

Ecology and Distribution Pattern

Parasites are defined as plants that are combined with a host plant throughout their lifetime, during which they receive a benefit from the host but give none to it (Douglas, 1994; Thompson, 1994). Parasitic interactions between organisms play a fundamental role in ecosystems. The interacting partners often belong to different families or even kingdoms. But there are many examples of parasitism in angiosperms (Weber, 1993). Based on chlorophyll content and nutrient uptake, two major types of plant parasites can be distinguished. Hemiparasites with green leaves contain chlorophyll and perform photosynthesis, but they are dependent upon host plants for water and nutrient uptake, Holoparasites have low chlorophyll content or lack chlorophyll altogether and are therefore often conspicuously pale green to brown. These plants take all nutrients and water by the help of haustorium from the host plants. Parasites are estimated to be 1% angiosperms, of which 40% are shoot parasites and rest 60% are root parasites (Musselman and Press, 1995). One well-known group of hemi-parasitic angiosperms are mistletoes. The majority of mistletoes are come under the families viz Loranthaceae and Viscaceae. *Loranthus* is a genus come under the family Loranthaceae. *Loranthus* is a common epiphytic stem parasites, which grows on the branchlets of old aged trees. These plant is classified as hemiparasite but are also called partial parasites, aerial parasite etc. In previous systematic classification, the mistletoe species have bisexual flowers, though some species with unisexual flowers, while most modern systematic classification *Loranthus europaeus* Jacq is represents only single species i.e monotypic genus. This plant grows on aged and mostly observed at a certain height from the surface. After establishment it's haustorium within host plant, it uptakes mineral water, side by side, they block sunlight by covering the encroached place.

Climate

The Ajodhya hills, Panchakot hills of Purulia district where rainfall is very uncertain and scarcity of water is observed of south West Bengal. It has a subtropical climatic nature. Annual rainfall exactly expressed the nature of climate of the district. The rainfalls of these districts are mainly dependent on south west monsoon. Annual rainfall on average of this area varies from 1100 mm to 1500 mm. The areas accompanied with high humidity, ranges from 75% to 85%. But it fall down from 25% to 35% in summer condition.

In summer, the climate of Sarenga jungle, Jalar jungle of Bankura district, the thermometer in the shade rising to around 45 °C (113 °F). The monsoon months i.e. June to September, the atmosphere is comparatively cooled down and pleasant. The average rainfall is 1,400 millimeters (55 in), and occurred within the month of June to September. Winters is also favorable as the temperatures dropping down to below 7⁰C-15⁰C in December.

The climate of Kushboni forest, Salboni forest, Dhamkurar jungle, Hoomgarh forest, Bulanpur forest of Midnapur district is hot with tropical monsoon weather pattern. Summer from last April and middle of June with highs ranging of temperature from the upper 30°C to the mid 40°C. Generally a mild wind or storm is often occurred at evening due to the raising heat at day time with rain commonly known as kalboishakhis. Monsoon rains occurred generally from last or mid-June, sometimes in late August or even September and the main source is southeast monsoon contributing the annual rainfall of around 1500 mm. Winter is short for 2 to 3 months and are mild; on that time varies from 8 °C – 14 °C.

The Soil character of this region may varies from alluvial with a high-degree of clay or sand to lateritic. Vegetation includes *Eucalyptus* and Sal forests are predominant in this area.

VI. A - Distribution of *Loranthus*

Loranthus is found to occur throughout the world. It is mostly distributed in the tropical region. In southwest Bengal, this parasitic plant (*Loranthus parasiticus*) found in district of PaschimMidnapur, Bankura and Purulia. The occurrence of the plant throughout the area of this region. But, the frequency is greater in natural forest vegetation like Kushboni forest, Salboni forest, Dhamkurar jungle, Hoomgarh forest, Bulanpur forest, Sarenga jungle, Jalar jungle rather than other part.

Host Range: This plant normally found in the natural forest of the tropical or subtropical region. Mostly the *Loranthus* plant grows on the deciduous tree plant such as *Ficus religion*, *Shorea robusta*. But diverse host range has also been observed in the natural forest during this study.

Table No-1: Name of the host List of *Loranthus parasiticus* distributed in part of South-West Bengal

Sl. No.	Name of the host plant	Local/Common Name	Family
1.	<i>Barringtonia asiatica</i> (L.) Kurz	Hizal	Lacynthidaceae
2.	<i>Bombax ceiba</i> L.	Cotton tree	Malvaceae
3.	<i>Shorea robusta</i> Roth.	Sal	Dipterocarpaceae
4.	<i>Terminalia catappa</i> Linn.	Indian Almond	Combretaceae
5.	<i>Lagerstroemia speciosa</i> (L.) Pers.	Jarul	Lythraceae
6.	<i>Toona serrata</i> M. Roem.	Chinese Mahogany	Meliaceae
7.	<i>Swietenia macrophylla</i> king.	Mahagoni	Meliaceae
8.	<i>Tectona grandis</i> L.f.	Teak	Lamiaceae
9.	<i>Facocia indica</i>		
10.	<i>Aegle marmelosa</i> Linn.	Beal, golden apple	Rutaceae
11.	<i>Madhuca longifolia</i> (J.Konig) J.F.Macbr.	Mahua	Sapotaceae
12.	<i>Ficus religiosa</i> L.	Ashwattha or Peepal	Moraceae
13.	<i>Albizia lebbek</i> (L.) Benth.	Siris	Leguminaceae
14.	<i>Terminalia arjuna</i> (Roxb.) Wight & Arn.	Aurjun	Combretaceae
15.	<i>Ficus hispida</i> L.	Dumur	Moraceae
16.	<i>Limonia acidissima</i> L.	Wood apple	Rutaceae
17.	<i>Mangifera indica</i> L.	Mango	Anacardiaceae
18.	<i>Melia azedarach</i> L.	Mahaneem	Meliaceae

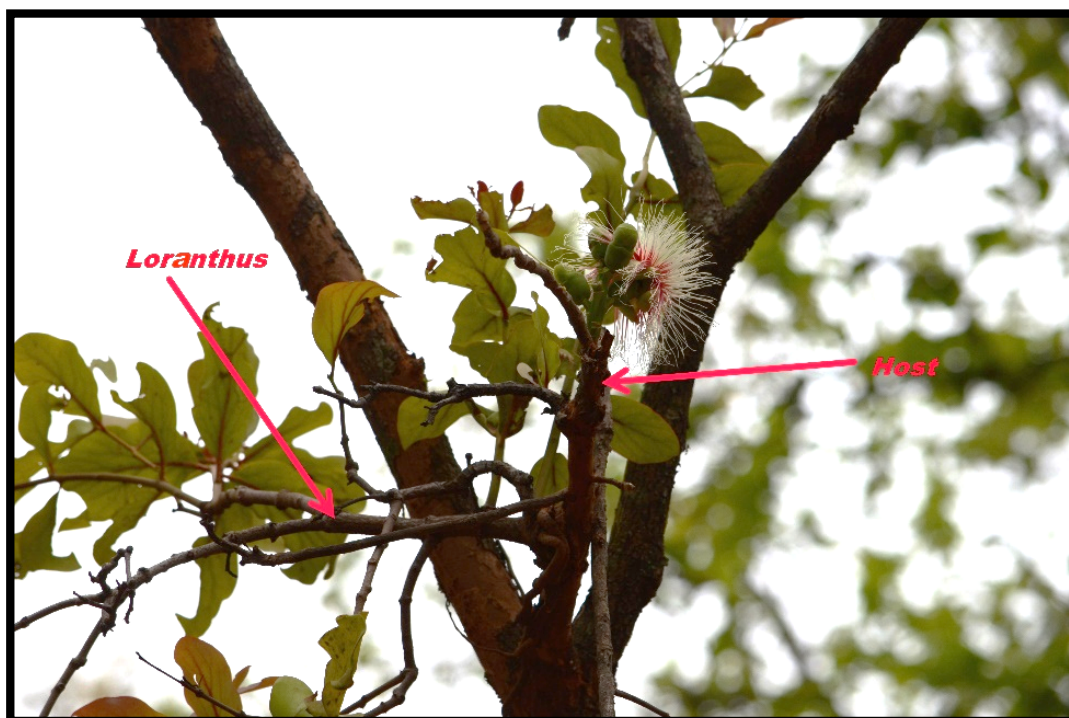


Fig-2: *L. parasiticus* on the host *Baringtonia asiatica* (L.)Kurz

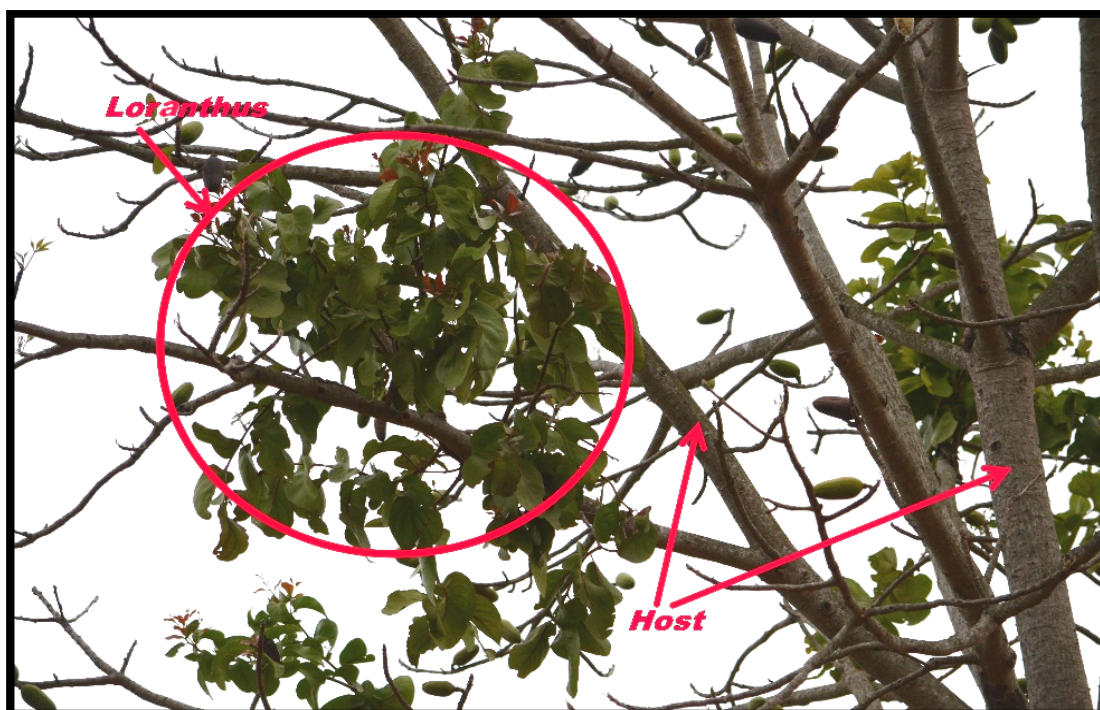


Fig-3: *L. parasiticus* on the host plant *Bombax ceiba* L.



Fig-4: *L. parasiticus* on the host plant *Shorea robusta* Roth.

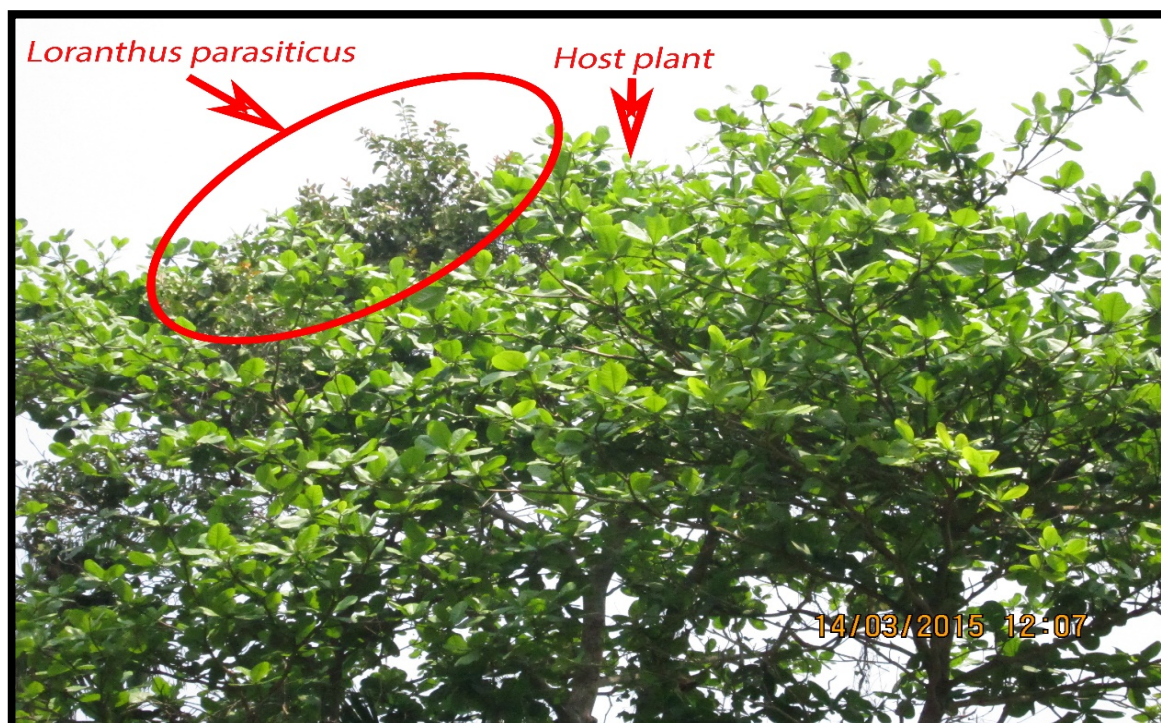


Fig-5: Showing *L. parasiticus* on the host plant *Terminalia catappa* linn.



Fig-6: *L. parasiticus* on the host plant *Lagerstroemia speciosa* (L.) Pers.

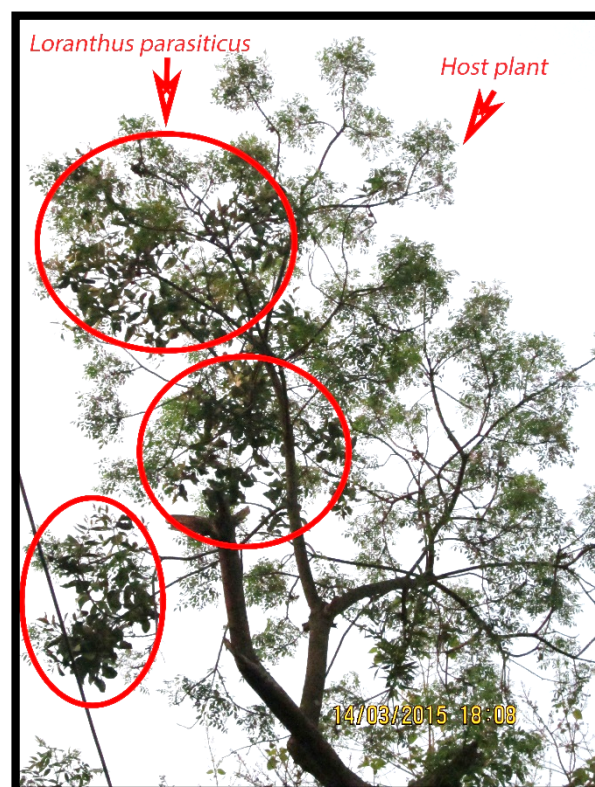


Fig-7: *L. parasiticus* on the host plant *Toona serrate* M. Roem.

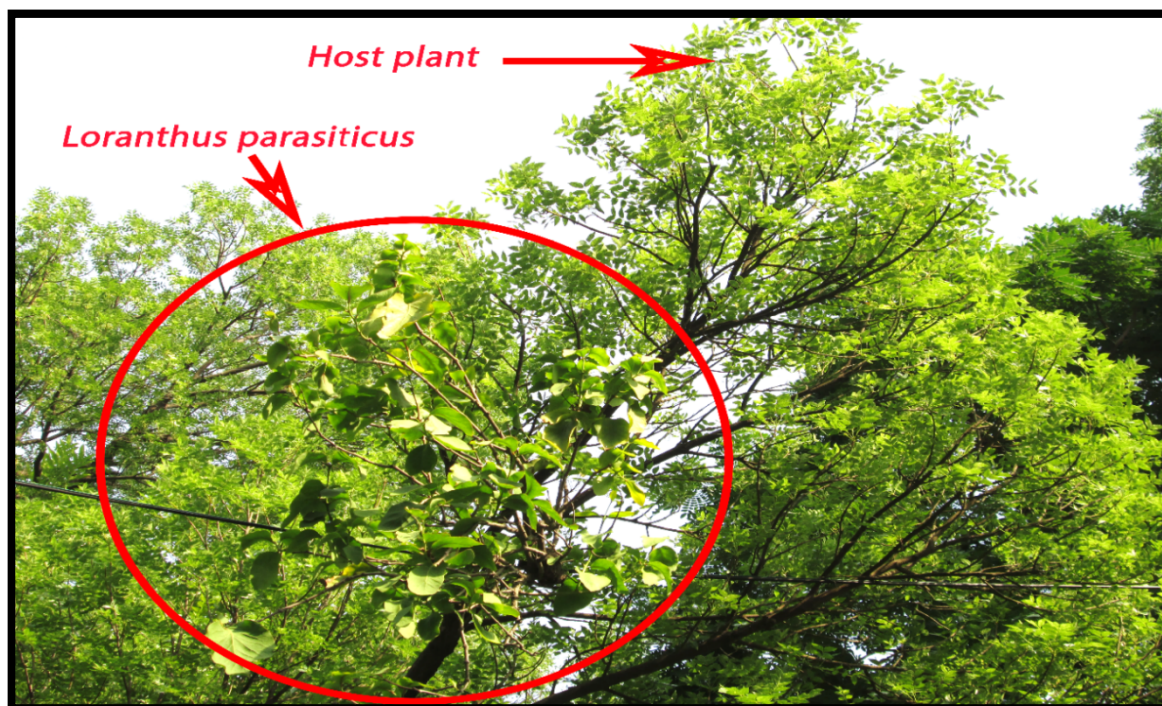


Fig-8: *L. parasiticus* on the host plant *Swietenia macrophylla* King.

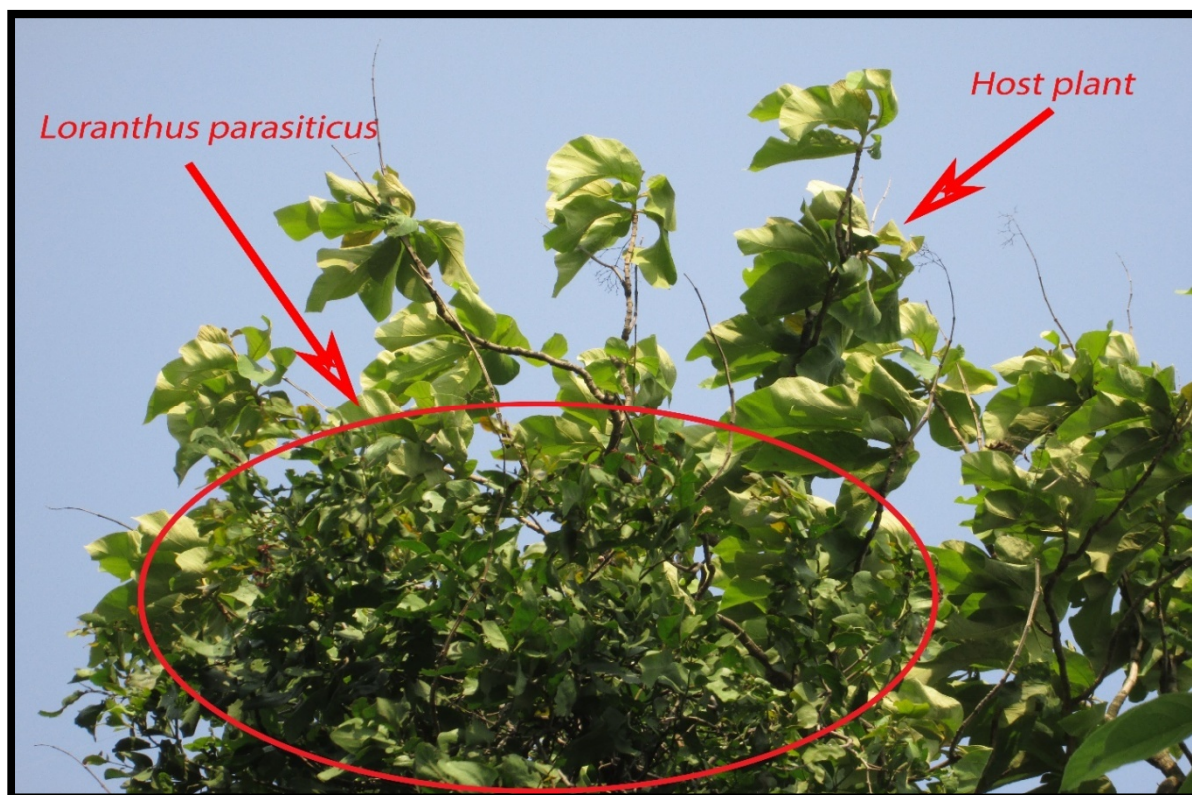


Fig-9: *L. parasiticus* on the host plant *Tectona grandis* L.f.



Fig-10: *L. parasiticus* on the host plant *Facocia indica*.

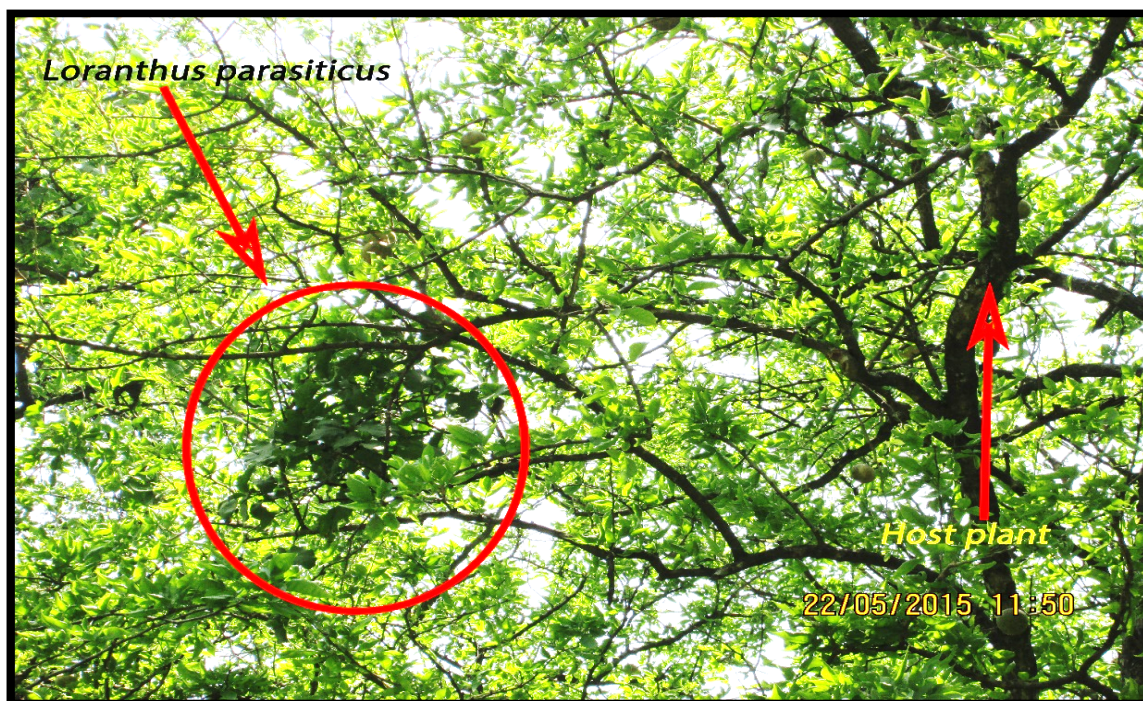


Fig-11: *L. parasiticus* on the host plant *Aegle marmelosa* Linn.

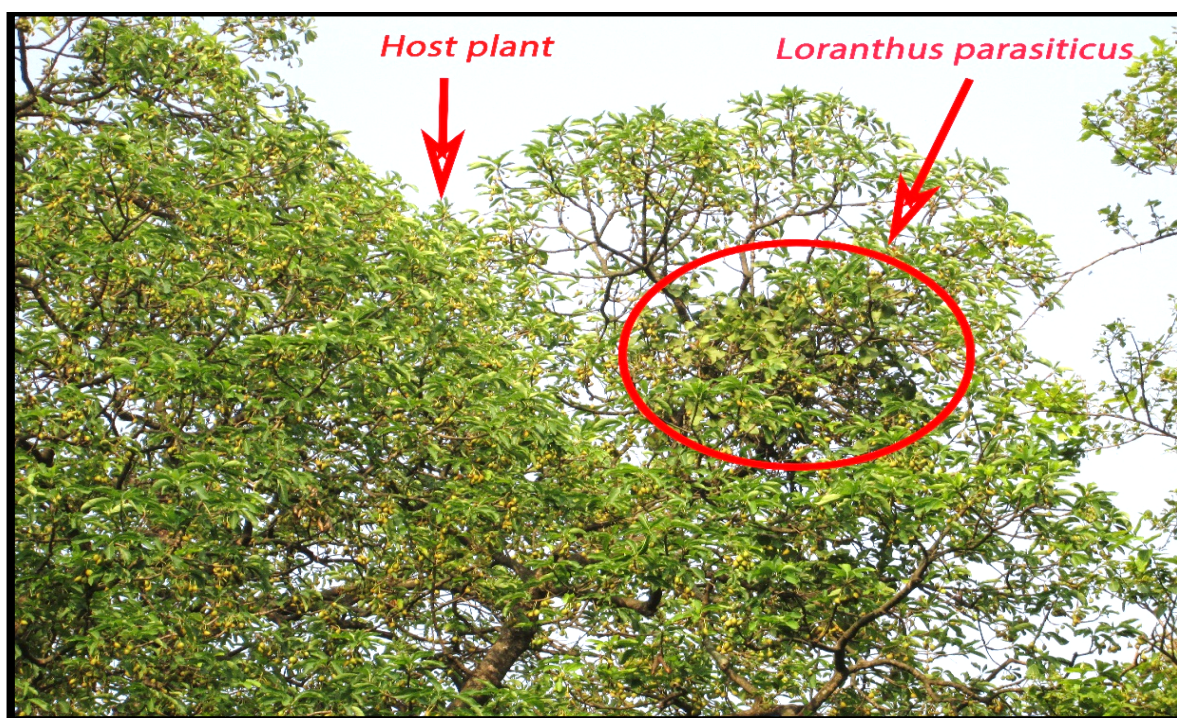


Fig-12: *L. parasiticus* on the host plant *Madhuca longifolia*(j.kongi) J.F. Macbr.

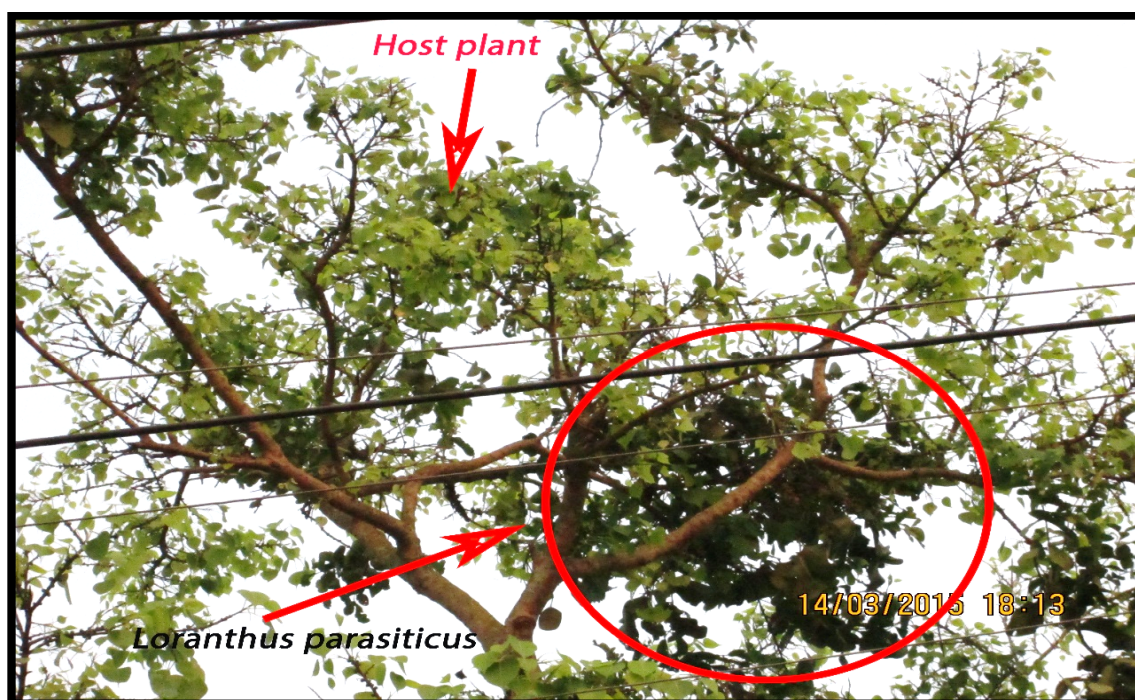


Fig-13: Showing *L. parasiticus* on the host plant *Ficus religiosa* L.

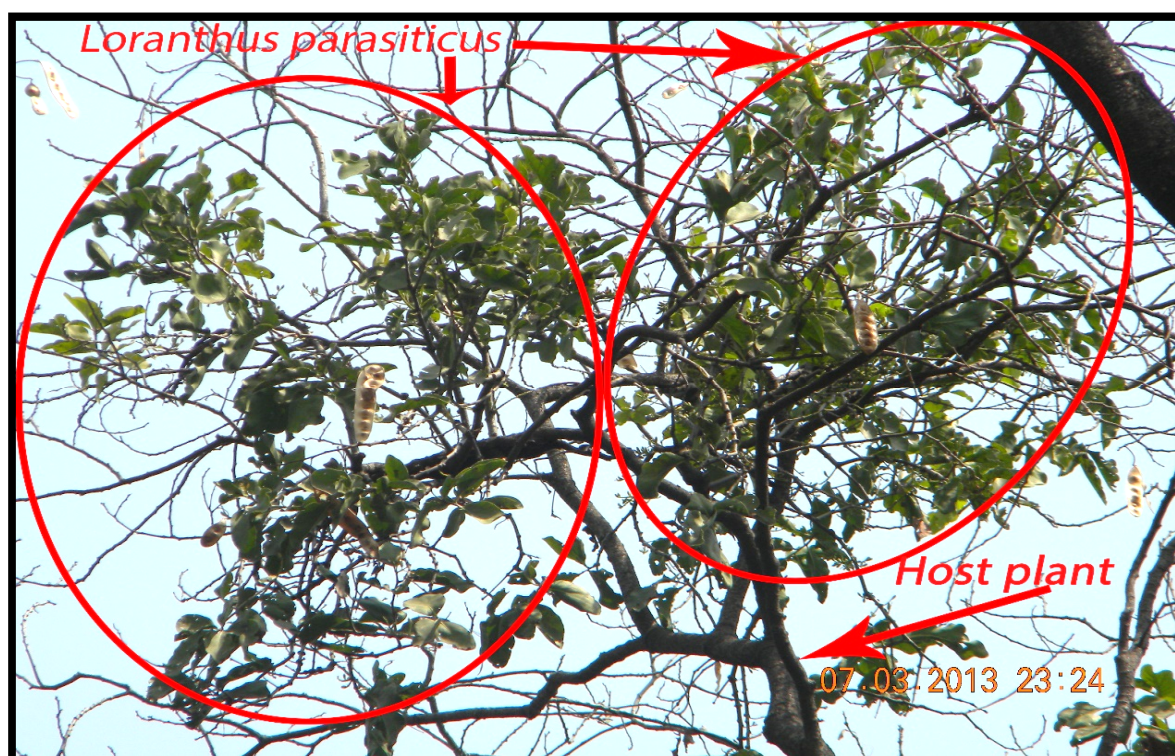


Fig-14: *L. parasiticus* on the host plant *Albizia lebbek* (L.) Benth.

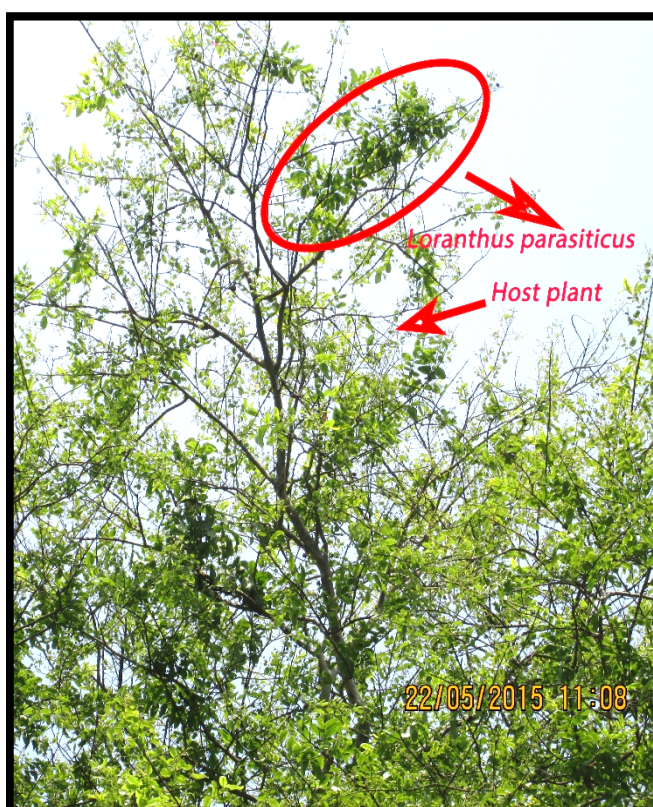


Fig-15: *L. parasiticus* on the host plant *Terminalia aurjuna* (Roxb.) Wight & Arn.



Fig-16: *L. parasiticus* on the host plant *Ficus hispida* L.



Fig- 17: *L. parasiticus* on the host plant *Limonia acidissima* L.

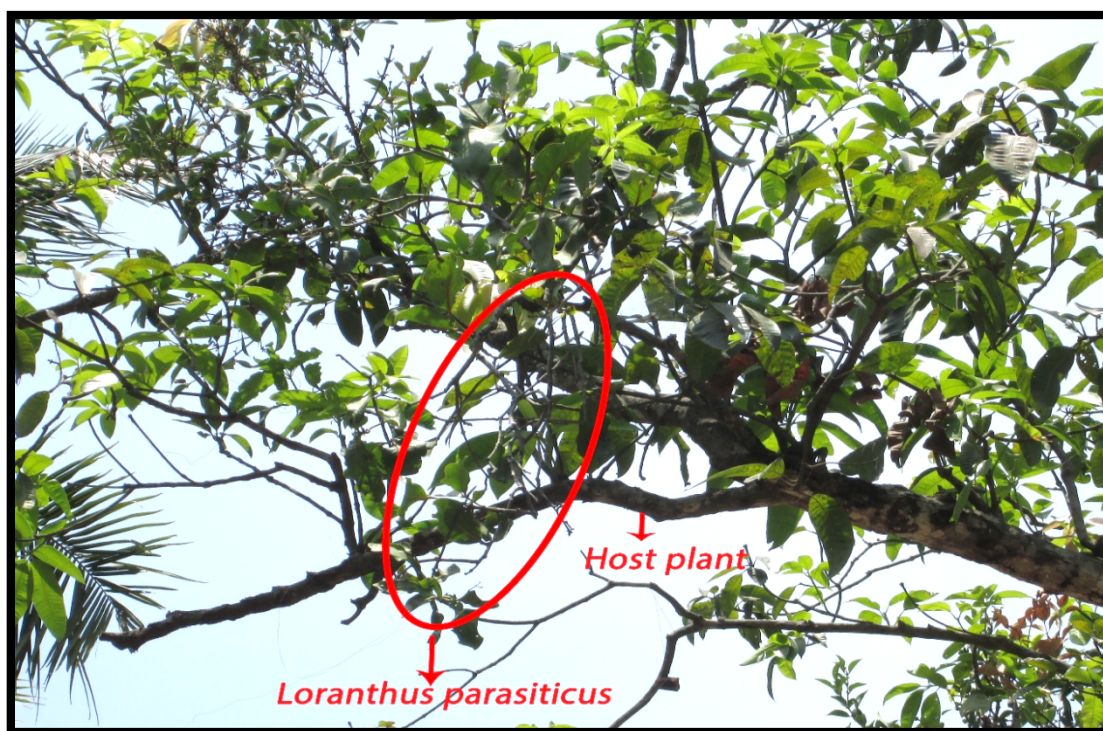


Fig- 18: *L. parasiticus* on the host plant *Magnifera indica* L.

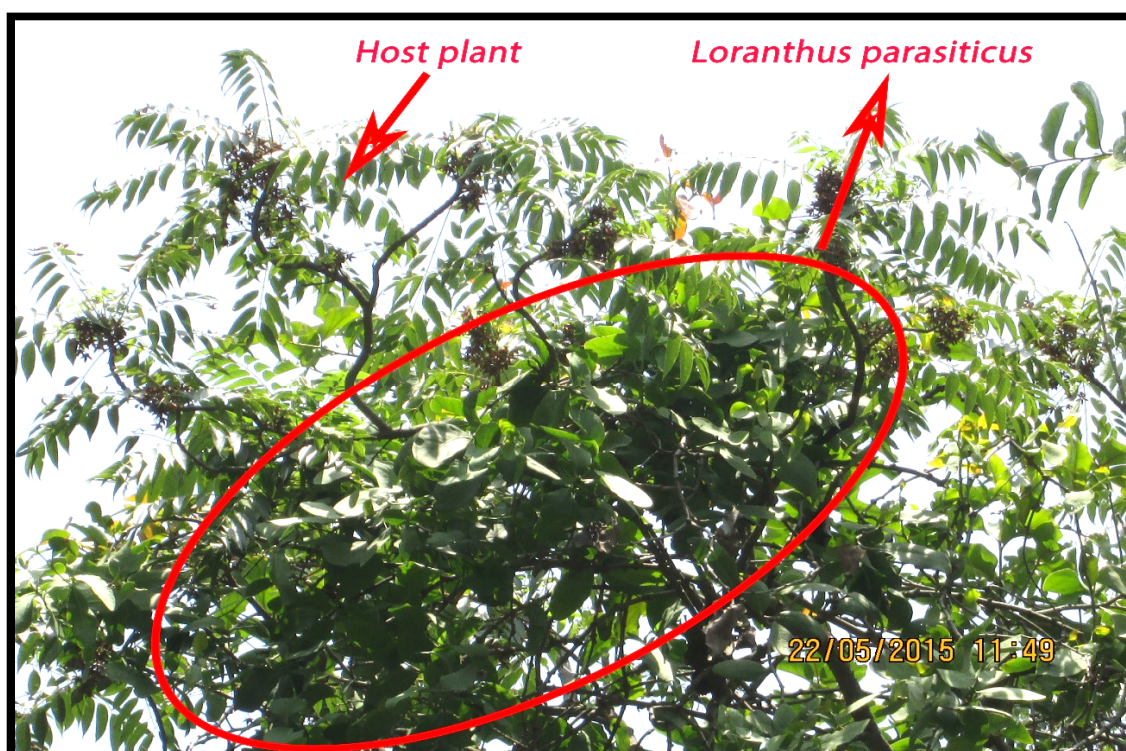


Fig-19: *L. parasiticus* on the host plant *Melia azedarach* L.

Flowering Period

Flowering session of this hemiparasitic plant viz. *Loranthus parasiticus* is ranges from December to February.

Pollination

The pollination of this taxa are done by the various types of birds mostly “sun bird”.

Seed Dispersal

Seeds of these parasitic taxa are spread mainly by birds which are the main eater of the fruits. The seeds are protected by viscin which is sticky in nature. The viscin has its typical role in attachment of seed to the host plant branches. After the attachment viscin, the material soon changes its sticky nature to harden and attaches the seed firmly to its future host, where it germinates and its haustorium penetrates the sound bark. Some species have different kind of dispersal mechanism like they distribute the seeds by the help of size and shape. On the other hand the feeding behavior pattern helps to disburse the seeds. Some species of mistletoe can regenerate if the pruning leaves any of the haustorium alive in the wood.

Host Parasite Interaction

This Hemi parasitic plants display a unique strategy of resource accumulation as they have their own photosynthetic activity. They uptake resources from the host plant through a specialized transfer organ or system called haustorium. This plants attack the host's xylem in contrast to the holopatasites which infect both phloem and xylem.

This plant has access to water and minerals but a little bit carbon due to its photosynthetic capability.

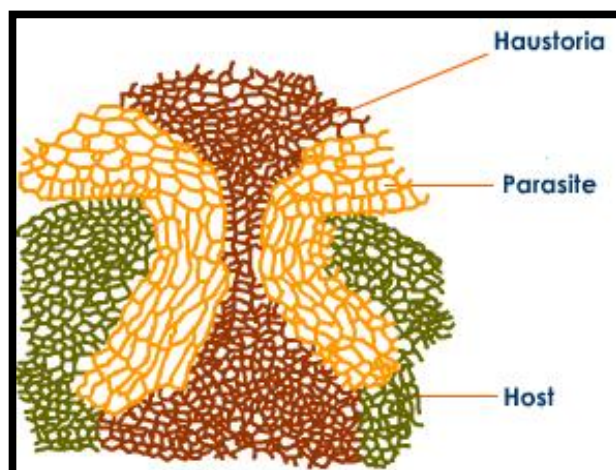


Fig – 20: Haustoria in the host tissue

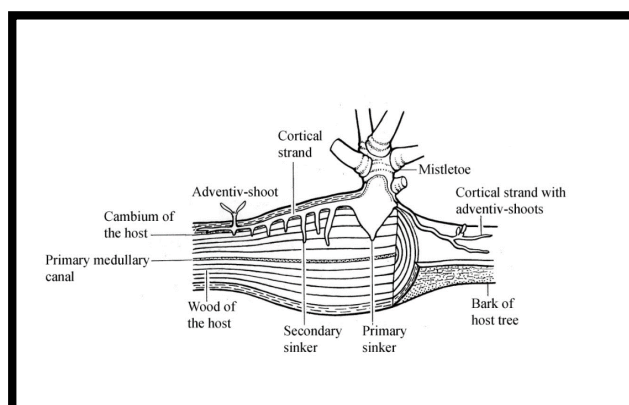


Fig – 21: Longitudinal section of host showing haustoria (primary & secondary) & adventitious shoots



Fig – 22: Infected host, showing swelling host tissue (Gall formation)

VI. B- Distribution of *Macrosolen* :

Macrosolen can be found throughout the world. It mostly distributed in the continental or tropical region. In south-west Bengal these plant found some natural forest as well as road side tree having massive girth and with cracked bark. The natural forest of Midnapur such as Salboni forest, Dhamkurar jungle, Kushboni forest, Hoomgarh forest, Bulanpur forest. In Bankura district, Sarenga jungle, Jalar jungle and in Purulia district, Arsha, Baghmundi, Jhalda, Jaipur forest region.

Host Range

Speciation via host race formation is an important evolutionary process in parasites. Genetically-based adaptation to hosts is important for the evolution of parasites, as parasite populations may eventually become differentiated into races and subsequently speciate as they adapt to the divergent selection pressures exerted by different host genotypes or taxa. Once host races are established, the development of isolation mechanisms eventually leads to the formation of new species. Limited gene flow can lead to increasing local adaptation and further to formation of host races. In general, host races are taxa that associate with different principal hosts, showing no consistent morphological or physiological differences, but genetic differentiation. This plant commonly found in the natural forest of the tropical or subtropical region. Mostly these plants grow on the evergreen tree plant such as *Mangifera indica*, *Eucalyptus polybrachtea*, *Casuarina equisetifolia*, *Ficus racemosa*, *Acacia auriculiformis*, *Annona squamosa* etc. Apart from that there are several other plants also where these hemi parasitic plants are dominating over themselves. From my observation, I thoroughly list up all those host plants in following table.

Table No- 2: Name of the Host Plants of *Macrosolen cochinchinensis* distributed in part of South-West Bengal

Sl. No	Name of the host plant	Local/Common Name	Family
1.	<i>Mangifera indica</i> L.	Mango tree	Anacardiaceae
2.	<i>Eucalyptus polybrachtea</i> R. Baker	Tailapatra, sugandhipatra	Myrtaceae
3.	<i>Casuarina equisetifolia</i> L.	Belatijhau	Casuarinaceae
4.	<i>Ficus racemosa</i> L.	Jaggadumur	Moraceae
5.	<i>Mimusops elengi</i> L.	Bakul, Spanish cherry	Sapotaceae
6.	<i>Acacia auriculiformis</i> <u>A.Cunn.</u> ex <u>Benth.</u>	Akashmoni	Fabaceae
7.	<i>Annona squamosa</i> L.	Atta, Sugar apple	Annonaceae
8.	<i>Strychnos nux-vomica</i> L.	Kunchle,poison nut, Rose bay	Loganiaceae
9.	<i>Manilkara zapota</i> (<u>L.</u>) P.Royen	sobeda	Sapotaceae
10.	<i>Toona serrate</i> (Royle) M. Roem	Chinese Mahogany	Meliaceae
11.	<i>Terminalia catappa</i> L.	Kath badam	Combretaceae



Fig – 23: *M. cochinchinensis* on the host plant *Mangifera indica*.



Fig - 24: *M. cochinchinensis* on the host plant *Mangifera indica*.



Fig – 25: *M. cochinchinensis* on the host plant *Casuarina equisetifolia*



Fig – 26: Showing *M. cochinchinensis* on the host plant *Strychnos nux-vomica*.



Fig - 27: *M. cochinchinensis* on the host plant
Acacia auriculiformis



Fig – 28: *M. cochinchinensis* on the host
plant *Mimosa elengi*.



Fig – 29: *M. cochinchinensis* on the host plant
Eucalyptus polybrachtea



Fig – 30: *M. cochinchinensis* on the host plant *Toona serrata*



Fig – 31: *M. cochinchinensis* on the host plant *Terminalia catappa*

Flowering periods

These parasitic plants (*Macrosolen cochinchinensis*) generally produced flower in mid-July to August.

Pollination

Pollination is usually mediated by the birds. The flower of *Macrosolen cochinchinensis* have particularly developed feature specialized to attract a unique vector. The ‘Blue-crowned Hanging Parrots’ (*Loriculus galgulus*) and ‘Sunbirds’ are also known to feed on the nectar from the flowers adding to the list of pollinators to this mistletoe. The birds assist in the pollination of this parasitic plants flowers, bribed by the offer of nectar.

Seed Dispersal

Seed dispersal and pollination is usually mediated by the birds.

Interaction between hemiparasite plant and their host

An ambiguous relationship has observed in hemiparasitic plants and their hosts. Following photograph shows the relationship within them.

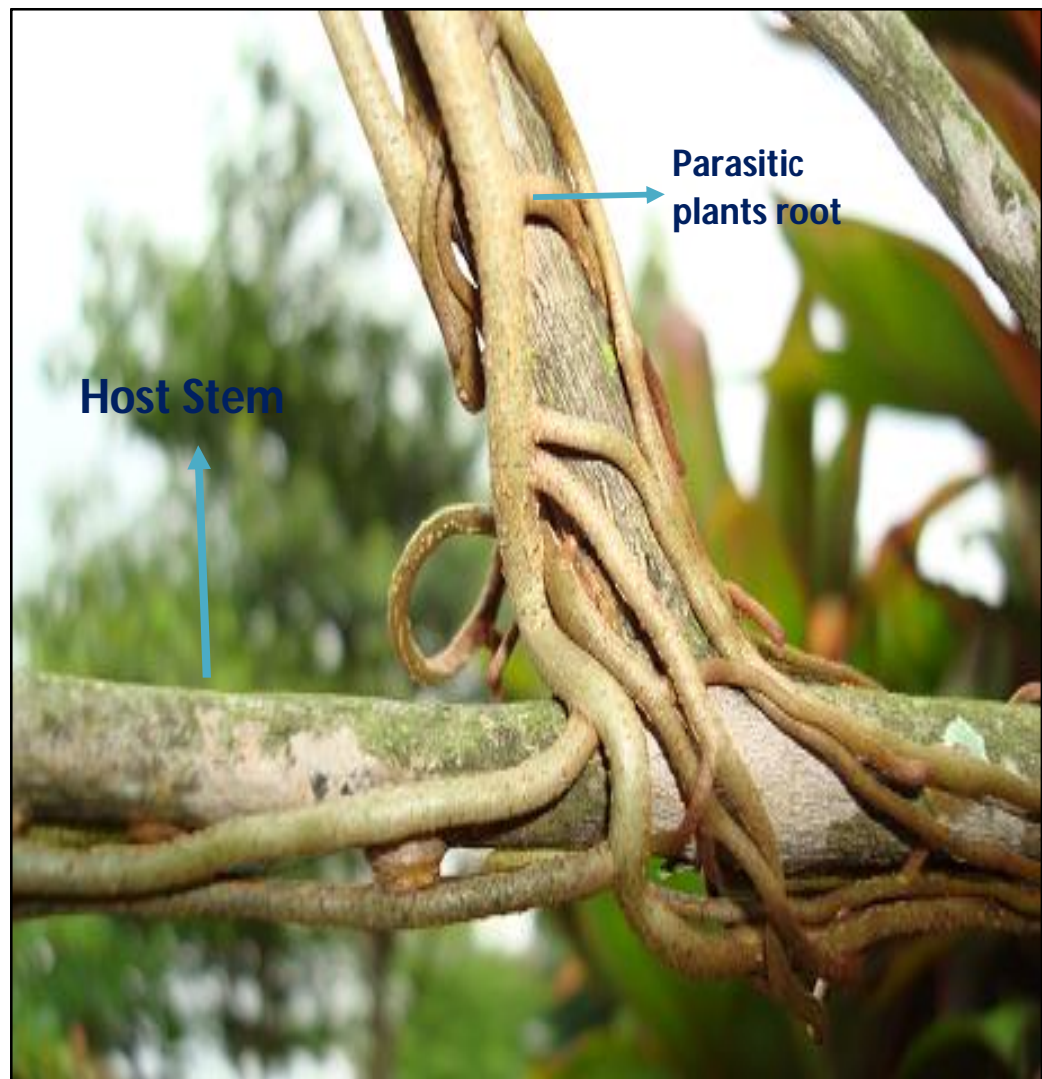


Fig – 32: Attachment of parasite roots with host stem



Fig – 33: Infected portion of host stem



Fig – 34: Interaction between host stem and parasitic plants root

VI. C - Distribution of *Viscum*

Viscum album is native to Europe and western and southern Asia. It has a significant role in European mythology, legends, and customs. In south-west Bengal these plant found some natural forest of Midnapur, Bankura & Purulia at an elevation of more than 800-1000 meter from sea level. We found the plant in area of Kankrajhore hills of Medinipur, Ajodhya hills, Panchakot hills of district Purulia and Susunia hills in Bankura district.

Host Range

This plant normally found in the natural forest of the tropical or subtropical region. Mostly the *Viscum* plant grow on the tree plant such as Gamhar tree, Jarul, Ashwattha etc. We documented the host range from our observation from some natural forest of southwest Bengal.

Table no – 3: Name of the host List of *Viscum album* distributed in part of South-West Bengal

Sl. No	Name of the host plant	Local/Common Name	Family
1.	Gmelina arborea Roxb.	Gamhar	Lamiaceae
2.	Lagerstroemia speciosa (L.) Pers.	Jarul	Lythraceae
3.	<i>Ficus religiosa L.</i>	Ashwattha or Peepal	Moraceae
4.	<i>Terminalia catappa L.</i>	Kath badam	Combretaceae
5.	<i>Robinia pseudocacia</i>		Fabaceae
6.	<i>Malus sp.</i>		Rosaceae



Fig – 35: *Viscum album* on the host plant *Lagerstromia speciosa*

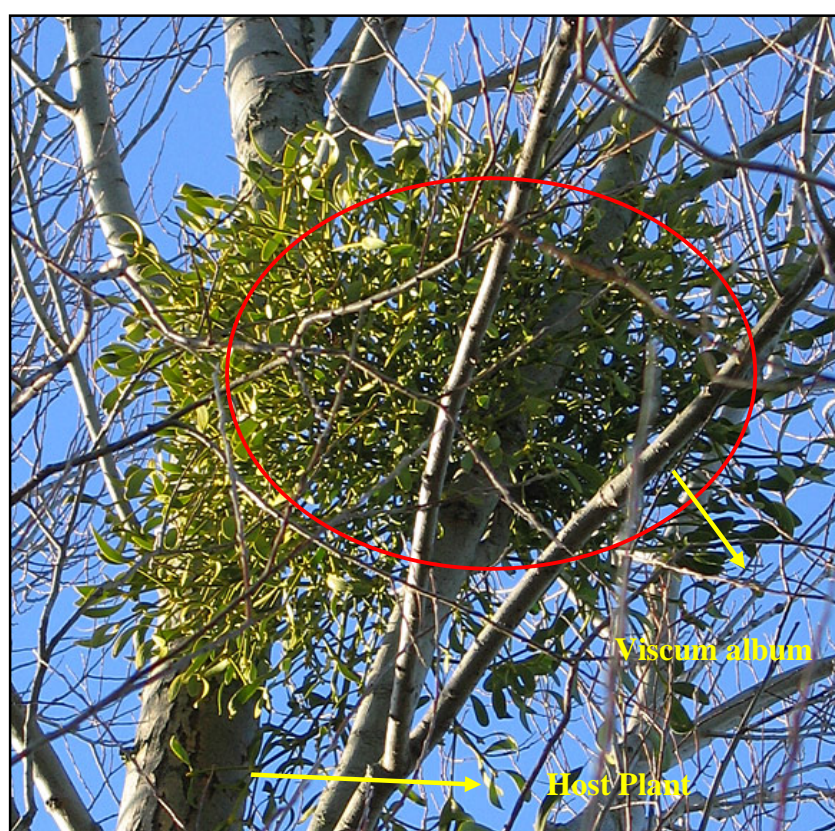


Fig – 36: *Viscum album* on the host plant *Gmelina arborea*



Fig – 37: *Viscum album* on the host plant *Terminalia catappa*

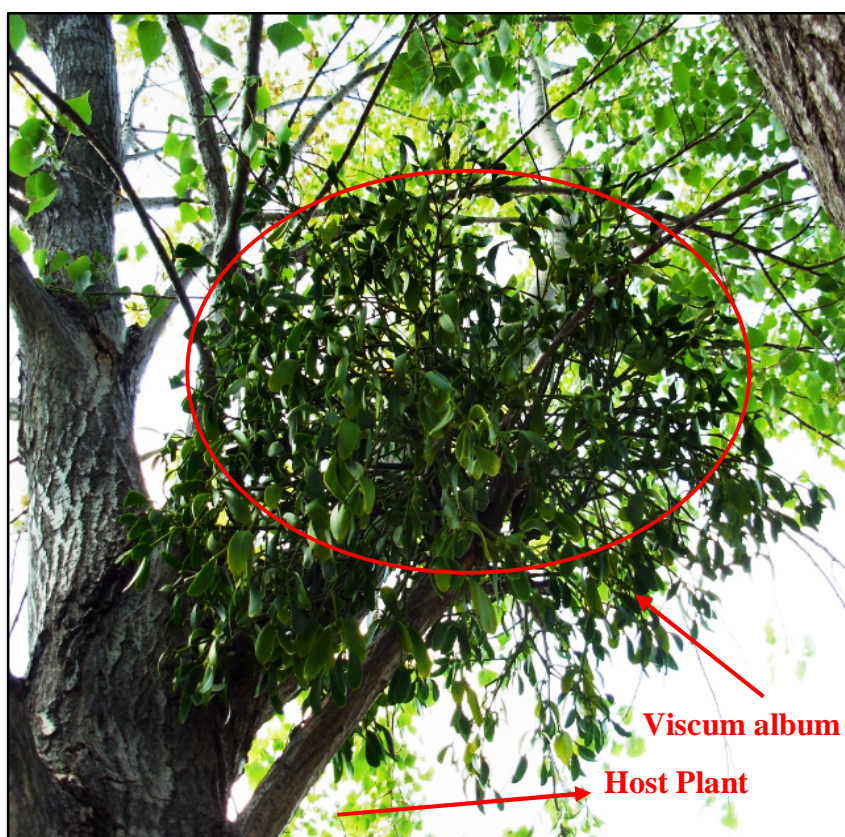


Fig – 38: *Viscum album* on the host plant *Ficus religiosa*

Flowering Session

Flowering session of this parasitic plant (*Viscum album*) is last February to April.

Pollination

The pollination of this taxa are done by the various types of insect mainly and also birds.

Seed Dispersal mechanism

White Berries are dispersed by a variety of birds. The most important being the mistle thrush (*Turdus viscivorus*) field fire (*Turdus pilaris*) waxwing (*Bombicillagarrula*) and black cap (*Sylvia atricapilla*).

The birds mainly feed on the berries but intestinal passage is not necessary for germination. The seeds of the fruits are protected by a sticky material called viscin. Once a mistletoe plant is established on its host, then it can flourish easily by penetrating haustoria in host tissue.

Host-Parasitic Interaction

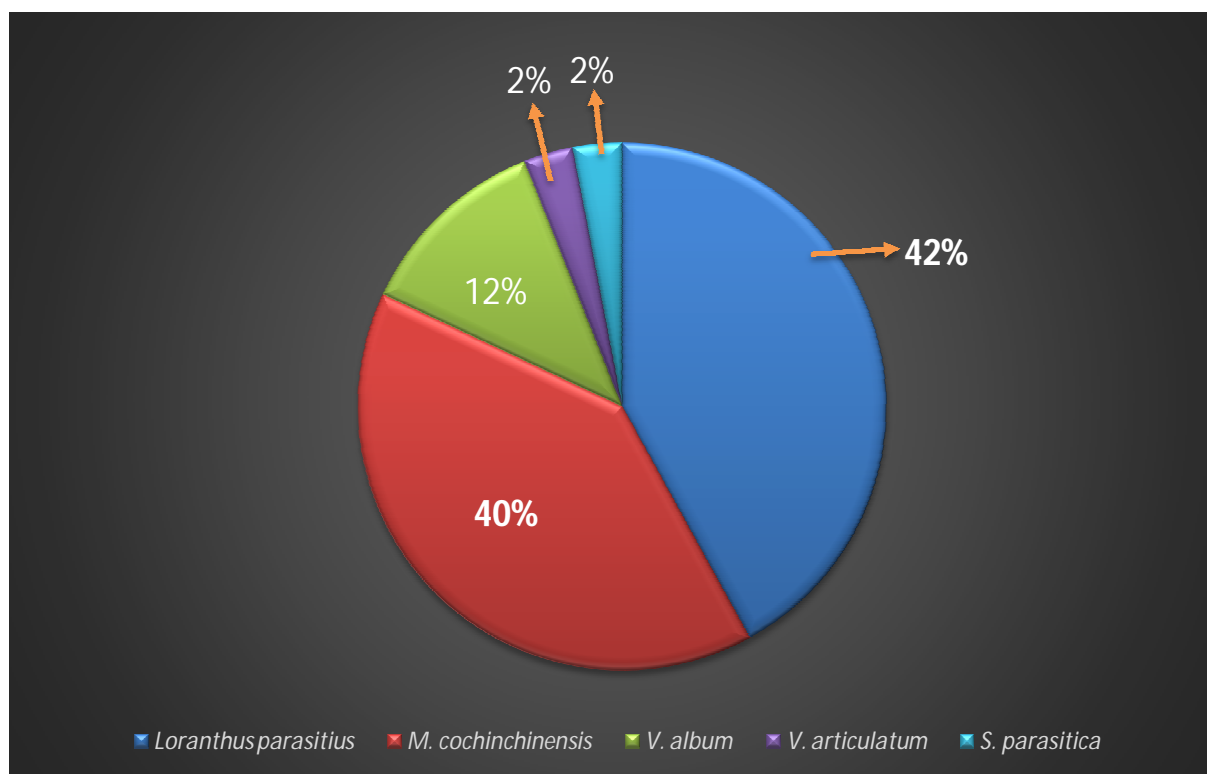
The following picture shows that how haustorium of *Viscum* penetrate and intermingled with host tissue.



Fig – 39: Interaction between host stem and parasitic plants root

VI. D - Distribution percentage:

From our survey, it has observed that, there are five hemi-parasitic taxas are distributed throughout the south west Bengal of which three are very much common viz. *Loranthus parasiticus*, *Macrosolen cochinchinensis*, *Viscum album* and other two are *Viscum articulatum*, and *Scurrula parasitica*. *Viscum articulatum* is known as leaf-less parasite. It has also noticed that, of these five common hemiparasitic taxas, *Loranthus parasiticus* and *Macrosolen cochinchinensis* are much more abundant than *Viscum album*, which is only confined to the hilly region at an elevation of more than 600-800 meter. The percentage of distribution of these five hemiparasitic taxa from South West Bengal is graphically represented in pie chart form.



Graph - 1: Distribution percentage of hemiparasitic taxa in South-West Bengal

