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Research Article

A new distribution record of false smut (*Graphiola phoenicis*) of *Phoenix sylvestris* from Telangana, India

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Abstract

A distinctive occurrence of false smut disease was recorded on *Phoenix sylvestris* within the campus of Hyderabad Central University (HCU), Telangana, India. The morphological features, supported by light and scanning electron microscopy, confirmed the causal agent as *Graphiola phoenicis,* an obligate foliar pathogen of the family Arecaceae. This study constitutes a new distribution record of *G. phoenicis* associated with *Phoenix sylvestris* in Telangana State, India. Further, the present findings extend the documented geographical range of false smut disease in India to include additional occurrences from the Andaman and Nicobar Islands, contributing to a more comprehensive understanding of the pathogen's distribution and host association across diverse ecological zones.

Keywords: Biotroph, False smut, Obligate foliar pathogen, Phylogeny, Silver date palm, Taxonomy

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1. Introduction

Phoenix sylvestris Roxb. commonly referred to as the Indian date, is a widely distributed species native to the Indian subcontinent, including the Andaman Islands, Bangladesh, India, Myanmar, Nepal, Pakistan, and the West Himalaya (POWO, 2025). It is cultivated along roadsides, canals, homesteads, field margins and even on wastelands; in addition, it is known to thrive even in marginal or degraded lands (Jain et al., 2018). In addition to its ecological adaptability, the fruit of *P. sylvestris* is recognized for its rich nutraceutical composition, containing alkaloids, amino acids, carbohydrates, dietary fibers, flavonoids, phenolic compounds, tannins, and terpenoids. These phytoconstituents contribute to its traditional use as antipyretic, cardiotonic, diuretic, laxative, and antioxidant agents (Jain et al. 2018). According to Newton et al. (2013), in India it is wild in Gujarat, Haryana, Himachal Pradesh, Karnataka, and Rajasthan. Members of the genus *Phoenix*, particularly *Phoenix dactylifera* and *P. sylvestris* and *P. canariensis* (Canary Island date palm), serve as primary hosts for the biotrophic basidiomycete, *Graphiola phoenicis* (Moug. ex Fr.) Poit., an obligate foliar pathogen belonging to the order Exobasidiales (Basidiomycota). *Graphiola phoenicis* causes the disease commonly referred to as "false smut" or "*Graphiola* leaf spot," which is characterized by the formation of tar-spot-like sori on palm fronds. Historically, the taxonomic placement of *G. phoenicis* has been highly ambiguous, having been variously classified as a myxomycete, discomycete, rust, pyrenomycete, smut, and hyphomycete over the past two centuries, largely due to limited understanding of its reproductive structures and life cycle (Cole, 1983). The widespread occurrence of *G. phoenicis* on *Phoenix* spp. across diverse agro-climatic zones of India has been previously documented. Prior to this report, the occurrence of false smut on *Phoenix* species had been documented in the Andaman and Nicobar Islands (India), as well as on *P. dactylifera* and *P. sylvestris* in Karnataka (India). Comprehensive details regarding its microscopic characteristics, spore morphology, and incidence were provided by Mahadevakumar et al. (2020, 2025).

During February-April, 2025, symptomatic *P. sylvestris* individuals, both naturally occurring and planted, were observed across various locations on the University of Hyderabad campus, Telangana. Infected plants were found to be associated with characteristic black tar spots that resembled sori (pycnidial-like) structures and upon close observation, the presence of conidia mass in the form of filaments was observed. Therefore, the present study documents the occurrence of *G. phoenicis* associated with false smut symptoms on *Phoenix dactylifera* from Telangana, thereby extending the known distribution of this pathogen within peninsular India. Further, this paper provides updated records of its incidence in the Andaman and Nicobar Islands recorded during April-May 2024 and contributes detailed insights into its symptomatology, spore morphology, and host-pathogen interaction.

2. Material and Methods

2.1 Sample Collection and Assessment of Disease Incidence

Samples of disease were collected during a survey at the Central University of Hyderabad, with sampling sites located in the vicinity of the Amphitheater (17°45'40"N, 78°31'94"E) and the

Tagore International Hostel (17°45'13"N, 78°31'53"E). The number of symptomatic palms reported relative to the total number of palms assessed was used to determine the disease incidence (Mahadevakumar et al., 2017). From each site, a subset of representative leaf samples bearing sori and associated lesions was aseptically collected and transported to the laboratory for detailed morphological, histopathological, and microscopic examination. Specimens were subsequently processed for herbarium preservation and permanently mounted on archival sheets. These reference samples are deposited in the Plant Pathology Laboratory, Department of Studies in Biotechnology, University of Mysore, and serve as authenticated material for future mycological and pathological studies.

2.2 Microscopy and Ultrastructural Characterization

For accurate identification of the false smut pathogen, comprehensive microscopic analyses were undertaken. Stereomicroscopic examination of the sori was performed using a Zeiss Discovery Research Microscope (Carl Zeiss, Germany) to document surface morphology at low magnification. Bright field microscopy was conducted using a Zeiss Axiom A1 compound microscope with an integrated digital camera (Carl Zeiss, Germany) to capture high-resolution images of pustules and fungal structures. For ultrastructural investigations, scanning electron microscopy (SEM) was employed. Leaf tissues exhibiting artificially induced smut sori were excised and affixed onto aluminum stubs using conductive double-sided carbon adhesive tape. Samples were sputter-coated with a gold-palladium (Au/Pd) alloy using the SPI-MODULE™ sputter coater (Structure Probe Inc., USA) to ensure adequate surface conductivity. Scanning electron microscope imaging was carried out using a Zeiss EVO LS10 Scanning Electron Microscope (Carl Zeiss, Germany) operating at an accelerating voltage of 15 KV. This enabled a detailed visualization of fungal sori architecture, including spore morphology.

2.3 Taxonomic Treatment and Sequence Analysis from Public Database

Taxonomic treatment is appended in the end along with complete information on description, known distribution, host records reported so far, distribution in India, and sequence analysis deposited at the GenBank database. Further, using the available sequence datasets, phylogenetic trees were constructed following the methodologies described by Mahadevakumar et al. (2025) for each dataset (nrITS, nrLSU and nrSSU) and the data are presented.

3. Results and Discussion

3.1 Field Observation

A survey of *Phoenix* sp. at the University of Hyderabad campus revealed symptoms characteristic of false smut infection, including leaflet desiccation and dark sori structures on shoots. Detailed examinations showed black eruptive fruiting bodies with conidial masses extruded through ostioles along with elator-like structures. Among 70 plants surveyed, the incidence was approximately 39%. Similar assessments in the Andaman and Nicobar Islands (Diglipur & Mayabunder 2024) recorded a higher incidence of 63%, with 38 out of 60 plants exhibiting comparable symptoms. These findings indicate a widespread and possibly emerging false smut infection in Phoenix species across geographically distinct regions. Representative specimens were deposited at the University of Mysore, Biotechnology Department, with accession numbers

UOM202501 (Mahesh, M.), UOM202508 (Mahesh, M. and Sarma, P.V.S.R.N) and UOM202510 (Sarma, P.V.S.R.N. and Danteswari, C.).

Fig. 1. Habit and symptoms of false smut infection on *Phoenix sylvestris* from Telangana, India: A & B, *P. sylvestris* from Hyderabad Central University Campus; C, *P. sylvestris* found associated with false smut recorded in Manasagangotri, University of Mysore Campus; D-F, Close-up view of infected rachis with false smut pustules distributed all over the surface.

3.2 Symptoms of Disease and Morphological Identification

The typical symptoms of the date palm false smut illness are depicted in Figure 1. Initial symptoms are characterized by the emergence of minutes, irregularly shaped sori, spherical to cylindrical in form, developing on both adaxial and abaxial surfaces of the leaf blades. The sori exhibited a color gradient, which can range from yellow to black during different stages of development. These structures represent the asexual fruiting bodies of the pathogen and were localized predominantly at apical regions of infected spots. The sori, measuring in diameter from 0.3 to 1.5 mm, originated sub epidermally and were enclosed within hard, melanized outer peridium walls (Fig. 2). Furthermore, many sori was observed in the apical regions of the host plants. Upon maturation, sori ruptured via an ostiole, extruding filamentous structures that appeared white to creamy in color. These filaments, ranging from 2 to 7 mm in length, discharged a golden, powdery spore mass. The spores were broadly spherical to ellipsoidal in form and had smooth hyaline walls measuring between 3 and 7 µm (Fig.3). Scanning electron microscopy

(SEM) of mature sori revealed that characteristic dehiscence of the peridium formed a thickened, collar-like ostiole, through which elongated elaters protruded (Fig.3). These morphological features, including the nature of the sori, ostiolar dehiscence, spore morphology, and filamentous elaters, were diagnostic for *G. phoenicis* (Moug. ex Fr.) Poit. and consistent with previous taxonomic descriptions (Cole, 1983; Djerbi, 1983; Abbas & Abdulla, 2004; Sepúlveda et al., 2017). The disease symptoms induced by *G. phoenicis* were distinctive and readily differentiated from those of other foliar diseases of palm species.

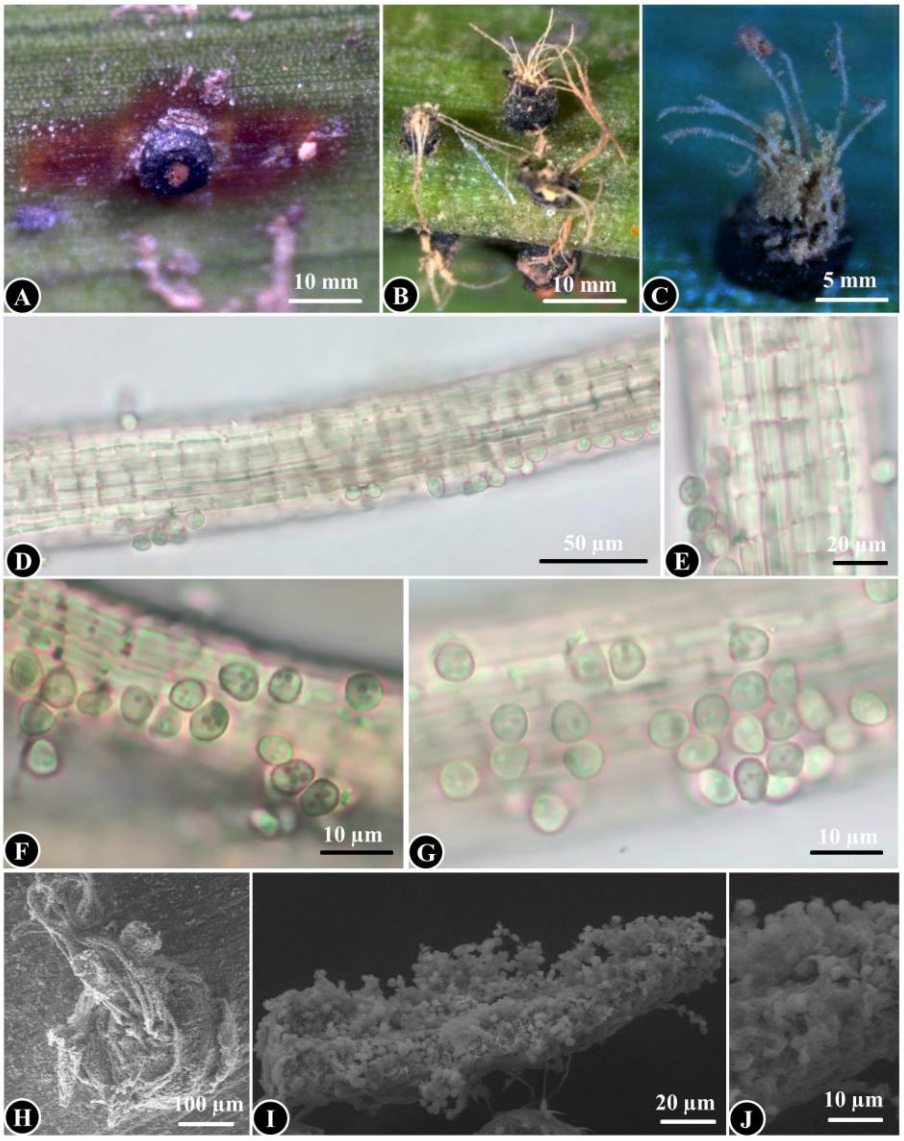

Fig. 2**.** Stereo view of filament structures of *Graphiola phoenicis* from the leaf sample from Hyderabad, Telangana; Microscopic observation of reproductive structures: D & E- Close-up view of filaments and their cell components; F & G-spores along with filament tissues; H–J Close-up view of sporidium along with filament; spore mass observed under SEM.

3.2 Taxonomy and Phylogeny

***Graphiola phoenicis* (Moug. ex Fr.) Poit. Ann. Sci. Nat. (Paris) 3: 473 (1824)**

Synonyms: *Phacidium phoenicis* Moug. ex Fr., Syst. mycol. (Lundae) 2(2): 572 (1823)
Trichodesmium phoenicis (Moug. ex Fr.) Chevall., Fl. gén. env. Paris (Paris) 1: 382 (1826)
Roestelia phoenicis (Moug. ex Fr.) Bonord., Handb. Allgem. Mykol. (Stuttgart): 55 (1851)

Descriptions: It typically grows as an epiphyllous parasite, distinctive, extended, irregular and in severe infections coalesces and forms patches, typically with a reddish-brown or dark-brown spot at the centre, spread on both sides of the mid-vein.

Fructifications: amphigenous, black, cupulate, 0.4–1.9 mm in diam. The peridium is usually thick and partially encloses the fertile tissue and forms a collar around the ostiole through which the narrow, white, flexuous filaments emerge. Filaments are tangled, hygroscopic, in fascicles, composed of rows of rectangular cells fused in a parallel fashion, extending up to 2–3 mm above the mouth of the fruiting body and sometimes covered with several propagules produced by the fertile cells (basidia) within the cavity of the fructification. The primary basidiospores (propagules) are ellipsoidal, verruculose, 2-celled, showing a smooth, slightly concave cross-wall when forcibly separated into two secondary spores and yellowish-brown in mass.

Host recorded: *Chamaerops humilis* L., *Cocos nucifera* L., *Livistona alfredii* F. Muell., *L. humilis* R.Br., *L. inermis* R.Br., *L. mariae* F. Muell., *L. rigida* Becc., *Phoenix canariensis* H. Wildpret, *P. dactylifera* L., *P. hanceana* Schaedtler, *P. reclinata* Jacq., *P. paludosa* Roxb., *P. sylvestris* (L.) Roxb. and *Sabal causiarum* (O.F. Cook) Becc.

Material Examined: India, Telangana, Hyderabad, Hyderabad Central University Campus, opposite to Tagore International Guest House and opposite to Amphitheatre, Gachibowli, Mahesh, Sarma and Danteswari, 02.03.2025; India, Andaman and Nicobar Islands, North and Middle Andaman, Diglipur, Mayabunder, Mahadevakumar, 18.04.2024; and India, Karnataka, Mysuru, University of Mysore, Manasagangotri Campus, behind the sericulture department and opposite to the EMRC Building, Mahesh, Mahadevakumar, 07.04.2025.

Distribution: Andaman and Nicobar Islands (ANI), Himachal Pradesh (HP), Karnataka (KA), Madhya Pradesh (MP), Meghalaya (M), Rajasthan (R), Tamil Nadu (TN), Telangana (TG) (present report), and Uttar Pradesh (Mahadevakumar et al., 2020, 2025) (Table 1; Fig. 3).

Extended distribution: previously, *G. phoenicis* was reported in Karnataka by Mahadevakumar et al. (2020), Tamil Nadu and Madhya Pradesh. However, recent observations reported by Mahadevakumar et al. (2025) showed the incidence of false smut in Port Blair and Campbell Bay of the Andaman and Nicobar Islands (Mahadevakumar et al., 2025). Therefore, the incidence of false smut on *P. sylvestris* in Diglipur, North Andaman, Mayabunder, and Middle Andaman is reported here as extended distribution. Therefore, the present study reports the first occurrence in the state of Telangana and extended distribution in the North and Middle Andaman group of islands.

Phylogeny and Sequence Data Analysis: a total of 31 nucleotide sequence data are available from the public domain (NCBI GenBank database under the key word *Graphiola phoenicis*)

representing the SSU, ITS region and LSU region. The details of DNA sequence data are presented in Table 2. The nrITS sequence dataset was subjected to phylogenetic analysis using the Maximum Likelihood Method. The Kimura-2-parameter model was applied to all positions, with less than 95% site coverage being eliminated (partial deletion). A total of 26 nucleotide sequences with 332 positions were in the final dataset, with *Mycosarcoma maydis* (AY345004) as the outgroup. For nrLSU based phylogeny, the same criteria were followed with 25 nucleotide sequences with 164 positions in the final dataset. However, in nrSSU phylogenetic analysis, the Jukes-Cantor model was applied, which involved 14 nucleotide sequences in the final dataset. Phylogenetic trees inferred from available sequence data separately using ITS, SSU and LSU are presented in Figure 4.

Table 1. List of *Graphiola phoenicis* associated with palm collections recorded from India

Herbarium #	Name of palm	Locality	Collector	Date of collection
IMI 135011	*Phoenix sylvestris*	Uttar Pradesh	D. V. Singh	05.04.1962
IMI 147237	*Phoenix* sp.*	Rajasthan	S. L. Jhamaria	03.10.1970
IMI 162210	*Phoenix* sp.	Rajasthan	Panwar, K.S.	??**
IMI 224721	On a leaf of *Palmae*	Meghalaya	Sharma, G.D.	26.11.1978
IMI 259308	*Phoenix sylvestris*	Uttar Pradesh	Rai, A.N.	19.05.1981
IMI 264906	On a leaf of *Phoenix*	Himachal Pradesh	Kaur, B.	15.07.1981
IMI 266307	*Phoenix sylvestris*	Uttar Pradesh	Singh, A.K.	25.03.1982
K-M000486438	*Phoenix sylvestris*	Madhya Pradesh	??	05.10.1984
K-M000510151	*Phoenix* sp.	Madhya Pradesh	Khan, K.S.	22.10.1986
IMI 333562	*Phoenix sylvestris*	Madhya Pradesh	??	10.04.1989
K-M000558973	*Phoenix sylvestris*	Bihar	??	04.01.1991
K-M000682947	*Phoenix dactylifera*	Bihar	Pandotra, V.R.	05.12.1961
UOM201810	*Phoenix sylvestris*	Karnataka	Mahadevakumar, S,	18.06.2018
UOM201812	*Phoenix dactylifera*	Karnataka	Mahadevakumar, S,	15.08.2018
PBL 34405	*Phoenix* sp.	A & N I	Mahadevakumar, S.	18.06.2022
PBL 34414	*Phoenix* sp.	A & N I	Mahadevakumar, S.	02.03.2023
PBL!!	*Phoenix sylvestris*	A & N I	Mahadevakumar, S.	18.04.2024
PBL!!	*Phoenix sylvestris*	A & N I	Mahadevakumar, S. 2024	18.04.2024
UOM202501	*Phoenix sylvestris*	Karnataka	Mahesh, M.	18.02.2025
UOM202508	*Phoenix sylvestris*	Telangana	Mahesh, M. & Sarma, P.V.S.R.N.	03.03.2025
UOM202510	*Phoenix sylvestris*	Telangana	Sarma & Danteswari	05.03.2025
CUPH 812	*Phoenix paludosa*	West Bengal	Pal	09.03.1996

*Details of species not available for the host; **?? No dates are available from the specimen.

There were no variations among the nrITS sequence datasets and the nrLSU sequence datasets (Figs. 4A & B); however, there are considerable variations observed in the nrSSU sequence datasets as depicted in phylogenetic inferences (Fig. 4C). It is mainly attributed to the sequence length. The sequence length varied from 250 bp to 1600 bp. Since the nrITS and nrLSU regions are more reliable for identification and differentiation of different taxa within the Exobasidiales group, the SSU sequence can be omitted or is otherwise applicable. Demographic observations revealed that most sequences were submitted from Germany, with seven sequence representations, followed by China with six and India and Taiwan with five each. Further, it was

noted that *G. phoenicis* is not only reported as an epiphyllous parasitic fungus, but also reported to occur as an endophyte on various plants. Sequence data available in GenBank (MF334572) was isolated/sequenced from environmental samples while analyzing the microbiome associated with heterotrophic gastrodic orchids; *G. phoenicis* (MK336541) was isolated as an endophyte associated with *Ipomoea pes-caprae* (a coastal-associated plant), and in 2024, researchers from Tamil Nadu isolated *G. phoenicis* as an endophyte on the stem part of *Oryza sativa* (PQ579389). Though *G. phoenicis* was recorded as an endophyte, establishment of culture is practically not possible. Most of the members belonging to Exobasidiales were obligate parasites. *Graphiola cylindrica* recorded from deep-sea sediments was based on culture-dependent studies (Singh et al., 2010). But, *G. phoenicis* was recorded as an endophyte from gastrodic orchids based on microbiome investigation. This information expands our knowledge on the possible occurrence of *Graphiola phoenicis* as an endophyte but can only be detected through culture-independent methods. In the future, we may come across possible host range extension and the role of endophytic isolates from various sources/habitats they play.

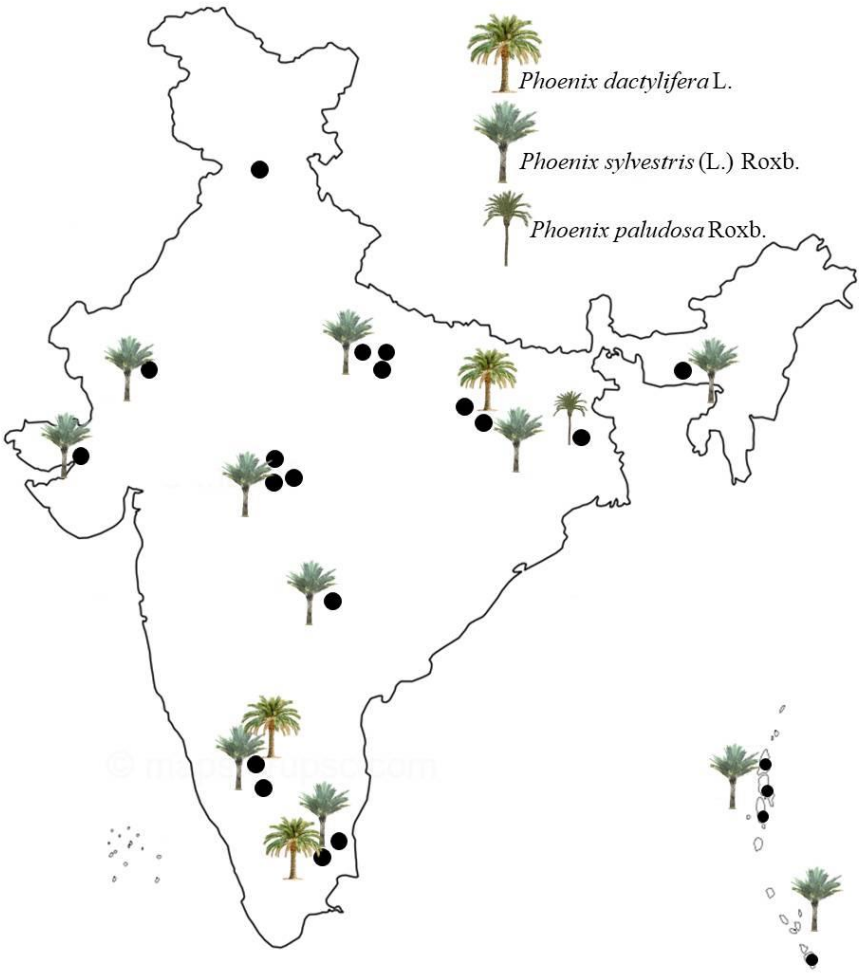

Fig. 3. Distribution of *Graphiola phoenicis* on *Phoenix dactylifera, P. sylvestris* and *P. paludosa* in India (except for Himachal Pradesh, where no palm species details are available).

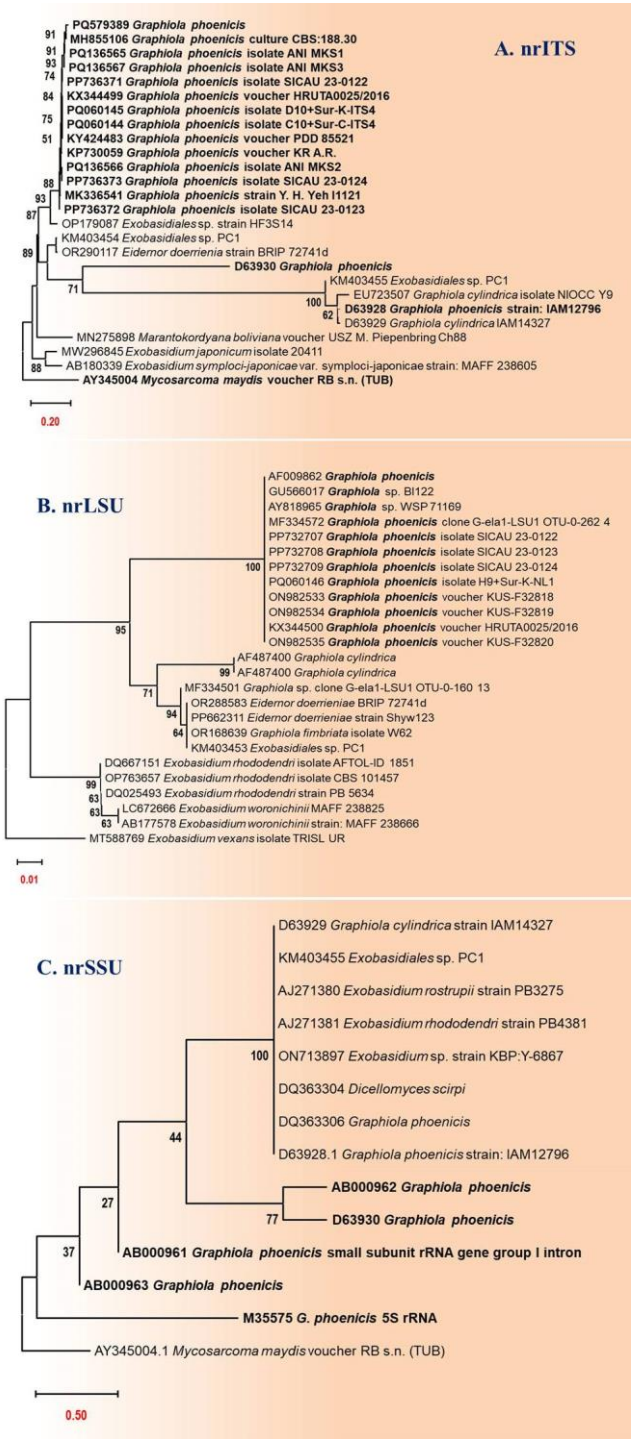

Fig. 4. Phylogenetic analysis of *Graphiola phoenicis* using MEGA XI software. Analysis was performed using the Maximum Likelihood Method with 1000 bootstrap replications. Phylogenetic trees inferred using A) nrITS sequence dataset; B) nrLSU sequence dataset; and C) nrSSU sequence dataset.

Table 2. List of DNA nucleotide sequences available at the NCBI GenBank database and used in the phylogenetic tree construction

Serial No.	Taxon	Voucher/Isolate	Country	Accession No	Reference/Remarks
01	*Graphiola phoenicis*	KR A.R. Wood	Germany	KP730059	Unpublished data
02	*Graphiola phoenicis*	HRUTA0025/2016	Chile	KX344499	Sepúlveda et al., 2017
03	*Graphiola phoenicis*	-	India	PQ579389	Unpublished Data
04	*Graphiola phoenicis*	D10+Sur-K-ITS4	Turkey	PQ060145	Unpublished data
05	*Graphiola phoenicis*	C10+Sur-C-ITS4	Turkey	PQ060144	Unpublished data
06	*Graphiola phoenicis*	SICAU 23-0122	China	PP736371	Unpublished data
07	*Graphiola phoenicis*	Y. H. Yeh I1121	Taiwan	MK336541	Unpublished data
08	*Graphiola phoenicis*	ANI_MKS3	India	PQ136567	Mahadevakumar et al., 2025
09	*Graphiola phoenicis*	ANI_MKS2	India	PQ136566	
10	*Graphiola phoenicis*	ANI_MKS1	India	PQ136565	
11	*Graphiola phoenicis*	SICAU 23-0124	China	PP736373	Unpublished data
12	*Graphiola phoenicis*	SICAU 23-0123	China	PP736372	Unpublished data
13	*Graphiola phoenicis*	CBS: 188.30	Indonesia	MH855106	Vu et al., 2019
14	*Graphiola phoenicis*	PDD 85521	Germany	KY424483	Unpublished data
15	*Graphiola fimbriata*	PC1	Iran	KM403454	Unpublished data
16	*Graphiola fimbriata*	PC1	Iran	KM403455	Unpublished data
17	*Graphiola cylindrica*	IAM1432	Japan	D63929	Unpublished data
18	*Graphiola cylindrica*	NIOCC Y9	India	EU723507	Singh et al., 2010
LSU					
19	*Graphiola phoenicis*	HRUTA0025/2016	Chile	KX344500	Sepúlveda et al., 2017
20	*Graphiola phoenicis*	FO 29350	Germany	AF009862	Begerow et al., 1997
21	*Graphiola phoenicis*	KUS-F32819	South Korea	ON982534	Unpublished data
22	*Graphiola phoenicis*	KUS-F32818	South Korea	ON982533	Unpublished data
23	*Graphiola phoenicis*	KUS-F32820	South Korea	ON982535	Unpublished data
24	*Graphiola phoenicis*	H9+Sur-K-NL1	Turkey	PQ060146	Unpublished data
25	*Graphiola phoenicis*	SICAU 23-0124	China	PP732709	Unpublished data
26	*Graphiola phoenicis*	SICAU 23-0123	China	PP732708	Unpublished data
27	*Graphiola phoenicis*	SICAU 23-0122	China	PP732707	Unpublished data
28	*Graphiola phoenicis*	G-ela1-SU1_OTU-0-262_4	Taiwan	MF334572	Unpublished data
29	*Graphiola fimbriata*	W62	Brazil	OR168639	Unpublished data
30	*Graphiola fimbriata*	PC1	Iran	KM403453	Unpublished data
31	*Graphiola cylindrica*	JCM 8561	Germany	AF487400	Unpublished data
32	*Graphiola* sp.	WSP 71169	USA	AY818965	Unpublished data
33	*Graphiola* sp.	BI122	Brazil	GU566017	Unpublished data
34	*Graphiola geonomae*	-	Germany	JN185909	Unpublished data
35	*Graphiola* sp.	G-ela1-SU1_OTU-0-160_13	Taiwan	MF33450	Unpublished data
SSU					
36	*Graphiola phoenicis*	FO29350	Germany	DQ363306	Unpublished data
37	*Graphiola phoenicis*	LSU1_OTU	Taiwan	AB000963	Unpublished data
38	*Graphiola phoenicis*	IAM12796	Japan	D63930	Unpublished data
39	*Graphiola phoenicis*	IAM12796	Japan	D63928	Unpublished data
40	*Graphiola phoenicis*	JCM 2001	Japan	AB000962	Unpublished data
41	*Graphiola phoenicis*	LSU1_OTU	Taiwan	AB000961	Unpublished data
42	*Graphiola phoenicis*	PB 4349		M35575	Blanz & Gottschalk, 1986

Date palms (*P. dactylifera*) have been reported to be susceptible to the false smut disease caused by *G. phoenicis* in Brazil as well as Egypt (Lima, 1996; Anonymous, 2003), Chile (Sepúlveda et al., 2017), Kenya (Kung'u & Boa, 1997), Libya (Edongali, 1996), Qatar (Abbas & Abdulla, 2004), Yemen (Sattar et al., 2013), and numerous other tropical and subtropical regions (Martinez, 1966; Tubaki & Yokoyama, 1971; Simon, 2004). Palms from tropical and subtropical climates around the world are reported to be parasitized by the genus *Graphiola* (Pipenbring et al., 2012).

False smut disease caused by *Graphiola phoenicis* is known to be associated with five different genera of palms, which include *Chamaerops*, *Cocos*, *Livistona*, *Phoenix*, and *Sabal*. Among them, the *Phoenix* is the most common and frequently recorded host for *G. phoenicis*. *Graphiola phoenicis* has been linked to date palms in Punjab, India (Sinha et al., 1970; Mehta et al., 1989). Additionally, several literary elements have documented the presence of *G. phoenicis* in several geographical areas, such as Karnataka, Madhya Pradesh, Meghalaya, Rajasthan, Tamil Nadu, and Uttar Pradesh (Mahadevakumar et al., 2025). A comparative account of morphological features of *G. phoenicis* recorded from Karnataka, the Andaman and Nicobar Islands and Telangana revealed that they exhibit similar morphological features. There have been reports of *Phoenix sylvestris* false smut fungus from several Indian states. However, as of now, there are no reports from Telangana of any instances of counterfeit smut on Indian date palms. Therefore, this is the first report of false smut on *Phoenix sylvestris* from Telangana state.

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Conflict of Interest

There is no conflict of interest.

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