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Lichen Diversity at Shivrajpur Coast, Devbhoomi Dwarka, including New Additions to Gujarat state, India

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ABSTRACT

The field excursions were arranged during 2015–2017 to prepare a checklist of the lichens in Shivrajpur, district Devbhoomi Dwarka, located on India's west coast. The vegetation of the studied sites is comprised of dry deciduous and scrub/thorny forests. A total of 44 lichen specimens were collected, which revealed 16 species within nine genera belonging to five families. Of the total recorded families, Arthoniaceae dominated with six species followed by Roccellaceae with four species, Lichinaceae, Peltulaceae and Lecanographaceae each with three, two and one species, respectively. The dominant genus was *Arthonia* with five species, followed by *Opegrapha*, *Peltula* and *Phylliscum* each with two species. Growth form of the species included a maximum of 81% crustose and the remaining 19% with squamulose growth form. With respect to habitat, corticolous consisted of 69% and saxicolous of 31%. Out of the recorded lichen species eight are new additions to Gujarat, these are *Arthonia recedens* Stirt., *Arthonia sps.*, *Arthothelium chiodectoides* (Nyl.) Zahlbr., *Lecanographa lynceoides* (Müll. Arg.) Egea & Torrente, *Opegrapha astraea* Tuck. *Opegrapha simplicior* (Nyl.) Nyl., *Peltula zahlbruckneri* (Hasse) Wetmore and *Thyrea* sps.. The present first report on lichens emphasizes the uniqueness of coastal habitats in terms of interesting lichen mycobiota of the study area and will be useful as baseline records for future studies in the Gujarat state.

INTRODUCTION

A lichen is one of the most remarkable alliances in nature. It can be regarded as a community rather than an organism because it always consists of at least one species of alga may be Cyanophyceae and Chlorophyceae and one species of fungus-most of the cases belongs to phylum Ascomycota and rarely to Basidiomycota. The lichen (photobiont) algal portion is its photosynthetic component and is very sensitive to sulfur dioxide in the atmosphere. The fungal portion (mycobiont) usually makes up the bulk of the body; it is drought-resistant and able to withstand long periods of hot and cold temperatures and dryness with no ill effect to the lichen which remains dormant (Nash, 2008). This makes the lichen a useful monitor for both pollution and water relations. Lichens are the significant components of Indian biota and at comprises over 2,900 species which is 14.8% of the world's known species (19,500 spp.) under phylum Ascomycota, of which about 540 (over 18%) species are endemic to Indian boundaries (https://bsi.gov.in/page/en/lichens). About 49 species are recorded from Gujarat state with special reference to coastal habitats of Gujarat state and islands of Marine Protected Area, Jamnagar district, Gujarat (Nayaka *et al*., 2010; Nayaka *et al*., 2013; Ingle *et al*., 2014; Ingle *et al*., 2017). A total of 79 species recorded for Gujarat state by Nayaka (2015) while assessing the diversity of mangrove lichens in Gujarat with special reference to coastal habitats, of which 31 species were mentioned from Jamnagar district. But Shivrajpur coastal area, Devbhoomi Dwarka district, was not explored for lichen diversity study so far. Hence, an attempt has been made to prepare a checklist of the lichens for the Shivrajpur coastal area located in between Dwarka and Mithapur-Okha, west coast of India.

Study Area

Shivrajpur, situated on the northwest tip of India's west coast, is a small coastal village (22°.329742 N; 68°.949565 E) near Dwarka, a major pilgrimage and tourist place (Fig. 1). Shivrajpur is located on the western shore on the Arabian coast of Gujarat. The study area consists of shallow bays located 15 km north of Dwarka town and 20 km south of Mithapur town in the Okhamandal region of Devbhoomi Dwarka district.

The coast is marked by long shore currents and high wave energy with strong surf action. The tides are generally low in the range of 2 to 3 m, and water is clear. Recently,

Fig. 1: Location of the study area-Shivrajpur coastal region. (Source: Google maps)

Shivrajpur shore, being calm and quiet, has attracted tourists [Autonomy (n.y.)]. The Shivrajpur coast has rocky and sandy terrain. The vegetation at Shivrajpur was poorly represented by few shrubs such as *Salvadora persica* Linn., *Capparis decidua* (Forssk.) Edgew., *Cassia auriculata* Linn., *Euphorbia neriifolia* Linn. etc. and small trees such as *Azadirachta indica* A.Juss., *Pithecellobium dulce* (Roxb.) Benth., *Moringa oleifera* Lam., *Tamarindus indica* Linn., *Thespesia populnea* (L.) Sol. ex Corrêa etc. The area has arid conditions and the average rainfall is 400 mm/yr [Autonomy (n.y.)]. The natural vegetation is classified as semi-arid scrub or thorny forest. *Prosopis juliflora* (Sw.) DC locally called *"Gando baval"* is an exotic small tree, which grows abundantly in the study area. The area falls under the Central Indian region of India's Lichenogeographical regions (Singh and Sinha, 1997).

MATERIAL AND METHODS

The present study is based on observations of 44 lichen specimens collected from the study area. All the collected samples were air dried, mounted on herbarium sheets with the help of quick-fix. They were examined in respect of their morphology, anatomy and chemistry. The morphological characters of lichen specimens were studied under MICROS LADYBIRD MZ 1240 Zoom Stereo Microscope. For external morphological studies, the type or growth form, colour, shape and size of the thallus, texture, presence of isidia, soredia, pycnidia, etc. were observed. The anatomy of lichen thallus and ascomata were examined under OLYMPUS MLX-B PLUS light microscope or Leica TM DM 500 optical microscope. Hand-cut section of thalli and apothecia were studied in distilled water, and KOH mounts. Colour spot tests of the thalli were tested with 5% KOH (K), undiluted commercial bleach (C) and 0.5 g of *p*-phenylenediamine diluted in 5 ml of ethanol (P). Thin-layer chromatography (TLC) was performed in solvent systems A and C on silica gel pre-coated $60F_{254}$ aluminum sheets 20 × 20 cm size (Orange *et al*, 2001). The specimens were identified up to species level following the literature of Awasthi (1991, 2007), Ertz And Diederich (2007), and Ertz (2009). The nomenclature is updated following mycobank.org and classification was updated following Lucking *et al*., 2017. The identified voucher specimens are preserved in the Department of Botany, Smt S M Panchal Science College, Talod, Gujarat. Later on, the specimens will be deposited in the herbarium of CSIR-National Botanical Research Institute, Lucknow (LWG).

RESULT AND DISCUSSION

The shore in the Shivrajpur beach is totally sandy and the area does not provide required humidity, shade and substratum for the growth of lichens due to the lack of large trees, shrubs, and rocks in the area. A total of 44 lichen specimens were collected from Shivrajpur area which revealed the occurrence of 16 species within nine genera belonging to five families (Table 1, Figure 6).

Out of the recorded lichen species eight are new to Gujarat, *Arthonia recedens* Stirt., *Arthonia sps.*, *A. chiodectoides* (Nyl.) Zahlbr., *Lecanographa lynceoides* (Müll. Arg.) Egea & Torrente, *Opegrapha astraea* Tuck. *Opegrapha simplicior* (Nyl.) Nyl., *Peltula zahlbruckneri* (Hasse) Wetmore and *Thyrea* sps. Arthoniaceae family represented six species followed by Roccellaceae with four, Lichinaceae with three, Peltulaceae and Lecanographaceae with single species each.. Arthoniaceae is the dominant family in the present study in the area with 37% species contribution to the total number of species (Figure 2). Among the dominant genus *Arthonia* represented five

Table 1. A list of lichen species with new records to Gujarat, habitat, growth form and status in Shivrajpur area.

Sl. No.	*Lichen taxa/Family*	*New records for Gujarat*	*Habitat*	*Growth form*	*Status*
1	*Arthonia cinnabarina* (DC.) Wallr./ Arthoniaceae		Corticolous	Crustose	Exposed arid habitats.
2	*Arthonia medusula* (Pers.) Nyl./ Arthoniaceae		Corticolous	Crustose	Exposed arid habitats.
3	*Arthonia radiata* (Pers.) Ach./ Arthoniaceae		Corticolous	Crustose	Exposed arid habitats.
4	*Arthonia recedens* Stirt./ Arthoniaceae	Yes	Corticolous	Crustose	Exposed arid habitats.
5	*Arthonia* sp./ Arthoniaceae	Yes	Corticolous	Crustose	Exposed arid habitats.
6	*A. chiodectoides* (Nyl.) Zahlbr./ Arthoniaceae	Yes	Corticolous	Crustose	Exposed arid habitats.
7	*Cresponea flava* (Vain.) Egea & Torrente/ Roccellaceae		Corticolous	Crustose	Exposed arid habitats and salt mist environ.
8	*Dirina indica* Upreti & Nayaka/ Roccellaceae		Corticolous	Crustose	Exposed arid habitats and salt mist environ.
9	*Lecanographa lynceoides* (Müll. Arg.) Egea & Torrente/ Lecanographaceae	Yes	Corticolous	Crustose	Exposed arid habitats.
10	*Opegrapha astraea* Tuck./ Roccellaceae	Yes	Corticolous	Crustose	Exposed arid habitats and salt mist environ.
11	*Opegrapha simplicior* (Nyl.) Nyl./ Roccellaceae	Yes	Corticolous	Crustose	Exposed arid habitats and salt mist environ.
12	*Peltula obscurans* (Nyl.) Gyeln./ Peltulaceae		Saxicolous	Squamulose	Exposed arid habitats.
13	*Peltula zahlbruckneri* (Hasse) Wetmore/ Peltulaceae	Yes	Saxicolous	Squamulose	Exposed arid habitats.
14	*Phylliscum indicum* Upreti/ Lichinaceae		Saxicolous	Crustose	Exposed arid habitats.
15	*Phylliscum testudineum* Henssen/ Lichinaceae		Saxicolous	Crustose	Exposed arid habitats.
16	*Thyrea* sps. A.Massal./ Lichinaceae	Yes	Saxicolous	Squamulose	Exposed arid habitats.

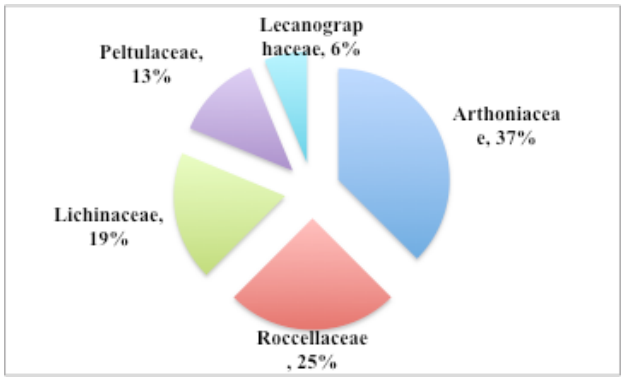

Fig. 2: Percentage of species in the family.

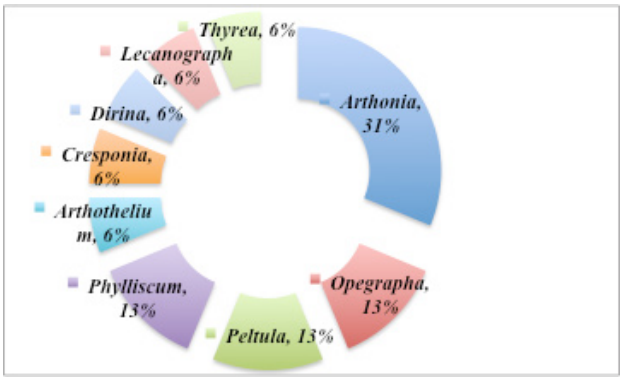

Fig. 3: Percentage of species in the genera

species with 31% contribution to the total species, followed by *Opegrapha*, *Peltula,* and *Phylliscum* with two species each. Hence, these four genera contribute 70% of the total number of species. However, *Arthothelium, Cresponia, Dirina, Lecanographa* and *Thyrea* represented single species each, hence these five genera contribute rest of 30% to the total number of species (Figure 3). Out of the total recorded species, most of the species showed crustose growth form, which contributed 81% with 13 species. However, *Peltula* and *Thyrea* have squamulose growth form with three species, contributed 19% to the total species (Figure 4). During the present study, foliose and fruticose growth forms were not reported from the area. Out of total recorded 16 lichen species from the study site, only two lichen species, such as *Phylliscum indicum* Upreti and *P. testudineum* Henssen, belonging to the family Lichinaceae were observed. The substratum for the growth of lichens at study area included rocks, *Salvadora persica* Linn.,

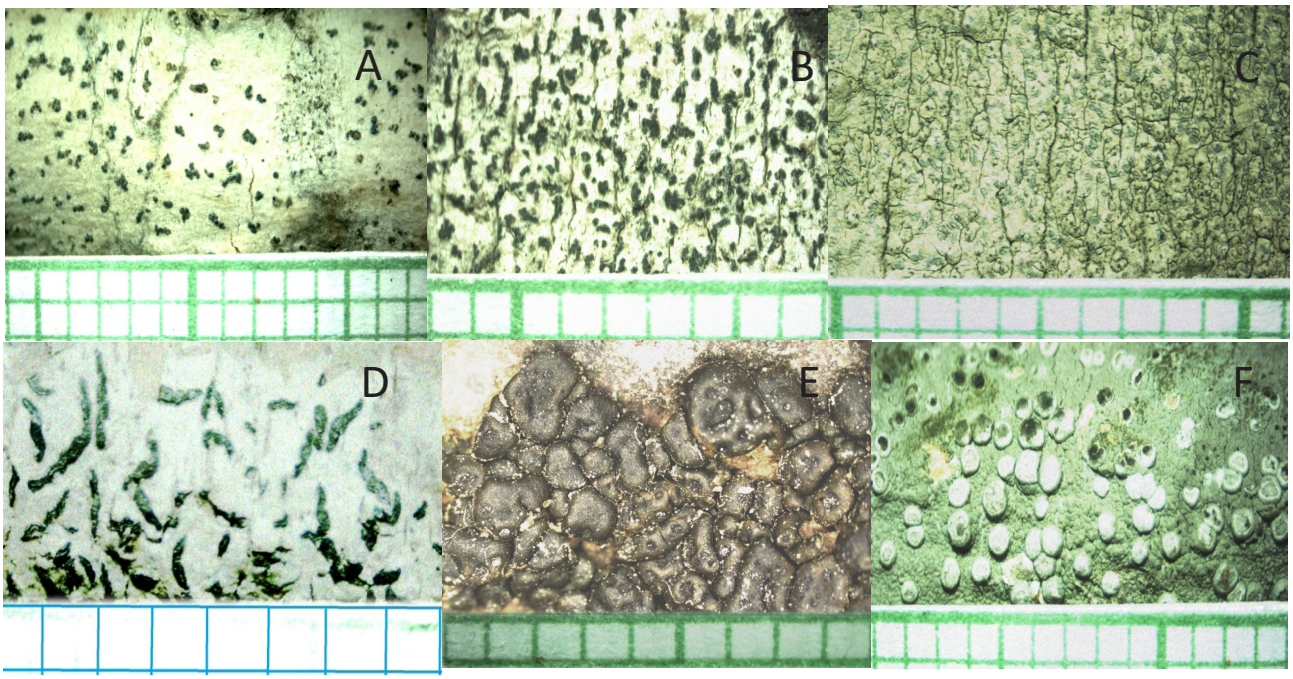

Fig. 4: Interesting saxicolous lichens from study area.
(A) *Arthonia recedens* Stirt. (B) *Arthothelium chiodectoides* (Nyl.) Zahlbr (C) *Lecanographa lynceoides* (Müll. Arg.) Egea & Torrente (D) *Opegrapha simplicior* (Nyl.) Nyl. (E) *Peltula zahlbrucknerii* (Hasse) Wetmore (F) *Dirina indica* Upreti &Nayaka

Euphorbia neriifolia Linn., *Azadirachta indica* A.Juss., *Ficus benghalensis* Linn., *Pithecellobium dulce* (Roxb.) Benth. etc. According to their substratum corticolous lichens dominated in the area represented by 11 species, which contributed 69% of the total species recorded and saxicolous by five species with 31% contribution (Figure 5). Due to absence of mangrove vegetation in the area, no lichens has been recorded on the mangroves.

CONCLUSION

The present study will serve as baseline data for future bio-monitoring studies as lichens are sensitive to air pollution and climate change. Some lichens such as *Cresponia flava, Dirina indica*, etc. can be used for regular pollution monitoring, as they are pollution-sensitive species. In contrast, species of *Dirinaria, Phylliscum, Peltula*, etc. can be used for studying pollution and climate change as they are pollution tolerant species. It is proposed that the same study should be launched after ten years at a reasonable conclusion about the quality of area with respect to pollution, as lichens are reliable bioindicators of air pollutants.

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