
An updated checklist of lichens from Goa with new records from Cotigao Wildlife Sanctuary

Pallavi Randive¹, Sanjeeva Nayaka² and M.K. Janarthanam^{3*}

^{1&3}Department of Botany, Goa University, Taleigao Plateau, Goa-403206

²Lichenology Laboratory, CSIR-National Botanical Research Institute, Rana Pratap Marg, Lucknow-226001

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*Corresponding author:

Email: jana@unigoa.ac.in

ABSTRACT

A checklist of 118 lichens species is prepared by compiling the published literature, unreported species from herbarium LWG and fresh collection from Cotigao Wildlife Sanctuary. The study added 47 species as new to Goa and *Anisomeridium angulosum* (Müll. Arg.) R.C. Harris as new to India. The state lichen biota is dominated by crustose lichens belonging to Graphidaceae and Pyrenocarpaceae group. Maximum number of lichens are listed from Cotigao Wildlife Sanctuary with 67 species. The study would serve as baseline information for further studies on lichen biota as well as biomonitoring in Goa.

INTRODUCTION

Goa state covers an area of 3702 km² of which about 60% is covered with forests. The forest of Goa is part of internationally recognized biodiversity hotspot, the Western Ghats. The biodiversity conservation has given prime importance in Goa state where in 20% of its geographical area is dedicated for the proliferation of wildlife. The protected areas of the state comprises six Wildlife Sanctuaries and one National Park (Anonymous 1). According to the information available at ENVIS site of Goa the state records a total of 1750 Angiosperms, one Gymnosperm, 65 Pteridophytes, 297 Algae (fresh water and marine) (Anonymous 2). The state also records 50 species of bryophytes (Phatak et al. 2007) and 48 lichens (Singh and Sinha 2010). This information indicates that while flowering plants of the state are fairly well studied, non-flowering plants are insufficiently explored. Lichens are symbiotic organisms and well known bioindicators of air pollution and climate change. India has rich diversity of lichens represented by about 2511 species (Singh and Dash 2017). However, the country has several biodiversity rich and interesting regions that are inadequately explored for lichens and Goa is one of them.

As per the herbarium records available at CSIR-

National Botanical Research Institute, Lucknow (CSIR-NBRI, acronym LWG) lichens from Goa state are being collected since year 1962. Dr. Prakash Chandra, a botanist from CSIR-NBRI was the first person to collect lichens from the state. Thereafter, researchers from CSIR-NBRI and Agharkar Research Institute, Pune collected lichens from the state mostly for monographic studies of various taxa. In the recent years, Phatak et al. (2004) surveyed Cotigao Wildlife Sanctuary of the state and reported 43 lichen taxa, while Nayaka et al. (2004) reported 21 species from Bondla and Bhagwan Mahavir Wildlife Sanctuary. Later, Nayaka et al. (2006) explored some coconut and arecanut orchards of Goa and reported 23 species of lichens (Fig. 1). Singh and Sinha (2010) in their monumental work 'Indian lichens, an annotated checklist' listed only 48 species of lichens from Goa, which is a low number for a biodiversity rich state. Therefore, a detailed exploration of lichen in Goa is recently initiated starting from Cotigao Wildlife Sanctuary. It is observed that several unidentified as well as unreported specimens collected from Goa are available at the herbarium LWG. The aim of the present study is to prepare a comprehensive checklist of lichens for Goa by compiling published literature, herbarium specimens and freshly collected samples from the state.

Table 1. Checklist of lichens from Goa [Note: * = New to Goa, GF = Growth Form, CR = Crustoe, FL = Foliose, LP = Leprose, Corti. = Corticolous, Foli = Foliicolous, Saxi. = Saxicolous, CWS = Cotigao Wildlife Sanctuary, BMWS = Bhagwan Mahavir Wildlife Sanctuary, BWS = Bondla Wildlife Sanctuary. Names in the parenthesis are the earlier annotated names]

Sr. No.	Taxa	GF	Substratum	Locality	Reference/Herbarium number
Arthoniaceae					
1.	<i>Arthonia cinnabarina</i> (DC.) Wallr. (= <i>Arthonia tumidula</i> (Ach.) Ach.)	CR	Corti.	Quepem	Nayaka et al. (2006), Singh & Sinha (2010), GU-L20
2.	<i>A. dispersula</i> Nyl.	CR	Corti.	CWS	Phatak et al. (2004)
3.	<i>Arthothelium chiodectoides</i> (Nyl.) Zahlbr.	CR	Corti.	Quepem	Nayaka et al. (2006), Singh & Sinha (2010)
4.	<i>A. confertum</i> (A.L. Smith) Makh. & Patw.	CR	Corti.	CWS	Phatak et al. (2004), LWG-03.001625
5.	* <i>Cryptothecia faveomaculata</i> Makh. & Patw.	CR	Corti.	CWS	GU-L102, GU-L122
6.	<i>C. lunulata</i> (Zahlbr.) Makh. & Patw.	CR	Corti.	BMWS, Quepem	Nayaka et al. (2004), Nayaka et al. (2006), Singh & Sinha (2010), LWG-03.001679, LWG-02.223409
7.	* <i>C. subnidulans</i> Stirton	CR	Corti.	CWS	GU-L95
8.	<i>C. subsecta</i> Stirton	CR	Corti.	CWS	Phatak et al. (2004), LWG-03.001674, LWG-03.001683
9.	* <i>Herpothallon cinereum</i> G. Thor	CR	Corti.	CWS	GU-L59, GU-L76, GU-L129 a, GU-L130
10.	* <i>H. echinatum</i> Aptroot, Lücking & Will-Wolf	CR	Corti.	CWS	GU-L100
Arthopyreniaceae					
11.	<i>Arthopyrenia alboatra</i> (Krempplh.) Müll. Arg.	CR	Corti.	CWS	Phatak et al. (2004), LWG-03.001602, LWG-03.001618
12.	<i>A. finkii</i> Zahlbr.	CR	Corti.	CWS	Phatak et al. (2004), LWG-03.001644, GU-L105, GU-L106
13.	* <i>A. grisea</i> (Schierch.) Körb.	CR	Corti.	CWS	GU-L121
14.	<i>A. indusiata</i> Müll. Arg.	CR	Corti.	CWS, BMWS	Phatak et al. (2004), Nayaka et al. (2004), LWG-03.001625, LWG-L-11441, LWG-L-11435, LWG-L11439
15.	<i>A. nidulans</i> Müll. Arg.	CR	Corti.	Quepem	Nayaka et al. (2006), Singh & Sinha (2010), LWG-02.223410
Caliciaceae					
16.	<i>Dirinaria aegialita</i> (Afz. in Ach.) Moore	FL	Corti.	CWS, Margoa	Phatak et al. (2004), LWG-11406
17.	* <i>D. confluens</i> (Fr.) Awasthi	CR	Corti.	Goa Uni., CWS	LWG-04.004378, GU-L170
18.	<i>Pyxine cocoes</i> (Sw.) Nyl.	FL	Corti.	CWS, Quepem	Nayaka et al. (2006), Singh & Sinha (2010), LWG-02.223402, GU-L19, GU-L113
19.	<i>P. cylindrica</i> Kashiw.	FL	Corti.	Quepem	Nayaka et al. (2006), LWG-03.001602
20.	* <i>P. soredata</i> (Ach.) Mont.	FL	Corti.	Margoa	LWG-s.n

Sr. No.	Taxa	GF	Substratum	Locality	Reference/Herbarium number
Catillariaceae					
21.	<i>Catillaria leptocheiloides</i> (Nyl.) Zahlbr.	CR	Corti.	Goa (?)	Singh & Sinha (2010)
Collemataceae					
22.	* <i>Leptogium azureum</i> (Sw. ex Ach.) Mont.	FL	Corti.	Valpai	LWG-04.004382
23.	* <i>L. chloromelum</i> (Sw.) Nyl.	FL	Corti.	CWS	GU-L61
24.	<i>L. denticulatum</i> Nyl.	FL	Corti.	CWS, Quepem	Nayaka et al. (2006), Singh & Sinha (2010), LWG-02.223404, GU-L181
25.	<i>L. austroamericanum</i> (Malme) C.W. Dodge	FL	Corti.	CWS, Quepem	Nayaka et al. (2006), Singh & Sinha (2010), GU-L160
Gomphilaceae					
26.	<i>Aulaxina epiphylla</i> (Zahlbr.) R. Sant.	CR	Folii	BMWS	Nayaka et al. (2004), Singh & Sinha (2010), LWG-03.001858
27.	<i>A. quadrangula</i> (Stirton) R. Sant.	CR	Folii	BMWS	Nayaka et al. (2004), Singh & Sinha (2010), LWG-03.001859
Graphidaceae					
28.	<i>Diorygma confluens</i> (Fée) Kalb, Staiger & Elix (= <i>Graphina confluens</i> (Fée) Müll. Arg.)	CR	Corti.	CWS	Phatak et al. (2004), LWG-03.001634
29.	<i>Glyphis cicatricosa</i> Ach.	CR	Corti.	CWS	Singh & Sinha (2010), GU-L12
30.	<i>Graphis adscibens</i> Nyl. (= <i>Graphina adscibens</i> (Nyl.) Müll. Arg.)	CR	Corti.	CWS	Phatak et al. (2004), LWG-03.001603
31.	<i>G. cincta</i> (Pers.) Aptroot	CR	Corti.	CWS, Quepem	Nayaka et al. (2006), Singh & Sinha (2010), GU-L09, GU-L47a
32.	<i>G. cleistoblephara</i> Nyl. (= <i>Graphina cleistoblephara</i> (Nyl.) Zahlbr.)	CR	Corti.	CWS	Phatak et al. (2004)
33.	<i>G. nigroglauca</i> Leight.	CR	Corti.	CWS, Quepem	Phatak et al. (2004), Nayaka et al (2006), Singh & Sinha (2010), LWG-04.004384, GU-L11
34.	<i>G. scripta</i> (L.) Ach.	CR	Corti.	BMWS, Panjim	Singh & Sinha (2010), LWG-10.29271, LWG-L11402
35.	* <i>Hemithecium aphanes</i> (Mont. & Bosch) M. Nakan. & Kashiw. (= <i>Graphis aphanes</i> Mont. & Bosch)	CR	Corti.	Valpoi	LWG-L11412
36.	<i>H. nakanishianum</i> (Patw. & C.R. Kulk.) Makh. & Dube	CR	Corti.	CWS	Phatak et al. (2004), LWG-03.001621
37.	<i>H. peplophora</i> (M. Wirth & Hale) V. Tewari & Upreti	CR	Corti.	CWS	Singh & Sinha (2010), LWG -03-001604
38.	* <i>Leucodecton anamalaiense</i> (Patw. & C.R. Kulk.) Rivas Platas & Lüicking (= <i>Myriotrema anamalaiense</i> (Patw. and Kulk.) Hale)	CR	Corti.	CWS	LWG-03.001628
39.	* <i>Myriotrema subconforme</i> (Nyl.) Hale	CR	Corti.	CWS	LWG-03.001627
40.	* <i>Ocellularia andamanica</i> (Nyl.) Tat. Matsumoto & Deguchi	CR	Corti.	Quepem	LWG-02.223414

Sr. No.	Taxa	GF	Substratum	Locality	Reference/Herbarium number
41.	<i>*O. groenhartii</i> Hale	CR	Corti.	CWS	LWG-03.001622
42.	<i>Pallidogramme chrysenderodes</i> (Nyl.) K. Singh & Swarnalatha	CR	Corti.	CWS	Phatak et al. (2004)
43.	<i>Platygramme wattiana</i> (Müll. Arg.) V. Tewari & Upreti (= <i>Pheographina wattiana</i> Müll. Arg.)	CR	Corti.	CWS	Phatak et al. (2004)
44.	<i>*Phaeographis brasiliensis</i> (A. Massal.) Kalb & Matthes-Leicht (= <i>Phaeographis subtigrina</i> Vain.)	CR	Corti.	CWS	LWG-03.001605/B
45.	<i>P. extrusula</i> (Stirton) Zahlbr.	CR	Corti.	CWS	Phatak et al. (2004)
46.	<i>P. platycarpa</i> Müll. Arg.	CR	Corti.	CWS	Phatak et al. (2004)
Lecanoraceae					
47.	<i>*Lecanora andina</i> Räsänen	CR	Corti.	CWS	GU-L14
48.	<i>*L. cenisia</i> Ach.	CR	Corti.	Goa (?)	LWG-11-027817
49.	<i>*L. chlorotera</i> Nyl.	CR	Corti.	CWS	GU-L72a
50.	<i>*L. cinereofusca</i> H. Magn.	CR	Corti.	Margoa	LWG-04.004373
51.	<i>L. fimbriatula</i> Stirton	CR	Corti.	Goa (?)	Singh & Sinha (2010), LWG-11498
52.	<i>L. helva</i> Stizenb.	CR	Corti.	CWS, Quepem, Goa Uni.	Nayaka et al. (2006), Singh & Sinha (2010), LWG-04.004379, GU-L13
53.	<i>*L. insignis</i> Degel.	CR	Corti.	Goa Uni.	LWG-s.n.
54.	<i>*L. leproplaca</i> Zahlbr.	LP	Corti.	CWS	GU-L137
55.	<i>L. tropica</i> Zahlbr.	CR	Corti.	CWS	Phatak et al. (2004)
Malmideaceae					
56.	<i>Malmidea granifera</i> (Ach.) Kalb, Rivas Platas & Lumbsch	CR	Corti.	CWS	Singh & Sinha (2010), LWG-03.001636, GU-L138, GU-L 161, GU-L 150a, GU-L 159
Monoblastiaceae					
57.	<i>*Anisomeridium angulosum</i> (Müll. Arg.) R.C. Harris	CR	Corti.	CWS	GU-L48
58.	<i>*A. biforme</i> (Borrer) R.C.Harris	CR	Corti.	Goa Uni.	LWG-04-0004381
59.	<i>*A. complanatum</i> (Makh.& Patw.) R.C. Harris	CR	Corti.	CWS	GU-L109, GU-L131
60.	<i>A. subnexum</i> (Nyl.) R.C. Harris	CR	Corti.	CWS	Phatak et al. (2004)
61.	<i>A. terminatum</i> (Nyl.) R.C. Harris	CR	Corti.	BMWS	Nayaka et al. (2004), Nayaka et al. (2006), Singh & Sinha (2010), LWG-03.001698
62.	<i>Monoblastia pellucida</i> Aptroot	CR	Corti.	Goa Uni.	Singh & Sinha (2010), LWG-04.004386, LWG-04.00438
Naetrocymbaceae					
63.	<i>*Naetrocymbe fraxini</i> (A. Massal.) R.C. Harris	CR	Corti.	CWS	GU-L07, GU-L92

Sr. No.	Taxa	GF	Substratum	Locality	Reference/Herbarium number
Parmeliaceae					
64.	<i>Parmotrema latissimum</i> (Fée) Hale	FL	Corti.	CWS	Phatak et al. (2004)
65.	<i>P. saccatilobum</i> (Taylor) Hale	CR	Corti.	Panjim	Singh & Sinha (2010), LWG-L11405
Pertusariaceae					
66.	* <i>Pertusaria coccodes</i> (Ach.) Nyl.	CR	Corti.	Goa Uni.	LWG-04-004376
67.	* <i>P. concinna</i> Erichson	CR	Corti.	CWS	GU-L30, GU-L163
68.	<i>P. flavida</i> (DC.) J.R. Laundon	CR	Corti.	BWS	Nayaka et al.(2004), Singh & Sinha (2010), LWG-03.00167, LWG-03.001658
69.	<i>P. leucostoma</i> (Bernh.) A. Massal.	CR	Corti.	Goa (?)	Singh & Sinha (2010)
70.	* <i>P. pallidula</i> Stirton	CR	Corti.	Panjim	LWG-03.001624
71.	* <i>P. punctata</i> Nyl.	CR	Corti.	CWS	GU-L21
Phlyctidaceae					
72.	<i>Phlyctis karnatakana</i> S. Joshi & Upreti	FL	Corti.	Panjim	Joshi et al. (2010), LWG- 09-011804
Physciaceae					
73.	<i>Heterodermia obscurata</i> (Nyl.) Trevisan	FL	Corti.	CWS	Phatak et al. (2004), LWG-s.n. 3
74.	<i>Physcia tribacia</i> (Ach.) Nyl.	FL	Corti.	CWS	Phatak et al. (2004), GU-L126c, GU-L133
Porinaceae					
75.	<i>Porina americana</i> Fée	CR	Corti	Quepem	Nayaka et al.(2006), Singh & Sinha (2010), LWG-02.223408
76.	<i>P. conica</i> R. Sant.	CR	Folii.	BMWS	Nayaka et al.(2004), Singh & Sinha (2010), LWG-1857
77.	<i>P. epiphylla</i> Fée	CR	Folii.	BMWS	Nayaka et al.(2004), Singh & Sinha (2010), LWG-03.001861
78.	<i>P. internigrans</i> (Nyl.) Müll. Arg.	CR	Corti.	CWS	Singh & Sinha (2010), LWG-03.0016953, GU-L57, GU-L63
79.	<i>P. kameruensis</i> F. Schill (= <i>P. chrysophora</i> (Stirton) R. Sant.)	CR	Folii.	BMWS	Nayaka et al. (2004)
80.	<i>P. mastoidea</i> (Nyl.) Müll. Arg.	CR	Corti.	BMWS, BWS, Quepem	Nayaka et al. (2004), LWG-L114771/B
81.	<i>P. subcutanea</i> Ach.	CR	Corti.	CWS	Singh & Sinha (2010), GU-L56
82.	<i>P. subhibernica</i> Upreti	CR	Corti.	CWS, Quepem	Nayaka et al.(2006), Singh & Sinha (2010), LWG-03.001626, LWG-L11468/B, GU-L18, GU-L 58
83.	* <i>P. subinterstes</i> (Nyl.) Müll. Arg.	CR	Corti.	Goa Uni.	LWG-04.004375/B
84.	<i>P. tetracerae</i> (Afz.) Müll. Arg.	CR	Corti.	BMWS, BWS, CWS, Quepem	Nayaka et al. (2004), Nayaka et al.(2006), Singh & Sinha (2010), LWG-03.001614, LWG-03.001635, LWG-06.001617, LWG-L11468/A, LWG-L11469/A, LWG-L114262, LWG-11468, GU-L87

Sr. No.	Taxa	GF	Substratum	Locality	Reference/Herbarium number
Pyrenulaceae					
85.	<i>*Pyrenula adacta</i> Fée	CR	Corti.	BMWS	LWG-03.001643
86.	<i>P. aggregata</i> (Fée) Fée (= <i>Pyrenula nuda</i> A. Singh & Upreti)	CR	Corti.	BMWS	Singh & Sinha (2010), LWG-79810, LWG-79875, LWG- L11447
87.	<i>*P. approximans</i> (Krempelh.) Müll. Arg.	CR	Corti.	CWS	GU-L17
88.	<i>P. aspistea</i> (Ach.) Ach. (= <i>Pyrenula subaggregata</i> (Nyl.) Müll. Arg., <i>P. subrizalensis</i> A. Singh & Upreti)	CR	Corti.	Valpoi, Quepem, Panjim	Singh & Sinha (2010), LWG-L11457, LWG-L11423, LWG-11409/D
89.	<i>*P. breutelii</i> (Müll. Arg.) Aptroot	CR	Corti.	CWS	GU-L03, GU-L47b
90.	<i>*P. brunnea</i> Fée	CR	Corti.	CWS	GU- L120
91.	<i>P. castanea</i> (Eschw.) Müll. Arg. (= <i>Pyrenula limae</i> Vain.)	CR	Corti.	Valpoi, BMWS	Singh & Sinha (2010), LWG-L81613/B, LWG- L81745, LWG-L11409/B, LWG-L11409/C, LWG-L11419, LWG-L11434
92.	<i>P. fetivica</i> (Krempelh.) Müll. Arg. (= <i>Pyrenula citrifomis</i> R.C. Harris)	CR	Corti.	BWS	Nayaka et al. (2004), Singh & Sinha (2010), LWG-03.001673/B
93.	<i>P. gibberulosa</i> (Vain.) Aptroot (= <i>Anthracotheicum goaense</i> A. Singh)	CR	Corti.	BMWS	Awasthi (1991)
94.	<i>P. immissa</i> (Stirton) Zahlbr.	CR	Corti.	BWS	Nayaka et al. (2004), Singh & Sinha (2010), LWG-03.001693, LWG-03.001653, LWG-03.001661, LWG-03.001652
59.	<i>*P. mamillana</i> (Ach.) Trevisan	CR	Corti.	CWS	LWG-03.00186
96.	<i>P. maravalensis</i> Vain. (= <i>Pyrenula subacutalis</i> Upreti)	CR	Corti.	BMWS	Singh & Sinha (2010)
97.	<i>*P. nitidula</i> (Bres.) R.C. Harris.	CR	Corti.	CWS	GU-L155
98.	<i>P. oculata</i> A. Singh & Upreti	CR	Corti.	BMWS	Nayaka et al. (2004), Singh & Sinha (2010), LWG-3.001686
99.	<i>P. quassiaecola</i> (Fée) Fée (= <i>Pyrenula defossa</i> Müll. Arg., <i>P. olivaceofusca</i> Müll. Arg., <i>P. pinguis</i> Fée)	CR	Corti.	BMWS	Nayaka et al. (2004), Singh & Sinha (2010), LWG-03.001691, LWG-L81153
100.	<i>P. subumbilicata</i> (C. Knight) Aptroot (= <i>Pyrenula immersa</i> Müll. Arg.)	CR	Corti.	BMWS, BWS	Nayaka et al. (2004), Singh & Sinha (2010), LWG-03.001668, LWG-03.00168
Ramalinaceae					
101.	<i>Bacidia connexula</i> (Nyl.) Zahlbr.	CR	Corti.	CWS	Phatak et al. (2004)
102.	<i>B. polychroa</i> (Th. Fr.) Kõrb.	CR	Corti.	Castle Rock	Singh & Sinha (2010)
103.	<i>*B. rosella</i> (Pers.) De Not.	CR	Corti.	CWS	GU-L143
104.	<i>B. submedialis</i> (Nyl.) Zahlbr.	CR	Corti.	Goa Uni.	Singh & Sinha (2010), LWG-04.004383
105.	<i>Phyllopsora corallina</i> (Eschw.) Müll. Arg.	SQ	Corti.	BMWS, BWS, Quepem	Nayaka et al. (2004), Nayaka et al. (2006), Singh & Sinha (2010), LWG-03-001681, LWG-03-001673/A
106.	<i>*P. nemoralis</i> Timdal & Krog	SQ	Corti.	CWS	GU-L111

Sr. No.	Taxa	GF	Substratum	Locality	Reference/Herbarium number
107.	<i>P. parvifolia</i> (Pers.) Müll. Arg.	SQ	Corti.	CWS	Phatak et al. (2004), Singh & Sinha (2010)
108.	<i>P. manipurensis</i> (Müll. Arg.) G. Schneider	SQ	Corti.	CWS	Phatak et al. (2004), LWG-03.001639, GU-L23, GU-L25a
Roccellaceae					
109.	* <i>Enterographa pallidella</i> (Nyl.) Redinger	CR	Corti.	CWS	GU-L125, GU-L126a
Strigulaceae					
110.	<i>Strigula smaragdula</i> Fr. (= <i>Strigula elegans</i> (Fée) Müll. Arg.)	CR	Folii.	BMWS	Nayaka et al. (2004), Singh & Sinha (2010), LWG-03.00186
Teloschistaceae					
111.	* <i>Blastenia ferruginea</i> (Huds.) A. Massal.	CR	Corti.	CWS	GU-L16
Trypetheliaceae					
112.	* <i>Laurera meristospora</i> (Mont. & Bosch) Zahlbr.	CR	Corti.	CWS	LWG-03.001616
113.	* <i>Marcelaria benguelensis</i> (Müll. Arg.) Aptroot, Nelsen & Parmen (= <i>Laurera benguelensis</i> (Müll. Arg.) Zahlbr.)	CR	Corti.	Panjim	LWG-L11401
114.	* <i>Trypethelium eluteriae</i> Sprengel	FL	Corti.	Quepem	LWG-03.001645
115.	* <i>T. endosulphureum</i> Makh. & Patw.	FL	Corti.	CWS	LWG-03.001649
116.	* <i>T. tropicum</i> (Ach.) Müll. Arg.	FL	Corti.	Quepem, CWS	LWG-02.223415, LWG-03.001638
Verrucariaceae					
117.	* <i>Endocarpon subrosettum</i> A. Singh & Upreti	SQ	Saxi.	Goa Uni.	LWG-04.004373
118.	* <i>Staurothele fissa</i> (Taylor) Zwack	CR	Saxi.	Panjim	LWG -04.004377

MATERIALS AND METHOD

The lichen taxa identified up to species level in publications of Phatak et al. (2004) and Nayaka et al. (2004, 2006) are listed. The taxa that are reported in earlier revisionary studies by various researchers are mostly included in checklist of Singh and Sinha (2010), however they were verified by consulting the original literature wherever necessary. The lichen samples collected from Goa by researchers of CSIR-NBRI are available at herbarium LWG, among them only well identified species are utilized for listing. The recent nomenclature changes are updated by referring to www.indexfungorum.org and publications

especially related to Graphidaceae (Staiger 2002, Kalb et al. 2004, Lücking et al. 2009), *Pyrenula* (Aptroot 2012) and foliicolous lichens (Singh and Pinokiyo 2014). The lichen taxa are segregated under various families following classification by Lücking et al. (2017a,b).

About 50 fresh samples of lichens were collected from Cotigao Wildlife Sanctuary located at Canacona taluka of Goa during March 2015. These lichens were mostly growing over tree bark and collected following standard procedure, air dried and preserved at herbarium of Goa University with details. The lichens were identified by studying their morphology, anatomy and chemistry (Nayaka 2014). Orange

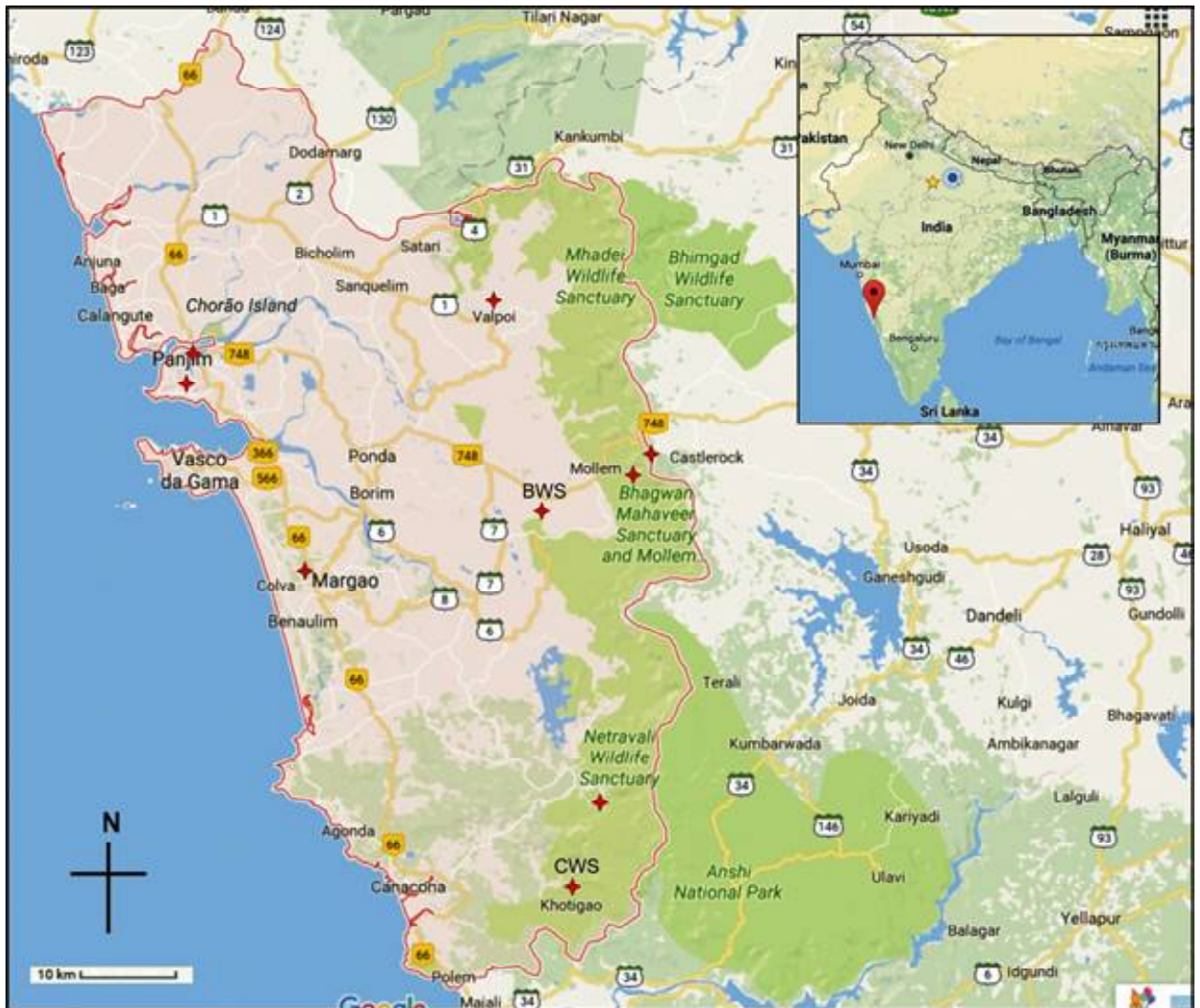


Fig. 1. Map of Goa showing localities explored for lichen collection by various researchers

et al. (2001) was followed for chemical analysis of the samples. Following literature are consulted for identification of various lichen taxa; Awasthi (1991, 2007), Upreti and Pant (1993), Upreti (1994, 1998), Harris (1995), Sparrius (2004), Lücking et al. (2009), Saag et al. (2009), Mishra et al. (2011), Jagadeesh Ram (2014), Jagadeesh Ram and Sinha (2016), Nayaka (2005), Singh and Pinokiyo (2014), Aptroot (2012).

RESULT

The compilation of lichens from published literature resulted in 71 species. The well identified lichens from LWG yielded about 100 specimens belonging to 70 species of

which 25 were not reported earlier. The freshly collected lichens from Cotigao Wildlife Sanctuary resulted in 39 species of which 23 are further addition to Goa. In total the present study resulted in 118 species distributed under 23 families and 42 genera, of which 47 are new to Goa (Table 1). The lichen biota of Goa is dominated by microlichens lichens represented by 97 crustose, one leprose and five squamulose forms. The foliose lichens are represented by only 15 species. Among crustose lichens the Graphidaceae and Pyrenocarpaceae lichens exhibited luxuriant growth. Graphidaceae with 10 genera and 19 species is the most common and widespread family in the state. The

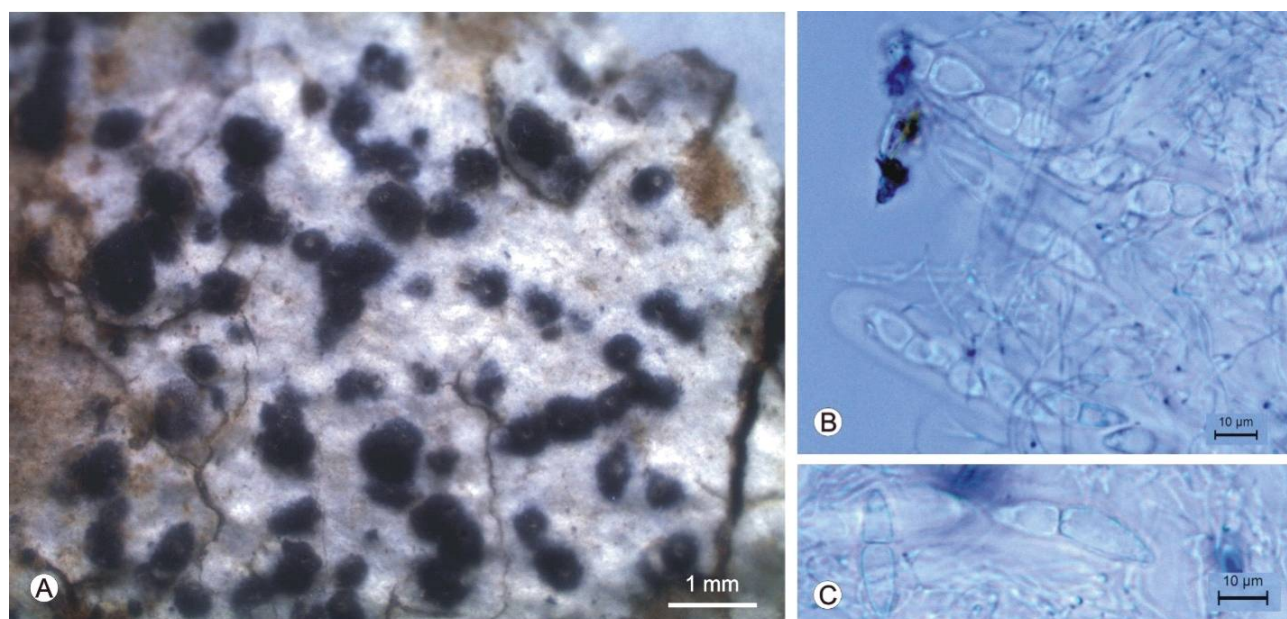


Fig. 2. *Anisomeridium angulosum* (Müll. Arg.) R.C. Harris. A. Habit, B. Asci with ascospores, and C. Ascospores

Pyrenocarous lichens are represented by 44 species under 8 families. *Pyrenula* and *Porina* with 16 and 10 species each are the major genera in the state. The lichens so far recorded mostly represent epiphytes growing on bark of the trees, but the state also has good number of foliicolous lichens represented by six species. Although lichen collection from Goa is cursory, but the important collections are from Cotigao Wildlife Sanctuary (67 species) and Bhagwan Mahavir Wildlife Sanctuary (21 species).

In the present study *Anisomeridium angulosum* (Müll. Arg.) R.C. Harris is reported as new record for India. The species is found growing on the tree trunk in Cotigao Wildlife Sanctuary. The species has a crustose, endophloeodal, ecorticate, whitish, faint UV+ thallus; black, exposed perithecia with eccentric ostiole; 8 spored ascus; uniseriate, hyaline, broadly fusiform, 1-septate ascospore of size 27.2 - 34.4 x 8.7-10.0 μm (Fig. 2). Earlier this species is reported from Cuba (Harris 1995).

DISCUSSION

In the publications of Phatak et al. (2004), and Nayaka et al. (2004, 2006) several taxa are identified up to genus level only and are not considered for preparing the checklist. Phatak et al. (2004) mentioned the occurrence of 43 species of lichens from Cotigao Wildlife Sanctuary, however their list contained only 27 species. It appears that table of their

article was not printed completely. Several of these specimens, especially collected by Nayaka et al. are recovered from the herbarium LWG. Ajay Singh described a new species *Anthracothecium goaense* from Goa (Awasthi 1991, addendum), however Singh and Sinha (2010) excluded it from Indian lichen biota for unknown reasons. Aptroot (2012) synonymized this species with *Pyrenula gibberulosa* (Vain.) Aptroot. Although type specimen of this species is untraceable at LWG it is included in the present checklist. For some species the exact locality of collection in Goa and collection numbers are not available.

As observed in the earlier studies fruticose lichens are completely absent in Goa. Mesta et al. (2015) also noted that species of *Usnea* are absent in Goa. The state lichen biota also lacks diversity of foliose lichens. Parmelioid lichens are usually prominent in tropical semi-evergreen forest such as in Goa, however in the present study only *Parmotrema latissimum* (Fée) Hale and *P. saccatilobum* (Taylor) Hale are recorded. The reason for such unusual observation is not clear and it is a matter for detailed ecological investigation. Intensive study of lichen in the state in future may yield parmelioid and fruticose lichens. Further, dominance of Graphidaceous and Pyrenocarous lichens, and importance of foliicolous lichens are already discussed by Nayaka et al. (2004).

CONCLUSION

Goa state has rich floristic diversity, however their compiled checklist or databases are not available in the public domain. For example, fungi of the state are well explored but their list or authentic total numbers are not available. Phatak et al. (2007) listed 50 species of bryophytes from Goa, but many more species are included in revisionary studies. Absence of such checklist deceives value of biodiversity for the state. Prabhugaonkar et al. (2009) opinioned exploration of flora of Goa is inadequate as publication dealing with new additions are frequenting. Datar and Lakshminarasimhan (2013) surveyed Bhagwan Mahavir National Park for flowering plants and reported 721 species. Intensive exploration of an area not only yields comprehensive list of organism in the area but also results in several novel taxa. Thirty nine lichens species from 50 specimens collected from Cotigao Wildlife Sanctuary with 23 additions including one new record for India clearly suggest the lichen richness of the area and encourages for further detailed exploration. The checklist of 118 lichens from Goa certainly forms the base for further studies on lichen biota as well as biomonitoring in Goa.

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