clearly. In the youngest stages there appear first to be small groups of threads in little secondary pits; very soon little rounded and bason-shaped masses of callus arise in the little depressions on either side of the thin membrane, and these finally unite to form a short callus-rod. In *Wistaria chinensis* and in *Vitis vinifera* three to five threads apparently of the nature of slime-strings have been seen in each callus-rod in sieve-plates of this age, but more detailed and careful examination is demanded before any conclusive statement can be made.

In the next older tube the boring out of these strings has proceeded further, and given rise to the single slime-string in each callus-rod so characteristic of the mature terminal sieve-plates of Angiosperms.

The views put forward to explain the origin of the callus in species of *Pinus* seem to apply with equal force in the present case: for the callus-rods appear to be formed by local alteration of the cell-wall, and to arise at first as cylindrical rods, which subsequently become hexagonal owing to growth and mutual pressure in the confined area of a pit.

As to the further production of callus towards the end of the season, it would appear that the protoplasm of the sieve-tube commences to form callus, which not only builds up the callus-pads on the callus-rods of the terminal and lateral sieve-plates, but also deposits callus-substance around all the groups of threads which connect the sieve-tubes with other elements of the phloem.

It has become clear during the progress of these researches that it is the slime-strings which are of primary importance to the sieve-tubes, and that the callus, though no doubt also playing an important rôle in the life-history of the sieve-tube, must be regarded as of altogether secondary importance, being for the most part subservient to the slime-strings and active or living sieve-tube contents, of which the slime-string itself is merely a continuation.

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KING'S COLLEGE, CAMBRIDGE,
Nov. 11, 1902.

NOTE ON THE DISPERSAL OF MANGROVE SEEDLINGS.—

During the year 1901 and for three months of the present year I was engaged in marine biological work for Sir Charles Eliot, K.C.M.G., H.B.M. Consul-General at Zanzibar and Commissioner for British East Africa. During all this time I was interested in, and at first much

puzzled, by the conditions under which I found mangroves growing in these regions.

The coasts of the whole of British and German East Africa are composed of a hard coral limestone of peculiar properties. (For a full account of this see my papers in the Proc. Phil. Soc. of Cambridge, vol. ix, pt. vi, Part i, 'On the Coral Reefs of Zanzibar.') The erosion of the waves has cut down this rock so that at low-tide there is an almost perfectly plane surface of rock, sloping gradually from the base of the cliffs to low-water level. In creeks and sheltered places generally, near high-water mark, this rock plane is full of irregular small holes and crannies, but no loose stones or deposits, other than a very thin coating of fine mud, interrupt its uniformity.

On this hard surface, sending their roots into the crannies, the greater number of the mangroves of Zanzibar flourish so well that a considerable trade is carried on from Chuaka Bay¹ in their stems. (These are used in the building of all the Arab and native houses of Zanzibar, being too hard for the jaws of the termites.) Only occasionally do we find mangroves growing in mud and see the demonstration of the well-known method of planting, viz. by the impact of its fall forcing the root of the embryo into the mud. In the majority of cases one finds the embryo placed in one of the holes of the rock, which is usually of but slightly larger diameter than itself. Obviously it did not fall by chance into this position; suitable holes are not so numerous, and the insertion of the radicle into them not so easy as this would imply. Moreover, I have often observed embryos neatly planted in these holes at a distance of more than a hundred yards from the shade of the nearest possible parent tree, and in a few cases at a distance of miles.

How this planting could be done, except by human hands, remained for a long time a mystery to me. The solution came when I noticed the frequency with which I met embryos floating in the sea, being carried out of the bay by the strong tidal currents. Often I passed through fleets of them, as it were, all floating in the same peculiar way, viz. vertically, with the leaf-bud just projecting from the water. (See the figure.) A consideration of the shape of the radicle shows that not only is there a perfect adjustment of the specific gravity of the whole to that of the sea water, but a peculiar distribution of it in

¹ A large and very shallow bay on the east coast of Zanzibar island, where most of my time was spent.

order that the *thick* end may sink, instead of floating uppermost, as it would if the specific gravity were the same throughout. Both kinds of embryo, the thick and the slender, float in the same way.

On reaching shore the embryos are planted by the insinuation of the root-tip into any softness or crevice of the bottom by the falling

FIG. 16.

tide. The figure represents a section of the rock of the shore across a crevice, which is full of mud, as shown by the dark shading. The vertical embryo is in the position in which it floats freely. The tide has fallen until its root-tip engages a projection on the bottom. The ripples will now cause its oscillation about the tip, which will thus be kept slowly boring down into any mud or crevice present as the

falling tide brings the weight of the embryo on to its point, until it has reached the position of the lower specimen in the figure.

The success of this method depends upon the action of ripples of the water, but on an exposed shore the waves will merely throw the embryo about as any other floating stick. Suitably shaped and fairly numerous crevices in the rock are usually met with near high-tide mark, the surface of the flats lower down being smoother and its crevices too shallow, or filled in with hard sand. In short, the conditions requisite to planting are generally those suitable for the life of the adult trees, but, as in the case of other trees, those conditions are sometimes found where the embryo can never develop into the adult. Embryos are often planted too low down the shore (I have even met with one, bearing two unfolded leaves, at low tide in the sand of the boat channel of the reef on the open coast), but in this case they will be usually floated off again by succeeding tides.

There are thus *two* adaptations of the mangrove, ensuring that, in the case of those trees which are growing in mud, too many embryos shall not be swept out to sea, and also that those which are so removed shall have a good chance of taking root in fresh localities. The mangrove has thus an effective means of dispersal, and it is probable that the juxtaposition of trees from different sources, whereby continued in-and-in fertilization is avoided, is just as important for them as for the great majority of living things. Furthermore, this adaptation for dispersal enables the embryos to be planted on surfaces to which the formerly known method is inapplicable.

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EXPLOSIVE DISCHARGE OF ANTHEROZOIDS IN FEGATELLA CONICA.—*Fegatella* (*Conocephalus*) *conica* is one of the commonest liverworts in the neighbourhood of Leeds. It grows in great abundance in moist and shaded places, especially on stones beside streams. In the beginning of July a large supply of male plants was collected, bearing young antheridial receptacles, which, as is well known, are sessile in this genus, and have the form of oval cushions, each situated at the anterior end of one of the branches of the thallus. Most of these plants were put into shallow vessels, covered with sheets of glass, and set in a shaded place. After a few

Crossland, Cyril. 1903. "Note on the dispersal of mangrove seedlings." *Annals of botany* 17, 267–270. <https://doi.org/10.1093/oxfordjournals.aob.a088913>.

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