plant-organ towards the point, not where it will find a minimum or maximum of moisture, but where it will, within certain limits, transpire most or least.

LÉO ERRERA, Brussels.

BOTANICAL NOTES.

No. 1. **ON THE THORNS OF RANDIA DUMETORUM, LAM.**—*Randia dumetorum* is a Rubiaceous plant widely distributed in tropical East Africa, India, the Malayan Archipelago, up to China, including Formosa and Hong Kong. The plant is very common on Dane's Island, Whampoa, where my observations were made.

Position and arrangement of the thorns.—The leaves of this plant are opposite as in most Rubiaceae. In the axil of each leaf is a branch, or bud, directly above which a thorn frequently occurs; so the thorns are supra-axillary. As a rule there is a distinct, often considerable, difference in the size of the two leaves at a node. The smaller leaf not uncommonly decays and drops off early in life. The thorn above this leaf is invariably inserted closer to the leaf-axil than is the thorn above the larger leaf. This is shown

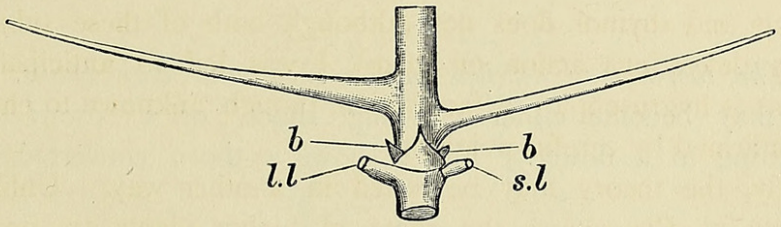

Fig. 1.

in the Fig. 1, in which *l.l.* and *s.l.* are the stalks of the large and small leaves respectively, and *b.b.* are the axillary buds. Thorns never occur in relation with the first pair of leaves of a branch, and they are occasionally not developed in connection with pairs of leaves higher up the branches; frequently a thorn occurs above only one of the leaves at a node, in which case it almost always is situated above the larger leaf.

Morphological Significance of the Thorns.—As far as the *position* of the thorn is concerned it might be a trichome, an emergence, or an accessory branch. It is not very exceptional to find in plants a protective outgrowth of the cortex above the axillary bud

and the thorn might readily have been derived from such an outgrowth. But the following facts prove that the thorns are accessory branches:

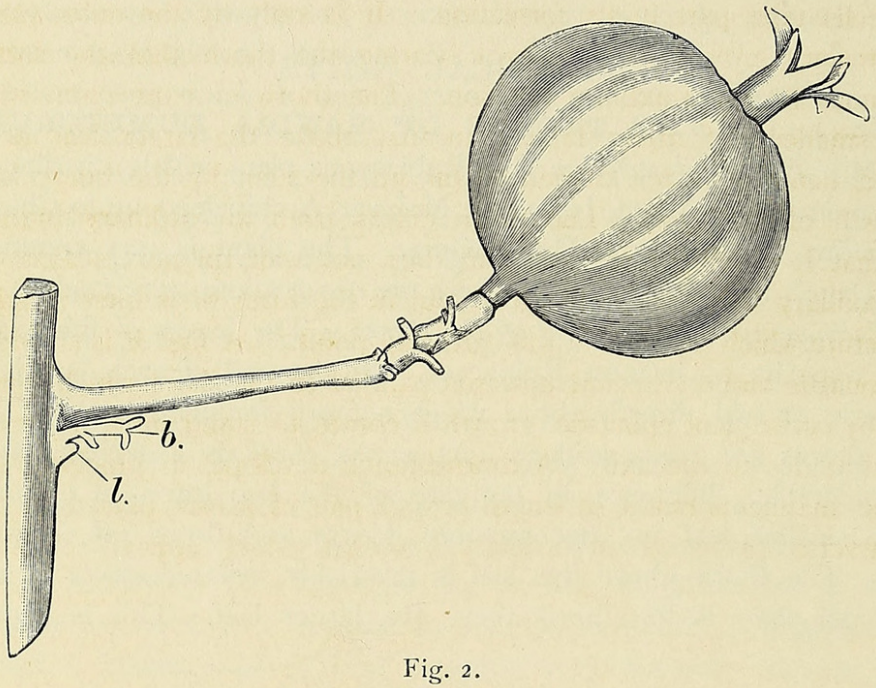

Fig. 2.

(i) *The thorn may develope into a shoot and bear leaves.* The thorn may become either a 'long shoot,' or a 'dwarf shoot' terminating in a flower. Fig. 2 shows a thorn converted into a

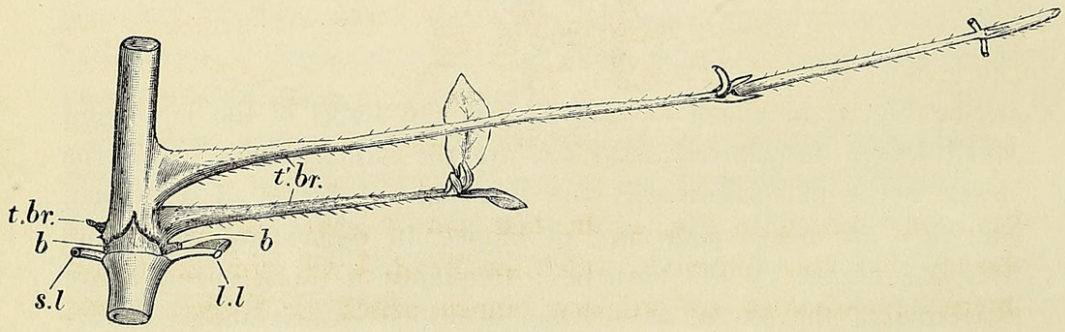

Fig. 3.

shoot and ending in a fruit. The ordinary axillary bud may develope as well; in one case I saw two superposed thorns changed into branches, as is shown in Fig. 3 in which *t'. br.* re-

presents the two thorn-branches, above the large leaf, and *t. br.* the arrested thorn-branch above the smaller leaf.

(ii) *The thorn arises and grows like a shoot.* It appears as a multicellular outgrowth in the axil of a leaf, and the deeper layers of cells take part in its formation. It is only by the subsequent intercalary growth of the shoot bearing the thorn that the latter assumes its supra-axillary position. The thorn in connection with the smaller leaf arises later than that above the larger leaf at a node, hence it is not carried so far up the stem by the intercalary growth of the stem. The thorn differs from an ordinary branch in that it developes at once and does not wait till next season as an axillary bud does. It grows out in the form of a long slender structure which tapers to a fine growing-point. At first it is strongly hyponastic and is directed upwards parallel to the shoot which bears it: by subsequent epinastic growth it comes to stand more or less at right angles to the axis. A thorn-branch developes in precisely the same manner; but it at length bears a pair of leaves, placed in the transverse plane as on ordinary branches, which appear relatively

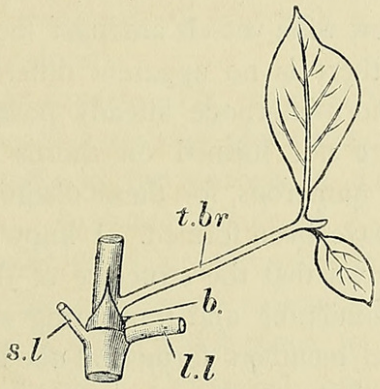

Fig. 4.

late. As is seen in Fig. 4, the first pair of leaves are inserted at the top of a long internode, which for brevity I will term the 'thorn-internode,' whereas an ordinary branch arises as a short broad outgrowth on which two leaves appear at once. Hence even old thorn-branches can be recognised as such by the long basal internode ('thorn-internode') with which they commence; this is clearly seen in the second figure. The typical leafless thorn does not differ from an ordinary shoot in that it only grows for a brief and

definite period, for this is also the case with the axillary shoots which terminate in flowers. But the thorn or thorn-branch has a peculiar feature in the pronounced dorsi-ventral nature of its base, as exhibited by its hyponasty and epinasty, and by its contour not being circular but elliptical with the long axis of the ellipse in an antero-posterior plane.

(iii) *The structure of a thorn agrees with that of a shoot.* It consists of epidermis (or periderm), cortex, vascular cylinder, and pith. But there are anatomical differences between the thorn and an ordinary shoot. The hairs on a thorn drop off much sooner than they do from a shoot, or even from a thorn-branch, and the cuticle thickens more rapidly. In the thorn the protoxylem has only a few narrow spiral vessels; and the later formed xylem consists of parenchyma and radial lines of thick-walled prosenchyma with small pits. In a shoot the primary annular and spiral vessels are more numerous and slightly larger; in the later-formed xylem wide vessels are interspersed amongst the thick-walled prosenchyma-cells which have larger pits. The sieve-tubes of the shoot have wider lumina. The 'thorn-internode' stands midway between a shoot and a thorn in structure, as there are a few wide vessels amongst the wood-prosenchyma. In the young stage there is no apparent difference in the structure of a thorn and a thorn-internode already possessing leaves. This shows that leaves are not formed on thorns because the vessels are wider and more numerous, for these distinctions do not appear till after the leaves have been formed. I know no case in which it can be so clearly shown that the structure of the wood depends on the extent of the assimilating and transpiring surface; here we can compare two identical members formed at the same time and under the same external circumstances, for we can examine a thorn and a thorn-internode arising at the same node.

Attention has already been directed to the dorsi-ventral nature of the thorns and 'thorn-internodes': these members also exhibit remarkable peculiarities in connection with the assumption of their ultimate position. Under all circumstances the thorn, or the 'thorn-internode,' assumes a position approximately at right angles to the shoot bearing it. Thus these structures assume their position independently of the two great directive influences of light and gravitation; and this is the more clearly seen when the thorn becomes a branch, in which case the subsequently formed internodes have their direction

governed by light and gravitation. I noted one especially striking series of thorn-branches which were on the lower surface of a horizontal lateral shoot. The 'thorn-internodes' pointed vertically downwards, i. e. at right angles to the shoot; but the remaining internodes of these thorn-branches were directed horizontally, that is at right angles to the thorn-internode and parallel with the lateral shoot and pointing towards its apex. Thus each thorn-branch was shaped like an L, doubtless because of the marked positive heliotropism of the later formed internodes.

Biological Significance of the Thorns.—The thorns are protective, and their particular *rôle* appears to be the defence of the young branches which arise in connection with the same leaves as themselves. They accomplish their end by (1) standing out at right angles to the stem or having a slightly ascending direction: (2) developing in the year of their origin and speedily becoming hard and lignified. In accordance with their particular function they are absent when there is no axillary branch to protect: for example, the bud in the axil of the smaller leaf frequently does not develope, and then there is no supra-axillary thorn: neither do the buds of the lowest pair of leaves of a shoot grow out, and here again thorns are absent.

The Atrophy of the Leaves.—The unequal size of the two leaves at a node is by no means a peculiar phenomenon, but it is interesting to find a plant actually in the process of diminishing the size of certain of its leaves. In some shoots of *Randia dumetorum* and other species of *Randia*, no difference exists between the two leaves at a node. But on the other hand extremes in the other direction exist in which there is marked difference in size and the smaller leaf falls off early in life. Connected with the atrophy of the leaf is the postponement of the development of the thorn, or its total absence, and the frequently permanent dormancy of the axillary bud. It is very suggestive that coffee-planters have ascertained by experience that the best method of cultivating another Rubiaceous plant, the coffee-plant, is to do just what *Randia dumetorum* seems to be aiming at, namely to nip off one leaf from each of the successive internodes so as to make the leaf-arrangement alternate. The postponement in the development of dwindling organs may be also seen in the late appearance of the first pair of leaves on a thorn-branch.