

On the asexual reproduction of *Plagiochila pluma* Steph.

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Abstract. Four types of asexual reproduction in *Plagiochila* and the Plagiochilaceae are known: propagules, caducous leaves, gemmae and cladia. *Plagiochila pluma* Steph. has caducous leaves and teeth with regenerants. The terms for asexual reproduction modes in liverworts are briefly discussed and new definitions proposed.

Gemmae were reported by Piippo (1989) in apical and distal margins of a Western Melanesian endemic, *Plagiochila pluma* Steph. of Sect. Kaalaasiae Carl. Asexual reproduction was not known earlier in this section (cf. Inoue 1984). The material, collected by Prof. Daniel H. Norris in the Solomon Islands in 1977 includes one specimen of *P. pluma*. In this specimen "far developed gemmae" can be seen on every leaf margin (Fig. 1). It is the only specimen of *P. pluma* with caducous leaves.

The leaves of *Plagiochila pluma* are not totally caducous but irregularly fragile to one third to one half or, rarely, to two-thirds of the leaf length. Apical parts of the leaves, sometimes the whole leaf, may be malformed and variable. The marginal cells seem to have a very high potential to regenerate and develop into short to fairly long gemmaling-like structures with one-lobed uniseriate "primary leaves" (cf. Fulford 1955a, 1955b, 1956, Nechira 1968, 1983, 1987). This capacity is not restricted to apical leaf margins. I have not, however, noticed rhizoids in gemmalings, as reported by the other authors above. When further developed, these gemmaling-like structures produce small 2-lobed leaves (Fig. 1g). Many of the larger structures have become

detached from the leaf margins. According to Degenkolbe (1938), in general the regenerating cells are usually marginal, and they first develop a protonema typical of gemmalings. Typically, gemmalings are similar to sporelings. In gemmaling formation the gemma first swells, then a wall divides the original cell into two (Fulford 1955c). Through cell division and growth, a filamentous protonema is formed.

Plagiochila pluma apparently reproduces also by caducous teeth (cilia), because many broken teeth of different length are visible. Some of these cilia are 2-seriate or wider at their apices, which is peculiar for cilia. Some "propagules" are produced also at the base of cilia. The high regeneration potential seems to involve all marginal cells and the cilia.

Inoue (1984, 1987, 1988a, 1988b) discussed the means of asexual reproduction in *Plagiochila* and the Plagiochilaceae. Four types are known. The two common modes of asexual reproduction in *Plagiochila* are by propagules developed on living leaves firmly attached to the stem, and by caducous leaves or leaf parts which after detaching may produce regenerants. More rarely, the marginal teeth may be fragile, as in *P. eppersii* Inoue (Inoue 1988a). The propagules

(Brutsprösschen, leaf cladia) are produced mainly from a single leaf cell on postical leaf surfaces (Carl 1933, Degenkolbe 1938, Schuster 1959, 1984), and these can be considered as highly modified regenerants (Schuster 1984). Most commonly the propagules occur in the apical leaf parts; The marginal cells lack the ability to produce propagules. The propagules usually originate from cells divided into two daughter cells. After further divisions the daughter cells develop into a structure with rudimentary leaves which suddenly develop into normal leaves. Sometimes propagules are only a few, but occasionally they occur in bundles.

In many sections of *Plagiochila* asexual reproduction is lacking, but in others it is typically either by caducous leaves or by propagules. In Asia caducous leaves are typical for Sect. Subtropicae Carl in, e.g., *Plagiochila parvifolia* Lindbg. and *P. tjibodensis* Schiffn. Propagules are common in Sect. Contiquae Carl, in *Plagiochila celebica* Schiffn. ex Inoue, *P. teysmannii* Sande Lac., and in *P. javanica* (Swartz) Dum. In the Palaeotropics no species are known with modes of asexual reproduction other than caducous leaves or propagules.

Recently two other modes of asexual reproduction were reported in the genus *Plagiochila*. Two species with gemmae, *P. moniliformis* Schust. (sect. Bidentes Carl) and *P. subfragilis* Inoue (sect. Zonatae Carl), were reported from Venezuela (Schuster 1978, Inoue 1988b). In *P. subfragilis* the teeth of leaf margins may be fragile, and their apices may produce 2-5-celled gemmae. The genus *Xenochila* of the Plagiophilaceae has multicellular gemmae which often have rhizoids at leaf margins (Inoue 1974).

In 1987 Inoue described a new genus of the Plagiophilaceae, *Steeerochila*, with gemmiferous branch apices. These "propagules" are thread-like, one-layered and 1-4-seriate, and are formed from malformed leaves; or 3-4-layered with 1-2-celled protuberances, and are formed from malformed branches. Both these branches and leaves are caducous. The former are not true propagules but cladia (i.e. caducous branches). According to Inoue (1987), morphologically these leaves and branches are similar to propagules. Because of lack of uniform terminology and difficulties in determining *Plagiochila pluma*

whether the asexual reproductive method in question concerns gemmae developing into gemmalings, or regenerating cells, I propose the following terminology for hepatics:

1. Propagules: plantlets developing from the laminal cells of non-caducous leaves.

2. Cladia: caducous branches.

3. Gemmae: various kinds of bodies (such as single- or multicellular, filamentous, globose, cylindrical, differentiated or undifferentiated from the other cells) occurring mainly at margins of non-caducous leaves, or at shoot apices or leaf axils.

4. Regenerants: protonema and plantlets developing on caducous or fragile leaves.

Distinguishing gemmae and regenerants still remains problematic in some cases, especially when the caducosity of leaves is not obvious.

Material studied (in addition to those listed by Piippo 1989): Solomon Islands. San Cristobal, Manighai, 1977 Norris & Roberts 48957 (H).

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Literature cited

- Carl, H. 1933:** Über die blattbürtigen Brutsprösschen bei *Plagiochila*. - Ann. Bryol. 6: 15-19.
- Degenkolbe, W. 1938:** Brutorgane bei beblätterten Lebermoosen. - Ann. Bryol. 10: 43-96.
- Fulford, M. 1955a:** The patterns of development of sporelings, gemmalings, and regenerants in *Nowellia curvifolia* (Dicks.) Mitt. - Rev. Bryol. Lichénol. 24: 41-48.
- Fulford, M. 1955b:** Sporelings, gemmalings and regenerants in *Isopaches bicrenatus* (Schmid.) Buch. - Bryologist 58: 317-322.
- Fulford, M. 1955c:** Sporelings, gemmalings and regeneration in *Blepharostoma trichophyllum* (L.) Dum. - Mitteil. ThÜring. Bot. Gesellsch. 1: 245-258.
- Fulford, M. 1956:** The young stages of the leafy Hepaticae: a résumé. - Phytomorphology 6: 199-235.
- Inoue, H. 1974:** Illustrations of Japanese Hepaticae. I. - i-viii, 189 pp. Tokyo.

- Inoue, H. 1984:** The genus *Plagiochila* (Dum.) Dum. in Southeast Asia. - 142 pp, 76 pls. Tokyo.
- Inoue, H. 1987:** *Steereochila*, a new genus of the Plagiochilaceae from the Neotropics. - Mem. New York Bot. Gard. 45: 279-282.
- Inoue, H. 1988a:** Notes on the Plagiochilaceae, XV. The genus *Steereochila* Inoue and *Plagiochila egersii*, sp. nov. - Bull. Natn. Sci. Mus. Ser. B (Bot.) 14: 135-141.
- Inoue, H. 1988b:** Concepts of sectional and subgeneric levels in the genus *Plagiochila* (Hepaticae). - J. Hattori Bot. Lab. 64: 67- 70.
- Nehira, K. 1968:** The germination of gemmae in *Calypogeia tosana* and *Cephalozia otaruensis*. - Bull. Biol. Soc. Hiroshima Univ. 34: 1-2.
- Nehira, K. 1983:** Spore germination, protonema development and sporeling development. - In: Schuster, R. M. (ed.), New manual of bryology. 1: 343-385.
- Nehira, K. 1987:** Germination of gemmae in some mosses collected from North America. - Pap. Plant Ecol. Taxon. Mem. Dr. Satoshi Nakanishi. Kobe Geobot. Soc. Sept. 1987: 355-360.
- Piippo, S. 1989:** Bryophyte flora of the Huon Peninsula, Papua New Guinea. XXX. Plagiochilaceae (Hepaticae). - Ann. Bot. Fennici 26: 183-236.
- Schuster, R. M. 1959:** A monograph of the nearctic Plagiochilaceae. I. - Amer. Midl. Nat. 62: 1-166.
- Schuster, R. M. 1978:** Studies on Venezuelan Hepaticae. I. - Phytologia 39: 239-251.
- Schuster, R. M. 1984:** Comparative anatomy and morphology of the Hepaticae. - In: Schuster, R. M. (ed.), New manual of bryology. 2: 760-891.