

Buckiella, a New Genus in the Hypnaceae (Musci)

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ABSTRACT. A new genus, *Buckiella*, is segregated from *Plagiothecium*. The type species, *Buckiella undulata* (Hedwig) Ireland, known from western North America, Europe, China, and New Guinea, has plants with strongly undulate leaves, short, inconspicuous triangular leaf decurrencies, minute, granular, cuticular papillae covering the leaf cells, and wrinkled capsules. A second species, *B. draytonii* (Sullivant) Ireland, endemic to the Hawaiian Islands, with undulate, nondecurrent leaves, cuticular papillae on the leaf cells, and wrinkled capsules is also included in the genus.

Key words: *Buckiella*, China, Europe, Hawaiian Islands, Hypnaceae, Musci, New Guinea, North America, *Plagiothecium*.

Plagiothecium undulatum (Hedwig) Schimper has always been one of the most distinct and easily recognized species in the genus *Plagiothecium* in North America and Europe. The two primary reasons for originally placing the species in the genus were its complanate-foliate plants and decurrent leaves. However, the species has several distinctive characters that consistently distinguish it from the other species in *Plagiothecium* and warrant establishing it as a new genus in the Hypnaceae.

Buckiella Ireland, gen. nov. TYPE: *Buckiella undulata* (Hedwig) Ireland.

Plantae dioicae hebetatae vel aliquantum nitidae pallide virides vel albo-virides interdum flavo-virides; caulis et ramis prostratis complanato-foliatis interdum julaceis magnis ad 15 cm longis vel ultra 1–7 mm latis; foliis imbricatis valde undulatis concavis ovatis vel ovato-lanceolatis acutis vel acuminatis non decurrentibus cellulis breviter decurrentibus 1–3; costis brevibus duplicibus; parietibus cellularum papillis cuticularibus minute granulatis obtectis; gemmis nullis. Setae elongatae ad 4.5 cm longae; capsulae inclinatae vel pendulae; thecis rugulosis; peristomis perfectis hypnaceis; opercula rostrata.

Buckiella undulata (Hedwig) Ireland, comb. nov.
Basionym: *Hypnum undulatum* Hedwig, Sp. Musc. Frond. 242. 1801. *Plagiothecium undulatum* (Hedwig) Schimper, in Bruch, Schimper & W. Gümbel, Bryol. Eur. 5: 195. 1851 (fasc. 48 Mon. 17. 13). *Stereodon undulatus* (Hedwig) Mitten, J. Linn. Soc., Bot. 8: 39. 1865. *Neckeropsis undulata* (Hedwig) Kindberg ex J. A. Allen, Mosses Cascade Mount. 117. 1900. [(Later homonym) (non (Hedwig) Reichardt 1870)]. TYPE: In silvis densis acerosis ad terram, in cavernosis saxosis Europae, in Hercynia Franconia (holotype?, G specimen in Hedwig-Schwaegrichen herbarium with no information on packet).

Plagiothecium undulatum subsp. *subneckeroides* Kindberg, Rev. Bryol. 36: 42. 1909. TYPE: Canada. British Columbia: Vancouver Island, Departure Bay, Newcastle Island, 10 July 1908, J. Macoun (isotype?, CANM).

Plagiothecium undulatum var. *myurum* Cardot & Thériot, Univ. Calif. Publ. Bot. 2: 304. 1906. *Plagiothecium undulatum* fo. *myurum* (Cardot & Thériot) Jedlička, Spisy Přír. Fak Masarykovy Univ. ser. L2 no. 308: 14. 1948. *Plagiothecium myurum* (Cardot & Thériot) Jedlička, Spisy Přír. Fak Masarykovy Univ., ser. L4, no. 318: 4. 1950. TYPE: Unalaska, June–Aug. 1899, W. A. Setchell s.n., (holotype, PC).

Plants dull or somewhat glossy, light green or whitish green, sometimes yellowish green, in thin to loose mats, stems to 15 cm long or longer, 1–7 mm wide. Stems and branches prostrate and complanate-foliate or sometimes erect and julaceous (ecological variation described as var. *myurum*, which I consider a synonym). Leaves imbricate, not spreading, strongly undulate, especially near apices, somewhat contorted near stem and branch apices, concave, usually symmetric, 2–5 mm long, 1–2 mm wide, ovate to ovate-lanceolate, rarely oblong-lanceolate, acute to acuminate, rarely somewhat obtuse; rhizoids brown to reddish brown, smooth or rarely minutely papillose, on the leaves on the undersurface of the stems from the base of the stems and branches about halfway up, borne on the costae and adjacent cells on the abaxial surface; margins plane, entire or usually serrulate to serrate at apices; costae short and double, ending

a short distance above base, rarely one branch reaching $\frac{1}{3}$ length of leaf; leaf cells covered with minute, granular, cuticular papillae, the papillae much more abundant on the abaxial surface than on the adaxial surface, walls of basal cells pitted; median cells mostly 96–175 μm long, 7–11 μm wide; decurrent alar regions triangular in outline, often indistinct, consisting of 1–3 rectangular cells extending down stem, 40–132 μm long, 9–22 μm wide, terminating at the base in a single cell. Asexual reproductive bodies unknown.

Dioicous, often fruiting. Seta 2.5–4.5 cm long, often curved, rarely circinate, dark red to light brown. Capsule inclined to pendulous, arcuate, or sometimes straight, light brown to orange-brown when mature. Urn 1.5–4.0 mm long, 0.4–0.9 mm wide, wrinkled, contracted below mouth when dry. Operculum rostrate, 0.8–1.2 mm long. Annulus deciduous. Peristome perfect, hypnaceous; exostome papillose in upper half, with fine transverse striations between the lamellae in lower half; endostome with 2–3 cilia, as long as or nearly as long as segments. Spores globose to ovoid, smooth or minutely papillose, 11–14 μm in greatest dimension. Calyptra cucullate, white to yellow, fugacious. Chromosome number: $n = 11$ (Smith & Newton, 1968).

Habitat. At low elevations in coniferous forests, often on rotten logs, stumps, and bases of trees; sometimes on boggy soil or soil and humus overlying rock; 0–1310 m; British Columbia; southern Alaska, extending out the Aleutian Islands to Attu Island, northern California and Idaho, Oregon, and Washington; northern, western, and central Europe, Faroes, Siberia (Smith, 1978); China: Anhui, Guizhou, Hubei, Heilongjiang, Jilin, Liaoning, Shandong, and Xizang Provinces (Redfearn et al., 1996); and New Guinea.

Illustrations. Ireland (1969), Lewinsky (1974), Smith (1978).

The genus *Plagiothecium* was last revised for North America by Ireland (1969), who fully illustrated and described the species and who later did a synopsis of the genus for the continent (Ireland, 1986). A scanning electron microscope study was also done on the spores of the North American species (Ireland, 1987). Jedlička (1948, 1950) monographed and illustrated the European species, including *B. undulata*. Iwatsuki (1970) revised the genus for Japan and adjacent areas but did not report *B. undulata* from that region. It has been reported from several provinces in China (Redfearn et al., 1996), and recently I have confirmed its presence in Yunnan Province (Redfearn, He & Su 826, MO). Ireland (1986) reported a recent discov-

ery of *B. undulata* from a single locality in New Guinea (Mount Wilhelm, Wade 233 (MICH), forwarded by Howard Crum, University of Michigan).

Buckiella undulata has been included in *Plagiothecium* by both Ireland and Jedlička, as well as by other bryologists, primarily on the basis of its complanate habit and decurrent leaf cells. However, it is now evident the species can be placed in the Hypnaceae as a separate genus since other species in some genera of the Hypnaceae have complanate plants with shortly decurrent leaves with 1–3 cells similar to those of *Buckiella undulata*, e.g., *Hypnum*. Indeed, Mitten (1865) at one time placed *Buckiella undulata* (as *Plagiothecium undulatum*) in the genus *Stereodon* nom. illeg., an illegitimate generic name for *Hypnum* nom. cons.

I (Ireland, 1969) commented when I first revised the genus *Plagiothecium* that the family Plagiotheciaceae is merely a weak segregate of the complex family Hypnaceae. Later, however, I agreed with W. R. Buck (Buck & Ireland, 1985) that it is a distinct family containing only *Plagiothecium* when we reclassified the Plagiotheciaceae, and a year later (1986) I confirmed the fact that it is prudent to recognize it as a monotypic family. Most of the 44 *Plagiothecium* taxa listed by Crosby et al. (1999) share a number of features that help establish the family, but until a worldwide monograph is done on *Plagiothecium* I still consider the Plagiotheciaceae to be a weak segregate of the large family Hypnaceae.

Members of *Plagiothecium* are mostly complanate-foliate with simple or scarcely branched stems that have an outer row of thin-walled cells; smooth or papillose rhizoids that arise from the stem cells just below the leaf insertion, often from cells on or beside the abaxial surface of the costae at the base of the leaves, or sometimes from cells on the abaxial surfaces of the leaf apices (Crundwell (1979) noted that they also occur here in one other pleurocarpous family, the Amblystegiaceae); leaves that are often asymmetric and generally always strongly decurrent with several rows of cells that are easily seen when the leaves are stripped off one side of the stem; costae short and double; leaf cells that are always smooth, more or less linear, densely chlorophyllose; alar cells that are differentiated, confined to the basal angles, cylindric or fusiform; septate brood-bodies of 2–7 cells, arising from branched stalks often present on stems; and capsules with hypnoid peristomes.

The family Hypnaceae, in comparison, has plants occasionally complanate-foliate but more often spreading and usually pinnately branched stems that have an outer row of thick- or thin-

walled cells; smooth or papillose rhizoids that are borne on the stems in the leaf axils or below the leaf attachment (Crundwell (1979) noted that *Taxiphyllum* has rhizoids nearest *Plagiothecium* since they are borne at the stem-leaf junction and vary from smooth to papillose) but apparently not at the leaf apices; leaves that are usually symmetric and seldom strongly decurrent with several obvious rows of cells; costae short and double, leaf cells that are smooth, sometimes papillose, but also with projecting cell ends (prorate), often linear, usually densely chlorophyllose; alar cells that are often differentiated, confined to the basal angles; various types of gemmae but occasionally with cylindrical or fusiform brood-bodies (e.g., *Isopterygiopsis*) like the Plagiotheciaceae but arising from stems on unbranched stalks; and capsules that have hypnoid peristomes.

Although I still believe that not enough is known about many of the hypnaceous genera to safely segregate out anything but a narrow monogeneric family Plagiotheciaceae, Hedenäs (1987, 1989, 1995) has continued to recognize a broader concept of the family. In addition to *Plagiothecium*, in which he placed *Buckiella undulata*, he included several other genera and species in the family that are placed in the Hypnaceae by many present-day bryologists, including *Catagonium*, *Isopterygiopsis*, and *Pseudotaxiphyllum elegans* (Bridel) Iwatsuki. Hedenäs (1987) separated the Plagiotheciaceae from the Hypnaceae by seven characters that he considered important enough to distinguish the two families, namely rhizoid position, rhizoid color, rhizoid ornamentation, branches, perichaetial leaves, exostome color, and exostome border. However, I believe many of the characters that he used for family distinction are insignificant, difficult to interpret and, due to insufficient studies, relatively meaningless, especially since he stated that his studies on the pleurocarpous mosses (Hedenäs, 1989: 157) are "somewhat biased since they included many more species of the holarctic region than of other biogeographic regions." He omitted many of the tropical and Southern Hemisphere species in his assessment of the families, which is a serious omission because of the large number of species in those regions.

Hedenäs used branches easily detached in the Plagiotheciaceae versus firmly attached in the Hypnaceae, which is not always a very distinctive character and one which is often difficult to determine. Although some of the branches in *Plagiothecium*, including those of *Buckiella*, do seem to be easily detached, other branches, especially the smaller ones, do not. The branches possess some rhizoids

at their base, and the easy detachment apparently represents a means of asexual reproduction that has not been reported in the past.

The rhizoid character that Hedenäs used seems to be the best. However, there are some problems. He stated that *Isopterygium elegans* (= *Pseudotaxiphyllum elegans* (Bridel) Z. Iwatsuki) is clearly separate from the other North European species in having the rhizoids inserted below the leaves. From the specimens I examined in Europe and North America, the rhizoids are borne at the base of the leaves on their abaxial surfaces. The rhizoid color he used is ambiguous, since in the Plagiotheciaceae he stated the rhizoids are purple (especially noticeable in the young rhizoids, according to him) or rarely dark red-brown, while in the Hypnaceae they are brown or reddish brown. I did not observe any of the rhizoids to be purple in any *Plagiothecium* species or in *Pseudotaxiphyllum elegans* (Bridel) Z. Iwatsuki. All of the rhizoids, including those of *Buckiella*, appear to be brown or reddish brown. The rhizoids in the Plagiotheciaceae according to Hedenäs are usually granular-papillose (rarely smooth), and in the Hypnaceae they are smooth. In *Pseudotaxiphyllum elegans*, which he placed in the Plagiotheciaceae, he pointed out that the young rhizoids are rough and the older ones smooth or less rough. Inconsistencies or ambiguities such as these make family distinction very difficult, and I seriously doubt if now is the time to split off families like the Plagiotheciaceae containing any genera besides *Plagiothecium* until more is known about all species in the Hypnaceae.

One major microscopic character of the species that helps to establish the genus *Buckiella* and one that I consider very important was found during my 1969 revision of *Plagiothecium*. Minute, granular cuticular papillae were discovered covering all the leaf cells in all the specimens I studied. The papillae are much more common on the abaxial surfaces of the leaves (Fig. 1A, B) than on the adaxial surfaces (Fig. 2A). This is the only species of *Plagiothecium* in North America that was observed with any papillae on their leaves. They are discernable under the compound microscope at magnifications of $\times 400$ or more (see Ireland, 1969, fig. 7, illustration of portion of cells of *Plagiothecium undulatum*). The cuticular papillae can be seen much more clearly under a scanning electron microscope (SEM) as shown in Figures 1 and 2. These irregularly shaped cuticular papillae were first shown under the SEM by Lewinsky (1974). Similar papillae have not been seen in any species in genera of the Hypnaceae, although many of them in the family have not yet been investigated. The

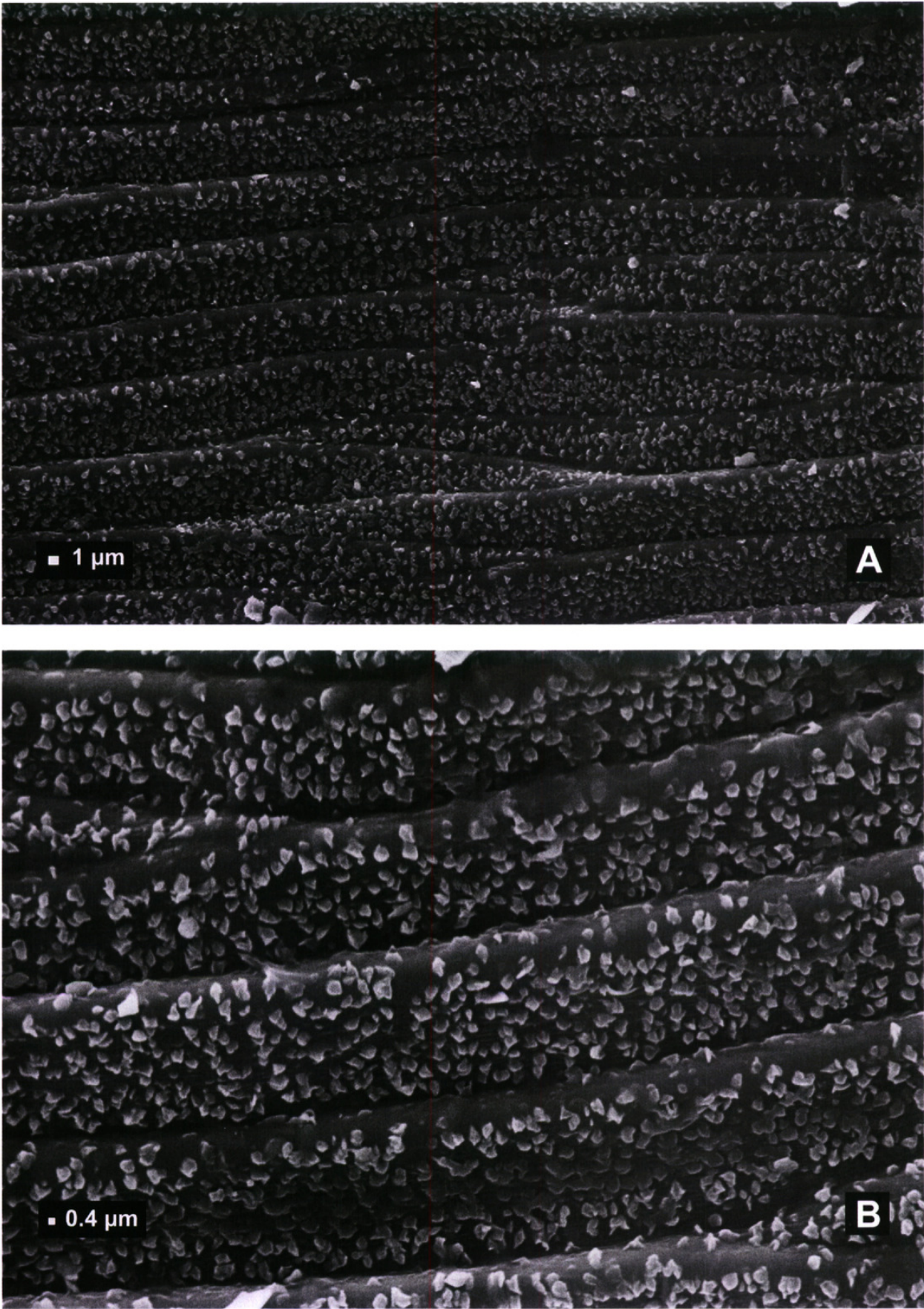


Figure 1. Scanning electron (SEM) photomicrographs of leaf cells of *Buckiella undulata*.—A, B. Cuticular papillae on abaxial surface of leaf from Washington specimen (*Ireland 5513*, US).

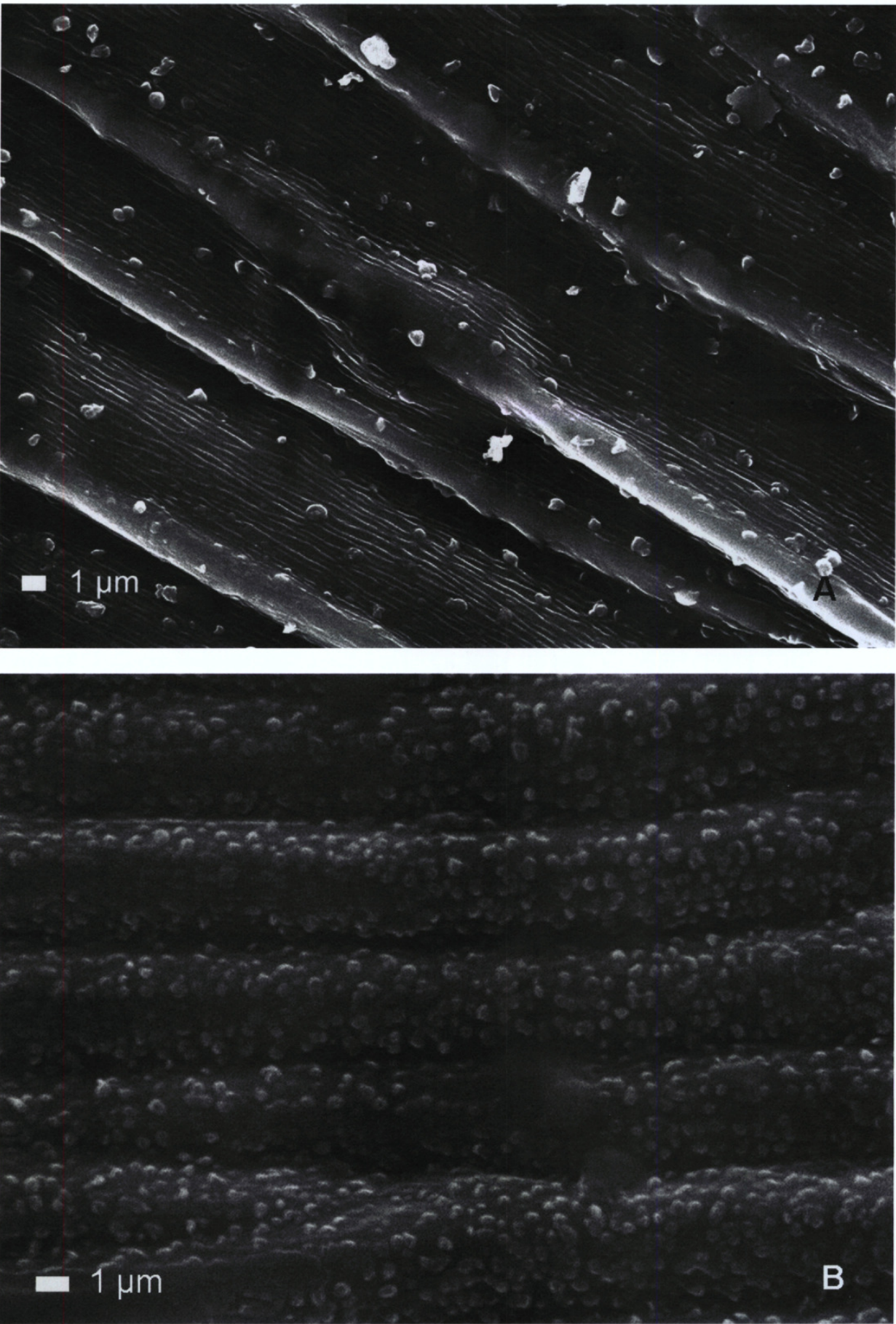


Figure 2. Scanning electron (SEM) photomicrographs of leaf cells of *Buckiella*.—A. Cuticular papillae on adaxial surface of leaf of *B. undulata* from Washington specimen (*Ireland* 5513, US). —B. Cuticular papillae on abaxial surface of leaf of *B. draytonii* from Hawaiian specimen (*Hoe*, Bryophyta Hawaiica Exsiccata 45, US).



Figure 3. Scanning electron (SEM) photomicrograph of leaf cells of *Plagiothecium denticulatum*.—A. Abaxial surface of leaf cells from Alberta specimen (Ireland 9564, US). —B. Adaxial surface of leaf cells from Alberta specimen (Ireland 9564, US).

smooth leaf cells of *Plagiothecium denticulatum* (Hedwig) Schimper are shown under the SEM (Fig. 3A, B), and similarly smooth cells are shown by Lewinsky (1974) of *P. laetum* Schimper.

Features that are important for placing *B. undulata* in the Hypnaceae are the symmetric leaves with very short, inconspicuous leaf decurrencies of only 1–3 cells, similar to species in some genera of the family. This is in contrast to species of *Plagiothecium*, which usually have asymmetric leaves with long, conspicuous leaf decurrencies in several rows extending down the stems. Also, there are minor features of *B. undulata* that are similar to the Hypnaceae in regard to its leaves that never have rhizoids at the leaf apices like most species of *Plagiothecium*, and no cylindrical or fusiform asexual reproductive bodies are ever produced like those in several species of *Plagiothecium*.

Plagiothecium draytonii (Sullivant) E. B. Bartram, an endemic species of the Hawaiian Islands, also has granular cuticular papillae (Fig. 2B), as well as other morphological features of the new genus *Buckiella*, e.g., undulate, nondecurent leaves and wrinkled capsules. Therefore, I am including it in the genus.

Buckiella draytonii (Sullivant) Ireland, comb. nov. Basionym: *Hypnum draytonii* (Sullivant, Proc. Amer. Acad. Arts Sci. 3: 76. 1854. *Plagiothecium draytonii* (Sullivant) E. B. Bartram, Bishop Mus. Bull. 101: 223. 1933. *Catagonium draytonii* (Sullivant) Müller Halle, Flora 82: 468. 1896. TYPE: Hawaiian Islands [U.S.A.]. Hawaii: Mauna Kea, C. Wilkes Expedition (holotype, FH not seen).

Hypnum eudorae Sullivant, Proc. Amer. Acad. Arts Sci. 3: 77. 1854. TYPE: Hawaiian Islands [U.S.A.]. Oahu: Kaala Mountains, C. Wilkes Expedition (holotype, FH not seen).

A complete description, habitat information, and distribution information of *B. draytonii* are found in Bartram (1933). *Buckiella draytonii* differs from *B. undulata* by the smaller plants, 5–10 cm long, by the smaller leaves, ca. 1 mm wide and 2 mm long, with a longer acuminate apex that is smooth or has only a few serrulations, and by the complete lack of decurrent cells. In comparison *B. undulata* has larger plants, sometimes over 15 cm long, larger leaves, 1–2 mm wide and 2–5 mm long, mostly acute or at times obtuse, less often acuminate at the apex with several serrations, and 1–3 decurrent cells, although they are often indistinct. The rhizoids are the same in both species. Also, both species are dioicous and possess wrinkled capsules.

Buckiella seems to be an isolated genus in the Hypnaceae, and to my knowledge it is not close to any extant genus. It is just as distinctive a genus in the Hypnaceae as it was in its former family the Plagiotheciaceae.

A. J. Sharp, University of Tennessee, suggested over 30 years ago, when I first started studying the genus, that perhaps a new genus should be described to accommodate *Plagiothecium undulatum*. He based his opinion on the superficial appearance of the species compared to the other species in the genus. It was the later discovery of the leaf cell papillae in my revision of the North American species of *Plagiothecium* that strongly convinced me after all these years to segregate the species into a new genus in a different family. In my synopsis of the genus (1986), I then mentioned that there are enough distinctive features to describe a new genus to accommodate the taxon. It is truly a pleasure to name this new genus in honor of William R. Buck, New York Botanical Garden, a long-time friend and authority of the pleurocarpous mosses who recently published his outstanding book, *Pleurocarpous Mosses of the West Indies* (Buck, 1998).

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