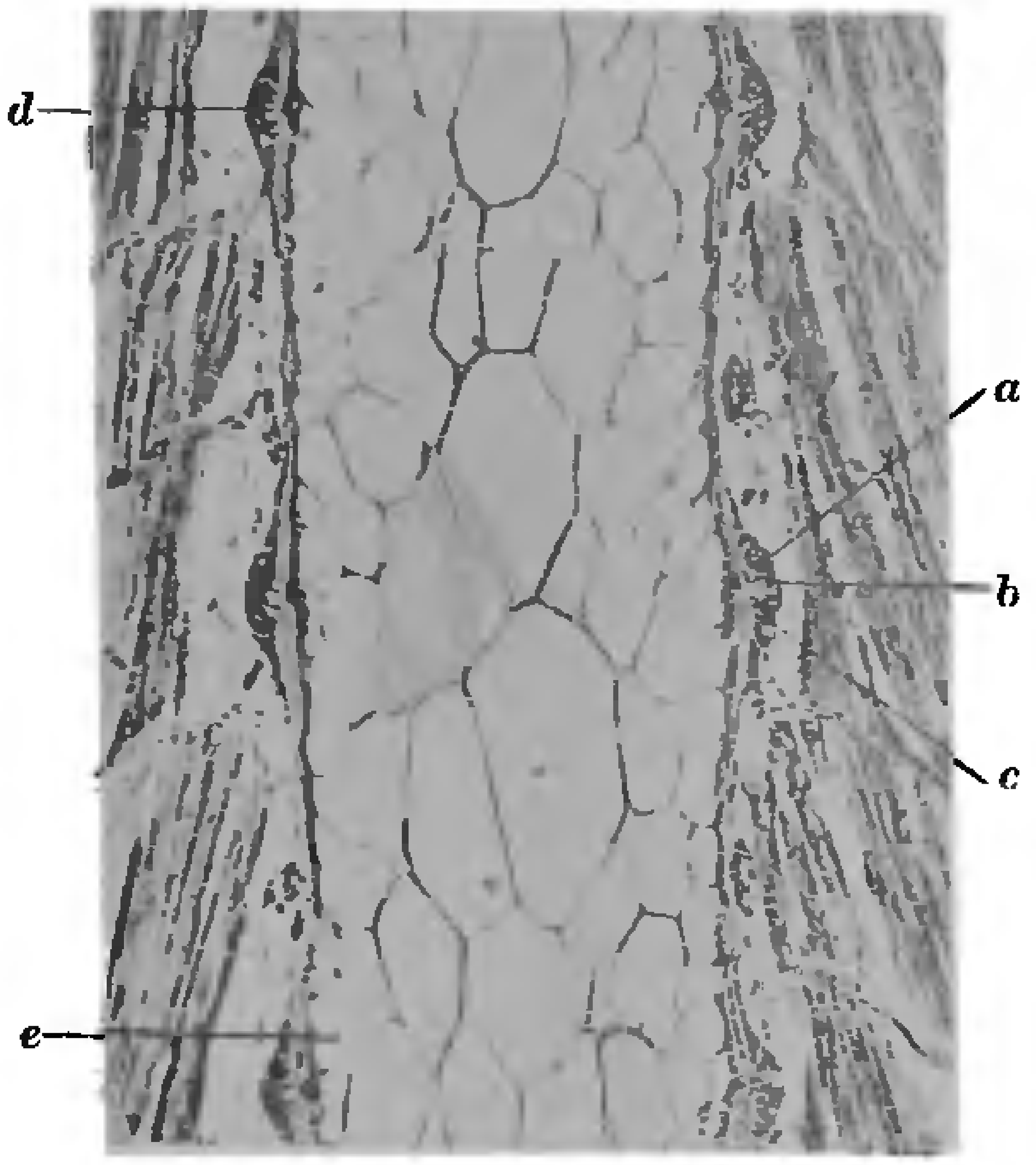

Fig. 1. × 185

A Photomicrograph of a frontal section passing through the middle region of the vertebral centra of *Ophicephalus striatus*, Bloch at 12 mm. stage showing the three cut ends of the connective tissue bands outside the bulging of the notochordal sheath in the intervertebral regions on either side of the notochord.

a, *b*, *c*—Cut ends of three bands of connective tissue. *d*—bulging of the notochordal sheath. *e*—notochord.

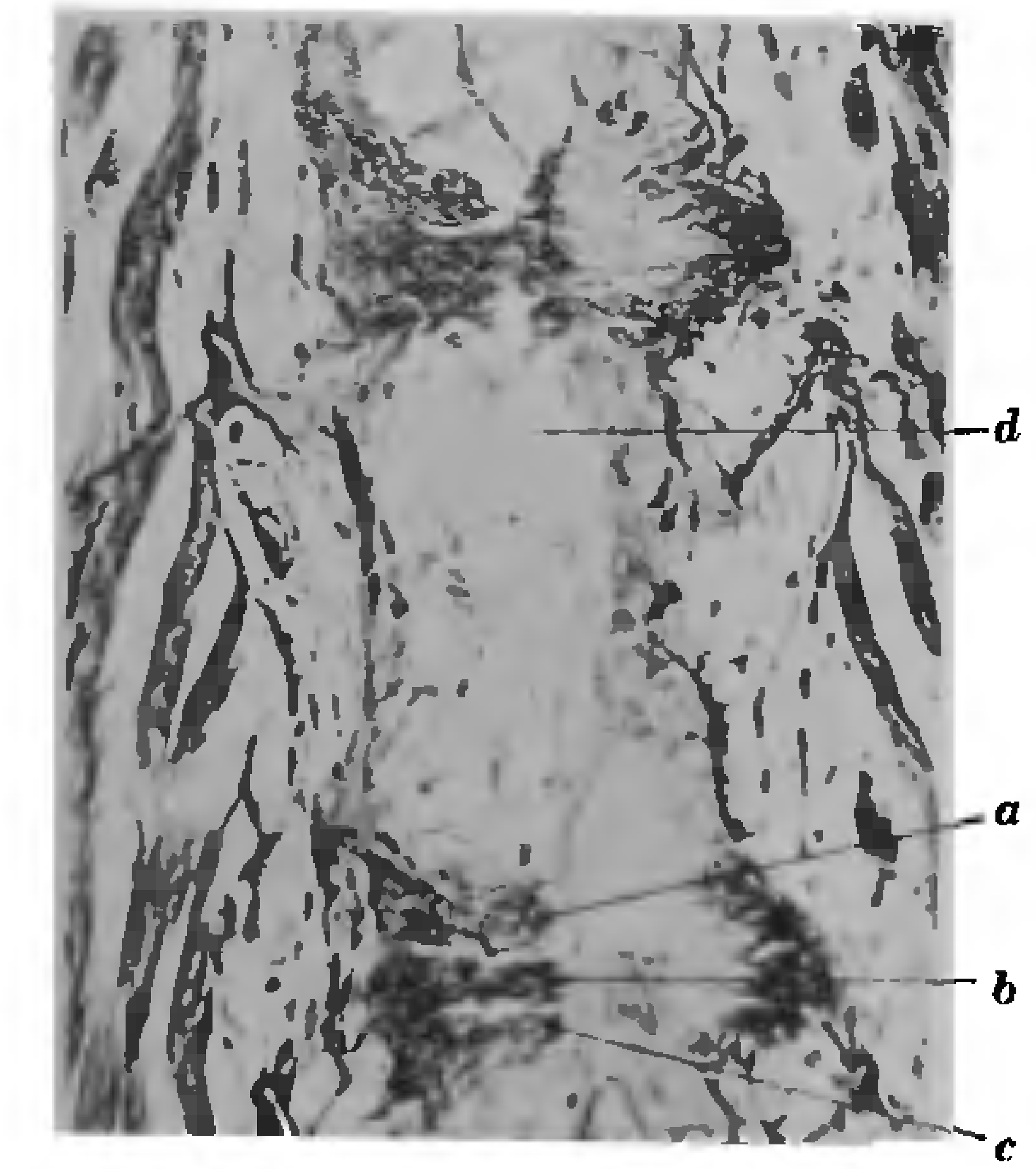

Fig. 2. × 225

A photomicrograph of a frontal section passing through the peripheri of the vertebral centra of *Ophicephalus striatus*, Bloch at 12 mm. stage showing the three bands of connective tissue cells in the intervertebral region.

a, *b*, *c*—three bands of connective tissue cells. *d*—notochord.

has also been traced by me in the vertebral columns of our house lizard and chick.

The statement of Ramanujam[3] is correct so far as the existence of the bulging of the notochordal sheath in the intervertebral region is concerned. The bulging which is due to the zone of growth of the notochord together with its sheath, is transferred from the vertebral to the intervertebral portions but this bulging of the notochordal tissue in the intervertebral region has nothing to do with the formation of the intervertebral ligament.

The details will be published elsewhere.

HIMADRI KUMAR MOOKERJEE.

Department of Zoology,
University of Calcutta,
February 8, 1934.

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Colour of Cotton Flowers.

IN the course of an investigation on the chemical constituents of the different species of the *Gossipium* (cotton) a marked difference in colour was noticed between the petals of the Cambodia, a South Indian variety of *G. Hirsutum* on the one hand and those of Uppam and Karunganni, South Indian varieties of *G. Herbaceum* and *G. Indicum* respectively on the other. The former are pale being only cream coloured whereas the latter are bright golden yellow. It is found that this difference in colour cannot be explained as due to the nature or the quantity of the pigments present. Cambodia contains mainly Quercimeritrin whereas Uppam contains Gossipitrin and Karunganni an almost equal mixture of the two. It is known that there is a close similarity between the two flavanol glycosides in their tinctorial properties and experiments now show that the Cambodia petals contain a higher percentage of the