EXPLOSIVE FRUITS IN *VISCUM JAPONICUM*, THUNB.

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It is generally believed that the seeds of the genus *Viscum*, and probably of all the species of *Loranthus*, are dispersed by birds, who eat the viscid pulp and leave the seeds sticking to the twigs of trees on which they rub their beaks. Another view which was current for some time, but which has been experimentally shown to be mistaken at least in the case of *V. album*[1], is that the seeds must pass through the alimentary canal of a bird before they can germinate. There is probably no doubt that the wide distribution of the Loranthaceæ is chiefly due to the viscid nature of the berries which are carried by birds even to distant oceanic islands. For this reason some interest attaches to those members of the family in which the seed, although embedded in a viscid pulp, does not seem to depend upon animals for its dispersal.

The object of the present note is to record one such case, namely *Viscum japonicum*, Thunb., which I have had under observation during a recent summer vacation at Lansdowne in Garhwal (Western Himalayas). In a mixed forest in which the dominant species of trees is *Quercus incana* (associated with *Rhododendron arboreum*, *Pinus longifolia*, etc.) there was hardly an oak which did not show one or more bunches of the parasite. The minute obovoid fruit ripens during the rainy season, which begins in July. The berries[2] are scarcely 2 mm long; when quite ripe they are somewhat translucent, the seed being just visible in the broader distal part of the berry. As the fruit is so small and inconspicuous, and as I never noticed any bird visitors, I kept some plants under close observation with a view to ascertain the mode of dispersal. Within the first fortnight of the monsoon season a number of seeds were found sticking to neighbouring twigs and leaves of the oak, and even on the moss-covered trunks far away from the attacked branches. I imagined at first that a possible agent in the dispersal might be the elusive cicadas, which are active at dusk, and abound in the forest. This was soon proved to be not the case. Oak twigs bearing ripe mistletoes were kept indoors overnight,

[1] See Engler and Prantl (1893), p. 160.

[2] The berry of the Loranthaceæ is in reality a false fruit as it includes the hollowed thalamus in which the ovary is sunk (cf. Engler *loc. cit.*).

covered with a handkerchief, the cut ends dipping in water. In the morning a number of seeds were found sticking to the cloth or lying in the water; the empty fruits as a rule remained attached to the *Viscum*, but in a few cases these were also lying free. Later in the season, when ripe fruits were common, I repeatedly confirmed the fact that the seeds are ejected with force to a distance of two feet or more; they are thus liable to get stuck to neighbouring twigs or fall upon branches lower down or get washed down by the rain. If caught in a gust of wind after being ejected they may even be carried to other trees. Their dispersal through any other agent, such as birds, seems to me very doubtful, except as a chance occurrence, e.g., when a seed during its flight through the air may happen to strike a bird. The ejection of the seeds can be conveniently watched if shoots bearing ripe fruits are kept completely immersed in water. It is then seen that the broad upper end of the fruit becomes very turgid and bursts at the apex, the seed travelling several inches under water.

I am not aware that the explosive mechanism in the fruit has ever been described in this or in any other species of the genus.

Among works on the Indian flora I have seen descriptions of *V. japonicum* by the following authors: Bamber, Brandis, Collett, Engler, Fyson, Hooker, Kanjilal and Parker.[3] None of them refers to the explosive nature of the fruit. Other species of the genus have been described from India, Burma, Ceylon and Java by Cooke, Haines, Kurz, Koorders and Trimen [4]. Neither these authors, nor Bentham and Hooker, nor Engler and Prantl say anything about this feature in *Viscum*; while Kurz even says that the fruit is indehiscent in the whole family. This latter statement is no doubt wrong. Prof. S. R. Kashyap drew my attention to Parker's[5] statement that in *Arceuthobium Oxycedri* (a minute parasite common on *Juniperus* in the interior N.-W. Himalayas) the seed is forcibly ejected in a manner somewhat like that described above. The process was first described by Reinaud de Fonvert in 1845[6]. The chief point of difference is that in *Arceu-*

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[3] Bamber (1916), p. 644; Brandis (1911), p. 552; Collett (1902), p. 440; Engler in Engler and Prantl (1893), p. 195; Fyson (1915), p. 356; Hooker (1890), p. 426; Kanjilal (1911), p. 339; Parker (1918), p. 440.

[4] Cooke (1906); Haines (1921), pp. 803-804; Kurz (1877), p. 323; Koorders (1912); Trimen (1895), p. 472.

[5] Parker (1918), p. 440. This author adds, p. 441, that presumably the seeds of *A. minutissimum* are dispersed in the same manner.

[6] Reinaud de Fonvert (1846); see also Stewart (1874), p. 395; Bentham and Hooker (1880), p. 213; Johnson (1888), p. 150, pl. X fig. 8; Engler and Prantl (1893) p. 193; Peirce (1905), p. 99; Brandis (1911), p. 553.

thobium the fruit wall is regularly thrown off as a cap which separates along a basal ring-shaped line of dehiscence. This latter fact is interesting because in *Viscum japonicum*, too, as already stated, the fruit

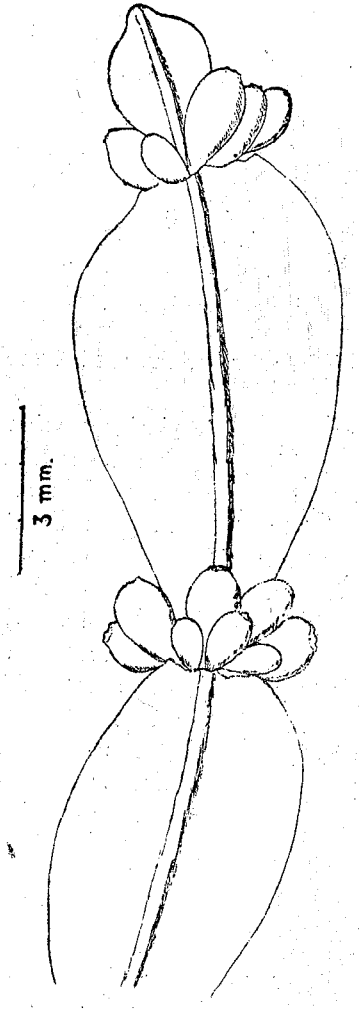

FIG. 1.

Fig. 1. A shoot bearing female flowers and "fruits"; the stem is flat and the internodes jointed, the shoot resembling a miniature *Opuntia*.

wall is sometimes thrown off as an empty sac although here the distal end is always ruptured. It would not be surprising to find a similar explosive mechanism in other Loranthaceae, especially in allied

species of *Viscum*, such as *V. articulatum*. The fact that no such cases have been recorded may be due to the scarcity of observations on the living plants.

It is always an interesting problem how certain species of plants, apparently having no very effective means of dispersal, have attained a wide geographical distribution. *Viscum japonicum* is a case in point. This plant occurs over an extensive area in the temperate Himalayas, and in the Khasia Hills, the Nilgiris,

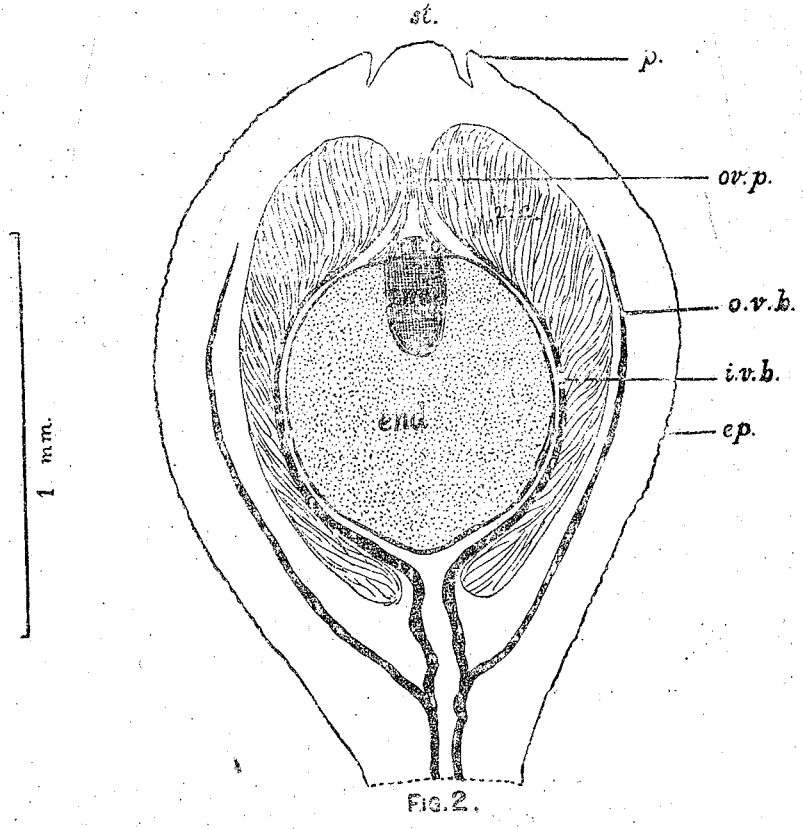

Fig. 2.

Fig. 2. A median longitudinal section of a nearly ripe "fruit". *st.* style, *p.* perianth, *ov. p.* remains of ovarian papilla, *o.v.b.*, *i. v. b.* outer and inner vascular bundles, *ep.* papillose epidermis with thick cuticle, *end.* endosperm (filled with starch), *emb.* embryo with projecting radicle, *v. c.* viscid cells with their proximal ends merging into the inner vascular bundles; the striation of the viscid layer as shown here roughly indicates the lie of the cells.

and the elevated parts of Ceylon. It extends into China, Japan and Australia; it has also been recorded from Mauritius and from the Sandwich Islands. As already stated, the fruit is unattractive and, so

far as I know, is never visited by birds. Apparently the only means of dispersal, therefore, is the explosive mechanism in the fruit possibly aided to some extent by the wind. It can only be by the merest coincidence that a seed thus carried through the air should get caught on the plumage of a bird. The chances of distant dispersal thus seem to depend more upon the small size of the seed than upon its viscid coat.

An equally interesting case is that of *Arceuthobium Oxycedri* which, like *Viscum japonicum*, has an explosive fruit, and a similarly wide distribution: Africa, Europe, North America, Himalaya and the Azores Islands. In discussing the distribution of this plant Guppy [7] expresses the opinion that birds probably actively disseminate the species, carrying the seeds adhering to their plumage. No one has, however, actually observed the seeds of this plant adhering to birds.

A detailed description of the floral and "fruit" structure (including the development) will be undertaken by Dr. P. Maheshwari but the main features of the ripe "fruit", so far as they relate to the explosive mechanism, may be briefly described here. From the section shown in fig. 2 it will be apparent that there is a fundamental resemblance with *Arceuthobium* as described by Johnson and by Peirce. In a median longitudinal section the "fruit" of *V. japonicum* exhibits a deceptive resemblance with a *Cycas* ovule. There is a double set of vascular bundles; the outer set runs in the perianth, while the inner is closely in contact with the inner ends of the viscid cells. These inner bundles are no doubt specially concerned with supplying the water which swells the viscid layer shortly before the ejection of the seed. A section cut from material which had been kept for several months in formalin-alcohol was placed on a slide in water; it was noticed that the expansion of the viscid layer began at the thicker distal end, which became raised in the form of a dome pressing the apex of the fruit upwards. This pressure would gradually be communicated to the more proximal parts of the fruit, and as the lateral and basal parts of the viscid layer also expand, there would be an all-round compression of the seed which would only be relieved by an apical rupture, when the seed would be shot out like a bullet from a gun. In *Arceuthobium* both Johnson and Peirce figure the viscid tissue as a continuous dome-shaped cap to the seed [8]. If the sections figured by these authors are really median, *V. japonicum* differs from *Arceuthobium* in the fact that the viscid layer is perforated at the top. Another point of difference, already noticed above, is the absence, in *Viscum*, of any

[7] Guppy (1917), p. 427.

[8] Johnson, *loc. cit.* pl. X, fig. 9; Peirce, *loc. cit.*, pl. III, fig. 3.

well defined abscission layer. As in *Arceuthobium*, the radicle of the tiny ill-developed embryo projects from the starch-filled endosperm as a hemispherical knob which is capped by the remains of the ovarian papilla in the form of an inverted funnel, simulating the pollen-chamber of a cycadean ovule.

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5th January, 1933.

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