Mini Review

Distribution and diversity of Polyporaceae in Western India: An overview and addition to mycoflora of the Gujarat state

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Abstract

Extensive fieldwork in different climatic regimes of Gujarat state during last four years resulted in the collection of more than 349 fungal species. Out of these, 37 species from 20 genera were found to be from the family Polyporaceae. Among these, five species are being reported for the first time here as new distribution records. The highest number of species is represented by the genus Trametes while, Cerrena unicola, Neolentinus kauffmanii, Dichomitus squalens, Panus conchatus and Laetiporus sulphureus possessed single species each.

Keywords
Bracket fungi; fungal diversity; Gujarat; Polyporaceae; Trametes

Introduction

Fungi are an ancient group of organisms which separated from animals about 900 million years ago (5) that adapted to variety of habitats by altering the hyphal structure, mode of nutrition, including substrates, reproductive structure and growth forms. They are indispensable mediators in recycling the carbon stored in plant material and other organic compounds and are thus an important component of the ecosystem (10). On the flip side, they also cause economic losses in the form of decay and deterioration of forest products and diseases to flora and fauna (7). Lately fungal strains have been used in the productions of enzymes on a commercial scale. White rot Basidiomycetes produce different types of peroxidases and laccases that have potential application in degradation of xenobiotic compounds. Most of the antibiotics available in the market are also obtained from fungi. Intensive research work has been initiated worldwide in search of new and novel biomolecules to combat diseases that plague mankind. Edible fungi are a rich source of nutrition. Many fungi are sources of edible as well as non-edible dyes. In spite of its various applications and importance, studies on fungal diversity of Gujarat state has not received much attention from the scientific community and there is very little published information on the subject (20).

In recent years, a few efforts have been made to document the same from the Gujarat state, but most of the reports are on human pathogen (3, 6, 8, 9, 18) and agricultural pathogen (17, 24, 29) but
but very few on saprophytic fungi occurring in the state (1, 2, 14, 16). Rajput et al. (20) compiled the first checklist for the state and reported 334 species. Therefore, it is essential to explore the diversity of such important group of organisms. In continuation of previous work, the present study is therefore, aimed to report the status and diversity of Polyporaceae from the Gujarat state.

Fig. 1A–D – Fruiting bodies of *Favolus grammoccephalus* (A,B); *Lenzites betulina* (C,D) and *Daedaleopsis confragosa* (E).

Scale bar: A-D = 10 mm, E: bar = 15 mm
Materials and Methods

Study area: Field work was carried out throughout the state of Gujarat, including undisturbed forests, secondary forests, agricultural fields, waste lands, wetlands, arid and semi-arid regions and bush fallow. Collection of fungal specimen started with the initiation of
Material Collection: Small parts of the fruiting bodies collected from the field were inoculated on PDA or MEA media. For establishing the cultures, fruiting bodies were suitably trimmed and surface sterilized by 0.1% HgCl₂ for 40-45 seconds, washed thoroughly with distilled water and treatment with 70% ethanol for a few seconds. Subsequently, these samples were inoculated on Potato Dextrose

Fig. 3A–F– Fungal fruiting bodies. A, B: _Daedaleopsis nitida_ (syn. _Hexagonia nitida_), C, D: _Trametes vernicipes_ (syn. _Microporus vernicipes_), E, F: _Lenzites elegans_, Figure 3A, B: Scale bar = 10 mm, C, D, E, F: Scale bar = 5 mm.
Agar (PDA) and Malt Extract Agar (MEA) media and incubated at 27°C. Pure cultures were established by serial transfer and stored at 4°C in refrigerator for further studies. Mycelia and spore characteristics were studied by staining with 1% aqueous solution of Congo red and mounted in 3% aqueous KOH or stained with lactophenol-cotton blue as a staining and mounting medium. Basidiomes were studied under Leica stereo zoom microscope, while hand sections of fruiting bodies

Fig. 4A–F—Fungal fruiting bodies. A, B: *Laetiporus sulphureus*, C: *Coriolopsis gallica* D: *Polyporus varius* E, F: *Polyporus tricholoma*, Figure 4A, B: Scale bar = 10 mm, C,D: Scale bar = 5 mm E,F: Scale bar = 5 mm.
were observed under Leica tri-nocular (DME 2000) research microscope. All specimens were examined on the basis of their morphological characteristics and identified with the help of available literature (4, 22, 23, 25), New Zealand Fungi database, Species Fungorum and MushroomExpert.com. Doubtful specimens (Polyporus tricholoma, Lenzites betulina, Trametes vernicipes [syn. Microporus vernicipes], Trametes hirsuta) were processed for molecular identification.

**Molecular identification:** Genomic DNA was extracted by conventional method (19) as well as using Plant/Fungi DNA isolation kit (Sigma Cat# E3038) from the fresh fruiting bodies or fresh mycelia from one week old fungal cultures. PCR was carried out using 1X final concentration of Ready Mix™ Taq PCR Reaction Mix (Sigma) and template DNA (50 ng/μl). Amplification of the DNA was performed by using Thermal cycler (Applied Biosystems Veriti®) and the ITS region was amplified by PCR machine using the primers ITS 1 and ITS 4 as described by White et al. (28). The amplified products were purified using Purelink™ Quick PCR Purification kit (Cat# K310001) and purified products were sent for sequencing to Eurofins Genomics India Pvt. Ltd., Bangalore.

Sequence data obtained after sequencing was subjected to sequence match analysis using Basic Local Alignment Search Tool (BLAST) on NCBI for identification of fungal species. Identification was done by 99% base-pair match of the sequence obtained to the closest available reference sequences. After the preliminary analysis, the sequence was submitted to NCBI by using BankIt tool and also submitted to BOLD SYSTEMS according to the guidelines provided on the BOLD website (http://www.boldsystems.org/). After molecular identification, characteristic features of identified species were also compared with the available literature.

**Result and Discussion**

Fungal diversity of the western part of India with special reference to the Gujarat state is poorly investigated (20). There are a few sporadic reports on the fungal diversity of the state, but these are either reports from medical colleges on human pathogens or from agricultural universities on plant pathogens. Saprophytic fungi, an important component of forest ecosystems have largely been ignored by researchers. Fungi play an important role in mineralization processes and carbon recycling of various carbohydrates and polysaccharides stored in plant cell walls (10, 21). Sporadic reports on wood rot fungi for the state are available (1, 2, 14, 16) but extensive studies on this group is lacking. Rajput et al. (20) compiled the first checklist on the basis of their own field survey and available literature on the fungal diversity of the state and reported 334 species. Koyani et al. (15) and Vasava et al. (26-27) documented the distribution and diversity of the Family Xylariaceae, Myxomycetes and Agaricaeae. Present study is therefore aimed to report the status and diversity of Polyporaceae from Gujarat state on the basis of our own fieldwork and available literature. The current study though preliminary makes an essential contribution to the fungal diversity of the Gujarat State. Still further studies along similar line to document the fungal diversity of the state are essential.

Supplementary Table 1 enlists 37 species belonging 20 genera of the family Polyporaceae on the basis of available literature and our own collections (Fig 1-4) from different biogeographic regions of Gujarat. The most represented genera of the family are *Trametes, Microporus, Polyporus, Lentinus, Lenzites, Coriolopsis* while *Trametes* is having maximum number with 11 species. From the total number of species, five species viz. *Favolus grammocepalhus, Lentinus squarrosulus, Polyporus leprieurii, Panus conchatus* and *Trametes trogii* are being reported for the first time from the western part of India.

**Competing interests**

The authors have declared that no competing interests exist.

**Authors contributions**

KSR conceived the idea; KSR & AMV prepared the manuscript. Field visit, collection and identification of specimen was done by AMV, RDK and RSP.

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**Supplementary Table 1:** List of species of Polyporaceae reported from different parts of Gujarat in the present study and by the earlier researchers

| Sr No. | Scientific name                                      | Distribution | Reference                     |
|--------|------------------------------------------------------|--------------|-------------------------------|
| 1.     | *Cerrena unicolor* (Bull.) Murrill, J. Mycol. 9(2): 91 (1903) | Ratanmahal   | Nagadesi & Arya 2014          |
| 2.     | *Coriolopsis aspera* (Jungh.) Teng, Chung-kuo Ti Chen-chun, [Fungi of China]: 759 (1963) | Ratanmahal   | Arya et al. 2008              |
| 3.     | *Coriolopsis gallica* (Fr.) Ryvarden, Norw. J. Bot. 19: 230 (1973) | Ratanmahal   | Nagadesi & Arya 2014          |
| 4.     | *Daedalea quercina* (L.) Pers., Syn. meth. fung. (Göttingen) 2: 500 (1801) | Ratanmahal   | Nagadesi & Arya 2014          |
| 5.     | *Daedaleopsis confragosa* (Bolton) J. Schröt., in Cohn, Krypt.-Fl. Schlesien (Breslau) 3.1(25–32): 492 (1888) [1889] | Rajkot, Baroda , Dang, Junagadh | Nagadesi & Arya 2016          |
| 6.     | *Daedaleopsis nitida* (Durieu & Mont.) Zmitr. & Malysheva, Mikol. Fitopatol. 47(6): 375 (2013) (syn. *Hexagonia nitida*) | Dharampur, Ratanmahal | Rajput et al. 2015            |
| 7.     | *Dichomitus squalens* (P. Karst.) D.A. Reid, Revta Biol., Lisb. 5(1-2): 150 (1965) [1964-5] | Junagadh     | Rajput et al. 2015            |
| 8.     | *Earliella scabrosa* (Pers.) Gilb. & Ryvarden, Mycotaxon 22(2): 364 (1985) | Junagadh     | Rajput et al. 2015            |
| 9.     | *Favolus grammocephalus* (Berk.) Imazeki, Bull. Tokyo Sci. Mus. 6: 95 (1943) | Ratanmahal, Dang, Jessore, Gandhinagar | Present study                  |
| 10.    | *Funalia caperata* (Berk.) Zmitr. & Malysheva(Funalia caperata (Berk.) Zmitr. & Malysheva, Mikol. Fitopatol. 47(6): 375 (2013) | Gandhinagar, Junagadh, Ahwa | Rajput et al. 2015            |
| 11.    | *Hexagonia tenuis* (Fr.) Fr., Epicr. syst. mycol. (Upsaliae): 498 (1838) [1836-1838] | Ratanmahal, Dang | Nagadesi & Arya 2012          |
| 12.    | *Leiotrametes lactinea* (Berk.) Welti & Courtec., in Welti, Moreau, Favel, Courtecuisse, Haon, Navarro, Taussac & Lesage-Meessen, Fungal Diversity 55(1): 60 (2012) | Ratanmahal   | Nagadesi & Arya 2014          |
| 13.    | *Lentinus arcularius* (Batsch) Zmitr., International Journal of Medicinal Mushrooms (Redding) 12(1): 88 (2010) | Dang, Ratanmahal | Rajput et al. 2015            |
| 14.    | *Lentinus squarrosulus* Mont., Anns Sci. Nat., Bot., sér. 2 18: 21 (1842) | Dang         | Present Study (GSBTM)         |
| 15.    | *Lentinus tricholoma* (Mont.) Zmitr., International Journal of Medicinal Mushrooms (Redding) 12(1): 88 (2010) | Gandhinagar, Rajpipla, Dang | Rajput et al. 2015            |
| No. | Species                                      | Authors/Publication Details                                      | Location(s)                      | References                          |
|-----|---------------------------------------------|-----------------------------------------------------------------|----------------------------------|-------------------------------------|
| 16  | *Lenzites betulina* (L.) Fr., Epicr. syst. mycol. (Upsaliae): 405 (1838) [1836-1838] | Ratanmahal, Junagadh                                           | Nagadesi & Arya 2012; Rajput et al. 2015 |
| 17  | *Lenzites stereoides* (Fr.) Ryvarden, Norw. Jl Bot. 19: 232 (1972) | Ratanmahal, Dang                                                | Arya et al. 2008                  |
| 18  | *Laetiporus sulphureus* (Bull.) Murrill, Annls mycol. 18(1/3): 51 (1920) | Dang, Junagadh, Vansda                                          | Korat et al. 2013; Rajput et al. 2015 |
| 19  | *Microporus affinis* var. glabriceps Nagdesi & Arya (Microporus affinis var. glabriceps Nagdesi & A. Arya, Mycosphere 3(6): 1000 (2012) | Ratanmahal                                                      | Nagadesi & Arya 2012               |
| 20  | *Microporus alboater* (Henn.) Kuntze, Revis. gen. pl. (Leipzig) 3(2): 494 (1898) | Ratanmahal                                                      | Nagadesi & Arya 2012               |
| 21  | *Microporus ochrotinctus* (Berk. & M.A. Curtis) Kuntze, Revis. gen. pl. (Leipzig) 3(2): 496 (1898) | Gandhinagar, Junagadh                                          | Rajput et al. 2015                 |
| 22  | *Microporus xanthopus* (Fr.) Kuntze, Revis. gen. pl. (Leipzig) 3(2): 494 (1898) | Junagadh, Pavagdh                                              | Rajput et al. 2015                 |
| 23  | *Navisporus floccosus* (Bres.) Ryvarden [as ‘floccosa’], in Ryvarden & Johansen, Prelim. Polyp. Fl. E. Afr. (Oslo): 443 (1980) | Ratanmahal                                                      | Arya et al. 2008                   |
| 24  | *Neolentinus kauffmanii* (A.H. Sm.) Redhead & Ginns, Trans. Mycol. Soc. Japan 26(3): 357 (1985) | Polo forest                                                     | Rajput et al. 2015                 |
| 25  | *Panus conchatus* (Bull.) Fr., Epicr. syst. mycol. (Upsaliae): 396 (1838) [1836-1838] | Baroda, Dang                                                   | Present study                     |
| 26  | *Phellinus badius* (Cooke) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res., Pl. Dis. Div. 164: 273 (1965) | Rajpipla                                                        | Nagadesi & Arya 2013               |
| 27  | *Polyporus leprieurii* Mont., Annls Sci. Nat., Bot., sér. 2 13: 203 (1840) | Vansada                                                         | Present study (GSBTM)              |
| 28  | *Trametes apiaria* (Pers.) Zmitr., Wasser & Ezhov, International Journal of Medicinal Mushrooms (Redding) 14(3): 317 (2012) | Ratanmahal                                                      | Nagadesi & Arya 2014               |
| 29  | *Trametes elegans* (Spreng.) Fr., Epicr. syst. mycol. (Upsaliae): 492 (1838) [1836-1838] | Dang, Junagadh, Ratanmahal                                     | Rajput et al. 2015                 |
| 30  | *Trametes flavida* (Lév.) Zmitr., Wasser & Ezhov, International Journal of Medicinal Mushrooms (Redding) 14(3): 310 (2012) | Junagadh, Polo forest                                          | Rajput et al. 2015                 |
| 31  | *Trametes gibbosa* (Pers.) Fr., Epicr. syst. mycol. (Upsaliae): 492 (1838) [1836-1838] | Ratanmahal                                                      | Nagadesi & Arya 2014               |
| 32  | *Trametes hirsuta* (Wulfen) Lloyd, Mycol. Writ. 7(Letter 73): 1319 (1924) | Junagadh                                                        | Rajput et al. 2015                 |
|   | Species                  | Author and Year | Location | Reference |
|---|--------------------------|-----------------|----------|-----------|
|33 | *Trametes ljubarskyi*    | Pilát, Bull. trimest. Soc. mycol. Fr. 52(3): 309 (1937) [1936] | Junagadh | Rajput et al. 2015 |
|34 | *Trametes palisotii*     | (Fr.) Imazeki, Bull. Gov. Forest Exp. Stn Tokyo 57: 120 (1952) | Ratanmahal | Nagadesi & Arya 2012 |
|35 | *Trametes trogii*        | Berk., in Trog, Mittheil. d. schweiz. Naturf. Ges. in Bern 2: 52 (1850) | Junagadh | **Present study** |
|36 | *Trametes vernicipes*    | (Berk.) Zmitr., Wasser & Ezhov, International Journal of Medicinal Mushrooms (Redding) 14(3): 312 (2012). (syn. *Microporus vernicipes*) | Waghai, Saputara, Junagadh | Rajput et al. 2015 |
|37 | *Trametes versicolor*    | (L.) Lloyd, Mycol. Notes (Cincinnati) 65: 1045 (1921) [1920] | Navsari, Ratanmahal, Junagadh | Korat et al. 2013; Nagadesi & Arya 2012; Rajput et al. 2015 |

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