

Heterojanczewskia stat. nov. with an emendation of generic delineation of *Janczewskia* (Rhodomelaceae, Rhodophyta)

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Abstract: The vegetative and reproductive morphology of some parasitic *Janczewskia* Solms-Laubach species including the type species was examined based on specimens collected from various localities around the world. In *J. gardneri* Setchell et Guernsey on *Osmundea spectabilis* (Postels et Ruprecht) Nam from California, secondary pit connections are not found between epidermal cells and vegetative axial cells have two pericentral cells. As its host, *J. gardneri* also has a typical filament type male structure in an apical urn-shaped pit of branches rather than the trichoblast type in other species including the type *J. verruciformis* Solms-Laubach and tetrasporangial origin of epidermal cells rather than pericentral cells. These significant differences between the species suggest that *J. gardneri* should be separated from the genus *Janczewskia*. Based on this morphological data, the section *Heterojanczewskia* Setchell including *J. gardneri*, together with an emendation of the generic delineation of *Janczewskia*, is elevated to the genus level. Relevant nomenclatural changes for some *Janczewskia* species are also included here.

Keywords: morphology, *Heterojanczewskia* stat. nov., emendation, generic delineation, *Janczewskia*

INTRODUCTION

Janczewskia Solms-Laubach, which is a parasitic red algal genus, is host-specific on members of Rhodomelaceae, particularly *Laurencia* complex Lamouroux and *Chondria* C. Agardh, at least in the field (Setchell 1914; Nonomura and West 1981; Apt 1987; Fujii and Guimarães 1999). This genus was established based on *J. verruciformis* Solms-Laubach from Naples, Italy (Solms-Laubach 1877). Since then, *Janczewskia* has been reported from the various localities around the world (Falkenberg 1901; Setchell 1914; Tokida 1947; Martin and Pocock 1953; Feldmann and Feldmann 1958; Saito 1971; Abbott and Hollenberg 1976; Chang and Xia 1978; Apt 1987). At present, eleven species are accepted in the genus (Guiry and Guiry 2022).

As in *Laurencia* complex, apical growing cell in *Janczewskia* is situated at the base of a pit in branches (Fujii and Guimarães 1999). The vegetative and reproductive structure is also basically similar to its host. This genus is characterized by wart-like thallus with coalescent branches to form a solid tissue. However, in some species, branches from the wart are projected more or less or are conspicuously free (Apt 1987; Fujii and Guimarães 1999). This kind of branch is not found in others (Setchell 1914; Apt 1987). In the species, the branches rarely project beyond the surface of the basal tubercle (Setchell 1914; Apt 1987).

Currently, *Janczewskia* is divided into three sections based on branch development (Setchell 1914; Chang and Xia 1978). The type section *Janczewskia* (*Eujanczewskia*) involves species essentially lacking free branches from a

Table 1. Details of the voucher specimens examined in this study

Species	Specimen No.	Collection data			Host
		Location	Collector	Date	
<i>Heterojanczewskia gardneri</i>	PKNU J2	Duxbury Reef, Marine Co., California	Maggs & West	22.vii.1964?	<i>Osmundea spectabilis</i>
	PKNU J3	Middle Reef, Moss Beach, California	Abbott	22.v.1966	
	PKNU J4	Middle Reef, Moss Beach, California	Saito	23.i.1967	
<i>Janczewskia verruciformis</i>	PKNU J1	San Marco di Castellabate, Italy	Tripodi	?	<i>Laurencia</i> sp.
<i>Janczewskia tasmanica</i>	PKNU J10	Kangaroo Island, Australia	Kraft	? .vii.1971	<i>Laurencia elata</i>
<i>Janczewskia morimotoi</i>	PKNU J20–24	Minami Kaybe, Japan	Nam	19.xi.1986	<i>Laurencia nipponica</i>

basal nodule, including the type species *J. verruciformis*, *J. solmsii* Setchell et Guernsey and *J. meridionalis* Martin et Pocock (Setchell 1914; Apt 1987). By the contrast, *Heterojanczewskia* Setchell involves species with simple free branches projecting from a nodule-like base, such as *J. gardneri* Setchell et Guernsey, *J. moriformis* Setchell and *J. lappacea* Setchell, *J. tasmanica* Falkenberg, *J. hawaiiiana* Apt, and *J. morimotoi* Tokida (Setchell 1914; Apt 1987). In the third section *Stipitijanczewskia* Chang et Xia, the species with radiating compound free branches without a distinct basal nodule, *J. ramiformis* Chang et Xia and *J. tokidae* Saito, are included (Chang and Xia 1978; Apt 1987).

However, this taxonomic scheme for the adelphoparasitic genus should be reconsidered, because the distinguishing features of branch development are variable (Nonomura and West 1981, the present study), and its host plants, such as *Laurencia* and *Osmundea* Stackhouse, show significant differences between them in fundamental vegetative and reproductive structures (Nam *et al.* 1994).

In this study, the vegetative and reproductive morphology of some *Janczewskia* species including the type species are examined based on specimens collected from various localities, and *Heterojanczewskia* stat. nov., together with an emendation of the generic delineation of *Janczewskia*, is proposed based on the features. Relevant nomenclatural changes for some *Janczewskia* species from California are also included.

MATERIALS AND METHODS

Data for this study were obtained from liquid-preserved

and herbarium specimens of *Janczewskia* collected near Naples (type locality), the Mediterranean Sea (Italy) and Pacific (Korea, Japan, California and Australia). Liquid-preserved material was stored in a 10% solution of formalin/seawater. For anatomical observations the material was cleared in 5–10% NaOH in distilled water for 2–7 days, then rinsed in distilled water. Branchlets dissected from the cleared material were longitudinally hand sectioned along the central axis, transferred to a slide with a drop of distilled water, and mounted in pure glycerin. For permanent slides, the glycerin was exchanged with 50% Karo[®] corn syrup. Transverse section of branches 50–200 μm or thicker, depending on the degree of clearing, were also used to observe the development of vegetative, female and tetrasporangial structures. Axial development was studied in sections mounted in reverse on the slide. This was effective for the examination of pericentral cells in an axial segment. Measurements were given as length x diameter. Voucher specimens (Table 1) have been deposited in Herbarium of Department of Marine Biology, Pukyong National University, Korea.

RESULTS AND DISCUSSION

In *Janczewskia gardneri*, thallus is globular wart-like, 3.5–4.5 mm in diameter, and parasitic on *Osmundea spectabilis* (Postels et Ruprecht) Nam from California (Fig. 1A and B). Coalesced branches arise conspicuously from a solid tissue (Fig. 1A) or are projected more or less as short protuberances (Fig. 1B).

Apical growing cell is located in the apical pit of branch-

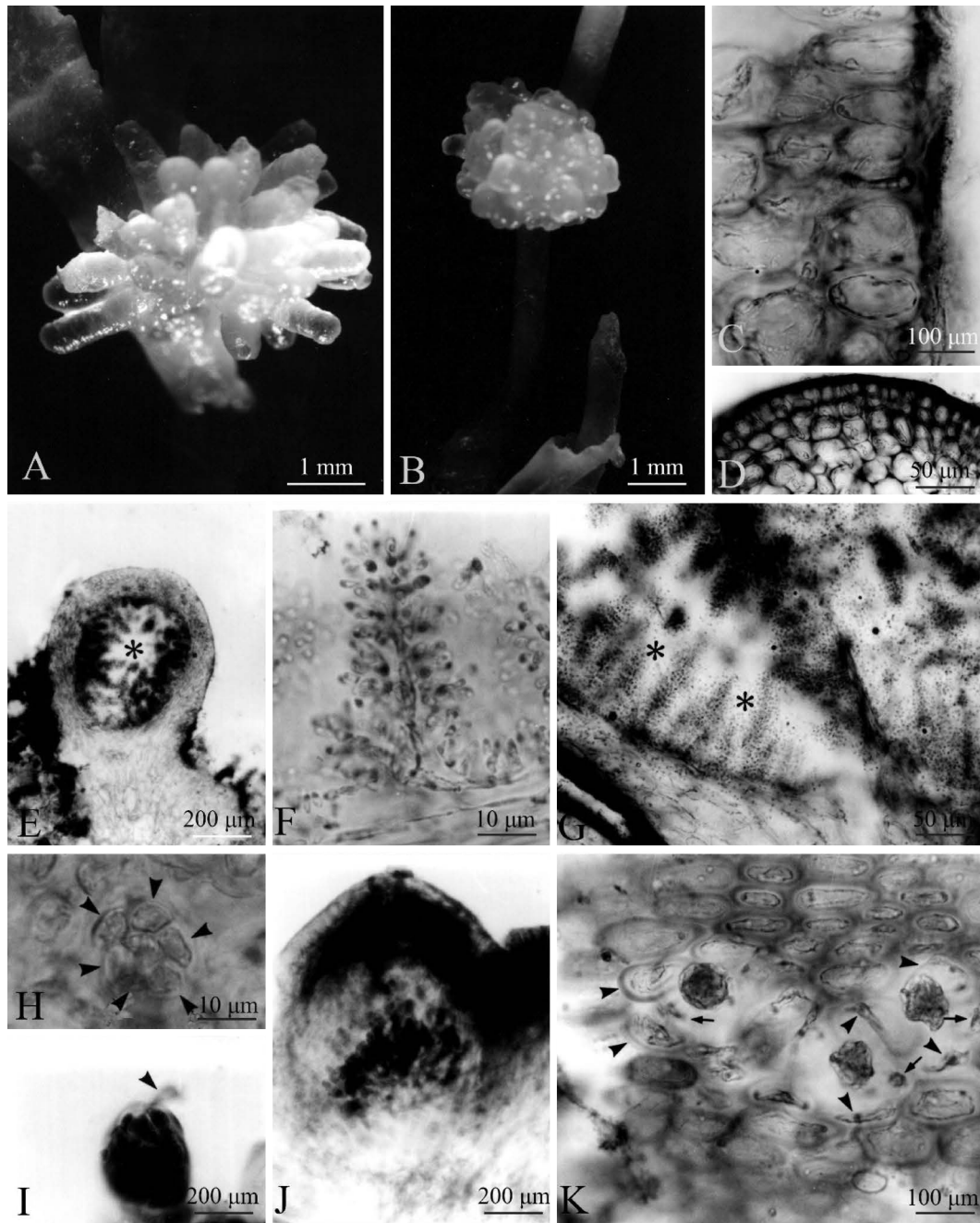


Fig. 1. *Heterojanczewskia gardneri* comb. nov. A, B. Thallus with coalesced branches conspicuously formed (A) or short protuberance (B). C, D. Longitudinal (C) and cross sections (D) of branches. E. Apical urn-shaped spermatangial pit (asterisk) in branches. F. Spermatangial filaments with numerous spermatangia. G. Spermatangial filaments (asterisks) derived from epidermal cells in apical pit. H. Procarpic axis with five pericentral cells (arrowheads). I. Procarp with a trichogyne (arrowhead). J. Cystocarp. K. Tetrasporangia on stalk cell (arrow) with two presporangial cover cells (arrowheads) showing parallel arrangement to stichidial axis.

lets, and successively cuts off axial cells. Each axial cell produces two pericentral cells giving rise to determinate growing filaments. Epidermal cells lack secondary pit connec-

tions between them, and show a non palisade-like arrangement in the transverse section of branches (Fig. 1C and D). Their size in ultimate branchlets is $10\text{--}23 \times 18\text{--}33 \mu\text{m}$.

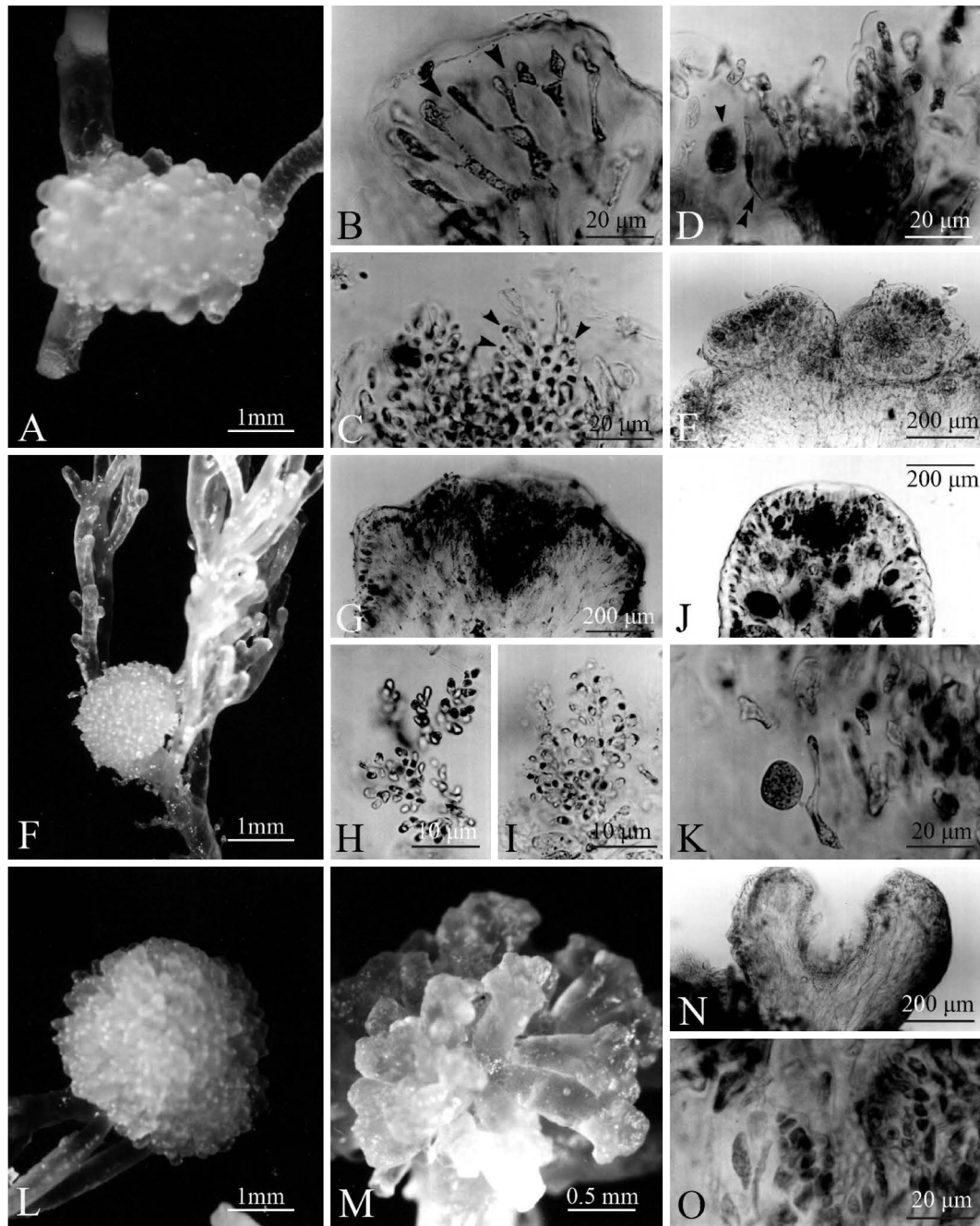


Fig. 2. *Janczewskia* species. A–E. *J. verruciformis*. A. Wart-like thallus. B. Epidermal cells with secondary pit connections (arrowheads) in longitudinal section of branch. C. Trichoblast with spermatangia (arrowheads). D. Tetrasporangium (arrowhead) abaxially formed from pericentral cell (double arrowhead). E. Short stichidia. F–K. *J. tasmanica*. F. Habit. G. Apical cup-shaped spermatangial pit of branch. H, I. Spermatangia. J. Tetrasporangia with parallel arrangement to stichidial axis. K. Tetrasporangium of abaxial formation from pericentral cell. L–O. *J. morimotoi*. L. Wart-like Habit. M. Thallus with conspicuous coalesced branches. N. Apical cup-shaped spermatangial pit of branch. O. Abaxial formation of tetrasporangial initial.

Lenticular thickenings are present in the medullary cells of male plants, but rarely observed in other sexual plants.

The urn-shaped apex of male branches is 690–890 × 790–980 µm, with numerous spermatangial filaments

derived from epidermal cells (Fig. 1E). Spermatangial filaments are terminated in a vesicular sterile cell with a relatively small size of $8 \times 10 \mu\text{m}$ (Fig. 1F). Spermatangia are produced from the filaments (filament type), $8\text{--}10 \times 4\text{--}5 \mu\text{m}$, with a single apical nucleus (Fig. 1F and G).

In female plants, the apical pit of branchlets contains young procarp derived from trichoblasts. The central cell of young procarp with a trichogyne has five pericentral cells (Fig. 1H and I). Cystocarps are ovoid, $440\text{--}490 \times 540\text{--}690 \mu\text{m}$, without protuberant ostiole (Fig. 1J). Mature carpospores are clavate, $20\text{--}25 \times 70\text{--}75 \mu\text{m}$.

Stichidial branchlets are cylindrical, $640\text{--}740 \mu\text{m}$ in diameter. Tetrasporangia are produced from random epidermal cells, with two presporangial cover cells arranged parallel to stichidial axis and one postsporangial cover cell, and tetrahedrally divided (Fig. 1K). They show a parallel arrangement to stichidial axis, and are $86\text{--}100 \mu\text{m}$ in diameter.

In other examined species of *Janczewskia* including the type species *J. verruciformis*, *J. morimotoi* and *J. tasmanica*, thalli are wart-like with short protuberance or conspicuous free branches (Fig. 2A, F, L and M), and epidermal cells are secondary pit-connected (Fig. 2B) and the vegetative axis has four pericentral cells. Spermatangia are produced from trichoblast in the apical cup-shaped pit of branches (Fig. 2C, G, H, I and N) (Trichoblast type: see Nam *et al.* 1994). Tetrasporangia arranged perpendicular or parallel to axis (Fig. 2E and J) are also derived from pericentral cells (Fig. 2D, K and O). The species with these spermatangial and tetraspermatangial features are parasitic on *Laurencia*, *Chondrophycus* (Tokida et Saito) Garbary et Harper, *Palisada* Nam or *Chondria* C. Agardh rather than *Osmundea*.

J. gardneri very differs from those species in reproductive features. As mentioned above, secondary pit connections are not found between epidermal cells and vegetative axial cells have two pericentral cells. As its host *O. spectabilis*, *J. gardneri* also has a filament type male structure (Nam *et al.* 1994) in the apical urn-shaped pit of branches rather than a trichoblast type, and tetrasporangial origin of epidermal cells rather than pericentral cells. These reproductive structures also appear to be found in *J. moriformis* and *J. lappacea* from California, particularly based on the original male description (Setchell 1914). However, these two species grow on *Chondria* rather than *Osmundea* (Abbott and Hollenberg 1976). As previously commented by Kurihara *et al.* (2010), this may indicate that those *Janczewskia* species evolved from *Osmundea* and that some of them switched hosts to *Chondria* after establishment of parasitism, based

Table 2. New combinations in the genus *Heterojanczewskia*.

***Heterojanczewskia gardneri* (Setchell et Guernsey) comb. nov.**

Basionym: *Janczewskia gardneri* Setchell et Guernsey in Setchell 1914: p. 12

***Heterojanczewskia moriformis* (Setchell) comb. nov.**

Basionym: *Janczewskia moriformis* Setchell 1914: p. 11

***Heterojanczewskia lappacea* (Setchell) comb. nov.**

Basionym: *Janczewskia lappacea* Setchell 1914: p. 14

on the evolutionary scenarios of red algal parasites (Goff *et al.* 1996).

Considering the variable features of branch development (Nonomura and West 1981; the present study), these significant differences of vegetative and reproductive structures between those species could be importantly adopted for the taxonomy of *Janczewskia*. This strongly suggests that *J. gardneri* should be separated from the genus *Janczewskia*. In conclusion, the section *Heterojanczewskia* including *J. gardneri*, together with an emendation of the generic delineation of *Janczewskia*, is elevated to genus level and relevant nomenclatural changes (Table 2) for some *Janczewskia* species are proposed as follows:

According to Setchell (1914), *J. tasmanica* seems to belong to Sect. *Heterojanczewskia*. However, its reproductive features show those of Sect. *Janczewskia* (Figs. 2G–K). *J. hawaiiiana* and *J. morimotoi*, which have been placed in Sect. *Heterojanczewskia* (Apt 1987), are also excluded from the section based on the male and tetrasporangial reproductive structure (Saito 1971, as *J. tokidaei*; Apt 1987; Tokida 1947).

***Heterojanczewskia* (Setchell 1914) stat. nov.**

Thallus parasitic; apical cell always sunk in an apical pit; central vegetative axis with two pericentral cells, recognizable only near apical cell; spermatangial structure with filament type (Nam *et al.* 1994) usually in apical urn-shaped pit; tetrasporangia produced from random epidermal cells.

Type species: ***H. gardneri* (Setchell et Guernsey) comb. nov.**

Type locality: California (Setchell 1914).

Basionym: *Janczewskia gardneri* Setchell et Guernsey in Setchell 1914: p. 12.

***Janczewskia* Solms–Laubach (1877) gen. emend.**

Thallus parasitic; apical cell always sunk in an apical pit; central vegetative axis with four pericentral cells, recog-

nizable only near apical cell; spermatangial structure with trichoblast type (Nam *et al.* 1994) usually in apical cup-shaped pit; tetrasporangia produced from particular pericentral cells.

Type species: *J. verruciformis* Solms-Laubach (1877).

Type locality: Naples, the Mediterranean Sea (Setchell 1914; Guriy and Guiry 2022).

CRedit authorship contribution statement

KW Nam: Methodology, Investigation, Writing-Original draft preparation, Reviewing, and Editing.

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