ON SOME ABNORMAL FEMALE RECEPTACLES OF ASTERELLA BLUMEANA NEES.*

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Asterella blumeana is a member of the Marchantiales assigned to the Rebouliaceae (Evans, 1939). The species is monoecious, bearing the male receptacle just behind the stalk of the female receptacle. The latter is terminal and long-stalked and usually bears 2–5 involucres. Normally each of the involucres may subtend a sporogonium, enclosed within a characteristic perinath. A normal specimen of Asterella blumeana is shown in Fig. 1. According to Kashyap (1929) the thallus, in this species, measures 7–10 mm. × 3 mm. and the stalk of the female receptacle is 8–10 mm. long.

The species is quite common in India, occurring abundantly in the Western Himalayas (Stephani, 1900; Kashyap, 1929); Eastern Himalayas (Mitten, 1861; Chopra, 1928); South India (Chopra, 1938); and Madhya Pradesh (Pandé and Srivastava, 1952).

While examining material of this liverwort, collected by us from Agumbe, in October 1950, we came across some anomalous specimens (Figs. 2, 3, 4 and 5 and Plate Figs. 7 and 8). These are described below.

Specimen 1.—The thallus in this specimen (Fig. 2) measures 4·5 mm. × 3 mm. and bears a stalked female receptacle. The stalk measures 8·5 mm. and carries a convex receptacle, measuring 1·5 mm. × 1 mm. The latter subtends three involucres. In normal plants the growing points of the receptacles give rise to archegonia which, after fertilisation, produce sporophytes. In the specimen under consideration, although the receptacle and involucres have been formed, the former has produced no archegonia, but from one of its growing points a vegetative shoot has developed. This shoot measures 1·6 mm. × 1 mm. and consists of a cylindrical basal and an expanded apical part. As in the normal plants the thalloid portion has pores and air-chambers on its dorsal surface while on its undersurface it bears scales and rhizoids. The other two growing points of the receptacle have, apparently, developed no structures. The second lobe of the normal thallus bears a stalk of the carpocephalum, but no receptacle. Obviously the receptacle got accidentally broken. Each of the two lobes of the main thallus bears a ventral shoot (Fig. 2, v.i.).

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Figs. 1–6. Fig. 1. Normal thallus, × 5. Fig. 2. Abnormal specimen 1. Note a vegetation thallus (t1,) that has developed from the receptacle. v.i., ventral innovation, × 5. Fig. 3. Abnormal specimen 2. Note the vegetative shoots (t1–t6,) coming out of the involucres, × 5. Fig. 3 a. Enlarged view of 3. All the six vegetative shoots t1–t6, are seen. One of these is seen from the ventral side. sc., scale. × 12. Fig. 4. Abnormal specimen 3. All the
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growing points of the receptacle have produced vegetative thalli; four of these (r1–r4) can be seen in the figure, × 5. Fig. 5. Abnormal specimen 4. The receptacle shows two vegetative thalli that bear female receptacles. r1–r2; thalli produced from the two growing points of the receptacle; r, primary receptacle; r1, r2, two secondary receptacles, × 5. Fig. 5 a. Enlarged view of 5. r, primary receptacle; r1, r2, secondary receptacles; r1, r2, vegetative thalli, × 10. Fig. 6. L.S. of the receptacle with 1.s. of the vegetative thallus produced from one of the growing points of the receptacle. r, receptacle; t, vegetative thallus; s, stalk, × 12. Fig. 6 a. Enlarged view of 6, × 36.

Specimen 2.—In this specimen the thallus measures 6 mm. × 3·5 mm. The receptacle is borne on a long stalk which measures 16·5 mm. and is, apparently, well developed. The receptacle is convex and measures 2·5 mm. × 1·2 mm. and subtends six involucres (Figs. 3 and 3 a and Plate Figs. 7 and 7 a), all of which are sterile as the receptacle, instead of developing archegonia, has produced vegetative shoots from its growing points (Fig. 3 a, t1–t6). These shoots are of different ages; the youngest one measuring 6·6 mm. × 4·4 mm. and the oldest 5 mm. × 3 mm. Two of them have dichotomised in front and the branching can be clearly seen in one of the shoots (Fig. 3, x). The structure of the shoots is quite normal, showing the usual type of scales and rhizoids on the undersurface, and normal pores and air-chambers on the dorsal.

Specimen 3.—This specimen is similar to the previous one. The female receptacle is carried on a long stalk which measures 24 mm. and bears six involucres each of which subtends a vegetative shoot arising from the growing point of the receptacle (Fig. 4). The shoots are of different ages. Each of the older shoots among these, consists of a short cylindrical basal portion and an expanded apical portion. The structure of the shoots is of the normal type. On the ventral surface, these bear scales and the two types of rhizoids, while on the dorsal side, they show air-chambers and pores as in normal plants. Two of the shoots show distinct dichotomy at the apex.

Specimen 4.—This specimen (Figs. 5, 5 a and Plate Fig. 8) appears to be somewhat more interesting. The thallus measures 6 mm. × 2·5 mm. The female receptacle is stalked, the stalk measuring 16·3 mm. while the receptacle measures 3·5 mm. × 1 mm. It is convex and bears two involucres on the two opposite sides of the receptacle. Both the involucres are sterile. Each growing point of the receptacle, in these involucres, has developed a vegetative shoot. The latter consists of a very short stalk-like basal portion, with which it is attached to the receptacle, and an expanded apical portion. One of the shoots is slightly older than the other. On the dorsal surface of these, abnormally developed thalli, there are pores and air-chambers, while their ventral surface bears rhizoids and scales. Both the vegetative shoots, while yet attached to the carpocephalum, have developed apical female
receptacles (Fig. 5 and Plate Fig. 8) as in the normal plants. The stalk of the older one measures 1.5 mm. and the receptacle itself 1.25 mm. \( \times 1 \) mm. In this receptacle there are indications of four rudimentary involucreus. Behind the stalk of the female receptacle there is a male receptacle but no antheridia have been produced.

The second abnormal shoot is comparatively younger. The stalk of the receptacle, in this case, measures 1 mm. while the receptacle is 1 mm. \( \times 0.9 \) mm. In this receptacle, also, there are indications of the formation of four involucres. The tissue of the receptacle, in both the cases, bears barrel-shaped pores. Like specimen one, this specimen, too, bears two ventral innovations, arising from near the apex. One of the ventral shoots has innovated again.

**CONCLUDING REMARKS**

As stated by Müller (1906–11, pp. 107–108), Lindberg (1875) and later on Klien (1881), noticed adventitious shoots coming out from the inflorescence and rhizoidal furrow of the stalk of *Dumortiera* and *Marchantia* (see Müller, *l.c.*, p. 108, Fig. 84), which under favourable conditions grow out into new plants.

Peissel (1925), as stated by Bergdolt (1926), notes abnormal female receptacles in *Asterella blumeana* in which vegetative shoots develop from the receptacle and its stalk. Bergdolt (*l.c.*) describes and figures (Bergdolt's Fig. 105, p. 61) a vegetative shoot arising from the growing point of one of the involucre of *Sauteria alpina*. Kashyap (1929) observes that in *Marchantia palmata* vegetative shoots develop from the carpocephalum and its peduncle. The cases described by us in *Asterella blumeana* are more or less of the same type. It is unfortunate that the original paper by Peissel was not available for comparison.

Srinivasan (1939) observes that in *Marchantia palmata* proliferations arise from the female receptacles in the form of small narrow lobes which produce antheridia directly. The proliferations noticed by us in *Asterella blumeana* grow out into normal vegetative thalli, which may remain sterile or may produce male and female receptacles (specimen four, Figs. 5 and 5a and Plate Fig. 8) as in normal plants.

In all our specimens, the female receptacles are comparatively long stalked (compare Figs. 1, 2, 3, 4 and 5 and Plate Fig. 7) and, apparently, follow the normal course of development and form involucres all of which, obviously, remain sterile and some even without any further noticeable growth but others produce vegetative shoots from the growing points of the receptacle (Figs. 2, 3, 4 and 5). The number of growing points of the
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receptacles, functioning in this way, varies. In two of the cases all the six growing points of the receptacles, the maximum number observed by us in this species, produce normal thalli while in other cases one, two or three of these may function in this way. The structure of the thalli, so produced, is, in all respects, similar to that of the ordinary thallus (Fig. 5). These shoots originate from the growing points of the receptacles and are organically connected with them (Figs. 6 and 6a and Plate Figs. 9 and 9a). It is thus obvious that the growing points of the receptacles, which ordinarily produce archegonia, have developed vegetative thalli. In all the specimens, examined by us, the shoots are borne on the apparently ventral side of the receptacle but, as we know from the history of the development of the receptacle and sex organs in Asterella and the allied genera, these originate on the dorsal surface. Their ventral position is due to subsequent downward shifting. For want of material a detailed developmental study of the vegetative shoots could not be followed. Each shoot consists of an expanded apical and a thick cylindrical basal part. In the specimens where several thalli are produced these are of different ages (Figs. 3 and 3a). The shoots, if detached would, undoubtedly, continue to grow and develop into independent plants.

The culminating stage of modification is shown by specimen 4 in which the thalli, produced from the receptacle, while yet attached to it have developed female receptacles, apparently, of the normal type except that these bear no archegonia.

The sterile shoots developed in the specimens, described here, show normal structure. A careful examination of microtome sections (Fig. 6) of one such specimen, showed no infection either by a fungus or any other pathogen. Apparently this is not a pathological phenomenon.

In liverworts, as a rule, vegetative reproduction plays an important part and, in many species, its role is even more important than that of the sexual process and, not unoften, this tendency has resulted in the total suppression of the sexual organs and their replacement by sterile structures. Apparently the conditions, under which liverworts grow, are often more favourable for the vegetative growth, and this possibly may have been the cause of degeneration and even elimination of the sexual organs and their replacement by the sterile shoots. The abnormal specimens of Asterella blumeana, described here, would support such an assumption. The shoots thus produced serve as organs of vegetative propagation but under xerophytic or otherwise unfavourable conditions, these would, undoubtedly, become condensed and tuberous and function as perennating organs.
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EXPLANATION OF PLATE

Fig. 7. Abnormal specimen 2. Photographed from the ventral side. Note the vegetative thalli coming out from the receptacle, × 5.
Fig. 7 a. Enlarged photograph to show the vegetative shoot. Note the air pores on the thallus, × 14.
Fig. 8. Abnormal specimen 4. Photograph shows the vegetative thalli that have developed from the receptacle. Each vegetative shoot has developed a female receptacle, × 12.
Fig. 9. Microphotograph of the L.S. of receptacle bearing vegetative thallus. th, thallus; r, receptacle, × 24.
Fig. 9 a. Same as above. th, thallus; r, receptacle, × 72.

* Original publication was not seen.