Vivipary in *Biota orientalis* Endl. – Rare phenomenon in a gymnosperm

Biota orientalis Endl. (*Thuja orientalis* L.) is a gymnospermic plant of the family Cupressaceae, order Coniferales. It is an ornamental plant with high medicinal value. Formerly it was known as *Thuja orientalis* L., but on the basis of morphological and embryological characteristics it has been separated from the genus *Thuja* and named as *Biota*. It is tolerant to dry, dusty and polluted conditions. The seeds normally after shedding and overwintering germinate in the soil. We report here a rare phenomenon of viviparous germination in a gymnosperm. This phenomenon in *Biota orientalis* can be utilized for better and ensured propagation of this species.

Biota orientalis Endl. is a gymnospermic monotypic genus of the family Cupressaceae of order Coniferales. It is one of the most commonly cultivated ornamental plants in the gardens because of its graceful habit and shape. Its different parts are of high medicinal use. This plant is used in Chinese herbalism, where it is considered to be one of the 50 fundamental herbs[1]. Both the leaves and the seeds contain an essential oil consisting of borneol, bornyl acetate, thujone, camphor and sesquiterpenes[2]. The leaves are antibacterial, antipyretic, astringent, diuretic, expectorant, refrigerant, stomachic and improve hair growth. They are used internally in the treatment of coughs, colds, haemorrhages, excessive menstruation, bronchitis, asthma, skin infections, mumps, bacterial dysentery, arthritic pain and premature baldness. The leaves can be used fresh or dried. The immature female cones are very effective in the treatment of warts. The seed is an aperient, lenitive and sedative. It is used internally in the treatment of palpitations, insomnia, nervous disorders and constipation in the elderly[3,4]. The plant is tolerant to dry dusty sites as well as atmospheric pollution in cities[5].

Presently, conifers are the most conspicuous group of gymnosperms of which Cupressaceae is the largest and an interesting family, in that half of some twenty two genera are restricted to northern hemisphere including *Biota orientalis* Endl., and half to the southern hemisphere in distribution. The plant is an evergreen tree with profuse branching reaching a maximum height of 15 m. There is considerable variation in shape of the tree under cultivation. The stem divides profusely into vertical main branches near the base. The branches are covered with minute scale-like dark green, opposite and decussate, closely adpressed leaves having a long groove in the middle of their abaxial (lower) surface. The leaves are fused with the stem up to one-third of their length. Plants are monoecious, male cones being produced at the tips of the minute branchlets, consisting of 4–6 pairs of opposite and decussately arranged microsporophylls bearing 3–5 microsporangia on the abaxial side near the base of the sporophyll. The pollen grains are non-winged. The female cones are produced on branches but their position is a

Table 1. Climatic data of Almora for the year 2005

	Range	Total	Average
Rainfall (mm)	11.0–361.3 (November) (July)	1011	–
Temperature (°C)			
Max.	16.09–31.3 (December) (June)	–	23.11
Min.	3.82–20.12 (February) (July)	–	12.93
Relative humidity (%)	59–94 (May) (January)	–	–

Figure 1. *Biota orientalis*. ***a***, ***b***, *In situ* germination. ***c***, Seeds at various stages of germination obtained from the cones. ***d***, Advanced stage of growth of *in situ* germinated seeds grown in soil in a petri dish.

little lower instead of terminal. Each cone consists of 3–4 pairs of decussate ovuliferous scales, bearing one to three erect ovules each on the adaxial (upper) side. For a long time, *Biota* was considered a part of *Thuja* as *T. orientalis*. It was Endlicher[6] who on the basis of morphological development of female gametophyte and embryological characteristics, raised this species to a new genus, *Biota*. This view was supported by several workers[7–10]. Singh and Oberoi[9] have given contrasting characters of *Biota* and *Thuja*. In *Biota* the bark peels off as papery scales, young branches are vertical, leaf has an adaxial groove, ovulate cone scales are strongly recurved at the time of pollination, becoming thick and woody with a prominent curved spine at maturity, seeds are thick without wings and triangular in cross section at maturity whereas in *Thuja* the bark peels off in the form of vertical strips, young branches are horizontal, ovulate cone scales are erect, remain thin and papery without spine, seeds are elliptical in cross section, thin and with two wings. The present study shows that *Biota* differs from *Thuja* in having vivipary also.

Seeds normally after shedding germinate in the soil when favourable conditions are available, or can also germinate after sowing under proper conditions. *Biota orientalis* normally propagates through the seeds. The seeds mature in October and after wintering they are able to germinate. During our investigations in gymnosperms we came across a very rare phenomenon of vivipary in a gymnospermic plant, *Biota orientalis* growing in the botanic garden of Kumaun University, SSJ Campus, Almora situated at an altitude of 1570 m asl. Table 1 shows the climatic data of Almora for the year 2005.

In late October or mid-November it was observed that many seeds had germinated while attached to the scale axils in the female cones. Various stages of viviparous condition were noticed (Figure 1 *a–c*). In many cases the roots had emerged completely and the shoot regions (including cotyledons) were partially out and partially inside the seed-coat and they were green in colour. Some of the germinated seeds appeared dried and more or less shrivelled. When these seeds were put in a petri dish lined with moist blotter and in the soil, they showed further growth (Figure 1 *d*).

Some seeds, which had not germinated in the cones, were also subjected to germination in the laboratory, and they germinated within a week. On perusal of literature on gymnosperms, the present report of *in situ* germination is new. In mangroves (*Rhizophora, Avecinnia*, etc.) it is a known fact that vivipary is an adaptation for propagation and survival of these plants. It may be that *Biota* has also adapted itself for more ensured and better propagation. This phenomenon can be utilized in better propagation of the said plant whereby one can avoid the loss of seedlings and seeds due to various reasons like animal pickings or due to degradation by soil microbes under natural conditions.

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S. S. GAHALAIN*
R. L. FOTEDAR
R. C. GUPTA

Department of Botany,
Kumaun University,
SSJ Campus,
Almora 263601, India
**For correspondence.*

Radiocarbon dating of some palaeochannels in Tamil Nadu and their significance

The fluvial landforms and the related life histories of the riverine systems have always attracted the geoscientists, as these stand as testimonies to the Late Quaternary isostatic, eustatic and climatic events. Hence, the mapping of fluvial landforms and derivation of Late Quaternary geological histories by dating such fluvial features have grown phenomenally all over the world. However, as far as the dating of such Late Quaternary events are concerned, various dating methods, viz. archaeological, epigraphical, historical, thermo-luminescence, radiocarbon, etc. have commonly been used[1–7].

In the Indian subcontinent, a number of studies have been carried out to understand the Late Quaternary geological and