

ORIGINAL ARTICLE

Role of *Capparis sepiaria* L. (Capparaceae) in the Food Chain of Sariska Tiger Reserve with special focus on winter, dry or drought seasons

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ABSTRACT

Present communication deals with the first information based on the field observations of 6 years on the lifeline role of *Capparis sepiaria* L. [Capparaceae] in the Food Chain of Sariska Tiger Reserve with special focus on winter, dry or drought seasons when whole forest ecosystem of deciduous and thorny nature experiences shortage of food supply for herbivores. This species is widely available, evergreen, drought & pathogen resistant and well adapted to tough climatic conditions, leaves are nutritious and best palatable source of food for dominant herbivores of reserve like Spotted Deer, Sambar Deer, Nilgai etc., thus helps to maintain the rhythm of food demand and supply requirement at successive trophic levels throughout the year. Domesticated browsers and livestock reared in and around villages of Sariska has created excess burden on food chain which lead to its poor vigor and stunted growth (such as in core areas like Kankwari, Keraska, Tehla, Akabarpur etc.), posed various threat and raised unwanted challenges for whole forest ecosystem which must be checked on priority to nullify any ill effect on Food Chain in near future. Finally, conservation of this plant is suggested with possible introduction of native alternate food species.

Key Words: Alternate; *Capparis sepiaria*; Food Chain; Sariska Tiger Reserve; Winter-Dry-Drought.

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INTRODUCTION

Sariska Tiger Reserve (hereafter, STR) situated in the north-eastern part of Aravalli mountain ranges (27°05'–27°45'N, 76°14'–76°35'E) in the Alwar district of Rajasthan. The vegetation of STR corresponds to the Northern tropical dry deciduous and Northern tropical thorn forests [2]. The climate of the area is subtropical, which have a distinct winter (minimum temperature goes down to near 0°C), summer (maximum temperature goes up to near 47°C), monsoon and post-monsoon seasons. After the departure of monsoon in September, there is a gradual change in the vegetation pattern due to successive fall in the temperature and moisture content in coming months with the arrival of winter. During this transition phase, the forest which is luxuriantly green (Fig. 1, A) with adequate food availability for herbivores till monsoon lasts started turning into brown with drying-up of vegetation. Leaf fall initiation in the majority of tree and shrub species in STR initiate during mid of October. Winter commences from November and lasts up to mid of March; during the month of peak winter 'December to February', majority of the ground flora, shrubs & even trees become almost leafless or with dry leaves (Table 2 & Graph 1) and whole forest looks dry and brownish (Fig. 1, B). As the ground flora including grassland vegetation which are major source of food for herbivores become dried up to larger extent (Fig. 1, H–J & Fig. 2), naturally the competition for food rises to its maximum threshold limit.

The dominant flora of the STR are Grasses, *Grewia flavescens* Juss., *G. tenax* (Forssk.) Fiori, *Justicia adhatoda* L., *Terminalia pendula* (Edgew.) Gere & Boatwr. [*Anogeissus pendula* Edgew.], *Butea monosperma* (Lam.) Taub., *Ziziphus mauritiana* Lam., *Boswellia serrata* Roxb., *Lannea coromandelica*

(Houtt.) Merr., *Vachellia* spp., *Senegalia* spp., *Capparis decidua* (Forsk.) Edgew. *Phoenix sylvestris* (L.) Roxb., *Mitragyna parvifolia* (Roxb.) Korth. etc. Except few all are deciduous and not evergreen.

Capparis sepiaria L. [Capparaceae] is a perennial, drought & pathogen resistant, evergreen and accessible species which locally known as 'Jaal, Kanker' plays an important role in survivorship of herbivores and therefore having management importance mostly in dry-deciduous and thorny scrub forests (Fig. 2). It is a typical component of both intact and degraded *Acacia-Anogeissus pendula* formations [2]. Although the species is distributed in major parts of India in scrub or deciduous forests, but as the observations were taken from STR of Rajasthan, so the authors narrates its importance keeping in view the ground reality of STR. As *C. sepiaria* L. is an evergreen species and whole plant (including green stem) is photosynthetic, it produces new young shoots and leaves throughout the year, so it's young shoots & leaves become a best palatable source of food for herbivores not only during dry winter or drought period but it remain as an important composition of fodder plants in Sariska throughout the year. The leaves are broad and bit thick which provides good nutrition to the herbivorous. It maintains fairly high level of crude protein throughout the year (9.6–14.25 %), much greater than dry season grass materials averaging below 4% and is important browser plant of extreme drought period [9]. Langurs and birds widely consume the ripe berries.

Herbivores

The principal herbivores and major prey species of Tiger's in STR are Spotted Deer or Chital (*Axis axis* Erxleben), Sambar Deer (*Rusa unicolor* Kerr), Nilgai (*Boselephous tragocamelus* Pallas) and other herbivores such as Four-horned Antelope (*Tetracerus quadricornis* Blainville), Wild Pig (*Sus scrofa* L.) and primate like Langur (*Presbytis entellus* Dufresne) also joins this group. The density of prey species Chital, Sambar, Langur and Nilgai in STR are $46.7 \pm 9.5/\text{km}^2$, $26.2 \pm 4.9/\text{km}^2$, $22.8 \pm 6.5/\text{km}^2$ and $19.5 \pm 3.3/\text{km}^2$ respectively, whereas Livestock (*Bubalis bubalis* L. and *Bos indicus* L.) density is $59.9 \pm 22.3/\text{km}^2$ [10]. The estimated population of herbivores in STR during 2005 was 22583 Nilgai, 14901 Sambar, 12408 Chital, 4177 Wild Pig and 19379 Langur [4].

Food sources for herbivores during winter-dry-drought seasons

The dominant herbivores viz. Chital, Sambar, Nilgai etc. mostly graze grasses, *Capparis sepiaria* L., *Grewia* spp., *Terminalia pendula* (Edgew.) Gere & Boatwr., *Ziziphus mauritiana* Lam. etc. *Terminalia pendula* (Edgew.) Gere & Boatwr., a small to medium sized deciduous tree with drooping branches adjacent to ground surface which is locally known as 'Dhowk or Dhokdo' is the most dominant tree species of STR and is widely available palatable food source for herbivores after the grasses but both of these can't feed the herbivores during the winter-drought seasons. Similarly, *Ziziphus mauritiana* Lam., *Z. nummularia* (Burm.f.) Wight & Arn. and *Grewia* spp. are another dominant species in forest; leaves & fruits of both the genus are highly preferred by herbivores but again they are also deciduous. One can find large scattered population of partial-green ground shrub like *Justicia adhatoda* L. during this period but majority of the herbivores do not prefer this species. Finally, on a broader scale the food choice lies with *C. sepiaria* L. (Fig. 2). Some winter weeds, herbs grow during winter but neither their biomass and nor their population sizes are enough to feed large herbivorous population. More or less the drought last till June or until arrival of monsoon, although the new leaves & flowering in some tree species start appearing from mid-March or April onwards at the top of canopy and even if in few tree species like *Diospyros melanoxylon* Roxb., *Vachellia leucophloea* (Roxb.) Maslin, Seigler & Ebinger [*Acacia leucophloea* (Roxb.) Willd.] etc. have some green leaves but it's beyond the reach of ground herbivores. In general, tree species are not accessible for ground herbivores. Under such circumstances, there is a great scarcity of food especially for ground herbivores, as the ground surface including grasslands become dried up to greater extent (Fig. 1, H–J) with fallen dried leaves. Dry plants or plant parts are difficult to chew, sometimes causing jaw injury but fortunately nature has blessed STR with evergreen shrub like *C. sepiaria* L.

MATERIAL AND METHODS

Frequent field survey cum floristic exploration of STR was carried out since 2016 to 2021 in all pockets of the reserve in such a manner that it should repeatedly cover all the months of a year. During survey, observations on feeding habits of wild herbivores; phenology, foliage pattern or condition and their availability on all dominant species with special focus on available food sources for leaf eating ground herbivores were recorded. Foliage pattern based on the average of multiple eye observations through random sampling and quadrat study (10 × 10 m) were categorized as Green leaf (+) [code used = 4], new leaf initiation (+N) [code used = 3], partial dry (±D) [code used = 2], fully dried (+D) [code used = 1] and leafless (-L) [code used = 0] conditions observed in dominant ground species and the most dominant tree of study area *Terminalia pendula* (Edgew.) Gere & Boatwr. (Table 2 & Graph 1) was also considered for this.

RESULTS AND DISCUSSION

A summarised account of *Capparis sepiaria* L.

Capparis sepiaria L., Syst. Nat., ed. 10. 2: 1071. 1759; Hook.f. & Thomson in Hook.f., Fl. Brit. India 1: 177. 1872; Parmar in B.V. Shetty & V. Singh, Fl. Rajasthan 1: 85. 1987; Sundararagh. In in B.D. Sharma & al., Fl. India 2: 289. 1993.

Perennial, spreading or large scandent, scrambling, widely much branched, densely armed, somewhat woody shrub or sometimes become small tree, 2 to 5 m tall, with greenish stem and zig-zag twigs (Fig. 1, C & G). Leaves ovate, ovate-elliptic, oblong or oblong-lanceolate, 1.75–5.5 × 0.5–3.5 cm, rounded at base, entire at margins, obtuse or retuse at apex, subcoriaceous, glabrous above and downy beneath, petiolate; stipular spines 2–5 mm long, recurved, brownish-black. Flowers 0.75–1.0 cm across, white-tomentum in umbel with slender pedicel (Fig. 1, E), sweet-scented. Stamens many; filaments exerted, white. Ovary ovoid, beaked, glabrous. Fruit globose berries, ca 1 mm across (Fig. 1, F & G), smooth, fleshy, dark purple to violate turning black, 1-seeded. Seeds discoid, 5–6 × ca 4 mm, brownish.

Phytosociology: In case of STR, it is one of the most dominant, an extensively spreading shrub species available as ground flora which grows independently or widely in association with *Grewia flavescens* Juss. (Fig. 1, D), *G. tenax* (Forssk.) Fiori, *Butea monosperma* (Lam.) Taub., *Phoenix sylvestris* (L.) Roxb., *Ziziphus mauritiana* Lam., *Vachellia* spp., *Senegalia* spp. etc. in a continuous patch.

Leaf flushing: It triggered in April, new leaves replaced the matured leaves simultaneously and maximum leaf formation took place during June and reduced thereafter.

Flowering: March–July; **Fruiting:** October–November.

Multiplication: It can easily be raised by stem cutting (**Vegetative propagation**).

Nutritional and medicinal values: Berries are edible. Many birds consume its small size fruits. All parts of *C. sepiaria* L. is used by local Vaidya's and herbal practitioners for treating various ailments. Recent research based studies also support the medicinal importance of this species [6]. Its leaves possess reducing sugars, flavonoids, steroids, tannins, glycosides, alkaloids, gums, resins, amino acids, proteins and anthraquinones which could serve as potential source of the crude drugs [8]. Its root shows anti-inflammatory and analyses activities [3].

Disease & drought resistant behavior: While some species in forest are prone to pathogens or termites but it strongly shows pathogen resistance behavior. This plant can tolerate extreme drought.

Ethnobotanical uses: Locals often used its stem for boundary fencing along with other spiny species in agricultural fields or villages to safeguard their territory from wild animals.

Distribution: In Rajasthan, *C. sepiaria* L. is common in scrub forests and wastelands, particularly in the east of Aravalli [12].

India: Almost throughout India, except Jammu & Kashmir, N.E. hill states, Andaman & Nicobar Islands and other high humid regions.

World: Australia, China, Malaysia, Pakistan, Sri Lanka and tropical Africa.

Socioeconomic aspects, grazing pressure and supporting role of *Capparis sepiaria* L. in the vicinity of STR

Total geographical area of STR is ca 1213 km². The boundaries of STR is surrounded by thickly populated villages and even inside STR there are 24 villages in core areas and 146 villages are in the periphery of reserve. About 2254 families live in the core area, while about 12000 families live around the critical tiger area [11]. This reserve is a human dominated landscape that is subjected to immense anthropogenic pressures [1]. The main occupation of village dwellers of the core areas are cattle rearing (Buffalo, Goat, Cow, Sheep and few have Camels) for milk and its mawa which they sell in local markets and some villages do very small scale farming but undoubtedly, legally or illegally the forest of STR is one of the major backbone for food availability (Fig. 3, E–H) to large population of cattle in and around STR; on average, each household in core areas of the villages have 26 livestock animals [5]. The most nearest local market in the vicinity of STR are Thanazagi & Kushalgarh and main town is Alwar, which are famous throughout the Rajasthan for a sweet-dish called 'Milk-cake' or 'Kalakand' or 'Mishri-Mawa' (Fig. 3, J). As the name suggest this 'Milk-cake' is made up of milk, the whole area is rich in high milk production, naturally the area is having high number of cattle population and directly or indirectly this large population of cattle put great pressure on ground flora of STR (Fig. 3, E–I) and increases the competition for food to many fold for native wild herbivores (specially for Spotted Deer, Sambar Deer, Nilgai etc.) of STR. 'Milk-cake' is one of the primary cause behind rampant livestock grazing in STR [13]. One can easily find herd of Sambar Deer near roadside on SH-13 in search of food during winter-dry or drought period, which may pose threat of road accident or may be easy poaching but wide availability of *C. sepiaria* L. in and around STR ease some pressure from ground flora during the harsh months. So again the *C. sepiaria* L. ensures its role in the food chain of STR and proved to be a lifeline plant of STR.

Capparia sepiaria L. and food chain during winter-dry-drought seasons

The self-sustainability of any ecosystem depends upon the amount of food supply available at each trophic level of food chain. In the absence of *C. sepiaria* L. in STR, continuous supply of food chain at producer level may collapse especially during the winter, dry or drought seasons as there is no evergreen alternative species widely available flora on ground during the mentioned period (clearly depicted from Table 2 & Graph 1) to feed large herbivorous population of STR. The ground flora remain dry on a broader scale till May switch over to revival of greenery from mid-June onwards with arrival of pre-monsoon and later monsoon rain which resumes the adequate supply of food at producer level specially on ground flora.

Thus, *C. sepiaria* L. seems to be a boon for principal herbivores like Chital, Sambar and Nilgai as they survives extreme winter and even drought by feeding its evergreen leaves (Fig. 2, E-J), which play an important role for the continuous supply of food chain at producer level as a major source of nutrient during such period. Equally, principal herbivores are major source of top predator's or consumer's diet i.e. Tiger and even Leopards highly depends on them (Table 1). Percentage frequency of occurrence of animals in leopard's and tiger's diet is given below in Table 1.

Table 1: Top predator's or consumer's diet

Animal	Leopard's diet Source: [7]	Tiger's diet Source: [7]	Tiger's diet Source: [10]
Sambar	45.5%	41.7%	45.2%
Chital	15.2%	26.2%	15.7%
Nilgai	8.9%	10.7%	16.5%
Cattle	7.1%	19.4%	10.4% (buffalo and cattle) and 1.7% goat
Langur	6.3%	1.9%	----
Peafowl	6.3%	----	----
Rodent	5.4%	----	----
Wild pig	2.7%	----	9.6%
Hare	2.7%	----	----
Porcupine	----	----	0.9%

Naturally, *C. sepiaria* L. have a great role to strengthen the food chain, food web and ecosystem of STR from producer to top consumer level as clearly depicted from Fig. 4.

Graph 1: Foliage pattern

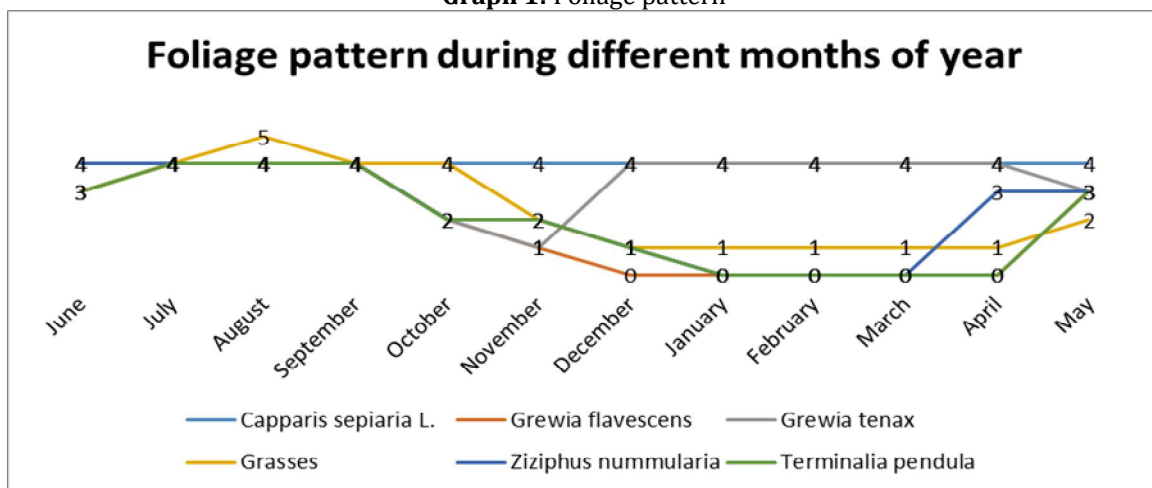


Table 2: Foliage patterns or conditions observed in dominant ground species including *Terminalia pendula* (Edgew.) Gere & Boatwr. in core areas of STR during all months of the year (2016-21); Green leaf = (+), new leaf initiation = (+N), partial dry = (\pm D), fully dried = (+D), leafless = (-L).

Sr. No.	Ground flora	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
I.	<i>Capparis sepiaria</i> L.	+	+	+	+	+	+	+	+	+	+	+	+
II.	Grasses or Grasslands	\pm	+	+	+	+	\pm D	+D	+D	+D	+D	+D	\pm
III.	<i>Grewia flavescens</i> Juss	+N	+	+	+	\pm D	+D	-L	-L	-L	-L	-L	+N
IV.	<i>Grewia tenax</i> (Forssk.) Fiori	+N	+	+	+	\pm D	+D	-L	-L	-L	-L	-L	+N
V.	<i>Terminalia pendula</i> (Edgew.) Gere & Boatwr.	+N	+	+	+	\pm D	\pm D	+D	-L	-L	-L	-L	+N
VI.	<i>Ziziphus nummularia</i> (Burm.f.) Wight & Arn.	+	+	+	+	\pm D	\pm D	+D	-L	-L	-L	+N	+N

Following are some of very important observations and suggestions based on field survey data's of 6 years (2015-21) in STR:

- Although *C. sepiaria* L. is one of the dominant species of STR, but there is a need to find another native evergreen species which can be introduced and multiplied to larger extent, as an alternative food choice for herbivores, so that there should not be over burden on this species during the winter, dry or drought period.
- The over burden on *C. sepiaria* L. species and high level of competition for food during winter, harsh or drought period can easily be understand by the fact that in such seasons one can easily find number of herds of Sambar Deer near roadside on SH-13, a busy road searching food or waiting for food from some passersby, sometime who feed them with roti, fruits, vegetables etc., although its illegal but this is a real fact which must be addressed at the earliest to save them from any possible threat.
- Presently *C. sepiaria* L. is experiencing extra burden of grazing pressure by domesticated animal like Goat (Fig. 3, D & F) and Camel. One can easily notice grazing activities of Goats in Knakwari, Keraska, Tehla, Udaynath forest (core areas) and other several parts of forest, these goats are causing poor vigor, stunted growth and reducing the natural population of *C. sepiaria* L. Camel grazing in wild areas can be seen in Prithivipura (Akbarpur range), Richunda, Dabkan (Tehla range) etc. Buffalo and cow although do not eat this plant but their presence inside forest (Fig. 3, G & H) create unnecessary food competition, posed various threat and raised unwanted challenges and narrow down the other available food resources for wild herbivores, it must be checked on priority to nullify any ill effect on Food Chain in near future.
- As *C. sepiaria* L. is holding the excess burden of food supply to herbivores and maintaining the rhythm of food chain especially during the winter or dry-drought period, if unfortunately any disease spreads or there is reduction in foliage production of this plant, then the herbivores will not left with any major alternative choice during the above mentioned period. So, there is a need of more research for more available options if any undesirable things happen to this species in near future.
- It was noticed that *C. sepiaria* L. provide safe shelters to some reptiles, birds or small prey from predators, due to its green bushy and thorny nature (Fig. 3, A-C). Its random presence at most of the valley where maximum number of herbivores resides provides an indirect shelter or protection to them from predators behind their bush, as the bush is spiny. Excess grazing pressure on it has disturbed the habitat of many prey species and greatly reduced its population & plant sizes as mentioned in above point number 'iv'.
- Sometimes herbivores mouth gets injured due to its hooked thorns as they do not have any alternative food choice during the dry-drought or winter period. So, the forest department should think for introduction of some alternative native species.
- Rainfall pattern is never uniform and full of uncertainty throughout Rajasthan. Whole plant of *C. sepiaria* L. looks green and full of leaves even in drier or drought parts of forest such as Kankwari

region and the plant has adapted well in wide range of temperature variations (0°C–47°C), so in case of draught or delay in monsoon arrival or even in case of climate change or global warming like situations it seems to have potential to serve as a key species for herbivores of STR. It was important browser plant even during extreme drought period of 1987-88 in Sariska [9].

- While discussion with many elderly people who are residing in and around STR since long back and rear their own cattle in Sariska on the question that ‘which plant do you think on ground flora can serve as an option for herbivores food during dry-winter or drought of STR’, they suggested that *Ziziphus nummularia* (Burm.f.) Wight and Arn. can be one option, although its leaves are small but for herbivores like Spotted Deer, Sambar etc. it is an important source of their diet, even its dried leaves and fruits in winter months are soft and easy to chew and widely available as ground flora. Langurs were seen to eat the dried fallen fruits of *Z. nummularia* (Burm.f.) Wight and Arn. It can easily be multiplied to large extent and have the ability to expand at rapid rate. Some also suggested that species like *Salvadora oleoides* Decne., *S. persica* L. can serve the purpose although both the species are rarely represented in the study area but many habitats of STR appears suitable for its growth. Moreover, it is a large evergreen shrub or tree species but its branches are drooping adjustment to ground and both leaves & fruits are widely consumed by many herbivores as seen in many parts of Aravalli range. Suggestions were also shouted for *Maerua oblongifolia* (Forsk.) A. Rich. etc. Future experiments can also be carried out with other shrubby relatives of *Capparis* genus like *C. grandis* L.f., *C. spinosa* L., *C. zeylanica* L. etc. which have possibilities to adapt in climate of Sariska.



Figure 1: A. Top view of STR during monsoon (Sept.) B. During winter (Dec.); *Capparis sepiaria* L. C. Habit D. Growing in association with *Grewia tenax* (Forssk.) Fiori & *G. flavescens* Juss E. Flower F. Fruit G. Zig-zag twigs H–J. Winter habitat.

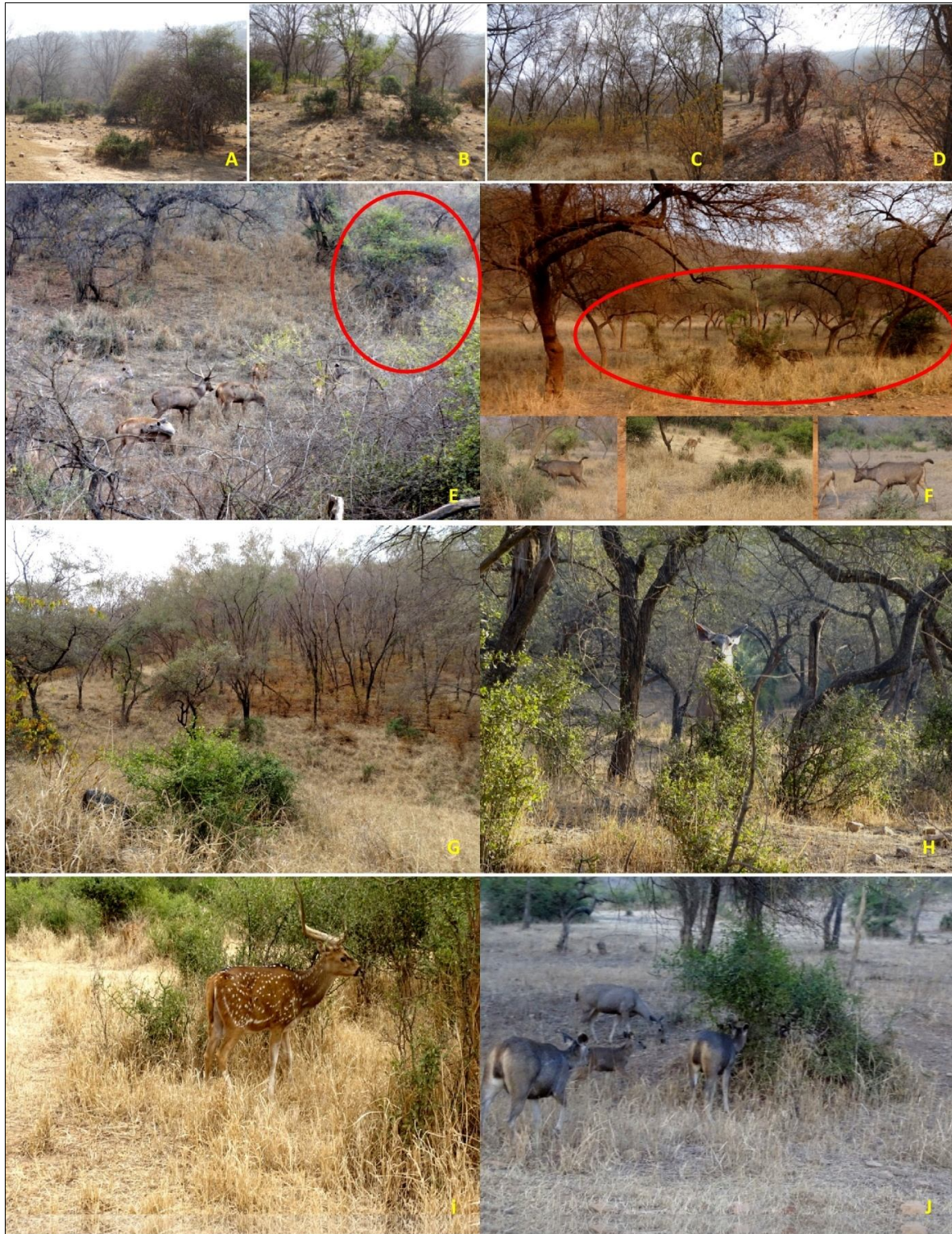


Figure 2: A-B. *Capparis sepiaria* L. in dry habitat; C-D. Deciduous & thorny forest of STR; E-J. High dependency of herbivores for food on *C. sepiaria* L. during winter-dry-drought period.



Figure 3: *Capparis sepiaria* L. proving shelter to **A.** Langoor **B.** Monitor Lizard **C.** Rodents; Kankwari village **D.** Grazing prone area **E.** Cattle rearing inside core area of STR, **F-I.** Excess grazing pressure of domesticated animals in and around STR **J.** A vender selling the famus *Milk-cake* of Alwar district in Kushalgarh (adjacent to boundary of STR).

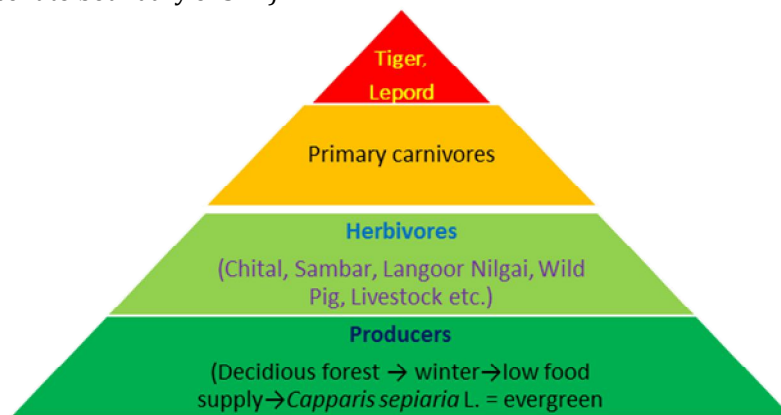


Fig. 4: Basic Food Chain in STR

CONCLUSION

Undoubtedly *C. sepiaria* L. is an integral component of the Food Chain of STR. It is an important lifeline ground-flora shrub-plant for herbivores of STR especially during the winter, dry or drought seasons. So all care should be taken for the maintenance of its dominant status even in future and making available other food options for herbivores by high level of research programme is an utmost need of time.

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