Scots pine dying in plantations in three different regions of East Anglia. *Fomes annosus* occurs on these trees and a species of *Phytophthora* has also been isolated from them. These trees consistently bear roots from which, on dying, resin flow has taken place to such an extent that a mass of resin-soaked soil usually adheres to them: their wood also is more or less soaked in resin. This is not typical of roots attacked by either *A. mellea*, *F. annosus*, or, according to recent experience in South Wales, of roots infected by *Phytophthora* species either. It has, however, been found before in pine roots in which abnormal zones associated with water deficiency occur.

The accompanying photographs show well-developed abnormal zones in roots cut from the East Anglian pines. The complete root-section was about three inches across. It will be seen that the bark of the root died down to the wood in places; frequently, however, only the outer part of the cortex dies, as is so often the case in frost-injured stems. These abnormal zones consist of unlignified collapsed tracheids. The upper part of the soil profile, in which the root systems of the affected trees grow, is sandy and subject to drought during any considerable dry period; the lower part of the profile consists, according to the district, either of re-cemented chalk or compact sand, both of which are very water-retentive. Dead roots and also roots in which abnormal zones occur may be found in both these parts of the soil profile and the evidence is, thus, that they arise both owing to drought and to waterlogging.

This East Anglian disease of pines appears, therefore, as a very interesting case in which severe injury to the root system has first developed owing to adverse physical conditions in the soil. Infection by fungi, although perhaps of considerable importance in the development of the disease and in bringing about the death of trees, appears as secondary to strongly adverse physical soil factors. This is, of course, a diagnosis which can be proved in detail only by long-term research. The evidence provided does, however, bring out strongly the very important part that can be played by non-biotic factors in the development of root disease, and stresses the need for soils research which is designed to show in what circumstances and with what severity conditions develop in the field which are sub-marginal for healthy root development, either directly or through predisposing roots to infection by parasites.

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Day, W. R., and Peace, T. R., "Spring Frosts", Forestry Commission Bull. 18. (London: H.M. Stationery Office, 1937.)

The Protein of Fruits

UP to the present, it has not been found possible to obtain more than an insignificant amount of the protein of apple-fruits in a soluble form except by treatments so drastic as to lead, inevitably, to some degradation as well as denaturation of the protein[1]; other acid tissues, for example, rhubarb leaves[2], behave in a similar way, whereas the protein can be easily extracted from non-acid tissues by water alone after maceration or cytolysis of the tissue.

I have found, recently, that it is possible to extract at least 50 per cent of the protein from apples by adding, a little at a time, the frozen and ground (at − 20° C.) tissue to a warm borate buffer solution (*p*H 9·2) which is being violently stirred. The protein can be recovered from the filtered solution by adjustment of the *p*H to 3. The crude precipitate, representing approximately 50 per cent of the protein-nitrogen of the original tissue, has a nitrogen content (ash-free) of 7·2 and gives a positive test for tyrosine and tryptophane and a strong Molisch reaction.

This observation suggests that, *in vivo*, the cytoplasm of the cells of the fruit must be at a much higher *p*H than that of the vacuolar sap (*p*H 3 or lower).

Work is proceeding with the object of obtaining larger samples of the apple-protein complex so that its properties may be studied.

This work was carried out as part of the programme of the Food Investigation Board.

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[1] Hulme, Rep. Food Invest. Bd., 1938 (p. 125).
[2] Chibnall, "Protein Metabolism in the Plant" (Yale University Press, 1939), p. 145.

A Response to Gravity in Young *Hydra*

WHILE keeping cultures of *Hydra vulgaris* Pallas for class work it was noticed that whereas adult animals seldom changed their position, buds immediately after their separation from the parent rapidly made their way up the side of the tank to the surface of the water. This reaction seemed worthy of further investigation, since previous workers on the behaviour of *Hydra* have not made any distinction between adults and buds. Upward movement has generally been regarded as a response to lack of oxygen or to a gradient in oxygen concentration, rather than as a gravity reaction[1,2,3]. I have found that the upward migration of recently separated buds is a response to gravity and not to lack of oxygen, or to a gradient of oxygen concentration. It takes place both when the water is at air saturation and there is no gradient of oxygen concentration, and also when the oxygen concentration is arranged to be lowest at the top and highest at the bottom of the vessel containing the animals.

Lowering the *p*H of the water with carbon dioxide has little or no effect on the reaction of young buds; but it evokes upward movement in adults which previously showed no such reaction. An equal alteration of *p*H produced by adding hydrochloric acid is ineffective. A reduction of the oxygen content of the water to approximately 1 ml. per litre is also without effect on adults, nor does it affect the normal upward migration of young buds.

The interaction of this gravity reaction of young buds and the well-known positive reaction of *Hydra* to light has also been investigated. The buds were allowed to walk on a vertical surface, and the light was arranged to come either from below or from the side in such a way that the rays were parallel to the face on which the animals walked. It was found that bottom light affects the gravity reaction much more strongly than does side light. This is true not only for animals taken from stock cultures in normal lighting conditions, but also for animals that had been grown for two generations in a tank lit from below. Haug[4] has shown that when behaving photopositively *Hydra* orientates itself klinokinetically, and although its oral end may during this orientation often be directed away from the light, the animal will not take a step when the oral end is at a lower intensity of illumination than the aboral end. This has the effect of inhibiting movement upwards when the animal is lit from below. In side light, on the other hand, even if the animal is orientated vertically upwards, walking is not inhibited, since the oral and aboral ends are then equally illuminated. The greater effect of bottom light on the gravity reaction therefore results from the way in which the response to light is made, and is not to be taken as showing that the unnatural direction of the light rays has enhanced their effect and, so to speak, confused the animal.

The biological significance of this negative geotaxis shown by young buds of *Hydra vulgaris* is clear. The reaction ensures the distribution of young buds, and prevents their staying in the immediate vicinity of their parent and so giving rise to local overcrowding.

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[1] Wilson, E. B., *Amer. Nat.*, **25**, 413 (1891).
[2] Haase-Eichler, R., *Zool. Jb.*, **50**, 265 (1931).
[3] Beutler, R., *Z. vergl. Physiol.*, **18**, 718 (1933).
[4] Haug, G., *Z. vergl. Physiol.*, **19**, 246 (1933).

Bacterial Origin of Some Insect Pigments

THE literature on symbiosis, as summarized in Buchner's[1] latest book, refers almost entirely to histological and cytological findings. Little work seems to have been done on the isolation of the symbiotes, and less still on their physiological role in insect metabolism. Koch[2] was the first to prove that the symbiote of *Sitodrepa panicea* provides a growth-promoting factor or vitamin for this insect. With regard to *Cicadella viridis*, I have published two[3,4] communications showing that the insect contains two bacteria: one on culturing produces a greenish-yellow pigment, identical with the colour of the insect, and the other β-carotene which is apparent at least on the legs of the males. In the female, β-carotene is reduced to the colourless vitamin A, which is needed by the insect.

Orthezia insignis is a scale insect often found in the greenhouses of botanical gardens in Europe. The long bacterium it harbours has been illustrated by Buchner[5] and also by Walczuch[6]. On culturing, it produces a greenish-yellow pigment like the colour of its host. Walczuch also figures the symbiotic bacteria of *Orthezia urticæ*, which, however, are not so happily represented. In smears their shape is like thick short rods rather elliptical at the ends. The bacteria of *O. urticæ* and *O. insignis* can never be mistaken in smears, a feature not well brought out in the illustrations of Walczuch. The symbiote of *O. urticæ* forms a relatively darker green pigment in cultures. When we compare the living adults of the two species of *Orthezia* and also their bacterial cultures, it is clear that the insects differ from each other in colour, *insignis* being yellower and *urticæ* greener, as is also the case with the pigment of their respective symbiotes.

That symbiotic micro-organisms can produce pigments was first suggested by Pierantoni and further elaborated by Tschirch, who unfortunately did not work with living lac insects, and his observations had to be differently interpreted[7]. However, it seems to me that some work has already been published which bears independent testimony to such a theory. In 1912, Buchner[8] reproduced a coloured illustration of an insect larva which could have belonged either to *Aphrophora alni* or *A. salicis*, but he left the species unidentified. The general body of this larval insect is ochre-coloured, but the marginal area of four abdominal segments is red. Buchner clearly indicates in the description of his Plate 11, Fig. 1, on page 115, that the symbiotic organ of this insect is red, the colour appearing through the chitin of the insect. I may add here that the tumour, formerly called 'mycotome', or as it should be called 'bacteriotome', varies in its colour intensity, but there is always a reddish zone which Buchner mentions and illustrates. He also illustrates in Figs. 2–5 histological sections, of the same species, where there are pigment granules resembling burnt sienna rather than ochre, which shows that the pigment was able to withstand the action of the fixative and of solvents like alcohol and xylol. When the adult insects of *A. alni* and *A. salicis* are compared, the former is reddish like burnt sienna, while the latter is ochre-coloured. The symbiotic organs likewise differ in colour when freshly dissected, but not to such an extent as the pigments they contain. Buchner's illustrations leave no doubt that the specimen he illustrated belongs to *A. alni*, the reddish of the two species.

In 1925, Buchner[9] illustrated as many as three symbiotic micro-organisms of *A. alni* (Fig. 10, p. 113). It is a very common insect all over Europe, and it is easy to confirm the illustrations given by Buchner, but the real symbiote is a small bacterium quite distinct from those suggested by him. It is best seen in smears and particularly when the insect is in the larval or young adult stage. Later on, the symbiotic organ becomes sterile and the bacteria are then found