Parasitic plants and their hosts: types and characteristics

Survival of one life form is dependent not only on its ability to search and utilize available life sustaining resources but also upon its healthy competition for various such requisites with other life forms belonging to either the same or different species. To facilitate this, different life forms have evolved with special assets of abilities to exist, work and exhibit a tendency to proliferate so as to flag their dominance on ecological niche. Scientific communities at times are amazed by the kinds of interaction in which different life forms co-exist with each other and also with the surroundings. In plants, interaction science has emerged as a major area of research which deals with investigating and studying such phenomena in detail, their mechanism, reasoning for interactions of plant with plant, animals, and/or micro-organism. Evolution of a new species from an existing ancestral mob assures adaptation to new and more efficient modes of existence, wherein lesser inputs are invested for more possible benefits. One such example is the parasitic plants or epiphytes.

Parasitic plants comprise 19 families in angiosperms and constitute to about 4, 100 species (Nickrent. and Musselman, 2004). Among these with various parasitic habits, mistletoes are well known as perrenial, polyphyletic group of angiospermic aerial plant parasites (Devkota, 2005) infecting generally host stem and/or branches, and belong to families, Viscaceae and Loranthaceae.

Mistletoes are considered as an important component of biodiversity (Watson, 2001; Shaw et al., 2004), and have been appraised not only due to their unique parasitic relationship with their respective hosts, their growth habits, mechanism of seed dispersal but also because of their miraculous medicinal values which includes their use as sympathetic medicine to take down abnormal tissue growth under cancer (Kunwar et al. 2005).

They are predominantly known to occur on fruit trees. Mistletoes are characterised by the development of a root like absorptive organ called haustorium which forms the host parasite interface and draws nutrients from the host conductive tissues to the parasite (Devkota, 2005).

Dendrophthoe falcata is a hemi-parasitic plant belonging to the Loranthaceae mistletoes and is considered as the commonest of all other mistletoes widely occurring in India (Parker acnd Westwood, 2009). The genus Dendrophthoe comprises of about 31 species spread across tropical Africa, Asia, and Australia (Flora of China, 2003) among which 7 species are found in India. The sp. falcata has its hold in India since ancient times and has been in use as traditional folklore medication for various ailments. Though a parasite incurring huge losses to commercial fruit and timer production, it is considered and welcomed as a sacred sign of prosperity in few areas of rural India. Well globally, much of the advanced scientific investigations have centered on other mistletoes such as Orobanche, Viscum etc. These studies have aimed towards understanding the parasite behaviour, sap flow dynamics at the host parasite interface, chemical compositions of floral organs, designing successful control strategies, evaluating medicinal potentials etc.

The present review will focus on the existing literature earlier attempts aiming study of various scientific aspects associated with D. falcata. The review considerably outlines the variety of studies performed revolving around the host-parasite relationship, morphology and geographical distribution, and studies aiming towards in vitro establishment and attempts towards scientific justification of the ethno-medicinal properties, and various existing and possible control strategies for this mistletoe family member.

Morphology and biogeography:

Evolutionarily, mistletoes belonging to Loranthaceae are considered older than those of Viscaceae and ever since their origin from dense Gondwanan forests; they have successfully encompassed tropics, subtropics and arid portions on the globe through their nutritional competition-driven conquests (Devkota et al, 2005). Notes on floral morphology and embryology in D. falcata have been provided by Singh (1952).

D. falcata bears grey barks, thick coriaceous leaves variable in shape with stout flowers (Wealth of India. 2002). The flowering inflorescences in D. falcata was previously referred to as axillary or as developing on the scars of fallen leaves, but Y. P. S Pundir (1996) verified it to be of strictly cauliflorous nature and also notified that it shares fundamental similarity to that of Ficus glomerata, F. pomifera and F. hispida.

Two of its varieties are widespread in India namely, var. falcata (Honey Suckled Mistletoe) and var. Coccinea (Red Honey Suckled Mistletoe) distinguished by occurrence of white and red flowering, respectively (Flowers of India, a World Wide Web resource). A comprehensive list of almost all the species within the genus Dendrophthoe can be availed (from web source at http://www. naturekind. org/taxpage/0/binomial/Dendrophthoe_falcata).

Haustorial polymorphism, leaf mimicry, explosive flowering, fruit adhesive pulp etc.

Singh, B., 1952. A contribution to the floral morphology and embryology of Dendrophthoe falcata (L. f.) Ettingsh. Jour. Linn. Soc., Lond., 53, 449.

Dendrophthoe homoplastica (mistle- toe) mimic those of its common host, Eucalyptus shirleyi. (Robert L. Mathiasen, David C. Shaw, Daniel L. Nickrent, David M. Watson, 2008 Plant Disease / Vol. 92 No. 7)

Hosts and host-parasite relationships:

Mistletoes occur mostly on forest, fruit and ornamental host trees preferentially harboring zones rich in biodiversity and thus are found excessively on mountain ridges provided with favorably optimum light intensities and in few in slopes and plains (Devkota, 2005 and references therein). Mistletoes do not follow a uniform pattern of distribution which is affected by local environments and effected by habits of seed dispersing avian visitors.

Host range:

Earliest, B. Singh (1962) reported that the leafy mistletoe D. falcata is parasitic on over 300 hosts in India, Pakistan, Southeast Asia, and northern Australia. Indiaï¿½s rich plant biodiversity in 1977 could report exclusive host range numbering 345 plants susceptible to infection from this mistletoe (Siva Sarma and Vijayalakshmi 1977) which is a significant number as it contributes to its comparatively recent global record for 401 hosts (Shaw 1993). Till date, D. falcata represents the only known mistletoe with the largest global host range (Calvin and Wilson, 2009) which is continuously and rapidly widening.

Haustoria:

Mistleoes are known to form haustorial structures at the point of attachment to the host.

Among angiosperms, parasitic relationship through the formation of haustorial linkages is known to be widespread (Wilson and Calvin, 2006). In general, haustorial connections among 72 (of the 75) ariel parasitic genera may belong to either of the four types viz., epicortical roots (ERs), clasping unions, wood roses, and bark strands (Calvin and Wilson, 1998). ERs may run along the host branches in either direction forming haustorial structures at variable intervals while ï¿½unionsï¿½ occur as single points of attachment of individual parasites hence pronounced as solitary. In D, falcata on different hosts two of the haustorial kinds have been observed viz., solitary unions as on Sugar apple (Annona squamosa), and epicortical roots as on sugar apple (Achras sapota), guava (Psidium guajava), pomegranate (Punica granatum) have been observed. It is unknown about what factors decide formation of different haustorial types by the leafy mistletoe on different hosts.

The host branches infected with D. falcata show a gradual reduction in growth and diameter as compared to other healthy uninfected branches (Karunaichamy et al, 1999).

It has also been reported that the development of mistletoe plants on the host tree is a dynamic process which necessarily leads to the death of the host tree and that the whole process may last for about a decade (Karunaichamy et al, 1999). It is known that mistletoes have higher nutrient titer than their host (Lamont, 1983; Karunaichamy et al, 1993) and this could probably be attributed to a competitively higher water (including dissolved nutrient and growth promoting metabolite) uptake rate by the parasite at its haustorium at a point in the host branch in comparison to that in the protruding lateral ends of the branch (that extends after the haustorium). This might render key nutrients be unavailable to the host branches that could repress growth post-infection (Stewart and Press, 1990). But in work by Karunaichamy et al (1999) one D. falcata seed per stem of Azadirachta indica seedling has been tested which has shown the life threatening effect on whole plant which again itself is at an immature seedling stage (so death of the whole plant could be expected). In a broad sense, physiological and metabolic perturbations induced by the parasite in the whole host plant outlined at the seedling stage surmised by the reduced host leaf area, leaf number, growth performance upon infection cannot be correlated to that in a fully mature host.

(statement in bold italics) could be justified by that there may be an increment in the probability of multiple mistletoe seed dispersals or extended reach of haustorial structures to other branches of the same tree (as we saw in Guava) that might possibly lead to a gradual depletion of key metabolites (thereby lowering an essential threshold titer for the same) required for growth of the host plant altogether. Alternatively though unknown, it might also be possible or still unknown if the hemi-parasites dissipate any unknown metabolite in to the host xylem at the point of anchor formation that may inhibit growth and metabolism in the hostï¿½s axillary meristems and the whole host plant life may only be at stake if such inhibitory effects are perceived by all plant parts. This again is contradictory hypothesis as evident from fact that the haustorial connections of the parasite with the plant are devoid of any retranslocation system (Smith and Stewart, 1990, also see later).

Once more, a report by Sridhar and Rama Rao (1978) unraveled the infection of D. falcata surprisingly hosting itself directly on the fruit (Table 1) of Acharas sapota (Sapota). Almost all the hemi-parasitic members of the Loranthaceae tap the xylem vessels of their host to avail water and minerals but to a considerable extent produce their own supply of assimilates (Kuijt, 1969). D. falcata does not have an indigenous rooting system and is dependent on the host for water and minerals. Nutrient dynamics have shown that a higher titre of N, P , K, Mg and Na in the leaves of mistletoe than the leaves of uninfected and infected hosts which may be due to differential translocation of elements within the host phloem (Prakash et al, 1967; Karunaichamy et al, 1999). Nitrogen loss is well pronounced in mistletoe infected hosts and a higher potassium levels in mistletoe is an indicative of higher transpiration rates and a lack of re-translocation system (Karunaichamy et al, 1999 and references therein). Though outlined above that the total phosphorous in mistletoe leaves is present in excess as compared to that the host leaves, fractionation studies have elucidated that percentage acid-insoluble phosphate is comparatively lesser in the parasite and also that further fractionation again infers a lower percentage of phospholipid, RNA, DNA and phosphoproteins. The DNA content of the infected host leaves however demonstrate a dramatic increase compared to the healthy uninfected leaves (Prakash et al, 1967).

Mistletoes are believed to mimic their hosts in floral structures. At some instance it was supported by a hypothesis which explains that such behaviour imparts protection to the mistletoe from the herbivores. Later, the hypothesis was field tested, rejected and replaced by a belief that a host parasite resemblance might help to safeguard hostsï¿½ individual fitness by signaling the birds to expel mistletoe seeds on other uninfected hosts (Atsatt, 1979). Moreover, the hosts and parasite follow individual developmental scheduling of events under which the parasite might experience an influence from a firm epigenetic hormonal control on leaf size and shape thus evolving the mimicry or resemblance to the host().

List of hosts:

Loranthaceous parasites were known in India since 1885 and until then only 35 species were known. Specifically for D. falcata from among the earliest of the reports, 268 host species have been known to be under the clutch of the deadly hemiparasite (Ravindranath and Narsimha Rao, 1959), and shortly later B. Singh (1962) reported its parasitic relation with over 300 hosts reported in India, Pakistan, Southeast Asia, and northern Australia. Until 1993, a report by Shaw III depicts a global increase of host range to 401. In Indian tropics 37 species of tree have been reported as the favourite hosts for D. falcata (Ghosh et al., 2002). Due to the ever increasing host range (Sridhar and Rama Rao, 1978) currently it is difficult to draw a margin between the more and less common host genera.

Vectors for seed dispersal and pollination:

Seed dispersal as well as pollination is usually mediated by the birds that thrive on fruits from the parasite and/or host. Particularly in southern India, Tickelï¿½s Flowerpecker which is also named as Pale-billed Flowerpecker (Dicaeum erythrohynchos, Latham) is reported to facilitate seed dispersal of D. falcata among Neem (Azadirachta indica A. Juss. belonging to Meliaceae) through fecal excretions or regurgitations (Karunaichamy et al, 1999; Hambali, 1977 and references therein). The mistletoe bird also eats insects and therefore has a grinding gizzard. When eating the mistletoe berry the bird is able to close the gizzard and the toxic seeds are usually swallowed as a whole and are shunt through their gut in about 3-4 minute (Murphy et al., 1993) and because the seed has a sticky coating, to get rid of the seed the bird applies its vent to the edges of the host tree branches and may turn around whereby the seed then sticks onto the branch where it may subsequently germinate (Ali, 1931; Ali 1932; Davidar, 1985). These birds also act as vectors for pollination in the hemi-parasite whose flowers bear a mechanism that causes pollen to explosively spray on the plumage of the visiting flowerpeckers (Karunaichamy et al., 1999; Vidal-Russell and Nickrent, 2008). Studies conducted in the higher altitudes of Western Ghats (where both the mistletoes and the flowerpeckers occur predominantly), which parallel the western coast of India infer that the flowerpecker pollinated mistletoes have particularly developed feature specialized to attract a unique vector both to facilitate pollination and seed dispersal: the fruit and flowers have similar resemblance and more significantly, the fruiting time overlap with the next flowering season (Davidar, 1983). Hair-crested Drongo or Spangled Drongo (Dicrurus hottentottus) is an Asian bird of the family Dicruridae and sunbirds (family= Nectariniidae) also known to feed on the nectar from the D. falcata flowers also adds to the list of pollinators to this mistletoe (Kunwar et al, 2005 and references therein).

Phytochemistry:

Results for the preliminary tests in phytochemical screening analyses using ethanolic extract of the whole plant reports the presence of carbohydrates, glycosides, steroids, tannins & phenolic compounds, flavonoids and triterpenes (Sahu et al, 2010). Chromatography of D. falcata fruits has recently added new members to the list of naturally occurring terpenes which has taxonomically been considered significant (Mallavadhani et al., 2006). Total phenolics in mistletoe have a comparatively higher concentration but it failed to correlate to any resistance by the host or its susceptibility to infection by the hemiparaste (Khanna et al,, 1968). Later a phenolic inhibitor of the enzyme a-glucan phosphorylase was reported ((Khanna et al,, 1971).

A study by Ramchandra and coworkers (2005) indicated that an elevated antioxidant potential in the mistletoe is due to sequestration of phenolic compounds from the host plants. Their HPTLC data on samples from mistletoe hosted on Mangifera indica (Mango), reportedly contained mangiferin, a C-glucosyl xanthone synthesized by the host plant. The report raises query concerning further investigations for whether the transfer of phenolics to the hemi-parasite indicates a preliminary host mediated defense or a mode of host identification by the parasite or as a mechanism from within the parasite to bypass rejection from the host plant.

In mature seed embryo 0. 65 mg chlorophyll/g fresh wt; chlorophyll a : b ratio of 1. 6 per mg chlorophyll has been evidenced. Moreover, in context to titre of enzymes for photorespiration, phosphoglycolate activity in the embryo has been recorded to be 16. 7 ï¿½mol substrate/min and 3-phosphoglycerate phosphatase activity 6. 8 ï¿½mol substrate/min. Similarly, NADH-linked glyoxylate reductase activity has been demonstrated in the embryo (0. 09 ï¿½mol substrate/min/g fresh wt) by Kachru, and Krishnan (1979). Chroamatography of the ethanolic extract followed by NMR and Mass spectrometry could isolate and identify Quercitin, a rhamnoside (Shihab et al, 2006). Hexokinase has been partially isolated and studied for its properties from D. falata leaves (Baijal and Sanwal, 1976).

In a comparative evaluation of this parasitic plant grown on various host plants, Nair et al. 10) reported the accumulation of kaempferol, quercetin, myrecitin, and their glycosides.

Medicinal Properties:

D. falcata possesses remarkable potentials as a medicinal plant evident from the wound healing, anti-microbial, anti-oxidant, antinociceptive properties of its ethanolic extracts (Pattanayak and Sunita, 2008, Shihab et al, 2006). Medicinal properties of this hemiparasite may vary in effects respective to different hosts it establishes a relation with (Mallavadhani et al., 2006).

The whole plant is used in indigenous system of medicine as cooling, bitter, astringent, aphrodisiac, narcotic and diuretic (Alekutty e al., 1993) and is useful in treating pulmonary tuberculosis, asthma, menstrual disorders, swelling wounds, ulcers, renal and vesical calculi and vitiated conditions of kapha and pitta (Anarthe et al., 20081; Anarthe et al, 2010; Sastry, 1952; Pattanayak et al., 2008). Also, the decoction of plant used by women as an anti-fertility agent has been evidenced to possess anticancer activity (Nadkarni, 1993). The leaf ethanolic extract significantly and dose dependently inhibits the acetic acid induced writhing in mice (Shihab et al, 2006) and has indicated a low level toxicity in the brine shrimp lethality assays. Besides, a more recent work by Pattanayak and Mazumder (2010) shows significant tumor reduction in induced mammary carcinogenesis in Wistar female rats when fed with hydroalcoholic extracts of D. falcata.

Ethno-medicinal aspects:

Ethnomedical studies are generally characterized by a strong anthropological and/or biomedical approach and in this context the use of D. falcata as a traditioal remedy for most if not all the ailments has been well appraised. Perhaps, the variety of knowledge available has not yet been exploited full fledgedly due to the currently over-recommended chemial analogs that are predominant over market most of which have side-effects associated under frequent use.

In vitro regeneration and gene introgression studies:

It is known that long term caulogensis from the endosperm tissue exhibits a high degree of polyploidisation of its cells associated with abnormalities such as chromosome bridges and lagging chromosomes but mistletoe endosperms have exceptional stability in their chromosome number (Razdan, 2003).

In the past, in vitro studies aiming towards investigating behavior of mature embryos have been reported in D. falcata (Johri and Bajaj, 1962). The effects of light, endosperm, endosperm extract, and position of the embryo on media have been studied on in vitro germination of D. falcata (Bajaj, 1968). Shoot induction has been successfully achieved in D. falcata (Bhojwani and Razdan, 1983). Shoot buds in Loranthaceae directly differentiate from the peripheral cells of the endosperm cultures though D. falcata may particularly require media supplemented with a combination of cytokinins and a low concentration of IAA or IBA. Among other cytokinins, 2-ip has been most effective and also addition of Casein hydrolysate (2000mg/l) has been necessarily recommended for shoot bud differentiation. For optimal shoot bud growth frequent subcultutres on fresh media is crucial. Caulogenesis from these shoot buds may be followed by differentiation into shoot and haustoria. The latter could be avoided by increased kinetin concentration and for such kinetin induced shoot bud differentiation, a low concentration of auxin (IAA or IBA) is necessary (Nag and Johri, 1971).

Ready to use tissue culture strategies have been discussed by a review article by Pattanayak and Mazumder (2008).

Advanced molecular level studies are surprisingly lacking for D. falcata with only single report where tests for amenability of this plant in gene introgression studies have been investigated via successful agrobacterium mediated transformation of its embryogenic cultures for GUS expression (Rohini et al, 2005).

Diseases of D. falcata:

Very little is known about diseases that victimize this hemiparasitc plant. The pathogen species that have been reported in association are generally known to commonly infect a wide range of plants off genera. There are realizations that propose that mistletoe specific pathogens are rare and develop endemism and be localized to favorably optimized areas where their growth requisites and nutritional demands are inline with the host mistletoe species and their host nutrient and sap flow dynamics.

Fungal:

The hemi-parasite itself is susceptible to diseases such as leaf blight caused by Colletotrichum state of Glomerella cingulata which has been reported on D. falcata which seriously infects Teak (Tectona grandis) plantations (Ali and Florence, 1987) in Kerala, India.

Epiparasitism

Plant: A surprising evidence of hyper-parasitism has been reported in the Mohand Range Forest (Dehradun, India) where D. falcata itself receives haustoria from Scurrula cordifolia (another mistletoe), both hosted together by Ougeinia oojeinensis (fabaceae) (Pundir, 1979). Similaly, Viscum orientale (Viscaceae) has also been reported to grow on D. falcata (Saxena, 1971). In another instance Cuscuta reflexa (Convolvulaceae) has been shown to act as a rival to the leafy mistletoe (Nath and Indira, 1975). Viscum capitellatum. Sm has also been evidenced from Sri Lanka to be an obligate epiparasite for

D. falcata (Calvin and Wilson, 2009) and symplastic continuity exists between their phloem (Glatzel and Balasubramaniam, 1987) which is an indicative of the aggressive epiparasitism depicted more vividly by the presence of graft-resembling ï¿½unionsï¿½. Viscum loranthi Elmer, thus has been advocated to have potentials for biological control of Loranthaceae hemiparasites (Pundir, 1981) damaging commercial timber crops. Well, other species such as D. glabrata has also been reported to be parasitized by Viscum articulatum (Robert L. Mathiasen, David C. Shaw, Daniel L. Nickrent, David M. Watson, 2008 Plant Disease / Vol. 92 No. 7). On the whole, 88% of Viscaceae and 61% Loranthaceae epiparasitize Loranthaceae (Calvin and Wilson, 2009).

Hyperparasitism in Other mistletoes in the same genus:

Notothixos subaureus (Viscaceae), parasitic on Dendrophthoe glabrescens (Loranthaceae) on Eucalyptus (source: http://www. panoramio. com/photo/1876445)

Insects:

Recently, Cockerell Scale insects, Pseudaulacaspis cockerelli Cooley (Diaspididae) have been reported to settle on the leaves, stems and haustoria of D. falcata parasitizing Senna siamea (unpublished communication). These scale insects are known to thrive on sap nutrients and their reproduction and hence their proliferation rate has depicted relation with the nitrogen status of the host. Well in this regard mistletoe particularly D. F indicates a favorable choice as their nutrient uptake seems more biased towards drawing more nitrogen rich species from the host sap.

The host S. siamea, though is a non-nodulating leguminous tree specie but can produce more nitrogen than the nodulating relatives.

Controlling the parasite:

Backed by easy seed dispersal by fruit eating birds, widespread and ever increasing host range of Dendrophthoe falcata continues to pose heavy losses in economically valuable fruit trees and those with medicinal properties whether growing in forests, orchards or gardens (Sridhar and Rama Rao, 1978).

Healthy tree hosts can tolerate few branch attachments with mistletoes but a heavily infected host slowly moves towards its decline as the mistletoe feeds upon its nutrients and spreads on all its ariel parts (Aly, 2007). Hostsï¿½ death is more probable when they become more prone to other forms of biotic ad abiotic stresses.

Reports from 1930s evidence that until then no proper control and eradication methods were available rather the only alternative used was excising off the parasite (before seed production) completely from below the point of infection in the host and their immediate incineration (Sridhar and Rama Rao, 1978).

Mechanical pruning of the infected host branches with cuts at least one foot below the point of mistletoe attachment in order to completely remove embedded haustoria has also been suggested as a method of choice but severe heading (topping) which is often used to remove heavy tree infestations weakens the host tree structure. Instead, it is best to remove severely infested trees entirely because they are usually a source of mistletoe seeds. Another method employed when mechanical pruning gives up upon mistletoe infection uses painting the infected area using a pruning paint or spray and wrapping it with layers of opaque polyethylene cover so as to restrict light source required by this leafy mistletoe. In another method, use of ethephon (a growth regulator) in form of spray to completely wet leaves of mistletoe harboring dormant host trees is recommended (Aly, 2007). Regrowth of the parasite may be prevented by pruning it and painting the spot in the host branch (Koski et al., 2009).

Lately, adopted method of control uses application of 50% diesel oil emulsion sprayed on mistletoe leaves. The said morbid effect of emulsion significantly increases the intra-molecular respiration rates in the leaves followed by a gradual decline in capacity of stomatal closure consequently leading to death of the hemiparasite (Singh and Sharma., 1970).

Delias eucharis, a medium sized pierid butterfly (Common Jezebel) commonly occurs in South and South-East Asia (Bingham, 1907) and is particularly known to lay its eggs and feed on leaves of mistletoes (Roychoudhury, 2005) and has been suggested in its use to control the parasitic mistletoes (Sevastopulo, 1950, Mushtaque and Baloch 1979).

Alternatively, resistance to D. falcata using herbicide (metribuzin) infusion of its host, Tectona grandis (Teak) has also been tested but is of limited help as the efficiency of parasite killing was not proportional to the amount of herbicide used which is required to estimate exact dosage and infusion time for multiple of infection on one host (Balasundaran and Ali, 1989).

In one of the papers from the proceedings of the 6th Asian-Pacific Weed Science Society conference, G. G. Hambali (1977) has discussed beside other uses the exploitaton of scolytid and cerambycid beetles in controlling Dendrophthoe spp. Several similar or other control alternatives have been suggested by Khan et al. (1987).

Approaches as highlighted above towards control of parasitic weeds by traditional methods are limitedly effective and best control via herbicides and fumigants may be hazardous to Mother Nature (Jacobsohn 1994).

Removal of mistletoe by hand is effective considerably under small degrees of infection but extensive infestation might render this approach as inevitably expensive (Aly, 2007) and cumbersome more particularly when the infestation spans large tree plantations or dense forests.

Replacing the infected plantations with resistant trees has also been a method of choice. Though not reported yet specifically for D. falcata, resistance for broadleaf mistletoe (Phoradendron macrophyllum) was evidenced in some tree species viz., pear, Chinese pistachio, crapemyrtle, ginkgo, sycamore, and conifers such as redwood and cedar (Perry 1995). These few resistant species are of significance to the plant breeders but raising parasitic plant resistant crop genotypes have been very difficult and yet lack success.

Use of high and low intensity fires has also been noted but is rather undesirable in plantations as wonï¿½t result in complete cure but only subside heavy infestation from the mistletoes in stand without suppression of re-infestation (Carnegie et al, 2009).

Chemical control of mistletoes has been extensively researched in Australia which points out the reasons for their limited routine practice in forests as these methods are labour intensive, cost-effective, variable or limited in results. Use of biological control strategies including mistletoe targeting fungi has also been evidenced (Carnegie et al, 2009).

Recent efforts by S. Aly and his workgroup (at the Department of Plant Pathology and Weed Research, Agricultural Research Organization, Newe Yaar Research Center, Israel) enlists successful biotechnological approaches which guarantee prospects towards achieving effective parasitic weed control and ensure environmental safety (Aly, 2007). Adoption of these tools within biotechnology viz, trait gene introgression, gene silencing, promoter technology etc accordingly towards generating transgenic host trees remain the only promising alternative to combat losses incurred from D. falcata infestations.

Aspects of biodiversity:

Management and control strategies whether mild or exhaustive and whether practiced on a low to high area of coverage should not overlook that mistletoes are considered a valuable component of biodiversity. They are seen as ï¿½a keystone resourceï¿½ of food and shelter for diverse population of vertebrates and invertebrates (Carnegie et al, 2009).

Conclusions:

(KEY: take up the previous issues in above topics and be general and also take examples from other species or genera about the same, for medicinal values and products again search for other existing natural resources.

Parasitic plants and their origin

Parasitic plants constitute to about 1% of the total angiosperms in nature.

Studies explaining the science behind the evolutionary origin of the ariel habit in Loranthaceae have recently been initiated where primitive hypotheses are being investigated with use of phylogenetic tools and analyses (Wilson and Calvin, 2006).

Phytochemistry:

Though in a recent review by D'Cruz et al (2010) considerable reproductive toxicity that may cause upon consumption of extracts from the hemiparasite and other plant extracts had been advocated. The article also appeals for extensive research on neutralizing the toxicity of plant based products before they could be validated for their health benefits.

Medicinal uses:

Antioxidants are considered important for preventing human diseases but the synthetic antioxidants viz., butylated hydroxy toluene (BHT) and butylated hydroxy anisole (BHA) that have a restricted use as preservatives in oils and fatty foods to minimize their oxidation are considered carcinogenic (Andlauer and Furst, 1998) which can be altered by use of ethanolic and/or methanolic D. falcata extracts as