

Diversity and regeneration of the Genus *Caralluma* (*Sensu lato*) in Chitradurga district of Karnataka.

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Introduction: *Caralluma* R.Br (*Sensu lato*) has been usually accepted to include about 120 taxa, with a wide African, Asian, South African and Southwestern European distribution it is belong to the subfamily Asclepiadoideae (Apocynaceae). The two genus are endemic in south India i.e., *Caralluma*, *Boucerosia* can easily be distinguished for arrangement of the flowers and by the nature of the stems. In India out of 13 species of *Caralluma* (Sl), 7 species and 5 varieties are solely endemic to Karnataka state in south India. **Material and methods:** A total of 12 quadrats were laid out randomly, with 4 quadrats per area. Morphological and diversity parameters were analyzed. **Result:** Density, abundance, frequency, IVI value, Shannan (4.151) and Simson (0.9658) were calculated. Twelve species of *Caralluma* were collected from different geographical locality from arid areas of Chitradurga. Other associated plants were encountered from sampling site. *Boucerosia indica*, *C. stalagmifera* var. *longipetala* *C. stalagmifera* var. *intermedia* species were first recorded in Karnataka. Among them *C. stalagmifera* var. *longipetala* were selected for reintroduction in various places of Hosabeelu, Janappanagudda and muddapura area of holalkere taluk .. **Discussion:** In present study, *Caralluma adscendens* and *Caralluma stalagmifera* showed intermediate stages of evolutionary advancement to get other varieties of *Carallumas*, and highlight the importance of flower architecture in systematic consideration of *Caralluma* (S l) species

Key words: Diversity, *Caralluma* (S l) and Morphological variation

1. Introduction

Caralluma adscendens var. *fimbriata* is a succulent plant belongs to the family Apocynaceae, sub Family Asclepiadoideae locally it is known as “Mangte” and “Manganakodu” in Karnataka. *Caralluma* is originated from Telugu vernacular “Kar or Karu-allam” Karu means forest and allam means ginger (Elliot, 1859). It has been eaten in rural India for centuries, raw, as a vegetable with spices, or preserved in chutneys and pickles and their medicinal properties include anti-inflammatory, anti-nociceptive, anti-ulcer, anti-diabetic, carminative, febrifugal, anti-pyretic and antioxidant *Caralluma* species have been used for centuries in semi-arid areas of Pakistan as emergency foods (Atal *et al.*, 1980); while *Caralluma edulis* is known for its antidiabetic properties (Wadood *et al.*, 1989) and other *Caralluma* species for their antihyperglycemic activity (Venktash *et al.*, 2003). Extracts from *Caralluma* species are nowadays the object of an increasing interest for small nutraceutical enterprises. Indian tribals chew chunks of *C. adscendens* var. *fimbriata* to suppress hunger when on a day’s hunt. These succulent is used among the labor class in South India to suppress appetite and enhance endurance. The *Caralluma* genus is one of edible cacti, which includes several species, many of which grow across is often found as a roadside shrub or boundary marker and waste land in India. The two genus *Caralluma* and *Boucerosia* species are endemic in south India. Most of the *Caralluma* (*Sensu lato*)=*Boucerosia* have a similar appearance having umbel flower, resemblance to pink, purple, gray or brown radar discs, stems with soft spinney like leaves. *Caralluma* (*Sensu stricto*) flowers are simple, open, and moderately odoriferous.

Booth (1985) has understanding the degraded forest then developed a tool to assess its growth capability in the region of interest. Such in-situ conservation is achieved both by setting aside areas as nature by ensuring that *C.stalagmifera var. longipetala* wild species as possible can continue to survive in managed habitats in specific sites of study area.

2. Materials and methods

The present investigation was undertaken to study distribution, population structure, and regeneration status of *C. adscendens var. fimbriata*. The details of the study such as materials, techniques and methodologies adopted are presented hereunder.

2. 1. Study area

Study area comprises six taluks of Chitradurga, in Central part of Karnataka

2.2. Enumeration of *Caralluma adscendens var. fimbriata*

A thorough survey has been conducted to assess species diversity and distribution of *C.stalagmifera var. longipetala* during the period December 2009 to December 2010 in selected study sites in Karnataka. However, it was not possible to survey quantitatively the entire research area; even then every effort was made to include the entire representative, topographic and physiological condition in the study area. Enumeration of *C.stalagmifera var. longipetala* and other plants of herbs and shrubs layer were done by laying 10×10 m² twelve quadrat randomly in different habitats like, waste lands, hills, fallow land, agriculture fields fences, and gomalas in scrubby vegetations. The initial point of the first quadrat was randomly selected by tossing a nail. After, we made quadrats in study sites at regular interval for measure 10 steps, Our collected specimens were deposited in the preparation of Herbarium and fresh uprooted *Carallumas (Sensu lato)* were planted in Department of Applied Botany poly house, Kuvempu University.

2.3. Population dynamics of *Carallumas*

A total of three permanent plots were established to find out the population dynamics at Janappana Gudda (on hill slope in forest), Hosabeelu (in between forest land and agricultural land) and Muddapura (near village area) for 3 years during 2009, 2010 and 2011. At each plot we laid 5 quadrats each of size 10x10m². A total of 15 quadrats were thoroughly surveyed during three years to study the plant diversity

and population dynamics studies. During this period frequent visits were made twice in every season to collect, identify and document the plants population in study sites.

2.4. Diversity studies using statistical analysis

The vegetation data were quantitatively analyzed for abundance, density and frequency (Curtis and McIntosh 1950), relative frequency, relative density were determined, while importance value index (IVI) was calculated following (Misra, 1968). Species diversity was determined with Shannon and Weiner information function (Shannon and Weiner, 1963). The concentration of dominance values was assessed by Simpson's index (Simpson, 1949) followed by Whittaker (1975). Beta diversity was calculated to measure the rate of species change across sites, besides this dominance diversity curve are also drawn to ascertain resource apportionment among the different species in various study sites for samplings.

2.5. *Caralluma (Sensu lato)* seedling

The healthy *C. adscendens* var. *fimbriata* 60 seeds and *C. stalagmifera* var. *longipetala* 50 seeds were collected and grown on natural soil (Forest litter soil) nursery bed Fig 2. *C. fimbriata* out of 60 seeds 45 plants were germinated and *C. longipetala* out of 50 seeds 36 plants was germinated. The fully developed plants were then transferred to polythine bags and kept on greenhouse condition up to three month. After complete developed the both species, 15 plants of *C. fimbriata* and 15 plants of *C. longipetala* species were shifted in their natural habitats and planted under the associated plant canopy.

3. RESULTS AND DISCUSSION

3.1. Diversity of *Carallumas* and their associated species in Chitradurga district

A total of 7 species (*C. adscendens*, *C. stalagmifera* *B. indica*, *B. truncato-coronato* = (*B. nilgiriya*), *B. umbellata*, *B. lasiantha*, and *B. diffusa*) and 5 varieties (*C. adscendens* var. *fimbriata*, *C. adscendens* var. *attenuata*, *C. stalagmifera* var. *stalagmifera*, *C. stalagmifera* var. *intermedia*, *C. stalagmifera* var. *longipetala*) of *Caralluma* were occurred in different geographical study area (Table 1.1). *C. adscendens* var. *fimbriata* and *C. stalagmifera* intermediated species were representing three varieties of *Caralluma* species was first recorded in Chitradurga, of Karnataka viz., *C. stalagmifera* var. *stalagmifera*, *C. stalagmifera* var. *langipetala* and *C. stalagmifera* var. *intermedia* (Fig 2). Increasing availability of plant material has demonstrated at intraspecific variability, where almost every population showed its own features many illustrations published by (Bruyns, 1987 b, 1988; Jonkers and Walker, 1993; Shaw, 1980; White & Sloane, 1937). Species such as *C. truncato-coronato*, *C. indica* and *C. nilgiriya* are rare in population in the study area and these are also new records after long years in Chitradurga.

Results revealed that dominant species of IVI values in Chitradurga districts of *C. adscendens* var. *fimbriata* (1.2) was followed by *C. adscendens* *C.attenuata* (0.4) and *C. stalagmifera* (0.45) *Caralluma st. var. stalagnifera* (0.3) *Caralluma st. var. longipetala* (0.34) *Caralluma st. var. intermedia* (0.18) *Caralluma laceantha* (0.41) *Caralluma umbellate* (0.41) *Caralluma trunkatacorinata* (0.73) *Caralluma indica* (0.18) *Caralluma diffusa* 0.26 (Table 1.1). In our study 5 species are newly recorded in Chitradurga districts of Karnataka. Karuppusamy *et al.* (2013) described *B. truncato-cronata* (= *C. nilagiriana*). *Caralluma* other associated species like *Albegia amara* (0.71), *Barlaria buxifolia* (0.99), *Bryophyllum pinnatum*(0.97), *Canthium parviflorum* (2.3), *Cassia auriculata* (0.71), *Lantana camara* (0.45) and *Opuntia elatior* (0.63), respectively Tab 1.

Table 1. Diversity of *Caralluma fimbriata* and their associated species from Chitradurga district.

Carallumas and their associated species	q st	q occ	ind	den	fre	abu	rd	rf	ivi
<i>Acheranthus aspera</i>	4	1	2	0.5	0.25	2	0.08	0.14	0.22
<i>Albegia amara</i>	4	3	7	1.75	0.75	2.3333	0.28	0.43	0.71
<i>Alternanthera pungens</i>	4	2	22	5.5	0.5	11	0.88	0.29	1.17
<i>Amaranthus viridis</i>	4	1	1	0.25	0.25	1	0.04	0.14	0.18
<i>Barlaria buxifolia</i>	4	3	14	3.5	0.75	4.6667	0.56	0.43	0.99
<i>Bidens biternata</i>	4	1	1	0.25	0.25	1	0.04	0.14	0.18
<i>Bryophyllum pinnatum</i>	4	2	17	4.25	0.5	8.5	0.68	0.29	0.97
<i>Calatropis gigantea</i>	4	2	2	0.5	0.5	1	0.08	0.29	0.37
<i>Canthium parviflorum</i>	4	4	43	10.75	1	10.75	1.72	0.58	2.3
<i>Caralluma adsendense</i>	4	2	6	1.5	0.5	3	0.24	0.29	0.53
<i>Caralluma attinuata</i>	4	2	4	1	0.5	2	0.16	0.29	0.45
<i>Caralluma umbellata</i>	4	2	3	0.75	0.5	1.5	0.12	0.29	0.41
<i>Caralluma st. var. stalagnifera</i>	4	1	5	1.25	0.25	5	0.2	0.14	0.34
<i>Caralluma st. var. longipetala</i>	4	1	5	1.25	0.25	5	0.2	0.14	0.34
<i>Caralluma st. var. intermedia</i>	4	1	1	0.25	0.25	1	0.04	0.14	0.18
<i>Caralluma fimbriata</i>	4	4	17	4.25	1	4.25	0.68	0.58	1.26
<i>Caralluma laceantha</i>	4	2	3	0.75	0.5	1.5	0.12	0.29	0.41
<i>Caralluma stalagmifera</i>	4	2	4	1	0.5	2	0.16	0.29	0.45
<i>Caralluma trunkatacorinata</i>	4	2	11	2.75	0.5	5.5	0.44	0.29	0.73
<i>Caralluma indica</i>	4	1	1	0.25	0.25	1	0.04	0.14	0.18
<i>Caralluma diffusa</i>	4	1	3	0.75	0.25	3	0.12	0.14	0.26
<i>Cartharanthus pusillus</i>	4	1	2	0.5	0.25	2	0.08	0.14	0.22
<i>Cassia auriculata</i>	4	3	7	1.75	0.75	2.3333	0.28	0.43	0.71
<i>Cassia uniflora</i>	4	1	15	3.75	0.25	15	0.6	0.14	0.74
<i>Celosia argentea</i>	4	1	2	0.5	0.25	2	0.08	0.14	0.22

<i>Croton bonplandianus</i>	4	3	23	5.75	0.75	7.6667	0.92	0.43	1.35
<i>Datura quercifolia</i>	4	1	2	0.5	0.25	2	0.08	0.14	0.22
<i>Dodonaea viscosa</i>	4	2	6	1.5	0.5	3	0.24	0.29	0.53
<i>Echinops echinatus</i>	4	1	4	1	0.25	4	0.16	0.14	0.3
<i>Euphorbia antiqurum</i>	4	2	3	0.75	0.5	1.5	0.12	0.29	0.41
<i>Evolvulus alsinoides</i>	4	2	2	0.5	0.5	1	0.08	0.29	0.37
<i>Flaveria trinervia</i>	4	2	4	1	0.5	2	0.16	0.29	0.45
<i>Gomphrena serrata</i>	4	1	3	0.75	0.25	3	0.12	0.14	0.26
<i>Ipomoea obscura</i>	4	1	5	1.25	0.25	5	0.2	0.14	0.34
<i>Lantana camara</i>	4	2	4	1	0.5	2	0.16	0.29	0.45
<i>Launaea procumbens</i>	4	2	6	1.5	0.5	3	0.24	0.29	0.53
<i>Ocimum sanctum</i>	4	1	2	0.5	0.25	2	0.08	0.14	0.22
<i>Opuntia elatior</i>	4	3	5	1.25	0.75	1.6667	0.2	0.43	0.63
<i>Pavetta indica</i>	4	2	4	1	0.5	2	0.16	0.29	0.45
<i>Plumbago zeylanica</i>	4	2	6	1.5	0.5	3	0.24	0.29	0.53
<i>Scilla hyacinthia</i>	4	1	5	1.25	0.25	5	0.2	0.14	0.34
<i>Solanum anguivi</i>	4	2	2	0.5	0.5	1	0.08	0.29	0.37
<i>Solanum nigrum</i>	4	2	5	1.25	0.5	2.5	0.2	0.29	0.49

3.2. Diversity of IVI values of 3 permanent plot on study sites

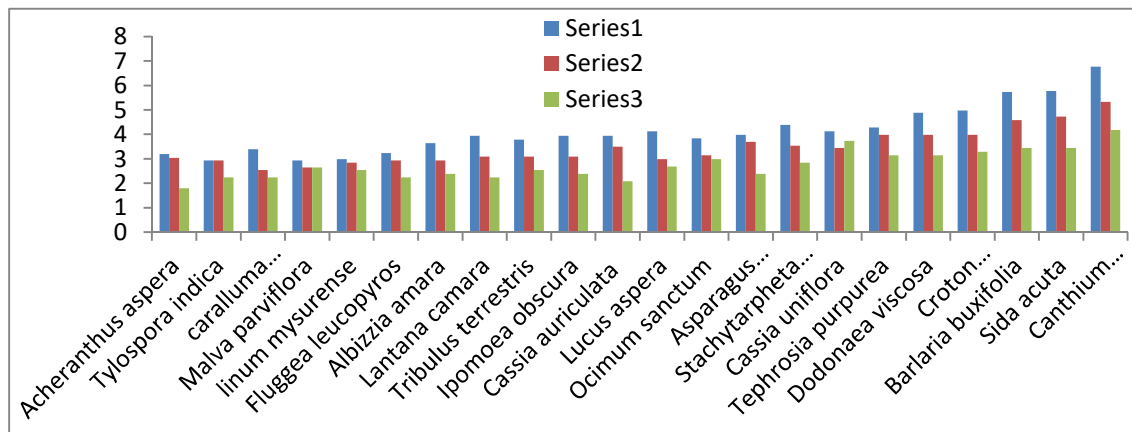
During the present study, three permanent plots were plotted in which each contained five quadrants. Totally 15 quadrants were plotted near agriculture land for study sites of diversity indices. Each plot was observed for the species that caused depletion and vegetation pattern of each plots during the year 2009 to 2011. In the first plot the rate of vegetation decreased from first year to next year due to encroachment of forest land. During the period 2009, the diversity IVI value of *Canthium parviflorum* was 6.77%, in the year 2011 it 4.18% followed by *Sida acuta* from 5.77% to 3.44%, *Barleria buxifolia* from 5.73% to 3.44%, *Dodonaea viscosa* from 4.88% to 3.14%, *Cassia uniflora* from 4.13% to 3.73%, respectively (Graph 1).

Similarly, the second plot was lied five quadrants to study diversity indices, near the agricultural land during the period of 2009 to 2011. The plant species depleted due to firing, encroachment of agricultural land, grazing, fire wood and the apical region infection by insect of *Caralluma* species. The plant population varied from year to year, during the study period of (2009) the dominant species of IVI values was *Canthium parviflorum* (11.60%); same species decreased during the study period of 2010, the IVI values of *Canthium parviflorum* was 9.79% in the year 2011. IVI values of same species was 7.19% followed by other species like *Dodonaea viscosa* (8.66%) in 2009, the same species decreased to 6.27%

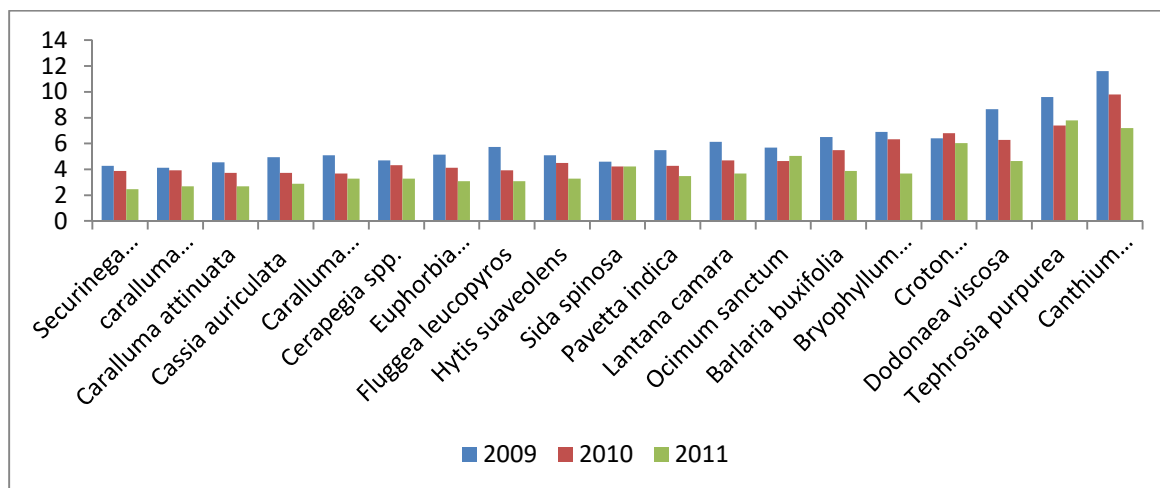
during the period of 2010, 4.65% in 2011, followed by other species like *Croton bonplandianus*, *Bryophyllum pinnatum*, *Barlaria buxifolia*, *Lantana camara*, *pavetta indica*, *Sida spinosa* respectively (Graph 2).

In plot 3, the dominant species in the year 2009 was *Cassia uniflora* (13.96%), the same species population in 2010 was 6.66% and 2011 was 1.98% followed by *Canthium parviflorum* (8.16%) in 2009, 4.15% in 2010 and 1.98% in 2011, *Croton bonplandianus* in 2009 was 7.58%, 3.77% in 2010 and 1.79% in 2011, *Barlaria buxifolia* in 2009 (6.43%), 2.61% in 2010 and 2.61% in 2011 followed by other species *Ocimum sanctum*, *Lantana camara*, *Cassia auriculata* respectively (Graph 3).

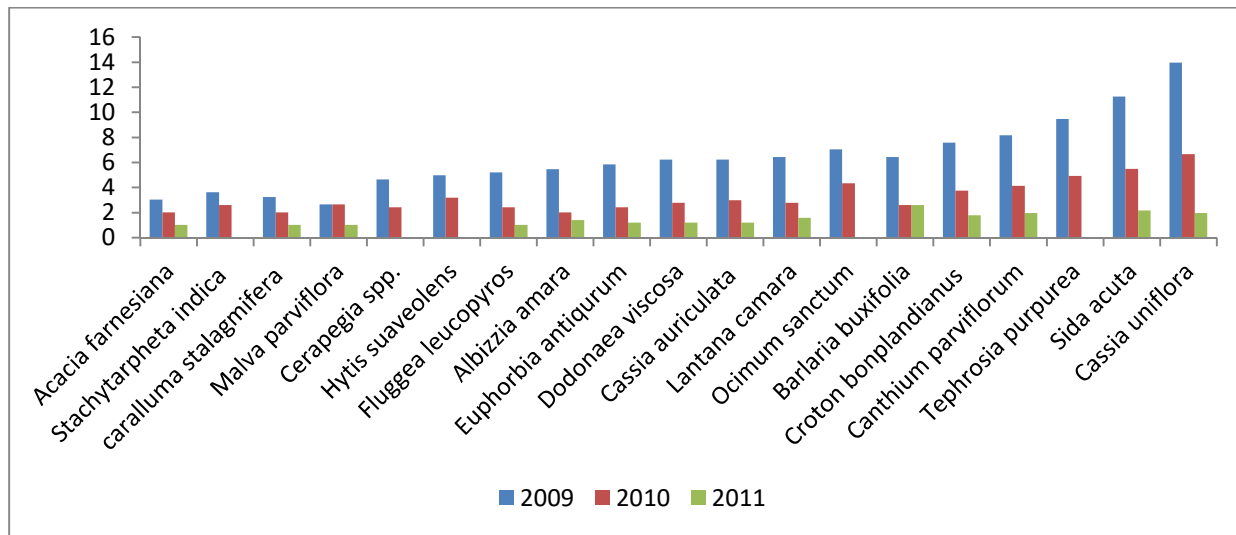
Graph 1. Diversity of IVI value of three year permanent plot studies sites



Graph 2. Diversity of IVI value of three year permanent plot studies sites



Graph 3. Diversity of IVI value of three year permanent plot studies sites



3.2.1. Alpha-diversity indices of *Caralluma* associated spp. from 3 permanent plots

In the present investigation maximum number of species were encountered in the three permanent plot in the study area, highest individuals of the species in plot 1 (570) belonging to the 82 species, followed by individual of the species in plot 2 (416) belong to the species (60) and individual of the species in plot 3 (297) belonging to the species (59) respectively (Table 2).

The concentration of the alpha-diversity dominance- D from three plots of study sites, probability of encountered dominance of the plot 3(0.04) followed by plot 2 (0.03) and plot 1 (0.02) plots, respectively (Table 3). When compared the diversity indices among the three plots, the species richness in plot 1, Shannon diversity index is $H^1 = 4.18$ followed by Plot 2 and Plot 3. Similarly, the highest number of Simpson diversity index was also found in plot 1 $D = 0.98$, plot 2 $D = 0.97$ and plot 3, $D = 0.96$. We also carried out highest Jaccard similarity index plot 1, $J = 0.95$, plot 2, $J = 0.91$ and plot 3, $J = 0.89$ respectively. The highest Fisher-alpha index is plot 1 is 21.19, followed by other two plots respectively (Table 3).

Table 3. Alpha-Diversity indices of three permanent plots

Diversity indices	plot1	plot2	plot3
Taxa_S	82.00	60.00	59.00
Individuals	570.00	416.00	297.00
Dominance_D	0.02	0.03	0.04

Simpson_1-D	0.98	0.97	0.96
Shannon_H	4.18	3.72	3.62
Evenness_e^H/S	0.80	0.68	0.63
Brillouin	3.93	3.48	3.33
Menhinick	3.44	2.94	3.42
Margalef	12.76	9.78	10.19
Equitability_J	0.95	0.91	0.89
Fisher_alpha	26.26	19.24	22.10
Berger-Parker	0.05	0.09	0.10

3.3. Threats to the *Caralluma* spp in the study area

The main threat to *Caralluma* population is over exploitation and selective removal of highly valuable medicinal plants of *Carallumas*.

3.3.1. Forest fires

The forest fires are the most important elements threatening the forests on scrubby jungles near study sites, in particular, the forests in the hilly region are under an intense threat in summer season.

3.3.2. For edible uses

The local people consume daily in several different forms as a regular vegetable, preparation of pickles and chutneys. Some village people and hunting tribes are using eat directly as raw in the dry part of Karnataka. In Chitradurga district few village peoples used *Caralluma* for preparing traditional drinks.

3.3.3. Medicinal uses

In Chitradurga district local people's, *Carallumas* were used for curing various diseases like paralysis, joint pains and cure burning wound,

3.3.4. Threats caused by insects

In studied period, the field was observed to be the food source (*Caralluma* species) of butterfly which is in larvae stage. The grass hopper also eat apical stem portion, hence, the young shoots are shrinked. These affected plants do not develop well and finally these shoot form brown colour and gets dried.

3.3.5. Expansion of agricultural area

Local people were encroachments of forest land and then converted to agricultural land due to the region of threatens the *Caralluma* species.

3.3.6. Collection of fuel wood

Most of the nearby villagers depend on the study area for their need of the fuel wood. During the field observation, maximum species like *Dodoneia viscosa*, *Lantana camara*, *Cantium parviflorum* and *Cassia auriculata* are being used as fuel wood. When these species are intervened for fireworks indirectly *Caralluma* population is also affected and decreased.

3.3.7. Mining and encroachment of forest land

Mining causes massive damage to landscape and biological communities. Plant community get disturbed due to mining activities, the habitats become impoverished presenting a very rigorous condition for its growth.

3.4. Reintroduction of *C. adscendens* var. *fimbriata* and *C. stalagmifera* var. *longipetala*

The conservation of wild species of *C. adscendens* var. *fimbriata* and *C. stalagmifera* var. *longipetala* plants is wherein protected and preserved in its natural habitat. After reintroduced plants species were observed four months (July, August, September and October) of plants height and leaves (ridges) from study sites. The plant species were maximum growth was observed in the month of September 10.19±0.27 cm and its number of leaf produced 26.00±0.80 and October month its growth on 11.46±0.30 cm and its numbers of leaf formed 31.53±0.74 Table 1.

Similarly the measurement of *C. stalagmifera* var. *longipetala* maximum growth an October 13.96±0.38 cm and their number of minute leaves 28.40±0.65 respectively Table 4.

Table 4. Monitored reintroduced plants height and leaves (ridges) from study sites.

Plants name	Characters	July	August	September	October
<i>C. adscendens</i> var. <i>fimbriata</i>	Height (cm)	9.09± 0.29	9.50± 0.29	10.19±0.27	11.46±0.30
	Leaves/ridges	17.80±0.74	21.87±0.74	26.00±0.80	31.53±0.74
<i>C. stalagmifera</i>	Height (cm)	7.87±0.19	8.41±0.19	9.95±0.25	13.96±0.38

var. <i>longipetala</i>	Leaves/ridges	16.53±0.61	19.00±0.66	22.87±0.67	28.40±0.65
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Refrence

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C.indica



C. laciantha



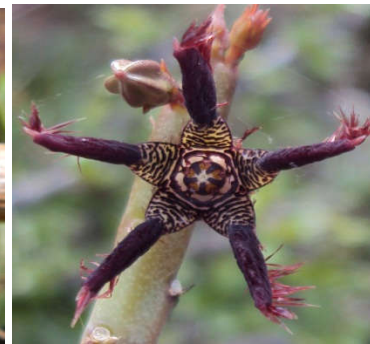
C. umbaleta



C.diffusa



Caralluma truncata



C. attenuata



Caralluma adsendense



C.fimbriata



C. stalagmifera



C.st var. longipetala



C.st var. stalagmifera



C.st var. intermedia