

REVIEW ON PARASITISM OF *CUSCUTA REFLEXA* ROXB. - A PLANT SOURCE FOR AKASHAVALLI

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ABSTRACT

Parasitism is an association of two organisms of same or different species, in which one lives at the cost of others. According to Elton, the union of parasite and host is usually an elaborate compromise between extracting sufficient nourishment to maintain and propagate itself and not impairing too much the vitality of its host which is providing it with a home and free ride. It is estimated that nearly 50% of the life forms on this planet are parasites. About 4,500 species of parasitic plant in approximately 20 families of flowering plants are known. Parasitic flowering plants exploit other flowering plants for water and nutrients by specialized structures called haustoria which are the active intrusive organ, which penetrates host tissue to establish contact with the conductive tissue of the host. Akashavalli is one such drug explained in Nighantu's with synonyms like Asparsha, swarnalatha and Nirmula etc are suggestive of its parasitic nature. The plant Hemiparasite *Cassytha filiformis* is used as a substitute for *Cuscuta reflexa* Roxb. The stem parasite belonging to Convolvulaceae family proven for its various pharmacological activities. This review article is an attempt to understand parasitism with special reference to *Cuscuta reflexa* Roxb, host range and major steps involved to control the parasite growth on host plants to avoid the complete damage.

KEYWORDS: Haustoria, Akashavalli, *Cuscuta reflexa* Roxb, parasitism, Host range

INTRODUCTION

Plants live in a world populated by numerous and varied herbivores and microbial pathogens that include insects, nematodes fungi, bacteria, and oomycetes. However, plants have evolved mechanisms to detect such attacks and counteract them with efficient immune responses¹. One such process is parasitism. Parasitism is a process indicates an organism that spends a significant portion of its life in or on the living tissue of a host organism and which causes harm to the host without immediately

killing it. Similar to parasitic plants, mycoheterotrophs may lack chlorophyll and photosynthetic capacity, but they live in symbiotic association with fungi that gain nutrition from autotrophic (self-feeding) plants or decaying vegetation. Such plants are not classified as parasitic, because they do not appear to harm the fungi and they lack haustoria. Akashavalli in Ayurveda told as ASPARSHA², SWARNALATHA³, and NIRMULA⁴ which are clearly indicating the characters of parasites and having various

Guna karma, which is botanically known as *Cuscuta reflexa* Roxb belonging to Convolvulaceae family. The current review article focuses on brief knowledge on parasitism, its mechanism invading the host plants, classical references about Akashavalli and its various pharmacological activities.

PARASITISM⁵

The word parasite means "A person who eats at the table of another", and "feeding beside". The parasite is: A Climbing plant which is supported by a wall, trellis etc. A parasitic plant is a plant that derives some or all of its nutritional requirements from another living plant. After a parasite attaches itself to a plant, it wraps itself around it. If the host contains food beneficial to it, it produces haustoria that insert themselves into the vascular system of the host. The original root of the parasite in the soil then dies. Parasite cells that intrude host vessel elements were first described by Leclere du sablon in 1887. One of such parasite is a holo-parasitic plant botanically known as *Cuscuta reflexa* Roxb and it has a special property of absorbing constituents for its nutrition by penetrating into xylem through haustorial tissue.

CLASSIFICATION OF PARASITE⁵:

1. Depending on the Physiology: **a.** obligate parasite, a parasite that cannot complete its life cycle without a host). **b.** Facultative parasite that which can complete its life cycle independent of a host.

2. Depending on the part of host attachment:

a. Stem parasite-a parasite that attaches to the host stem. **b.** Root parasite-a parasite that attaches to the host root.

3. Depending on dependency on host:

a. Hemi-parasite – a plant that is photosynthetic to some degree. Hemi parasites may just obtain water and mineral nutrients from the host plant. **b.** Holo-parasite - a parasitic plant that derives all of its fixed carbon from the host plant. Commonly lacking chlorophyll, holo-parasites are other colors (yellow) other than green.

Example: Dodder- *Cuscuta reflexa* Roxb is a stem Holo-parasite. *Hydnora africana* is a root Holoparasite. ***Cuscuta reflexa* Roxb is a stem holoparasite.**

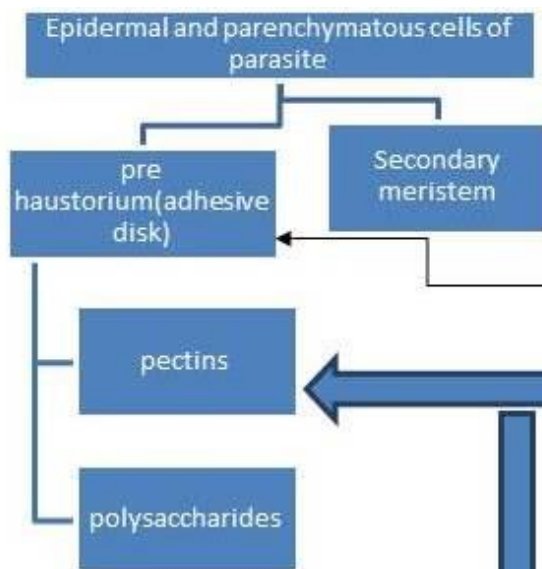
MECHANISM OF PARASITE INVADING HOST⁶

1.Independent phase: The seedling develops independently for short while up to the stage when it attaches to a host. After finding an appropriate host plant, the first physical contact initiates

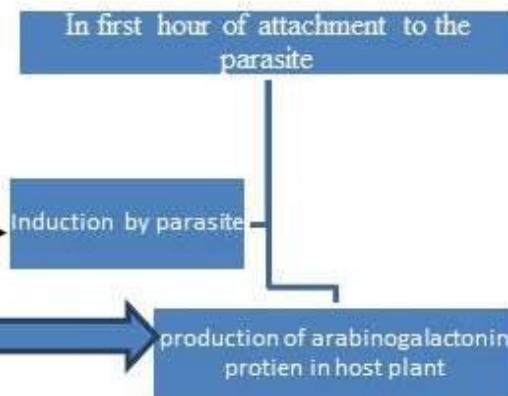
2. An attachment phase / Intrusive development phase: This involves two steps-

a. Development of terminal haustorium at the tip of radicle. **b.** Invasion of the haustorium into host tissues. Important signals initiating and controlling this pre-haustoria formation include mechanical pressure, osmotic potentials, and phytohormones such as cytokines and auxin.

CHANGES OCCURING IN PARASITE



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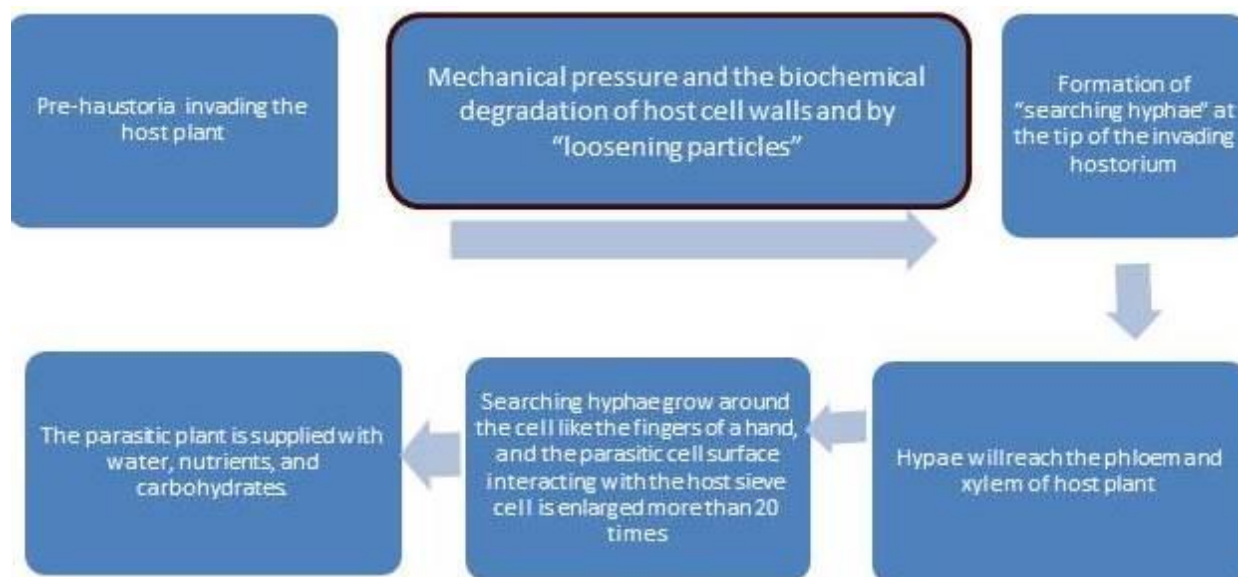


These proteins are secreted by the host plant and localize to the cell-wall where they reinforcing the adhesion together with other sticky components such as pectin of parasite.

During this attachment phase, host cells in proximity to the *Cuscuta*, haustoria respond with an increase in cytosolic calcium, detectable in host plants expressing aequorin as calcium reporter. This increase lasts for about 48 h after the initial contact. Cytosolic

calcium signals are part of several signal transduction pathways, initiated by diverse stimuli such as touch, osmotic signals, phyto-hormones, or defense triggers. Since these signals could be a part of the plant-plant interaction.

3. The penetration phase



Interestingly, during this process, chimeric cell walls of host and parasite constituents are formed, and interspecific plasmodesmata build up a cytoplasmic syncytium between *Cuscuta* and the host plant. To form a connection to the xylem, parasitic and host cells of the xylem parenchyma commence a synchronized development, fusing to build a continuous xylem tube from the host to the parasite. With functional connections to the xylem and phloem of its host, the parasitic plant is supplied with water, nutrients, and carbohydrates. Finally in the compatible phase the parasite development is coordinated with that of the host.

HAUSTORIUM⁷: The term was introduced by A.P. de Condolle to describe the connection between the *Cuscuta reflexa* Roxb and host plant. Fahn's opinion that the haustorium is a "specialized plant organ that draws nutrients from other organs or tissues" resembles the original meaning of the term haustorium, assuming that this organ is an active organ and not a passive bridge and physical connection between the parasite and host. At first the haustorium serves as an attachment organ, and then it develops as an intrusive structure that penetrates the host plant, later as a water and nutrient absorption organ by invading the xylem and phloem of host or both. The parasite accumulates alkaloids from the host plant. The highest concentration of alkaloids found in the haustorium region because alkaloid pattern closely resembles to that of the haustorium⁸.

Types of Haustorim: **1. Terminal haustorim** – develops directly from the apex of the primary root. **2. Lateral haustorium-** develops laterally on young

lateral and adventitious root. Terminal haustorium is characteristic of holoparasite i.e. *Cuscuta reflexa* Roxb. which produces numerous seeds, which have only small amount of nutrients and cannot start their life cycle without an immediate connection to a compatible host for nutrient supply, which is achieved by the terminal haustorium.

STRUCTURE OF HAUSTORIUM⁷- It is composed of several structural regions: The "Haustorium" is an invasive structure which is responsible for complete developmental stages, from initiation, attachment and invasion, until the establishment of complete vessel connection and maturation.

1. First part of the mature haustorium is located inside the host tissue and is regarded as Endophyte.

2. Further part is located between the host and main body of the parasite and is regarded as exophyte/upper haustorium, haustorial bridge/ haustorium neck.

The most advanced haustorium from both anatomical and physiological point of view are those containing phloem with sieve elements, occurring close to or in connection with host sieve elements. This has been demonstrated with *Cuscuta reflexa* Roxb. Presence of phloem with completely distinguished sieve tubes is close to host sieve tubes that explain *Cuscuta* being one of the fastest growing parasites.

CLASSICAL REFERENCES OF AKASHAVALLI

A famous saying goes as "There is no plant without medicinal value in the world" and dravya

being second prime importance in chikitsa chatuspada, one should use them according

their intellectual power. The plant Akashavalli is mentioned under Guduchyadi Varga by Pandit Narahari². It is told as “Asparsha²”, “Vyoma vallika”^{10,2} (unable to touch), as it grows on herbs, shrubs as parasite without rooting into the soil. There are no references found in Vedic and Samhitha period. In Raja nigantu² and Bhavaprakasha nigantu⁹ it is mentioned under Guduchyadivarga. Khavalli^{9,10,2}, Vyomavallika and Asparsha are the synonyms mentioned in Raja, Bhavaprakasha and Kaiyadeva nigantuku¹⁰. Akashavalli is mentioned as Hridhya by Bhavaprakasha nigantukara⁹ and Jwarahara, Vrishya, Graahi by Kaiyadeva nigantukara¹⁰ and also Vrishya, Rasayani and Balya by Raja nigantukara². Latha vishesha, Akashaschavallobha, Khavalli, Nirmuli and Swarnalatha etc are the synonyms which indicate the morphological property of the plant akashavalli as it is wide spread and grows to any height of sky and it is climber, not having roots and stem is golden yellow in color.

Actions and properties of akashavalli mentioned are; Akashavalli is having Tikta rasa and Picchilaguna and kaphapittahara property. Agnikari, hrudhya, amanashini, rasayana, vrushya, balya, mutrakrita, grahanihara^{11, 12}, swedajanan and pushtid, jaravyadinashana¹² are the karmas mentioned in classics.

HOST RANGE- There is 53 host plants, from 27 families for *Cuscutareflexa* Roxbin India. They include both herbaceous species (42%), shrubs (26%), climbers (21%) and trees (11%) and concluded that, tree species are parasitized in their early stages of growth only¹¹. Commonly seen host plants

for *Cuscuta reflexa* Roxb are *Santalum album* L, Juss, *Butea monosperma* L, *Lantana camara* L, *Abutilon indicum* L, *Adhatoda vasica* L, *Vitex nigundo* L, *Durantaplumieri* L⁶⁴ etc. Host range is mainly influenced by geographical (host distribution) and ecological (dispersal biology and environmental factor) relationship. In tropical areas it can grow more or less continuously, and may reach high into the tip of shrubs and trees. In temperate areas it is an annual plant and is restricted to relatively low vegetation that can be reached by new seedlings each spring. A report demonstrated that dodder use airborne like volatile principles clues to locate their host plants¹³.

DISPERSAL AND GERMINATION STRATEGIES: Seed dispersed by birds eating the fruit seeds are often placed directly on a branch of suitable host. These seeds are relatively large with enough nutrients to produce large terminal haustorium, with photosynthesis in the endosperm may provide additional nutrients until a vascular connection is established with the host.

CULTIVATION AND PROPAGATION- Cultivation: Holoparasitic species are devoid of leaves, root and chlorophyll and so they totally dependent upon its host. They must be grown next to the host plant, which penetrates with haustorium in order to obtain nutriment. **Propagation:** It is propagated through seeds. It is best sown as soon as it is ripe in the autumn, by holding it among the stems of host plant or scrapping the stem of host plant that is being grown in a pot in greenhouse. **Germination:** Germination does not require host plant. Seed can remain

viable in the soil for at least 10 years. Emergence is typically from the top 5cm of the soil. The period of emergence ends by mid may.

CHEMICAL CONSTITUENTS¹²: **Stem:** Cuscutin, amarbelin, cuscutalin, mangiferine, quercetin, kuskutin, lactone, reducing sugar, quercetin, resins and cuscutine. **Seed:** fixed oil (3%), colouring matter (amarbelin), wax, dulcitol, laurotetanine (alkaloid), scoparone, melanettin, hyperoside, aromadendrin, taxifolin, astragalol, myricetin, kaempferol.

CONTROL MEASURES: Control of *Cuscuta reflexa* Roxb. is difficult, because of the parasitic nature, so for the recognized control measure being adopted is manual cutting from its attachment (up to the ground level) and burning after their removal from the host. Seed germination and seedling growth of the parasite is inhibited by *Azadirachta indica* A. Juss. (Neem) leaf extract¹⁴.

PART USED¹⁵: stem, fruit and seed

DOSE¹⁵: Juice 10-20ml, Seed powder 3-6 gms

RESEARCH WORKS ON *CUSCUTA REFLEXA* ROXB

1. Anti-alopecia¹⁶- Effect of *Cuscuta reflexa* Roxb on androgen-induced alopecia, petroleum ether extract of *C. reflexa* exhibited promising hair growth-promoting activity as reflected from follicular density, anagen/telogen ratio, and skin sections. Inhibition of 5 α -reductase activity by extract and isolate suggest that the extract reversed androgen-induced alopecia by inhibiting conversion of testosterone to dihydrotestosterone. **2. Anti-hyperglycemic activity¹⁷**- Effect of *Cuscuta reflexa* Roxb.

stem and *Calotropis procera* leaf extracts on glucose tolerance in glucose-induced hyperglycemic rats and mice. Methanol and chloroform extracts of *Cuscuta reflexa* Roxb. whole plant demonstrated significant oral hypoglycemic activity in glucose-loaded rats. kaempferol and quercetin could significantly improve insulin-stimulated glucose uptake in mature 3T3-L1 adipocytes. It was further reported that these two compounds act at multiple targets to ameliorate hyperglycemia. **3. Antitumor activity¹⁸**- Antitumor activity of the chloroform and ethanol extracts of *Cuscuta reflexa* Roxb. was evaluated against Ehrlich ascites carcinoma (EAC) tumor in mice at doses of 200 and 400 mg/kg body weight orally, respectively, while acute oral toxicity studies were performed to determine the safety of the extracts. **4. Diuretic activity¹⁹**- Comparative Study of *Cuscuta reflexa* Roxb and *Cassytha filiformis* for Diuretic Activity. Aqueous and alcoholic extract of *Cuscuta reflexa* Roxb and *Cassytha filiformis* exhibited significant diuretic activity and caused marked increase in Na⁺ and K⁺ excretion, when compared to saline treated controls. However the diuretic activity of *Cassytha filiformis* extract was higher than that of *Cuscuta reflexa*. **5. Cholinergic Action²⁰**- The effects of the stem extract of *C. reflexa* resembled acetylcholine when tested on isolated rabbit ileum and frog rectus abdominis and heart. Effect of the extract on isolated frog rectus abdominis muscle was blocked by pancuronium and potentiated by neostigmine. **SUBSTITUTION-** Hemiparasite *Cassytha filiformis* is used as a substitute for *Cuscuta reflexa* Roxb.

Table no 1; Comparison between *Cuscuta reflexa* Roxb and *Cassytha filiformis*²¹

Particulars	<i>Cassytha filiformis</i>	<i>Cuscuta reflexa</i>
Family	Lauraceae	Convolvulaceae
Type Parasitism	Hemi parasite	Holo parasite
Stem	Stout, rough, mild Fleshy, 1cm in diameter, greenish Pale yellow in color.	Slender, glabrous, shiny, fleshier, 0.25 cm in diameter, Pale yellow in color.
Flower	Spicate inflorescence	Globose clusters or cymose clusters
Fruit	Globose, smooth	Globose, smooth with drupe enclosed in a fleshy perianth tube
Growth Habitate	Climbing, spreading	Mainly spreading across ground covers
Host Preference	Virtually indiscriminate, tending in to infest woody plants (trees and shrubs), but also a parasite of a wide range of herbaceous hosts	Generally herbaceous plants

Parasitic plant obtains all or part of its nutrition from another plant (host) without contributing to the benefit of the host and in some cases causes extreme damage to the host. The defining structural feature of a parasitic plant called Haustorium, is a “specialized plant organ that draws nutrients from other organs or tissues”. Growth of haustorium occurs with the partial participation of host plant and complete participation of parasite. The volatile organic compound and immunity of the host plant plays an important role to locate and select the host by the parasite respectively. It is having special cultivation and propagation on host and easily hosted on weak stems as compared to thick bark of host. There are no references found in Samhita’s in classics but different synonyms, properties and actions are discussed in various Nighantu’s. As concerned with the verities, Bhavaprakasha nighantu mentioned. 1. Amarabel-*Cuscuta*

reflexa Roxb (Convolvulaceae)¹⁴. Akashabel- *Cassytha filiformis* (Lauraceae), which is having few similar appearances to *Cuscuta reflexa* Roxb therefore used as substitute. Control measures are essential to avoid complete damage of host plant. Recently, various pharmacological activities are explored in this domain.

DISCUSSION & CONCLUSION

This article reveals the Akashavalli is parasite with supportive classical references like Asparsha, Nirmula etc. Even though the parasite mechanism and host range of *Cuscuta reflexa* Roxb is known, it is revealed that grade of invasion depends mainly on the immunity of the host plant. This article also affirms that the methods discussed above could be potentially adopted in order to prevent complete damage to the host plant by parasite. Further, studies are undertaken to evaluate the complete lifecycle of parasites.

REFERENCES

1. Frontiers in plant science. Parasitic plants of the genus *Cuscuta* and their interaction with susceptible and resistant host plants. Institute of Plant Biochemistry, Centre for Plant Molecular Biology, University of Tübingen, Tübingen, Germany: 2015 Feb.
2. Narahari Pandit, Rajanighantu, Vyakhyakara- Dr. Indradev Tripathi, 3rd edition, Chaukhamba Krishnadas Academy, Varanasi, 2003. Tpg-703
3. Nighantu rathnakara, edited by Bhishagvarya Navra Krishnashastry, Published by Jawaji Vasudev, Bombay 1936, Tpg 808
4. Gaoud SD. Shankar Nighantu. Varanasi: Chaukhambha Vidhyabhavan; 2002. p.11
5. Parasitic plant Wikipedia: https://en.wikipedia.org/wiki/Parasitic_plant; 8/8/2017
6. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4316696/> Bettina Kaiser et al. Parasitic Orobanchaceae book online "Parasitic plants of the genus *Cuscuta* and their interaction with susceptible and resistant host plants"; 8/8/2017
7. D. M. Joel et al. Parasitic Orobanchacea. DOI 10.1007/978-3-642-34146-1: spinger-verlag Berlin Heidelberg; 2nd chapter; 2013.
8. **The wealth of India**- A dictionary of Indian Raw materials and industrial products- Raw materials [Revised] New Delhi, Publications and Information Directorate, Council for Scientific and Industrial Research. 2nd Volume. 2 (Cl-Cy): Reprint 2005. Tpg.336
9. Bhavamishra. Bhavaprakasha Nighantu- Hindi Commentary by K.C. Chuneekar. 1st ed. Varanasi: Published by Chaukhumbha Bharathi Academy; 2002, Tpg-984
10. Kaiyadeva Acharya, Kaiyadeva Nighantu, Pathyapattya vibodhaka, Sampadde Acharya Priyavrit Sharma and Guruprasad Sharma, Varanasi, Chowkamba Orientalia, 1979. Tpg-696;
11. Madanapala Nrupa, Madanapala Nighantu, Published by Ganga Vishnu Sri Krishnadas, Bombay, 1867., Tpg- 296
12. Nighantu rathnakara, edited by Bhishagvarya Navra Krishnashastry, Published by Jawaji Vasudev, Bombay 1936, Tpg 808
13. "Parasitic Weed Seems to Smell Its Prey". Associated press, 2006. Retrieved 2010-06-22.
14. Ruchi Tiwari, Amit Kumar Verma, Sandip Chakraborty, Kuldeep Dhama and Shoor Vir Singh, 2014. Neem (*Azadirachta indica*) and its Potential for Safeguarding Health of Animals and Humans: A Review. *Journal of Biological Sciences*, 14: 110-123.
15. Quality Standards of Indian Medicinal Plants, 5th edition, Indian Council of Medical Research, New Delhi.
16. Pandit S, Chauhan NS, Dixit VK. Effect of *Cuscuta reflexa* Roxb on androgen-induced alopecia. Department of pharmaceutical Sciences, Dr. Harisingh Gour University, Sagar, Madhya Pradesh, India. 2008 Sep;7(3):199-204.
17. Mohammed Rahmatullah et al. Effect of *Cuscuta reflexa* Roxb Stem and *Calotropis Procera* Leaf Extracts on Glucose Tolerance in Glucose-Induced Hyperglycemic Rats and Mice. Department of Biotechnology and Genetic Engineering, University of Development Alternative, Bangladesh. 2010; 7(2): 109-112.
18. Dandopani Chatterjee et al. Evaluation of Antitumor Activity of *Cuscuta reflexa* Roxb (Cuscutaceae) Against Ehrlich Ascites Carcinoma in Swiss Albino Mice.

Department of Pharmacognosy, Oriental College of Pharmacy, Bhopal. Tropical Journal of Pharmaceutical Research August 2011; 10 (4): 447-454

19. <https://www.researchgate.net/publication>. Sharma Sakshy et al. Comparative Study of *Cuscuta reflexa* Roxb. and *Cassytha filiformis* for Diuretic Activity. Research gate, September 2009.

20. The effect of antiadrenaline compounds on acetylcholine responses of frog rectus abdominis muscle. Pubmed.gov.1970 Feb;38(2):386-93.

21. Scot C. Nelson. *Cassytha filiformis*. Department of Plant and Environmental

Protection Sciences: Plant Disease; July 2008

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IMAGES OF *CUSCUTA REFLEXA* ROXB AND *CASSYTHAFILIFORMIS*

<i>CUSCUTA REFLEXA</i>	<i>CASSYTHAFILIFORMIS</i>
 <p data-bbox="354 594 634 625">Stem of <i>cuscutareflexa</i></p>	 <p data-bbox="954 594 1268 625">Stem of <i>cassythafiliformis</i></p>
 <p data-bbox="347 1014 656 1045">Flower of <i>cuscutareflexa</i></p>	 <p data-bbox="964 1014 1305 1045">Flower of <i>cassythafiliformis</i></p>
 <p data-bbox="347 1549 634 1581">Fruit of <i>cuscutareflexa</i></p>	 <p data-bbox="964 1539 1292 1570">Fruit of <i>cassytha filiformis</i></p>