

Community Structure and Distribution of Climbers across Ecosystem Gradients in the Dryland of Kachchh, Gujarat, India

Dipmala Gajjar^{1,2}, Arun Kumar Roy Mahato^{1,3,*}, Kalpesh Sorathia⁴

¹Terrestrial Ecology Division, Gujarat Institute of Desert Ecology, India

²Department of Earth and Environmental Science, K. S. K. V. Kachchh University, India

³Department of Zoology, K. B. College, India

⁴Department of Biology, Tolani College of Arts and Science, India

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Abstract Climbers are a unique form of vegetation that needs the support of other host species or support for their growth and development. The composition and distribution of climbers are varying among various types of ecosystems and habitats within a larger landscape and climatic region. Kachchh is an arid climatic region of India, while due to its geographical position, topography of the land, large coastline and climatic condition, the distribution and composition of climbers are thought to vary among ecosystems and habitats of the district. Hence, the study was made to assess the phytosociology and distribution of climber species in the major habitat of dryland Kachchh. Systematic field surveys were conducted using line transects in represented ecosystems of the district. A total of 86 species of climber under 55 genera and 19 families were recorded from the district, in which the highest number of species was recorded from the tropical thorn forests (69 species) and agro-ecosystem (68 species), while only 11 species were recorded from Inland wetlands of the district. Among the recorded species, *Coccinia grandis*, *Cocculus hirsutus*, *Cucumis callosus*, *Pergularia daemia* and *Rhynchosia minima* were most abundant and recorded in all the major ecosystems of Kachchh. The species include *Coccinia grandis*, *Rhynchosia minima*, *Pergularia daemia* and *Cocculus*

hirsutus which were frequently distributed. Densely distributed species include, *Coccinia grandis*, *Rhynchosia minima*, *Pergularia daemia*, *Distimake aegyptius*, *Cucumis callosus*, *Cocculus hirsutus* and *Dalechampia sp.* While, *Passiflora edulis* was the highly abundant climber of the study area. The study highlighted that Important Value Index (IVI) of some species, namely *Coccinia grandis*, *Rhynchosia minima*, *Pergularia daemia*, *Distimake aegyptius* and *Cucumis callosus* was the highest among the recorded climber species. Further, about 30% of the climber species have restricted distribution and are found in either tropical thorn forests or in agro-ecosystem due to the presence of host species in both ecosystems.

Keywords Climber, Phytosociology, Distribution, Ecosystem, Dryland, Kachchh

1. Introduction

Climbers are plants that germinate from soil and are unable to grow vertically or horizontally, therefore they rely on external support to grow [1]. They normally grow by twisting around and leaning on other plants or with other physical support [2]. The phytosociology and

distribution of climbers are dependent primarily on abiotic factors viz. water, temperature, soil and community structure of the ecosystem in which they are part of the vegetation [3-5]. Climbers contribute substantially to the floristic, structural and functional diversity of tropical forests [6], where they can compete with other vegetation, and their rich diversity is found in tropical forests/ecosystems due to the presence of diversity in microhabitats and host species [7].

Climbers play a vital role in ecosystem function and productivity [8] such as different patterns of pollination, dispersal and phenological systems, provide several resources and also an important role in the protection of biological diversity [9]. They significantly contribute to the species diversity and structural complexity of tropical forests composing up to 25% of woody individuals and species [10]. Climber connects trees together by which they provide canopy-to-canopy access for tree-dwelling animals, and maintaining the productivity of vegetation by enriching soil through nutrient-rich decomposable leaf litter [11]. They also access deep nutrients and water from the soil [12]. Furthermore, climbers may also play a role at the ecosystem level by contributing to the carbon budget of tropical forests, representing as much as 10% of fresh aboveground biomass [13]. However, a climber is comparatively less studied than other habits of plants in various natural ecosystems [14].

Climbers are an abundant and diverse life-form in most tropical forests, which are varied with numerous factors, including soil and disturbance regime, host species and floristic composition [4, 15]. The manmade and climate-induced disturbances are likely to promote species diversity and abundance of climber [4, 15-18], as they are fast-growing vegetation and most of them have short life span varying from a single season to annual.

Lianas, a type of climber contribute significantly to species richness, accounting for up to 25% of woody stem diversity [19]. Tropical wet forests are characterized by a high abundance and diversity of lianas, and contribute substantially to the diversity and structure of mature tropical forests [20]. Ecological studies on climbers have been carried out by various authors in different forest types. Notably, the diversity and distribution of climbers have been examined in a rainforest system of Ghana [21]. Also, the diversity and ecology of lianas in the tropical forests of Coromandel Coast in India have been assessed under different disturbance regimes [17].

The plant diversity of the Kachchh district was initially studied by Palin who listed 246 plant species from Kachchh [22]. Later some notable works have been carried out on plant diversity in the arid region of the district [23-26]. Rao [27] had noted 700 plants from the whole of the Kachchh district. While, Rao [28] compiled the flora of the south-eastern part of Kachchh, in which he reported 574 species. Bhatt [29] studied the flora of western Kachchh and recorded 518 plants species. In spite of the above-mentioned studies, specific study on the ecology of

climber species in this dryland has not been carried out so far. Therefore, lack of information on various ecological aspects of climber species, in particular to the dryland region.

Despite the aforementioned studies on the climbers, crucial aspects such as community structure and diversity, they are comparatively less known life forms as compared to other plant habits such as herbs, shrubs and trees. Furthermore, there is a lack of knowledge on phytosociology, diversity, and distribution of climbers in India, specifically in the dryland regions. Therefore, the present study has been carried out to understand the phytosociology and distribution of climbers in different ecosystems of the drylands of Kachchh, Gujarat. The results of the study will provide a vital and important database and knowledge to the policymakers for evolving conservation and management measures for the economically important and threatened species of climbers in this region.

2. Materials and Methods

2.1. Study Area

This study was conducted at five distinct and widely distributed habitats in the Kachchh dryland located in the northwestern part of the Gujarat, India (Figure 1). The study area lies between 22°44'11 to 24°42'25 N and 68°09'46 to 71°55'47 E. Kachchh is the largest district in India falling under the arid climatic region and has the longest coastline of about 406 km., among the coastline districts of Gujarat state. The political boundary of the district is 45,674 km² which alone occupies 23.27% of the total geographical area of Gujarat state. Among the geographical areas of the district, 51 percent of area is occupied by a saline marshy desert which is known as Rann of Kachchh.

The study area is also a drought prone zone based on the type of vegetation, climatic conditions, scanty rainfall and high soil salinity. The climate of the Kachchh district is known for its long hot summer and cold winter with very scattered rain in monsoon and represents biodiversity supported by arid conditions. The area experiences three distinct seasons annually which include; winter (December to February), summer (March to mid-June) and monsoon (mid-June to September). This seasonal cycle with a scarcity of rainfall results in general moisture deficiency, indicating sustained potential water deficit where potential evaporate-transpiration (PET) outweighs precipitation. The region is marked by a very high aridity index of over 40% with reference to continuous desertification.

Based on the physiography, Kachchh district exhibits various types of landscape; as a result the district has the presence of diverse habitats which support the diversity of species.

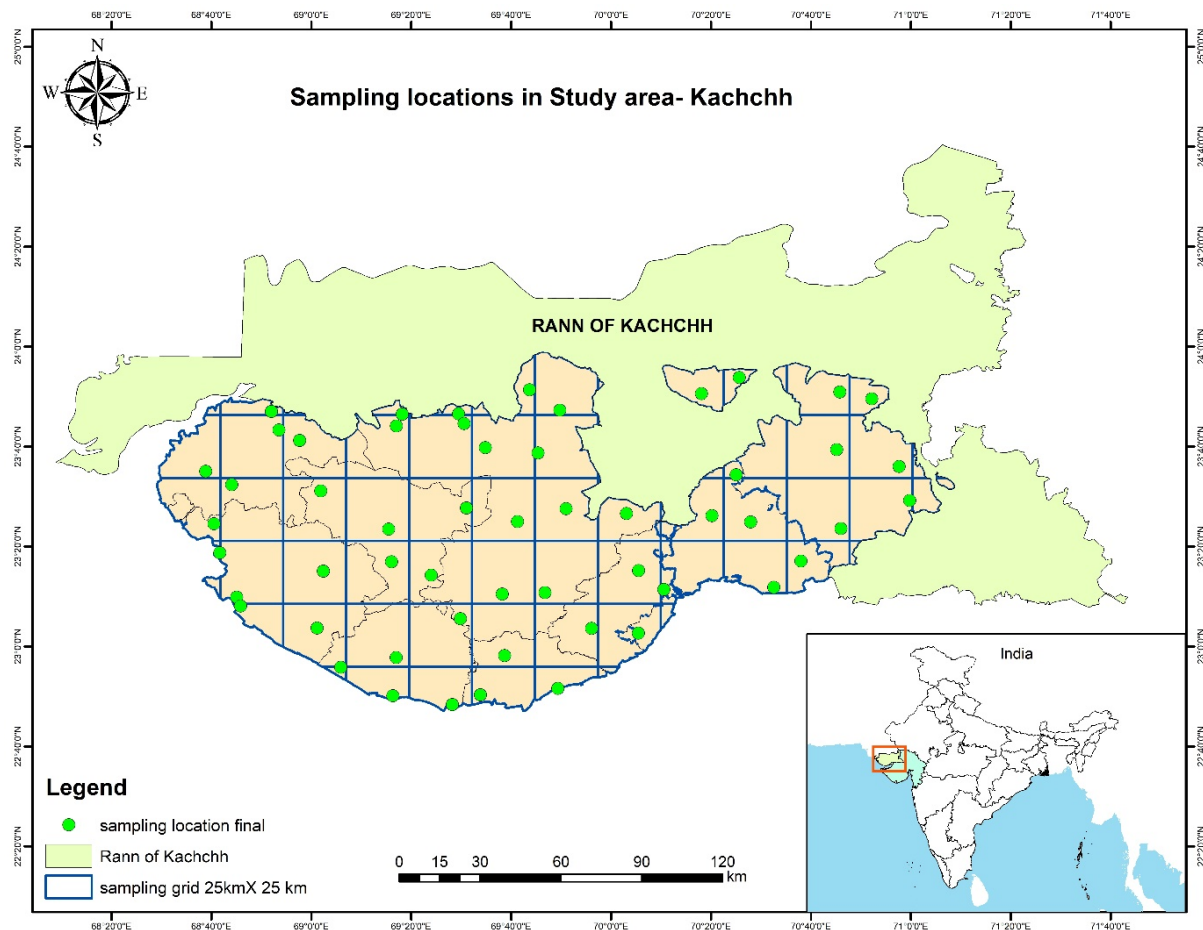


Figure 1. Grid map of the study area with sampling location for climbers

The land area of the district has five distinct ecosystems/habitats which include; grassland (3900 km²), tropical thorn forest (8,375 km²), coastal and swamp forest (456 km²), agro-ecosystem (7827 km²), and wetland (50 km²). These ecosystem/habitat types were surveyed for the ecological assessment of climbers.

2.2. Floristic Survey and Sampling

Fieldwork was carried out between January 2019 to March 2022 in the systematically identified sampling location distributed in different parts and represented ecosystems of Kachchh district. Initially, reconnaissance surveys were made to the various habitats of the district to understand various types of land use and land cover. Based on the reconnaissance survey, sampling points for detailed study as mentioned in the objective were finalized.

Though, the major parts of the district are primarily dryland, various ecosystems are present which are ecologically distinct with respect to the vegetation types. Therefore, the study was conducted in the five distinct and major habitat types which include; Tropical Thorne Forest, Grassland Ecosystem, Agriculture/cropland, Coastal ecosystem and Wetland. For the systematic floristic survey, covering all the represented ecosystems distributed in

different parts of the district, the study area was divided into 55 equal grids of size 25 km X 25 km (Figure 1). The field survey and sampling were carried out using Mueller-Dombois & Ellenberg, 1967, and Misra, 1968. The floristic survey was conducted using one line transects varying from one (1) km to 1.5 km in each grid. Survey transects were randomly laid down within each grid to get a representative sample from each of the major ecosystem/habitat types of the district. For the quantitative data collection on climbers, five quadrates of size 10m X 10m at a distance of 200 m along the line transects were used. Altogether, a total of 275 quadrates were sampled for enumeration and collecting quantitative data. The taxonomic identification of climber species encountered during the survey was made using various literature on regional floras, viz. Flora of Gujarat, Flora of Rajasthan, Flora of Indian desert. The recorded climber which is unable to be identified during field surveys, the specimens of such climber were collected and prepared herbarium for identification with the help of a plant taxonomist.

2.3. Data Analysis

The enumerated data collected from the field survey in various ecosystem types were used to assess the species

area curve, phytosociology, viz. density, frequency, abundance, relative density, relative frequency, Important Value Index (IVI) and family value index (FIV) of climbers across various ecosystem/habitat types were calculated as per Curtis and McIntosh (1950) using Microsoft Excel. Important Value Index (IVI) is an important index to understand the value of individual species of climbers in each type of ecosystem identified for the study. The IVI was calculated by the percentage values of the relative frequency and relative density summed up together using Curtis (1959). Further, various species diversity indexes such as Simpson index, Shannon index, dominance Index, species richness and evenness index of climber species in different ecosystem/habitat types were calculated using a statistical software package.

3. Results

During the field survey, a total of 1155 individuals of climbers were quantified from 272 quadrates surveyed across five distinct ecosystems of Kachchh. The survey recorded a total of 86 species of climbers belonging to 55 genera and 19 families. Among the recorded species highest number of taxa was recorded from the tropical thorn forests (69 species), followed by the agriculture/cropland ecosystem (68 species), grassland and the lowest number of species recorded from the coastal ecosystems of the district (Figure 2). Among the total recorded climber species, five (5) species namely; *Coccinia grandis*, *Cocculus hirsutus*, *Cucumis callosus*, *Pergularia daemia* and *Rhynchosia minima* were most abundant and recorded in all the major ecosystems of Kachchh, while, 28 species of climbers were recorded from only one ecosystem of the district. A total of 13 species of climber include; *Basella alba*, *Benincasa hispida*, *Canavalia gladiata*, *Ceropegia bulbosa*, *Convolvulus glomeratus*, *Cucumis melo*, *Ipomoea dichroa*, *Ipomoea triloba*, *Lufa cylindrica*, *Momordica charantia*, *Passiflora foetida*, *Pentalinon luteum* and *Vigna unguiculata* were recorded only from the agro-ecosystem, while a total of 17 species of climber viz. *Asparagus racemosus*, *Bougainvillea spectabilis*, *Cissampelos pareira*, *Corallocarpus conocarpus*, *Corallocarpus epigaeus*,

Cyclea peltata, *Cynanchum viminalis*, *Dioscorea bulbifera*, *Hemidesmus indicus*, *Ipomoea concanica*, *Ipomoea indica*, *Ipomoea pes-caprae*, *Ipomoea muricata*, *Jacquemontia pentantha*, *Jasminum grandiflorum*, *Mucana prurita* and *Thunbergia grandiflora* were recorded only from the tropical thorn forests of the district.

Four different types of climbing modes of climber species were recorded from the survey which includes; twiner, tendrill climber, hook climber and scrambler. Among the different recorded climbing modes, twiner and tendrill climber were recorded from the ecosystem while hook climber and scrambler were recorded only from tropical thorn forests and agro-ecosystem. The number of twiner species was recorded as the highest from tropical thorn forests, followed by agriculture and the lowest number of species from coastal ecosystems. While, number of species of tendrill climbers was recorded as the highest from agriculture, followed by tropical thorn forests, grassland and the lowest number of species from coastal and wetland ecosystems (Figure 3).

3.1. Species Area Curve of Climbers in Different Ecosystem

Based on the recorded climber species in different ecosystems the species area curve has been analysed which has highlighted that climbers are highly abundant and common in tropical thorn forests and agriculture ecosystems (Figure 4). As per the species curve, the probability of species occurrence varied between 50-60, however, 71 species were recorded from the survey. While in grassland, the probability of species occurrence is approximately 60, and the survey recorded 69 species. The probability of species occurrence was high and randomly distributed with more than 80% of the recorded climbers from these two ecosystems. The probability of climber species occurrence in grassland is comparatively low in relation to tropical thorn forests and agriculture, which might be due to the lack of host plants in grassland and high grazing pressure in Kachchh grassland (Figure 4). In coastal and wetland ecosystems, the probability of occurrence of climber species is slightly highest from the actual number of species recorded from these ecosystems (Figure 4).

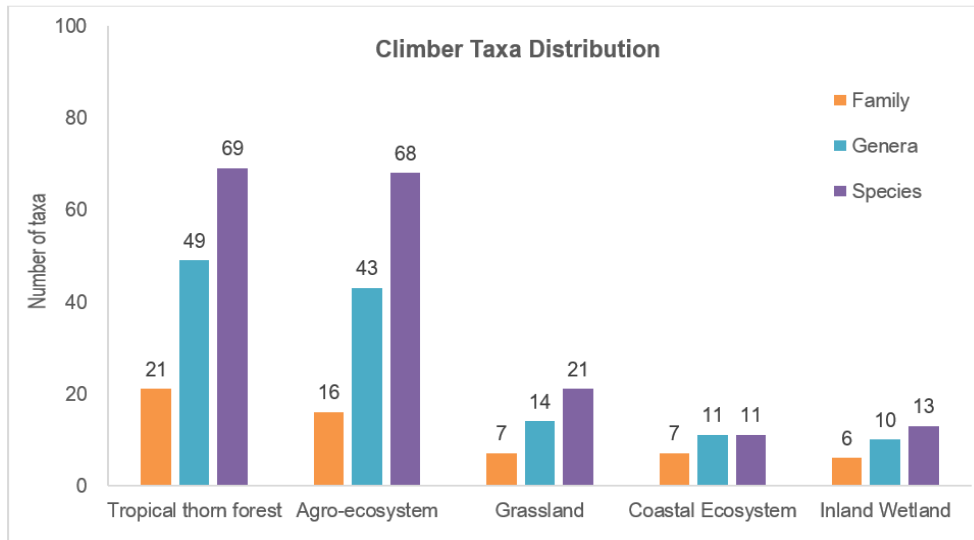


Figure 2. Climber taxa distribution in major ecosystem types of Dryland Kachchh

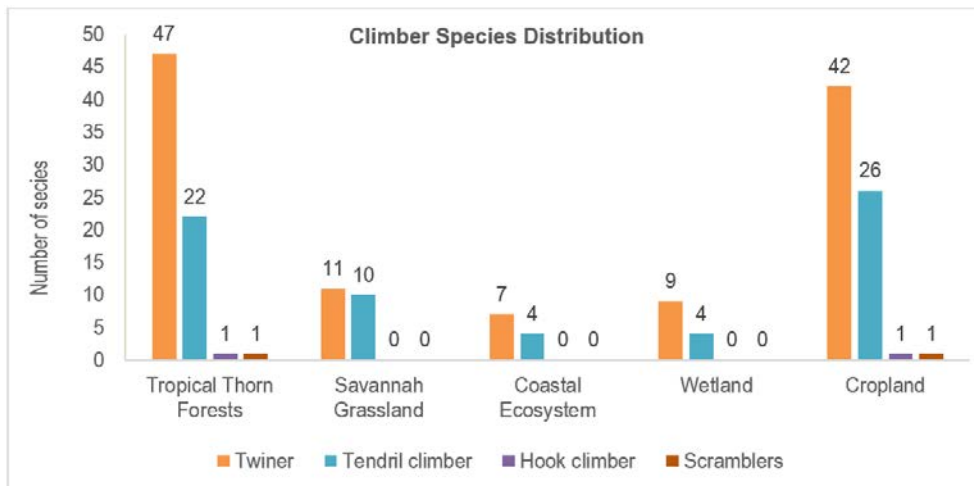


Figure 3. Distribution of climbing mode in major ecosystem of dryland Kachchh

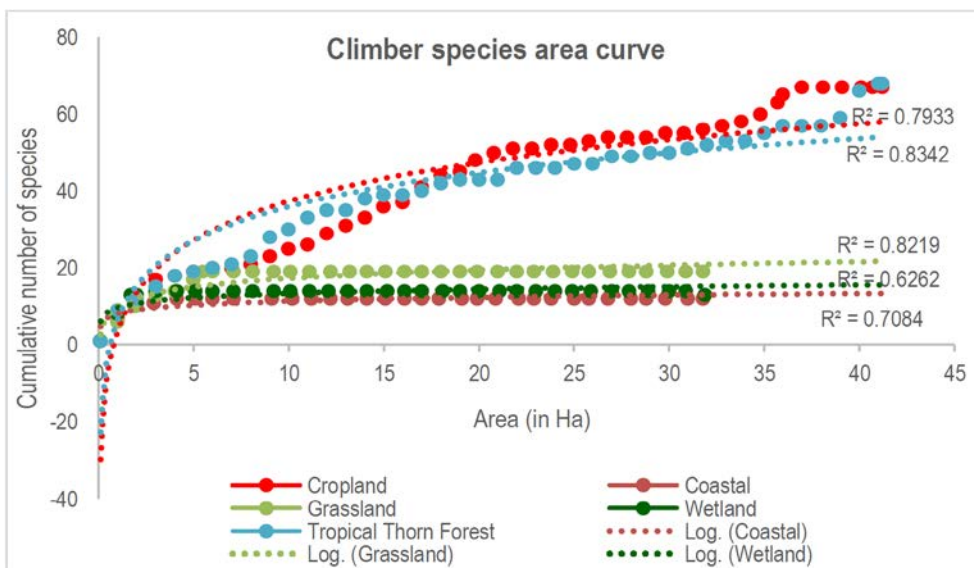


Figure 4. Species-area curves for climbers in various habitats of Kachchh

3.2. Phytosociology

The phytosociological analysis of climber species recorded from the study area found that *Coccinia grandis*, *Rhynchosia minima*, *Pergularia daemia* and *Cocculus hirsutus* were frequently distributed species among the recorded climbing species, while 8 species viz. *Thunbergia grandiflora*, *Benincasa pruriens*, *Ipomoea concanica*, *Ipomoea muricata*, *Ipomoea pes-capare*, *Mucuna pruriens*, *Passiflora edulis* and *Passiflora foetida* were least frequent species (Table 1). Similarly, among the recorded species of climbers, the density (Ind./ha) of *Coccinia grandis* was recorded highest, followed by *Rhynchosia minima*, *Pergularia daemia*, *Distimake aegyptius*, *Cucumis*

callosus, *Cocculus hirsutus*, *Dalechampia scandens*, while lowest density was recorded of 5 species include; *Benincasa pruriens*, *Ipomoea concanica*, *Ipomoea muricata*, *Mucuna pruriens* and *Thunbergia grandiflora* from the study area (Table 1). Analysis of the abundance of climber species recorded from the area during the survey period it was revealed that *Passiflora edulis* was the highly abundant climber followed by *Cissus repanda*, *Ipomoea aquatica*, *Asparagus racemosus*, *Luffa aegyptiaca*, while the *Convolvulus glomeratus* was least abundant species from the study area (Table1). Analysis also revealed that 20% of the recorded climber has equal and low abundant species (Table 1).

Table 1. Phyto-sociology of climber in the dryland of Kachchh

Sr. No	Scientific Name	Density (Ind./Ha)	Frequency	Abundance	Relative Density	Relative Frequency	Important Value Index
1	<i>Abrus precatorius</i>	2.42	0.36	1.33	0.35	4.65	5.00
2	<i>Antigonon leptopus</i>	1.82	0.24	1.50	0.26	3.49	3.75
3	<i>Aristolochia bracteolata</i>	3.03	0.24	2.50	0.44	5.81	6.25
4	<i>Asparagus racemosus</i>	15.76	0.97	3.25	2.27	30.23	32.50
5	<i>Basella alba</i>	1.21	0.24	1.00	0.17	2.33	2.50
6	<i>Benincasa pruriens</i>	0.61	0.12	1.00	0.09	1.16	1.25
7	<i>Blastania cerasiformis</i>	5.45	0.73	1.50	0.79	10.47	11.25
8	<i>Bougainvillea spectabilis</i>	2.42	0.24	2.00	0.35	4.65	5.00
9	<i>Canavalia gladiata</i>	3.03	0.36	1.67	0.44	5.81	6.25
10	<i>Cardiospermum halicacabum</i>	13.94	2.06	1.35	2.01	26.74	28.75
11	<i>Causonis trifolia</i>	6.67	0.85	1.57	0.96	12.79	13.75
12	<i>Ceropegia bulbosa</i>	2.42	0.36	1.33	0.35	4.65	5.00
13	<i>Cissampelos pareira</i>	5.45	0.73	1.50	0.79	10.47	11.25
14	<i>Cissus quadrangularis</i>	1.21	0.24	1.00	0.17	2.33	2.50
15	<i>Cissus repanda</i>	6.67	0.36	3.67	0.96	12.79	13.75
16	<i>Citrullus colocynthis</i>	4.24	0.61	1.40	0.61	8.14	8.75
17	<i>Citrullus lanatus</i>	3.03	0.48	1.25	0.44	5.81	6.25
18	<i>Clitoria ternatea</i>	4.85	0.61	1.60	0.70	9.30	10.00
19	<i>Coccinia grandis</i>	61.82	6.91	1.79	8.90	118.60	127.51
20	<i>Cocculus hirsutus</i>	29.70	4.24	1.40	4.28	56.98	61.25
21	<i>Cocculus pendulus</i>	1.82	0.36	1.00	0.26	3.49	3.75
22	<i>Combretum indicum</i>	1.21	0.24	1.00	0.17	2.33	2.50
23	<i>Convolvulus glomeratus</i>	1.82	0.48	0.75	0.26	3.49	3.75
24	<i>Corallocarpus conocarpus</i>	2.42	0.24	2.00	0.35	4.65	5.00
25	<i>Corallocarpus epigaeus</i>	1.82	0.24	1.50	0.26	3.49	3.75
26	<i>Cryptostegia grandiflora</i>	3.03	0.36	1.67	0.44	5.81	6.25

Table 1 continued

27	<i>Cucumis callosus</i>	31.52	2.91	2.17	4.54	60.47	65.00
28	<i>Cucumis gracilis</i>	9.09	1.21	1.50	1.31	17.44	18.75
29	<i>Cucumis melo</i>	1.82	0.24	1.50	0.26	3.49	3.75
30	<i>Cucumis prophetarum</i>	12.73	1.94	1.31	1.83	24.42	26.25
31	<i>Cucumis sativus</i>	3.03	0.48	1.25	0.44	5.81	6.25
32	<i>Cucurbita maxima</i>	2.42	0.48	1.00	0.35	4.65	5.00
33	<i>Cuscuta hyalina</i>	3.03	0.24	2.50	0.44	5.81	6.25
34	<i>Cuscuta reflexa</i>	8.48	0.85	2.00	1.22	16.28	17.50
35	<i>Cyclea peltata</i>	1.21	0.24	1.00	0.17	2.33	2.50
36	<i>Cynanchum viminale</i>	5.45	0.73	1.50	0.79	10.47	11.25
37	<i>Dactyliandra welwitschii</i>	4.24	0.61	1.40	0.61	8.14	8.75
38	<i>Dalechampia scandens</i>	28.48	2.30	2.47	4.10	54.65	58.75
39	<i>Dioscorea bulbifera</i>	1.21	0.24	1.00	0.17	2.33	2.50
40	<i>Diplocyclos palmatus</i>	11.52	1.45	1.58	1.66	22.09	23.75
41	<i>Distimake aegyptius</i>	38.79	3.52	2.21	5.58	74.42	80.00
42	<i>Hemidesmus indicus</i>	1.21	0.24	1.00	0.17	2.33	2.50
43	<i>Ipomoea alba</i>	4.85	0.73	1.33	0.70	9.30	10.00
44	<i>Ipomoea aquatica</i>	6.06	0.36	3.33	0.87	11.63	12.50
45	<i>Ipomoea cairica</i>	9.09	1.58	1.15	1.31	17.44	18.75
46	<i>Ipomoea concanica</i>	0.61	0.12	1.00	0.09	1.16	1.25
47	<i>Ipomoea dichroa</i>	1.21	0.24	1.00	0.17	2.33	2.50
48	<i>Ipomoea eriocarpa</i>	9.09	0.97	1.88	1.31	17.44	18.75
49	<i>Ipomoea hypocrateriformis</i>	13.33	2.42	1.10	1.92	25.58	27.50
50	<i>Ipomoea indica</i>	1.82	0.36	1.00	0.26	3.49	3.75
51	<i>Ipomoea muricata</i>	0.61	0.12	1.00	0.09	1.16	1.25
52	<i>Ipomoea nervosa</i>	3.03	0.48	1.25	0.44	5.81	6.25
53	<i>Ipomoea nil</i>	7.88	0.85	1.86	1.13	15.12	16.25
54	<i>Ipomoea obscura</i>	6.06	0.97	1.25	0.87	11.63	12.50
55	<i>Ipomoea pes-caprae</i>	1.21	0.12	2.00	0.17	2.33	2.50
56	<i>Ipomoea pes-tigridis</i>	16.97	2.18	1.56	2.44	32.56	35.00
57	<i>Ipomoea triloba</i>	3.03	0.24	2.50	0.44	5.81	6.25
58	<i>Ipomoea quamoclit</i>	1.82	0.36	1.00	0.26	3.49	3.75
59	<i>Ipomoea tuberculata</i>	3.03	0.36	1.67	0.44	5.81	6.25
60	<i>Jacquemontia pentantha</i>	1.21	0.24	1.00	0.17	2.33	2.50
61	<i>Jasminum grandiflorum</i>	1.82	0.36	1.00	0.26	3.49	3.75
62	<i>Lablab purpureus</i>	5.45	0.85	1.29	0.79	10.47	11.25
63	<i>Lagenaria siceraria</i>	19.39	2.91	1.33	2.79	37.21	40.00
64	<i>Leptadenia reticulata</i>	3.03	0.48	1.25	0.44	5.81	6.25
65	<i>Luffa acutangula</i>	29.70	3.03	1.96	4.28	56.98	61.25
66	<i>Luffa aegyptiaca</i>	3.64	0.24	3.00	0.52	6.98	7.50
67	<i>Maerua oblongifolia</i>	7.27	1.09	1.33	1.05	13.95	15.00

Table 1 continued

68	<i>Merremia emarginata</i>	4.24	0.48	1.75	0.61	8.14	8.75
69	<i>Momordica balsamina</i>	4.85	0.48	2.00	0.70	9.30	10.00
70	<i>Momordica charantia</i>	3.64	0.48	1.50	0.52	6.98	7.50
71	<i>Momordica dioica</i>	3.03	0.48	1.25	0.44	5.81	6.25
72	<i>Mucuna pruriens</i>	0.61	0.12	1.00	0.09	1.16	1.25
73	<i>Operculina turpithum</i>	3.03	0.24	2.50	0.44	5.81	6.25
74	<i>Passiflora edulis</i>	7.27	0.12	12.00	1.05	13.95	15.00
75	<i>Passiflora foetida</i>	1.21	0.12	2.00	0.17	2.33	2.50
76	<i>Pentalinon luteum</i>	3.03	0.24	2.50	0.44	5.81	6.25
77	<i>Pentatropis capensis</i>	19.39	2.30	1.68	2.79	37.21	40.00
78	<i>Pergularia daemia</i>	46.06	5.21	1.77	6.63	88.37	95.00
79	<i>Rhynchosia minima</i>	53.94	5.58	1.93	7.77	103.49	111.25
80	<i>Thunbergia grandiflora</i>	0.61	0.12	1.00	0.09	1.16	1.25
81	<i>Tinospora cordifolia</i>	10.91	1.33	1.64	1.57	20.93	22.50
82	<i>Trichosanthes cucumeroides</i>	1.82	0.36	1.00	0.26	3.49	3.75
83	<i>Trichosanthes dioica</i>	4.24	0.61	1.40	0.61	8.14	8.75
84	<i>Vigna unguiculata</i>	2.42	0.24	2.00	0.35	4.65	5.00
85	<i>Vincetoxicum spirale</i>	3.03	0.48	1.25	0.44	5.81	6.25
86	<i>Xenostegia tridentata</i>	1.21	0.24	1.00	0.17	2.33	2.50

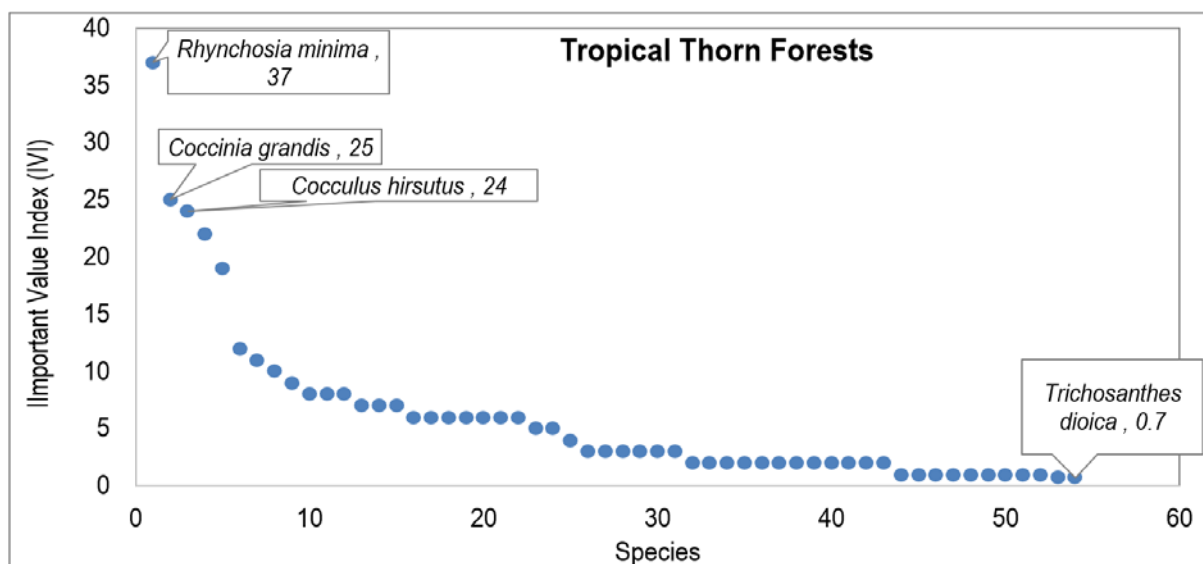


Figure 5. Important Value Index (IVI) of climber species in the Tropical Thorn Forests

Analysis of the Important Value Index (IVI) of recorded climber species from the quadrat enumeration data it was highlighted that the IVI of *Coccinia grandis* was highest followed by *Rhynchosia minima*, *Pergularia daemia*, *Distimake aegyptius* and *Cucumis callosus*, which are top five dominant climber species by its population and distribution (Table 2). The IVI of five species viz. *Benincasa pruriens*, *Ipomoea concanica*, *Ipomoea muricata*, *Mucuna pruriens* and *Thunbergia grandiflora*

were recorded lowest among the climber species recorded from the dryland of Kachchh (Table 2).

The study found variation in the IVI of climber species among different ecosystems. Based on the calculated IVI of the climber species in tropical thorn forest, *Rhynchosia minima* is the most dominant species, followed by *Coccinia grandis*, *Cocculus hirsutus*, and the least dominant species of this ecosystem was *Trichosanthes dioica* (Figure 5).

Table 2. Important Value Index (IVI) of climbers in the dryland of Kachchh district

S. No	Species	Agro-ecosystem	Tropical Thorn Forest	Grassland	Coastal ecosystem	Inland Wetland
1	<i>Abrus precatorius</i>	3.49	3.34	-	-	-
2	<i>Antigonon leptopus</i>	5.23	1.67	-	-	-
3	<i>Aristolochia bracteolata</i>	-	6.68	-	-	13.57
4	<i>Asparagus racemosus</i>	-	43.42	-	-	-
5	<i>Basella alba</i>	6.98	-	-	-	-
6	<i>Benincasa pruriens</i>	1.74	-	-	-	-
7	<i>Blastania cerasiformis</i>	6.98	5.01	13.10	-	-
8	<i>Bougainvillea spectabilis</i>	-	6.68	-	-	-
9	<i>Canavalia gladiata</i>	3.49	-	-	-	-
10	<i>Cardiospermum halicacabum</i>	15.70	26.72	19.64	-	-
11	<i>Causonis trifolia</i>	8.72	13.36	-	-	-
12	<i>Ceropegia bulbosa</i>	1.74	-	-	-	-
13	<i>Cissampelos pareira</i>	-	15.03	-	-	-
14	<i>Cissus quadrangulare</i>	1.74	1.67	-	-	-
15	<i>Cissus repanda</i>	8.72	1.67	-	68.18	-
16	<i>Citrullus colocynthis</i>	3.49	5.01	6.55	-	13.71
17	<i>Citrullus lanatus</i>	6.98	-	13.10	-	-
18	<i>Clitoria tematea</i>	12.21	3.34	6.55	-	-
19	<i>Coccinia grandis</i>	78.51	56.78	111.31	54.55	27.69
20	<i>Cocculus hirsutus</i>	26.17	46.76	26.19	13.64	13.98
21	<i>Cocculus pendulus</i>	3.49	-	6.55	-	-
22	<i>Combretum indicum</i>	1.74	1.67	-	-	-
23	<i>Convolvulus glomeratus</i>	5.23	-	-	-	-
24	<i>Corallocarpus conocarpus</i>	-	6.68	-	-	-
25	<i>Corallocarpus epigaeus</i>	-	3.34	-	-	-
26	<i>Cryptostegia grandiflora</i>	6.98	1.67	-	-	-
27	<i>Cucumis callosus</i>	61.06	5.01	32.74	109.09	56.47
28	<i>Cucumis gracilis</i>	5.23	20.04	-	-	-
29	<i>Cucumis melo</i>	6.98	-	-	-	-
30	<i>Cucumis prophetarum</i>	19.19	10.02	26.19	-	-
31	<i>Cucumis sativus</i>	12.21	-	6.55	-	-
32	<i>Cucurbita maxima</i>	1.74	-	19.64	-	-
33	<i>Cuscuta hyalina</i>	5.23	3.34	-	-	-
34	<i>Cuscuta reflexa</i>	8.72	10.02	6.55	27.27	-
35	<i>Cyclea peltata</i>	-	3.34	-	-	-
36	<i>Cynanchum viminalae</i>	-	15.03	-	-	-
37	<i>Dactyliandra welwitschii</i>	13.96	1.67	-	-	-
38	<i>Dalechampia scandens</i>	43.61	35.07	-	13.64	-
39	<i>Dioscorea bulbifera</i>	-	1.67	-	-	-
40	<i>Diplocyclos palmatus</i>	15.70	13.36	-	27.27	-
41	<i>Distimake aegyptius</i>	43.61	63.46	-	-	14.25
42	<i>Hemidesmus indicus</i>	-	3.34	-	-	-
43	<i>Ipomoea alba</i>	3.49	10.02	-	-	-
44	<i>Ipomoea aquatica</i>	5.23	10.02	6.55	-	-

Table 2 continued

45	<i>Ipomoea cairica</i>	10.47	11.69	6.55	-	14.39
46	<i>Ipomoea concanica</i>	-	1.67	-	-	-
47	<i>Ipomoea dichroa</i>	3.49	-	-	-	-
48	<i>Ipomoea eriocarpa</i>	15.70	10.02	-	-	-
49	<i>Ipomoea hypocrateriformis</i>	15.70	20.04	-	-	14.52
50	<i>Ipomoea indica</i>	-	5.01	-	-	-
51	<i>Ipomoea nervosa</i>	1.74	6.68	-	-	-
52	<i>Ipomoea nil</i>	3.49	16.70	-	-	14.66
53	<i>Ipomoea obscura</i>	5.23	10.02	-	-	14.80
54	<i>Ipomoea pes-caprae</i>	-	3.34	-	-	-
55	<i>Ipomoea pes-tigridis</i>	27.91	15.03	19.64	-	-
56	<i>Ipomoea triloba</i>	8.72	-	-	-	-
57	<i>Ipomoea marginata</i>	3.49	16.70	6.55	-	-
58	<i>Ipomoea muricata</i>	-	1.67	-	-	-
59	<i>Ipomoea tuberculata</i>	5.23	3.34	-	-	-
60	<i>Jacquemontia pentantha</i>	-	3.34	-	-	-
61	<i>Jasminum grandiflorum</i>	-	5.01	-	-	-
62	<i>Lablab purpureus</i>	10.47	5.01	-	-	-
63	<i>Lagenaria siceraria</i>	33.15	20.04	6.55	-	-
64	<i>Leptadenia reticulata</i>	3.49	1.67	6.55	-	14.93
65	<i>Luffa acutangula</i>	69.78	15.03	-	40.91	-
66	<i>Luffa cylindrica</i>	10.47	-	-	-	-
67	<i>Maerua oblongifolia</i>	5.23	15.03	-	-	-
68	<i>Merremia emarginata</i>	6.98	5.01	-	-	-
69	<i>Momordica balsamina</i>	5.23	8.35	-	-	-
70	<i>Momordica charantia</i>	10.47	-	-	-	-
71	<i>Momordica dioica</i>	5.23	3.34	-	-	-
72	<i>Mucana prurita</i>	-	1.67	-	-	-
73	<i>Operculina turpthum</i>	8.72	3.34	-	-	-
74	<i>Passiflora edulis</i>	15.70	10.02	-	-	-
75	<i>Passiflora foetida</i>	3.49	-	-	-	-
76	<i>Pentalinon luteum</i>	8.72	-	-	-	-
77	<i>Pentatropis capensis</i>	12.21	40.08	-	13.64	-
78	<i>Pergularia daemia</i>	85.48	30.06	32.74	13.64	45.20
79	<i>Rhynchosia minima</i>	83.74	88.52	39.29	13.64	30.41
80	<i>Thunbergia grandiflora</i>	-	1.67	-	-	-
81	<i>Tinospora cordifolia</i>	5.23	25.05	-	-	-
82	<i>Trichosanthes dioica</i>	3.49	1.67	-	-	-
83	<i>Trichosanthes cucumerina</i>	5.23	6.68	-	-	-
84	<i>Vigna unguiculata</i>	6.98	-	-	-	-
85	<i>Vincetoxicum spirale</i>	1.74	6.68	-	-	-
86	<i>Xenostegia tridentata</i>	1.74	1.67	-	-	-

Among the climber species recorded from Agroecosystem, *Coccinia grandis* (59.37%), *Rhynchosia minima* (58.52%) were the most dominant species, followed by *Pergularia daemia* (38.17%) and *Cocculushirsutus* and least dominant species were *Benincasa hispida*, *Ceropegia bulbosa*, *Cissus repanda*, *Ipomoea dichroa* (Figure 6). In the grassland ecosystem, *Coccinia grandis* (24%), followed by *Cocculus hirsutus*, *Cucumis propheterum*, and *Leptadenia reticulata* was the least dominant species among the recorded climber species

(Figure 7). While in the coastal ecosystem, *Coccinia grandis* was recorded as the most dominant climber species, followed by *Cocculus hirsutus*, *Cucumis callosis*, and the least dominant species was *Cayoponia laciniosa* (Figure 8). In the Inland wetland ecosystem of the dryland Kachchh, *Cucumis callosus* was the most dominant species, followed by *Rhynchosia minima*, *Citrullus colocynthis*, and the least dominant species was *Pergularia daemia* among the recorded climber species from the ecosystem (Figure 9).

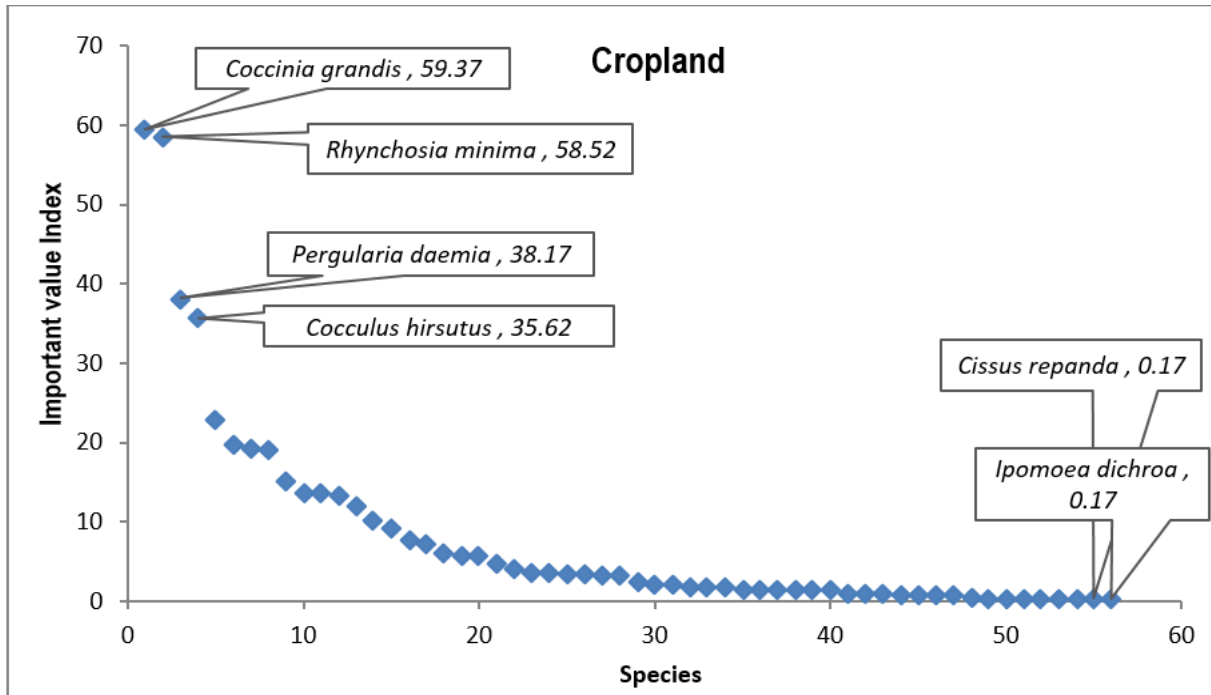


Figure 6. Important Value Index (IVI) of climber species in the Agro-ecosystem

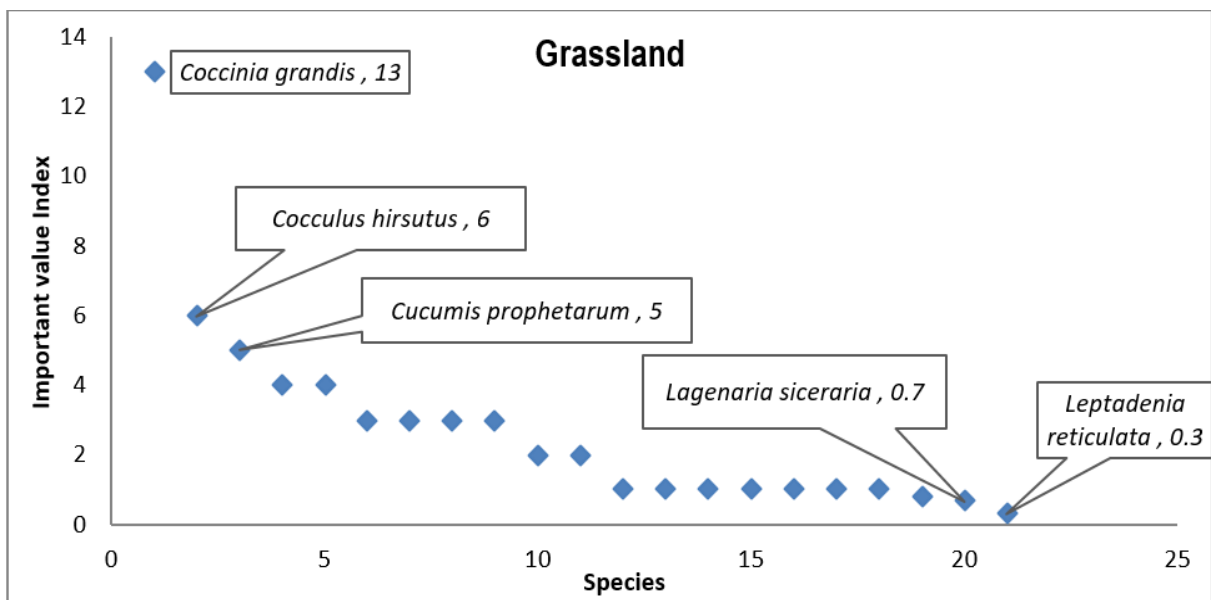


Figure 7. Important Value Index (IVI) of climber species in Grassland ecosystem

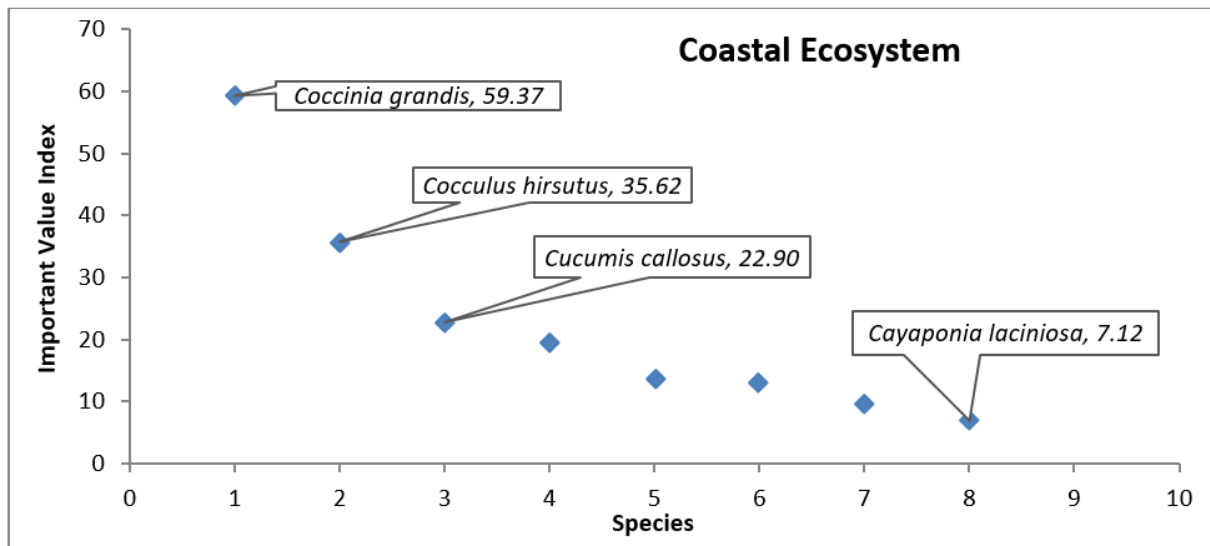


Figure 8. Important Value Index (IVI) of climber species in the coastal ecosystem

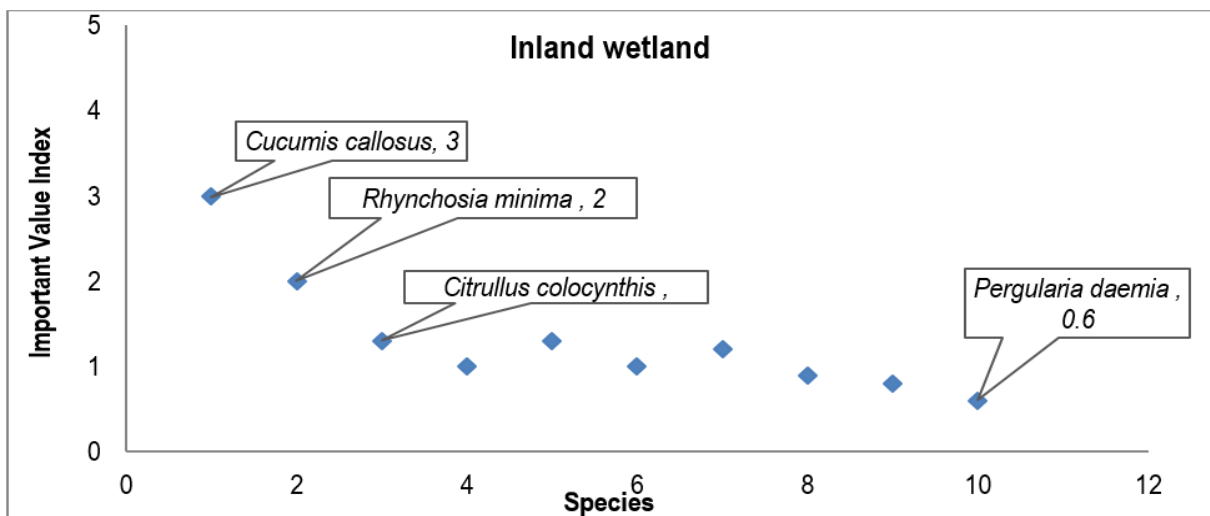


Figure 9. Important Value Index (IVI) of climber species in the wetland ecosystem

4. Discussion

The present study has recorded 86 species of climbers belonging to 55 genera and 19 families from the different habitats of Kachchh, while a study recorded 24 species, 19 genera, and 15 families of climbers from the dry Afromontane forests of Africa [18]. The number of species recorded from the study is higher than the reported number of species (72 lianas) recorded from the Semi-Deciduous rain forest, in Ghana [21]. Similarly, number of climber species is higher than the rain forests of Ethiopia (72 lianas) [30], dry evergreen forests on the Coromandel Coast of India (77 species) [17], while lesser than the species recorded from the tropical forests of north-eastern Ghats (170 species) of Andhra Pradesh, India [31] and four tropical forests (39 species) of Coromandel coast, India [9]. The climber species diversity recorded in this study in Kachchh is comparatively higher than the other studies it

might be due to the large area covered under the present study having the presence of varieties of landscapes and habitats in Kachchh.

A study in different elevation gradients at Arunachal Pradesh, India reported some climber species [32] which are also reported from the present study, such as *Cuscuta reflexa*, *Cissampelos sp.*, *Thunbergia grandiflora*, *Ipomoea quamoclit* and *Ayryreia nervosa* in different ecosystems of dryland Kachchh. The study also reported four different climbing modes of species from the area in which twining and tendril climbers are dominant. Similarly, in the present study four different climbing modes of species were recorded from the Kachchh in which twining and tendril climbers were also dominant among other climbing mode.

Schnitzer [5] reported a density of 1358 individuals/ha of lianas in the forest of Panama and similarly, Romero-Saltos [33] found 1600 individuals/ha of lianas

from a forest in Ecuador. Anbarashan and Parthasarathy [17] reported 1422.25 individuals/ha of climbers from the tropical dry forests of the Coromandel Coast of India. While, Senbeta et al. [30] reported density of lianas varied from 1807 to 13,880 individuals/ha in the rainforests in Ethiopia. In the present study, the density of the climber was recorded at 680.58 individuals/ha which is comparatively much lower than the above-mentioned studies, as the present study area is falling in the arid climatic region and also have high salinity in the soil which supports low number of vegetation.

5. Conclusions

Kachchh is falling under a highly arid landscape having the presence of different types of ecosystems due to its geographical position. The various physiography, biological factors and anthropogenic influence, presence of a diversity of vegetation are distributed in various compositions in different ecosystems of Kachchh. The diversity of climbers recorded from the study is comparatively higher than some of the tropical forests present in similar kinds of climatic regions over the globe. A good number of climber species recorded from the district are also reported from the different kinds of ecosystems like hilly regions of Himalayas and Eastern Ghats. The study highlighted that some of the species were dominated in all kinds of ecosystems of the district while about 30% of the climber species have restricted distribution and are found in either tropical thorn forests or in agro-ecosystem due to the presence of host species in both the ecosystem.

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