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Vegetative Propagation in *Dictyopteris undulata* and *Stypopodium zonale* (Dictyotaceae, Phaeophyta)[1]

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Results of the present writer's observations on vegetative propagation occurred in *Dictyopteris undulata* Holmes and *Stypopodium zonale* (Lamouroux) Papenfuss (Dictyotaceae, Phaeophyta) in nature are presented in this report.

Vegetative propagation in *Dictyopteris undulata* occurred solely from the midrib of the blade. Gemmae were conical to subcylindrical or compressed and underwent apical growth at early stage of development. Thereafter they became broader and flattened by replacing an apical cell to the marginal meristem, and gemmae developed into the typical foliose blade with a midrib.

In *Stypopodium zonale* vegetative propagation occurred solely from the primary rhizoids. Gemmae were cylindrical to subcylindrical or compressed and underwent apical growth at early stage of the development. Thereafter gemmae became broader and flattened by replacing an apical cell to the marginal meristem. Then they developed into typical fan-shaped blades.

Key Index Words: Dictyopteris undulata, *Dictyotaceae*, *Phaeophyta*, Stypopodium zonale, *vegetative propagation*.

Introduction

Vegetative propagation has not been reported for *Dictyopteris undulata* and *Stypopodium zonale* since they were described. These two species are common in the Oki Islands, and this time the present writer could detect the vegetative propagation of them occurred in nature.

Materials and Methods

Many material specimens of *Dictyopteris undulata* were collected from the Oki Islands for this study: at 1 m depth, at Sasuka, on August 12, October 22, 1993; at 1 m depth, at Sasuka, Takeishi, Tsutsuka Bay, on April 22, at 15-20 m depth, off Tsudo, on June 14, 17, at 1 m depth, at Sasuka, on July 21, 1994. Abundant material specimens of *Stypopodium zonale* were collected also from the Oki Islands for this study: at 1 m depth, at Uzunohana, on September 1, 1994.

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All of the material plants were examined just after each collection. Sections were made by hand for the morphological examination.

Observations

***Dictyopteris undulata* Holmes** 1895: 251, pl. 8, fig. 1.

Vegetative propagation in this species occurred in July in the Oki Islands prior to decomposition of the old thallus.

Vegetative propagation occurred solely from the midrib of the old blade. The initial cell of gemmae was dome-shaped and *ca.* 65 μm in diameter (Fig. 1). The gemma was conical to subcylindrical and underwent apical growth at early stage of development (Fig. 2). Thereafter gemmae gradually became broader and compressed. Gemmae then became spatulate (Fig. 3) by replacing the apical cell to the marginal meristem occupying almost semicircular distal edge (Fig. 4). Gemmae of the spatulate stage were still monostromatic (Fig. 6), then they developed into several-cell-layered typical foliose blade with a midrib (Figs. 7, 8). The developing gemmae produced many trichoblasts in tufts on the surface and the secondary rhizoids proximally (Fig. 5).

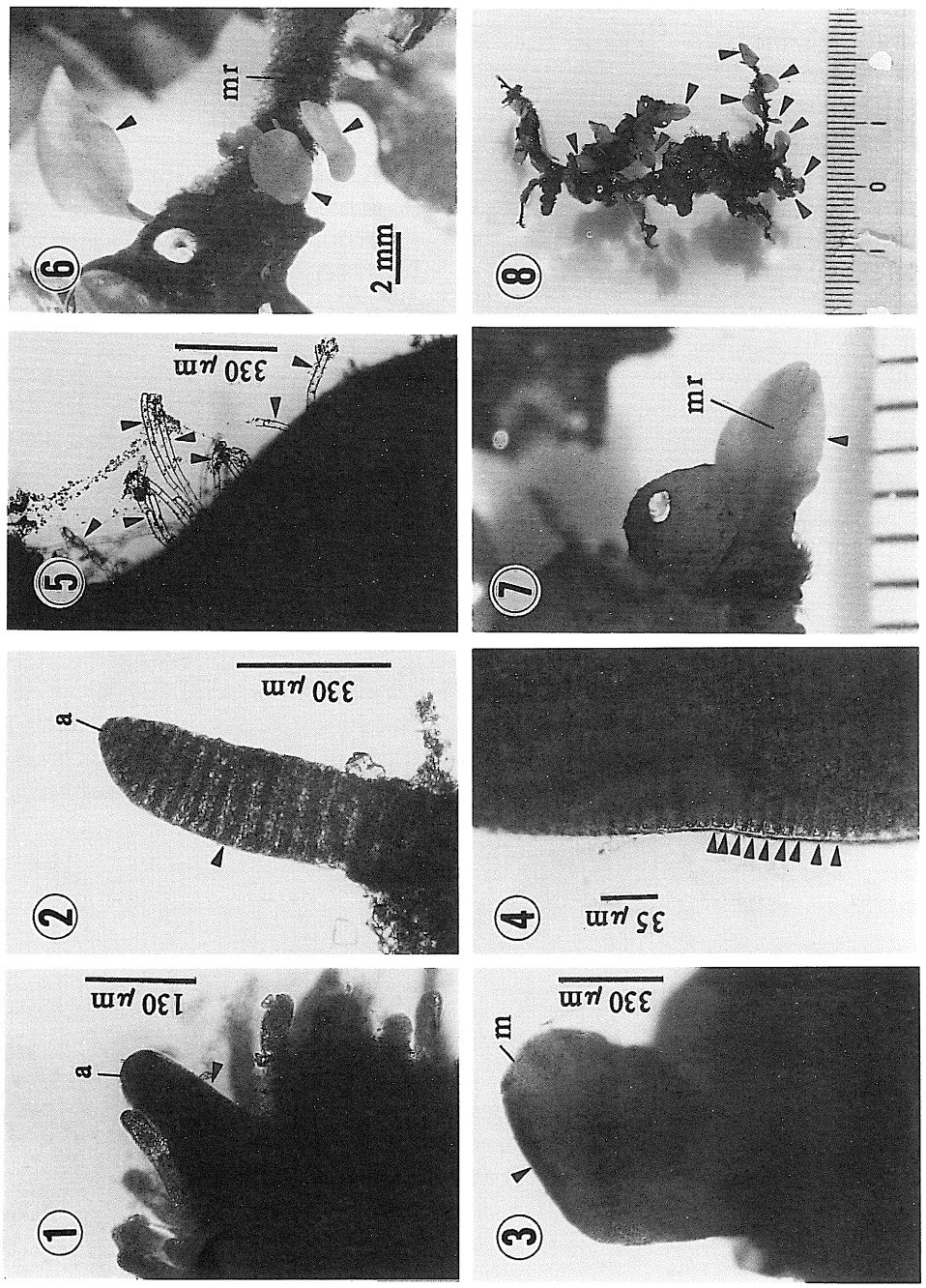
***Stypopodium zonale* (Lamouroux) Papenfuss** 1940: 205.

Vegetative propagation occurred solely from the primary rhizoids. Gemmae were formed terminally or laterally on the primary rhizoid (Figs. 9, 10, 12). The initial cell of gemmae was dome-shaped to subspherical and *ca.* 65 μm in diameter (Fig. 9). The gemma was cylindrical to subspherical and underwent apical growth at early stage of development (Figs. 10, 11, 12). Then gemmae gradually became compressed and produced the secondary rhizoids proximally. Thereafter gemmae became flattened and broader by replacing the apical cell to the marginal meristem occupying almost all of the semicircular distal edge (Fig. 13). The meristematic cells elongated perpendicularly to the distal margin of the gemma and divided repeatedly periclinally and anticlinally, consequently the gemma rapidly increased in total size as well as its cell number. The spatulate monostromatic gemma developed into typical fan-shaped blade (Fig. 14) and all part of the margin of the blade became fringed with meristem (Fig. 15) even when the blade is still monostromatic (Fig. 16).

Vegetative propagation in this species occurred in September in the Oki Islands prior to decomposition of the old thallus.

Discussion

Dictyopteris undulata is related to those four species of Dictyotaceae in the occurrence of vegetative propagation solely from the blade, such as *Dictyota dichotoma* (Hudson) Lamouroux, *Dictyota linearis* (C. Agardh) Greville, *Dilophus okamurae*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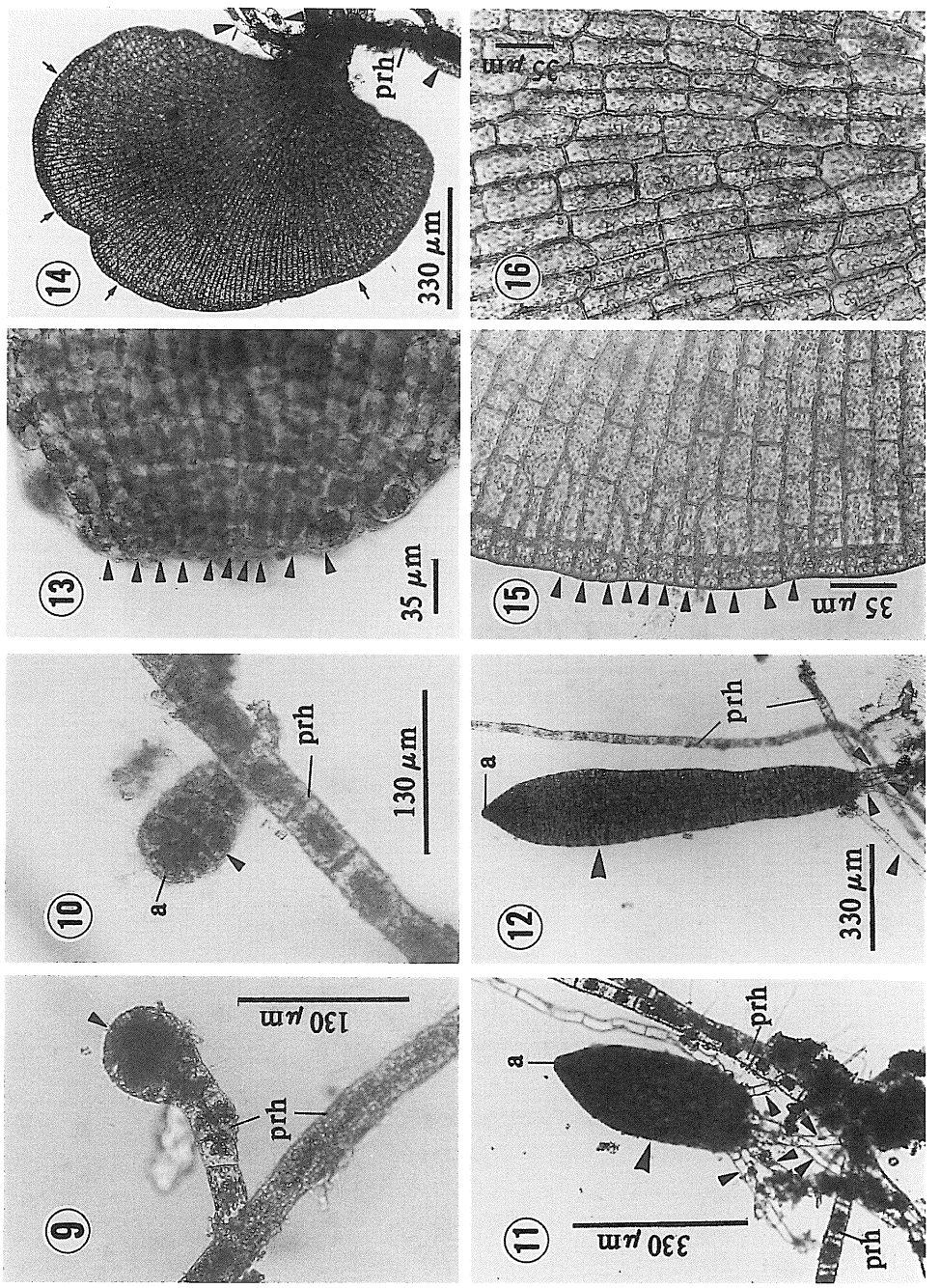
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Dawson and *Pachydictyon coriaceum* (Holmes) Okamura (Table I). *Dictyopteris undulata*, however, is distinct from those five species whose vegetative propagation occurs solely from the rhizoid, such as *Dictyopteris divaricata* (Okamura) Okamura, *Dictyopteris prolifera* (Okamura) Okamura, *Padina crassa* Yamada, *Zonaria flabellata* (Okamura) Papenfuss and *Stypopodium zonale* (Table I). *Dictyopteris undulata* is also distinct not only from *Padina pavonica* (Linnaeus) Thivy and *Padina japonica* Yamada whose vegetative propagation occurs solely from the rhizome, but also from *Distromium decumbens* (Okamura) Levring and *Zonaria diesingiana* J. Agardh whose vegetative propagation occurs from both of the blade and the rhizoid (Table I). *Dictyopteris undulata* is specifically distinct from *Spatoglossum pacificum* Yendo whose vegetative propagation occurs solely from the sporeling (Table I).

Stypopodium zonale is related to those four species in the occurrence of vegetative propagation solely from the rhizoid, such as *Dictyopteris divaricata*, *Dictyopteris*

Figs. 1–4. *Dictyopteris undulata* Holmes.

Fig. 1. A conical juvenile gemma (arrowhead) with an apical cell (a) and arising from a midrib of the old thallus.

Fig. 2. A compressed young gemma (arrowhead) with an apical cell (a).

Fig. 3. A spatulate developing gemma (arrowhead) with terminal meristem (m).

Fig. 4. Distal margin of the gemma in Fig. 3 showing several meristematic cells (arrowheads).

Figs. 5–8. *Dictyopteris undulata* Holmes.

Fig. 5. Part of a developing gemma showing some trichoblasts (arrowheads) arising from its surface.

Fig. 6. Part of an old thallus showing three developing gemmae (arrowheads) arising from the midrib (mr).

Fig. 7. A developing gemma (arrowhead) with an evident midrib (mr).

Fig. 8. Some developing gemmae (arrowheads) arising from the midrib of the old thallus.

Figs. 9–12. *Stypopodium zonale* (Lamouroux) Papenfuss.

Fig. 9. An initial cell of gemma (arrowhead) arising terminally from a primary rhizoid (prh).

Fig. 10. A cylindrical juvenile gemma (arrowhead) with an apical cell (a) and arising laterally from the primary rhizoid (prh).

Fig. 11. A compressed young gemma (large arrowhead) with an apical cell (a) and several secondary rhizoids (small arrowheads).

Fig. 12. A compressed further developed young gemma (large arrowhead) with an apical cell (a) and several secondary rhizoids (small arrowheads), and arising laterally from the primary rhizoid (prh).

Figs. 13–16. *Stypopodium zonale* (Lamouroux) Papenfuss.

Fig. 13. Distal part of a flattened developing gemma showing some meristematic cells (arrowheads).

Fig. 14. A developing typical fan-shaped still monostromatic gemma with extending marginal meristem (arrows) and several secondary rhizoids (arrowheads).

Fig. 15. Part of margin of the gemma in Fig. 14, showing some meristematic cells (arrowheads).

Fig. 16. Middle part of the gemma in Fig. 14, showing cell arrangement in surface view.

Table I. Comparison of dictyotaceous species on the position of vegetative propagation.

Species	Position	Reference
Dictyopteris undulata Holmes	On blades	Present study
Stypopodium zonale (Lamouroux) Papenfuss	On rhizoids	Present study
Spatoglossum pacificum Yendo	On blades and rhizoids of sporelings	Kumagae, 1972; Kajimura, 1995
Padina japonica Yamada	On rhizomes	Kajimura, 1994
Dictyopteris prolifera (Okamura) Okamura	On rhizoids	Kajimura, 1994
Dictyota linearis (C. Agardh) Greville	On blades	Kajimura, 1994
Padina crassa Yamada	On rhizoids	Kajimura, 1993
Dilophus okamurae Dawson	On blades	Kajimura, 1992
Zonaria flabellata (Okamura) Papenfuss	On rhizoids	Kajimura, 1992
Distromium decumbens (Okamura) Levring	On blades and rhizoids	Kajimura, 1986
Pachydictyon coriaceum (Holmes) Okamura	On blades	Kumagae, 1977
Zonaria diesingiana J. Agardh	On blades and rhizoids	Kumagae, 1977
Dictyopteris divaricata (Okamura) Okamura	Oh rhizoids	Tokida, *et al.*, 1953
Dictyota dichotoma (Hudson) Lamouroux	On blades	Hoyt, 1907
Padina pavonica (Linnaeus) Thivy	On rhizomes	Reinke, 1878

prolifera, *Padina crassa* and *Zonaria flabellata* (Table I). *Stypopodium zonale*, however, is distinct from those five species whose vegetative propagation occurs solely from the blade, such as *Dictyota dichotoma*, *Dictyota linearis*, *Dictyopteris undulata*, *Dilophus okamurae* and *Pachydictyon coriaceum* (Table I). *Stypopodium zonale* is also distinct not only from *Padina pavonica* and *Padina japonica* whose vegetative propagation occurs solely from the rhizome, but also from *Distromium decumbens* and *Zonaria diesingiana* whose vegetative propagation occurs from both of the blade and the rhizoid (Table I). *Stypopodium zonale* is specifically distinct from *Spatoglossum pacificum* whose vegetative propagation occurs solely from the sporeling (Table I).

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