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Two new European species from the heterogeneous *Caloplaca holocarpa* group (*Teloschistaceae*)

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Abstract: The *Caloplaca holocarpa* group contains members of the family *Teloschistaceae* with a strongly reduced thallus and conspicuous yellow, orange or red apothecia. In the absence of well-defined thallus characters, taxa of this group must be identified mainly by apothecial characters and are as a result often difficult to separate. The species of this group have been shown not to form a monophyletic entity, with representatives of other *Teloschistaceae* with more complex thalli intermixed among them. *Caloplaca skii* and *C. syvashica* are recognized here as two homogeneous clades with *Caloplaca holocarpa*-like phenotypes. *Caloplaca skii*, which is widespread in southern Europe, resembles *C. cerinelloides* but is distinguished by its smaller and narrower ascospores and by growing predominantly on xerophilous shrubs. *Caloplaca syvashica* is restricted to shrubs in salt marshes in the northern Black Sea region. It is similar to the British *Caloplaca suaedae* and Australian *C. yarraensis*, but differs from both, mainly in ascospore characters. *Caloplaca yarraensis* is closely related to the new *C. syvashica* but arguments against their conspecificity are emphasised. A key for epiphytic *C. holocarpa*-like *Teloschistaceae* from Europe is provided.

Key words: convergence, cryptic biodiversity, lichenized fungi, phylogeny, taxonomy, thallus simplification

Introduction

Lichens have evolved similar morphologies often in rather distantly related lineages (Grube & Hawksworth 2007). Unsurprisingly, parallelism also occurs within more closely related groups, where the molecular results have changed the traditional views on relationships. For instance, molecular studies showed that the foliose genera of the *Physciaceae* are nested among the large crustose genus *Rinodina* (e.g. Grube & Arup 2001; Helms *et al.* 2003). Similarly, foliose and fruticose thallus shapes also arose within crustose *Lecanora* (e.g. Arup & Grube 2000) and *Caloplaca* (Gaya *et al.* 2008).

Reduction of morphological complexity has also occurred in lichens. As we will show below, reduction of the thallus has occurred independently several times in the evolution of *Teloschistaceae*, resulting in several lineages that are difficult to separate on purely phenotypic grounds. An artificial unit, that we call the *Caloplaca holocarpa* group, contains many of these lineages, which are similar to *C. holocarpa* s. str. in external morphology and anatomy. Several lineages of the group will be characterized here and two new species will be described.

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Materials and Methods

The material investigated has been collected by the authors mainly from Europe and Western Asia in 2000 and later (Table 1). Thirty phenotypic characters have been studied. The new species are fully described but only diagnostic characters are used for characterizing the other lineages. Fourteen selected characters are listed for investigated species in Table 2; primary data

TABLE 1. *Sample data and GenBank accession numbers of the ITS sequences used in the phylogenetic analysis; new sequences are highlighted in bold*

Specimen indication in the phylogenetic tree	Voucher data or source data of GenBank sequences	GenBank accession number
Caloplaca alcarum AY081156	Iceland (Søchting *et al*. 2002)	AY081156
C. alociza EF090936	Italy (Muggia *et al*. 2008)	EF090936
***C.* aff. *cerinella* Ukraine**	Ukraine, Crimean peninsula, Alushta, Kanakskaya balka, 2007, *J. Vondrák* (CBFS JV7018)	**HM582147**
***C. cerinella* Czech Republic**	Czech Republic, Votická pahorkatina upland, Tábor, Opařany, Skrýchov, 2004, *J. Vondrák* (CBFS JV1869)	**HM582148**
***C. cerinella* Greece**	Greece, Crete, Levka Ori Mts: Hania, Kambi, 2005, *J. Vondrák* (CBFS JV4221)	**HM582149**
***C. cerinella* Turkey**	Turkey, Sea of Marmara coast, Şarköy, 2007, *J. Vondrák* (in CBFS JV6959)	**HM582150**
***C. cerinella* Romania**	Romania, Dobruja, Tulcea, Enisala, 2007, *J. Vondrák* (CBFS JV7011)	**HM582151**
C. cerinella FJ346538	Denmark (Arup 2009)	FJ346538
C. cerinella FJ346537	Denmark (Arup 2009)	FJ346537
***C. cerinelloides* Czech Republic_1**	Czech Republic, Plzeň Reg., Konstantinovy Lázně, 2006, *J. Šoun* (hb. Šoun 269)	**HM582152**
***C. cerinelloides* Czech Republic_2**	Czech Republic, Sokolovská pánev basin, Sokolov, Lomnice, 2007, *J. Vondrák* (CBFS JV6076)	**HM582153**
C. citrina DQ173226	Sweden (Arup 2006)	DQ173226
C. coronata DQ173239	Austria (Arup 2006)	DQ173239
C. decipiens EU639637	Spain (Gaya *et al*. 2008)	EU639637
C. demissa AF353962	Europe (Arup & Grube 1999)	AF353962
C. dolomiticola AF353957	Europe (Arup & Grube 1999)	AF353957
***C. ferrugineoides* Iran_1**	Iran, NW Iran, Lake Urmia, Bandar-e-Rahmanlu, 2007, *J. Vondrák* (CBFS JV7057)	**HM582154**
***C. ferrugineoides* Iran_2**	Iran, NW Iran, Lake Urmia, Saraydeh, 2007, *J. Vondrák* (CBFS JV7058)	**HM582155**
***C. ferrugineoides* Iran_3**	Iran, NW Iran, Khalkhal, 2007, *J. Vondrák* (CBFS JV7056)	**HM582156**
C. gloriae AF101282	Spain (Gaya *et al*. 2008)	AF101282
***C. holocarpa* Czech Republic**	Czech Republic, Křivoklátsko, Rakovník, Zbečno, 2004, *J. Vondrák* (CBFS JV2405)	**HM582157**
C. holocarpa FJ346539	Sweden (Arup 2009)	FJ346539
C. holocarpa FJ346540	Sweden (Arup 2009)	FJ346540
C. marmorata EU639621	France (Gaya *et al*. 2008)	EU639621
C. aff. *oasis* EU639631	France (Gaya *et al*. 2008, as *Caloplaca polycarpa*)	EU639631
C. oasis FJ346544	Austria (Arup 2009)	FJ346544
***C. oasis* Bulgaria**	Bulgaria, Black Sea coast, Burgas, Nesebar, 2005, *J. Vondrák* (CBFS JV3444, as *Caloplaca holocarpa*)	**HM582158**
C. oasis AF353945	Austria (Arup & Grube 1999, as *Caloplaca holocarpa*)	AF353945

TABLE 1. *Continued*

Specimen indication in the phylogenetic tree	Voucher data or source data of GenBank sequences	GenBank accession number
C. oasis FJ346546	Sweden (Arup 2009)	FJ346546
C. oasis FJ346545	Russia (Arup 2009)	FJ346545
C. oasis FJ346547	Austria (Arup 2009)	FJ346547
C. ochracea EU639620	Spain (Gaya *et al*. 2008)	EU639620
C. polycarpa FJ346552	Italy (Arup 2009)	FJ346552
C. polycarpa FJ346551	Italy (Arup 2009)	FJ346551
***C. pyracea* Hungary**	Hungary, Bükk Mts, Mályinka, Látó-kövek, 2008, *J. Vondrák* & *A. Khodosovtsev* (CBFS JV6365)	**HM582159**
***C. pyracea* Czech Republic_1**	Czech Republic, Šumava Mts foothills, Husinec, 2007, *J. Vondrák* (CBFS JV6971)	**HM582160**
***C. pyracea* Czech Republic_2**	Czech Republic, South Bohemian Reg., České Budějovice, Kaliště u Lipí, 2006, *J. Šoun* (hb. Šoun 74)	**HM582161**
***C. pyracea* Czech Republic_3**	Czech Republic, Plzeň Reg., Konstantinovy Lázně, 2006, *J. Šoun* (hb. Šoun 485)	**HM582162**
C. pyracea AF353949	Sweden (Arup & Grube 1999)	AF353949
C. pyracea FJ346554	Sweden (Arup 2009)	FJ346554
C. pyracea FJ346555	Sweden (Arup 2009)	FJ346555
C. pyracea FJ346553	Sweden (Arup 2009)	FJ346553
***C. raesaenenii* Bulgaria**	Bulgaria, Black Sea coast, Burgas, Sozopol, 2007, *J. Vondrák* (CBFS JV7014)	**HM582163**
***C.raesaenenii* Czech Republic_1**	Czech Republic, Beroun, Koněprusy, 2006, *J. Šoun* (hb. Šoun 52)	**HM582164**
***C. raesaenenii* Czech Republic_2**	Czech Republic, Pavlovské vrchy hills, Mikulov, 2005, *J. Vondrák & J. Šoun* (CBFS JV2908)	**HM582165**
***C. raesaenenii* Czech Republic_3**	Czech Republic, Pavlovské vrchy hills, Bavory, 2005, *J. Vondrák & J. Šoun* (CBFS JV2906)	**HM582166**
***C. raesaenenii* Czech Republic_4**	Czech Republic, Podyjí, Čížov, 2005, *J. Vondrák & J. Šoun* (CBFS JV2904)	**HM582167**
***C. raesaenenii* Czech Republic_5**	Czech Republic, Pavlovské vrchy hills, Pavlov, 2005, *J. Vondrák & J. Šoun* (CBFS JV2840)	**HM582168**
***C. raesaenenii* Czech Republic_6**	Czech Republic, Pavlovské vrchy hills, Mikulov, 2005, *J. Vondrák & J. Šoun* (CBFS JV2841)	**HM582169**
***C. raesaenenii* Czech Republic_7**	Czech Republic, Český kras karst, Srbsko, 2006, *J. Vondrák* (CBFS JV4412)	**HM582170**
***C. raesaenenii* Czech Republic_8**	Czech Republic, Podyjí, Čížov, 2005, *J. Vondrák & J. Šoun* (CBFS JV2815)	**HM582171**
***C. raesaenenii* Czech Republic_9**	Czech Republic, Pavlovské vrchy hills, Mikulov, 2005, *J. Vondrák & J. Šoun* (CBFS JV2913)	**HM582172**
***C. raesaenenii* Hungary**	Hungary, Bükk Mts, Repáshuta, 2006, *J. Šoun* (hb. Šoun 59)	**HM582173**

TABLE 1. *Continued*

Specimen indication in the phylogenetic tree	Voucher data or source data of GenBank sequences	GenBank accession number
***C. raesaenenii* Iran**	Iran, NW Iran, Hashtpar (Talesh), near road Asalem-Khalkhal, 2007, *J. Vondrák* (CBFS JV7013)	**HM582174**
***C. raesaenenii* Romania**	Romania, Black Sea coast, Tulcea, Enisala, 2007, *J. Vondrák* (CBFS JV6955)	**HM582175**
***C. raesaenenii* Ukraine_1**	Ukraine, Crimean Peninsula, Alushta, Semidvorye, 2006, *J. Vondrák & J. Šoun* (CBFS JV4998)	**HM582176**
***C. raesaenenii* Ukraine_2**	Ukraine, Crimean Peninsula, Bakhchysarai, 2006, *J. Vondrák* (CBFS JV7019)	**HM582177**
***C. raesaenenii* Ukraine_3**	Ukraine, Nikolaev Region, Zapovidnik Yelanetskiy Step, 2006, *J. Vondrák* (CBFS JV7020)	**HM582178**
***C. raesaenenii* Ukraine_4**	Ukraine, Nikolaev Region, Zapovidnik Yelanteskiy Step, 2006, *J. Vondrák* (CBFS JV7022)	**HM582179**
***C. raesaenenii* Ukraine_5**	Ukraine, Khersonska Region, Shyroka Balka, 2003, *A. Khodosovtsev 2718* (KHER)	**HM582180**
***C. raesaenenii* Ukraine_6**	Ukraine, Crimean Peninsula, Bakhchysarai, Mashino, 2006, *J. Vondrák* (CBFS JV7021)	**HM582181**
***C. raesaenenii* Russia_1**	Russia, Taman Peninsula, Primorskiy, 2007, *J. Vondrák & J. Šoun* (CBFS JV7374)	**HM582182**
***C. raesaenenii* Russia_2**	Russia, Volgogradskaya oblast, Volgograd, on soil, 2001, *O. Redchenko* 2701 (KHER)	**HM582183**
***C. saxifragarum* Bulgaria**	Bulgaria, Pirin Mts, Banderitsa, 2004, *Š. Bayerová & Slavík* (CBFS JV3007)	**HM582184**
***C. saxifragarum* Montenegro**	Montenegro, Prokletije Mts, Plav, Gerani, 2007, *J. Košnar* (hb. Šoun 303)	**HM582185**
***C. saxifragarum* Romania_1**	Romania, Retezat Mts, Lupeni, Câmpu lui Neag, 2005, *J. Vondrák* (CBFS JV3942)	**HM582186**
***C. saxifragarum* Romania_2**	Romania, Retezat Mts, Lupeni, Câmpu lui Neag, 2005, *J. Vondrák* (CBFS JV3948)	**HM582187**
C. scopularis AY081155	Iceland (Søchting *et al*. 2002)	AY081155
***C. skii* Bulgaria**	Bulgaria, Black Sea coast, Burgas, Sozopol, 2007, *J. Vondrák & J. Šoun* (CBFS JV7375)	**HM582188**
***C. skii* Greece**	Greece, Crete, Koufonisi Island, 2001, *Sterner* (GZU)	**HM582189**
***C. skii* Romania**	Romania, Black Sea coast, Tulcea, Enisala, 2007, *J. Vondrák & J. Šoun* (CBFS JV7376)	**HM582190**
***C. skii* Russia_1**	Russia, Black Sea coast, Taman Peninsula, Peresyp', 2007, *J. Vondrák & J. Šoun* (CBFS JV7017)	**HM582191**
***C. skii* Russia_2**	Russia, Black Sea coast, Taman Peninsula, Primorskiy, 2007, *J. Vondrák & J. Šoun* (CBFS JV7016)	**HM582192**

TABLE 1. *Continued*

Specimen indication in the phylogenetic tree	Voucher data or source data of GenBank sequences	GenBank accession number
***C. skii* Turkey**	Turkey, Black Sea Coast, Kandıra, Cebeci, 2007, *J. Šoun* (hb. Šoun 486)	**HM582193**
***C. skii* Ukraine_1**	Ukraine, Crimean peninsula, Opukskij zapovednik, 2006, *J. Vondrák & J. Šoun* (CBFS JV7015)	**HM582194**
***C. skii* Ukraine_2**	Ukraine, Crimean peninsula, Krasnoperekopsk, Nadezdino, 2006, *J. Vondrák* (CBFS JV5164)	**HM582195**
***C. skii* Ukraine_3**	Ukraine, Mikolajivska oblast, Zapovidnik zlanetskiy Step, 2006, *J. Vondrák* (CBFS JV5215)	**HM582196**
***C. suaedae* s. lat. Great Britain**	Great Britain, England, Dorset, The Fleet, Chesil Beach, 2000, *Gilbert & Giavarini* (UPS-isotype)	**HM582197**
***C. suaedae* s. lat. Greece**	Greece, Crete, Koufonisi Island, on *Coridothymus capitatus*, 2001, *Sterner* (GZU)	**HM582198**
***C. suaedae* s. lat. Morocco**	Morocco, Atlantic Ocean coast, Agadir, Massa, 2007, *J. Šoun* (hb. Šoun 484)	**HM582199**
***C. suaedae* s. lat. Turkey**	Turkey, Black Sea coast, Lülenburgaz, Vize, Kiyiköy, 2005, *J. Vondrák* (CBFS JV3061)	**HM582200**
***C. syvashica* Ukraine_1**	Ukraine, Crimean Peninsula, Krasnoperekopsk, Nadezdino, 2006, *J. Vondrák & J. Šoun* (CBFS JV7012)	**HM582201**
***C. syvashica* Ukraine_2**	Ukraine, Nikolaev region, Ochakov district, protected area Kinburnskaya kosa, 2009, *J. Vondrák* (CBFS JV7131)	**JF826401**
***C. syvashica* Ukraine_3**	Ukraine, Kherson region, Sadove, protected area "Chornomorskiy zapovednik", 2009. *J. Vondrák* (CBFS JV7142)	**JF826400**
C. texana EU639656	Mexico (Gaya *et al*. 2008)	EU639656
C. ulcerosa GU080297	Russia (Vondrák *et al*. 2009*b*)	GU080297
C. ulcerosa EU639623	Spain (Gaya *et al*. 2008, as *Caloplaca holocarpa*)	EU639623
C. vitellinula FJ346558	Sweden (Arup 2009)	FJ346558
C. vitellinula FJ346559	Sweden (Arup 2009)	FJ346559
C. vitellinula FJ346556	Sweden (Arup 2009)	FJ346556
C. vitellinula FJ346557	Sweden (Arup 2009)	FJ346557
***C. yarraensis* Australia**	Australia, Western Australia, Carnamah, on bark of *Halosarica* in salt marsh, 2004, *I.Kärnefelt & J. Carnfield* (LD; Dupla Graec. Lich. 596; Isotype)	**JF826398**
***C. yarraensis* Australia**	Australia, Western Australia, Carnamah, on bark of *Halosarica* in salt marsh, 2004, *I.Kärnefelt & J. Carnfield* (LD1270694; Isotype)	**JF826399**
Fulgensia fulgida AY051359	France (Beck *et al*. 2002)	AY051359
Teloschistes chrysophthalmus AF098409	Spain (Gaya *et al*. 2008)	AF098409
Teloschistes fasciculatus EU639653	Australia (Gaya *et al*. 2008)	EU639653
Teloschistes sieberianus EU639655	Australia (Gaya *et al*. 2008)	EU639655

TABLE 2. *Fifteen phenotypic characters for selected little-known epiphytic species of* Caloplaca holocarpa*-like* Teloschistaceae *including both new species. Numbers of measurements (*n*) are shown*

Selected characters	*C. cerinelloides*	*C. ferrugineoides*	*C. pyracea*	*C. raesaenenii*	*C. saxifragarum*	*C. skii*	*C. syvashica*	*C. suaedae*
Thallus height (µm)	(20–)33 ± 17·22 (–60) (*n* = 10)	(80–)158 ± 92·11(–400) (*n* = 10)	(60–)85 ± 20·95(–125) (*n* = 15)	(40–)67 ± 14·7(–80) (*n* = 10)	(35–)42 ± 10·6(–50) (*n* = 10)	(20–)35 ± 12·69(–60) (*n* = 10)	(50–)145 ± 39(–200) (*n* = 16)	50–100 (*n* = 2)
Mature apothecia diameter (mm)	(0·25–)0·36 ± 0·06 (–0·45) (*n* = 20) sessile	(0·4–)0·69 ± 0·18 (–1·0) (*n* = 25), stipitate	(0·4–)0·52 ± 0·08(–0·7) (*n* = 18), sessile	(0·25–)0·43 ± 0·1(–0·6) (*n* = 41), sessile	(0·2–)0·31 ± 0·18(–0·45) (*n* = 17), sessile	(0·2–)0·31 ± 0·09(–0·5) (*n* = 45), sessile	(0·2–)0·53 ± 0·19(–1·0) (*n* = 35), sessile	0·2–0·6 (*n* = 2), sessile
Margin (true + thalline exciple width) (µm)	(40–)58 ± 12(–80) (*n* = 10)	(50–)89 ± 21·83(–120) (*n* = 10)	(120–)79 ± 23·7(–40) (*n* = 10)	(30–)40 ± 6·69(–55) (*n* = 20)	(37–)49·7 ± 7·1(–70) (*n* = 10)	(30–)41·5 ± 9·73(–60) (*n* = 10)	(50–)72·5 ± 14·19(–100) (*n* = 10)	50–70 (*n* = 2)
True exciple width (µm)	(20–)26 ± 5(–30) (*n* = 10)	(25–)40·0 ± 11·55 (–60) (*n* = 10)	(45–)56 ± 8·1(–75) (*n* = 10)	(30–)40 ± 6·69(–55) (*n* = 20)	(37–)49·7 ± 7·1(–70) (*n* = 10)	(25–)37·6 ± 7·17(–50) (*n* = 10)	(20–)51·33 ± 12·6(–65) (*n* = 10)	40–50 (*n* = 2)
Width of cortex / alveolate cortex in thalline exciple (µm)	(5–)9 ± 3·2(–15) (*n* = 10)	(25–)33·8 ± 5·1(–40) (*n* = 10)	(15–)20 ± 3·6(–25) (*n* = 10)	Not developed	Not developed	(5–)7·35 ± 2·45(–12) (*n* = 10)	(5–)7·36 ± 1·83(–10) (*n* = 10)	5–8 (*n* = 2)
Cells of cortex / alveolate cortex in thalline exciple (µm)	(2·0–)2·8 ± 0·61(–3·5) (*n* = 10)	(5·75–)8·7 ± 2·0(–12·5) (*n* = 10)	(3·0–)4·15 ± 1·13(–6·0) (*n* = 10)	Not developed	Not developed	(2·5–)3·5 ± 0·62(–4·5) (*n* = 10)	(2·0–)3·0 ± 0·61(–4·0) (*n* = 10)	3·5–5·0 (*n* = 2)

TABLE 2. *Continued*

Selected characters	*C. cerinelloides*	*C. ferrugineoides*	*C. pyracea*	*C. raesaenenii*	*C. saxifragarum*	*C. skii*	*C. syvashica*	*C. suaedae*
Hypothecium height (µm)	(30–)37 ± 5·5(–45) (*n* = 10)	(25–)37·5 ± 7·83(–50) (*n* = 12)	(50–)73·5 ± 14·2(–100) (*n* = 10)	(30–)46 ± 12(–70) (*n* = 10)	(35–)42 ± 10·6(–50) (*n* = 10)	(30–)38 ± 6·3(–50) (*n* = 10)	(35–)52·9 ± 15(–80) (*n* = 10)	Not examined
Ascospore length (µm)	(10·0–)11·83 ± 1·5 (–15·0) (*n* = 30)	(9·0–)11·4 ± 1·41(–14·0) (*n* = 25)	(9·0–)11·7 ± 1·7(–14·75) (*n* = 35)	(8·0–)11·45 ± 1·6(–15·0) (*n* = 67)	(10·0–)12·08 ± 1·06 (–13·5) (*n* = 25)	(7·5–)10·38 ± 1·06 (–12·75) (*n* = 76)	(9·5–)12·87 ± 1·59(–16·5) (*n* = 34)	(12·0–)13·58 ± 1·09 (–14·75) (*n* = 5)
width (µm)	(6·25–)7·84 ± 0·7(–9·25) (*n* = 30)	(3·25–)4·82 ± 0·75 (–6·25) (*n* = 25)	(5·0–)6·63 ± 0·72(–8·25) (*n* = 35)	(4·0–)5·75 ± 0·93(–7·25) (*n* = 67)	(5·5–)7·13 ± 0·53(–8·75) (*n* = 25)	(3·5–)5·19 ± 0·66(–6·5) (*n* = 76)	(4·75–)5·91 ± 0·81(–7·5) (*n* = 34)	(3·7–)4·4 ± 0·51(–5·0) (*n* = 5)
septa width (µm)	(4·25–)5·1 ± 0·57(–6·5) (*n* = 30)	(2·5–)3·34 ± 0·58(–4·75) (*n* = 25)	(3·75–)4·77 ± 0·58 (–6·0) (*n* = 35)	(2·0–)3·63 ± 0·63(–4·75) (*n* = 67)	(3·5–)4·57 ± 0·35(–5·5) (*n* = 25)	(3·5–)4·98 ± 0·69(–6·5) (*n* = 76)	(2·5–)3·69 ± 0·62(–5·0) (*n* = 34)	(3·5–)4·1 ± 0·51(–4·75) (*n* = 5)
ratio length / width	(1·17–)1·52 ± 0·22 (–2·04) (*n* = 30)	(1·52–) 2·43 ± 0·52 (–3·5) (*n* = 25)	(1·33–)1·79 ± 0·26 (–2·38) (*n* = 35)	(1·33–)2·03 ± 0·39 (–3·31) (*n* = 67)	(1·48–)1·7 ± 0·04(–2·11) (*n* = 25)	(1·55–)2·03 ± 0·35 (–3·13) (*n* = 76)	(1·67–)2·2 ± 0·32(–3·05) (*n* = 34)	(2·8–)3·13 ± 0·52(–4·0) (*n* = 5)
ratio septum width / ascospore length	(0·35–)0·44 ± 0·05 (–0·55) (*n* = 30)	(0·19–)0·30 ± 0·06 (–0·44) (*n* = 25)	(0·28–)0·41 ± 0·07 (–0·55) (*n* = 35)	(0·18–)0·32 ± 0·06 (–0·44) (*n* = 67)	(0·31–)0·38 ± 0·08 (–0·53) (*n* = 25)	(0·33–)0·48 ± 0·06 (–0·6) (*n* = 76)	(0·20–)0·29 ± 0·05(–0·41) (*n* = 34)	(0·23–)0·30 ± 0·05 (–0·35) (*n* = 5)
Paraphyses tips width (µm)	(3·0–)4·07 ± 0·43(–5·0) (*n* = 30)	(3·5–)6·56 ± 1·34(–9·25) (*n* = 21)	(4·5–)5·5 ± 0·6(–6·25) (*n* = 10)	(3·0–)5·16 ± 1·13(–7·75) (*n* = 46)	(2·5–)3·2 ± 0·53(–4·0) (*n* = 25)	(3·5–)4·33 ± 0·61(–5·5) (*n* = 35)	(3·5–)4·81 ± 0·71(–6·0) (*n* = 15)	2·0–4·0 (*n* = 2)
Pycnidia, conidia	Not found	Not found	Present, often small and inconspicuous	Not found	Not found	Not found	Present, often small and inconspicuous	Present

(measurements and measured samples) are available from the authors. Paraphyses tips were observed after pre-treatment with *c*. 10% KOH. Only those ascospores with well-developed septa were measured; in these ascospores loculi were connected by a thin cytoplasmatic channel, never disconnected. The measurements are given as (min.–) $\bar{x}$ ± SD (–max.), where $\bar{x}$ = mean value and SD = standard deviation; total numbers of measurements (*n*) are given. Morphological terminology follows Smith *et al*. (2009). Anthraquinone secondary metabolites were determined from their HPLC retention times and absorption spectra (see Søchting 1997 for details).

DNA extraction, amplification and sequencing

Direct PCR was used for PCR-amplification of the ITS region including the 5.8S locus of the nuclear rDNA following Arup (2006). Primers used for amplification were ITS1F (Gardes & Bruns 1993) and ITS4 (White *et al*. 1990). PCR cycling parameters followed Ekman (2001). Products were cleaned using JETquick PCR purification Spin Kit (Genomed). Both complementary strands were sequenced with BigDye (BigDye Terminator Cycle sequencing kit, version 3.1, Perkin-Elmer, Applied Biosystems, Foster City, CA) using the primers mentioned above, and run on an ABI 3130 × l Genetic Analyzer.

Alignment and phylogenetic analysis

Fifty-nine newly generated ITS sequences were aligned, along with 38 sequences from GenBank. Sequence fragments were subjected to the BLAST searches for a first verification of their identities. Sequences of species with known phylogenetic identity (Gaya *et al*. 2008), *Caloplaca alociza* (EF090936), *C. demissa* (AF353962), *C. dolomiticola* (AF353957), *C. gloriae* (AF101282) and *Fulgensia fulgida* (AY051359), were selected as an outgroup. Sequences were aligned using MAFFT 6 (on-line version in the Q-INS-i mode; see Katoh *et al*. 2002) and manually cut to eliminate the unalignable ends and ambiguously aligned regions of ITS1 and ITS2. The final alignment retained 510 positions. Bayesian phylogenetic analyses were carried out using the program MrBayes 3.1.1 (Ronquist & Huelsenbeck 2003). The GTR+I+G model of molecular evolution was estimated with the program MrModeltest v2.3 (Nylander 2004) using the Akaike Information Criterion. The MCMC analyses were run for ten million generations, performed in two runs, each with four independent chains starting from a random tree. Trees were sampled every 100th generation, and the first 21 070 trees were discarded as burn-in, using standard deviation of splits between runs less than 0·01 as a convergence criterion. The remaining trees were used to calculate the posterior probabilities (PP) as a measure of support.

Results

The resulting dataset for molecular analysis contains 97 sequences of the ITS region. The final alignment has 510 positions, of which 298 are variable and 261 parsimony-informative. The resulting phylogenetic tree (Fig. 1) revealed 14 well-resolved clades of highly similar *Caloplaca holocarpa*-like phenotypes in various positions and nested within lineages with more complex phenotypes. All basic thallus morphologies (fruticose, foliose, squamulose, lobate and crustose) appear within sister lineages to some simplified clades.

The 14 *Caloplaca holocarpa*-like clades share the following characters.

1) Thallus poorly developed; endolithic or endophloeodal, or forming a thin yellowish or greyish crust on the substratum.

2) Yellow to orange apothecial discs and margins, both with a uniform anthraquinone content: parietin (main compound), ± emodin, fallacinal, parietinic acid and teloschistin.

3) Apothecial margin zeorine; composed of an inner purely fungal part (the true exciple) and an outer part (the thalline exciple) containing photobiont cells enclosed by a fungal tissue.

4) Ascospores *c*. 8–16 × 4–7 μm, with medium to thick septa (2·5–5·5 μm wide).

5) Pycnidia unknown in most of the species (and clades), but when present, producing ellipsoid conidia, *c*. 2·5–4·0 × 1·0–1·5 μm.

The species included here occur on a wide variety of substrata: tree bark, siliceous or calcareous rock, concrete, plant debris, mosses and loess. However, individual species are rather substratum specific, and this can be crucial for species identifications. The most favourable substrata for *C. holocarpa*-like species are twigs of shrubs in xeric conditions; five out of fourteen clades occur in this habitat.

Caloplaca holocarpa-like clades included in the molecular analysis

Caloplaca cerinella (Nyl.) Flagey

Thallus inconspicuous, mostly endophloeodal; apothecia small (0·25–0·4 mm

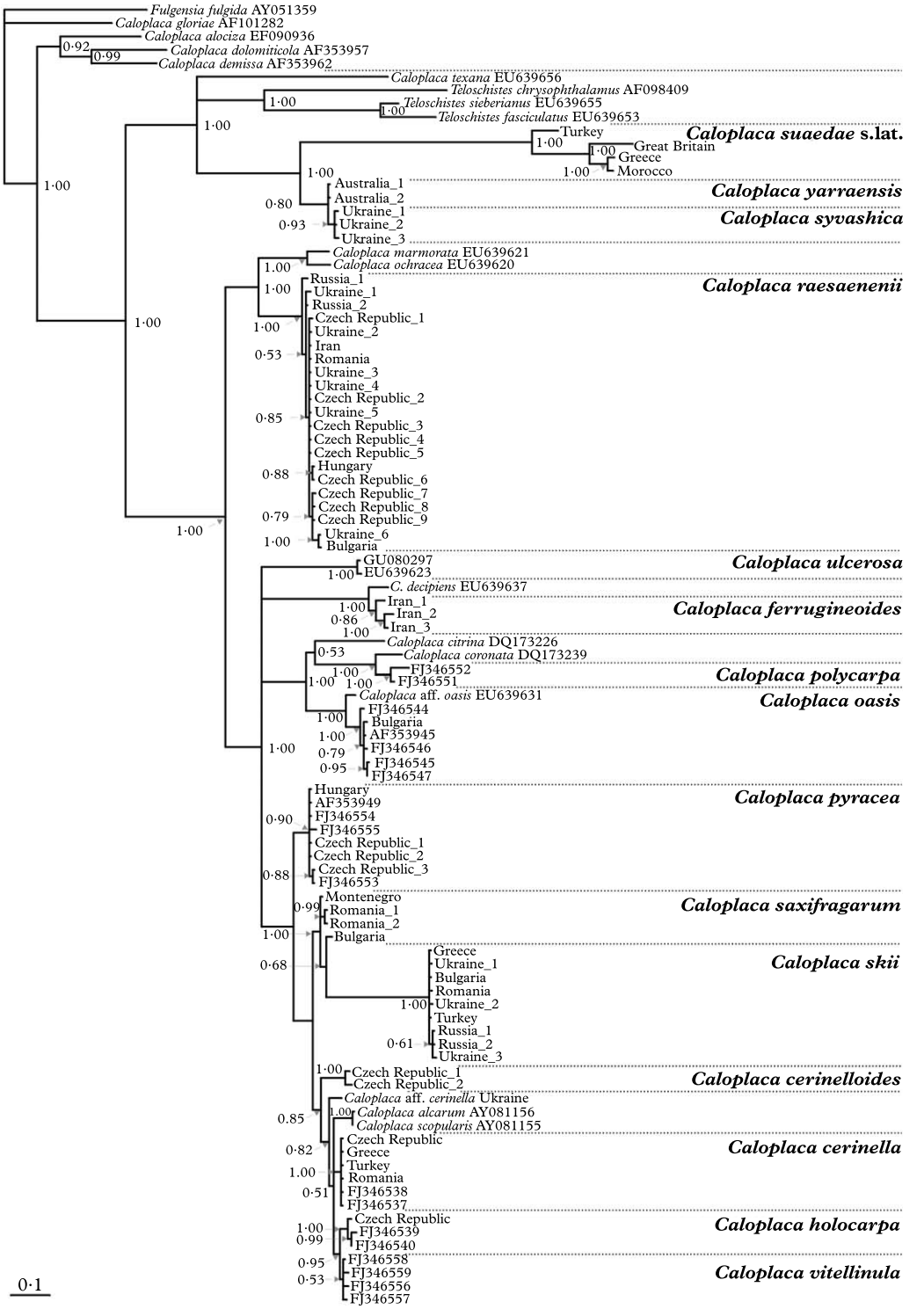

FIG. 1. Bayesian phylogeny of a section of the *Teloschistaceae* covering simplified *Caloplaca holocarpa*-like lineages (named on the right). Posterior probabilities are present at nodes.

diam.), yellow to orange; asci containing more than 8 spores; occurring on trees and shrubs throughout Europe (Arup 2009).

Caloplaca cerinelloides (Erischsen) Poelt

Thallus inconspicuous, partly endophloeodal; apothecia small (0·2–0·4 mm diam.), yellow to orange; ascospores ellipsoid (length/breadth ratio *c.* 1·5); on nitrophilous bark throughout Europe, often together with *C. pyracea*.

Caloplaca ferrugineoides H. Magn.

Thallus grey, partly endophloeodal, but often distinctly superficial; apothecia somewhat stipitate when mature, 0·4–1·0 mm diam.; thalline exciple covered by distinct paraplectenchymatous cortical tissue in lower part; on xerophilous shrubs in Central Asia, southern Russia, Turkey and Iran. The type material deposited in S (China: Kansu, Yü-ehr-hung, on dry twigs of a bush, 1932, *B. Bohlin*; nr L2612) is not well-developed but we consider it conspecific with our Central Asian material.

Caloplaca holocarpa (Hoffm.) A. E. Wade

Thallus inconspicuous, in shades of grey; apothecia yellow to orange, 0·3–0·7 mm diam.; a nitrophilous species usually on siliceous stones and rocks, but sometimes also on iron, wood and tree bases (Arup 2009).

Caloplaca oasis (A. Massal.) Szatala

Thallus crustose, areolate or often inconspicuous; apothecia orange, small (0·2–0·5 mm diam.); occurring as a lichenicolous lichen on endolithic *Verrucaria* spp. on limestone rock, but also as a free-living pioneer on concrete and other lime-rich substrata in Europe (Arup 2009).

Caloplaca polycarpa (A. Massal.) Zahlbr.

Phenotypically and ecologically similar to *C. oasis* but with a more developed, yellow thallus (Arup 2009).

Caloplaca pyracea (Ach.) Zwackh

Thallus grey to yellow-grey, endophloeodeal or superficial; apothecia 0·4–0·7 mm diam., orange, zeorine, usually with distinct white-grey or yellowish thalline exciple; thalline exciple covered by a distinct paraplectenchymatous cortical tissue in lower part; common species on nitrophilous bark throughout Europe (Arup 2009).

Caloplaca raesaenenii Bredkina (syn. *C. thuringiaca* Søchting & Stordeur)

Thallus inconspicuous; apothecia orange, small (0·2–0·6 mm diam.), biatorine or zeorine, urceolate; on shrubs, plant debris, rabbit droppings, mosses and loess in arid regions of Europe and Asia.

Caloplaca saxifragarum Poelt

Thallus inconspicuous; apothecia orange, *c.* 0·2–0·4 mm diam., biatorine to zeorine; occurring on tufts of perennial plants and on twigs of shrubs in alpine habitats. Muscicolous species, *Caloplaca chelyae* I. Pérez-Vargas and *C. schoeferi* Poelt, have similar phenotypes (Pérez-Vargas & Pérez de Paz 2009) but their phylogenetic identities were not studied.

Caloplaca skii (described below)

Caloplaca suaedae s. lat.

Thallus grey, partly endophloeodal, but often distinctly superficial; apothecia orange, *c.* 0·3–0·5 mm diam.; on Mediterranean shrubs or lignicolous. This unit probably contains several species with yellow (anthraquinone-containing) pycnidia, a character which is absent in other clades. The maritime species *C. suaedae* O. L.

Gilbert & Coppins (Gilbert 2001) belongs here.

Caloplaca syvashica (described below)

Caloplaca ulcerosa Coppins & P. James.

Thallus inconspicuous, partly endophloeodal, whitish, with green-grey crater-like soralia; apothecia orange, *c.* 0·3–0·4 mm diam.; occurring on trees and shrubs around sea coasts of Europe (Vondrák *et al.* 2009*b*).

Caloplaca vitellinula (Nyl.) H. Olivier

Phenotypically and ecologically similar to *C. holocarpa*, to which it is closely related, but usually with a distinct, thin yellow thallus (Arup 2009).

Caloplaca yarraensis S.Y. Kondr. & Kärnefelt

This recently described species from Australia (Kondratyuk *et al.* 2009) is closely related to *Caloplaca syvashica*, but strongly differs in ascospore characters (see the description of *C. syvashica*).

The New Species

Caloplaca skii Khodosovtsev, Vondrák & Šoun sp. nov.

MycoBank No.: MB 519676

A *Caloplaca cerinelloides* ascosporis angustioribus et minoribus (7·5–) 10·4 ± 1·06 (–12·8) × (3·5–) 5·2 ± 0·66 (–6·5) µm differt.

Typus: Russia, Black Sea coast, Taman Peninsula, sand dunes E of Peresip', 45°20′17·60″N, 37°11′04·59″E, on stems of *Artemisia*, 19 May 2007, *J. Vondrák & J. Šoun* (CBFS JV7017—holotypus; LD, GZU—isotypi). ITS sequence of the holotypus: HM582191.

(Fig. 2A)

Thallus thin, film-like, inconspicuous, visible only around apothecia, whitish, light grey or pale yellowish, (20–)35 ± 13(–60) µm high (*n* = 10). *Prothallus* not developed. *Cortex* not developed. *Alveolate cortex* (*sensu* Vondrák *et al.* 2009*a*) thin, (5·0–)6·8 ± 1·6 (–10·0) µm wide (*n* = 10), formed of loose paraplectenchyma with cells of lumina *c.* 3·5–5 µm wide. *Algal layer* (10–)20 ± 6 (–30) µm high (*n* = 10); *algal cells* globose, (11·3–)14·3 ± 2·26(–18·0) µm diam. (*n* = 10). *Medulla* not developed.

Apothecia zeorine to biatorine, dispersed, small, (0·2–)0·3 ± 0·08(–0·5) mm wide (*n* = 45); apothecial primordia and young apothecia immersed in thallus, yellowish to white yellowish; mature apothecia sessile to weakly constricted at the base; *disc* flat to weakly convex in mature ascomata, yellow-orange, non-pruinose; *true exciple* well defined, persistent, yellow, non-pruinose, always paler than disk, (25–)38 ± 7(–50) µm wide (*n* = 10) in upper part, consisting of radiating cells; marginal cells ± isodiametric with lumina (2·5–) 3·7 ± 0·7 (–5·0) µm (*n* = 10); *thalline exciple* visible only in young apothecia, white greyish to yellow-white, later inconspicuous but persistent on lower side of apothecial margin, (10–)40 ± 14(–60) µm wide (*n* = 10). *Alveolate cortex* of thalline exciple thin, (5·0–)7·4 ± 2·45(–12·0) µm wide (*n* = 10) formed of loose paraplectenchyma, with cells (2·5–)3·5 ± 0·62(–4·5) µm diam. (*n* = 10). *Hypothecium* colourless, (30–)38 ± 6(–50) µm high (*n* = 15), formed of variously shaped cells. *Hymenium* hyaline (50–)60 ± 7(–70) µm high (*n* = 15), with oil drops. *Paraphyses* of thin-walled cells, 1·5–2·0 µm thick in lower part, sometimes branched; apical cells swollen, sometimes with oil drops, (3·5–)4·3 ± 0·6(–5·5) µm wide (*n* = 35) covered by external anthraquinone pigments. *Asci* clavate, 8–spored, *Teloschistes*-type, (35·0–)42·8 ±5·5 (–55·0) × (11·0–)13·1 ± 1·5(–16·0) µm (*n* = 15). *Ascospores* polarilocular, ellipsoid, (7·5–) 10·4 ± 1·06(–12·8) × (3·5–)5·2 ±0·66(–6·5) µm (*n* = 76); length/breadth ratio (1·55–) 2·0 ± 0·35(–3·2); *ascospore septa* (3·5–) 5·0 ± 0·69(–6·5) µm thick (*n* = 76); ratio of septum width/ascospore length (0·33–) 0·5 ± 0·06(–0·61); *ascospore wall* thin (up to 0·5 µm).

Conidiomata not seen.

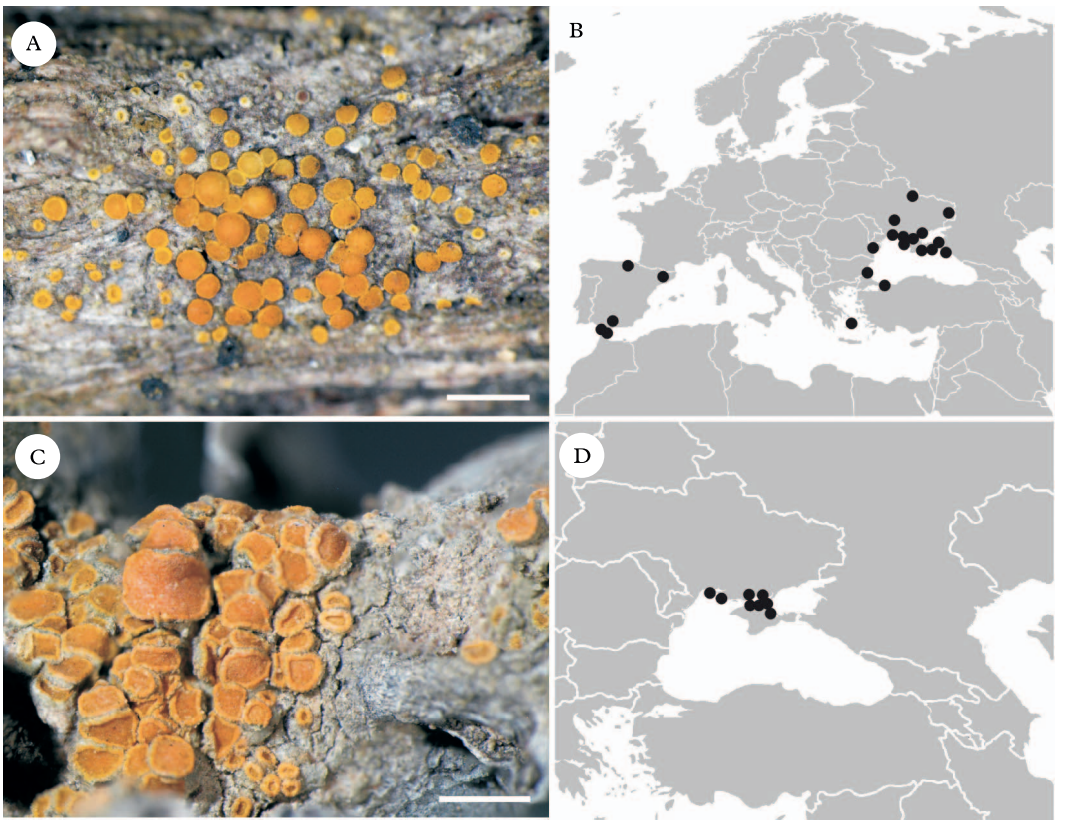

FIG. 2. The new species. A, *Caloplaca skii*, holotypus; B, *C. skii*, distribution; C, *Caloplaca syvashica*, holotypus; D, *C. syvashica*, distribution. Scales: A, C = 1 mm.

Chemistry. Thallus C−, K− (pale yellow thalli K+ purple); apothecia K+ (purple), C− or rarely C+ reddish, P−, UV+ orange-red. Compounds: parietin (major), ± traces of emodin, parietinic acid, fallacinal and teloschistin.

Etymology. The name honours the Ukrainian lichenologist Sergiy Kondratyuk for his significant contribution to the taxonomy of *Teloschistaceae*.

Phylogeny. Nine ITS sequences of *Caloplaca skii* obtained from a large territory are almost identical with only two variable nucleotide positions. They form a well supported monophyletic group (PP = 1·00) related to *C. saxifragarum*, but not closely. The noteworthy characters shared by sequences of *C. skii* are synapomorphies causing the long branch of the group in Fig. 1.

Ecology and distribution. Caloplaca skii prefers branches of shrubs in lowlands, especially close to sea shores. It has been found on *Artemisia arenaria*, *A. lerchiana*, *A. santonica*, *Corydothymus capitatus*, *Ephedra distachya*, *Halocnemum strobilaceum*, *Helichrysum stoechas*, *Jasminum* sp., *Kochia prostrata*, *Lycium* sp., *Paliurus spina-christi*, *Pinus halepensis*, *Thymus dimorphus*, and *T. cretaceus* in arid and semi-arid regions. Sometimes it grows over old bones or plant debris. The accompanying species are, for example, *Caloplaca haematites* (Chaub.) Zwackh, *C. lobulata* (Flörke) Hellbom, *C. phlogina* (Ach.) Flagey, *C. sterilis* Šoun, Khodosovtsev & Vondrák, *C. raesaenenii*, *Lecanora hagenii*

(Ach.) Ach., *Physcia adscendens* H. Olivier, *Rinodina pyrina* (Ach.) Arnold, and some species of *Xanthoria*. It has a southern distribution in Europe (Bulgaria, Greece, Romania, Spain, southern Russia and Ukraine); it is also known from Turkey (Fig. 2B).

Remarks. *Caloplaca cerinelloides* is similar, but *C. skii* has shorter and narrower ascospores and prefers the bark of shrubs in arid regions of S/SE Europe. In steppes, *C. skii* sometimes grows together with *C. raesaenenii*, but both species are usually distinguishable in the field by the colour of their apothecia; dark orange in *C. raesaenenii* and yellow-orange in *C. skii*. Aberrant forms of *C. skii* with more orange apothecia can be distinguished by the wider septa. The boreal species *C. sibirica* is similar but has a strongly reduced thalline exciple and the true exciple is darkened by an olive pigment (at least in the lower part).

Paratypes. **Bulgaria:** *Black Sea coast*: Burgas, Sozopol, sand dunes near seashore *c*. 5·5 km S of town, 42°21′59·76″N, 27°42′31·11″E, on coastal shrubs, 9 iv 2007, *J. Vondrák & J. Šoun* (CBFS JV7375, will be distributed in Vondrák*: Sel. Exs. of* Caloplaca, *fasc. 3*; JV7626; JV8321).—**Greece:** *Crete*: Koufonisi islands, auf *Corydothymus capitatus*, 2001, *Sterner* (GZU).—**Romania:** *Dobruja*: Tulcea, Enisala, limestone outcrops 250 m SE of Enisala castle ruin, alt. *c*. 70 m, 44°52′56·03″N, 28°50′12·41″E, on *Thymus*, 3 iv 2007, *J. Vondrák & J. Šoun* (CBFS JV7376).—**Russia:** *Black Sea coast*: Novorossiysk, coastal rocks near Yuzhnaya Ozereevka, 44°40′13·38″N, 37°37′57·04″E, on twigs of *Paliurus spina-christi*, 18 v 2007, *J. Vondrák* (CBFS JV7508*); ibid*.: on *Jasminum*, 18 v 2007, *J. Vondrák* (CBFS JV7537); Taman Peninsula, loess steppe near road E of Primorskiy, 45°16′24·05″N, 36°57′12·40″E, on dead shrub twigs, 19 v 2007, *J. Vondrák & J. Šoun* (CBFS JV7016); Taman Peninsula, salt marsh SW of Primorskiy near Taman' Bay coast, 45°15′16·05″N, 36°53′40·46″E, on *Halocnemum strobilaceum*, 20 v 2007, *J. Vondrák & J. Šoun* (CBFS JV7377).—**Spain:** *Andalucia*: Alora, El Chorro, at village, alt. *c*. 250 m, 36°54′N, 4°45′W, on bark of *Pinus halepensis*, 24 ii 2008, *J. Vondrák* (CBFS JV6263); Antequera, Torcal de Antequera, *c*. 7 km S of town, alt. *c*. 1200 m, 36°57′21·41″N, 4°32′23·30″W, on bark of small shrubs in shrub vegetation, 5 iii 2008, *J. Vondrák* (CBFS JV8320); Tarifa, El Santiscal, coastal cliffs 1·5 km W of village, 36°5′9·38″N, 5°47′4·37″W, on bark of shrub close to sea, 29 ii 2008, *J. Vondrák* (CBFS JV6312). *Basque Country*: on bark of shrub *Helichrysum stoechas* at Atlantic coast, 30 vi 2002, *J. Vondrák* (CBFS JV7816). *Catalonia*: Lleida, Balaguer, wasteland *c*. 4 km NEN of town, alt 250 m, 41°48′6·51″N, 0°51′7·13″E, on small shrub in garrigue, 7 iii 2008, *J. Vondrák* (CBFS JV6283).—**Turkey:** *Black Sea coast*: Kandıra, sand dunes and coastal limestone rocks 6 km E of Cebeci, 41°12′00·35″N, 30°19′47·18″E, on coastal shrubs, 15 iv 2007, *J. Vondrák & J. Šoun* (CBFS JV7378, hb. Šoun 486).—**Ukraine:** *Crimean Peninsula*: Leninsky district, Kerch Peninsula, Opukskiy zapovednik, coastal cliffs, alt. *c*. 100 m, 45°01′53·00″N, 036°12′47·94″E, on *Thymus*, 14 vi 2006, *J. Vondrák & J. Šoun* (CBFS JV7015); Krasnoperekopsky district, vill. Nadezdino, at small shallow gulf S of village, alt. 0 m, 46°01′48·09″N, 033°59′42·57″E, on *Artemisia* twigs, 8 vi 2006, *J. Vondrák* (CBFS JV5164); Chornomorskiy district, vil. Olenevka, cape Tarchankut, coast of Black Sea, on twigs of *Artemisia lerchiana*, N 45·20617°, E 32·30476°, alt. 15 m, 4 v 2010, *A. Khodosovtsev* (KHER, KW); Sudak, Meganom cape, on *Ephedra distachya*, 4 v 2004, *A. Khodosovtsev* (KHER 2933). *Kherson region*: Goloprystansky district, Black Sea biosphere reserve, Tendrovs′ka kosa island, on bones, 6 vii 1992, *A. Khodosovtsev* (KHER); *ibid*.: on *Artemisia arenaria*, 1 v 2009, *A. Khodosovtsev* (KHER, CBFS JV7381, KW); Skadovsky district, Dzharylgach island, on *Artemisia arenaria*, 28 vii 2009, *A. Khodosovtsev* (KHER); Genichesky district, Biryuchy island, on plant debris, 1995, *A. Redchenko* 2931 (KHER). *Kharkiv region*: Vivchansky district, vill. Mala Vovcha, right bank of river Vovcha, chalk outcrops, on plant debris, 9 ix 2005, *A. Gromakova* (KHER). *Lugansk region*: Starobilsky district, vill. Starobilska, cretaceous outcrops, on *Thymus cretaceus*, 28 ix 1953, *A. Oxner* (KW 3600). *Nikolaev region*: nature reserve 'Yelanetskiy Step', *c*. 60 km N of town, alt. *c*. 50 m, 47°32′40·54″N, 032°04′54·27″E, 7 vi 2006, *J. Vondrák* (CBFS JV5215).

Caloplaca syvashica Khodosovtsev, Vondrák & Šoun sp. nov.

MycoBank No.: MB519677

A *Caloplaca suaedae* ascosporis latioribus, (10·5–) 12·87 (–16·0) × (4·75–) 5·91 (–7·25) µm, et apotheciis pruinosis differt.

Typus: Ukraine, Crimean Peninsula, Sivash lake, Krasnoperekopsk, Nadezhdino, salt marshes at small shallow sea-gulf S of village, alt. 0 m, 46°01′48·09″N, 33°59′42·57″E, on wooden stems of *Limonium suffruticosum*, 8 June 2006, *J. Vondrák & J. Šoun* (CBFS JV4996—holotypus; CBFS JV7012—isotypus; isotypi will be also distributed in Vondrák: *Sel. Exs. of* Caloplaca, *fasc. 3*). ITS sequence of the isotypus: HM582201.

(Fig. 2C)

Thallus crustose, rimose areolate, sometimes inconspicuous; (50–)145 ± 40(–200) µm thick (*n* = 11). *Areoles* flat to weakly convex, (0·10–)0·3 ± 0·1(–0·5) mm wide (*n* = 15), greenish, grey greenish or greenish

white; ± covered by white crystals; sometimes indistinctly granular in shaded conditions (e.g. on lower sides of twigs). *Prothallus* dirty whitish, usually not developed. *Cortex* not developed, but indistinct *alveolate cortex* (*sensu* Vondrák *et al.* 2009*a*) present, (7–)12 ± 3(–18) µm high (n = 10), composed of loose paraplectenchyma of rounded cells with lumina *c.* 3·5–5·0 µm wide. *Epinecral layer* present, partly formed by colourless crystals, not dissolving in K and N. *Algal layer* (40–)76 ± 23(–120) µm high (n = 10) with *algonecral medulla* (*sensu* Vondrák *et al.* 2008) below; *algal cells* globose, (11·3–) 14·1 ± 3·8(–22·0) µm diam. (n = 10). *Medulla* inconspicuous, white, formed by loose prosoplectenchyma with 2·5–3·5 µm thick hyphae.

Apothecia zeorine (0·2–)0·5 ± 0·19 (–1·0) mm wide (n = 35), associated in small groups, rounded or angular, yellow-orange to orange-red, sessile to constricted at the base. *Disc* flat or slightly convex; orange-red, often with white pruina. *True exciple* in upper part (20–)51 ± 13 (–65) µm wide (n = 15), orange, consisting of gelatinous radiating cells; marginal cells with ± rounded lumina (2·0–)3·0 ± 0·52(–3·8) µm diam. (n = 10). *Thalline exciple* (50–)73 ± 14(–100) µm wide (n = 10), yellow to greyish green, distinct in mature apothecia; cortical tissue of the *thalline exciple* (5·0–)7·4 ± 1·8(–10·0) µm wide (n = 10), formed of paraplectenchymatous cells (2·0–)3·0 ± 0·61(4·0) µm diam. (n = 10), usually covered by white pruina. *Hypothecium* colourless, (35–)53 ± 15(–80) µm high (n = 11), formed of variously shaped cells. *Hymenium* hyaline, (60–)73 ± 8(–85) µm high (n = 10), rarely with some oil drops. *Paraphyses* of thin-walled cells, 1·5–2·0 µm thick, sometimes branched; apical cells swollen, (3·5–)4·8 ± 0·7(–6·0) µm wide (n = 15). *Epihymenium* covered by orange granules of anthraquinones dissolving in K; colourless crystalline pruina ± present, insoluble in K and N. *Asci* clavate, 8-spored, *Teloschistes*-type (50·0–)56·7 ± 4·3(–65·0) × (12·0–) 14·5 ± 1·6(–17·0) µm (n = 10). *Ascospores* polarilocular, narrowly ellipsoid, (10·5–) 12·9 ± 1·59(–16·5) × (4·8–)5·9 ± 0·81(–7·5) µm (n = 34); length/breadth ratio (1·67–) 2·2 ± 0·32(–3·05); *ascospore septa* (2·5–) 3·7 ± 0·62(–5·0) µm thick (n = 34); ratio of septum width/ascospore length (0·20–) 0·3 ± 0·05(–0·41); *ascospore wall* thin (up to *c.* 0·5 µm).

Pycnidia small, *c.* 20–35 µm diam., inconspicuous, sometimes several per areole, deeply immersed in thallus; ostioles often do not emerge at the surface. *Pycnoconidia* bacilliform, (2·5–)3·0 ± 0·61(–4·0) × (0·9–)1·1 ± 0·15(–1·3) µm (n = 5).

Chemistry. Thallus K−, C−, apothecia K+ (purple), C−, P−, UV+ orange-red. Compounds: parietin (major), ± traces of emodin, parietinic acid, fallacinal and teloschistin.

Etymology. The species is named after the Sivash salt lake, a big lagoon of the Azov Sea situated between the Ukrainian mainland and the Crimean Peninsula.

Phylogeny. Three ITS sequences of *Caloplaca syvashica* from different localities are identical and form the monophyletic group (PP = 0·93). The Australian *C. yarraensis* is closely related since its two identical sequences generated from isotype samples only differ from those of *C. syvashica* in three nucleotide positions. The grouping of both species is in a sister relationship to *C. suaedae* s. lat. clade (Fig. 1), but both clades differ considerably in the characters of their ITS sequences.

Ecology and distribution. The species grows on small halophilous shrubs (*Halocnemum strobilaceum* and *Limonium suffruticosum*) in salt marshes, especially at the Sivash Lake in the northern Black Sea region (Fig. 2D). It prefers shrubs in the driest parts of salt marshes, which are not periodically inundated by water. The associated species are, for example, *Arthonia apatetica* (A. Massal.) Th. Fr., *Caloplaca phlogina*, *Candelariella boikoi* Khodosovtsev & S. Kondr., *Lecania inundata* (Hepp ex Körb.) M. Mayrhofer and *Lecanora hagenii*. We have searched for, but not found, *C. syvashica* in similar habitats

with *Halocnemum strobilaceum* on the northern Caspian Sea coast, at the salt lake Baskunchak (Russia, Astrkhan region) and at salt lakes Inder and Cholcar in Kazakhstan.

Remarks. Morphologically and ecologically, *C. suaedae* s. str. (Gilbert 2001) is a similar species, but it has non-pruinose apothecia, narrower ascospores and is known only from England, where it occurs in maritime habitats. The widespread *C. pyracea* has thick ascospore septa and a thick cortex in the lower part of a grey yellowish thalline exciple. *Caloplaca raesaenenii* differs in its smaller, non-pruinose apothecia with reduced thalline margin and in having a less conspicuous, film-like thallus.

The Australian *C. yarraensis* is surprisingly closely related to the new species. It also occurs in salt marshes and shares some morphological characters with *C. syvashica* (Kondratyuk *et al.* 2009). We have investigated two isotype samples of *C. yarraensis* in detail and found some considerable differences from the new species: 1) ascospores small, (9·0–) 11·0 ± 1·1(–13·75) × (4·5–) 5·0 ± 0·25(–5·75) µm (n = 20); 2) ascospore septa very thin (1·0–) 1·5 ± 0·25(–2·0) µm (n = 20); 3) paraphyses tips strongly swollen, (4·0–)4·9 ± 0·7(–6·25) µm (n = 21). Among these characters, ascospore septa differ the most; their ranges in these two species do not overlap.

As the new species has a close relative in Australia and their clade is very isolated from the other European clades investigated, we suggest that *C. syvashica* may be a recent colonizer of a restricted area in the Black Sea region, and that it may belong to some Southern Hemisphere group of *Teloschistaceae*.

Paratypes. **Ukraine:** *Crimean Peninsula*: Dzhankoys'ky district, vill. Predmostnoye, Sivash lake coast, on *Halocnemum strobilaceum*, 4 iv 2007, *A. Yena* (KHER); Nizhnegirsky district, vill. Dmytrivka, on *Halocnemum strobilaceum*, 8 vi 2003, *A. Khodosovtsev* (KHER 2734). *Kherson region*: Chaplynsky district, SE from vill. Pershokonstantinovka, coast of Sivash Laguna, on *Halochemum strobilaceum*, 12 vi 2008, *A. Khodosovtsev & J. Vondrak* (KHER, CBFS JV7208, KW); Genichesky district, peninsula Chongar, Sivash coast, on *Halocnemum strobilaceum*, 3 v 1996, *R. Mishustin* (KHER 2725; 2724, 2721); Station Sivash, Sivash coast, 20 ix 1995, *A. Khodosovtsev* (KHER 2719); Island Kuyk-Tyk, on *Halocnemum strobilaceum*, 18 ix 1994, *A. Khodosovtsev* (KHER 2720); Golopristanskiy district, vill. Sadove, Nikolaivka, section of protected area Black Sea biosphere reserve, on *Halocnemum strobilaceum* in salt marsh, with *Caloplaca phlogina*, 26 vi 2009, *J. Vondrák* (CBFS JV7142). *Nikolaev region*: Ochakov district, regional nature reserve "Kinburnskaya kosa", on *Halocnemum strobilaceum*, with *Caloplaca phlogina*, 26 vi 2009, *J. Vondrák* (CBFS JV7131).

Key to the corticolous *Caloplaca holocarpa*-like species in Europe

1 Thallus with soredia 2
Thallus without soredia 3

2(1) Apothecia yellowish; soralia small and often sparse, 80–120 µm wide, dark grey (soredia K+ violet in section); in boreal zone of Europe . . . . . **Caloplaca ahtii Søchting**
Apothecia orange; soralia larger and frequent, 200–400 µm wide, green-grey (K− in section); Mediterranean-Atlantic . . . . . **Caloplaca ulcerosa**

3(1) Asci (8–)12–16-spored. . . . . **Caloplaca cerinella**
Asci 8-spored. 4

4(3) Septa wide – mean in representative sample of ascospores (n >10) 4–5 µm thick; septum width/spore length ratio mostly >0·35 5
Septa thinner – mean in representative sample of ascospores (n >10) 3–4 µm thick; septum width/spore length ratio mostly <0·35 11

5(4) Thallus, apothecial margin, or disc with olive-black to olive-grey pigment (K− or K+ sordid violet, but its reaction is overshadowed by K+ purple anthraquinones) . 6
Thallus, apothecial margin and disc without olive-black or olive-grey pigmentation 7

6(5) Outer apothecial margin usually with olive pigmentation (young apothecia often lack pigmentation); disc yellow to pale orange without olive pigmentation; corticolous in boreal zone of Europe . . . . . **Caloplaca borealis (Vain.) Poelt**
Apothecial margin usually without olive pigmentation; disc of mature apothecia with olive pigment (at least in parts); on arctic-alpine shrubs, plant debris or bryophytes . . . . . **Caloplaca tiroliensis Zahlbr.**

7(5) Thalline exciple clearly visible, 50–80 μm thick, yellow greyish to pale grey, with distinct cortex in lower part, up to 20 μm wide; disc orange to dark orange contrasting with greyish outer margin . . . . . **Caloplaca pyracea**
Thalline exciple usually not apparent, 0–50 μm thick, without a cortex or cortex poorly developed, up to 10 μm wide; disc yellow to orange 8

8(7) Ascospores narrowly ellipsoid, *c.* 4·0–6·0 μm wide; length/breadth ratio often >2·0; on shrubs; S-SE Europe . . . . . **Caloplaca skii**
Ascospores ellipsoid, *c.* 6·0–8·0 μm wide; length/breadth ratio usually <2·0 . . . 9

9(8) Mature apothecia 0·3–0·7 mm diam., sometimes with yellow or greyish areoles around apothecia; usually saxicolous but rarely on dusty bark and lignum . . . . . **Caloplaca holocarpa**
Mature apothecia *c.* 0·2–0·4 mm diam.; thallus greyish, inconspicuous; not saxicolous 10

10(9) Apothecia yellowish, on bark of deciduous trees, temperate-boreal . . . . . **Caloplaca cerinelloides**
Apothecia orange to dark orange; on dead tufts of *Saxifraga* and on small shrubs and woody plants, alpine . . . . . **Caloplaca saxifragarum**

11(4) Mature apothecia stipitate, cortex of thalline exciple 15–40 μm thick with large isodiametric to oval cells, 5–10 μm wide; on steppe shrubs, in Europe restricted to southern Russia . . . . . **Caloplaca ferrugineoides**
Mature apothecia sessile or weakly constricted at base, cortex of thalline exciple not developed, but an indistinct alveolate cortex (*sensu* Vondrák *et al.* 2009*a*), 0–15 μm wide, sometimes present 12

12(11) Pycnidia present, with yellow (K+ purple) anthraquinone pigments around ostioles . . . . . **Caloplaca suaedae s. lat.**
(***Caloplaca suaedae*** O.L. Gilbert & Coppins s. str. is characterized by narrowly, ellipsoid ascospores, *c.* 3–5 μm thick; length/breadth ratio *c.* 3·0; known from *Suaeda vera* shrubs in England)
Pycnidia absent or present but without yellow (K+ purple) anthraquinones; ascospores ellipsoid, *c.* 5–7 μm thick; length/breadth ratio *c.* 2·0 13

13(12) Apothecia 0·2–1·0 mm diam., orange-red, ± white pruinose, usually zeorine with paler yellowish-orange thalline exciple; thallus green-grey, rimose areolate covered by crystals, known only from *Halocnemum strobilaceum* and rarely from *Limonium suffruticosum* in salt marshes in southern Ukraine . . . . . **Caloplaca syvashica**
Apothecia 0·2–0·6 mm diam., bright orange to dark orange, not pruinose, usually biatorine without visible thalline margin; thallus usually film-like, greyish, without crystals, on shrubs (not on *Halocnemum strobilaceum* and rarely on *Limonium suffruticosum*), soil, plant debris, wood, rarely on bases of trees in arid regions of Eurasia . . . . . **Caloplaca raesaenenii**

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