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**Abstract.** The occurrence of *Platismatia erosa* in Tibet and adjacent regions is reported. The shape of (hitherto rarely found) apothecia and pycnospores (the latter observed for the first time) are illustrated and compared with those of European material of *P. glauca*. TLC analyses of *P. erosa* samples revealed two substances, hitherto unknown in *Platismatia*, namely pannaric acid and jackinic acid, the latter also found in fruiting material of *Platismatia glauca* from Europe. Two chemotypes of *P. erosa* are recognized: chemotype I with caperatic acid as main fatty acid, and chemotype II (found only once) with jackinic acid as main aliphatic substance.

**Keywords.** Lichen, *Platismatia glauca*, conidia, chemotypes, taxonomy.

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Describing the genera *Cetrelia* W.L. Culb. & C.F. Culb. and *Platismatia* W.L. Culb. & C.F. Culb. in 1968 (Culberson & Culberson 1968) came early in the race to segregate new genera in the cetrarioid lichens (Parmeliaceae, lichenized Ascomycota) (Randlane et al. 1997). Delimitation of *Platismatia* was judged according to both morphological and chemical characters with in particular, the presence of caperatic acid in the medulla considered a decisive trait. According to the recent phylogenetic analyses, *Platismatia* belongs neither to the core group of cetrarioid lichens (Thell et al. 2002, 2009), nor to the parmelioid clades (Crespo et al. 2010), and its closest relatives in the family remain obscure.

The genus *Platismatia*, with eleven species known worldwide (Culberson & Culberson 1968; Lumbsch et al. 2011) shows its center of diversity in the northern hemisphere. Only *P. glauca* (L.) W.L. Culb. & C.F. Culb., the type species of the genus, is widely distributed (Culberson & Culberson 1968: 532, Fig. 22), occurring on all continents except Australia (fide McCarthy 2011). *Platismatia norvegica* (Lynge) W.L. Culb. & C.F. Culb., an oceanic species, inhabits the northern part of Europe, the southern part of the Russian Far East, and both coasts of North America. *Platismatia stenophylla* (Tuck.) W.L. Culb. & C.F. Culb. and *P. wheeleri* Goward, Altermann & Björk are endemic to North America. *Platismatia tuckermannii* (Oakes) W.L. Culb. & C.F. Culb., *P. herrei* (Imshaug) W.L. Culb. & C.F. Culb., and *P. lacunosa* (Ach.) W.L. Culb. & C.F. Culb., all of them with mainly North American distribution, were also reported from East Asia (see e.g. Urbanavichus 2010: 130). While *Platismatia formosana* (Zahlbr.) W.L. Culb. & C.F. Culb., *P. regenerans* W.L. Culb. & C.F. Culb., and *P. interrupta* W.L. Culb. & C.F. Culb. are restricted to several East Asian islands, *Platismatia erosa* W.L. Culb. & C.F. Culb., —the focus of the

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present contribution—is more widespread and occurring in several central- and east-Asian countries (for more detailed data see below).

Here we update the circumscription of the genus *Platismatia* and present new data on *P. erosa*, focusing on the morphology of pycnospores, chemical variation and its distribution in temperate Asia.

## Materials and Methods

Twenty-one collections of *Platismatia erosa* were studied. Part of this material was collected during two field trips of the first author to Tibet and adjacent areas in 1994 and 2000. Additional specimens come from collections of Georg Miehe (Marburg/Lahn, Germany) and Bernhard Dickoré (Munich, Germany). All cited specimens are housed in GZU. Habit photographs were taken with a LEICA Wild M3Z stereo-microscope assembled with a ZEISS Axiocam MRc5 camera. To extend depth of field of the images, the program 'CombineZP', open source image processing software, was used. Photos of spores and pycnospores came from a ZEISS Axioskop microscope, equipped with the same camera as given above.

For the identification of lichen substances, thin layer chromatography (TLC) was performed following Culberson & Ammann (1979) and Elix et al. (1987). Running height of the plates were 15 cm. For a better detection of fatty acids, glass plates (Macherey-Nagel TLC Plates, ADAMANT UV254 with 0.25 mm silica gel layer) were dipped into (rather calcium rich = 'hard') tap water for only 1 second (instead of spraying).

The following species and specimens (all GZU) were used as a source for comparison of secondary compounds in TLC studies:

- *Platismatia glauca* (all specimens with atranorin and caperatic acid syndrome):

  a) sterile material: Austria. Styria, Hochschwab-Gruppe, *Obermayer 10375*. Portugal: madeira. Pico Areeiro, Achada Grande, *Hafellner 28083*. Russia. Komi Republic, upper stream of Pechora River, *Zhurbenko 97141*; Murmansk Region, Kola Peninsula, along Evtyukovskii stream, *Zhurbenko 97120*. Uganda. Mount Elgon, 1°4′39″N, 34°28′42″E, *Wesche 1899*. U.S.A. new hampshire, White Mountain National Forest, *Wetmore 73113*.

  b) material with apothecia (partly with jackinic acid in addition): Germany. Schwarzwald, Baden, Nordhang des Notschreis, *Poelt 5056 & Wirth*. Slovenia. Pokljuka, Triglav National Park, Mrzli Studenec, *Mayrhofer 12495*. Italy. Calabria, Prov. Cosenza, Monte Pollino, Serra del Prte, *Poelt s.n.*

  c) material with apothecia and pycnospores: Slovenia. Triglav National Park, Pokljuka, Mrzli Studenec, *Mayrhofer 12495*.

- *Cladonia rangiformis* (source for rangiformic acid and norrangiformic acid): Spain. Sierra de Gata, 5 km NW of San José, 6.4.1979, *Buschardt s.n.*
- *Flavoparmelia caperata* (source for caperatic acid syndrome): Austria. Steiermark, Koralpe, Reinischkogel, Stangelbauer, *Teppner s.n.*
- *Lepraria jackii* (source for jackinic acid and norjackinic acid): Germany. 'Flora des Gesenkes', *Schenk s.n.*
- *Lepraria membranacea* (source for pannaric acid): Austria. Styria, Obertal S of Schladming, *Obermayer 09411*.
- *Lepraria diffusa* (source for 4-oxypannaric acid 2-methy lester): Austria. Styria, Grazer Bergland, W of Kleinstübing, 12.5.1988, *Moberg & Poelt s.n.*

## Results and Discussion

The genus *Platismatia* is characterized as follows (compiled from Culberson & Culberson [1968] and Ryan [2002]; supplemented by our own results): Thallus foliose (up to 20 cm broad) with often ascending and undulated lobe margins. Upper surface often shiny, grayish-white to (greenish-)brown (marginally often dark brown) and often net-like wrinkled, pseudocyphellae sometimes present (elongated, on ridges, often as a pre-stage of an area where later on isidia are developed), faintly elongated maculae present, isidia or soralia present in some species (on margins or laminal on ridges). Cortex in several species IKI+ bluish-lilac. Lower surface creamy white to shiny brownish (at the margin) or shiny blackish (at the center), often mottled, some species with white, punctiform (to slightly elongated), slightly raised pseudocyphellae. Apothecia rare, up to 4 cm in diameter, marginal or submarginal, with a brown (sometimes perforate) disc. Asci of the Lecanora-type, 8-spored. Spores single-celled, colorless, rather small (3.5–10.0 µm in length), ellipsoid or subglobose. Pycnidia rare, immersed, marginal. Conidia often cited as 'bacilliform' or 'rod-shaped', but at least in *Platismatia erosa* and *P. glauca* bottle-shaped (=sublageniform; see Thell 1995: 253) to slightly 'bowling pin-shaped', 4.0–7.8 × 0.85–1.30 µm. Chemistry: Atranorin, chloroatranorin (see Elix & Scholz 1995–2002), fatty acids (caperatic acid syndrome in most specimens, rarely substituted by jackinic acid syndrome [in *P. erosa*; discussion see below]), fumarprotocetraric acid (only in *P. lacunosa*), pannaric acid [in *P. erosa*; see below], pseudoplacodiolic acid (in *P. glauca*, see Elix & Scholz 1995–2002), yellow pigment(s?) (p.p. in *P. erosa, P. herrei, P. interrupta, P. regenerans*).

Phylogenetic inferences from DNA data (Thell et al. 1998) suggest that among *Platismatia glauca, P. herrei, P. lacunosa, P. norvegica, P. stenophylla*, and *P. tuckermanii*, *P. lacunosa* is the most divergent species. *Platismatia herrei* and *P. stenophylla* are only weakly distinct in their ITS sequences, although easily distinguished morphologically (margin of the lobes are isidiate in *P. herrei*). In addition, *Platismatia glauca* was shown to have the largest infraspecific variation in DNA sequences and a close relationship to *P. tuckermannii* was strongly supported. According to MycoBank (http://www.mycobank.org/DefaultPage.aspx) six taxa, formerly described at different taxonomical levels, are currently treated as 'forma' within *P. glauca* (i.e. *f. coralloidea* (Wallr.) J.C.Wei, *f. divaricata* (Rass.) S.Kondr., *f. fallax* (Weber) Oxner & S.Kondr., *f. fusca* (Flot.) Oxner & S.Kondr., *f. reticulata* (Rass.) S.Kondr., and *f. ulophylla* (Wallr.) Oxner & S.Kondr.). Note, that *Platismatia wheeleri* has been separated recently from *P. glauca* on morphological grounds (Lumbsch et al. 2011).

**Platismatia erosa** W.L. Culb. & C.F. Culb., Contr. U. S. Natl. Herb. 34: 526. 1968.

TYPE: TAIWAN (Formosa): Mt. Niitaka (=Mt. Morrison), *Sasaki* (holotype: W).

*Cetraria formosana* Zahlbr. var. *isidiata* Zahlbr., Repert. Spec. Nov. Fedde 33: 60. 1934 [1933].

*Cetraria reticulata* Krempelh. ex Räsänen, Kuopion Luonnon Ystäväin Yhdistyksen Julkaisuja, B 2, 6: 44. 1952 (not validly published, because not described in Latin; see Randlane & Saag 2000).

For the full and detailed description see Culberson & Culberson (1968: 527).

***Diagnostic morphological characters.*** Within the genus *Platismatia*, *P. erosa* is characterized by the combination of the following five traits: 1) reticulately ridged upper surface (rarely almost not ridged) (**Figs. 1B & 2A**), 2) isidia on ridges of marginal lobes (rarely absent) (**Figs. 3A–C**), 3) rather small, elongated pseudocyphellae on the upper surface (mostly on the crest of ridges) (**Fig. 2B**), 4) small, white, punctiform or shortly elongated pseudocyphellae on the lower surface (**Fig. 3A**), 5) a negative colour reaction of the upper cortex with IKI.

***Comments on fertile structures.*** Conidia (=pycnospores=pycnoconidia=spermatia) are rare in *Plastimatia* (Culberson & Culberson 1968: 525) and pycnidia producing conidia were unknown in *P. erosa*, which is very infrequently fertile (Culberson & Culberson 1968: 527). As already discussed in detail for *Cetraria islandica* (Obermayer 2008: 125–126), also for *Platismatia*, literature information on shape of conidia is rather divergent. In the monograph of *Platismatia*, Culberson and Culberson (1968: 525) note that conidia are "…rod-shaped the ends not inflated…". Yet, under *P. glauca*, the authors refer to the observations of Hillmann & Grummann (1957: 671) that pycnoconidia are "…an einem Ende verdickt…" (i.e. thickened at one end). Even in rather recent treatments, like the British Lichen Flora, the shape of conidia is given as "…cylindrical, not swollen at apices…" (Duke & Purvis 2009: 719), although previously Thell (1995: 253) and Thell et al. (2002: 337) described the conidia as 'sublageniform (=bottle-shaped)' in the cetrarioid genera *Cetrariella* Kärnefelt & A. Thell, *Platismatia* and *Vulpicida* J.-E. Mattsson & M.J. Lai. Most recently, Thell et al. (2009) regarded the shape of conidia as having the "…strongest correlation with DNA based phylogeny…" and state, that "…the main difference between the conidia is the number of swellings: none, one or two…". The 'bottle-shaped' conidia of the group cited above were included in the type with one swelling. We generally accept this term for the pycnoconidial type also for our two studied taxa. A closer view additionally shows, that part of the conidia look slightly 'bowling pin-shaped', with two unequal swellings connected by an elongated conical neck (best seen in **Fig. 4A** [two pictures at far right]; in comparison, conidia of *Cetrelia chicitae* (W.L. Culb.) W.L. Culb. & C.F. Culb. with two symmetrical swellings [dumb-bell shaped] are pictured in Obermayer & Mayrhofer 2007: 282, Fig. 43).

The conidia of *Platismatia glauca* and *P. erosa* are morphologically similar and differ only in their length ([4.5–]4.9–5.3[–5.8] µm in *P. erosa* versus

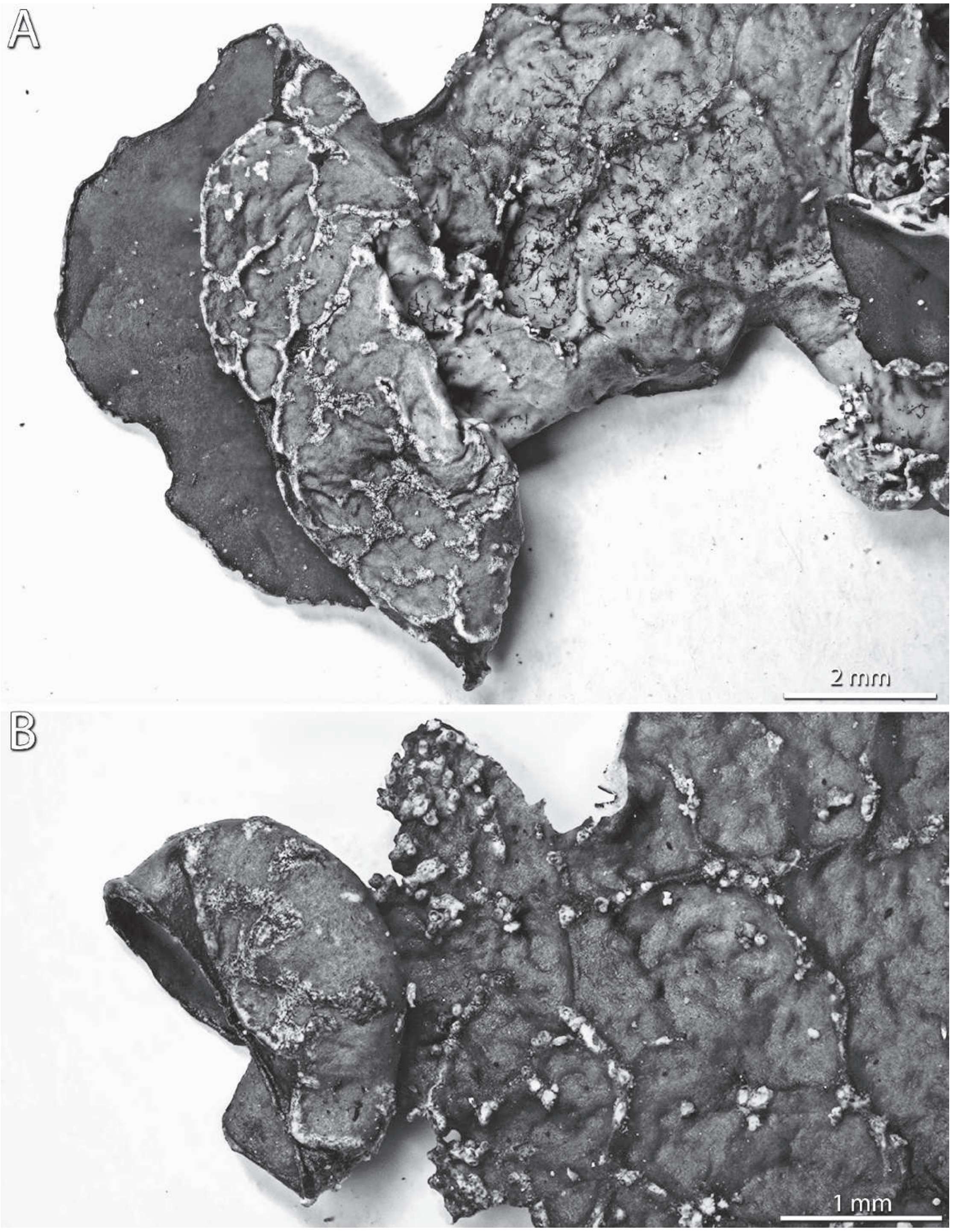


**Figure 1. A & B.** Fertile material of *Platismatia erosa* (*Miehe 94-208-6-K*, GZU). Pseudocyphellae (developed as net-like structures on crests) on thallus and lower side of margins of apothecia.

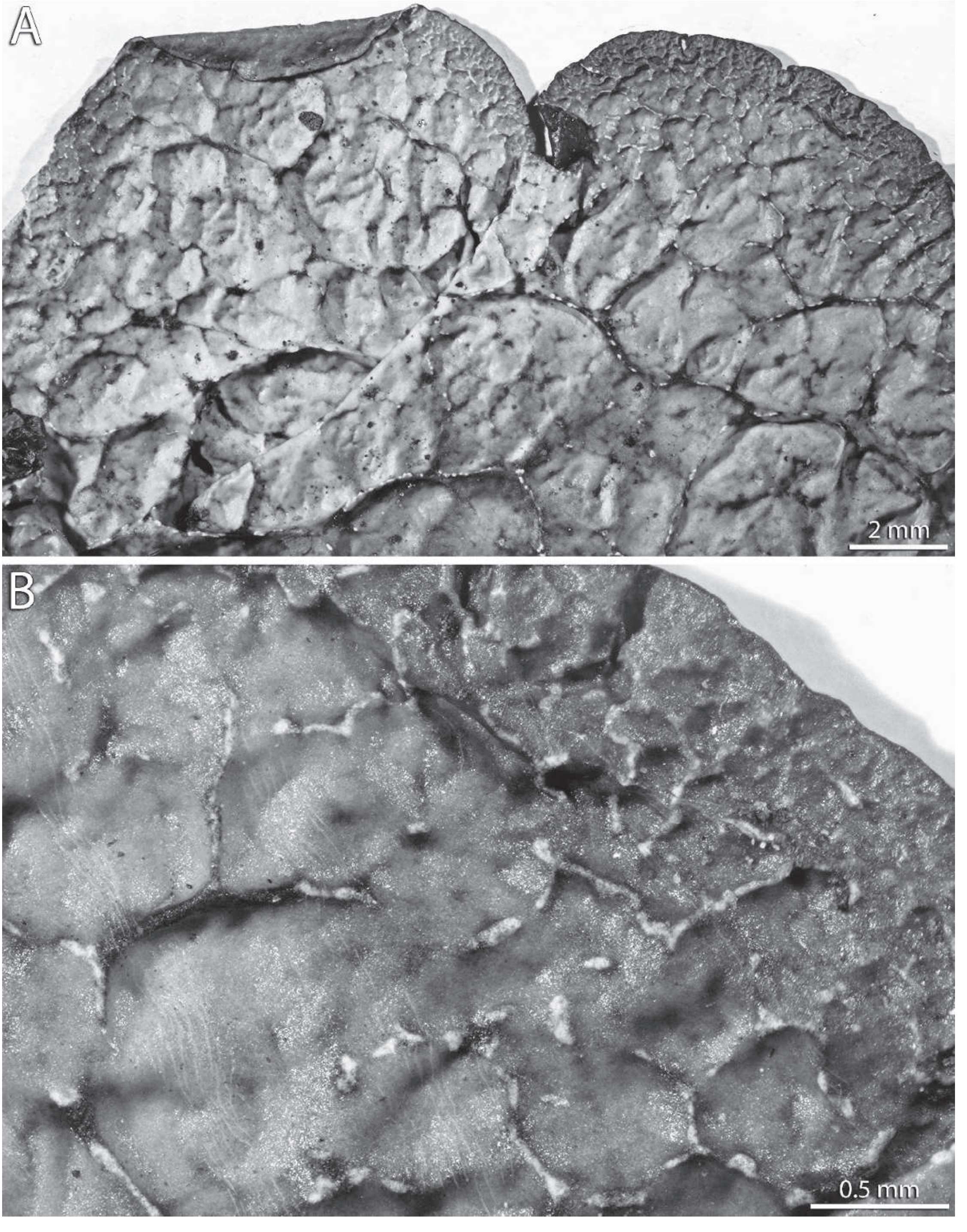


**Figure 2. A & B.** Thallus (upper surface) of *Platismatia erosa*, chemotype II (*Miehe 00-291-34-02*, GZU). Elongated pseudocyphellae on crests.

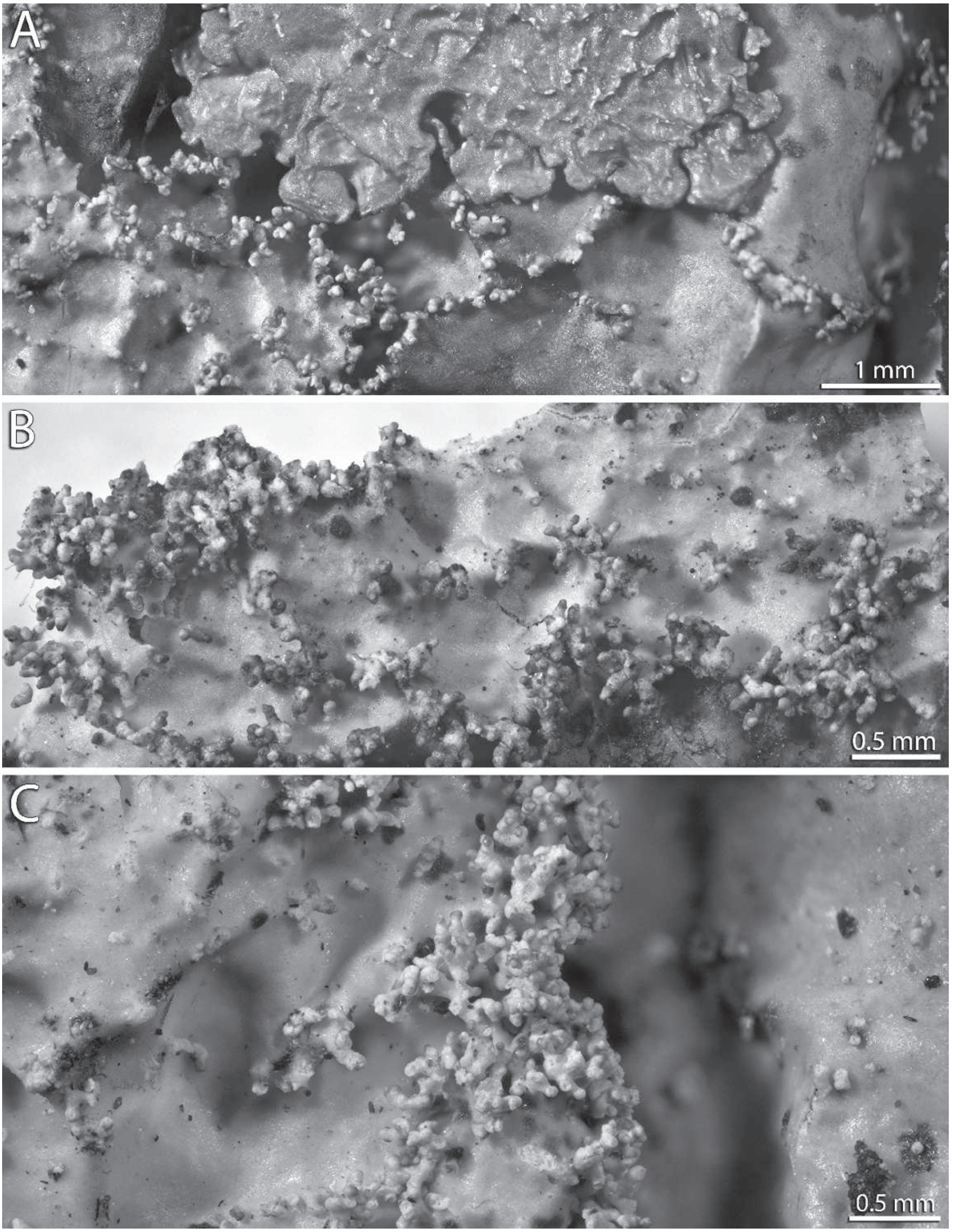


**Figure 3.** Development of isidia in *Platismatia erosa*. **A & B.** Chemotype II (*Miehe 00-291-34-02*, GZU). Upper part of A shows the lower side of the thallus with punctiform and elongated pseudocyphellae. **C.** Chemotype I (*Obermayer 6929*, GZU).

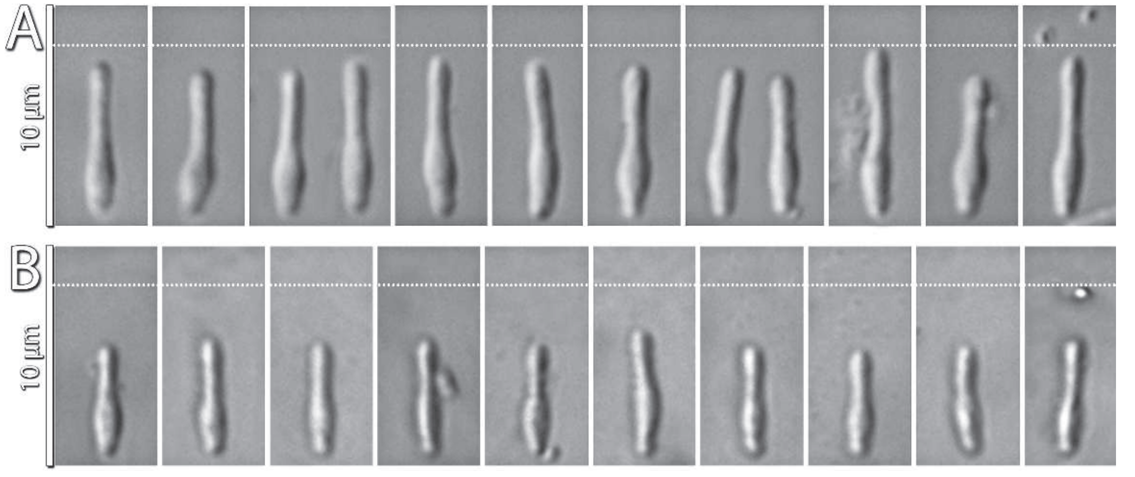


**Figure 4.** Bottle-shaped to slightly 'bowling pin-shaped' conidia (spermatia) in *Platismatia*. **A.** *Platismatia glauca* (*Mayrhofer 12495*, GZU). **B.** *Platismatia erosa* (*Miehe 94-208-6-K*, GZU). The dotted line (in **A** and **B**) marks the length of the longest conidium in *Platismatia glauca* (7.8 µm).

[5.6–]6.0–7.4[–7.8] µm in *P. glauca*) (**Figs. 4A, B**) and very slightly in their thickness (1.10–1.30 µm [bigger swelling at the base] / 0.80–0.90 µm [middle constriction] / 0.90–1.00 µm [smaller swelling at the top] in *P. erosa* and 1.35–1.45 µm / 1.00–1.15 µm / 1.15–1.20 µm in *P. glauca*).

The apothecia of the present material (**Figs. 1A, B**) are rather large (up to 1.2 cm in diam.) and imperforate. The 'thalline margin' is covered with strongly elongated pseudocyphellae, which form a net like structure.

***Comments on the chemistry.*** Two chemotypes were identified in *Platismatia erosa*. Chemotype I contains atranorin and caperatic acid as major substances, a further fatty acid of the caperatic acid syndrome, pannaric acid (in traces or not detected), and jackinic acid (traces or mostly not detected). Chemotype II contains atranorin and jackinic acid as major substances, norjackinic acid (traces), and pannaric acid (traces). The majority of our specimens represent chemotype I while only one specimen belongs to chemotype II.

The detection (**Fig. 5**) and distribution of these compounds is summarized here:

- Atranorin: the substance occurs in almost all specimens in variable amounts and is totally lacking only in one specimen. The presence of chloroatranorin was not tested.
- Caperatic acid: this fatty acid is always present in chemotype I, but lacks in chemotype II. A lack of caperatic acid in members of the genus *Platismatia* was previously only recorded from *P. lacunosa* (see Culberson & Culberson 1968: 542). The spot contours of caperatic acid shows a bulge towards the top of the plate in solvent system A and towards the baseline in B′ and C. In solvent system B′, a second, much weaker fatty acid spot appears shortly below the 'double spot' of caperatic acid.
- Jackinic acid: the identity of this compound (including norjackinic acid) was proven with extracts of *Lepraria jackii* (determined by Kümmerling in 1993). The rather similar running rangiformic acid (extracted from *Cladonia rangifor mis*) is slightly below jackinic acid in B′ and slightly above in A and C (note that in 1988 Johnson & C.F. Culberson annotated a specimen from the Langtang Area [*Miehe 13824f*] with "…rangiformic acid++, prob. tr. norrangiformic acid…"). Chemotype II contains jackinic acid in rather high concentration, whereas in chemotype I the substance is present in trace amounts or often not detectable. One specimen (*Miehe 13824f*) containing a noticeable amount of jackinic acid was included here because of the additional occurrence of caperatic acid as main substance. Two fertile specimens of *Platismatia glauca* were tested in comparison: in one specimen (*Poelt s.n. 10.VII.1988*), the apical part of a thallus lobe (with apothecia) was compared with the basal part of the same lobe (without apothecia). Only the fertile piece contained jackinic acid in detectable amounts. The second fertile specimen (*Poelt 5056*) revealed small amounts of jackinic acid also in non-apothecia-bearing lobes. Further chemical studies might show, whether this fatty acid is constant (but mostly very low concentrated) in samples of *Platismatia glauca* in other regions of the world.
- Pannaric acid: when first encountered, this substance was regarded as a contaminant from a leprarioid lichen (soredia of *Lepraria* s. lat. were occasionally found on upper or lower surfaces of thalli of our *Platismatia* specimens). Thus some samples have been tested twice or even four times, and special

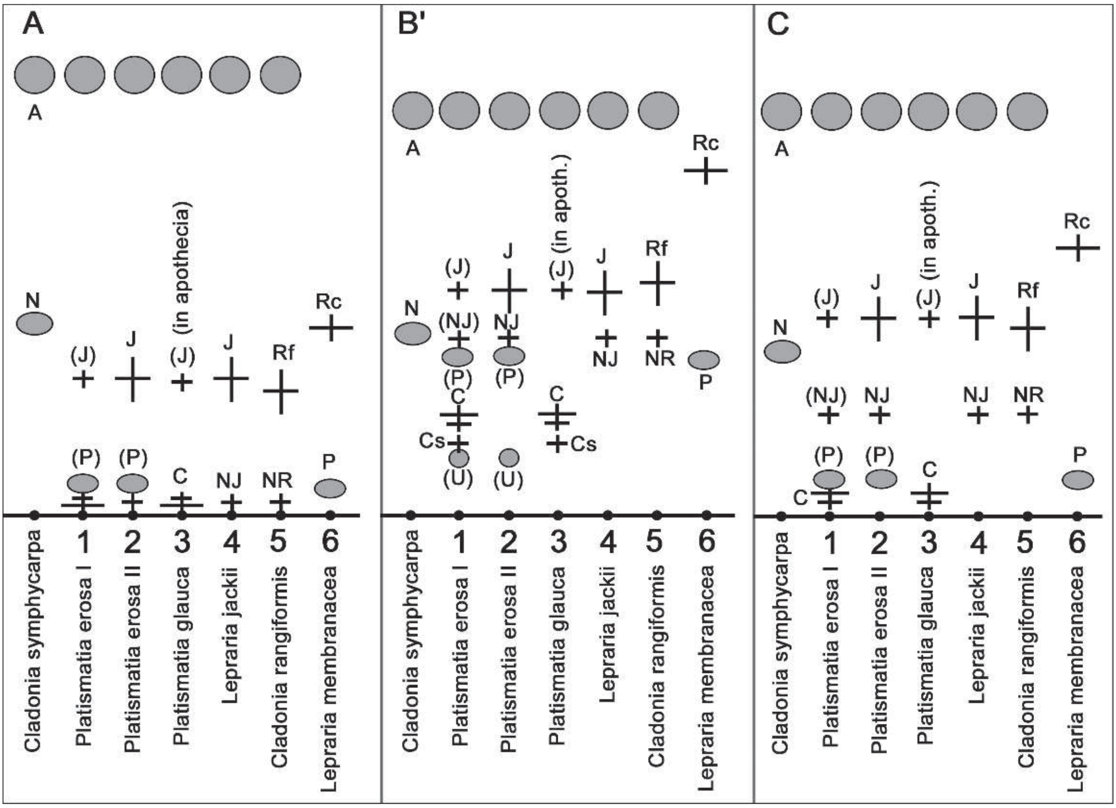


**Figure 5.** Running heights of lichen substances (in solvent systems A, B′, and C) extracted from *Platismatia erosa* and *P. glauca* (*Cladonia symphycarpa, Lepraria jackii, Cladonia rangiformis*, and *Lepraria membranacea* were used as sources of compounds for comparison). **A.** In solvent A. **B.** In solvent B′. **C.** In solvent C. Abbreviations: A = atranorin, C = caperatic acid (partly seen as double spot and thus marked with a double cross), Cs = fatty acid of the caperatic acid syndrome, J = jackinic acid, N = norstictic acid, NJ = norjackinic acid, NR = norrangiformic acid, P = pannaric acid, Rc = roccellic acid, Rf = rangiformic acid. Substance abbreviation in parentheses means lichen substance present in low amounts or absent.

care has been applied to avoid even traces of admixtures. The extract of the cleaned samples were run side by side with that of *Lepraria membranacea* (a source for pannaric acid). Running height, as well as colour and contour characters of the spot exactly matched that of pannaric acid. A second, weaker, spot with similar UV-characteristics appears in B′ slightly above the height of 4-oxypannaric-acid-2-methylester (extracted from *Lepraria diffusa* (J.R. Laundon) Kukwa). Minor amounts or traces of pannaric acid were found in the following 7 specimens of *Platismatia erosa*: *Miehe 7619* (this specimen showed the highest amount), *Miehe 00-13-07/04*, *Miehe 00-137-42/03*, *Miehe 00-291-34/02*, *Miehe 00-336-15(II)/04*, *Obermayer 6287* and *Olley AC11-duplum*.

- Unknown pigment: a yellow pigment (which was not found in the present study) is reported for *Platismatia erosa* as well as for *P. interrupta*, *P. formosana*, and for *P. regenerans* (Culberson & Culberson 1968, Plate 6, Fig. 35). Note, that pseudoplacodiolic acid, which is cited for *P. glauca* (Elix & Scholz 1996–2002) can be seen on TLC-plates in daylight as a pale dull yellow pigment (if it is very strongly concentrated).

***Distribution and ecology.*** *Platismatia erosa* is known from Bhutan (see Global Biodiversity Information Facility website [http://www.gbif.org/] specimen in LD), China (provinces of Sichuan [Culberson & Culberson 1968: 529], Xizang [Wei 1991: 206], and Yunnan [Aptroot & Sparrius 2011]), India (Sikkim and Darjeeling; Awasthi 2007), Indonesia (Java), Japan, Nepal (Culberson & Culberson 1968: 529; Poelt 1990: 438), Taiwan, Philippines, Russia (Far Eastern Federal District; Chabanenko 2002: 98), and Vietnam (Culberson & Culberson 1968: 529). In the Tibetan Area, *Platismatia erosa* shows an altitudinal range between 3000 and 4600 m and was found on the following substrates: *Abies*, *Betula*, *Juniperus*, *Rhododendron*, *Salix*, as well as on lignum and rock walls. Considering the extensive lichen collections

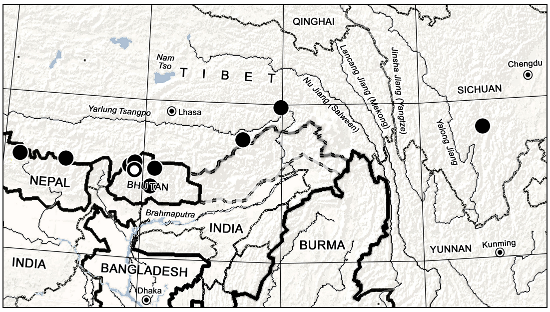


**Figure 6.** Geographic distribution of examined specimens of *Platismatia erosa*. Black dots: chemotype I. Circle: chemotype II.

available from Nepal, Tibet, and Bhutan in GZU, and the low number of records of *P. erosa* from this huge area (**Fig. 6**), the species can be regarded as rare. The few reports of *P. glauca* from Yunnan (Hue 1887:19; Hue 1889: 163) and Sichuan (Zahlbruckner 1934: 211), which are cited in Wei (1991: 207) most probably refer to *Platismatia erosa*. Furthermore it is worth noting that of the 850 lichen collections of Handel-Mazzetti from South-West China, none were assigned by Zahlbruckner (1930: 197) to *Platismatia* (at that time summarized under *Cetraria glauca* s.l.). This suggests that overall the genus Platismatia is rare in South-East Tibet and adjacent areas.

***Phylogenetic relationship.*** Only one specimen of *Platismatia erosa*, has hitherto been included in phylogenetic studies (Thell et al. 2002: 347, 'Clade A'). The published strict consensus tree illustrates its genetic distance from *P. glauca*. Although not having included other taxa of *Platismatia*, these authors resolved *P. formosana* and *P. regenerans* as the closest relatives to *P. erosa* (Thell et al. 2002: 346). Morphologically, these two taxa differ from *P. erosa* in always lacking isidia and *P. regenerans* further differs by the absence of reticulately ridged on the upper surface of the thallus. The isidiate *P. erosa* can be mistaken for two other isidiate taxa of *Platismatia*, namely *P. norvegica* or *P. interrupta*. *Platismatia norvegica* lacks pseudocyphellae on the upper and lower surfaces of the thallus. *Platismatia interrupta* bears pseudocyphellae on the upper surface but they are much bigger than in *P. erosa* and are not only confined to the crests of the ridges (as in *P. erosa*). In addition, *P. interrupta* lacks pseudocyphellae on the lower surface.

***Specimens of examined*: chemotype 1** (atranorin, caperatic acid, pannaric acid [traces or not detected], jackinic acid syndrome in traces or mostly not detected): BHUTAN. Tongsa distr., Black Mountains NW of Nubji, *Miehe 00-13-07/04, 00-13-10/05*; Gasa distr., Limithang, *Miehe 00-252-03(II)/10*; W of Tarina Lakes, *Miehe 00-336-15(II)/04*; Bumtang distr., below Tsochen Chen, *Miehe 00-137-42/03*. CHINA. TIBET, PROV. XIZANG: W above Gyala Peri-N Glacier, *Miehe & Wündisch 94-208-6K* [fertile material!]; Tsangpo tributary, Lilung Chu Eastern branch, *Dickoré & Wündisch 94-180-6D*; Himalaya Range, 40 km SW of Mainling, *Obermayer 06017*; 45 km SW of Mainling, *Obermayer 06279, 06287*; Nyainqêntanglha Shan, N-Side of Gyala Peri, 6 km S of Dongjug village, *Obermayer 06929;* W above Gyala Peri-N Glacier, *Miehe (94-215-42/04-B) & Wündisch*. Everest E, Kama Chu, W of Sakyetang, *Dickoré K-84-11, K-84-12*. PROV. SICHUAN: Gongga Shan, Hailougou glacier and forest park, *Obermayer 08599, 09028, 09040*. NEPAL. Langtang Area, Phedi above Tarkegyang, *Miehe 7619*; Upper Langtang, near Brombring, *Miehe 13824f*; Gopte to Tharepati, *Sharma Olley & Cross AC-11-duplum*. **Chemotype 2** (atranorin [major], jackinic acid [major], norjackinic acid [traces], pannaric acid [traces]; caperatic acid not detected!): BHUTAN. Flor-Prov. N18 (Upper Mo Chu), Gasa distr., Rodophu, 28°02′N, 89°47′E, 4220 m altitude, *Juniperus indica* forest on S-facing slope, 16.VIII.2000, *Miehe (00-291-34/02)*.

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