are known to transmit antibiotic resistance genes in the food chain and environment. Therefore, the emergence of this pathogen may cause public health hazards. Further studies to explore detailed genetic features of this isolate are under way.

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Nesting sites of birds and spiders in the semi-arid zone of Rajasthan, India

A plant when present outside its native range is termed as non-native/exotic. Some of these non-native species can outcompete the native species, becoming invasive owing to either phenotypic plasticity, absence of natural predators and pathogens, or the presence of efficient seed dispersal and allelopathic mechanisms[1,2]. Successful eradication of such invasive species is almost impossible and extremely expensive, posing a significant threat to the native biodiversity and community[3,4]. *Prosopis juliflora*, a native plant of Central America, northern South America and the Caribbean islands has invaded several regions throughout the world, including India[5]. According to IUCN 2009 ranking, *P. juliflora* is among the top 100 invasive alien species of the world invading land at a rapid rate[6]. The estimated invasion rate in Ethiopia, and Gujarat, India was 3.48 km^2/year and ~6.19 km^2/year respectively[7,8]. The increased invasion rate was attributed to its high adaptability, germination and dispersal rate[8]. Very few animals graze on the foliage of *P. juliflora* because of its unpalatable leaves and long spines. *P. juliflora* is slowly replacing grassland habitats in Great Rann of Kutch, Gujarat, negatively impacting the livestock population in these areas[7]. *P. juliflora* invaded region has altered soil chemistry[9] and microbiota[10], and reduced the watertable[11] that can further affect the native plant diversity. Within the invaded region *P. juliflora* has impacted indigenous biodiversity and plant communities changing their composition and adversely affecting endangered plant species like *Commiphora wightii* in Jamnagar district, Gujarat[7,12]. *P. juliflora* negatively impacts biodiversity due to its chemical and morphological characteristics[13–17]. In a competition assay, *P. juliflora* outperformed *P. cineraria* in terms of germination, growth rate and drought tolerance[18]. The allelochemicals secreted

by it suppress the growth and germination of many plants, including *Prosopis cineraria*, its congener native to India[9]. In contrast to *P. juliflora*, leaves of *P. cineraria* are palatable. *P. cineraria* acts as a facilitator for other native plants by improving soil quality through the provision of nutrients like nitrogen, phosphorus and potassium[9]. Very little is known about the impact of *P. juliflora* on the fauna outside its native range[5,19–21]. Known faunal associations rely on consumption of flowers and pods[19,22], further aiding the dispersal of seeds. Chandrasekaran *et al.*[20] reported a reduced nesting success of wetland birds on *P. juliflora* in Vettangudi Bird Sanctuary, pertaining to the branching pattern of the plant. The present study evaluates the influence of *P. juliflora–P. pallida* complex (*P. juliflora–P. pallida* com.) on the bird and insect life, through assessment of their nesting preference for *P. juliflora* and *P. cineraria*.

Two main field locations were considered for the study, Pilani (at the intersection of 28°37′ lat. and 75°6′ long.) and Chhapar (at the intersection of 27°42′ lat. and 74°20′ long.), both belonging to semi-arid zone of Rajasthan, India. Multiple field sites in and around the locations not exceeding 3 km radius were surveyed for the presence of *P. cineraria* (Figure 1 *a*) and *P. juliflora* (Figure 1 *b*). Pilani is a town in Jhunjhunu district, Rajasthan. While Chhapar is a sparsely populated village in Churu district, Rajasthan and away from city with minimal human intervention. Tal Chhapar Wildlife Sanctuary, one of the important bird areas from India[23], is located in Chhapar village. Multiple *P. cineraria* and *P. juliflora–P. pallida* com. trees are seen around the village and over 175 bird species have been recorded from the Sanctuary[24].

Morphological characteristics were used to identify the two *Prosopis* species[5]. *P. juliflora* has multiple thorny stems that start forking low on the trunk that is grey–brown, rough, and fibrous with finely fissured bark[25]. *P. juliflora* and *P. pallida* share morphological similarities in terms of flower, pod, leaf and tree form, making it difficult to distinguish them[5]. Naturally occurring hybridization between them further adds to the confusion[5]. Considering this, *P. juliflora* was treated as *P. juliflora–P. pallida* com. *P. cineraria* has tuft-like nodes from which the slender glabrous branches emerge[25]. The branches bear internodal prickles of 3–6 mm length[25]. The trunk is straight with grey, rough bark that exfoliates into multiple small flecks[25].

Non-destructive qualitative method was preferred over destructive methods (like pitfall or sticky trap) to assess the fauna associated with the respective trees. Trees belonging to *P. cineraria* and *P. juliflora–P. pallida* com. were identified in each location and then scanned for the presence of intact bird nest(s) and spider web(s), or their remnants with the help of binoculars. The *Prosopis* trees were selected randomly, but those shorter than ~6 ft in height were excluded. For *P. juliflora–P. pallida* com. short coppiced and prostrate forms were excluded. A total of ~350 trees of each species were scanned and the observations recorded (Table 1).

GraphPad Prism (version 5) software was used for plotting and analysing the data. Chi-square test with Yates correction was applied on proportion data to test the significance of the difference observed.

P. cineraria and *P. juliflora–P. pallida* com. trees were scanned visually for the presence of bird nest(s) and spider web(s) and data were recorded (Table 1). The percentage of trees with either bird nest, or spider web or both was calculated and compared between the two *Prosopis* species. A total of 704 *Prosopis* trees were surveyed (Table 1). Of all the trees analysed, ~27–55% (*P. cineraria*: ~55% and *P. juliflora–P. pallida* com.: ~27%) supported either spider or bird population. Of these, ~23–42% had only spider web while ~3–6% had only bird nest built on them, while 0.9–7% had both spider web and bird nest built on them. When the *Prosopis* species were analysed individually, it was found that the percentage of *P. cineraria* with spider webs (48.54 ± 28.31 versus 23.72 ± 16.91), bird nests (13.17 ± 12.45 versus 4.04 ± 5.510) and both (*P. cineraria*: 7.05 ± 2.07 and *P. juliflora–P. pallida* com.: 0.9 ± 0.6) were significantly (chi-square test with Yates correction, $P < 0.001$) high compared to *P. juliflora–P. pallida* com. (Figure 2 and Table 2). Thus it can be concluded that between the two *Prosopis* species, birds and spiders preferred *P. cineraria* for constructing their nest/web, implying negative faunal association with *P. juliflora–P. pallida* com. compared to *P. cineraria*. While recording the observations, some insects like ants and flies were found in greater abundance and richness on *P. cineraria* compared to *P. juliflora–P. pallida* com. (data not shown).

The difference in faunal association on the *Prosopis* trees could be attributed to the difference in morphological and chemical characteristics of the two species. *P. cineraria* has a straight trunk with dense rounded canopy, and irregular branching (Figure 1 *a*) and thus might provide a better platform for nest-building. Whereas *P. juliflora–P. pallida* com. in general, is thorny, often branching low on the trunk having shrubby appearance (Figure 1 *b*) and a wide, flat-topped crown. The branching angle for *P. juliflora–P. pallida* com. is between 165° and 190° (refs 20, 26), which may not provide a suitable platform for birds to build a stable nest. Chandrasekaran *et al.*[20] reported increased mortality of the nestlings (eggs or chicks) from the nests on *P. juliflora* compared to *Acacia nilotica*. This could prevent birds from nesting on *P. juliflora* trees if other favourable ones like *P. cineraria* are available. Juliflorine produced by *P. juliflora* is toxic to some insects[5,27]. Such effects could reduce the number of insects on *P. juliflora*. As insects form a significant part of spider diet, the reduced prevalence

Figure 1. *Prosopis cineraria* (***a***) and *Prosopis juliflora* (***b***) trees near Tal Chappar, Rajasthan, India.

Table 1. Record of trees with bird nest, spider web and both at different locations

		Prosopis cineraria					*Prosopis juliflora–Prosopis pallida* complex				
Location	Site	Bird + spider	Bird only	Spider only	None	Total	Bird + spider	Bird only	Spider only	None	Total
Pilani	S1	0	0	9	5	14	0	0	3	5	8
	S2	0	0	0	15	15	0	0	0	20	20
	S3	2	3	2	9	16	1	1	1	10	13
	S4	2	1	3	5	11					
	S5						0	0	3	10	13
	S6	3	2	5	7	17	0	0	4	5	9
	S7	0	0	2	1	3	0	0	2	2	4
	S8						0	0	0	5	5
	S9	0	0	3	0	3					
	S10	1	1	2	7	11	0	1	1	12	14
	S11	0	0	6	10	16	0	2	2	14	18
	S12	0	1	3	11	15	0	0	2	6	8
Chhapar	S13	20	2	88	12	122	0	1	34	40	75
	S14	8	5	43	18	74	1	3	12	45	61
	S15	4	9	19	25	57	2	7	21	52	82
						374					330

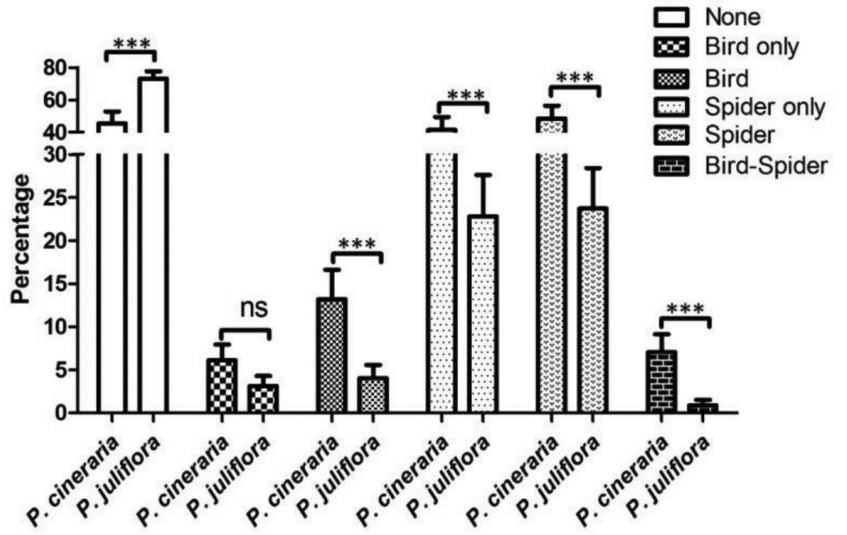

Figure 2. Percentage of *Prosopis* trees with either bird nest or spider web or both. Bird only, Trees with only bird nest; spider only, Trees with only spider web; bird, trees with bird nest that may or may not have spider web; spider, Trees with spider web that may or may not have bird nest, bird–spider; Trees that have both bird nest and spider web. ***$0.0001 < P \leq 0.001$, and ns, $P > 0.05$.

Table 2. Results of chi-square test with Yates correction on proportion data

Trees with bird nest	
Chi-square, df	20.66, 1
P value	<0.0001
P value summary	*
Trees with bird nest only	
Chi-square, df	0.8432, 1
P value	0.3585
P value summary	ns
Trees with bird nest and spider web	
Chi-square, df	25.31, 1
P value	<0.0001
P value summary	*
Trees with spider web	
Chi-square, df	76.82, 1
P value	<0.0001
P value summary	*
Trees with spider web only	
Chi-square, df	40.68, 1
P value	<0.0001
P value summary	*

*$P < 0.0001$.

of spiders on *P. juliflora* could be thus explained. However, juliflorine may directly act against spiders, thus reducing their number. The exact cause for low number of spiders on *P. juliflora* needs further study. There is a need for assessing faunal diversity (or change in community composition) associated with *P. juliflora* with respect to its native congener, *P. cineraria*. This will improve our understanding on the overall impact of this notorious invader.

Similar to other studies it was observed that the sites with higher human habitation had increased frequency of *P. juliflora–P. pallida* com. trees compared to human uninhabited sites (data not shown)[12,28,29]. This demonstrates that anthropogenic disturbance may lead to increased dispersal of *P. juliflora* possibly through livestock-mediated seed dissemination. The problem can be further aggravated considering the fact that *P. juliflora* is superior to *P. cineraria*[18]. In a competition assay, it outperformed *P. cineraria* in terms of germination, growth rate and drought tolerance[18]. This implies that *P. cineraria* may get severely impacted and become endangered over a period of time. Deracination of *P. cineraria* by *P. juliflora–P. pallida* com. from its native range would prove detrimental to

biodiversity, especially to important bird species like the critically endangered *Sarcogyps calvus*, *Gyps indicus* and *Gyps bengalensis* that nest on these trees[30]. In early 1990s, Tal Chhapar had a breeding population of *G. bengalensis* and some sightings of *G. indicus* and *S. calvus* have been indicated[31]. If *P. juliflora* trees increase in abundance, especially in semi-arid regions where other trees are scarce, birds would be forced to nest on the former trees reducing breeding success owing to the higher mortality rates of nestlings associated with *P. juliflora*[20]. Taking into consideration the negative impacts of *P. juliflora–P. pallida* com. on plant communities[12,14,18], bird life[20] (the present study) and insect life (the present study), the ability of *P. juliflora* to disperse at a rapid rate and outcompete *P. cineraria* may prove highly detrimental to biodiversity in general.

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