intraspecific genetic variability of *Argemone*[28], *Coriandrum sativum*[29], *Mangifera indica*[30] and *Cissus quadrangularis*[31] has been studied. However, earlier studies on inter- and intra-specific diversity were based on locality characteristics, e.g. area, geographical isolation or environmental heterogeneity[32].

The morphovariants in plants such as the nature of tomentum (less or dense), lamina lobes (number, deep or shallow), presence or absence of serration (single or double), and flower and fruit colours need to be studied with respect to temperature, rainfall, humidity, altitude, latitude and longitude across different geographical regions. In addition, phytochemical, pharmacognostic and genetic studies at molecular level need to be significantly correlated with edaphic, climatic and biotic factors. By advanced tools and techniques, the morphovariant of *A. precatorius*, viz. two shades of flower and nine different shades of seed coat needs to be verified at genetic or molecular level. Unless, if it has not been proved the statement 'the survival of individuals and populations are fundamental for all the species and an important aspect of every ecosystem, the aspect of changing intraspecific diversity on predictability and stability of survival has been over looked to date'[33], will be true.

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Orbicular structures near Pichhore, Shivpuri district, Bundelkhand Craton: forerunner for geoheritage site

Geoheritage sites are places that possess imprints of geological processes in the past with unique and interesting geological features. They generate inevitable interest among geoscientists and common people alike. Since its inception 4600 million years ago, Earth has been evolving to attain its present conditions. During this course of evolution, many places become scientifically important in providing vital links in the form of rocks, minerals, fossils, flora–fauna, various landscapes, etc. Keeping these in mind, it is our responsibility to identify and preserve such scientifically important and aesthetically beautiful sites (such as stratigraphic sections with important rock types, tectonic locations, fossil sites, ancient mining sites, canyons, valleys, deltas, springs, etc.). Effective mechanisms with the help of government agencies should be developed to protect these sites from the effects of mining, excavations, urbanization, real estate activities, industrialization, agriculture and natural degradation. Preserving these sites will also open a new window for our future

Figure 1. Satellite image of the proposed site in Kutawali village, Pichhore Tehsil, Shivpuri district, Madhya Pradesh.

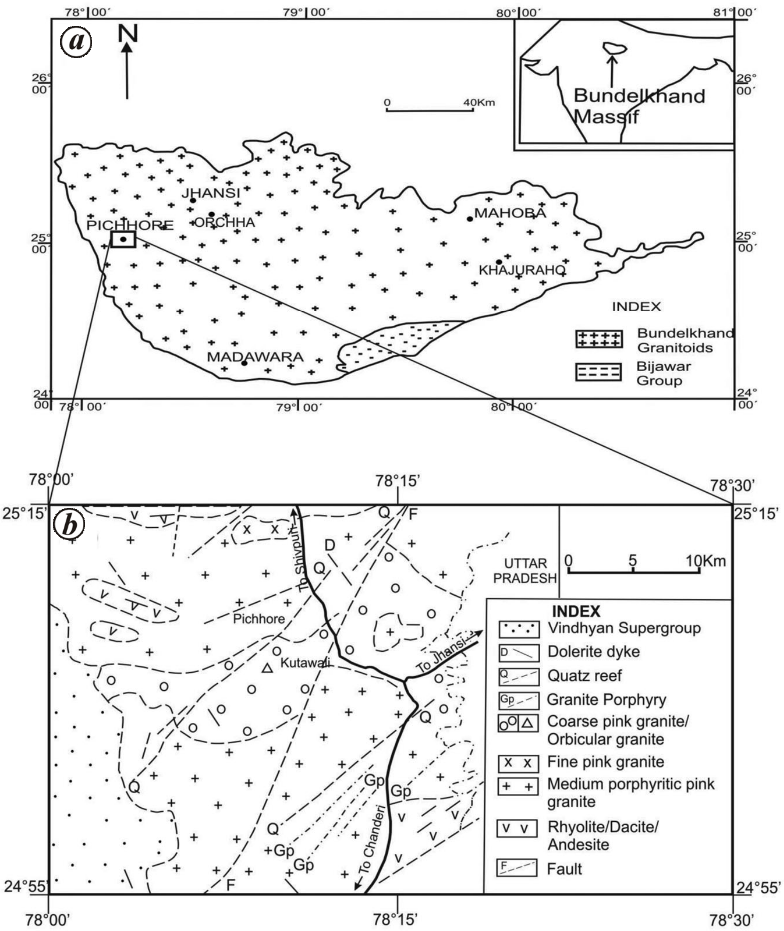

Figure 2. ***a***, Geological map of Bundelkhand craton showing the proposed site: Pichhore along with other tourist sites of the region like Jhansi, Orchha, Khajuraho, Madawara. (Inset) Position of Bundelkhand massif in central India. ***b***, Detailed geological map of the Pichhore area[3].

generations in understanding the mystery of the Earth. After the United Nations millennium declaration of assertion of fundamental value of 'Respect for Nature' in the management of all living species and natural resources, the onus is on the geoscience fraternity to attract the attention of people about the natural processes and products of the Earth. Efforts should be made so that the policy makers understand the worth of geoheritage and take similar actions like in the case of wildlife sciences and historical/archaeological sites. Many countries have come forward in response to growing public awareness for the conservation of geological and geographical features. In this backdrop, the world community has already started working by illustrating methods of site conservation and declaring a particular site as geoheritage site.

India lags far behind when geoheritage issues are concerned. Awareness and significance of geoheritage issues assume negligible priority in the minds of public and the decision-makers as well. The threat to geoheritage sites is growing commensurately with the rapid growth of urbanization, industrialization, mining, excavations, agriculture and physical degradation. These sites demand proper observation, care and preservation; otherwise we will lose these treasure soon. In an effort to conserve such places, the Geological Survey of India has already declared many sites as Earth heritage sites and national geological monuments. However, much needs to be done in order to have our presence felt in the international organizations in this regard. Therefore, it is warranted that India, keeping pace with the international practices and standards, devices a systematic and objective-oriented system to recognize and protect its important natural heritages and sites of geological importance.

This correspondence is an effort to draw the attention of the concerned authorities towards one such site from Bundelkhand Granitoid Complex, which bears excellent example of orbicular structures in the granitoids. The site is located SSW of Kutawali village (25°07.274′N, 78°09.897′E) in Pichhore Tehsil, Shivpuri district, Madhya Pradesh. The proposed site in Kutawali village is well connected by roads, and is surrounded by agricultural land as can be observed in the satellite image (Figure 1). The position of Pichhore (Tehsil) along with other places of major tourist attraction like Jhansi, Orchha, Khajuraho, Mahoba, Madawara, etc. is shown in Figure 2 *a*. The proposed site is around 6 km from Pichhore (Figure 2 *b*) and Jhansi is the nearest major city. Pichhore is about 66 km from Jhansi and the site can be approached by car/jeep in both summer (March–June) and winter (October–February). The area receives heavy rainfall (average precipitation up to 310 mm) during monsoon season (July–September). The unmetalled roads during rainy season may make accessibility difficult.

The Bundelkhand Granitoid Complex mostly comprises of granitoids and gneisses broadly divided into two assemblages – (i) older basement assemblages, and (ii) younger intrusive assemblages. The older basement assemblage includes the highly deformed, medium-grade tonalite trondjhemite granodiorite gneisses (3.3–2.7 Ga) and the relatively low-grade volcano-sedimentary sequences. The younger intrusive phases of granitoids, widely known as Bundelkhand granitoids (2.5 Ga), are undeformed in nature[1]. These are divided as hornblende granitoids, biotite granitoids and leucogranitoids in the order of age[2]. The granitoids which constitute the main body of the batholith in Pichhore area are medium-grained porphyritic biotite granitoids. The outcrop which bears the well-rounded orbicular structures is an intrusive, elliptical, medium to coarse-grained, pink to grey porphyritic granitoid about 30 m × 40 m in dimension and lies in the midst of a farming field (Figure 1). The orbicules, both single- and multi-shelled with circular rims of biotite at their margins, are mostly up to 20–25 cm in diameter (Figure 3 *a* and *b*). On an average, 70% of the outcrop is covered with the orbicules and the rest 30% is covered with the aplitic groundmass. The principal mineral constituents of the orbicules are quartz, *K*-feldspar, plagioclase along with subordinate amount of biotite and hornblende. The composition of the granitoids falls in the quartz monzonite to granodiorite field. Occurrence of orbicular structure in Bundelkhand massif has been reported earlier[3,4]. Pati and Mamgain[4] reported orbicular structures from Rauli–Kalyanpur area, Banda district, Uttar Pradesh. The orbicules of Pichhore are analogous to their counterpart in Rauli–Kalyanpur area, except that the orbicules of Pichhore are larger in shape.

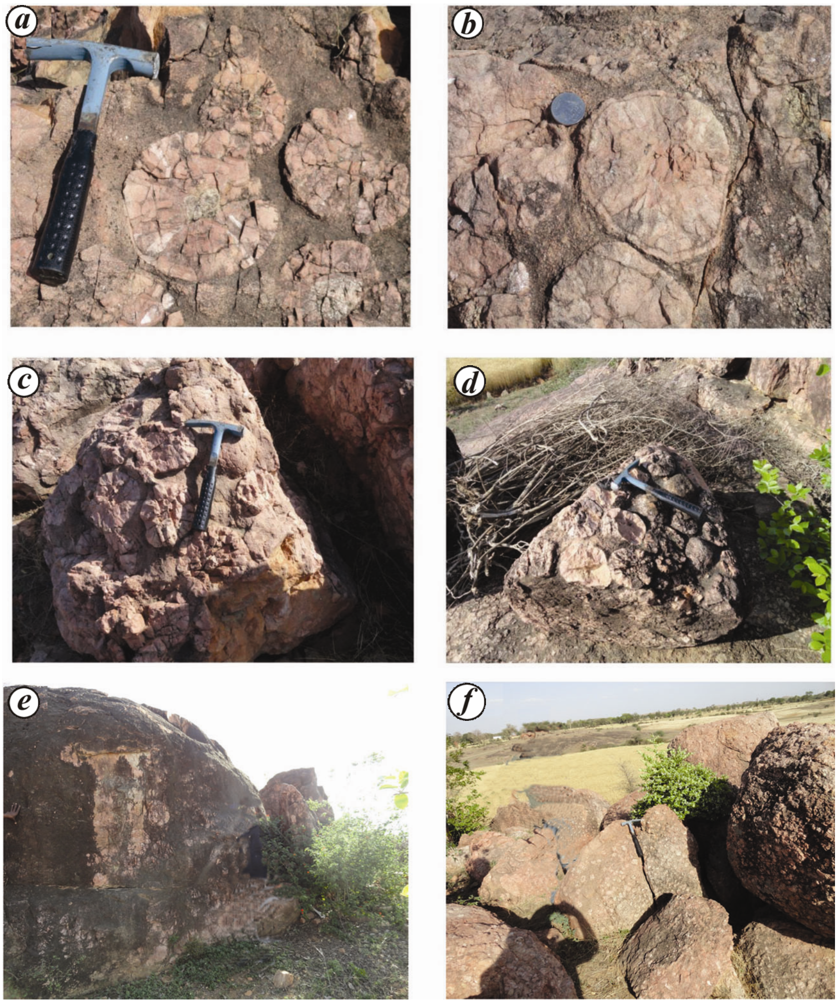

Figure 3. ***a***, Multi-shelled orbicules without core. ***b***, Single-shelled orbicule with a rim of biotite at the margin. ***c***, Cluster of orbicules in the shape of 'lochai' (name given by the local people to the circular shape). ***d–f***, Orbicule outcrops disturbed by physical processes and human activities.

Several possible mechanisms for the formation of orbicular structures in granite, including magma mixing, liquid immiscibilty[5], rhythmic supersaturation with crystallization around particular centres in magma[6], and rhythmic precipitation during granitization[7] have been debated throughout the world. Our field observations indicate that the orbicules of Pichhore might have possibly formed by the incorporation of hydrous mafic magmatic enclaves into medium-grained, grey granites in superheating conditions. Geologically speaking, this proposed site provides ample evidence of magma mixing conditions and certainly is a key factor in understanding the crust-forming processes of the complex Bundelkhand terrain. The presence of orbicular structures in granitoids is not common in this part of the Indian shield. However, a number of cases have been reported earlier from the Dharwar craton, southern India[8–10].

The proposed site is capable of grabbing the attention of local people as the beautiful, circular flower-like designs on the rocks are an uncommon visual treat. The orbicular structures of Pichhore are also given the name of 'lochaitorai' by local people, indicating hillock ('torai') containing circular objects ('lochai') (Figure 3 *c*). The place can become a famous tourist spot in the Bundelkhand region, which consists of several historical and cultural places. Thus it will also help in bringing revenue for the government, and job opportunities to the local people of the area.

At present, the proposed site is not looked after by any government or private agencies. Possible threats of damage to the site come from the local people themselves (Figure 3 *d–f*) because the site lies in the middle of an agricultural farmland (Figure 1). Also, the site is on the verge of destruction. Villagers use this site for grazing of their cattle and thus are destroying the eye-pleasing structures. However, proper preservation will help conserve this as a geoheritage site. It is proposed that concerned authorities declare this as a 'geoheritage' site for academicians, professionals and tourists. Time has come that we realize its importance and sustain our heritage of geological significance.

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Acid mine drainage, a potential threat to fish fauna of Simsang River, Meghalaya

Acid mine drainage (AMD) is formed when water and air come in contact with pyrite (FeS_2) present in coal and exposed rocks, to form sulphuric acid. The process of pyrite oxidation further leads to the formation of Fe^{3+} and some or all of this Fe^{3+} precipitates to cause red, orange or yellowish colour of the water. The Fe^{3+} precipitate also deposits at the bottom of the stream[1] to give black or orange coloured bed. Moreover, AMD is known to contain high levels of heavy metals, such as cobalt, aluminium, copper, nickel, manganese and lead[2]. Therefore, exposure of fishes to extremely low pH (pH $\leq$ 4.0) and heavy metal causes mass fish kill, and eventually loss of fish biodiversity[3].

The coal deposits in Meghalaya, India along the southern fringe of Shillong plateau are distributed in Khasi, Garo and Jaintia hills[4]. Among these, the East Garo Hill region is a major producer of coal, and coal excavation is commonly done by primitive mining method known as 'rat-hole' mining[4].

In the present study, it has been observed that more than 100 km stretches of the Simsang River are severely affected due to coal mining (Figures 1 and 2). The Simsang River, while passing through Nongal Bibra, a small town in the East Garo Hill, receives a large amount of AMD. This river was once well known for its abundant fish faunal diversity, which has gradually declined over the years due to indiscriminate coal mining (estimated coal reserve is 359 million tonnes)[5]. The primary cause of degradation of water quality and decline in fish biodiversity in the water bodies of the mining area is attributed to AMD[6] that makes the water highly acidic and rich in heavy metal concentration. This 'acid flow' has altered the physico-chemical parameters of the environment, adversely affecting the health of rivers and streams. Many AMD-impacted water bodies have pH < 4, with high sulphur and as aluminium and iron contamination[7]. The contaminated water can be toxic to aquatic organisms except a few tolerant organisms. At low pH, the fish die due to acidaemia and toxicity of metals, especially aluminium that has been implicated as the primary toxicant[8]. Fish generally do not inhabit waters severely polluted by coal-mine drainage, because in the waters with pH < 4.2 CO_2 is present in its free form. Without buffering capacity from carbonates and bicarbonates, many aquatic animals would die due to acute acidaemia. Additional sources of toxicity of this water are the sulphate and salts of aluminium and iron. Recruitment failure is also a commonly reported cause of fish population decline associated with acidification[9].

In the present study, four sampling sites (William Nagar, Nongal Bibra, Siju and Baghmora) were selected in relation to drainage from upstream to downstream along the Simsang River, which flows to the south (Figure 2). William Nagar, situated upstream, is away from the coal-mining areas. But coal excavation is carried out adjacent to the river bank at Nongal Bibra and Siju. Though coal excavation is not carried out near the river bank at Bagmora downstream, it is one of the AMD receiving points, including Nongal Bibra and Siju along the Simsang River. Fish sampling was carried out 48 times (12 times at each site) at William Nagar (90°39′34″E and 25°28′44″N, 213 m amsl), Nongal Bibra (90°44′39″E and 25°28′22″N, 145 m amsl), Siju (90°45′22″E and 25°23′46″N, 138 m amsl) and Baghmara (90°38′22″E and 25°12′03″N, 20 m amsl). Cast net of similar weight and mesh size was operated 12 times at each sampling site by a single fisherman for 4 h. AMD samples were collected from Nongal Bibra. A total of 24 AMD samples were collected from August 2013 to December 2014. The pH, dissolve oxygen, temperature and conductivity were measured *in situ* using a multiparameter probe (HI