PRIMARY RESEARCH PAPER | *Philippine Journal of Systematic Biology*
DOI 10.26757/pjsb2022a16003

Two new records of Philippine *Parmotrema* species (Ascomycota) from Mt. Candalaga, Maragusan, Davao de Oro

Paulina Adanglao-Bawingan[1,2]*, Princes Luise C. Dela Tina[3,4], Pradeep Kumar Divakar[5]

Abstract

This paper reports two *Parmotrema* species new to the Philippines, sampled from Mt. Candalaga, Maragusan, Davao De Oro during an initial survey of lichen diversity and distribution on the mountain. This resulted to a total of 32 *Parmotrema* species described from the Philippines to date. The finding confirmed the presence of more undiscovered lichen species in many places around the country, especially in Mindanao. In addition, an updated key for the identification of the known Philippine *Parmotrema* species is given.

Keywords: lichen, mycology, Parmeliaceae, *Parmotrema melanothrix, Parmotrema planatilobatum*

Introduction

The latest report on Philippine *Parmotrema* (Bawingan *et al*. 2017) showed 30 identified species collected from various parts of the country, mostly in high-altitude areas. However, there are still many unexplored forests and mountains in the Philippines where lichens are yet to be discovered. Mt. Candalaga in Maragusan, Davao De Oro on Mindanao Island is one of them.

Mt. Candalaga stands at more than 2,400 m above sea level and its tough trails make trekking difficult but this is outweighed by amazing views, the invigorating deep forest, and the calming sound of its 13-level Marangig waterfalls. Located within the municipality of Maragusan in Davao de Oro province (**Fig. 1**), it is home to the ethnic Mandaya and Mansaka tribes. The mountain is said to be untamed and wild and houses a forest with deep and dense foliage where diverse flora and fauna are found (Pinoy Mountaineer 2008). One observes along the trail many orchids, ferns, vines, and trees covered with moss. *Rafflesia mira Fernando & Ong*, the largest among the *Rafflesia* species in the Philippines, with a diameter of 22-29 cm was first discovered in the area in 2005. The average lowest temperature in Maragusan is 24°C in the month of November to January but the temperature can drop by 5°C in the mountain (Gabriel n.d.). The average precipitation in the area is 140.4 mm, the average humidity is 82%, and the average dew point is 25°C (Climate and Weather Averages in Maragusan n.d.).

The first lichen collecting trip on Mt. Candalaga was conducted in November 2021. This initial survey of the lichen flora of Mt. Candalaga resulted in the identification of more than 80 species of lichens. Eight out of these identified lichens belong to the genus *Parmotrema*. Six of the eight have been previously reported from the Philippines: *Parmotrema clavuliferum* (Räsänen) Streimann, *P. cristiferum* (Taylor) Hale, *P. grayanum* (Hue) Hale, *P. reticulatum* (Taylor) M. Choisy, *P. tinctorum* (Despr.) Hale, and *P. submerrillii* Elix. Two of the eight are new records which are presented and described in this paper. Subsequently, an update of the key to the Philippine *Parmotrema* species is also provided.

[1]Graduate School, University of Santo Tomas, Sampaloc, Manila 1008, Philippines
[2]School of Advanced Studies, Saint Louis University, Baguio City 2600, Philippines
[3]Bukidnon State University, Malaybalay City 8700, Philippines
[4]Davao De Oro State College-Maragusan Branch, Maragusan, Davao De Oro 8808, Philippines
[5]Faculty of Pharmacy, Universidad Complutense de Madrid, 28040 Madrid, Spain

*Corresponding author: pbawingan@gmail.com

Date Submitted: 03 September 2022
Date Accepted: 10 October 2022

Materials and Methods

After securing the necessary permits to conduct the study, lichen collection was done following standard protocol. Purposive sampling along 100 m long transects in different elevations along the mountain was employed. Lichens were placed in paper packets with proper labels, then air-dried, examined, and identified in the laboratory. Morphological observations were made using a stereomicroscope; anatomical structures such as sections of the thallus and apothecia, as well as spore types, were observed under a compound microscope. Lichen substances were determined using the standard spot tests. Spot test involves the use of reagents such as KOH (K test), para-phenylenediamine (P test), and NaOCl (C test). A drop of these solutions was placed on the cortex and the medulla. The presence or absence of color changes may indicate the presence of certain lichen acids in the specimen. TLC was also undertaken to verify these determinations using solvents A and C following procedures described by Elix and Ernst-Russell (1993) and Orange et al. (2001). Spots were evaluated based on their retention factor (Rf) and spot colors under white light and UV light short wavelength (254 nm) and long wavelength (365 nm). Identification of the new records was verified after a thorough examination of their features.

Results and Discussion

One of the two new records, *Parmotrema melanothrix* (Mont.) Hale, was previously reported from South America, particularly in Brazil (Eliasaro & Donha 2003), Chile (Kennedy 2022), Paraguay (Telenius & Shah 2018), Colombia (University of Minnesota Bell Museum 2021), and from New Guinea (University of Minnesota Bell Museum 2021) and India (Mishra & Upreti 2017). The other new record, *Parmotrema planatilobatum* Hale

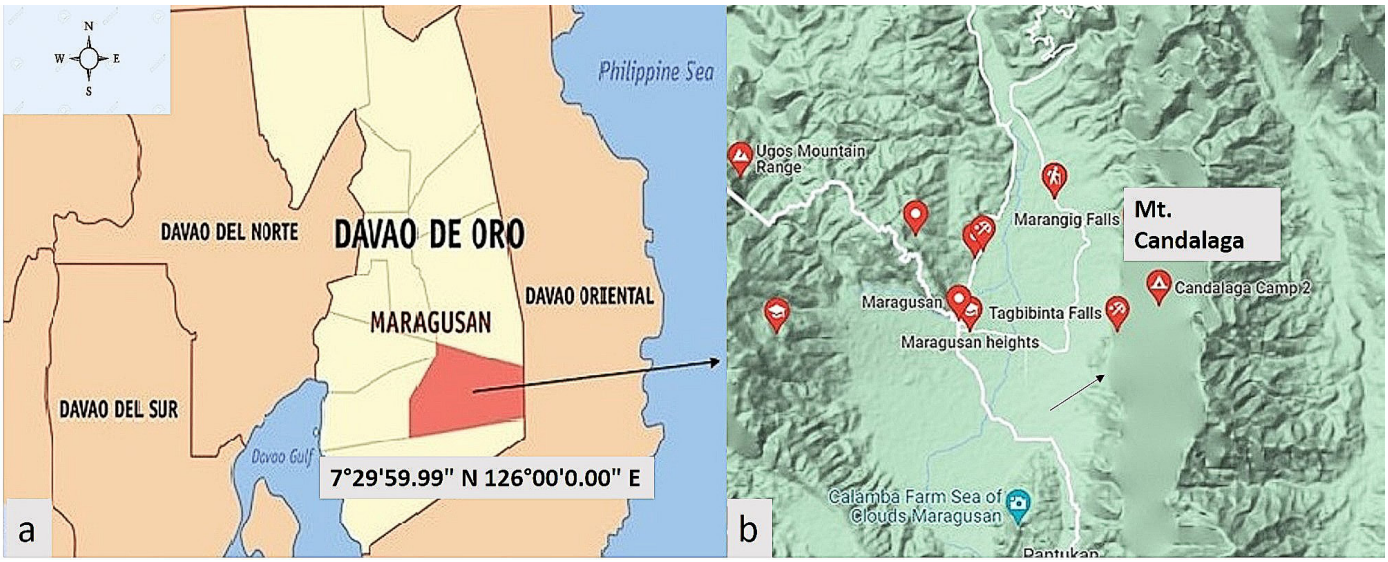

Figure 1. Map of Maragusan (a) and location of Mt. Candalaga in the municipality (b) with respect to other tourist spots. Map of Maragusan was obtained from https://commons.wikimedia.org/wiki/File:Ph_locator_davao_de_oro_maragusan.svg; location of Mt. Candalaga obtained from https://www.google.com/maps/place/Mount+Candalaga/

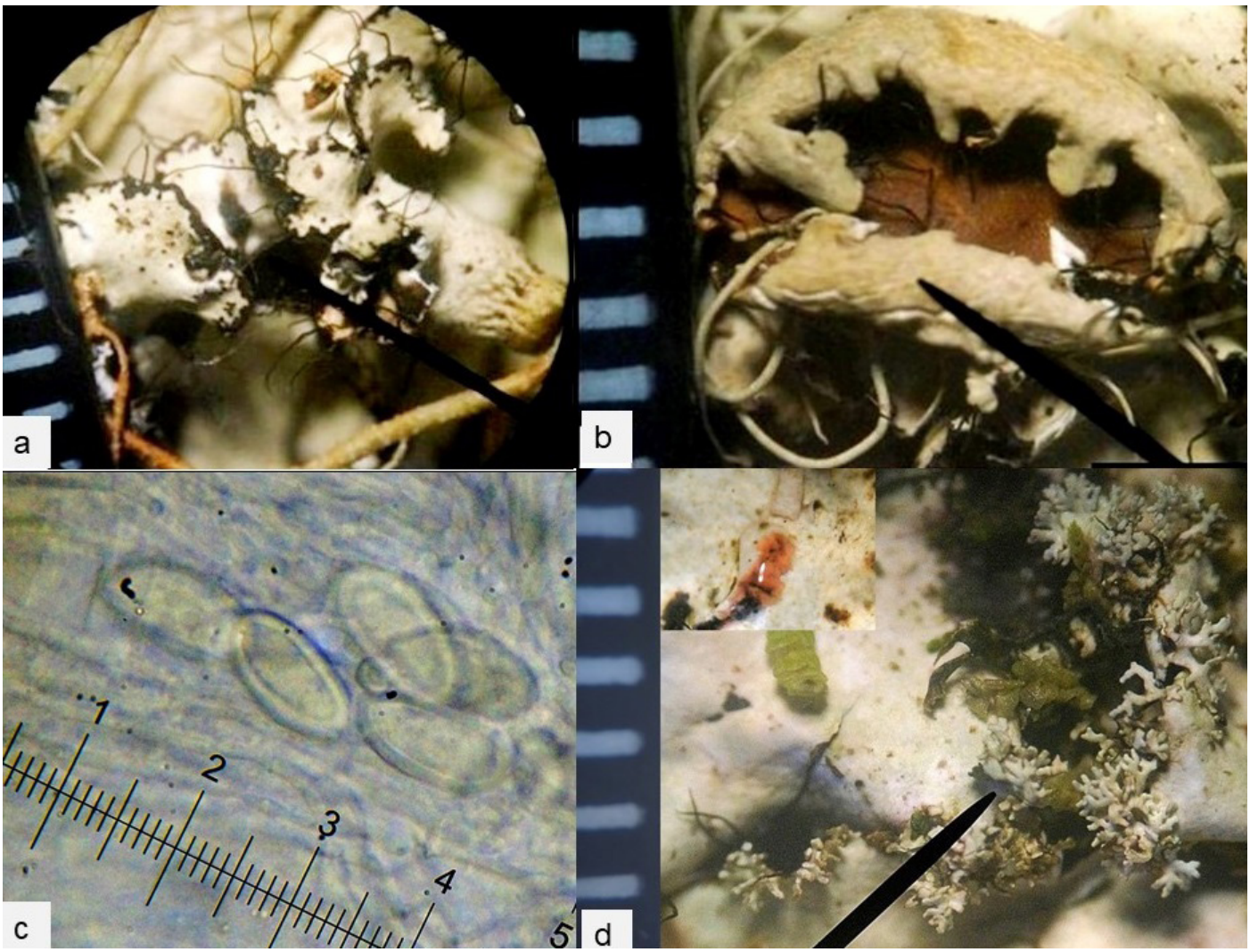

Figure 2. Features of the two new records of Philippine *Parmotrema* species observed under the microscope: *Parmotrema melanothrix* lobes thallus showing cilia, pycnidia, and developing apothecium (a), apothecium with ciliate external exciple (b), and simple, oval-ellipsoid spores (c); *Parmotrema planatilobatum* showing lacinulate phyllidia (d) and the C+ pale pink reaction (inset). Scale of ruler shown: 1 division = 1mm. Scale in the micrometer eyepiece: 1 division = 2.8 μm.

was reported from Indonesia (Botanic Garden and Botanical Museum Berlin 2016), Thailand (Arizona State Biocollections 2022), Vietnam (Duong et al. 2011), India (Mishra & Upreti 2017), and Kenya (Launis 2012).

***Parmotrema melanothrix* (Mont.) Hale, Phytologia 28(4):337. 1974.** (Figs. 2a–c)
(≡ *Parmelia melanothrix* Mont. = *Parmelia nylanderi* Lynge)

Description. Thallus corticolous, loosely adnate; up to 10 cm wide; lobes rotund, up to 10 mm wide; margins entire to crenate, ciliate; cilia simple, 2-4 mm long. Upper surface gray to gray-green, emaculate, lacking isidia and soredia. Medulla is white. Lower surface is black with wide erhizinate marginal zone tan to mottled white; rhizines black, simple to occasionally branching. Apothecia substipitate, disc wide, imperforate, concave, brown, thalline exciple ciliate; asci 8-spored; ascospores simple, hyaline, oval-ellipsoid, 20-26 × 12–16 μm. Pycnidia abundant, conidia filiform. Chemistry: cortex K+ yellow (atranorin); medulla K-, C-, KC-, P-.

Remarks. The absence of vegetative propagules and the negative results for medullary tests identified this species. However, TLC showed the presence of protolichesterinic acid, traces of alpha-alectoronic acid, and unidentified fatty acids (Eliasaro & Donha 2003; Mishra & Upreti 2017).

Specimens examined. Mt. Candalaga, Maragusan, Davao De Oro, 7° 18' 56" N, 126° 11' 40" E, 1867 m, *P.L. Dela Tina* PLDT169; 7° 16' 48" N, 116° 12' 36" E, 1989 m, *P.L. Dela Tina* PLDT210, 7° 18' 56" N, 126° 11' 40" E, 1992 m, *P.L. Dela Tina* PLDT 212, PLDT216a, PLDT217a.

***Parmotrema planatilobatum* (Hale) Hale Phytologia 28: 338. 1974** (Fig. 2d)
(≡ *Parmelia planatilobata* Hale, J. Jap. Bot. 40: 200. 1965).

Description. Thallus corticolous, tight to loosely adnate, up to 8 cm wide; lobes rotund, 4–10 mm wide, apical margin entire or crenate, ciliate; cilia black, simple, 1–2 mm long, longer cilia usually found in the leaf axils. Upper surface whitish to grey-green, smooth, shiny, emaculate, with laminal to marginal phyllidia, initially simple becoming lacinulate or subsquamulose. Medulla white. Lower surface centrally black, with brown erhizinate marginal zone; rhizines abundant, black, simple, 1–2 mm long. No apothecia were observed. Pycnidia not seen. Chemistry: cortex K+ yellow (atranorin); medulla K-, C+ faint rose (gyrophoric acid), KC+ reddish-pink, P-. Skyrin was detected through TLC (Mishra & Upreti 2017) and traces of protolichesterinic acid.

Remarks. This species is distinguished by the laminal to marginal isidia or phyllidia becoming lacinulate to subsquamulose, and the C+ faint rose reaction of the medulla indicative of gyrophoric acid.

Specimen examined. Mt. Candalaga, Maragusan, Davao De Oro, 7° 19' 35" N, 126° 11' 17" E, 1312 m, *P.L. Dela Tina* PLDT050a.

Updated Key to the Philippine *Parmotrema* Species

This updated key not only includes *Parmotrema melanothrix* and *P. planatilobatum* but also *P. clavuliferum* (Räsänen) Streimann nd *P. vartakii* Hale, which were missed in the previous report on Philippine *Parmotrema* species by Bawingan et al. (2017). It also corrects the KC reaction of *P. elacinulatum* (Kurokawa) Streimann and *P. overeemii* (Zahlbr.) Elix, which is KC+ reddish, erroneously indicated to be KC- in the previous key, and of *P. vartakii* that tests negative for all spot tests erroneously reported as medulla K+ pale orange, C+ pale orange, KC+ red-orange.

1. Thallus without wide erhizinate marginal zone on the lower surface; upper surface maculate, with or without cracks **2**
– Thallus with wide erhizinate marginal zone in the lower surface; upper surface with or without maculae **5**
2. Soredia present **3**
– Soredia absent **4**
3. Soredia pustulate, marginal to submarginal, maculae forming areoles then flaking off ..... ***P. neopustulatum***
– Soredia not pustulate, marginal, labriform to linear, maculae not forming areoles or flaking off ..... ***P. reticulatum***
4. Maculae forming areoles, then flaking off ..... ***P. austrocetratum***
– Maculae not forming areoles or flaking off ..... ***P. cetratum***
5. Thallus lacking phyllidia, isidia and soredia **6**
– Thallus with phyllidia, isidia or soredia **11**
6. Medulla partly orange-pigmented near lower cortex, pigmented part K+ purple **7**
– Medulla entirely white **8**
7. Thallus lobulate-laciniate; no rhizines growing upward to penetrate the thallus; conidia bacilliform ..... ***P. subrugatum***
– Thallus not lobulate-laciniate; some rhizines growing upward to penetrate the thallus; conidia filiform ..... ***P. corniculans***
8. Medulla KC-, P ..... ***P. melanothrix***
– Medulla KC+, P+ **9**
9. UV+ white, medulla KC+ purple, P+ red; alectoronic acid present ..... ***P. maclayanum***
– UV-, medulla KC+ red, deep orange; protocetraric acid present **10**
10. Cilia present, prominent; conidia bacilliform ..... ***P. elacinulatum***
– Cilia present or absent; conidia sublageniform ..... ***P. overeemii***
11. Thallus with isidia or phyllidia **12**
– Thallus with soredia **17**
12. Isidia cylindrical, simple or branched **13**
– Phyllidia becoming lacinulate or subsquamulous ..... ***P. planatilobatum***
13. Lobe margins eciliate **14**
– Lobes conspicuously ciliate **15**
14. Medulla C+ red, P-; lecanoric acid present .... ***P. tinctorum***
– Medulla C-, P+ brick-red; protocetraric acid present ..... ***P. saccatilobum***

15. UV + white, medulla K-, KC+ red; with alectoronic and α-collatolic acids ..... ***P. mellissii***
– UV- or UV+ bright yellow, medulla K+ yellow or red, KC **16**
16. UV-, medulla K+ yellow; stictic acid present ..... ***P. crinitum***
– UV bright yellow, medulla K+ yellow to red; salazinic acid present ..... ***P. ultralucens***
17. Lobes eciliate or sparsely ciliate **18**
– Lobes conspicuously ciliate **22**
18. Medulla K- ..... ***P. praesorediosum***
– Medulla K+ yellow or yellow then red **19**
19. Medulla K+ yellow then red; salazinic acid present, protocetraric acid present **20**
– Medulla K+ dull yellow to yellow-brown; protocetraric acid present **21**
20. Upper surface with reticulate maculae, sometimes becoming cracks, laciniate, lacinia bearing soralia ..... ***P. clavuliferum***
– Upper surface without reticulate maculae; non-laciniate ... ***P. cristiferum***
21. Upper surface gray; usnic acid and echinocarpic acid absent ..... ***P. gardneri***
– 21b Upper surface pale yellowish-grey; usnic acid and echinocarpic acids present ..... ***P. dilatatum***
22. Medulla K+ or K- **23**
– Medulla C+ or C- **24**
23. Medulla K+ yellow turning red, C-, P+ orange; norstictic and salazinic acids present ..... ***P. parahypotropum***
– Medulla K-, C-, P-; traces of alectoronic and α- collatolic acids ..... ***P. vartakii***
24. Medulla C+ red **25**
– Medulla C- **27**
25. Lower medulla pigmented, medulla C+ pink; gyrophoric acid present ..... ***P. permutatum***
– Medulla entirely white **26**
26. 26a Medulla C+ intense red, KC+ red; lecanoric acid present ..... ***P. cooperi***
– Medulla C+ pink or pale red, KC + pale red; gyrophoric acid present ..... ***P. sancti-angelii***
27. Medulla entirely white **28**
– Medulla with pigmented areas **30**
28. Medulla KC-; fatty acids present ..... ***P. grayanum***
– Medulla KC+ red; alectoronic acid ± α-collatolic acid present **29**
29. Upper surface maculate; secondary lobules often present ..... ***P. lobulascens***
– Upper surface emaculate; secondary lobules absent ..... ***P. poolii***
30. Medulla P+ orange; protocetraric acid present ..... ***P. subarnoldii***
– Medulla P-; alectoronic acid ± α-collatolic acid present ... **31**
31. Thallus coriaceous; upper surface distinctly maculate; without skyrin ..... ***P. negrosorientalum***
– Thallus membranaceous; emaculate upper surface; with skyrin ..... ***P. rampoddense***

Acknowledgments

Our heartfelt gratitude goes to the Local Government Unit of Maragusan for the support given to the researchers and to all those who helped during the lichen collection, especially Mr. Rholey Picaza. The comments from anonymous reviewers are much appreciated.

Literature Cited

Arizona State University Biocollections, 2022. Arizona State University Lichen Herbarium. Occurrence dataset https://doi.org/10.15468/qrwfjc accessed via GBIF.org on 2022-02-19. https://www.gbif.org/occurrence/2270779514

Bawingan, P.A., M.P. Lardizaval, P.F. Rosuman, W.T. Fajardo, A. Azuelo, J. Elix, J. & J.-H. Hur, 2017. Philippine species of *Parmotrema* (Ascomycota, Parmeliaceae). *Philippine Journal of Science 146*(2), 145–158.

Botanic Garden & Botanical Museum Berlin, 2016. Lichens at Herbarium Berolinense, Berlin.

Occurrence dataset https://doi.org/10.15468/gmyyyu accessed via GBIF.org on 2022-02-19. https://www.gbif.org/occurrence/1212180011

Climate and Weather Averages in Maragusan. Retrieved on July 11, 2022, from https://www.timeanddate.com/weather/@1689089/climate)

Duong, H.T., C.B.L. Huyn, P.X. Ha, Q.T. Ton & P.K.P. Nguyen, 2011. Some phenolic compounds of lichen *Parmotrema planatilobatum* (Hale) Hale (Parmeliaceae). *Science and Technology Development Journal* 14(4), 5–10. DOI: https://doi.org/10.32508/stdj.v14i4.2041

Eliasaro, S. & C.G. Donha, 2003. The genera *Canomaculina* and *Parmotrema* (Parmeliaceae, Lichenized Ascomycota) in Curitiba, Paraná State, Brazil. *Revista Brasileira de Botânica*, 26(2), 239–247.

Elix J.A. & K.D. Ernst-Russel, 1993. A catalogue of standardized thin layer chromatographic data and biosynthetic relationships for lichen substances, 2nd ed. Canberra: Australian National University.

Gabriel, A. Mt. Candalaga. Retrieved on July 11, 2022, from http://www.mtapoadventures.com/other-mountains-for trekking/mt-kandalaga/

Kennedy J., 2022. Harvard University Herbaria: All Records. Harvard University Herbaria. Occurrence dataset https://doi.org/10.15468/o3pvnh accessed via GBIF.org on 2022-02-19. https://www.gbif.org/occurrence/1998762625

Launis, A., 2012. Some insights to the lichens of the Taita Hills. *Expedition Reports of the Department of Geography, Finnish Museum of Natural History, Botany Unit 2012*(50), 39-45.

Mishra, G.K. & D.K. Upreti, 2017. The lichen genus *Parmotrema* A. Massal. (Lecanorales, Ascomycota) from India with addition distributional records. *Cryptogam Biodiversity and Assessment* 2 (2), 18–40.

Orange A, James P.W. & F.J. White, 2001. Microchemical methods for the identification of lichens. British Lichen Society. 101 pp. Pinoy Mountaineer, 2008 http://www.pinoymountaineer.com/2008/07/mt-candalaga-2402.html

Telenius A. & M. Shah, 2018. Botany (UPS). GBIF-Sweden Occurrence dataset https://doi.org/10.15468/ufmslw accessed via GBIF.org on 2022-02-19. https://www.gbif.

org/occurrence/328196890
University of Minnesota Bell Museum, 2021. Bell Museum lichens. Occurrence dataset https://doi.org/10.15468/up3htf accessed via GBIF.org on 2022-02-19. https://www.gbif.org/occurrence/2266182873