# Lichen Diversity of Rewa and adjacent areas in Vindhyanchal in relation to bio-monitoring studies

## Introduction:

### Definition of the Problem:

Rewa is one of the biggest district in Vindhyanchal Region of Madhya Pradesh. Out of the three major geomorphic landscapes (Son, Narmada and Chambal Sector), in central India, the Rewa plateau is a prominent North facing escarpment. The Floristic account of the vascular plant from the Rewa and adjacent area are well workout in the last more than hundred years, however the lower group of plants are either almost unexplored or underexplored from this region. Madhya Pradesh is represented by the occurrence of 179 lichen species belonging to 51 genera and 26 families, enumerated by Upreti *et al.* (2005). The Hoshangabad district and Shahdol districts exhibit the maximum diversity of lichens represented by 98 and 97 species respectively. The macro and micro lichens of Pachmarhi Sanctuary were enumerated by Singh (1977) and Singh & Awasthi (1978). The Pachmarhi Sanctuary and Amarkantak areas were exhaustively explored for lichen in the past and 25 taxa of microlichens and 16 of macrolichens were recorded from Pachmarhi area by Singh (1977). Recently, 130 species of the lichens of Achanakmar and Amarkantak Biosphere Reserve (AABR) are also enumerated by Satya (2006). The Chhatarpur and Sagar district exhibit the poor representation of lichens with 5 and 2 species only (Upreti *et al.* 2005).

The lichens growing on historical buildings and monuments in Khajuraho of Chhatarpur district were listed by Upreti (2002). Apart form the above exploration, few lichen taxa were also included in the revisionary and monographic account of different lichen genera form India (Awasthi, 1976, 1980, 1983, 1991: Singh & Awasthi, 1981; Awasthi and Mathur, 1987; Awasthi & Srivastava, 1989; Pant & Awasthi, 1989; Pant, 1998)

The Bhimbetka rock shelters in Raisen district of Madhya Pradesh is represented by the occurrence of 42 species belonging to 17 Genera and 11 Families of lichens. (A. Bajpai, 2007). Monuments and rocks representing seven districts of the state of Madhya Pradesh exhibit occurrence of a total number of 95 species belonging to 34 Genera and 17 Families of lichens. (Bajpai, R., 2008).

Out of the 48 districts of the state of Madhya Pradesh the lichen records of only eight districts (Anoopur, Chhatarpur Chhindwada, Dindori, Hoshangabad, Mandla, Sagar, Jabalpur) are so far available (Upreti *et al*, 2005). Most of the districts belonging to the Vindhyanchal range including Rewa, Satna, Sidhi, Panna, Katni and Umaria are almost unexplored for their lichens.

**Lichens as Bio-monitoring:**

The lichens are valuable bio-monitors of environmental change, the changes due to the climatic condition or atmospheric pollution in an area greatly influence the lichen flora of that area. Lichens at community or population level are used as sensitive indicators of the biological effect of pollutants or climatic changes.

The routine mapping of lichen diversity provides an indication of the biological impact of air pollution. The routine mapping is a quick and inexpensive method and provides result on which predictions for human health can be based. The lichen biodiversity counts (LB) can be taken as estimates of environmental quality. The high value of LB corresponds to natural situation while low value indicates high alteration quality.

The mapping of air pollution pattern in an area can be based on the number of species on a particular substrates and the percentage cover of a particular species or life form of lichen.

Such data can be plotted on maps graphs based on information available on the lichen of that area.

The distribution maps of common and sensitive lichen species is a relatively simple and inexpensive method for air quality monitoring. The method distinguishes areas with varying degrees of pollution. The distribution map helps to determine the distribution of a species that has change in the area in the course of time. Sufficient number of distributional data collected in the past help to assess the change more easily.

For continued success of conservation as well as ensuring the ecological continuity in the area there is a need of scientific monitoring. Among the various monitoring units the uses of lichen as biomonitoring units is quite economic and fast. The listing of new sensitive/tolerant indicators species of lichens form the Rewa and adjacent area can be used in future for assessment of the change of environment as well as to know the extend of pollution in the area. The different localities of the area can also be assessed under "disturbed" and "undisturbed" category based on the type of lichen species encountered. The sensitive, tolerant and indicator species will be identified on the basis of their habitat, microclimate preference and dominance.

**Need of lichenological studies in the area:**

Lichens are omnipresent plants except in extremely dry and high polluted areas. The central Indian region presents a peculiar type of climatic conditions resulting in a unique lichen flora. It is a meeting place of the Himalayan and South Indian elements together with elements migrated form the eastern region of India. Such a unique habitat was not still attracted the attention of the lichenologist of the country so far.

The information available on lichens of most of the districts belonging to Vindhyanchal range is meager and quite insufficient. Thus there is a lot of scope for supplementing substantial

knowledge about the lichens of this area. The present proposal in meant to fill at least some part of the wide gap in the knowledge of lichen species occurring in various parts of Rewa and adjacent areas of Vindhyanchal for assessment of the key type species of lichens to know the status of the environmental conditions of the area and also to make a complete assasment of the status of lichen diversity of the state.

**Main objectives:**

1. Survey, collection and identification of lichens in Rewa and adjacent districts.
2. To study the distribution of different growth forms of lichens growing on diverse substrates (rocks, trees, decaying wood and soil).
3. To list few sensitive/tolerant indicator species of lichens and their ecology.
4. Assessment of the status of different taxa via adopting ecological parameters (diversity, abundance and cover) and also to record the endemic and threatened species under IUCN categories.
5. To mark the different “Lichen rich" and Lichen poor" sites of lichens in the study area.

   To publish a field guide of lichens of that area for use of naturalist and tourists.

## Findings:

### A. Appointment of Research Staff:

Two Research Scholars as Project Assistant Mr. Satish Mohabe and Mr. Gaurav Mishra were appointed under the project w.e.f. 14 Jan. 2009.

## B. Material and methods:

### 1. First field survey and collection:

During 16-22 Feb. 2009 and 02-10 Dec. 2009 two field trips were organized for collection of lichens in the Rewa, Katni, Panna district and Van Vihar area of Bhopal city Madhya Pradesh. More than 750 specimens of lichens were collected from 57 localities of Rewa and Katni and 37 sites of Satna and Panna districts. Raipur, Gurh, Mauganj, Hanumana, Toenther, Sirmaur, Rewa H.Q. , Govindgarh, Chuiya ghati, Kyoti fall, Sitlaha, Chachai fall and Bardhaghati localities were the major localites of Rewa districts explored for collection of lichens. While 25 localities with Bahoriband, Dhimarkheda and Vijayrahavagarh of Katni district were explored for collection.

Under Satna district 19 localities of Majhgawan, Nagod and Maihar area wre explored for lichen collection, while 18 localities Shahnagar, Repura, Pandavfall and Ajaygarh as the major localities of Panna district were surveyed for collection.

### 2. Identification:

The lichens were collected from all the available substrates. The epiphytic lichens on trees were collected from base to the chest height. The saxicolous (rock inhabiting) lichens were collected from rock substrates along with a small piece of the substratum with the help of a hammer and chisel. The collected specimens after their proper drying and labeling were investigated morphologically, anatomically and chemically. The colour spot tests were performed with the usual reagents of K (5% Potassium hydroxide), C (Aqueous solution of Calcium hypochlorite) and PD (paraphenylene diamine). Lichen substances were investigated with thin layer chromatography (TLC) in solvent A (180 toluene: 60 dioxane: 8 acetic acid), using the technique of Walker and James (1980). All the families, genera and species are

arranged alphabetically together with their substrates and place of collected. The identified specimens are preserved in herbarium of National Botanical Research Institute (LWG).

Both Rewa and Katni districts exhibit luxuriant growth of some lichen taxa growing mostly on *Mangifera indica* trees. Other trees such as *Acacia nelotica*, *Zizyphus, Phyllanthus, Schleiretera*, *Azadirechta*, *Syzygium, Ficus*, *Pongamia pinnata* and, *Bachanania* also bear poor to scarce growth of lichens.

**Result and discussion:**

**1. Lichen diversity of Van Vihar Bhopal:**

Bhopal District is a district of Madhya Pradesh state in central India. Bhopal has an average elevation of 499 metres (1637 ft). Bhopal is located in the central part of India, and is just north of the upper limit of the Vindhya mountain ranges. Bhopal city is known as "city of lake" on the basis of there local lakes (Upper lake, Lower lake, Shahpura lake and Manisha lake). The city of Bhopal lies in the southern part of the district and as its landscape is dotted with a number of natural lakes. Bhopal is also one of the greenest cities of India. Bhopal has a humid subtropical climate, with mild, dry winters, a hot summer and a humid monsoon season. The Van Vihar National Park is a national park situated beside the Upper Lake. Some trees like as *Zizyphus mauritiana*, *Cassia fistula*, *Pongamia pinnata* and exposed siliceous rocks exhibit lichen diversity in this area. Van Vihar area has represnted by 10 species of lichens belonging to 9 genera and 11 families. Four growth forms of lichens (leprose, crustose, squamulose and foliose) represented by 1, 1, 4 and 4 species respectively.

the lichen family Pamaliaceae, Physciaceae, Caliciaceae, Ramalinaceae, Lecanoraceae, Peltulaceae, and Sterecaulaceae are recorded, which are belonging to *Parmotrema praesorediosum*, *Hyperphyscia adglutinata*, *Pyxine cocoes*, *Bacidia inundata*, *Lecanora perplexa*, *Lecanora tropica*,

*Peltula euploca* species, *Lecania and Lepraria* genera. Similar number of 5 and 5 species recorded on trees and exposed rocks.

**Lichen diversity in Rewa district:**

Rewa lies between 24˚ 18′ and 25˚ 17′ N latitudes and 81˚ 20′ and 82˚ 18′ E longitudes in the north-east of the state of Madhya Pradesh is basically a plateau with dissected hills, ravines, plain plateau, scarp and waterfalls. Rewa district alone exhibit the occurrence of 30 species of lichens, belonging to 19 genera and 11 families. Both the trees and rocks bear almost similar number of lichens species represented by 17 saxicolous and 13 corticolous species. Among the different growth forms, species with squamulose thallus dominate the area with 12 species belonging to the lichen genera such as *Caloplaca, Endocarpon, Phylliscum* and *Peltula.* The *Mangifera indica* tree exhibit luxuriant growth of corticolous foliose and crustose lichens such as *Pyxine cocoes, Pheophyscia hispidula* and *Lecanora achroa* and *Petusaria leioplaca*. The exposed silicious rocks in open areas bear luxuriant growth of the species of *Peltula euploca* and *Caloplaca tropica.*

**2. Lichen diversity in Katni district**

Katni is located in central part of Madhya Pradesh. The district extends from 23˚ 3′ N to 20˚ 80′ N and from 79˚ 57′ E to 80˚ 58′ E at altitude of 392 m. The shape of this district is roughly oval and is also known as the "City of lime". The Bahoriband, Dhimarkheda, Saleemanabad and Vijayraghavrgarh area of the district exhibit good forest variation of deciduous trees.

As compared to Rewa, the Katni district showed more diversity of lichens represented by 36 species belonging to 22 genera and 11 families. Similar to Rewa district the *Mangifera indica* trees in Katni also bear luxuriant growth of *Pyxine cocoes, Lecanora achroa, Phaeophyscia hispidula,*and *Pertusaria leucostoma*. The exposed siliceous rocks in the open area bear luxuriant

growth of squamulose lichen species such as *Peltula euploca, Caloplca* sp., *Endocarpon sp, Dimalena thysonata, Phylliscum indicum* and *Verrucaria elaeomelaena. Parmotrema praesorediosum,* a foliose lichen exhibit its dominance both on bark of *Mangifera indica* and siliceous rocks in moist places.

**3. Lichen rich sites:**

Among the 57 sites surveyed for collection of lichens in both the districts, Govindgarh, Chhuiyaghati, Khamariya, Sirmaur kyotifall, Bardhahaghati and Mauganj are the lichen rich sites in Rewa district. In Katni district, Dhimarkheda, Bahoriband, Khamtara forest area, Geruha river area and Barhi exhibit rich diversity of lichens.

The identification of all the specimens collected reveals the occurrence of 46 species of lichens belonging to 22 genera and 12 families from Rewa and Katni districts, of which 28 species are common in both the district. Rewa district alone exhibit the occurrence of 30 species of lichens, belonging to 19 genera and 11 families. Both the trees and rocks bear almost similar number of lichens species represented by 17 saxicolous and 13 corticolous species. *Pyxine cocoes*, a common tropical, foliose lichen was recorded growing both on Mango and other trees and rocks. The squamulose growth form of lichens dominates the rocky areas. Other species of squamulose lichen genera *Caloplaca*, *Dimelaena*, *Endocarpon*, *Peltula*, and *Phylliscum* also grow luxuriantly on exposed siliceous and sandstone rock.

The *Mangifera indica* trees in dense, moist shady mango orchard exhibit luxuriant growth of the members of lichen family Physciaceae such as *Pyxine cocoes*, *Phaeophyscia hispidula*, *Hyperphyscia adglutinata* and *Rinodina sophodes*. Among the rock inhabiting saxicolous lichens, the squamulose species such as *Caloplaca tropica*, and *Peltula euploca* exhibit their

luxuriant growth on exposed rocks. As compared to Rewa, the Katni district showed more diversity of lichens represented by 44 species belonging to 21 genera and 12 families.

Similar to Rewa district the *Mangifera indica* trees in Katni also bear luxuriant growth of *Pyxine cocoes*, *Lecanora achroa*, *Phaeophyscia hispidula*, and *Pertusaria leucostoma* species. The exposed siliceous rocks in the open area also bear luxuriant growth of *Peltula euploca*, *Caloplaca tropica*. *Dimalena tenuis, Physlliscum indicum* and *Verrucaria elaeomelaena*.

*Parmotrema praesorediosum,* a foliose Parmelioid lichen exhibit its occurrence both on bark of *Mangifera indica* and siliceous rocks in moist place. Among the 35 sites surveyed for collection of lichens Govindgarh, Gurh, Sirmaur, Kyotifalls, Sohagiparwat, Raghunathganj Raipur, and Mauganj are the lichen rich sites in Rewa, while Bahoriband, Barhi, Dhimarkheda, Khitauli, Kua forest, Saleemanabad, and Singori exhibit rich diversity of lichens in Katni district. In both the districts *Mangifera indica* exhibit luxuriant growth of both the crustose and foliose lichens. Other trees such as *Acacia nelotica Azadiracta indica*, *Bachanania lanzan*, *Ficus* sp, *Zizyphus* sp, *Phyllanthus embelica*, *Schleiretera oliosa*, *Syzygium cuminii* and *Pongamia pinnata* exhibit poor to scarce growth of lichens.

So far, not a single record of lichen from the Rewa and Katni district of Madhya Pradesh were available. The present study added 15 lichen taxa in the lichen flora of Madhya Pradesh earlier recorded by Upreti et al (2005). The present lichen distributional data on lichens of both the districts will act as a base line recorded for conducting future environmental studies in the area.

**5. Lichens diversity of Satna district**

Satna district lying in the north eastern part of Madhya Pradesh, the district is located between 23º58' to 25º12' north latitude and 80º21' to 81º23' east longitude. Satna district lies on

Vindhyan Plateau, has four ranges such as with an average altitude of 1000' to 11000'. The district has mixed forests over an area Satna, Majhgawan, Nagod and Maihar of 900 square miles.

A total of 19 localities of the Satna district were explored for collection of lichens. The identification of all the specimens recorded the occurrence of 33 species of lichens belonging to 18 genera and 11 families. The districts showed maximum diversity of lichens represented by 20 corticolous and 13 saxicolous species. On the basis of growth form of lichens, district showed dominance of crustose and squmulose lichens represented by 14 and 12 species respectively. Only 7 species of foliose lichen are known from the area. The crustose lichen genera *Lecanora* and *Pertusaria* showed their maximum diversity on *Mangifera indica* trees and other trees. Squamulose lichen genera as *Caloplaca* and *Peltula* grow luxuriantly on exposed siliceous rocks. The Ramnagarghati and Jaryari village area of the district showed maximum diversity of lichens represented by 9 and 8 species respectively. *Rinodina sophodes* a crustose lichens showed maximum dominans on the trees of *Mangifera indica* and *Acacia nilotica* while *Lecanora tropica* grow luxuriantly on the bark of *Mangifera indica*, *Feronia elephantum* (Kaitha), *Zyziphus nummularia* (Mukuiya), *Diospyros Melanoxylon* (Tendu) and *Zizyphus mauritiana* (Ber) trees.

**Lichens diversity of Panna district:-**

Panna district is located in the north-eastern part of Madhya Pradesh. The district extends from 23°45' N to 25°10' N and from 79°45' E to 80°40' E. The shape of district is roughly triangular. Panna is famous for its diamond mines located in a belt of about 80 kms across the town. Panna is picturesque place lying strategically in a valley amidst forest covered by lofty hills. The district has scattered patchy forest of evergreen trees.

Identification of lichens collected 16 localities of the Panna district revealed the occurrence of 31species belonging to 18 genera and 10 families. The district showed maximum diversity of lichens represented by 17 corticolous and 14 saxicolous lichens. The crustose and squamulouse forms dominate the district represented by 11 species each, while, foliose and leprose lichens are represented by 6 and 1 species only. *Mangifera indica, Acacia nilotica, Cassia fistula* (Amaltas), and *Saraca indica* (Ashok) exhibit the luxuriant growth of crustose lichen *Rinodina sophodes* and *Lecanora tropica*. Members of crustose and squamulose lichen genera *Caloplaca* and *Peltula* showed dominance on exposed siliceous rocks of the area. Among the different localities, the Shahnagar area exhibit the luxuriant growth of lichens represented with 7 species only.

The Satna and Panna district showed occurrence of 43 species of lichens belonging to 21 genera and 12 families. 20 species are common in both the district out of the total 43 species known from the district 23 species are corticolous and 21 are saxicolous. The crustose growth form of lichens dominante the trees and squamulose growth form dominates the open exposed rocks. Some of the crustose lichen genera *Bacidia, Buellia, Staurothele, Varrucaria*, and *Leprocollema* also grow luxuriantly on exposed siliceous and marvel stone rocks.

The *Mangifera indica, Phoenix sylvestris, Acacia nilotica, Ficus bengalensis, Beutea monosperma, syzygium cumini, Cassia fistula, Polyalthia* and *Zyziphus nummularia* tress support luxuriant growth of crustose and foliose lichen species in both the district.

The *Mangifera indica* trees in dense, moist shady mango orchard exhibit luxuriant growth of the members of lichens family Physciaceae such as *Rinodina sophodes*, *Pyxine cocoes*, *Phaeophyscia hispidula* and *Hyperphyscia adglutinata*. Among the rock inhibiting saxicolous lichen, the squamulose species *Caloplaca cupulifera* and *Peltula euploca,* exhibit their luxuriant growth on exposed rocks. As compared to Panna the Satna district showed more diversity of lichens due to the presence of more dense mixed forest vegetation *Mangifera indica* is the best host tree for colonization of the lichens as compare to the other trees of the districts,

Similar to Rewa and Katni *Parmotrema praesorediosum* a foliose parmelioid lichen also exhibit its occurrence both on bark of *Mangifera indica, Syzyzium cumini* and siliceous rocks in moist places.

Among the 37 sites surveyed for collection of lichens the Ramnagarghati and Amanganj Chitrakut, Birshinghpurand Unchehra are the lichen rich sites of Satna while, Shahnagar, Repura, Pandavfall and Ajaygarh are the lichen sites of Panna district.

It is interesting to note that the Satna district shows occurrence of *Xanthoparmelia pseudocongensis* a rock inhibiting foliose lichen which has a restricted distribution in Madhya Pradesh and Rajasthan. The presence of this species indicates an undisturbed, healthy, condition of habitat tree from anthropogenic and cattle grazing activities.

**Determination of atmospheric heavy metal pollution using two lichen species in Katni and Rewa cites:**

A biomonitoring study was conducted to assess the levels of atmospheric heavy metal pollution in Katni and Rewa cities of Madhya Pradesh, state in central India. The *Pyxine cocoes* and *Phaeophyscia hispidula*, two epiphytic foliose lichen were used as bioindicators in the present study and seven metals (As, Al, Cd, Cr, Fe, Zn, Pb) were analyzed in naturally growing thallus. The concentrations of these metals was observed to be in higher range as maximum values of Al, Cd, Cr, and Zn were reported from the lichen samples from Rewa city which was 561.8±2.4, 6.8±0.8, 35.2±1.4, 214.6±2.0 µg $g^{-1}$ dry weight respectively. Whereas As, Fe and Pb were reported maximum in the lichen samples collected from Katni city areas with 33.4±0.05, 689.4±2.6, 13.3±0.5 µg $g^{-1}$ dry weight respectively. However the accumulation of Cd and Pb from both the cities are more or less similar in concentration. The selectivity sequence of metals were Fe>Al>Zn>As>Cr>Pb>Cd in Katni city, and Al>Fe>Zn>Cr>As>Pb>Cd in Rewa city. The findings of this study indicates that extent of heavy metal pollution in the atmosphere of the two cities which may lead to adverse health affects.

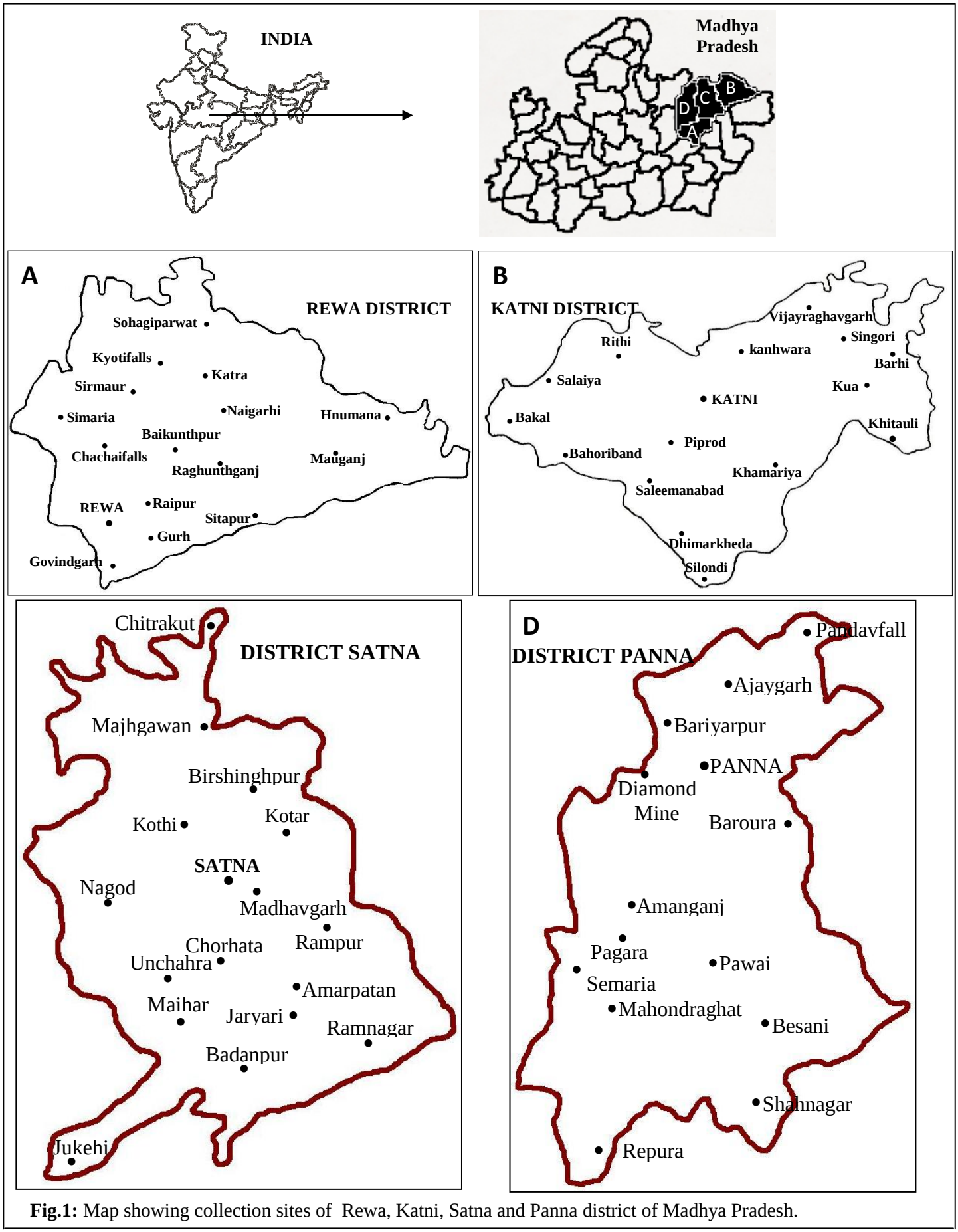


**Fig.1:** Map showing collection sites of Rewa, Katni, Satna and Panna district of Madhya Pradesh.

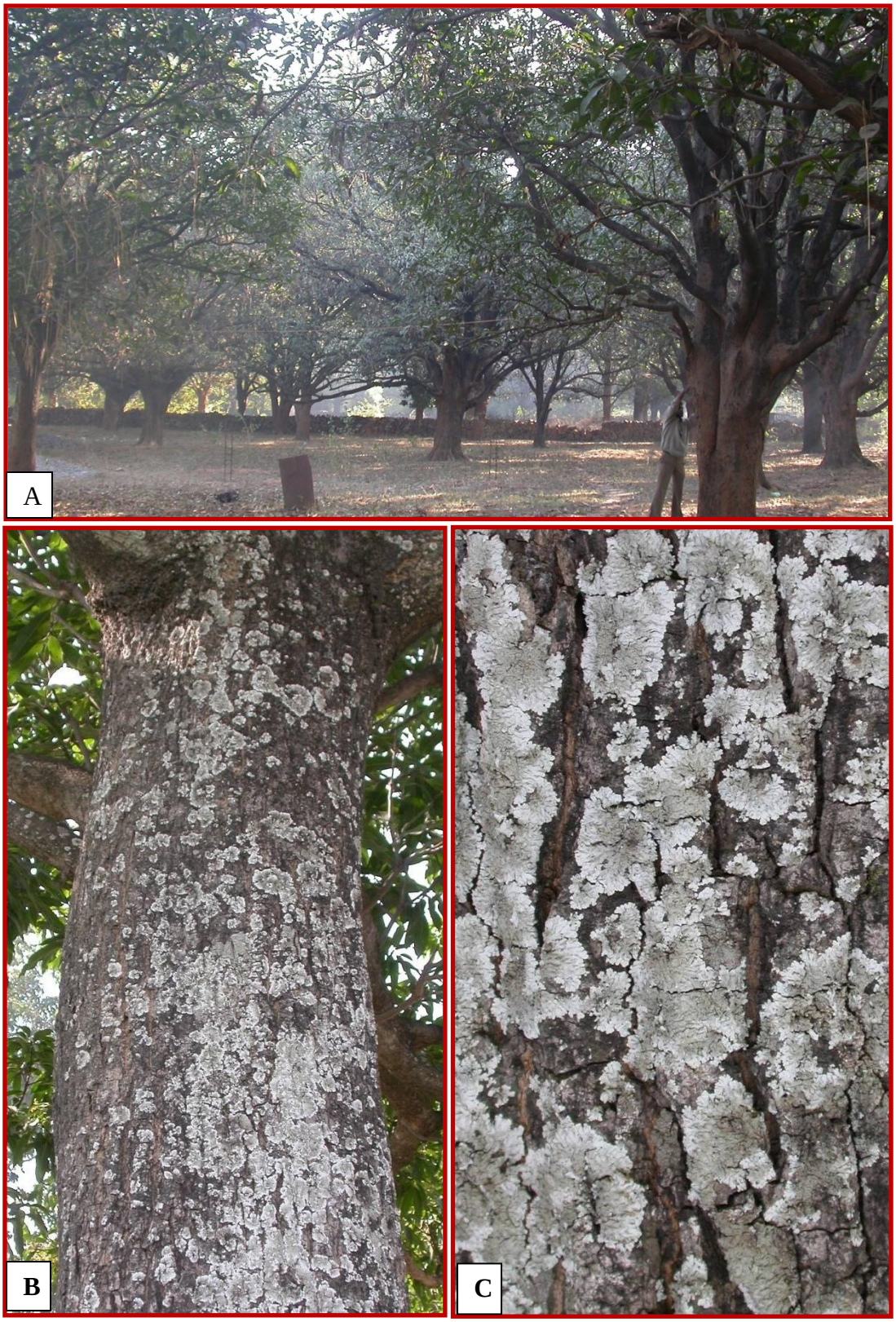


**Plate 2.** *Mangifera indica* orchard in Rewa and Katni district- Rich habitat for epiphytic lichens **B.** *Pyxine cocoes* (Sw.) Nyl. growth on *Mangifera* tree trunk. **C.** *Pyxine cocoes* (Sw.) Nyl.

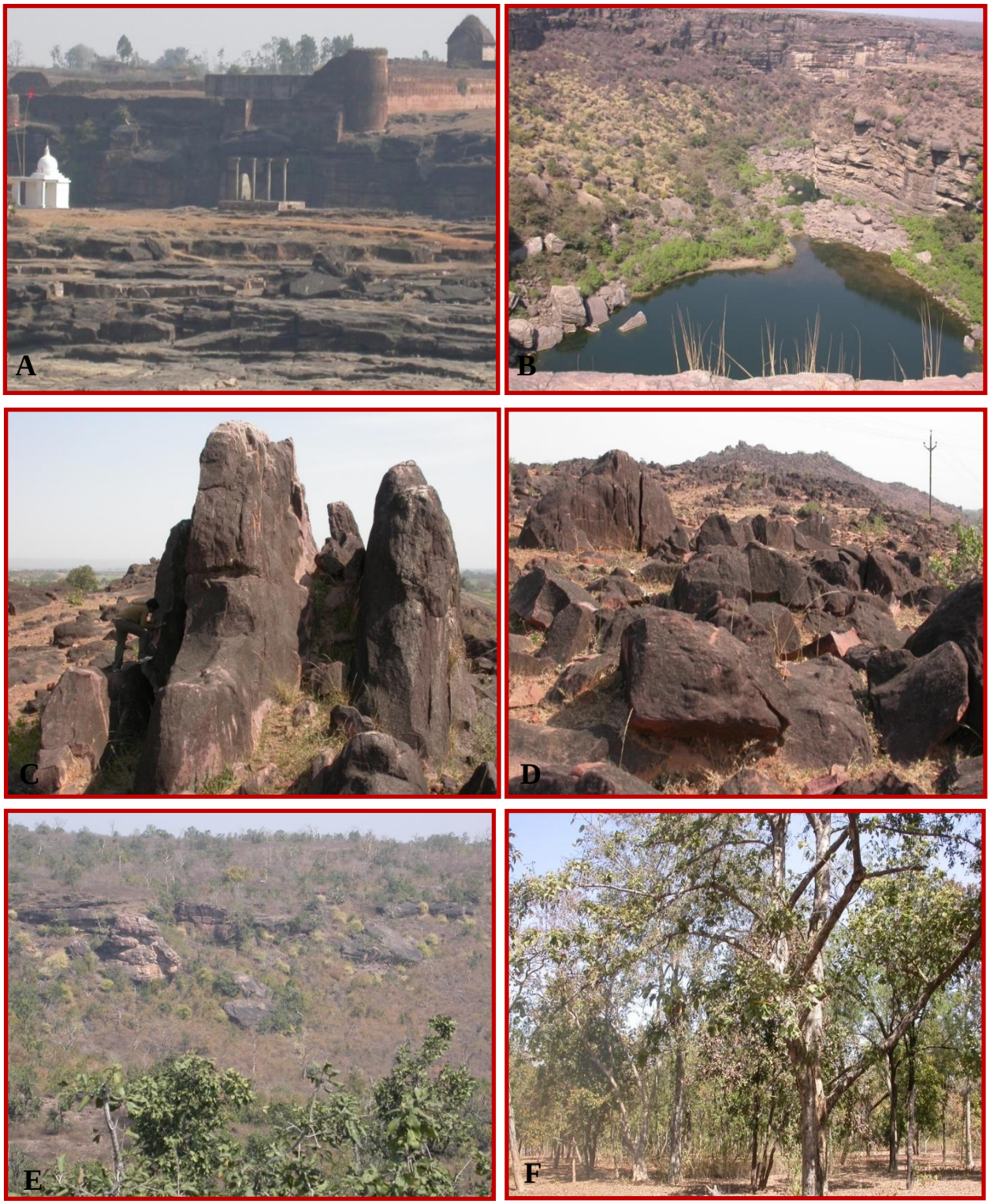


**Plate 3. Lichen rich site for saxicolous lichens in Rewa and Katni district**
**A**.Chahai falls B**.** Kyoti falls **C.** Bahoriband **D.** Dhimarkheda. **E**. Bardhaha ghati
**F**. Kua forest


**Plate 5: A & B –** Open forest of mango and lichen growing on mango tree twigs,
**C** – *Caloplaca bassiae*, **D** – *Pyxine cocoes* on Khajur tree trunk,
**E** – *Hyperphyscia adglutinata* on mango tree trunk,
**F** - *Peltula euploca* on marvel stone.

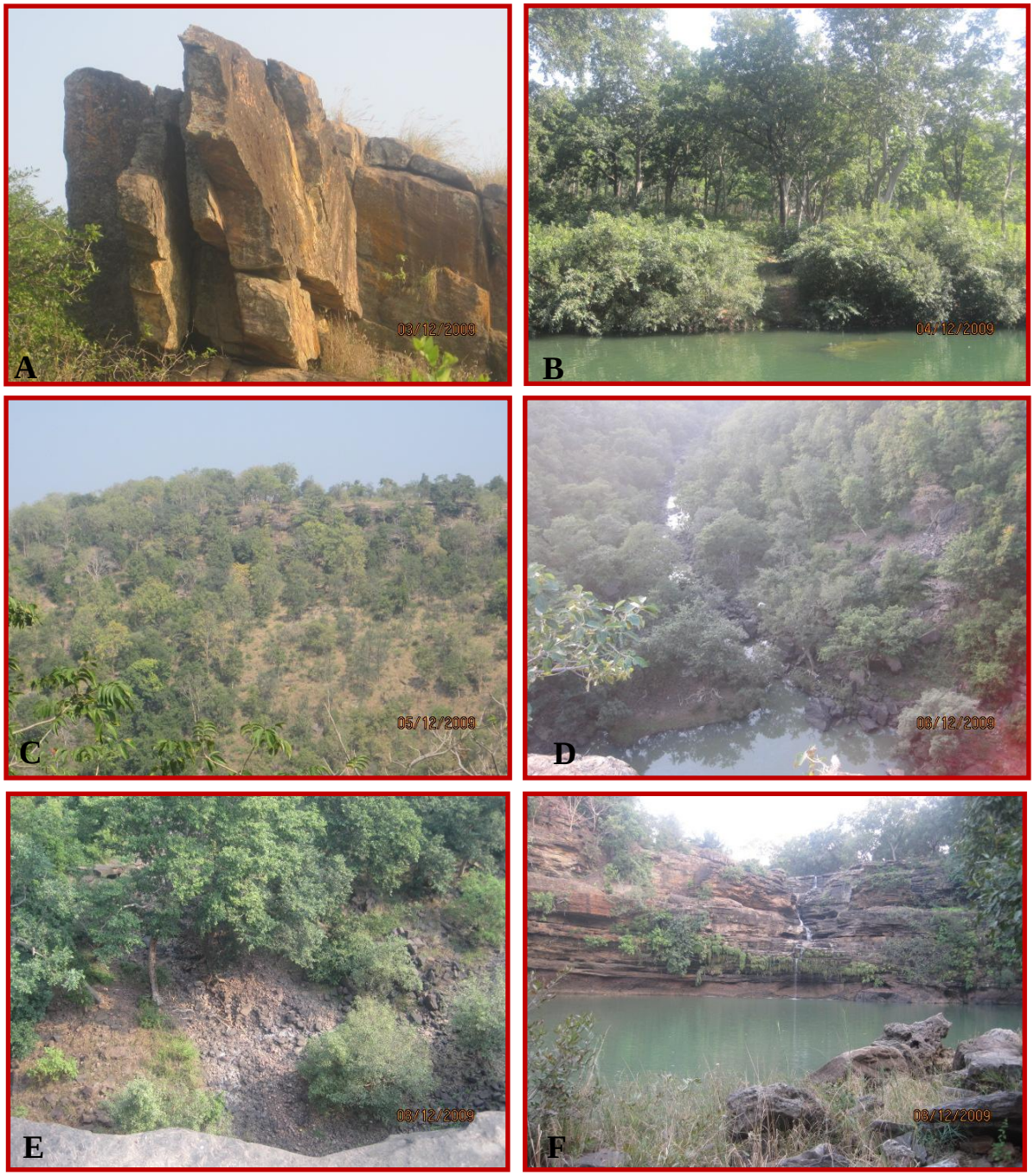


**Plate 6:** Lichen rich sites of Satna and Panna: **A-** Ramnagarghati, **B** – Chitrakut dense forest, **C** – Chitrakut open forest, **D** – Badorsiha diamond mine, **E** – Shah baba siha, **F** – Pandav Fall

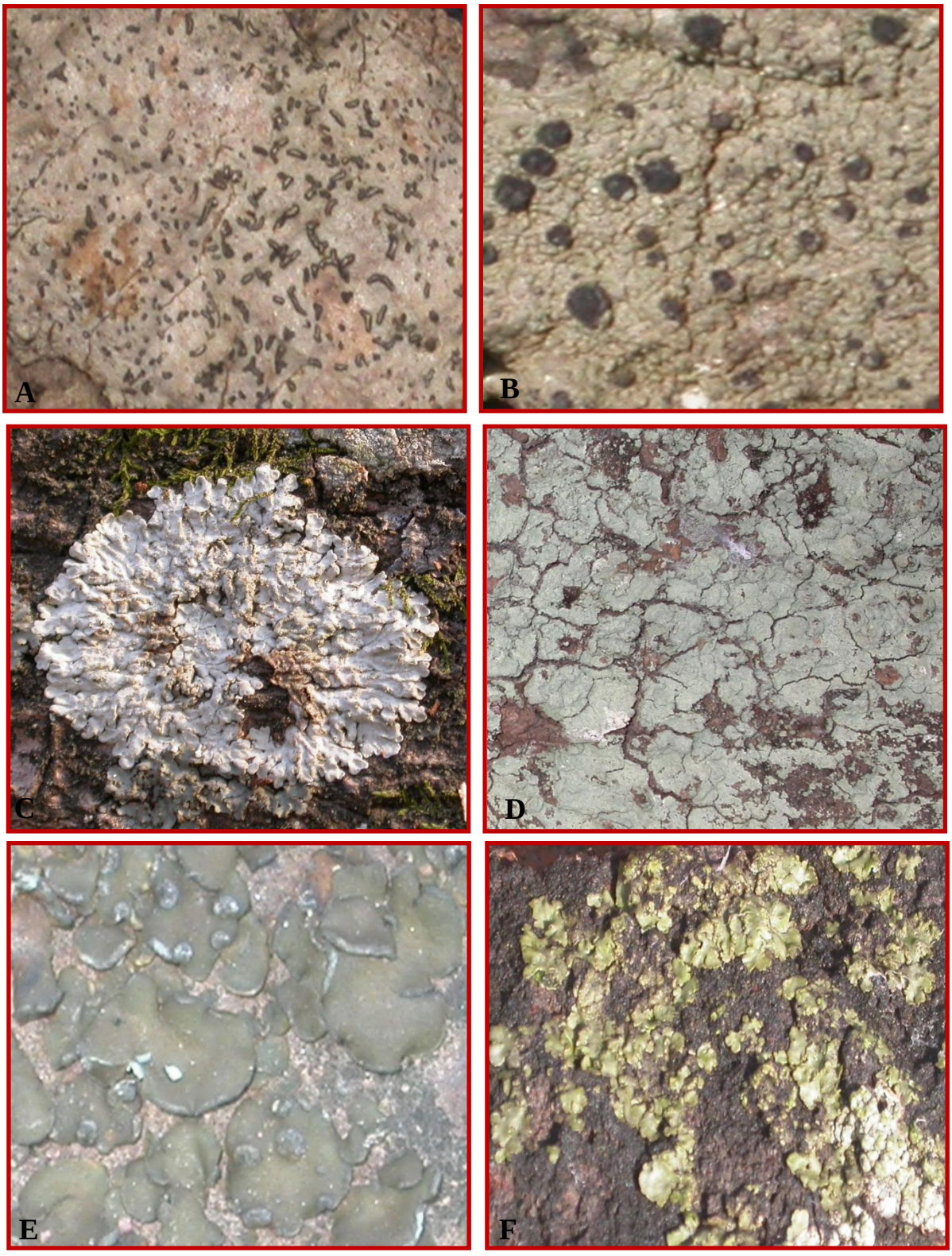


**Plate 7. A**.*Graphis* **B**. *Rinodina sophodes* (Ach.) Massal. **C.** *Pyxine cocous* (Sw.) Nyl. **D.** *Lepraria lobificans* Nyl. **E.** *Peltula euploca* (Ach.) Poelt **F.** *Hyperphycia adglutinata* (Flk.) Mayerh. & Poelt


**Plate 8. A.** *Caloplaca cupulifera* (Vainio) Zahlbr. **B.** *Calopalaca cinnabarina* (Ach.) Zahlbr, **C.** *Dimelaena thysonata* **D.** *Lecanora achroa* (Nyl), **E.** *Dirinaria applanata* (Fee)D.D. Awasthi (Nyl.) Gyeln **F.** *Parmotrema prasorediosum* (Nyl.)Hale