The Lichenologist **43**(2): 141–146 (2011)
doi:10.1017/S0024282910000812

Caloplaca aequata is a synonym of *C. cinnabarina* (*Teloschistaceae*)

Yogesh JOSHI, Holger THÜS and Jae-Seoun HUR

Abstract: In 1915 Hue described *Lecanora* (sect. *Placodium*) *aequata* growing over quartzite rocks from Busan and the Kangwon Provinces of South Korea. Later Zahlbruckner (1931) transferred it to the genus *Caloplaca*. Careful examination of syntype material of *L. aequata* lodged at The Natural History Museum, UK (BM) demonstrates that the species is conspecific with *C. cinnabarina* (Ach.) Zahlbr. and we henceforth synonymize it with that species.

Key words: Asia, Hue, *Lecanora*, lichen-forming fungi, South Korea, Zahlbruckner

Introduction

At the beginning of the twentieth century, the French lichenologist Auguste-Marie Hue (1840–1917) described a saxicolous lichen under the name *Lecanora* (sect. *Placodium*) *aequata*, based on material collected in Kang-ouen-to, Corea (=Kangwon-do, South Korea, where *do* means province) and Fusan (=Busan) (Hue 1915). The taxon was later transferred to the genus *Caloplaca* by Zahlbruckner (1931).

Caloplaca aequata (Hue) Zahlbr., was later included in the checklists of Japan, Korea and Thailand by Harada *et al.* (2004), Hur *et al.* (2005) and Wolseley *et al.* (2002), respectively. Unfortunately, the exact locality from which the type collections were made is unclear. Hue (1915) in his protologue cited "In Corea quartzicolam legit *R. P. Faurie* in Kang-oue-to, n. 4289 et 4319, ac in Fusan, n. 4395, julio et octobri 1901", while Zahlbruckner (1931) cites "Corea, quartzicola". In addition, there is no material to be found under either *Lecanora* or *Caloplaca aequata* in the major herbaria of the Asian countries.

Y. Joshi and J.-S. Hur: Korean Lichen Research Institute, Sunchon National University, Sunchon 540-742, Republic of Korea. Email: jshur1@sunchon.ac.kr
H. Thüs: Botany Department, The Natural History Museum, Cromwell Road, London SW7 5BD, UK.

Judging from the species epithet, we first suspected *C. aequata* to be an aquatic species, growing either near fresh water or in maritime regions. However, after consulting the original publication, we came to the conclusion that these collections had all the characteristic features in common with *C. cinnabarina* and to clarify this situation a thorough taxonomic revision of the relevant type material of *C. aequata* (Fig. 1C–E) was necessary. After studying syntype material, it became clear that *C. aequata* and *C. cinnabarina* are same taxon, and that *C. aequata* should be synomymized under the earlier name.

An updated list of various synonyms belonging to this species, provided by earlier workers (Poelt & Hinteregger 1993; Wetmore & Kärnefelt 1999), is also included in the text.

Materials and Methods

We examined type specimens of *C. aequata* (deposited in BM) and *C. cinnabarina* (deposited in H), as well as additional material [*C. almorensis* (Räsänen) D.D. Awasthi and *C. cinnabarina*] from the herbaria of LWG-LWU, LWG-AWAS, Hector Osorio and KoLRI for comparative purposes. Several standard Asian and American flora and a few specific papers were used for identification (e.g. Kärnefelt 1988; Poelt & Hinteregger 1993; Wetmore & Kärnefelt 1999).

Morphology and anatomy were examined by standard microscopic techniques. Thallus and apothecial

characters were studied on hand-cut sections mounted in water. For characters such as size of thallus, apothecia and thickness of the hymenium, hypothecium, exciple, five measurements were recorded for each specimen; 10 measurements per specimen were recorded for ascospore dimensions. Ascospore measurements are given as: (min.–) {$\bar{x}$−SD}−{$\bar{x}$+SD} (–max.), where min. and max. are the extreme values, $\bar{x}$ the arithmetic mean, and SD the corresponding standard deviation. Chemistry was analyzed using standardized TLC (Orange *et al.* 2010).

Results and Discussion

Caloplaca cinnabarina (Ach.) Zahlbr.

In Engler & Prantl., *Nat. Pflanzenfam.* **1**(1)**:** 228 (1908).

Basionym: *Lecanora cinnabarina* Ach., *Lichenogr. Univers.*: 402 (1810); type: Lesser Antilles, St. Bartholomie [St. Barthelemy], *Forström* (H-Ach. 1242!).

Synonyms nova: *Lecanora* (sect. *Placodium*) *aequata* Hue, *Annals. mycol.* **13**(2)**:** 78 (1915); type: Corea (=South Korea), Kan.ouen.to (=Kangwon-do), julio 1901, leg. *Faurie*, det. *Hue* 4319 (BM!, lectotype selected here).—*Caloplaca aequata* (Hue) Zahlbr., *Cat. Lich. Univ.* **7:** 211 (1931).

Additional synonyms (after Poelt & Hinteregger 1993; Wetmore & Kärnefelt 1999): *Parmelia cinnabarina* (Ach.) Spreng., *Syst. Veget.* **4**(1)**:** 301 (1827).—*Placodium cinnabarinum* (Ach.) Nyl., in *Mémoir. Soc. Imp. Scienc. Natur. Cherbourg.* **3:** 178 (1856).—*Callopisma cinnabarinum* (Ach.) Müll. Arg., *Flora* **64:** 513 (1881).—*Blastenia cinnabarina* (Ach.) Lindau, *Die Flechten:* 207 (1913).

Caloplaca holochracea (Nyl.) Zahlbr., *Cat. Lich. Univ.* **7:** 144 (1930).—*Lecanora holochracea* Nyl. *J. Linn. Soc. London, Bot.* **15:** 171 (1876); type: India, Mt. Khasya, J. D. Hooker (H-Nyl. 29527).

?*Caloplaca intermedia* (B. de Lesd.) Zahlbr., *Cat. Lich. Univ.* **10:** 624 (1940).

Callopisma almorense Räsänen, *Suom. Elain-ja Kasvit. Seuran Van. Tiedon.* **6:** 82 (1952); type: India, Kumaun, Almora district (now Pithoragarh district), Berinag, near *Pinus* forest, alt. 5000 ft., on stones, 26 September 1950, *D. D. Awasthi* 804 (Isotype-LWG-AWAS!).—*Caloplaca almorensis* (Räsänen) D. D. Awasthi, *Beih. Nova Hedwigia* **17:** 33 (1965).

(Fig. 1)

Thallus saxicolous, continuous, smooth, cracked-areolate in centre, marginal areoles elongated with a distinct and abrupt thallus edge that does not taper off to a prothallus; reddish orange to orange (Fig. 1B & F). *Cortex* thin, paraplectenchymatous.

Apothecia immersed in central areoles to finally raised, 1–3 per areole, 0·1–0·4 mm diam., disc little darker orange than the thallus. *Epihymenium* golden brown, 10–20 µm high. *Hymenium* hyaline, 40–55 µm high. *Hypothecium* hyaline, of indistinct cells, with oil globules. *Parathecium* poorly developed. *Amphithecium* with algae. *Paraphyses* simple or sparsely branched, with no swollen tips or 1–2 slightly swollen cells. *Asci* 8-spored, ascospores polarilocular, (8–)8·3–10·7 (–11·2) × (3·9–)4–4·5(–5·6) µm, isthmus (1·8–)2–2·8(–4·2) µm.

For further morphological and anatomical descriptions see Wetmore & Kärnefelt (1999) who placed this species within its own group.

Chemistry. Spot tests: thallus K+ red, C−, P−. TLC: parietin (major), emodin, fallacinal. Wetmore & Kärnefelt (1999) mentioned in their description of that species a C+ red reaction of the thallus. The species is never C+ red. It was a typographic error as suggested by Dr. Wetmore (personal communication) and should be corrected to C−. Parietin along with traces of emodin and fallacinal are reported in the specimens examined.

For additional secondary metabolites reported in this species, see Santesson (1970) who found teloschistin, xanthorin and parietinic acid as compounds as well as those reported in our study.

Ecology and distribution. It is a common rock dwelling lichen generally found growing over siliceous rocks (granite, quartzite), but sometimes on calcareous rocks in rather exposed situations, throughout tropical and subtemperate regions of the world. The taxon has previously been reported from America (Wetmore & Kärnefelt 1999), Asia (Poelt & Hinteregger 1993; Aptroot & Seaward 1999; Aptroot & Sipman 2001; Joshi 2008; Joshi *et al.* 2010), West and South Africa (Kärnefelt 1988), New Zealand (Galloway 2007), Australia (Wetmore & Kärnefelt 1999) and Oceania (Elix & McCarthy 1998).

One of the authors (YJ) noticed that the species has a wide distribution in India, extending from arid tropical regions to cold

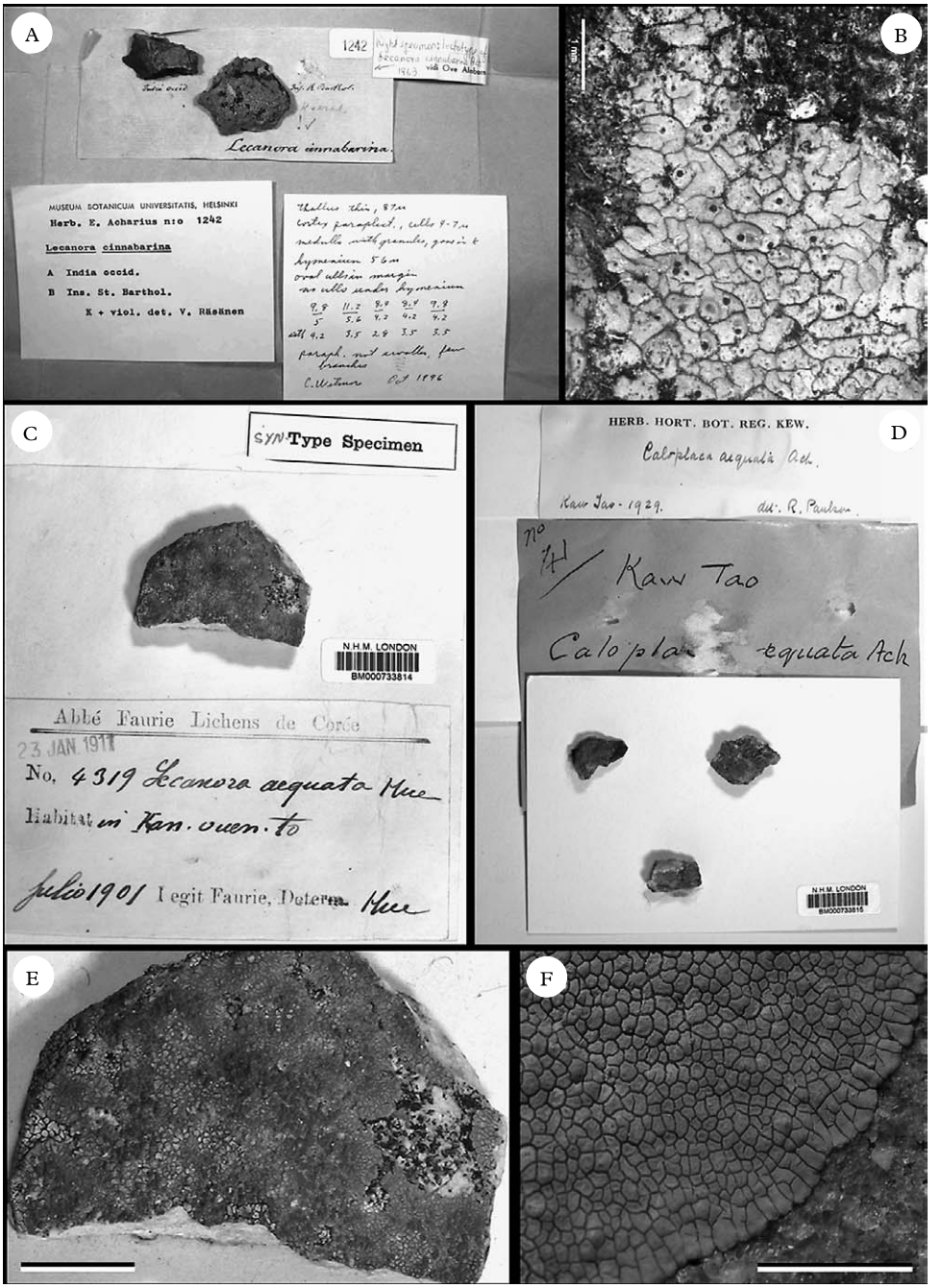

FIG. 1. A, lectotype collection of *Caloplaca cinnabarina* (Ach.) Zahlbr.(H, Ach = 1242); B. magnified image of *Lecanora cinnabarina*; C, syntype collection of *Lecanora aequata* Hue (Abbé Faurie: *Lichens de Coreé*, no. 4319 = BM000733815) [= *Caloplaca cinnabarina* (Ach.) Zahlbr.]; D, specimens of *Caloplaca aequata* (Hue) Ach. (anon., Kaw Tao, L41 = BM000733814); E, magnified image of *Lecanora aequata*; F, isotype collection of *Callopisma almorense* Räsänen lodged at LWG-AWAS showing subeffigurate marginal areoles and immersed apothecia. Scales: B = 1 mm; E = 2 mm; F = 3 mm.

https://doi.org/10.1017/S0024282910000812 Published online by Cambridge University Press

subalpine regions. In temperate to subalpine regions, the species is found between 1440 and 2700 metres growing with *Caloplaca flavovirescens* (Wulfen) Dalla Torre and Sarnth. and *Ioplaca pindarensis* (Räsänen) Poelt & Hinter., while in tropical regions (500–1170 m), it is found growing with *C. awasthii* Y. Joshi & Upreti, *C. poliotera* (Nyl.) J. Steiner, *C. subpoliotera* Y. Joshi & Upreti, *Endocarpon* spp. and *Peltula placodizans* (Zahlbr.) Wetmore (Joshi 2008). However, South Korean specimens show a greater affinity to maritime regions, having a tropical distribution (10–260 m), and are found growing on cliffs and boulders along with *C. bogilana* Y. Joshi & J. S. Hur and *C. decipiens* (Arnold) Blomb. & Forssell (Joshi *et al.* 2010).

Nomenclatural notes. Two well preserved and fertile samples of *C. aequata* lodged at BM, 4319 (BM000733815) and L41 (BM000733814) were investigated. Sample 4319 contains one piece of rock glued onto a card, which itself is mounted on a big sheet (Fig. 1C). The text on the card reads "*Lecanora aequata* Hue, Kan-ouen-to, julio 1901, leg. Faurie, det. Hue, Abbé Faurie Lichens de Coreé, no. 4319 (syntype)", in black ink, except the word "syntype", which is written in red ink. It corresponds with the locality and collection in the protologue, and consists of a large piece of lichen with an orange-red thallus having immersed to sessile dark red apothecia. On the other hand, the sample L41 contains three pieces of rock glued onto a card (Fig. 1D). There was no text on the card, but the annotation slip and envelope bears the information "*Caloplaca aequata* Ach., Kaw Tao – 1929, det. R. Paulson, no. L41, Herb. Hort. Bot. Reg. Kew" in black ink. Both samples of *C. aequata* at BM, including the syntype are in good condition, and their macroscopic and microscopic characters fit well with those of *C. cinnabarina*. In the syntype, the marginal areoles are 0·5–0·8 mm long and 0·3–0·4 wide. The thallus is 72–95 µm thick, without a necral layer, the cortex is 14–20 µm thick, the algal layer continuous and the medulla dense and without crystals. The apothecia are immersed to raised, 1–4 per areole, round to irregular and 0·1–0·35 mm diam. The golden brown epihymenium is 10·5–12·5 µm high and the hyaline hymenium, 37·5–50 µm high. The hyaline hypothecium is made up of indistinct cells without oil droplets. The parathecium is poorly developed and the amphithecium with alga extending below the hypothecium. The paraphyses are simple to ±furcate at the tips, with or without 1–2 swollen cells at the tips. Ascospores are (8–)10–11 × 4–4·5 µm and the isthmus 2·3–2·8 µm. Hence all the characters fall within the range of *C. cinnabarina* as outlined above and described in detail by Wetmore & Kärnefelt (1999).

The date of the combination of *C. aequata* is given as 1931 (Zahlbruckner 1931), while that of *C. cinnabarina* is 1908 (Zahlbruckner 1931), which means that *C. cinnabarina* has nomenclatural precedence over *C. aequata*. Henceforth, *C. aequata* is herewith synonymized with *C. cinnabarina*. In addition, *C. aequata* should be cited as *C. aequata* (Hue) Zahlbr., not *C. aequata* Ach. (as mentioned by R. Paulson on the packet L41).

Despite the fact that Hue did not give an exact locality (type locality), select a holotype specimen or mention any herbarium, the names [*L.* (sect. *Placodium*) *aequata* and *C. aequata*] are valid. The publication antedates the effective dates of the respective articles in the International Code of Botanical Nomenclature [ICBN *Art. 37.1* (type specimen): 1 January 1958; ICBN *Art. 37.6* (inclusion of "typus" or "holotypus"): 1 January 1990; ICBN *Art. 37.7* (herbarium name): 1 January 1990] (McNeill *et al.* 2006).

Hue (1915) in his original description of *Lecanora* (sect. *Placodium*) *aequata*, mentioned three specimens from Korea: two from Kang-ouen-to (4289 and 4319) and one from Fusan (4395). We studied the specimen 4319 along with the specimen of *Caloplaca aequata* (L41) determined by Paulson. Both of them were identical to *C. cinnabarina*. As sample 4319 is in good condition and bears numerous apothecia and well developed thallus, we have selected it here as the lectotype according to *Art. 9.2* of ICBN Vienna Code (McNeill *et al.* 2006).

Remarks. *Caloplaca cinnabarina* is macroscopically a distinctive species because of its areolate to subeffigurate, cinnabarine coloured thallus with small, immersed to ± sessile apothecia mostly obscuring the thallus. The only three species in the Asian mycobiota with which it might be confused are *Ionaspis lacustris* (With.) Lutzoni, *Ioplaca pindarensis* and *Caloplaca rubelliana* (Ach.) Lojka. *Ionapsis lacustris* differs in lacking anthraquinones and having halonate, simple spores. *Ioplaca pindarensis* is similar in external morphology, but differs in having a dark under surface (black hypothallus), egg-yolk coloured thallus and is endemic to the Himalayan region. The widespread *Caloplaca rubelliana*, another member of the *Cinnabarina* group differs in having thallus edges tapering off gradually either to nothing or to a pale prothallus, while thallus edges in *C. cinnabarina* have distinct abrupt edges without thinning or prothalli. Besides that, *C. rubelliana* has a scarlet red disc and a greyish to brown-orange thallus. *Caloplaca subunicolor* (Nyl.) Zahlbr., a species with scattered records across the Southern Hemisphere, has gradually tapering thallus margins without prothallus and apothecia soon becoming sessile, while in *C. cinnabarina* the thallus edge is always abrupt and the apothecia remain more or less immersed or finally become raised.

Specimens examined as *C. aequata*. **Korea:** *Kaw Tao*: on rock, 1929, det. *R. Paulson* 41 (BM). *Kan-ouen-to*: on rock, 1901, coll. *A. Faurie*, det. Hue 4319 (BM).

Specimens examined as *C. cinnabarina*. **India:** *Himachal Pradesh*: alt. 2700 m, 1949, *Harish C. Raghubir* 430 (LWG-AWAS); alt. 1440 m, 2002, *S. Nayaka* & *R. Srivastava* 02-001208 (LWG). *Karnataka*: alt. *c*. 980 m, 1979, *D. D. Awasthi*, *D. K. Upreti* & *U. C. Misra* 79-212, 79-213, 79-231, 79-242, 79-261, 79-269 (LWG-LWU); alt. 900 m, 1997, *S. Nayaka* 413 (LWG); 1956, *D. D. Awasthi* 3595 (LWG-AWAS). *Madhya Pradesh*: 18 iv 1973, *P. S. H. Khan & party* s. n. (LWG); 12 vii 2004, *D. K. Upreti* s. n. (LWG); alt. 500 m, 2004, *Y. Joshi* 04-004542 (LWG). *Orissa*: 17 ix 1993, *Vivek Pande* s. n. (LWG). *Rajasthan*: alt. 1680 m, 1973, *A. Singh* 101472 (LWG); alt. 1170 m, 1973, *A. Singh* 101421 (LWG). *Tamil Nadu*: alt. 950 m, 1996, *G. N. Hariharan* CS4 (MSSRF); alt. 1000 m, 1999, *S. Nayaka* 99-75925 (LWG); alt. 700 m, 1999, *S. Nayaka* 99-75952 (LWG); alt. 1490 m, 1999, *S. Nayaka* 307/B (LWG); alt. 2100 m, 1959, *D. D. Awasthi* 4544 (LWG-AWAS); alt. *c*. 2100 m, 1971, *K. P. Singh* 71.776 (LWG-LWU); alt. *c*. 2250 m, 1971, *D. D. Awasthi* & *K. P. Singh* 71.270 (LWG-LWU); alt. *c*. 2400 m, 1971, *K. P. Singh* 71.721 (LWG-LWU); alt. 1400–1500 m, 1990, *D. K. Upreti* & *Hariharan* 202170 (LWG). *Uttarakhand*: alt. 1800 m, 1956, *D. D. Awasthi* 3464 (LWG-AWAS); alt. 1700 m, 2005, *D. K. Upreti* 05-005058 (LWG); alt. 2400 m, 1950, *D. D. Awasthi* & *A. M. Awasthi* 620 (LWG-AWAS); alt. 1760 m, 2007, *Y. Joshi* & *S. Joshi* 07-010304, 07-010305, 07-010084, 07-010085 (LWG); alt. 1350 m, 1967, *A. Singh & party* 91539 (LWG); alt. 1950 m, 1954, *D. D. Awasthi* 2673 (LWG-AWAS); alt. 1500 m, 1999, *H. C. Pande* 99-65596 (LWG); alt. 2300 m, 2000, *V. Pant* 20-67548 (LWG); alt. 1600 m, 1989, *D. K. Upreti* 201883 (LWG); alt. 1500 m, 1950, *D. D. Awasthi* 803 (LWG-AWAS); 2001, *V. Pant* 02-223452 (LWG); 1951, *D. D. Awasthi* 855 (LWG).—**South Korea:** *Gyeongnam Prov*.: 34°46′08·3″N, 127°59′24″E, alt. 171 m, 2004, *Jae-Seoun Hur* 040022 (KoLRI). *Jeonbuk Prov*.: 35°37′02·7″N, 126°35′01·7″E, alt. 260 m, 2004, *Jae-Seoun Hur* 040167 (KoLRI). *Jeonnam Prov*.: 34°25′20·8″N, 127°08′43·1″E, alt. 10 m, 2005, *Jae-Seoun Hur* 050208/1 (KoLRI); 34°09′64″N, 126°35′11·5″E, alt. 15 m, 2010, *Y. Joshi*, *H. S. Jeon & M. H. Jeong* 100166, 100194 (KoLRI); 34°10′90″N, 126°31′83·6″E, alt. 11 m, 2010, *Y. Joshi*, *H. S. Jeon & M. H. Jeong* 100256, 100257 (KoLRI); 34°38′23·9″N, 127°25′19·5″E, alt. 85 m, 2010, *Y. Joshi*, *H. S. Jeon & G. S. Han* 100270 (KoLRI).—**Uruguay:** Maldonado-Cerro Pan de Azucar, 100 m.s.m., 1951, *H. S. Osorio* 4652 (hb. Hector Osorio).—**W Nepal:** Seti zone, alt. 1500 m, 1977, *L. R. Sharma* 77.4 (LWG-LWU); Karnali-zone, alt. 2250 m, 1977, *L. R. Sharma* 77.207A, 77.207B (LWG-LWU); alt. 2250 m, 1977, *L. R. Sharma* 77.202 (LWG-LWU).

We are grateful to the directors of the herbaria cited for placing material at our disposal, Drs S. Kondratyuk and L. Lőkös for critically reviewing the manuscript and providing Hue's reprints, and to Sunchon National University for providing the laboratory facilities. This work was supported by grants from the Korea National Research Resource Center Program (2010-0000660) through the National Research Foundation of Korea (NRF) and the Korean Forest Service Program (KNA 2010) through Korea National Arboretum. The first author also thanks Dr Leena Myllys for providing the type specimen of *Lecanora cinnabarina* Ach. on a loan basis and to Mr Xin Yu Wang, Miss Thi Thuy Nguyen, Jung Ae Ryu and Hae Sook Jeon for their help and kindness.

References

Aptroot, A. & Seaward, M. R. D. (1999) Annotated checklist of Hong Kong lichens. *Tropical Bryology* **17:** 57–101.

Aptroot, A. & Sipman, H. J. M. (2001) New Hong Kong lichens, ascomycetes and lichenicolous fungi. *Journal of the Hattori Botanical Laboratory* **91:** 317–343.

Elix, J. A. & McCarthy, P. M. (1998) Catalogue of the lichens of the Smaller Pacific Islands. *Bibliotheca Lichenologica* **70:** 1–361.

Galloway, D. (2007) *Flora of New Zealand – Lichens. Revised 2nd edition*. Lincoln, New Zealand: Manaaki Whenua Press.

Harada, H., Okamoto, T. & Yoshimura, I. (2004) A checklist of lichens and lichen-allies of Japan. *Lichenology* **2:** 47–165.

Hue, A. (1915) Lichenes novos vel melius cognitos exposuit. *Annales Mycologici* **13:** 73–103.

Hur, J.-S., Y. J. Koh & Harada, H. (2005) A checklist of Korean lichens. *Lichenology* **4**(2): 65–95.

Joshi, Y. (2008) *Morphotaxonomic studies on lichen family* Teloschistaceae *from India*. Ph.D. Thesis, Kumaun University.

Joshi, Y., Wang, X. Y., Yamamoto, Y., Koh, Y. J. & Hur, J.-S. (2010) A first modern contribution to *Caloplaca* biodiversity in South Korea; two new species and some new country records. *Lichenologist* **42:** 715–722.

Kärnefelt, I. (1988) Morphology and biogeography of saxicolous *Caloplaca* in southern Africa. *Monographs in Systematic Botany from the Missouri Botanical Garden* **25:** 439–452.

McNeill, J., Barrie, F. R., Burdet, H. M., Demoulin, V., Hawksworth, D. L., Marhold, K., Nicolson, D. H., Prado, J., Silva, P. C., Skog, J. E. *et al.* (eds), (2006) International Code of Botanical Nomenclature (Vienna Code). Adopted by the Seventeenth International Botanical Congress Vienna, Austria, July 2005. Regnum Vegetabile 146. Liechtenstein: A. R. G. Gantner Verlag, Ruggell.

Orange, A., James, P. W. & White, F. J. (2010) *Microchemical Methods for the Identification of Lichens. Second edition*. London: British Lichen Society.

Poelt, J. & Hinteregger, E. (1993) Beiträge zur Kenntnis der Flechtenflora des Himalaya. VII. Die Gattungen *Caloplaca*, *Fulgensia* und *Ioplaca* (mit englischem Bestimmungsschlüssel). *Bibliotheca Lichenologica* **50:** 1–247.

Santesson, J. (1970) Anthraquinones in *Caloplaca*. *Phytochemistry* **9:** 2149–2166.

Wetmore, C. M. & Kärnefelt, E. I. (1999) What is *Caloplaca cinnabarina? Bryologist* **102:** 683–691.

Wolseley, P. A., Aguirre-Hudson, B. & McCarthy, P. M. (2002) Catalogue of the lichens of Thailand. *Bulletin of the Natural History Museum London* (*Botany*) **32:** 13–59.

Zahlbruckner, A. (1931) *Catalogus Lichenum Universalis. Band VII*. Leipzig: Gebrüder Borntraeger.

Accepted for publication 09 *December* 2010