

A note on the occurrence of *Xanthoparmelia saxeti* (Stizenb.) Amo, A. Crespo, Elix & Lumbsch in India

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The paper describes for the first time the occurrence of *Xanthoparmelia saxeti* (Stizenb.) Amo, A. Crespo, Elix and Lumbsch in Himalaya, where it was found growing over siliceous rocks in and around Sun Temple, Kosi Katarmal, Almora district, Uttarakhand. Previously, the species was reported for the first time under the name *Karoowia saxeti* from Karnataka and recently Divakar and colleagues collected specimens from the same state, but the species had not been previously mentioned by any Indian worker from India. A brief description of the species along with the status of *Karoowia* and *Xanthoparmelia* is given in the text.

Keywords: Himalaya; *Karoowia*; Uttarakhand; *Xanthoparmelia saxeti*

Introduction

Himalaya is one of the biodiversity hotspots considered by Conservation International. Moreover, it has always been a delight for lichenologists, with several new species and new varieties being described from the area, including the most diverse and well-studied Parmelioid lichens, which are abundant here. Parmelioid lichens, a diverse and ubiquitous group of lichens and the largest group within Parmeliaceae (Crespo et al. 2007), is also one of the largest families of lichen-forming fungi and has a worldwide distribution.

The group has approximately 1800 species (DePriest 1999; Hale and DePriest 1999; Crespo et al. 2007; Kirk et al. 2008; Thell et al. 2012) and includes species that are mainly foliose, usually with rhizines on the lower surface, *Lecanora*-type asci, simple hyaline ascospores and laminal pycnidia (Crespo et al. 2007, 2010). Within this group, nine well-supported clades were found that show distinct ecological preferences (Crespo et al. 2010).

One of the major clades identified among parmelioid lichens is the *Xanthoparmelia*-clade (Blanco et al. 2006; Lumbsch et al. 2008; Crespo et al. 2010). This monophyletic clade includes only one genus, *Xanthoparmelia*, having more than 700 species (Hale 1990; Blanco et al. 2004) occurring on siliceous rocks or soil mainly in arid or semi-arid subtropical areas, with some species extending into temperate regions, with a centre of diversity in the southern hemisphere. Morphological variations within this clade are likely to be driven by environmental factors and were overemphasized in previous classifications (Lumbsch et al. 2008). The species in this clade lack true pseudocyphellae, have a pored epicortex (Blanco et al.

2004, 2006), small ascospores with an arachiform vacuolar body (del Prado et al. 2007); they show a considerable variation in cortical chemistry, including species containing usnic acid, atranorin or lacking cortical phenols (Blanco et al. 2004, 2006), and have cell wall polysaccharides with *Xanthoparmelia*-type lichenan. Within this clade, many previously described genera (e.g. *Almbornia* Essl., *Chondropsis* Nyl. ex Cromb., *Namakwa* Hale, *Neofuscelia* Essl., *Omphalodiella* Henssen, *Paraparmelia* Elix and J. Johnst., *Placoparmelia* Henssen and *Xanthomaculina* Hale), including genus *Karoowia* Hale, were synonymized under *Xanthoparmelia* (Hawksworth and Crespo 2002; Elix 2003; Blanco et al. 2004; Thell et al. 2006; Amo et al. 2010a, 2010b).

The genus *Karoowia* was earlier segregated from *Xanthoparmelia* by Hale (1989) to accommodate 19 subcrustose species similar to *Xanthoparmelia* but differs in having rhizoid-like structures instead of true rhizines and producing longer cylindrical conidia (6–12 mm long) in comparison to the shorter bifusiform to bacilliform (4–9 mm long) conidia present in *Xanthoparmelia*. Recently, the phylogenetic position of *Karoowia* was investigated using a combined data set of internal transcribed spacer (ITS), nuclear large subunit (nuLSU) and mitochondrial small subunit (mtSSU) sequences of rDNA, revealed that characters such as growth form and conidial morphology are homoplasious within the *Xanthoparmelia*-clade and all species of *Karoowia* and *Xanthoparmelia* examined show reactions typical for the *Xanthoparmelia*-type lichenan (Blanco et al. 2004; Amo et al. 2010b). Molecular studies also revealed that *Karoowia* species do not form a monophyletic group but cluster with different

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clades within *Xanthoparmelia*, indicating that the subcrustose thallus has evolved several times in different clades of *Xanthoparmelia* (Amo et al. 2010b) and confirming previous findings that growth form is a poor phylogenetic discriminator at the generic level in the *Xanthoparmelia*-clade.

During a field trip to Sun Temple, Kosi Katarmal, Almora, Uttarakhand, one of the authors (YJ) found luxuriant growth of foliose lichen on vertical surfaces of sandstones, growing in association with *Caloplaca cinnabarina* (Ach.) Zahlbr., *Lecanora* sp., *Phaeophyscia hispidula* (Ach.) Essl., *Endocarpon* sp., *Xanthoparmelia coreana* (Gyeln.) Hale. The species at first glance was revealed to be *Karoowia saxeti*, which was previously reported from Karnataka in India (Hale 1989). An extensive literature survey regarding its occurrence within India (Divakar and Upreti 2005; Awasthi 2007; Singh and Sinha 2010) revealed that the species was not previously reported from India and is also now being synonymized under *Xanthoparmelia* (Amo et al. 2010b). However, during the field trip to Western Ghats in 2008, the species was once again collected from the same state by P. K. Divakar and D. K. Upreti and lodged in the National Botanical Research Institute (LWG-19727i) with a duplicate in Universidad de Complutense, Spain, where it was sequenced (MAF 16,624). The present study of its occurrence in subtropical regions of Western Himalaya extends its distribution within India and raises the tally of *Xanthoparmelia* to 17.

A brief description of the species is provided here-with along with ecological remarks.

Materials and methods

The study is based on specimens collected in and around Sun Temple, Kosi Katarmal, Almora and deposited at the herbarium of Kumaun University, Almora (ALM). Morphological characters of thallus, colour, size and shapes were examined under a stereo-zoom dissecting microscope (SZM-2LED OPTIKA). Thin hand-cut sections were made for studying the anatomy of thalli and were examined under a compound microscope (B-150DB OPTIKA). Colour spot test reactions were carried out on thalli using routine reagents K (potassium hydroxide), C (bleach) and Pd (para-phenylenediamine). Thin-layer chromatography was performed as described by Orange et al. (2001).

Taxonomic observations

Xanthoparmelia saxeti (Stizenb.) Amo, A. Crespo, Elix and Lumbsch, Aust. Syst. Bot. 23(3): 182. 2010. (Figure 1)

Diagnostic characters

Thallus subcrustose, more or less lobate at the centre with clearly lobed margins, pale yellowish green,



Figure 1. *Xanthoparmelia saxeti* (Stizenb.) Amo, A. Crespo, Elix and Lumbsch. Scale = 5 mm.

saxicolous. Lobes irregular, flat to more or less convex, contiguous to subimbricate. Upper surface emaculate, moderately isidiate. Isidia subglobose to cylindrical, darkening at the tips and unbranched. Lower surface of the thalli black with a spongy rhizoidal and lamellar layer.

Chemistry

Spot tests: Cortex K⁻, medulla K⁺ yellow, C⁻, KC⁻, Pd⁺ orange. Thin-layer chromatography stictic acid, norstictic acid and usnic acid.

Specimen examined

INDIA: Uttarakhand: Almora district, Sun Temple, Kosi Katarmal, 29°37'55" N, 79°36'53" E, altitude 2116 m, on rock, 21 April 2013, Y. Joshi and party, s.n. (ALM).

Discussion

In the present paper an attempt has been made to provide the current status of *Karoowia saxeti* in India. It is the most widespread species of this genus across the world and occurs commonly on sandstones in South Africa,

southwest Africa, Brazil, Uruguay, Australia, Hong Kong, Taiwan and Japan (Lim et al. 2006). East Asian specimens (Taiwan, Japan and Korea) were mainly found along sea coasts (Lim et al. 2006; Joshi et al. 2010) in association with *Caloplaca cinnabarina*. In India, the species was previously reported from Kuvempu University Campus, Karnataka at an elevation of 685 m. The present study reveals its luxuriant growth on vertical surfaces of sandstones at an altitude of 2116 m in association with species of *Caloplaca cinnabarina*, *Lecanora* sp., *Phaeophyscia hispidula*, *Endocarpon* sp., *Xanthoparmelia coreana* so extending its distribution in Himalaya up to a height of 2116 m.

This taxon is often confused with *Xanthoparmelia conspersa* (Ehrh. ex Ach.) Hale and *Xanthoparmelia pseudocongensis* Hale in having similar chemistry, black lower surface and cylindrical isidia, but differs in being distinctly subcrustose/effigurate. Both *X. conspersa* and *X. pseudocongensis* are distinctly foliose.

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