The lichen genus Tuckneraria Randlane & Thell — a new segregate in the Parmeliaceae

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The new lichen genus Tuckneraria Randlane & Thell is described. The separation from Nephromopsis is based mainly on anatomical characters in the reproductive structures, such as shape and size of ascospores and structures of exciple and ascus, but also on morphological characters — thallus surface features and the presence of cilia. The genus Tuckneraria includes the three species T. laureri (Kremp.) Randlane & Thell, T. laxa (Zahlbr.) Randlane & Thell, T. pseudocomplicata (Asah.) Randlane & Saag and the newly described T. ahtii Randlane & Saag. Nephromopsis nipponensis (Asahina) M.J.Lai is considered synonymous with Tuckneraria pseudocomplicata.

Key words: lichenized Ascomycotina, Nephromopsis, Parmeliaceae, Tuckermannopsis, Tuckneraria

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INTRODUCTION

The generic complex comprising Cetrariopsis –Cetreliopsis–Nephromopsis (Ascomycotina, Parmeliaceae) has so far not been monographed on a worldwide basis. The species within these rare Asiatic genera are poorly known and have been referred to during the last few decades only in some local floristic studies (Rassadina 1971, Golubkova 1981, Awasthi 1982, Park 1990, Kurokawa 1991), with the exception of a significant paper on cetrarioid lichens of East Asia (Lai 1980). A team of researchers is now carrying out a detailed study of this group and the present paper is the first report of the project.

Until recently, the genus Nephromopsis Müll.Arg. has been delimited mainly on the basis of morphological and chemical characters (Lai 1980, Randlane & Saag 1991, 1992) such as loosely attached foliose thallus; the tendency of marginal apothecia to be situated on the lower surface; the presence of laminal pseudocyphellae over the lower cortex; the occurrence of pycnidia, frequently on emergent projections, marginally and/or laminally; the complex of secondary compounds including usnic acid, fatty acids, orcinol depsides and depsidones and anthraquinones. However, anatomical studies of ascocarps clearly demonstrate that species
treated under this genus vary significantly in their shape of ascospores, ascus type and excipular structure. As the division of species into groups based on anatomical qualities is also correlated with morphological characters, the segregation of a new genus is fully justified.

**MATERIAL AND METHODS**

About 250 herbarium specimens from B, DUKE, FH, GZU, H. KW, LD, M, MB, S, TAIM, TNS, TU, UPS, US, the majority of them belonging to *T. laureri* (Kremp.) Randlane & Thell, were studied. Chemical analyses according to the standardized TLC methods (Culberson 1972, 1974) were carried out in Tartu University. The acetone extracts were run in solvent systems B, C and G (Culberson et al. 1981). After spraying with 10% sulphuric acid, the plates were air dried and then heated at about 100–120°C for up to 15 min.

Anatomy of ascomata and conidiomata was examined at the University of Lund. Sections were made with a Knomat, Leitz freezing microtome and stained in lactophenol cottonblue. After pretreatment with 10% KOH solution, asci were squashed in a 0.3% Lugol’s solution. The characters were studied with a Zeiss Axioscope light microscope, and photomicrographs made with a Zeiss M 35 W camera.

**TAXONOMY**

*Tuckneraria* Randlane & Thell, *gen. nova*

Thallus foliaceus, medio-cr(is (ad 7 cm latus), pallide flavescent, virescens vel glaucus; laciniae oblongae aut suborbiculariae; partim ascendentes; marginibus interdum ciliatis; margin soredata aut soredata desunt. Superficies inferior pallida, fusca vel nigra; pseudocyphellata; rhizinata. Apothecia marginalia, orbicularia vel reniformia, ad 10 mm lata; sporae 8-nae, subglobose, 5–7 x 4–5 μm; asci 30–50 x 10–14 μm. Pycnidia marginalia, papillaria vel spinuliformia; conidia 4–5 x 1.5 μm, extremis nonnihil inflatis.

Type species: *Tuckneraria pseudocomplicata* (Asahina) Randlane & Saag

Thallus foliose, medium (to 7 cm broad), smooth or only slightly rugose; light yellow, yellowish-green or yellowish-grey, +/- loosely attached to the substratum; lobes elongate or rounded, with ascending margins and numerous or occasional marginal cilia; with or without marginal soredia; lower surface whitish, light to dark brown or black; white or light brown, usually small and plain pseudocyphellae situated on lower cortex; rhizines simple, at times long and numerous; both cortices parapectenchematous; cortical hyphae strongly gelatinized.

Apothecia marginal, disc brown, rounded or re 그렇지, to 10 mm in diameter, facing up- or downwards; excipula 2-layered; ascospores simple, globose - subglobose, 5–7 x 4–5 μm, 8 per ascus; asci 30–50 x 10–14 μm, clavate, spores arranged +/- uniseriately; asci *Tuckermannopsis*-type (Kärnefelt et al. 1992) with rather small thallus, very broad ocular chamber and broad axial body (2.5–4 μm). Pycnidia on marginal (occasionally laminal on both surfaces) emergent projections; pycnoconidia bifusiform, 4–5 x 1–1.5 μm.

Chemical constituents: usnic acid +/- in the cortex; lichenistanic- and protolichenistanic-type fatty acids, caperatic acid, and orcinol depsidones (physodic, conphysodic, aleteroncic, collatolic acids) in the medulla.

The name for the new genus is compiled from the names of the related lichen genera *Tuckermannopsis* and *Nephromopsis*, com-bining them with *Cetraria*. The species within *Tuckneraria* are morphologically reminiscent of the species in *Nephromopsis* but in ascocarp anatomy more like *Tuckermannopsis*. These two genera are probably the most closely related entities to the new genus. Still, there are certain differences even in the morphological characters between *Nephromopsis* and *Tuckneraria* (Figs. 1–5); the thallus of the species within *Nephromopsis* is usually coriaceous, thick and often strongly

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*Figs. 1–5. Morphology of the genus *Tuckneraria*. — 1: *T. ahtii*, part of the frequently ciliate thallus, China, Yunnan, Handel-Mazzetti 660 (US). — 2: *T. laureri*, showing the soredata margin and the marginal apothecium, Austria, Stubauer Alpen, 1958 Steiner (LD). — 3: *T. pseudocomplicata*, part of the ciliate thallus; Japan, Shikoku, Awa, Fujikawa 29560 (TNS). — 4: *T. laxa*, characterized by the same type of cilia; Taiwan, Miaoli Co., Lai 7770 (TAIM). — 5: Lobes of the same specimen with marginal pycnidia and cilia. Scale in Figs. 1, 2, 4 = 1 cm, in Figs. 3, 5 = 1 mm. p = pycnidia, s = soredata.*
reticulated or rugose; the lobes are usually rounded, not elongate; the marginal cilia are absent; pseudocyphellae on the lower surface are large, well delimited, either on special outgrowths or concave. In Tuckneraria cortical hyphae are always strongly gelatinized (Figs. 7–9). The ascospores of these two genera essentially differ, being ellipsoid in Nephromopsis and subglobose in Tuckneraria, while the anatomical characters of exciple (Fig. 8) and asci (Figs. 6, 10, 11) present similarities as well as differences (Table 1). Pycnoconidia are bifusiform (5 x 1–1.5 μm) in both genera (Figs. 12, 13). Secondary chemistry of Nephromopsis and Tuckneraria is similar: both have usnic acid in the cortex; both have lichesterinic- and protolichesterinic-type fatty acids and occasionally caperatic acid in the medulla together with the orcinol depsidones physodic and conphysodic acids; a few Nephromopsis species also contain orcinol de-pside olivetoric acid and the anthraquinone en-docrocin or secalonic acid, none of which are present in Tuckneraria.

The best characters for the separation of Tuckneraria from Nephromopsis are the general habit of the thallus and the ascospore shape. Species within Tuckermanopsis are easily separated from both genera by their lack of pseudocyphellae on the lower cortex.

The genus Tuckneraria includes 4 species growing on deciduous and coniferous trees mainly in eastern and south-eastern Asia.

**Tuckneraria ahtii** Randlane & Saag, *spec. nova*
Thallus foliaceus, laciniae 4–10 mm latae; marginibus interdum ciliatis; superficies superior virescens vel fuscescenti-flavens. Superficies inferiors pallide fusca, in centro fere nigra, pseudocyphellata; rhizinae fuscae, ad 5 mm longae. Apothecia marginalia, ad 8 mm longa et 5 mm lata; ascosporae subgloboseae, 5–7 x 4–5 μm; asci clavati, 30–50 x 10–14 μm. Pycnidia marginalia, papillaria vel spinuliformia; conidia 5 x 1–1.5 μm recta, extremis nonnihil inflatis. Acidum usnicum +/- in cortice superiore; acidum lichesterinicum et protolichesterinicum in medulla.

**Type:** China. Prov. Yunnan, Lijiang County. Mt. Yulongshan, lower central E slope, Ganeha, 3 200–3 300 m, 27°06′N, 100°14′E, on Abies, 23 April 1987, Teuvo Ahti, Jian-Bin Chen & Li-Song Wang, 46649 (H, holotype: TU, isotype).

Thallus foliose, upper surface pale glaucous or yellowish-brown, lower surface light to dark brown or almost black in central parts. Lobes rounded at the tips but usually elongate in general habit, 4 to 10 mm wide, bearing con-spicuous black marginal pycnidial projections and sometimes also numerous or occasional pale or brown cilia (Fig. 1). Pseudocyphellae on lower cortex plain, white or light brown, in-frequent on some specimens. Rhizines brown, simple, sometimes very long, to 5 mm, and numerous.

Apothecia marginal, with oblong or reniform brown disc, to 8 x 5 mm; ascospores subglobose, 5–7 x 4–5 μm; asci 30–50 x 10–14 μm, narrowly clavate; axial body 2.5–4 μm. Pycnidia on emergent projections, usually marginal and numerous, some laminal pycnidial projections may be present on both surfaces (on the lower cortex growing out from rim of pseudocyphellae); pycnoconidia bifusiform, 5 x 1–1.5 μm (Fig. 12).

Chemistry: usnic acid present or absent in the cortex; lichesterinic- and protolichesterinic-

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Table 1. Comparison of characters of *Tuckneraria* with those of the related genera *Nephromopsis* and *Tuckermannopsis*.

<table>
<thead>
<tr>
<th></th>
<th><em>Nephromopsis</em></th>
<th><em>Tuckneraria</em></th>
<th><em>Tuckermannopsis</em> s. str.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thallus</td>
<td>foliose, coriaceous</td>
<td>foliose, paper thin</td>
<td>foliose, paper thin</td>
</tr>
<tr>
<td>Lobe shape</td>
<td>rounded</td>
<td>rounded to elongate</td>
<td>elongate</td>
</tr>
<tr>
<td>Lower surface</td>
<td>rugose or reticulated</td>
<td>+/- smooth</td>
<td>smooth</td>
</tr>
<tr>
<td>Marginal cilia</td>
<td>absent</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td>Pseudocyphellae on lower surface</td>
<td>large, distinct</td>
<td>small, indistinct</td>
<td>absent</td>
</tr>
<tr>
<td>Exciple</td>
<td>3-layered</td>
<td>2-layered</td>
<td>2-layered</td>
</tr>
<tr>
<td>Asci</td>
<td>30-70 x 9-14 µm</td>
<td>30-50 x 10-14 µm</td>
<td>25-40 x 8-15 µm</td>
</tr>
<tr>
<td>Ascospores</td>
<td>ellipsoid, 5-10 x 2.5-5 µm</td>
<td>subglobose, 5-7 x 4-5 µm</td>
<td>globose, 3.5-5 x 3.5-5 µm</td>
</tr>
<tr>
<td>Axial body</td>
<td>2-4 µm</td>
<td>2.5-4 µm</td>
<td>3-4 µm</td>
</tr>
<tr>
<td>Cortical substances</td>
<td>usnic acid</td>
<td>usnic acid</td>
<td>atranorin</td>
</tr>
<tr>
<td>Medullary substances</td>
<td>a) fatty acids</td>
<td>present</td>
<td>present</td>
</tr>
<tr>
<td></td>
<td>b) secalonic acids</td>
<td>absent</td>
<td>absent</td>
</tr>
<tr>
<td></td>
<td>c) orcinol depsides &amp; depsidones</td>
<td>olivetoric or physodic acid</td>
<td>alectoronic, collatolic, physodic acid</td>
</tr>
</tbody>
</table>

Type fatty acids always present in medulla, while caperatic acid is an accessory substance.

Distribution: China, Nepal, Taiwan.

Specimens of this lichen species have usually been erroneously identified as *Nephromopsis delavayi* Hue, even though several characters do not correspond with the original description of *N. delavayi* (Hue 1899-1900). The most important character is the shape and size of the ascospores: *N. delavayi* has ellipsoid ascospores (7-11 x 4-5 µm) and therefore probably belongs to the genus *Nephromopsis*, while the ascospores of the species described here are subglobose (5-7 x 4-5 µm). Other characters such as the size and reticulation of the thallus, absence of cilia and the apothecial measurements highlight the essential differences between these two entities. According to Lai (1980), the type material of *N. delavayi* contains secalonic acid and is morphologically identical with *Nephromopsis ornata* (Müll.Arg.) Hue. We are in agreement about the synonymy of *N. delavayi* with *N. ornata* proposed by Lai but propound here a new species, *Tuckneraria ahtii*, to include the specimens that in many herbaria have been wrongly determined as *N. delavayi*. Teuvo Ahti collected wonderful material from China, Yunnan, and it was in the Helsinki herbarium in 1992 that we first began to speculate about the new species.

Specimens examined — China. Prov. Yunnan, Mt. Yulongshan near Lijiang, 3450-3500 m, Handel-Mazzetti 3563 (US, FH), Lijiang County, Mt. Ndana Ko, 4000 m, Rock (Zahlbruckner-Redinger: Lich. Rar. Exs. 31 S); Lijiang County, Yangtze watershed, eastern slopes of Lijiang Snow Range, Rock 11773 (UPS); Prov. Xizang, 3300 m, Zong Yu-chen & Liao Yin-shiang 307, Nepal. Langtang area, Pamdang Karpo, 4620 m, Miehe 13056f (GZU), Langschisa Glacier, 4090 m, 4400 m, 4480 m, 530 m, Miehe 11725b, 13846, 13424, 11835 (GZU), Dupku, Helambu, 4090 m, Miehe 7396e (GZU), Pangtang, 3400 m, Miehe 2284 (GZU), Taiwan. Prov. Taichung, Mt. Armashan, Lai 6860 (TAIM).
**Tuckneraria laureri** (Kremp.) Randlane & Thell, *comb. nova*


Thallus light yellow on upper surface, white to pale brown on lower surface. Lobes rounded, up to 5 mm broad, ascending to spreading in the margins, bearing marginal soredia (sometimes almost isidia-like structures) and scattered cilia (Fig. 2). Pseudocyphellae on lower cortex white, plain, rounded or irregular, often surrounded by a light brown line, at times absent from some specimens. Rhizines scattered.

Apothecia very rare, marginal, with brown disc and sorediose thalline margin; ascosporo subglobose, 5–6 x 4–4.5 µm; asci clavate, 35–45 x 10–12 µm (Fig. 10); axial body 2.5 µm. Pycnidia on marginal emergent projections; pycnoconidia bifusiform, 5 x 1–1.5 µm (Fig. 13).

Chemistry: usnic acid in the cortex; licheterinic- and protolicheterinic-type fatty acids in the medulla. Medulla P–, K–, C–, KC–.

Distribution: montane forests of Central Europe (the Alps, the Carpathians); Asia (Russia, China, Mongolia, Japan, Nepal); South-America (Venezuela, Colombia).

*T. laureri* is the only sorediate taxon within the *Cetrariopsis–Nephromopsis–Tuckneraria* complex, thus representing a 'secondary' species. In accordance with the 'species-pairs' theory (Poelt 1970), it is the most widely distributed of all other — 'primary' — species discussed here, growing widely in Eurasia and found also in the northern part of South America. Because of its superficial morphological similarity (yellowish thallus, marginal soredia) to the North American and European lichen *Tuckermannopsis oakesiana* (Tuck.) Hale, it has sometimes been confused with it. However, *Tuckneraria laureri* and *Tuckermannopsis oakesiana* cannot be phylogenetically closely related be-cause of essential differences in their repro-ductive structures and secondary chemistry. The present generic position of the former species is not satisfactory either, but this problem will be discussed in a future paper.

More than 170 specimens were examined from different parts of the whole distribution area.


**Tuckneraria laxa** (Zahlbr.) Randlane & Thell, *comb. nova*


Thallus pale yellow on both surfaces, lobes elongate and narrow (up to 2 mm broad) with abundant marginal cilia, yellowish-brown or darker brown to black at the tips. Pseudo-cyphellae on lower cortex in the form of tiny, white, plain spots. Rhizines scattered, simple or occasionally branched.

Apothecia very rare, marginal, with a brown rounded disc; ascosporo subglobose, 5 x 4 µm; asci clavate, 40–45 x 12–13 µm; axial body 3 µm. Pycnidia marginal, on +/- emergent projections. Pycnoconidia not seen.

Chemistry: usnic acid in the cortex; licheterinic- and protolicheterinic-type fatty acids in the medulla. Medulla P–, K–, C–, KC–.

Distribution: endemic to Taiwan.
This species stands somewhat alone in the genus due to its highly characteristic morphology (uniformly pale color of the thallus on both surfaces, narrow and elongate lobes, abundant marginal cilia, extremely small pseudocyphellae) (Figs. 4, 5). Evidently its distribution is restricted to the island of Taiwan. However, the presence of pseudocyphellae on the lower cortex and marginal position of apothecia in *T. laxa*, as well as the anatomical structures of the asci and thallus (Fig. 6), clearly place it in *Tuckneraria*.

*Specimens examined* — Taiwan, Nimandaira, Mt. Arisan, Asahina, (H). Miaoli County, Mt. Dadachienshan, Lai 7770 (TAIM). Hua-lien County, Shyu-lin village, 2700 m, Koponen 18 024 (H).

**Tuckneraria pseudocomplicata** (Asah.) Randlane & Saag, *comb. nova*


Thallus greenish on upper and white or light brown on lower surface. Lobes rounded, to 7 mm broad, bearing scattered marginal cilia (Fig. 3). Pseudocyphellae on lower cortex not numerous; in the form of rounded or irregular white, small, plain patches, often with light brown margins. Rhizines pale, simple, long (to 3 mm). Apothecia marginal, rounded or reniform, to 6 mm in diameter, with reddish-brown disc; exciple 2-layered (Fig. 6); ascospores subglobose, 5–6 × 4–5 μm; ascii clavate, 30–35 × 12–14 μm; axial body 3.5 μm. Pycnidia numerous, situated on marginal emergent projections; pycnoconidia bifusiform, 5 × 1–1.5 μm.

Chemistry: usnic acid present or absent in the cortex; as for the medullary compounds, two different chemotypes can be distinguished. The first chemotype, formerly *Nephromopsis pseudocomplicata*, contains eletoronic acids (α and β forms) as the major, and α-collatolic acid as a minor substance in the medulla; lichesterinic- and protolichesterinic-type fatty acids may occur rarely. The second chemotype, formerly *Nephromopsis nipponensis*, contains equally constantly orcinol depsidones physisodic and conphysodic acids as well as lichesterinic- and protolichesterinic-type fatty acids. Both chemo-types respond similarly to medullary colour tests: Pd−, K−, C−, KC+ red and no morpho-logical or anatomical differences.

**Distribution:** Eastern Asia (Sakhalin island, Japan, Taiwan).

*T. pseudocomplicata* is chosen to be the type species of the new genus because of its supposed central position in this group of taxa. It evidently has some affinities to all the species in *Tuckneraria*. Its chemical diversity can be interpreted in terms of evolutionary potential.

About 60 specimens were examined from Japan and Taiwan.

*Selected specimens examined* — The first chemotype with eletoronic acids. Japan, Prov. Suruga, Mt. Fuji, Culberson & Culberson 10 805, 10 807 (US), Lake Saiko, Culberson & Culberson 10 803 (M); Prov. Yamanashi, Adzumazawa, Mitomimura, 2300 m, Omura 395 (US); Prov. Shinano, Mt. Tadesina, Kurokawa 51 747 (M). Mt. Yatsugatake, Kurokawa 58 303 (TAIM); Honshu, Prov. Nara, Mt. Odaigakara, Tagawa 319. Komagatake, Faurie 6759, Taiwan. Taitung County, Yakou, 2750 m, Lai 9484 (US) — besides eletoronic acids also lichesterinic- and protolichesterinic-type fatty acids.


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