

Sporopodiopsis, a new genus of lichens (Ectolechiaceae) from S-E Asia

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Keywords: *Sporopodiopsis*, Ectolechiaceae, campylidia, Papua New Guinea, Malaysia/Sabah, Mt Kinabalu.

Abstract: *Sporopodiopsis* Sérusiaux gen. nov. (Ectolechiaceae) is characterized by its unique campylidia which produce their conidia in small locules located in their upper half and which are organized in such a way that the conidia can be dispersed together with the photobiont. Two species are known: *S. mortimeriana* Sérusiaux sp. nov. from Papua New Guinea (known only with campylidia) and *S. sipmanii* Sérusiaux sp. nov. from Malaysia/Sabah (known with apothecia and campylidia).

Introduction

During an expedition to Papua New Guinea in 1992, together with my friends and colleagues A. Aptroot, P. Diederich and H. Sipman, I gathered a large collection of a curious foliicolous lichen in the mountains of the Central Range. It turned out to be congeneric with an unidentified species collected on Mt Kinabalu by H. Sipman several years before. Both species represent a new genus which is described in this paper.

Material and methods

The material was observed in tap water, in Lugol's iodine solution, in lactophenol cotton-blue (LCB) or in brilliant cresyl blue (CRB). The measurements given in this paper always refer to preparations in water.

Sporopodiopsis Sérusiaux gen. nov.

Thallus crustaceus, areolis dispersis irregularibusque vel verrucis parvulis constatus, cum prothallo distincto, caeruleo-nigro. Algae verosimiliter ad *Chlorococcaceas* pertinentes. Campylidia praesentia, cassidiformia, cum conidia producenti strato in duobus vel tribus cavitatibus in plicis profundis superioris partis et ad maturitatem exposito; conidia

parva, simplicia et ellipsoidea; algae praesentia super campylidiorum pagina et verosimiliter cum conidiis depulsae. Apothecia (in una specie solum cognita) circularia et in thalli verrucis evoluta; excipulum ramosis anastomosantibusque hyphis compositum; hamathecium dense ramosis anastomosantibusque paraphysibus compositum, circa ascos reticulatis; asci *Sporopodii*-typo; sporae solitariae in asco, ellipsoideae et muriformes.

Thallus crustose, made of dispersed irregular patches or made of small verrucae, with a distinct, bluish black prothallus. Photobiont: most probably a species of the *Chlorococcaceae*. Campylidia present, with the conidiogenous layers in two or three cavities located in deep folds of the upper part, but nevertheless exposed to the air in mature stages; conidia small, simple and ellipsoid; lichenized algae present on the campylidia surface and most probably dispersed together with the conidia. Apothecia (known in one species only) circular and developing in thallus verrucae; excipulum of branched and anastomosing hyphae; hamathecium of densely branched and anastomosing paraphyses, forming a close net around the asci; asci of the *Sporopodium*-type; spores 1/ascus, ellipsoid and muriform.

Type species: *S. sipmanii* Sérusiaux

Sporopodiopsis is best characterized by its unique campylidia which are in all respects the most sophisticated ones known today. They do not belong to any of the morphological types described so far (Sérusiaux 1995).

The conidiogenous layer is located in the upper half of the campylidium and is exposed to the air in mature stages; such a situation occurs only in *Badimiella serusiauxii* Malcolm & Vězda, a foliicolous, monotypic genus known from New Zealand (Sérusiaux 1986: 30; Malcolm & Vězda 1994). In this species, the conidiogenous layer forms a circular, slightly convex surface and is only protected by the upper sterile part of the campylidium that forms, in dry conditions, a "roof" over it. In *Sporopodiopsis*, the conidiogenous layer is located into two (in *S. sipmanii*) or three (in *S. mortimeriana*) small lodges that are protected on all sides by deep folds of the sterile "tissue" of the campylidium. In the campylidia produced by *Sporopodium phyllocharis* (Mont.) Massal., the conidiogenous layer is also located in several locules, but here carpets a multilocular cavity developed in the socle of the structure and is connected to the "ostiole" (mouth of the campylidium in the sense of Sérusiaux 1986:19-20) through a long tube. Such a morphology is also quite different from the situation observed in *Sporopodiopsis*.

The campylidia produced in the genus *Badimia* Vězda (Sérusiaux 1986) may appear quite similar to those of *Sporopodiopsis* as they look like obliquely erect scales and as the conidial mass is located almost at the top of their inner cupulate side. In such campylidia, however, the conidiogenous layer and the conidia are never exposed to the air (except in damaged ones) and are always covered by a "hood" and thus appear deeply buried under it. Another major difference between *Badimia* and *Sporopodiopsis* is the size and shape of the conidia as, in the former, they are filiform, multi-septate, very long and flexuose and convoluted, with crooks at both ends and with pedicellate appendages, that are terminated by a sticky mass, spread along their length.

At the inner base of the campylidium, algal cells are present near the surface of the "tissue" in which they grow and they produce aplanospores that can be taken away by the conidia when they disperse. In *S.*

mortimeriana, the occurrence of algal cells on the surface of the campylidium at that level is easily seen under the dissecting microscope as a greenish hue is always distinct. In *S. sipmanii*, the inner surface of the campylidium base is invaded by small whitish granules similar to those of the thallus; these granules are filled with algal cells undergoing aplanospore production and they tend to climb up along the inner campylidium surface to reach the small lodges containing the conidiogenous layer. It cannot be ruled out that the occurrence of thallus granules on the inner side of campylidia is not an age artefact. It is nevertheless remarkable that, even in campylidia apparently "in good shape", thallus granules rich in algae are always present in the vicinity of the conidial masses that accumulate on the surface of the small lodges containing the conidiogenous layer.

Lücking (1995) has argued that the orientation of the campylidia is a way to use the splash-cup mechanism to disperse their conidia, while Sérusiaux (1995) has suggested that campylidia act as small cupules that collect water droplets to let their conidia spread out over their surface. Whatever the solution to that debate is, the campylidia produced by both species of *Sporopodiopsis* are able to disperse their conidia and algal cells together, just by giving them an opportunity to become mixed. In *S. mortimeriana*, the mechanism is even better organized as the small conidial lodges are distinctly orientated towards a tiny cupule located at the inner base of the campylidium, whose surface has abundant algal aplanospores; a tiny furrow joins the cupule to the lower side of the small conidial lodges.

The only other campylidia that are organized in such a way that their conidia and algal cells are dispersed together occur in the genus *Sporopodium* Mont.; in this genus, algal cells are present within the conidiogenous layer and are mixed with the conidia, or agglutinated together with them into a sticky globose mass at the "mouth of the campylidia". Algal cells are also present in the conidiogenous layer in *Loflammia demoulinii* Sérusiaux (nom. inval.; art. 43.1 ICBN) but both collections referred to that species are unusual forms of *Sporopodium leprieurii* Mont. (specimens in LG!).

The type species chosen for the new genus *Sporopodiopsis* is logically that known with ascomata (*S. sipmanii*). There is no guarantee that the other one (*S. mortimeriana*) belongs to the same

genus: ascomata are much needed for such evidence. I have, however, decided to describe the latter in the same genus for the following reasons:

- the thallus of both species is discontinuous and made of isolated whitish granules and a bluish-black prothallus is present;
- the conidiogenous layer is developed in the upper parts of the campylidia in both species, it is exposed to the air in the mature stages, although it is located in deep folds of the campylidium; the conidia produced are small and ellipsoid and are able to take away algal cells when they are dispersed. Such features are so far unique in lichenized fungi and are most probably apomorphies of a single genus.

The ascus type of *S. sipmanii* belongs to the *Sporopodium*-type (sensu Haffelner 1984: 276-277). Although its excipulum structure is not paraplectenchymatous as in the typical genera accepted in that family (*Calopadia* Vězda, *Lasioloma* R. Sant., *Loflammia* Vězda, *Sporopodium* Mont. and *Tapellaria* Müll.Arg.), I therefore assign this new genus to the *Ectolechiaceae* Zahlbr.

Although no detailed ontogenetic studies were conducted for lack of sufficient material, I believe that the opening of the apothecia is hemiangiocarpic, as defined by Letrouit-Galinou & Bellemère (1989:216): the roof of the primordia ruptures after the differentiation of the hamathecium and of the hymenium.

Sporopodiopsis is known from only two localities: one on Mt Kinabalu in Malaysia/Sabah and the other one in the mountains of the Central Range in Papua New Guinea. It is either rare or confined to undisturbed mountain forests, a very rich habitat in S-E Asia and seldom visited by lichenologists.

Sporopodiopsis mortimeriana Sérusiaux sp. nov. (Figs 1-5)

Species epiphylla, insignis campylidiis fungilliformibus, cum cupula prope basin, parte superiore algis impleta, et conidia producenti strato in cavitatibus tribus.

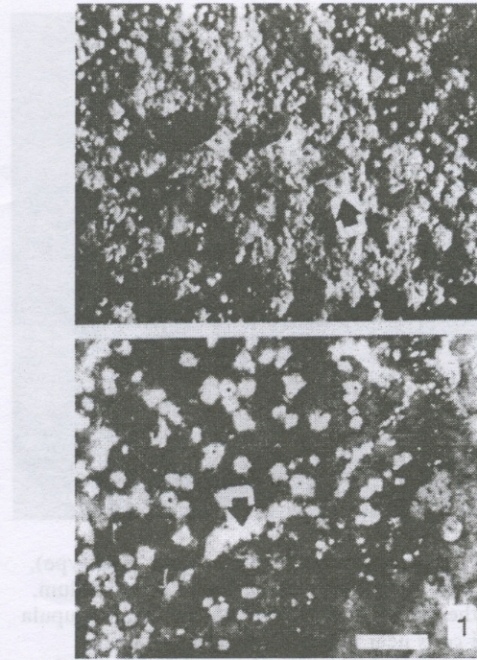


Figure 1: *Sporopodiopsis mortimeriana* (holotype), thallus with campylidia (arrows) and with its conspicuous, black prothallus. Scale = 1 mm.

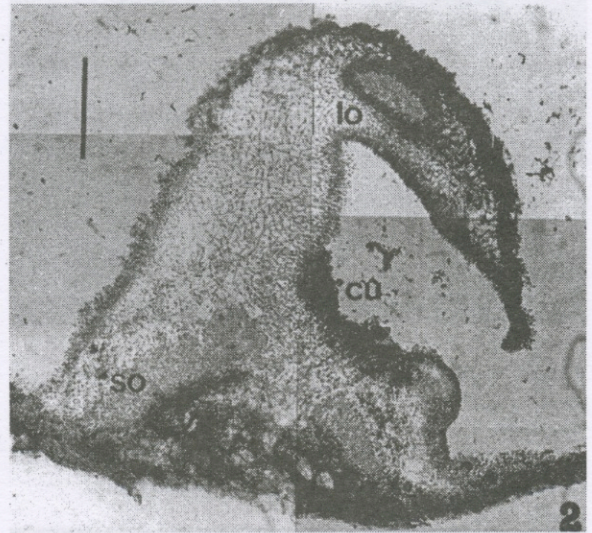


Figure 2: *Sporopodiopsis mortimeriana* (holotype), perpendicular section through a "dry" campylidium, showing the socle filled with crystals (so), the cupula with algal cells near its surface (cu) and a locule containing the conidiogenous layer (lo). Mounted in LCB. Scale = 100 μ m.

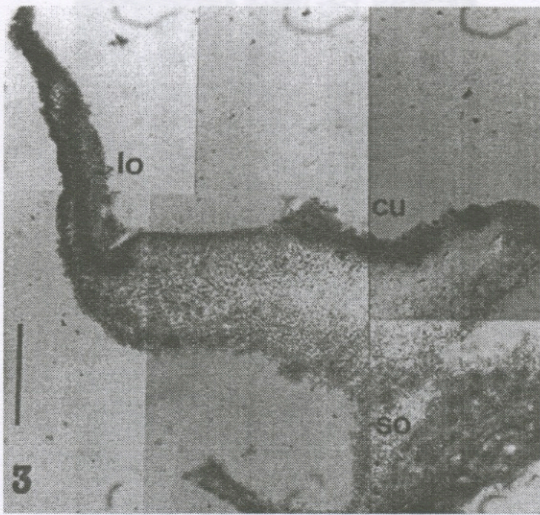


Figure 3: *Sporopodiopsis mortimeriana* (holotype), perpendicular section through a "wet" campylidium, showing the socle filled with crystals (so), the cupula with algal cells near its surface (cu) and a locule containing the conidiogenous layer (lo). Mounted in LCB. Scale = 100 μm .



Figure 4: *Sporopodiopsis mortimeriana* (holotype), transverse section through a campylidium, showing the three locules containing the conidiogenous layer (lo), the conidial mass (co) and the socle filled with crystals (so). Mounted in LCB. Scale = 100 μm .

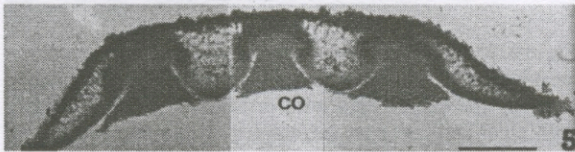


Figure 5: *Sporopodiopsis mortimeriana* (holotype), transverse section through the upper part of a campylidium, showing the three locules containing the conidiogenous layer and the conidial masses (co). Mounted in LCB. Scale = 100 μm .

Thallus epiphyllous, +/- circular, c. 1 cm in diam., made of dispersed and irregular patches that are irregular in outline, 0.2-0.5 mm across, white to greyish white, with an irregular to puffy, nitidous surface, containing minute (c. 1-3 μm across), irregular and colourless crystals (refringent under polarized light); prothallus present, almost entirely encrusted with crystals and linking the algiferous patches, with conspicuous, radiating bundles of dark blue hyphae over a membranous layer (hyphae 3 μm large, with dichotomous branches, K- or K+ greenish blue, with small encrustations on their surface).

Photobiont: most probably a species of *Chlorococcaceae*, with green, spherical cells, 8-14 μm in diam.

Campylidia present on almost all thalli, but never abundant, first seen as a dark blue spot on a small thallus verruca containing numerous, pale orange to brownish crystals (refringent under polarized light). Mature ones looking like tiny carpophores of an agaric when observed "fullface", and thus with two distinct parts: (i) a cap, c. 0.5 mm large and c. 0.2 mm high, dark blue with a white, tomentose cover, and (ii) a bell-shaped (bell "standing up on its top") or +/- cylindrical socle, c. 0.3 mm large and c. 0.15-0.2 mm high. In sections made perpendicularly, the socle is usually constricted at its base and the fan- or shell-shaped part is obliquely fixed on one side; that part supports on its inner face three conidiogenous cavities and its upper half bends over them in dry conditions; it unfolds upwards in wet conditions, so that the conidiogenous cavities are fully exposed to the air.

Socle lacunose at its centre, with numerous, pale orange to brownish crystals (refringent under polarized light), with a distinct, albeit very slightly prominent, whitish outer margin that contains numerous, minute crystals in a rather disorganized network of hyphae; upper part of the socle with a very small depression (here named the cupula), encircled by a slightly prominent ring that is discontinuous to make possible the connection between the cupula and the furrow coming from the lower edge of the conidiogenous cavities. Cupula and its bordering ring yellowish green, minutely scurfy, containing numerous algal cells with abundant aplanospores production, especially near its surface which is usually disrupted; free algal cells are therefore frequently seen on it.

Fan- or shell-shaped part made of a dense network of branched and anastomosing hyphae, becoming +/- paraplectenhyematous towards its upper edge, c. 100 μm at its maximum thickness; outer surface dark

blue to greenish black, encrusted with pale orange to brownish crystals at mid-height, covered with minute, globose cells that form the whitish tomentum seen under high magnification; inner surface colourless, made of a 10-15 μm high layer, of anticlinally arranged hyphae, that covers the network of branched and anastomosing hyphae forming the "core" of the campylidium.

Conidiogenous layer developed into three, ellipsoid cavities that are delimited on all sides, except the upper one, by deep folds in the sterile "tissues" of the campylidium, connected to the cupula by a distinct furrow (not always seen, perhaps best described as a concave surface underneath the three cavities, that is connected to the cupula of the socle); "tissue" underneath the conidiogenous layers and forming the folds between the conidial cavities usually dark blue to greenish black (same colour as the outer surface of the campylidium).

Conidiogenous cells cylindrical, forming a regular layer over polygonal cells, 10-12 x c. 2 μm ; conidia arising singly at the apices of conidiogenous cells, hyaline, ellipsoid, +/- truncate at their proximal ends, simple, 5-6 x 2.5-3 μm , accumulating in a +/- compact mass over the conidiogenous layer. Conidiogenesis probably following this pattern: first holoblastic conidial ontogeny, septum delimitation, schizolytic secession, enteroblastic conidiogenous cells proliferation followed by another holoblastic conidial ontogeny, but never more than one colarete observed.

Apothecia unknown.

Type: **Papua New Guinea**, Eastern Highlands prov., Mt Gahavisuka Provincial Park, 11 km N of Goroka, c. 2300-2450 m, on leathery leaves of a *Rhododendron* on the outskirts of little disturbed mossy mountain forest (dominated by *Castanopsis*), 11 viii 1992, *Sérusiaux* 13762-80 (LG-holotypus; B, LAE, herb. Lücking-isotypi).

This new species is named after Prof. Mortimer, the hero of the comic strip series of E. P. Jacobs known as "Black & Mortimer"; indeed, its campylidia, when observed fullface, look like the police robots that appear in the story "Le piège diabolique".

Sporopodiopsis mortimeriana has been found on leathery leaves at the outskirt of a little disturbed mossy mountain forest in the Gahavisuka Provincial Park, at 2300-2450 m elevation in the Central Range of Papua New Guinea. Unfortunately, I could not find any ascomota and, in spite of its conspicuous aspect (mainly due to its bluish prothallus), I did not find it in any other locality.

Sporopodiopsis sipmanii *Sérusiaux* sp. nov.
(Figures 6-11)

Species epiphytica, insignis campylidiis squamuliformibus, conidia producenti strato in duobus cavitatibus et verrucis algis impletis; apothecia ut in generis descriptione.



Figure 6: *Sporopodiopsis sipmanii* (holotype), thallus with apothecia and with campylidia (arrows). Scale = 1 mm.



Figure 7: *Sporopodiopsis sipmanii* (holotype), perpendicular section through a campylidium, showing a locule with the conidiogenous layer (lo) and the thallus granules containing algal cells (gr). Mounted in LCB. Scale = 100 μm .

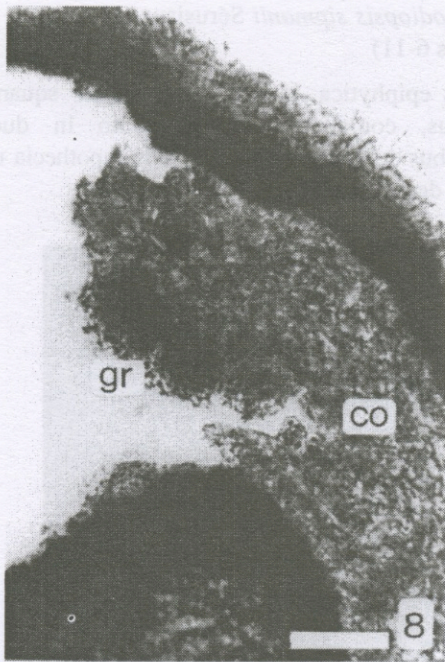


Figure 8: *Sporopodiopsis sipmanii* (holotype), detail view of the upper part of a perpendicular section through a campylidium, showing the thallus granules (gr) agglutinated to the conidial mass (co). Mounted in LCB. Scale = 50 μ m.



Figure 10: *Sporopodiopsis sipmanii* (holotype), transverse section through the apothecial margin. Mounted in LCB. Scale = 50 μ m.

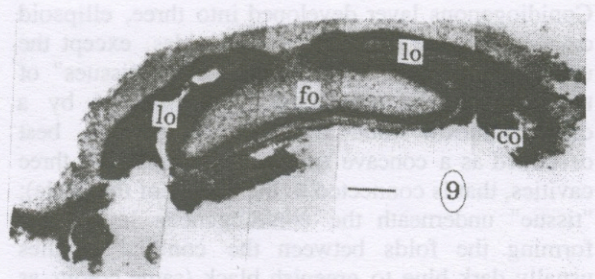


Figure 9: *Sporopodiopsis sipmanii* (holotype), transverse section through the upper part of the campylidium, showing the two locules containing the conidiogenous layer (lo), the deep fold (fo) protecting them and the conidial masses (co). Mounted in LCB. Scale = 100 μ m.

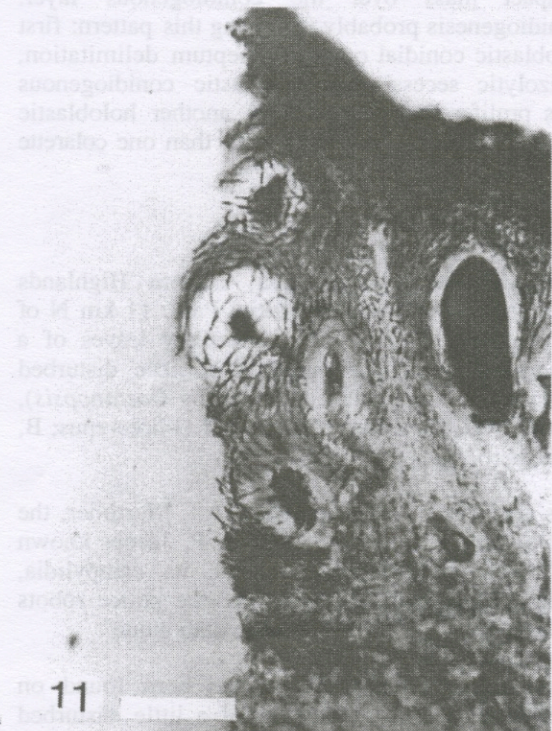


Figure 11: *Sporopodiopsis sipmanii* (holotype), detail view of the network of branched and anastomosed paraphyses. Mounted in LCB. Scale = 50 μ m.

Thallus epiphytic, covering large surface of the bark on which it grows (at least several cm²), formed of +/- dispersed or densely aggregated white to whitish granules, 0.2-0.4 mm in diam., sometimes finger-like and looking like small isidia, or flattened, with a smooth and matt surface (very rarely "bursting" and with a scurfy, erose surface), not containing any crystals; prothallus distinct, bluish black, 0.2-0.4 mm wide. Photobiont: most probably a species of the *Chlorococcaceae*, with green spherical cells, 8-14 μ m in diam.

Campylidia few, mainly present on thalli not producing apothecia, first seen as dark blue spots on thallus verrucae containing numerous, pale brownish crystals (refrangent under polarized light). Mature ones can be described as +/- flat, glossy, dark blue to blackish scales, slightly widened in their upper parts, obliquely laying down on a whitish socle, and with two conidiogenous cavities in their upper parts; size: 0.8-1.1 mm in height and scale 0.9-1.0 mm large. In sections made perpendicularly, the socle is +/- triangular and not constricted at its base and the upper part supports on its inner face two conidiogenous cavities that are protected by the upper edge that slightly bends over them in dry conditions.

Socle made of a network of branched and anastomosing hyphae, usually without crystals, except, in young campylidia, just under its inner surface (small, numerous, pale orange to brownish crystals, best seen under polarized light), without cortex but with hyphae becoming globose to torulose on the outer surface and thus responsible for the whitish, scurfy surface seen under high magnification; small, white thallus granules are always present on the lower inner parts in mature campylidia (they eventually invade almost the whole scale surface, up to the conidiogenous cavities), containing numerous algal cells with abundant aplanospores production, especially near the surface.

Upper part made of a dense network of branched and anastomosing hyphae, becoming +/- paraplectenchymatous towards its upper edge, and with their outer and inner surface dark blue to dark green (c. 20 μ m thick); outer surface covered with minute, globose cells that form the whitish tomentum seen under high magnification, but highly disrupted in old campylidia (tomentum and dark layer are absent); inner surface covered with a colourless, 10-15 μ m high layer made of anticlinally arranged hyphae.

Conidiogenous layer developed into two, ellipsoid cavities that are delimited by very deep folds in the sterile "tissues" of the campylidium, on their inner and lower sides. Indeed, a fold is hardly seen on the outer side of the cavity and none can be observed on the upper side of it; but folds are so deep between both cavities that, in a transverse section, an umbrella-like (c. 0.2-0.25 large and c. 200-250 μ m thick) fold can be observed. Thallus granules are seen in the surroundings of the conidiogenous cavities in all mature campylidia.

Conidiogenous cells and conidia identical to those of *S. mortimeriana*.

Apothecia abundant, circular, distinctly constricted at their basis, 0.5-0.8 mm in diam. and c. 0.4 mm in height; disc plane to slightly convex, dark bluish to almost black, with a minutely rugose surface; margin white, at first completely covering the disc (young apothecia are formed within a globose verruca, whose "roof" tears up into small triangular lobes), then prominent and eventually thin and hardly distinct. Disc of old apothecia (not producing ascospores any more) invaded by minute thallus granules.

Excipulum c. 80 μ m thick in mature apothecia (= triangular lobes of the teared up roof already vanished, and producing ascospores), colourless, made of densely branched and anastomosing hyphae, filled, especially in its outer parts, with small, colourless or brownish crystals (refrangent under polarized light); hypothecium 100-130 μ m thick, crimson violet or purplish, K+ more purple; hymenium 150-170 μ m thick, colourless, sometimes with large, cubic (c. 20 μ m) or rectangular (c. 20-25 x 8 μ m) crystals (refrangent under polarized light); epithecium c. 15 μ m thick, dark green, with numerous, small, pale brownish or bluish-violet granules (sometimes polyhedral), K + bright green and granules either K - (remaining colourless) or K + ink blue; hamathecium of dense, richly branched and anastomosed paraphyses and forming a close net around the asci; asci clavate, 90-120 x 40-45 μ m, belonging to the *Sporopodium*-type (*sensu* Haffelner 1984: 276-277); spores 1/ascus, ellipsoid, muriform, (61-) 68-75 x (25-)31-39 μ m.

Type: **Malaysia/Sabah**, Kola Belud distr., Kinabalu Park, S-slope, c. 2800 m, on tree in stunted mossy forest on mountain ridge +/- halfway between Villosa shelter and Carson's camp, 12 v 1989, *Sipman* 31293 (B-holotypus; LG-isotypus).

Other specimen: Malaysia/Sabah, Ranau distr., Kinabalu Park, S-slope, c. 3200 m, on tree in stunted, open *Leptospermum*-dominated forest along Summit Trail, 12 v 1989, Sipman 31256 (B).

Most of the campylidia present in the type collection seem to be in a rather bad condition (most of them are probably old ones) and the other specimen has very few campylidia. Some details of the above description given may therefore require some corrections when further material becomes available.

This new species is named after my friend and colleague Dr. H. Sipman, a distinguished lichenologist, who collected it on Mt Kinabalu in 1989. It has been found at two different elevations (2800 and 3200 m) on the southern slope of this mountain, well-known for its extraordinary biodiversity.

Acknowledgements. I would like to thank the curators of the following institutions and the colleagues who keep private herbaria which allowed me to study material in their care: B, GZU, TUR, UPS, herb. A. Aptroot, herb. K. Kalb, herb. A. Vězda. Special thanks are due to Dr. H. Sipman (B) who allowed me to publish the new species found in his collections from Mt Kinabalu. Prof. J. Lambinon

has read and improved my manuscript and is warmly thanked here.

My studies in Papua New Guinea are funded by the Belgian "Fonds de la Recherche Fondamentale Collective", contract no. 2.9006.86. I am mostly grateful for its financial support.

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