

Type studies on *Pycnolejeunea* (Lejeuneaceae, Hepaticae), IV

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Pycnolejeunea surinamensis Steph. is transferred to *Cheilolejeunea* (Spruce) Schiffn. as *C. surinamensis* (Steph.) He; *Rectolejeunea maxonii* Evans is transferred to *Lejeunea* Libert as *L. maxonii* (Evans) He, and *Pycnolejeunea miradorensis* Steph. is synonymized with *Lejeunea maxonii*; *Pycnolejeunea flagellifera* S. Arnell is synonymized with *Rectolejeunea berteroaana* (Gott.) Evans; and the status of *Lejeunea novoguineensis* Schiffn. and the genus *Rectolejeunea* Evans are reviewed. Complete descriptions and illustrations are provided.

Key words: *Cheilolejeunea*, Hepaticae, *Lejeunea*, Lejeuneaceae, *Pycnolejeunea*, *Rectolejeunea*

Cheilolejeunea surinamensis (Steph.) X.-L. He, *comb. nov.* (Fig. 1)

Basionym: *Pycnolejeunea surinamensis* Steph., Spec. Hep. 5: 605. 1914. — Type: Suriname. Bergen achter Brokponde, boren Suriname, 13.IV.1885 *Suringar* (G!, L!, isotypes).

Autoicous. Plant to 2.0 cm long and 1.5 mm wide, yellowish brown in dry condition, creeping loosely or forming appressed mats on substratum. Branching *Lejeunea* type, growth habit irregularly pinnate, microphyllous branches frequently produced. Stems 53–90 µm in diam., stem cells rectangular, on the ventral side 20–43 µm long and 13–28 µm wide, in cross-section composed of 7 epidermal cells surrounding 9–10 medullary cells, epidermal cells rectangular, 25–33 µm long, 15–18 µm wide, cell walls thickened, medullary cells smaller than epidermal cells, isodiametric; ven-

tral merophytes on stems 2 cells wide. Leaves imbricate or rarely contiguous, when moist widely spreading to slightly upward direction, insertion line J-shaped; lobes ovate, 0.38–0.60 mm long and 0.32–0.45 mm wide, dorsal margin broadly arched, ventral margin almost straight or slightly arched with a gentle angle near apex of lobule, apex obtuse and rounded, margins entire; lobe cells isodiametric to elongate, apical marginal cells 13–20 × 10–15 µm, median cells 25–35 × 20–25 µm, basal cells 30–45 × 20–30 µm, trigones large, well developed, triangular, occasionally becoming confluent, intermediate thickenings usually present, cuticle smooth; ocelli absent, oil bodies unknown. Lobules ovate, strongly inflated, small, 0.20–0.44 of lobe length, cells isodiametric, 13–18 µm long and 10–13 µm wide, keel short, slightly arched, free margin strongly incurved from base to apex, lobule apex semicircular, the

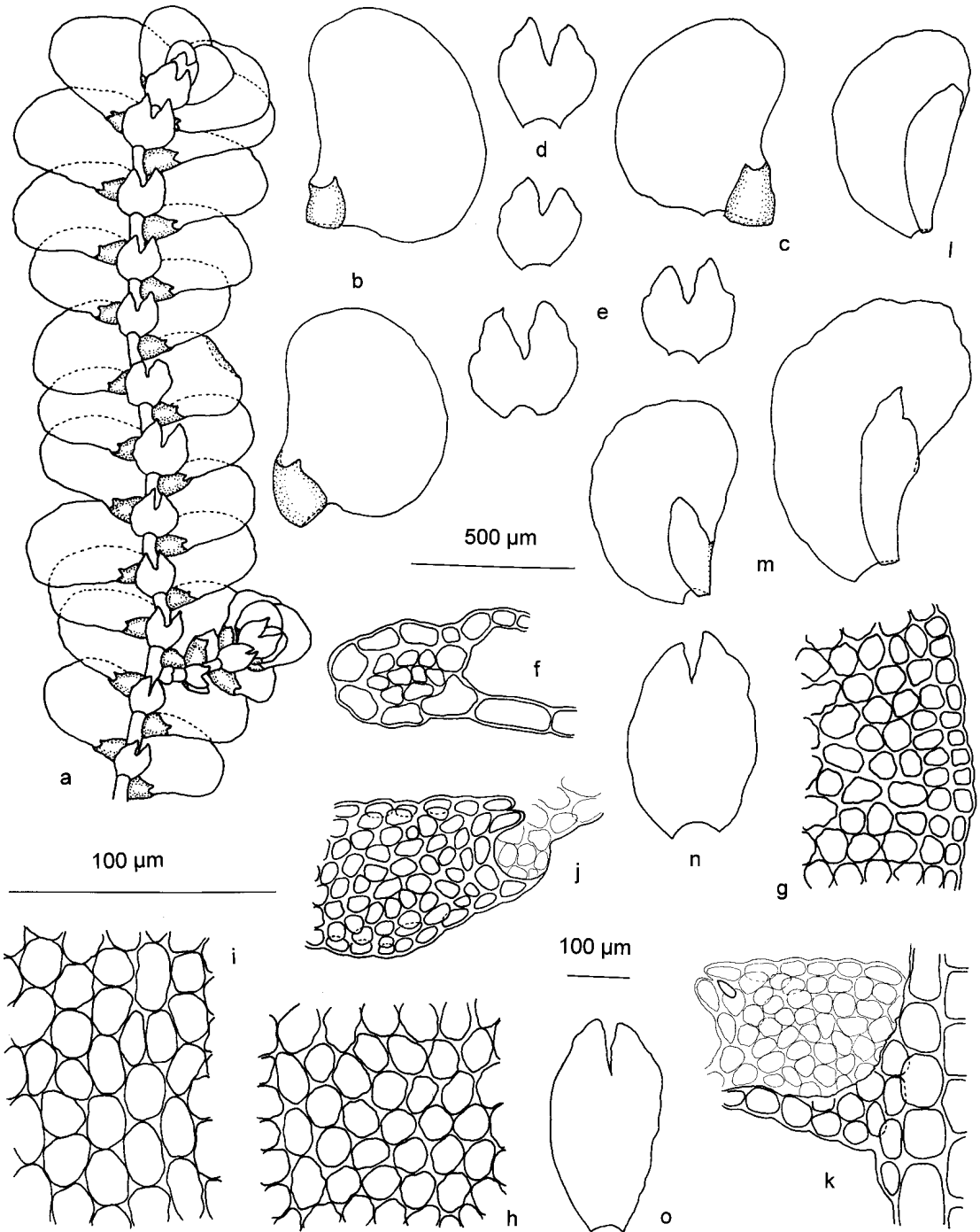


Fig. 1. a–o. *Cheilolejeunea surinamensis* (Steph.) X.-L. He (drawn from *Suringar*, L). — a: Habit. — b–c: Leaves. — d–e: Underleaves. — f: Cross-section of the stem. — g: Cells from apical leaf margin. — h: Cells from middle portion of leaf. — i: Cells from basal portion of leaf. — j: Leaf lobule. — k: Leaf lobule from inner side with hyaline papilla. — l–m: Female bracts. — n–o: Female bracteoles. — Use the 500 µm scale for a, the longer 100 µm scale for f–k, and the shorter 100 µm scale for b–e and l–o.

first tooth and the second tooth both present, 1-celled, obtuse to acute, sometimes the second tooth not seen, hyaline papilla on the inner side of lobule, situated between the two lobule teeth. Underleaves distant, $1.8\text{--}2.9 \times$ stem width, orbicular, lobed ca. 0.5 of their length, lobes triangular, with a V-shaped sinus, margins entire, sometimes crenulate, insertion line arched. Rhizoid disc usually well developed, with hyaline rhizoids at base of underleaves. Androecia on short specialized or elongated branches, terminal in position, spicate, bracts in 3 pairs, with hypostatic lobules, male bracteole 1, restricted to the base of spike, margins plane, entire. Gynoecia terminating on short branches, innovation absent, female bracts in one pair, suberect, sometimes larger than vegetative leaves, bract lobe ovate-oblong, $0.55\text{--}0.62$ mm long, $0.28\text{--}0.42$ mm wide, slightly concave, apex obtuse, margins entire; bract lobule $0.50\text{--}0.75$ of bract length, narrowly oblong-acute, keel $0.25\text{--}0.60$ of bract length, without wing; bracteole oblong, ca. 0.45 mm long and 0.28 mm wide, the apex 2-lobed to ca. 0.25 of bracteole length, lobe apex acute, sinus narrow. Perianth emergent, long-pyriform, with 2 smooth ventral keels, dorsal keel reduced, perianth apex truncate, beak short.

The lack of ocelli, the hyaline papilla on the inner side of lobule, the absence of gynoecial innovations and perianth with a reduced dorsal keel indicate that *Pycnolejeunea surinamensis* Steph. belongs to *Cheilolejeunea* (Spruce) Schiffn. The distinctive features of *Cheilolejeunea surinamensis* are the presence of both lobule teeth, the hyaline papilla positioned on the inner side of lobule, and the microphyllous branches on most plants.

Distribution: Brazil, Lago Janauaca (Schäfer-Verwimp & Vital 1989); Suriname.

Lejeunea novoguineensis Schiffn. (Fig. 2)

Nova Acta Acad. Caes. Leop.-Carol. German. Nat. Cur. 60: 238. 1893. — Type: Papua New Guinea. Morobe Prov.: Sattelberg bei Finschhafen; epiphyll, *Warburg* (JE-H2383!, isotype).

Autoicous. Plant delicate, shoots < 1.5 mm wide, nearly pellucid, pale green or whitish brown in dry condition, on bark, loosely attached to substrate. Branching *Lejeunea* type, growth habit ir-

regularly pinnate. Stems $73\text{--}135$ μm in diam., stem cells rectangular, on the ventral side $48\text{--}70$ μm long and $25\text{--}48$ μm wide, in cross-section composed of 7–8 epidermal cells surrounding 8–11 medullary cells, epidermal cells rectangular or suborbicular, $18\text{--}38$ μm long, $10\text{--}28$ μm wide, cell walls thickened, medullary cells smaller than epidermal cells, isodiametric, $13\text{--}18$ μm long, $8\text{--}13$ μm wide, ventral merophytes on stems 2 cells wide. Leaves subimbricate to contiguous, widely spreading, flat when moist, often essentially flat when dry, insertion line J-shaped; lobes ovate to suborbicular, $0.47\text{--}0.83$ mm long and $0.36\text{--}0.60$ mm wide, dorsal margin broadly arched, ventral margin straight, or slightly arched with a gentle angle near the lobule apex, margins entire, plane, apex obtuse; lobe cells isodiametric or ovate, apical marginal cells $13\text{--}23 \times 10\text{--}18$ μm , median cells $33\text{--}40 \times 25\text{--}30$ μm , basal cells $32\text{--}55 \times 30\text{--}35$ μm , trigones lacking or poorly developed, intermediate thickenings few or lacking, cuticle smooth; ocelli lacking, oil bodies unknown. Lobule ovate to triangular, strongly inflated, $0.22\text{--}0.27$ of lobe length, cells irregularly quadrate, $13\text{--}18$ μm long and $10\text{--}15$ μm wide, keel arched, ca. 0.2 of lobe length, without wing, free margin strongly incurved to the apex of lobule, the first tooth usually large, obtuse, the second tooth reduced, hyaline papilla proximal to the first tooth. Underleaves small, distant, $2.0\text{--}3.5 \times$ stem width, rotund, lobed $0.5\text{--}0.7$ of their length, lobes triangular, sinus usually broad, rounded, margins entire, plane, cuneiform, insertion line usually shallow. Rhizoid disc well developed at the underleaf base, rhizoids numerous. Androecia on elongated or short specialized branches, terminal in position, spicate, bracts in 2–4 pairs, with hypostatic lobules, male bracteoles 1–3, nearly throughout the spike, margins entire, plane. Gynoecia on main shoots or short branches, innovation single, innovation leaf sequence lejeuneoid; female bracts in one pair, suberect, shorter than vegetative leaves, bract ovate to ovate-oblong, $0.54\text{--}0.59$ mm long and $0.33\text{--}0.40$ mm wide, apex usually obtuse, plane, margins entire, bract lobule $0.48\text{--}0.60$ of bract length, oblong, apex obtuse or acute, margins entire or slightly crenulate with protruding cells, keel $0.27\text{--}0.29$ of bract length, without wing, bracteole oblong, ca. 0.35 mm long and 0.23 mm

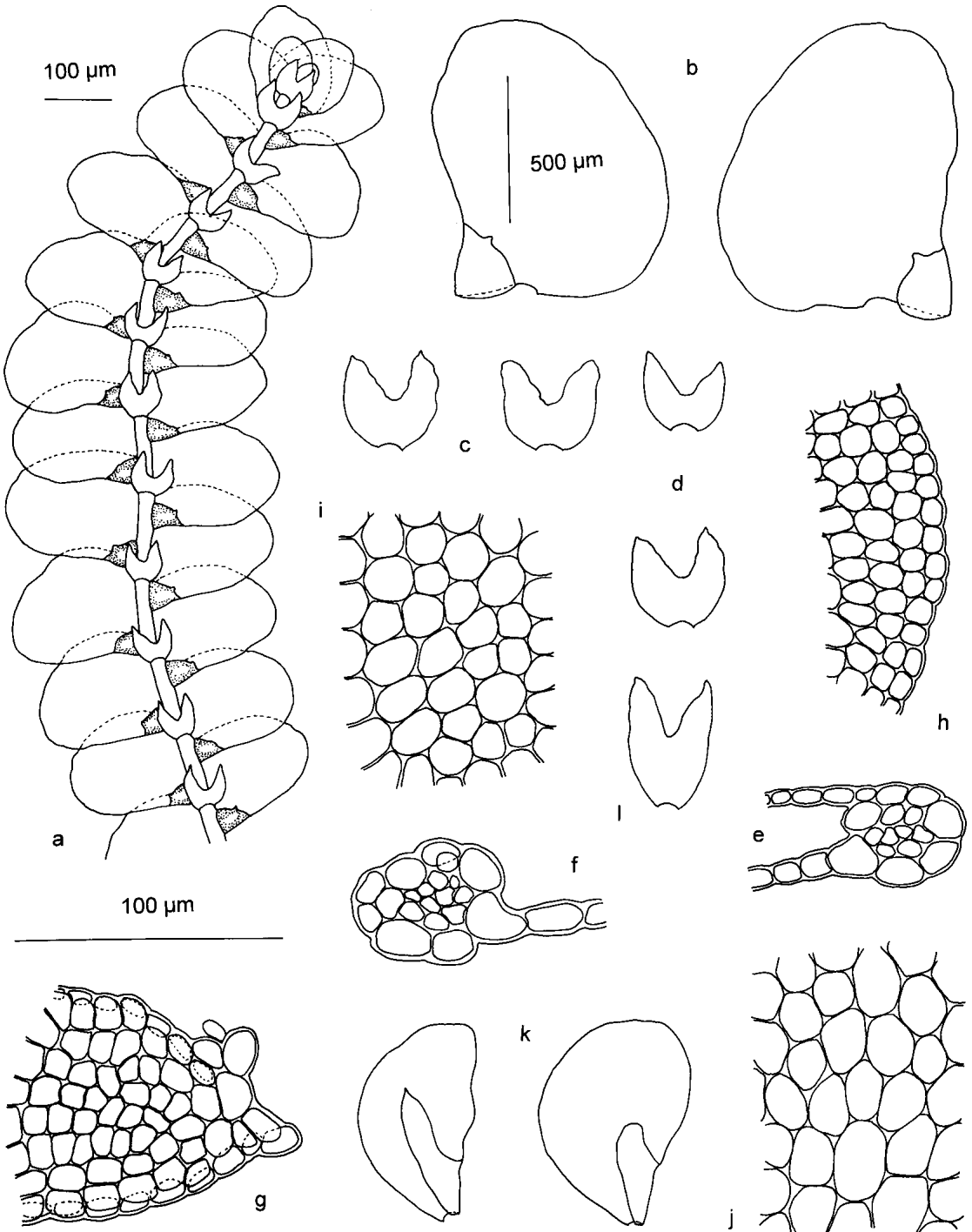


Fig. 2. a-l. *Lejeunea novoguineensis* Schiffn. (drawn from Warburg, JE-H2383). — a: Habit. — b: Leaves. — c-d: Underleaves. — e-f: Cross-section of the stem. — g: Leaf lobule and its hyaline papilla. — h: Cells from apical portion of leaf. — i: Cells from middle portion of leaf. — j: Cells from basal portion of leaf. — k: Female bracts. — l: Female bracteole. — Use the 500 μm scale for a, the longer 100 μm scale for e-j, and the shorter 100 μm scale for b-d, k, and l.

wide, the apex 2-lobed to ca. 0.5 of bracteole length, lobe apex acuminate, sinus narrow or V-shaped, margins entire, plane. Perianth emergent, obovate, 5-keeled, lateral and ventral keels sharp, dorsal keel small; beak short.

Schiffner (1893a) described the above species as subspecies *Cheilo-Lejeunea novoguineensis* under *Lejeunea*. In the same year Schiffner (1893b) raised the "Sprucean subgenera" (Spruce 1884–1885) of *Lejeunea* to generic rank, and the species *Cheilolejeunea novoguineensis* (Schiffn.) Schiffn. was recognized. Later on Stephani (1914) transferred the above species to *Pycnolejeunea novoguineensis* (Schiffn.) Steph. The species is characterized by pale green or whitish brown colour, lacking or poorly developed trigones, lacking ocelli, small and distant underleaves, and lejeuneoid innovation leaf sequence, all features typical of *Lejeunea*. Therefore, Schiffner's original placement of the species under *Lejeunea* seems consistent.

Distribution: Indonesia, Papua New Guinea.

Additional specimen examined: Indonesia: Java, "Tjebodas", *Renner 334/a*, 380 (JE), Banjoemas, Slamet, 1 500–2 000 m, no. 1562 (JE); Sumatra, Prapat, *Renner 278/a* (JE).

Rectolejeunea berteroa (Gott.) Evans (Fig. 3)

Bull. Torrey Bot. Club 33: 12. 1906. — *Lejeunea* (*Odontolejeunea*) *berteroa* Gott. & Steph., *Hedwigia* 27: 282. 1888. — Type: Puerto Rico, *Bertero 165* (G-18939!, lectotype, *nov.*), *Bertero 22* (G-18943!, syntype), *Bertero N. 2* (G-18940!, syntype), *Bertero* (FH!, syntype).

Lejeunea versifolia Gott. & Wright., *Hep. Cubenses* (without description); Schiffner, in *Engler's Bot. Jahrb.* 23: 597. 1897 (as synonym). — *Cheilolejeunea versifolia* Schiffn., in *Engler's Bot. Jahrb.* 23: 597. 1897; Evans, *Mem. Torrey Bot. Club* 8: 145. 1902. — Type: Cuba, *Wright 1202* (G-18938!, syntype); *Wright 131* (YU!, syntype).

Pycnolejeunea flagellifera S. Arnell, *Österr. Akad. Wiss., Math.-Naturwiss. Kl., Denkschr.* 111: 114. 1964, *syn. nov.* — Type: Brazil. Prov. S. Paulo, in silvis ad Brasso Grande in districtu urbis Itapeirica, ca. 1 000m., *Schiffner 1845*. *Hb. W* (W!, holotype).

Diocious. Plants delicate, shoots < 1.2 cm long and < 1.0 mm wide, pale green or light brown in dry condition, on leaves, forming appressed mats or loosely creeping on substratum. Branching *Lejeunea* type, ramification pattern irregularly pinnate. Stems 45–83 μ m in diam., stem cells rec-

tangular, on the ventral side 18–30 μ m long and 10–15 μ m wide, in cross-section composed of 7 epidermal cells surrounding 8 medullary cells, epidermal cells rectangular, cell walls slightly thickened, medullary cells somewhat smaller than epidermal cells, isodiametric, ventral merophytes on stems 2 cells wide. Leaves fragile, relatively imbricate, widely spreading or directed obliquely upward, insertion line J-shaped; lobes ovate to ovate-oblong, 0.31–0.50 mm long and 0.21–0.40 mm wide, dorsal margin strongly arched, ventral margin straight or slightly arched with a gentle angle near apex of lobule, apex rounded, margins entire; lobe cells usually small, subhexagonal or subquadrate, rectangular at the base of lobe, apical marginal cells 11–18 \times 6–14 μ m, median cells 18–25 \times 13–23 μ m, basal cells 20–53 \times 15–30 μ m, trigones and intermediate thickenings lacking, ocelli present, each leaf with 6–24 scattered ocelli, almost as the same size as the other ordinary cells, leaf base with 2–9 larger ocelli, occasionally arranged in a short vitta; oil bodies not seen. Lobules ovate-truncate, inflated, small, 0.21–0.31 of lobe length, cells rectangular to isodiametric, 8–18 \times 5–11 μ m, keel short, straight to slightly arched, free margin entire, slightly involute to the lobule apex, the apex somewhat semi-circular, the first tooth 1-celled, acuminate to somewhat falcate, hyaline papilla relatively large, oblong, situated at the proximal base of the first tooth. Underleaves relatively small, distant to contiguous, 2–3 \times stem width, orbicular, lobed 0.4–0.5 of their length, lobes triangular, acute, ocelli lacking, margins entire or 1-celled lateral teeth present on each side, cuneate, insertion line deeply arched. Rhizoid disc well developed, with numerous rhizoids at base of underleaves. The caducous leaves present on the apex of shoots, ovate, imbricate, smaller than ordinary leaves, margins with 1-cell wide, irregular rhizoids, scattered ocelli present, but larger basal ocelli lacking, lobule strongly reduced to spike-like, a few-celled, small basal fold, bearing at the apex a liner erect tooth formed of 1–5 superposed cells, terminated by the hyaline papilla. Underleaves also present on the flagelliform branches, densely imbricate, margins entire or bluntly unidentate on each lateral side. Androecia on short branches, terminal in position, spicate, bracts in 2–4 pairs, imbricate and saccate,

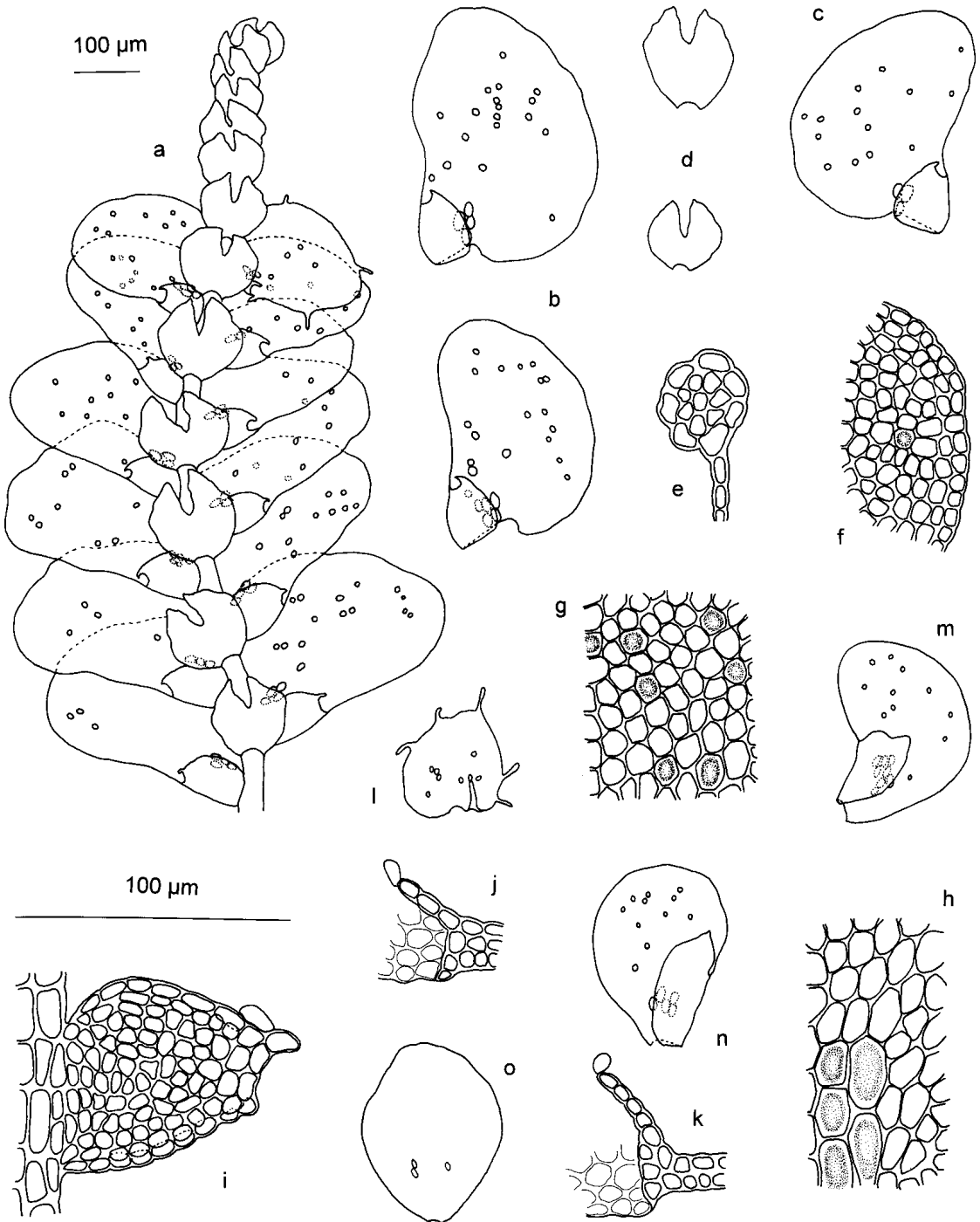


Fig. 3. a–o. *Rectolejeunea berteriana* (Gott.) Evans (drawn from Schiffner 1845, W). — a: Habit. — b–c: Leaves. — d: Underleaves. — e: Cross-section of the stem. — f: Cells from apical portion of leaf. — g: Cells from middle portion of leaf. — h: Cells from basal portion of leaf. — i: Leaf lobule and its insertion on dorsal side of stem. — j–k: Reduced lobules. — l: Caducous leaves. — m–n: Female bracts. — o: Female bracteole. — Use the longer 100μm scale for e–k, and the shorter 100 scale for a–d and l–o.

with hypostatic lobules, male bracteoles 1–2, restricted to the base of spike, occasionally present bracteoles with another half reduced above ordinary bracteoles. Gynoecia on main stem, innovations single, innovation leaf sequence pycnolejeuneoid, female bracts in one pair, suberect, bract lobe ovate, 0.39–0.43 mm long and 0.30–0.31 mm wide, plane or slightly concave, scattered ocelli present, apex rounded, margins entire; bract lobule 0.56–0.67 of lobe length, without wing, bracteole ovate, ca. 0.42 mm long and 0.33 mm wide, with ocelli, apex obtuse, margins entire. Perianth not seen.

The original collections of *Pycnolejeunea flagellifera* S. Arnell have caducous leaves and flagelliform branches, imbricate underleaves present on the terminal shoots, leaf lobes have both larger basal ocelli and smaller scattered ocelli, and trigones and intermediate thickenings are lacking. These characters are typical of the genus *Rectolejeunea* Evans subgenus *Rectolejeunea* Evans. The dioicous plants, flagelliform branches, and lacking ocelli in underleaves indicate that *Pycnolejeunea flagellifera* is conspecific with *Rectolejeunea berteriana* (Gott.) Evans.

Rectolejeunea berteriana is closely allied to the other two West Indian species *Rectolejeunea flagelliformis* Evans and *R. emarginuliflora* (Gott.) Evans. The main differences between these three species are given in the following key:

1. Plants without flagelliform branches; underleaves with scattered ocelli *Rectolejeunea emarginuliflora*
1. Plants with flagelliform branches; underleaves without ocelli 2
2. The margins of underleaves on the flagelliform branches entire or bluntly unidentate on each lateral side; dioicous *Rectolejeunea berteriana*
2. The margins of underleaves on the flagelliform branches distinctly dentate, the lobes sharply pointed, the lateral teeth 1–3 cells long and 1–2 cells wide at base; autoicous *Rectolejeunea flagelliformis*

Evans (1906) discussed the difference between *Rectolejeunea berteriana* and *R. emarginuliflora* in his early study of the genus in his "Hepaticae of Puerto Rico" series. He stated (Evans 1906) that the ocelli of *R. emarginuliflora* are indistinct or undeveloped. However, in my studies, I clearly observed the scattered ocelli in both leaf lobes and underleaves, a condition also observed by Dr. Grolle. The ocelli in the underleaves of *R. emarginuliflora*

is a key character to separate this species from the other two species.

Two subgenera of *Rectolejeunea* have been recognized. The subgenus *Rectolejeunea* including above three species, has ocelli, marginal rhizoids on leaves and pycnolejeuneoid gynoecial innovations. These characters isolate the subgenus distinctively from the subgenus *Heterolejeunea* Shust. of *Rectolejeunea*. Grolle (Grolle 1995) recently placed the subgenus *Heterolejeunea* in *Lejeunea*, because of the lack of ocelli, the presence of the lejeuneoid gynoecial innovations and the lack of marginal rhizoids, etc. In deed, the subgenus *Heterolejeunea* bears close affinities with the genus *Lejeunea*, it differs from the latter genus by having caducous leaves and flattened perianths, the characters are also presented in some species in *Lejeunea* (Shuster 1962, 1980). Therefore, placing the subgenus *Heterolejeunea* of *Rectolejeunea* in the genus *Lejeunea* to me is appropriate.

Distribution: widespread in the neotropics.

Additional specimens examined. — *Rectolejeunea berteriana* (Gott.) Evans: **Cuba:** Wright 1202 (G-18938, syntype); Wright 131 (YU, syntype). **Puerto Rico:** Bertero 165 (G-18939, lectotype), Bertero N.2. (G-18940, syntype), Bertero 22 (G-18943, syntype), Bertero (FH, syntype). — *Rectolejeunea emarginuliflora* (Gott.) Evans: **Cuba:** Wright (BM-79533); Wright (FH, holotype); Wright 1120 (G-18954, syntype); Wright 1119 (G-18952, syntype); Wright 1255 (G-18953, syntype); Wright 1265 (G-18951, syntype); Wright (JE-H2281, isotype). — *Rectolejeunea flagelliformis* Evans: **Cuba:** Prov. Oriente, Baracoa, base of El Yunque Mt., Cooper's Ranch, 1903 Underwood & Earle 346 (YU, holotype; JE, isotype; NY, isotype), 521 (NY); Wright (BM-79535).

Lejeunea maxonii (Evans) X.-L. He, *comb. nov.* (Fig. 4)

Basionym: *Rectolejeunea maxonii* Evans Bull. Torrey Bot. Club 39: 609: 1912. — Type: Jamaica, Cinchona, *Maxon* (FH!, isotype).

Pycnolejeunea miradorensis Steph., Spec. Hep. 5: 603. 1914, *syn. nov.* — Type: Mexico. "Mirador" (G!, lectotype, *nov.*).

Dioicous. Plants rather small, shoots < 0.5 cm long, and < 1 mm wide, fragile, pale green in dry condition, on bark, loosely creeping or forming appressed patches. Branching *Lejeunea* type,

ramification pattern irregularly pinnate. Stems 40–67 μm in diam., stem cells rectangular, on the

ventral side 25–40 μm long and 15–23 μm wide, in cross-section composed of 7 epidermal cells

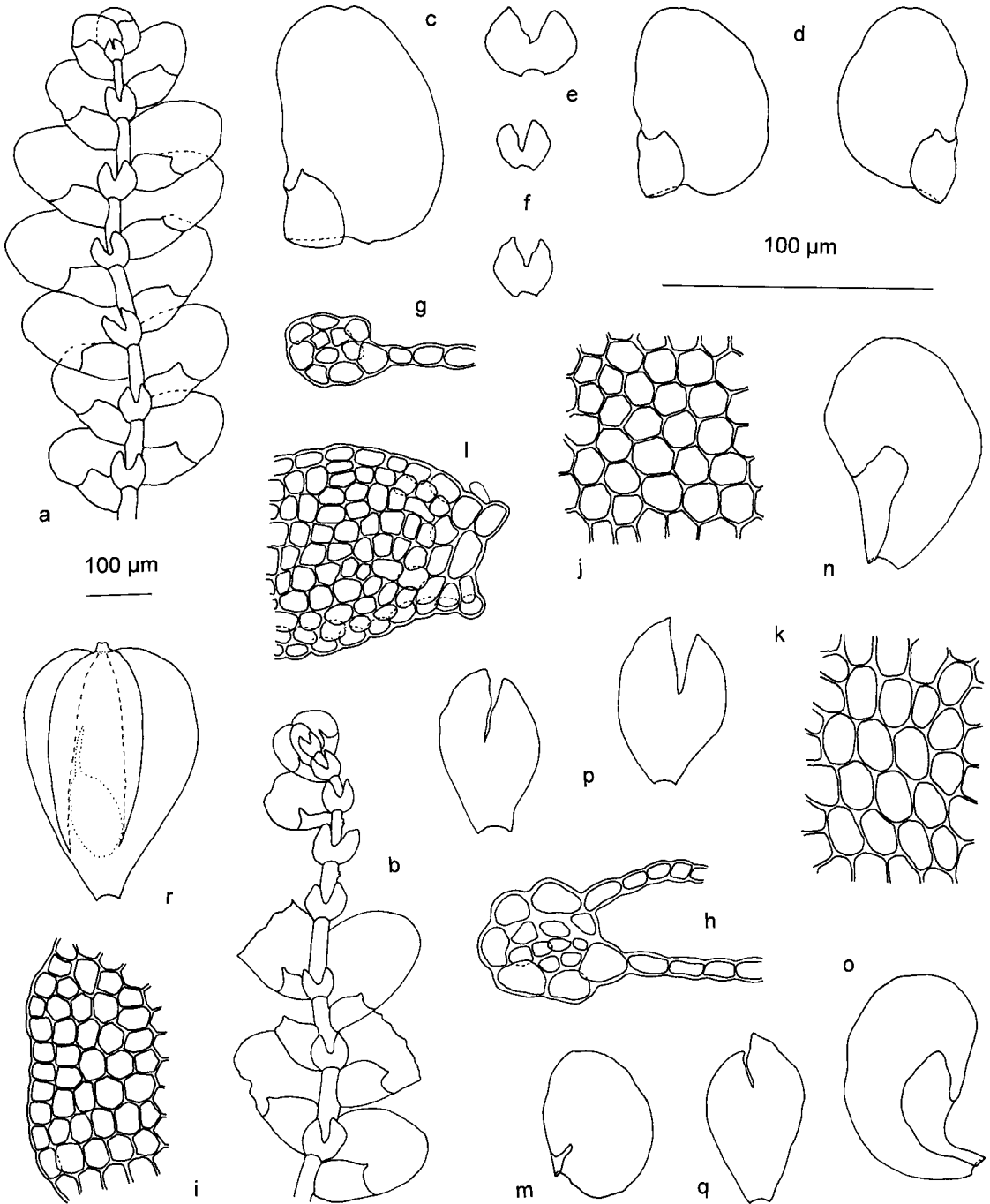


Fig. 4. a–r. *Lejeunea maxonii* (Evans) He (drawn from G, letotype, specimen number unknown). — a: Habit. — b: Plant with caducous leaves. — c–d: Leaves. — e–f: Underleaves. — g–h: Cross-sections of the stem. — i: Cells from apical portion of leaf. — j: Cells from middle portion of leaf. — k: Cells from basal portion of leaf. — l: Leaf lobule with hyaline papilla. — m: Caducous leaves. — n–o: Female bracts. — p–q: Female bracteoles. — r: Perianth. — Use the longer 100 μm scale for g–l, and the shorter 100 μm scale for a–f and m–r.

surrounding 4–8 medullary cells, cell walls thickened, medullary cells smaller than epidermal cells, isodiametric, ventral merophytes 2 cells wide. Leaves contiguous or imbricate, widely spreading when moist, insertion line J-shaped; lobes ovate to ovate-suborbicular, 0.31–0.72 mm long and 0.22–0.46 mm wide, dorsal margin broadly arched, ventral margin slightly arched, occasionally straight, apex obtuse, margins entire or sometimes slightly crenulate, lobe cells somewhat hexagonal or isodiametric, apical marginal cells 15–18 × 10–30 µm, median cells 25–33 × 20–30 µm, basal cells 25–40 × 18–28 µm, trigones absent; ocelli absent, oil bodies not seen. Lobules ovate to ovate-truncate, inflate on noncaducous leaves or often reduced on caducous leaves, cells subquadrate, 10–25 × 7–15 µm, keel short and slightly arched, free margin entire, the apex obtuse or truncate, the first tooth 1-celled, obtuse on normal lobule, hyaline papilla proximal, when lobule reduced to a small rectangular to triangular fold, lobule tooth 2–3 cells long, obliquely upwards, hyaline papilla terminal. Underleaves small, distant, 2–3 × stem wide, rotund or somewhat wider than long, lobed 0.5–0.6 of their length, lobes triangular, acute or rounded-obtuse, sinus usually V-shaped, margins entire or crenulate, cuneiform, insertion line broadly arched. Rhizoids few, or abundant at base of underleaves. Vegetative reproduction present by caducous leaves, which are highly unmodified, sometimes lobules remaining attached to the stem. Androecia on short branches, terminal in position, spicate, bracts in 2–6 pairs, imbricate and saccate, with hypostatic lobules, male bracteole 1, restricted to the base of spike, margins entire and plane. Gynoecia on main stem and elongate branches, innovations single, innovation leaf sequence lejeuneoid, female bracts in one pair, suberect, bract lobe ovate-oblong, ca. 0.67 × 0.40 mm, apex obtuse-rounded, margins entire; bract lobule ca. 0.5 of lobe length, usually narrowly oblong, apex obtuse, keel ca. 0.4 of bract length, without wing; bracteole ovate-oblong, ca. 0.52 × 0.30 mm, the apex 2-lobed to 0.33–0.44 of bracteole length, lobe apices acute, margins entire. Perianth obovate, with 2 ventral, smooth keels, dorsal keel reduced, somewhat visible, perianth apex usually truncate, with a short beak.

The absence of ocelli and trigones, the lejeuneoid innovation leaf sequence and caducous

leaves indicate that *Pycnolejeunea miradorensis* Steph. does not belong to *Pycnolejeunea*. According to my observations, the small size of the plants, the pale green colour, the proximal hyaline papilla, and the small and distant underleaves fit well within the genus *Lejeunea*, only the character of shoots with partly unmodified caducous leaves stands in the *Rectolejeunea* subgenus *heterolejeunea* Schust. The species is also characterized by the androecia with 2–6 pairs of bracts, 1 male bracteole restricted at base of spike, and perianth with reduced dorsal keel, characters which confirm that *Pycnolejeunea miradorensis* is conspecific with *Rectolejeunea maxonii* Evans, a species which must be renamed as *Lejeunea maxonii* (Evans) He. According to Grolle (Grolle 1995), *Rectolejeunea maxonii* must be transferred to *Lejeunea*, therefore, *Pycnolejeunea miradorensis* is a synonym of *Lejeunea maxonii* (Evans) He, a widespread species in the West Indies.

Distribution: Galapagos islands (Gradstein & Weber 1982), Jamaica, Cinchona (Evans 1912), Mexico, Puerto Rico (Pagán 1939, Gradstein 1989), southeast United States (Schuster 1980).

Additional specimens examined: **Jamaica:** Cinchona, 1903 *Maxon 1361* (FH, isotype).

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