

Section	ASCOSPORE			CHEMICAL REACTION			APOTHECIA			AREOLES			SUBSTRATUM	SPECIES	
	Size um Ranked by maximum spore length; arranged in 10 um groups	Septation	Longit - Longitudinal	Epl. = epithelium s = strong y = yellow r/y = red/yellow br = brown v = violet b = blue p = purple	I = light r = red o = orange g = green bl = black	Shape and size in (mm)	Colour, s.y = strong yellow l.y = light yellow w/y = whitish yellow y/g = yellowish green l.y/g = light y/g f.d = finely divided proth. = prothallus	Size (mm), Shape	Angular Round Concave Convex Flat Crescentic Fissured						
										Length	Width	Murif - Muriform			
Superficial = S Viridiatum = V Alpicola = A Rhizocarpon = R	S	9-14	5-7	1.	P-	K-	I+v		0.2-0.3	+		y/w/y ± scattered, thin, smooth, black proth.	0.1-0.4	Para. on <i>Tremolechia</i> . Exposed	<i>R. parvum</i> (Norway, Alps)
	S	9-16	4-9.5	1.	P+y	K-	I-		0.3-0.7			sy thick, contiguous, marginal proth. on rock	0.2-0.6	Para. on <i>Sporastatia</i> species. Si, Exposed	<i>R. pusillum</i> (High Mts. S. Europe)
	S	18-32	9-15	1.	P+y(-)	K-	I-		0.3-0.8	+		Clumped, i. mainly with 1 papilla	0.3-0.8	Hard, vertical exposed rocks Si	<i>R. effigatum</i> * (High Mts. S. Europe Rockies)
	S	9-15	6-7	1.	P+y(-)	K-	I+s.b Epl. dark K-(+r,y)		0.3-0.7			sy Proth. absent. Scattered in groups	0.3-0.7	Calc. or metal rich, Si. Exposed	<i>R. norvegicum</i> (Arctic, alpine. Open communities Rockies)
	V	12-15	6-7	Few septa	P+y/r(-)	K-	I-		+			Thallus small	0.3-0.8	Para. on <i>Aspidia</i>	<i>R. atroviridulum</i> (W. France, Spain)
	V	12-15	8-10	?	?	?	?		?			Thallus small, ± glossy. Rarely collected		Para. on <i>Protoparmelia</i> & allied species	<i>R. dinothetes</i> (Europe)
	S	?		1.	P+y(r)	K+r(y)	I-		0.6-2.0 (warty)			sy-w/y close, smooth or scabrous	0.5-1.5	+ Si, hard, exposed rocks	<i>R. superficiale</i> ssp. superficiale (High Mts. S. Europe Rockies)
	S	11-18	6-8	1.	P+r	K+y	I-		0.6-2.0 (warty)			y-w/y-g/y ± scattered/dose. Scabrous, thick. Subradial margins. f.d	0.3-2.5	+ Si, exposed rocks	<i>R. superficiale</i> ssp. splendulum (Arctic, alpine)
	S	11-18	5-8	1.	P+y	K+r	I+v		0.3-1	+		ly scattered in groups on proth. Matt smooth ± scabrous 0.4-1.5	0.3-1	Para. on <i>Tremolechia</i>	<i>R. dispersum</i> (Spitzbergen)
	S	13-18	7.5-8.5	1.	P+r	K+r	I-		0.1 protruding			y-g/y Scattered/close, margins ± crenulated	0.5-1.5	+ Si	<i>R. superficiale</i> ssp. boreale (W. Arctic, Scotland)
R	21-30	6-14	1-3 —1 Longit.	P-	K-	I+s.b		0.2-0.8 (warty)	+		y-w/y Scattered/ dose. Smooth, matt	0.2-0.8	Si. Dry, cold exposed rocks	<i>R. carpaticum</i> (Scandinavia, sub-alpine)	
V	14-20	8-11	1-5	K+r/v	I-(-)	K+I.b		?			Thallus often large, matt	0.3-0.8	Para. <i>Aspicilia</i> <i>Lecanora</i> ± Calc	<i>R. kakurgon</i> (Alpine)	
V	14-20	10-13	Few septa Murif.	P-	K+r/v	I-		0.4-0.7	+		y-w/y No proth. smooth, matt, verrucose	0.2-0.5	Si. Para on <i>Tremolechia</i>	<i>R. subtile</i> (Arctic)	
R	12-21	6-10	1-4 —1 Longit.	P-	K-	I+s.b Epl. indistinct		0.2-0.5	+		sy-g/y Smooth, grouped, scattered ± proth. ± matt. 0.3-0.7	0.2-0.5	Mineral-rich Si. or Calc. exposed surface	<i>R. intermediellum</i> (Open communities, Arctic, Alpine, Rockies)	
R	14-22.5	10-16	1-5	P+y	K+r	I+br Epl. r/br		0.5-0.8			ly-g/y Scattered, grouped on good prot.	0.2-1	Para. on <i>Lambiella</i> <i>mullensis</i>	<i>R. rapax</i> (C. Europe & Alps)	
V	15-23	9-12	Few septa	?	?	?		0.2-0.4			Small thallus	0.2-0.3	Para. <i>Pertusaria</i>	<i>R. lusitanicum</i> (S. Europe)	
V	17-26	6.5-9.5	±4 Murif.	P+y	I+b Epl. r/br K+r			0.2-0.8	+		sy Scattered groups	0.2-0.6	Para. on <i>Lecidea</i> Metal-rich Si exposed	<i>R. furax</i> (Alpine & C. Europe)	
V	12-28	7-14	Few septa Murif.	P-	K-	I-		0.4-1	+		y/g-g Smooth, matt. no proth.	0.3-1.2	Para. on <i>Circinaria</i> <i>caesiocinerea</i>	<i>R. viridiatrum</i> (Temperate areas)	
A	21-30	10-12	1.	P+y(-) K+r Epi K+g	I-(-b)			0.5-1	+		w/y-b/g Scattered/ close, smooth, matt.	0.4-1	± Basic, exposed alpine sites	<i>R. inarense</i> (Circumpolar, Scotland)	
R	20-30	12-16	Few septa Weekly murif.	P+y	K-	I+b Epi. K+r		0.5-1			y-y/g Clumped SOREDIA. Smooth, matt.	0.5-1	Southerly under-hangs, ± Fe. rich	<i>R. ridescens</i> (C. Europe, Alps, Scotland)	
R	?	?	?	P+y	K-	I+s.b/v		Apothecia rare	+		y/g Clumped/scattered SOREDIA smooth, matt. 0.3-1	0.3-1	± Ferruginous rock.	<i>R. solediosum</i> (N. & C. Europe)	
V	?	?	?	P-	K-y	I-v		No Apothecia			Clumped, mainly with one Papilla	0.2-0.5	Gneiss	<i>R. papillatum</i> (High Alps)	
R	30-32.2	17-19.5	Few septa Murif.	P-		I+b/v Epi K+r/v		0.56-0.87	+		w/y-y Verrucose, clumped, scattered + divided. 0.4-1.1	0.56-0.87	± Si. Exposed, positions	<i>R. tinei</i> * ssp. arcticum (Arctic, Scotland)	
R	21-33	11-15	"	P-		I+b/v Epi K+r/v		0.3-0.9	+		s.y-w/y Scattered/close, smooth, ± glossy	0.2-0.6	± Si. Exposed, above tree line	<i>R. rigidum</i> * (Arctic, N. Europe, Mountain)	
R	32	12	"	P-		I+b/g Epi K+		0.3-0.15	+		g/y-s.y Elongated, matt, smooth, subdivided	0.4-0.8	Si. Damp, sunny,	<i>R. geographicum</i> * ssp. geographicum (widespread)	
R	36-37.6	12.9-14.5	"	P-		I+b/v Epi-		0.17-0.37	+		s-y-g Smooth, glossy or matt. Thin, f.d	0.4-0.7	Si. Exposed rocks	<i>R. geographicum</i> * ssp. prospectans (Maritime & Montane)	
A	18-32	9-18	1.	P+y(-)	K+y/r	I+b/v Epi. K+r/br		0.4-1.2	+		w/y-y Scattered/close. ± Farinose	f.d-1.5	± Calc./si. vertical surfaces	<i>R. eupstaeoides</i> (Circumpolar)	
A	18-35	9-16	1.	P+y	K-	I-		0.6-1.5	+		w/y-sy/g ± Massed at margin. Thick/thin, smooth/undulant 0.4-3	0.4-3	Si. late snow patches, sloping lower surfaces strong competitor	<i>R. alpicola</i> (Montane)	

R	10-38	6-20	1-4 -1 Longit.	P+y K+r(-) I+s.b		0.6-1.5	w-w/y Thick, ± d. Proth. ± thick, centrally tesellate, ± farinose, -1.5	± Calc. Late snow patches and damp cliffs	<i>R. atroflavescens</i> (Arctic, alpine)
R	23-38	13-20	Few septa	P+y(-) K+r I+s.b		0.6-1.2	w-w/y Thick, pruinose 0.4-1.5 ?	± Calc. ± dusty surfaces	<i>R. pulverulentum</i> (Europe, montane)
R	36-53.	16-21	Multiseptate Murif.	P- I+b/v Epi K-		0.4-1.0	g/y-y Not strongly subdivided 0.35-0.46	Sl. Dusty, wide ecological spread	<i>R. lindsayanum</i> ★ (Europe)
R	26-43.2	13-22.1	"	P- I+b/v Epi K- 0.41-0.74		0.3-0.7	y-w/a-w/a Strongly subdivided 0.41-0.74	Sl. Shade, often North facing	<i>R. riparium</i> ★ (Europe, montane)
R	20-35	10-17.4	"	P- I+b/v Epi K+r/v		0.33-0.65	sy-g/y Thick, smooth ± matt 0.7-0.1	Sl. Exposed, late snow patches	<i>R. geographicum</i> ssp. <i>diabasicum</i> (Widespread) ★
R	25-41.2	12.3-14.4	"	P+o I+b/v Epi K-		0.4-0.7	w/y-g ± Scattered, joint pairs attached to apothecia, matt 0.3-0.7	Calc. Exposed, mineral rich sites open communities	<i>R. ferax</i> Scandinavia, UK, Alps, Tatra ★
V	24-40	12-19	"	P+r/br(-) K- I- Epi. indistinct		0.6-1.4	y-w/g Smooth/scabrous, matt. Scattered/ close 0.4-1.5	Sl. Rocks	<i>R. oportense</i> (Spain, Sardinia)
R	35-45.3	17-20.7	"	P- I+b/v Epi. K-		0.3-0.96 - scattered	w/a-a/v ± Thick, ± matt, strongly divided 0.3-1.3	Sl. Dusty, smooth noulders	<i>R. sphaerosporum</i> (N.-C. Europe, temperate) ★
V	27-40	14-21	"	P+r K+y I- Epi. br K- greenish		0.6-1.2	y/g Smooth, close ± verrucose, matt 0.3-0.7	Exposed rocks between 500-1400m	<i>R. tetrasporum</i> (S. Europe Mts.)
R	25-40	12-22	"	P+y/br K- I+s+b Epi. br K+r/p		0.3-0.7	w/y-s/y Thin, smooth, ± matt 0.3-0.7	Sl. Including volcanics. Strong competitor	<i>R. tinel</i> (Mediterranean, C. Europe)
R	25-40	13-22.5	"	P- I+b/v Epi -/r/v		0.3-0.65	svthick close, smooth, matt 0.3-0.7	?	<i>R. tavaresii</i> (Mts. Portugal, Sardinia, Atlas) ★
R	37.3-60.8	16.6-25.1	"	P+y I+b/v Epi. K-		0.2-0.89	y-w/g rarely y/g ± Thick, scattered/close ± matt. 1-2 apothecia per areole 0.3-1.3	Sl. Dusty, well lit, wet surfaces Fe tolerant	<i>R. lecanorinum</i> (Temperate Mts., widespread) ★
R	39-45.8	17.8-19.3	"	I+b/v Epi K+r/v		0.54-0.9	w/y Farinose. Matt, no proth. 0.5-1.1	Calc. Near water	<i>R. saanaense</i> (Arctic, alpine) ★
R	42-53.9	18.8-19.4	"	P- I+b/v Epi K+r/v		0.26-0.66	sy-l/y Thin, matt, smooth, f.d. 0.5-1.0	Sl. Well lit, dusty, wet stream margin	<i>R. macrosporum</i> (Widespread, continental Mts.) ★
R	28-54	15-25	Muriform	P+o I+b/v Epi. K-		0.35-0.57	Sy-y Clustered/scattered on strong black proth. 0.2-0.4	Sl. Hard, dusty, vertical, damp, high forest zone	<i>R. drepanodes</i> (C.-S. Europe, U.K. widespread) ★
R	48-56.1	20.3-23.2	Multiseptate Murif.	P- I+b/v Epi. K+r/v		0.54-0.10	sy-w/y Thick, smooth, matt, f.d. 0.9-1.7	Sl. Well lit and shade	<i>R. subcladum</i> (Widespread) ★

KEY for the more rapid identification of the yellow-green *Rhizocarpon* group: collated from Runemark 1956a; Thompson 1967; Wirth 1972; Feuerer 1978; Poelt et al. 1988; and including 15 species ★ checked by Roca-Valiente et al. 2016.

Column headings for apothecia, areoles and substratum. Strength of the characteristics:
+ = strongly; ± = usually; ± = slightly, occasionally; - = rarely.

Chemical compounds: P = para-phenylenediamine, K = potassium hydroxide, I = iodine
Colour and strength of the reactions shown in column heading, + = positive reaction, - = no reaction

Benedict (1988) describes the procedures for applying these chemicals. He recommends that where samples cannot be collected, the morphology of the thallus is described using a hand lens and a millimeter scale in the field. And a razor blade used to collect a few apothecia and areoles from the centre of the thallus for microscopic examination and chemical testing in the lab.

The symbols describing the shape of the apothecia and areoles are shown in the column headings. These can be used in the description: angular, round, concave, convex, flat, innate, rimmed, crescentic (collar-like), fissured.

The species are mostly ranked by maximum spore length quoted by above authors. Six species do not conform to this order owing to subsequent adjustments to the key. Compiled by Winchester (1989: unpublished thesis, later revised 2022).

References:

- Runemark, H. 1956a Studies in *Rhizocarpon* I: Taxonomy of the yellow species in Europe. *Opera Botanica*, 2 (1): 5-152.
Wirth, V. 1972. Die Silikatflechten-Gemeinschaften in basseralpinen Zentral-Europa. *Dissertationes Botanica*, 17: 1-306.
Feuerer, T. 1978. Zur Kentisder Flechtengattung *Rhizocarpon* in Bayern. *Berichte Bayerischen Botanischen Gesellschaft zur Erforschung der Heimischen Flora*, 49: 59-135.
Poelt, J., Černohorský, Z., Schaefer, J. 1988. *Rhizocarpon* Ram. Em. Th. Fr. Subgenus *Rhizocarpon* in Europe. *Arctic and Alpine Research*, 20 (3): 292-298.
Roca-Valiente, B., Hawksworth D., Pérez-Ortega, S., Crespo, A. 2016. Type studies in the *Rhizocarpon geographicum* group (*Rhizocarpaceae*, lichenized *Ascomycota*). *The Lichenologist*, 48 (2): 97-110.
Benedict, J.B., 1988. Techniques in lichenometry: identifying the yellow *Rhizocarpons*. *Arctic and Alpine Research*, 20 (3): 285-291.

TABLE 1a, b. Synoptic key for the yellow-green *Rhizocarpon* group.