



## FIRST DATA ON MOLECULAR PHYLOGENY OF THE GENUS *PROTOPARMELIOPSIS* M. CHOISY (LECANORACEAE, ASCOMYCOTA)

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**Abstract.** Results on molecular phylogeny of lichen-forming fungi of the genus *Protoparmeliopsis* based on nrDNA ITS1/ITS2 and 28S LSU and mtDNA 12S SSU as well as on combined data set are provided. The position of this genus in the phylogenetic tree of the family Lecanoraceae is discussed. The genus *Protoparmeliopsis* found to be polyphyletic similarly to the genera *Rhizoplaca*, *Lecanora* and *Protoparmelia*.

**Key words:** *Protoparmeliopsis*, *Lecanora*, *Rhizoplaca*, nuclear, mitochondrial DNA, sequences

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### Introduction

The first molecular data of the genus *Protoparmeliopsis* M. Choisy were provided by ARUP & GRUBE (2000). Four species (*P. muralis* (Schreb.) M. Choisy, *P. acharianum* (A.L. Sm.) Moberg & R. Sant., *P. laatokkaensis* (Räsänen) Moberg & R. Sant., and *P. macrocyclos* (H. Magn.) Moberg & R. Sant.) have been included in the genus since then (SANTESSON 2004). Further members of this genus were recently proposed (KONDRATYUK 2010; KONDRATYUK *et al.* 2012). Five species, i.e. *P. esfahanensis* S.Y. Kondr. & B. Zarei-Darki and *P. zareii* S.Y. Kondr. (both from Iran), *P. chejuensis* S.Y. Kondr. et J.-S. Hur (from South Korea); *P. pseudogyrophoricum* S.Y. Kondr., S.-O. Oh et J.-S. Hur (from China); and *P. taranii* S.Y. Kondr. et Tchaban. (from Russia) were recently described too (KONDRATYUK *et al.* 2012, 2013c).

The genus *Protoparmeliopsis* is not accepted in current taxonomy of the family Lecanoraceae (LUMBSCH & HUHDORF 2007, 2010) due to lack of molecular data. Sequences from only three species *P. acharianum*, *P. macrocyclos* and *P. muralis*, were hitherto available in the

GenBank. Several species recently described in *Protoparmeliopsis*, or combined in the genus, based on results from morphology (KONDRATYUK 2010, KONDRATYUK *et al.* 2012, 2013 c), were here included in a molecular analysis.

### Material and methods

Specimens (Tab. 1) were examined using standard microscopic techniques, i.e. hand-sectioned under Nikon SMZ645 dissecting microscope, sections were observed under Nikon E200 and Olympus BX51 microscope. Photos were done with Olympus DP-Soft photo program.

The methods used for extraction, amplification and phylogenetic analyses are described in previous papers (KONDRATYUK *et al.* 2013 a, b, d, 2014 a, b).

### Results

Within this study the position of *P. muralis* and the new Asian species *P. zareii*, data on which were for the first time submitted into GenBank, as well as two species *P. acharianum*

**Table 1.** Specimens included into phylogenetic analysis with GenBank numbers.

	Taxon name	ITS1/ITS2 nrDNA	28S LSU nrDNA	12S SSU mt DNA
1.	<i>Lecanora allophana</i>	AF070031	AY853376	AY567710
2.	<i>Lecanora allophana</i>	AF159939		
3.	<i>Lecanora allophana</i>	AF070014		
4.	<i>Lecanora achroa</i>	JN943714	JN939502	JQ782663
5.	<i>Lecanora achroa</i>	JN943715	JN939504	
6.	<i>Lecanora achroa</i>	JN943719	JN939527	
7.	<i>Lecanora caesiorubella</i>	JN943722	JN939506	JQ782667
8.	<i>Lecanora caesiorubella</i>	JN943727	JN939508	JQ782666
9.	<i>Lecanora caesiorubella</i>	JN943728	JN939509	
10.	<i>Lecanora campestris</i>	AF159930	DQ787361	DQ787362
11.	<i>Lecanora carpinea</i>	AY541249	DQ787363	DQ787364
12.	<i>Lecanora carpinea</i>	AY541247		
13.	<i>Lecanora carpinea</i>	AY541248		
14.	<i>Lecanora contractula</i>	AF070032		
15.	<i>Lecanora contractula</i>	HQ650604	DQ986746	DQ986898
16.	<i>Lecanora farinacea</i>	AY541261		
17.	<i>Lecanora farinacea</i>	AY541262		
18.	<i>Lecanora farinacea</i>	JN943726	JN939511	JQ782672
19.	<i>Lecanora farinacea</i>	JN943725	JN939513	JQ782671
20.	<i>Lecanora farinacea</i>	JQ782710		JQ782670
21.	<i>Lecanora flavopallida</i>	JN943723	JN939514	JQ782674
22.	<i>Lecanora flavopallida</i>	JN943724	JN939516	
23.	<i>Lecanora intricata</i>	AY398703	DQ787345	DQ787346
24.	<i>Lecanora intricata</i>	AF070022		
25.	<i>Lecanora perpruinosa</i>	AF070025	DQ787343	DQ787344
26.	<i>Lecanora aff. perpruinosa</i>	SK777	SK777	SK777
27.	<i>Lecanora polytropa</i>	DQ534470	DQ787347	DQ787348
28.	<i>Lecanora polytropa</i>	HQ650643	DQ986792	DQ986807
29.	<i>Lecanora polytropa</i>	JN873881		
30.	<i>Lecanora polytropa</i>	AF070017		
31.	<i>Lecanora sulphurea</i>	AF070030	DQ787355	DQ787356
32.	<i>Lecanora sulphurea</i>			EF105419
33.	<i>Lecanora tropica</i>	JN943718	JN939518	JQ782699
34.	<i>Lecanora tropica</i>	JN943720	JN939533	
35.	<i>Lecanora tropica</i>	JN943721	JN939537	
36.	<i>Oxneria alfredii</i>	EU681345		EU680933
37.	<i>Oxneria huculica</i>	EU681346	KC179279	EU680931
38.	<i>Oxneria ulophyllodes</i>	EU681341	KC179284	EU680929
39.	<i>Protoparmelia badia</i>	JN009728	DQ431917	AF351179
40.	<i>Protoparmelia badia</i>	EU075540	DQ431916	EF105420

Table 1. Continued.

	Taxon name	ITS1/ITS2 nrDNA	28S LSU nrDNA	12S SSU mt DNA
41.	<i>Protoparmelia badia</i>	EU075539	EF105425	EU075526
42.	<i>Protoparmelia badia</i>	KF562191	KF562183	DQ899311
43.	<i>Protoparmelia badia</i>	AF070023	DQ787365	
44.	<i>Protoparmelia montagnei</i>	SK A7	SK A7	SK A7
45.	<i>Protoparmelia montagnei</i>	AF101277		AF101276
46.	<i>Protoparmelia montagnei</i>	AF101275		
47.	<i>Protoparmelia picea</i>	KF562194	KF562186	DQ899312
48.	<i>Protoparmeliopsis acharianum</i>	AF070019	DQ973027	DQ977926
49.	<i>Protoparmeliopsis acharianum</i>	SK A4	SK A4	SK A4
50.	<i>Protoparmeliopsis acharianum</i>	SK A8	SK A8	SK A8
51.	<i>Protoparmeliopsis acharianum</i>		DQ787341	DG787342
52.	<i>Protoparmeliopsis chejuensis</i>	SK A6	SK A6	SK A6
53.	<i>Protoparmeliopsis aff. chejuensis</i>	SK A24	SK A24	SK A24
54.	<i>Protoparmeliopsis garovaglii</i>	SK A3	SK A3	SK A3
55.	<i>Protoparmeliopsis garovaglii</i>	AF189718		AF189718
56.	<i>Protoparmeliopsis muralis</i>	AF070015		AH013686
57.	<i>Protoparmeliopsis muralis</i>	AF159922	DQ787339	DQ787340
58.	<i>Protoparmeliopsis muralis</i>	EU266090		AY464085
59.	<i>Protoparmeliopsis muralis</i>	FJ372568		
60.	<i>Protoparmeliopsis muralis</i>	FJ497040		
61.	<i>Protoparmeliopsis muralis</i>	HM209239		AY464076
62.	<i>Protoparmeliopsis muralis</i>	HQ650653	HQ660533	HQ660556
63.	<i>Protoparmeliopsis muralis</i>	JN943617		
64.	<i>Protoparmeliopsis pseudogyrophoricum</i>	SK A1	SK A1	SK A1
65.	<i>Protoparmeliopsis pseudogyrophoricum</i>	SK A11	SK A11	SK A11
66.	<i>Protoparmeliopsis zarei</i>	SK A2	SK A2	SK A2
67.	<i>Protoparmeliopsis zarei</i>	SK 480	SK 480	SK 480
68.	<i>Protoparmeliopsis zarei</i>	SK 481	SK 481	SK 481
69.	<i>Protoparmeliopsis zarei</i>	SK 765	SK 765	SK 765
70.	<i>Rhizoplaca chrysoleuca</i>	HMS77253	HMS77031	DQ787354
71.	<i>Rhizoplaca chrysoleuca</i>	HMS77252	HMS77030	
72.	<i>Rhizoplaca chrysoleuca</i>	HMS77251	HMS77029	
73.	<i>Rhizoplaca chrysoleuca</i>	AY509799	DQ787353	
74.	<i>Rhizoplaca melanophthalma</i>	JX948289	JX948188	DQ787352
75.	<i>Rhizoplaca melanophthalma</i>	JX948294	JX948187	
76.	<i>Rhizoplaca melanophthalma</i>	JX948293	JX948185	
77.	<i>Rhizoplaca melanophthalma</i>	JN873909	DQ787351	
78.	<i>Rhizoplaca melanophthalma</i>	HMS77381		
79.	<i>Rhizoplaca peltata</i>	AF159925		
80.	<i>Rhizoplaca peltata</i>	AY530887		

**Table 1.** Continued.

	Taxon name	ITS1/ITS2 nrDNA	28S LSU nrDNA	12S SSU mt DNA
81.	<i>Rhizoplaca peltata</i>	AY509803		
82.	<i>Rhizoplaca peltata</i>	AY509802		
83.	<i>Rhizoplaca peltata</i>	DQ321749		
84.	<i>Rhizoplaca subdiscrepans</i>	AY509789		

and *P. garovaglii* were confirmed belonging to the genus *Prototarmeliopsis* by results from the phylogenetic analysis based on nr DNA ITS1/ITS2 and LSU, mtDNA 12S SSU sequences as well as combined data set (Fig. 1). At the same time another Asian species, i.e. *P. chejuensis* and *P. pseudogyrophoricum* were found to be separate and distant from the genus *Prototarmeliopsis* based on results from a phylogenetic analysis.

Thus, according to our opinion, the genus *Prototarmeliopsis* is confirmed as a separate genus within the Lecanoraceae. At the same time it is for the first time shown that the genus *Prototarmeliopsis* is the same polyphyletic as the genera *Rhizoplaca*, *Lecanora* and *Prototarmelia*.

### Conclusion

The further molecular data on various *Prototarmeliopsis* species groups will reveal their status within the Lecanoraceae.

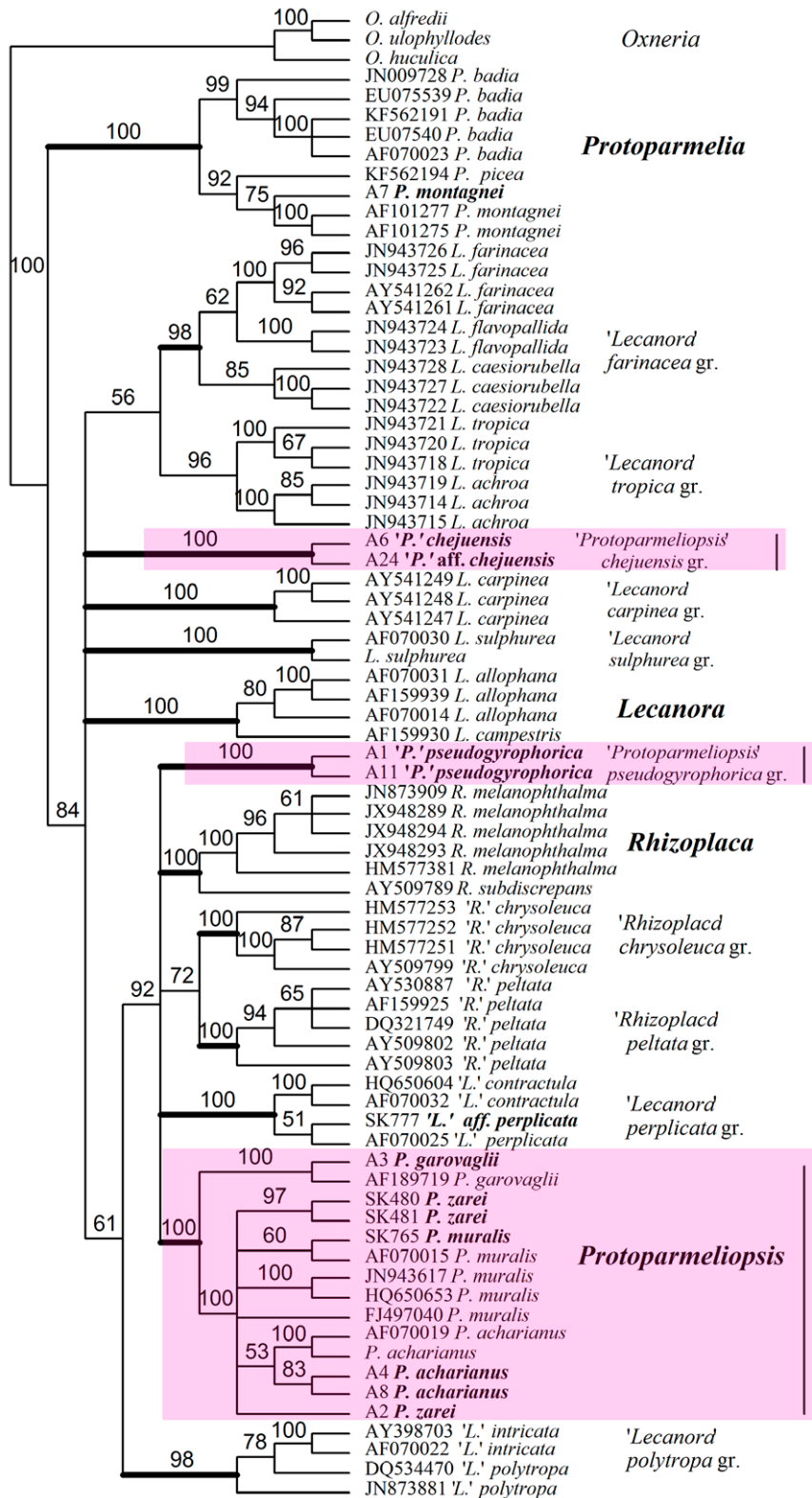
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**Fig. 1.** The phylogenetic tree of the representatives of the family Lecanoraceae including genera *Prototarmeliopsis*, *Lecanora*, *Rhizoplaca* and *Prototarmelia* based on combined molecular data set.



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