Research Article (Open access)

Studies on the Haustorial Growth Pattern of *Helicanthes elastica* (Desr) Danser in Selected Hosts

Lizzy Mathew[1], Ajith Kumar T G[1*]
[1]Research Scholar, Department of Botany, St Teresa's College, Ernakulam Dist. Kerala, India

[*]**Address for Correspondence:** Mr. Ajith Kumar T G, Research Scholar, Department of Botany, St. Teresa's College, Ernakulam Dist. Kerala, India

Received: 21 March 2016/Revised: 15 April 2016/Accepted: 03 May 2016

ABSTRACT- Haustoria, the organ of absorption of nutrients found in semi parasite *Helicanthes elastica* growing on six different host plants were examined for the growth pattern of epicortical roots over the host stem. Anatomical sections of haustoria entry portions were taken to study the establishment of haustoria inside the hosts. Surface characterstics and nature of the conducting tissues of the host decides the growth pattern of epicortical roots over the host, entry of haustoria in to the host and its successive establishment. The nature of bark is of prime importance in the penetration. Branches of haustoria are chiefly found in the secondary xylem and also in some portions of the secondary phloem. Presence of parasitic hypahe for the absorption has been found in some of the selected hosts.

Key-Words: Epicortical roots, Haustoria, Secondary xylem, Parasitic hyphae, *Helicanthes elastic*

--IJLSSR---

INTRODUCTION

Haustorium was originally defined by De Candolle [1], who took it from the latin word *'haurire'* meaning 'to draw up' or 'to drink' which points to an active role. Haustorium was defined as the special organ of parasitic plants which invades host tissues and serves as the structural and physiological bridge that allows the parasites to withdraw water and nutrients from the conductive systems of the living host plants [2]. Parasitism by means of haustorial connections to a host is widespread in angiosperms, having arisen independently [3].

Phanerogamic parasites of the mistletoe group (family Loranthaceae) have been the object of curiosity for thousands of years. Their victims mostly dicotyledonous and gymnosperms, include horticultural plants as well as forest trees. Eventhough the members fall under semiparasite category most of them causes a great damage to their hosts. The degree of damage depends on the parasitic species, host and intensity of parasitism [4].

Access this article online	
Website: www.ijlssr.com	**DOI:** 10.21276/ijlssr.2016.2.3.8
Quick Response Code:	
ISSN 2455-1716	

Of the 75 genera comprising the Loranthaceae 72 are aerial parasites. Four basic haustorial types are recognized in aerial forms- epicortical forms, clasping unions, wood roses and bark strands [5]. Epicortical roots that spread along host branch surfaces and at intervals form huastoria are regarded as ancestral [8]. *H. elastica* is one of delicate mistletoe which can grow rapidly over the host by means of epicortical roots.

Almost 47 different trees are reported [10,12] as host of *H. elastica*, all of these have varied foliage and growth pattern. When the parasite infects, it produce a large number of haustoriferous runners or epicortical roots from base to all sides. These branches produce haustoria at regular intervals that will penetrate in to the host trunk and helps its establishment of the parasite.

Most of the economically important trees are attacked by *H. elastica* causing severe damage. By having dichotomous branching pattern of haustoriferous runners, it can attack the main trunk of the trees and in a short while it covers a large area of the host body [6]. It has been reported that the trees, where barks have acrid, bitter or astringent qualities with limpid or milky juice are little liable to be affected by the Loranthii [7] But *H. elastica* found to affect a lot of rubber trees, heavy barked trees like *Terminalia* and trees that shed their bark like *Lagerstomea* [6,10]. Well establishment of the haustoria inside the host enable the better survival of the parasite as it sucks the water and minerals needed for the parasite. The dead parasite can be distinguished by the netlike haustorial growth, dichotomous branching and swollen nodes.

Copyright © 2015-2016 | IJLSSR by Society for Scientific Research under a CC BY-NC 4.0 International License

In the present study, the morphological evaluation of the haustoriferous runners on six different hosts and the resultant anatomical pattern of haustorial growth in the host was studied to find out how the nature of the host trunk allows the parasite to grow within it or how the parasite's haustoria establish inside the host.

MATERIALS AND METHODS

Helicanthes elastica along with its haustorium attached host branch were collected from various parts of Ernakulam district, Kerala. The six different hosts selected were *Nerium indicum, Murrayya koenigii. Citrus maxima, Hevea braziliensis, Saraca indica, Anacardium occcidentale*. The collected specimen was photographed and the haustorial penetrated portion of the hosts was preserved in 70% ethanol for subjecting in to sledge microtome studies. Thin sections of the haustoria attached portion were taken by sledge microtome and were microphotographed. Abbreviations were assigned for samples as follows; HEA- *H. eastica* on *Anacardium occcidentale* HEN- *H. eastica* on *Nerium indicum* HEM-*H. eastica* on *Murrayya koenigii*. HEC- *H. eastica* on *Citrus maxima*. HEH- *H. eastica* on *Hevea braziliensis.* HES- *H. eastica* on *Saraca indica.*

RESULT

Growth pattern of parasite over host

In HEA, the unbranched epicortical roots or suckers of the parasite grow over the host stem. It produces aerial branches. The production of haustoria is more and it intermittently occurs after 2 to 3 cm. The entry results in small swelling on the host stem and it can easily see externally. The epicortical roots not entangled the host stem. It grows parallel to the host stem. The parasite produces haustoria and aerial branches simultaneously from the same node. [Plate I-1]

The epicortical roots of HEC produce multiple branches over the host. The newly born branches readily establish haustoria in the host stem. The external morphology of the host stem do not show apparent change due to the entry of the haustorium. The aerial branches are seen crowded over the host stem. [Plate I-2]

The suckers of HEM crowded over the host stem and produce haustoria wherever it touches the host. The separation of the host and parasite seems to be very difficult because of the branching pattern of the parasite. In some cases the host stem is completely covered over by the epicortical roots. The well established haustoria produce swellings externally. [Plate I-3]

The epicortical roots grow appressed to the host stem in parallel manner in HEH. It does not produce haustoria on the entire length as seen in HEA. The haustorial production occurs in between a distance of 4-6 cm. The existence and establishment of haustoria with in the host alter the morphology of the host but the ready entry does not affect the external features of the host. Later on it produce slight swellings intermittently. [Plate I-4]

In HEN epicortical roots grow parallel to the host stem in an appressed manner. It produces branches sometimes and it circles the stem. The host shows a bulging morphology at point of entry of the parasitical root. The growth of the affected branch of the host readily declines after the entry of the haustoria compared to other hosts. [Plate I-5]

The relationship seen in HES is interesting because wherever the paraite produce haustoria; both host and parasite produce swelling in that region. The swelling in the host is clearly visible due to the establishment of the haustoria with in it. As the epicortical roots grow parallel to the host stem by producing haustoria intermittently the host stem appears in the form of beaded string as the swellings were more prominent compared to the rest of hosts studied. [Plate I-6]

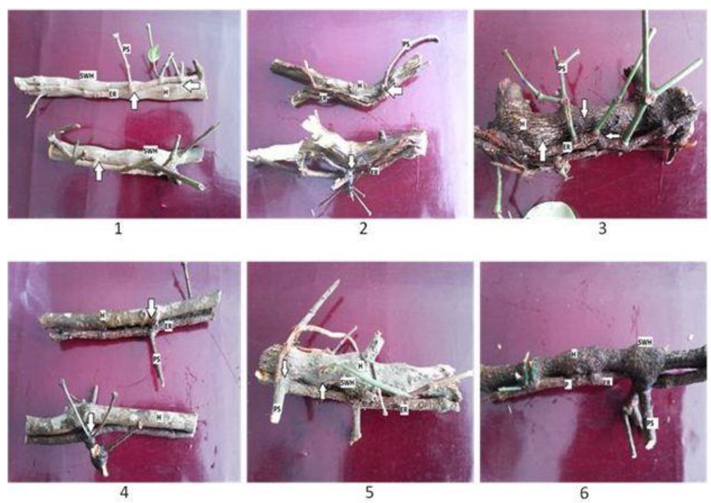


Plate I: Host stem with attached epicortical roots of *H.elastica* 1. **HEA** 2. **HEC** 3. **HEM** 4. **HEH** 5. **HEN** 6. **HES**. H-host stem, P- parasite, SWH- swelling of host stem, ER-epicortical roots, PS-parasite's stem. Arrow marks indicate the region of penetration of haustoria.

Anatomy

The haustoria of HEA shows dichotomous branching with in the secondary xylem and medullary rays of the host [Plate II-1a]. The haustoria grow as a single unit till it reaches the secondary xylem. Then it crushes the host tissue on its way and absorbs the nutrients from the conducting tissues. The lumen of the xylem vessels contains hair-like structures produced by the haustoria. [Plate II-1b].

Destruction of the host tissue is clearly visible by the establishment of haustoria in HEC [Plate II-2a]. A channel is formed in the growth of haustoria by the destruction of host tissues. An air gap can also be seen between the growing haustoria and host tissues. The close relationship or a merging of haustorial tip and the host's secondary xylem is clearly seen. [Plate II-2b].

The growth of the haustoria is found not much drastic in the case of HEH. The thickness of the haustoria is not much

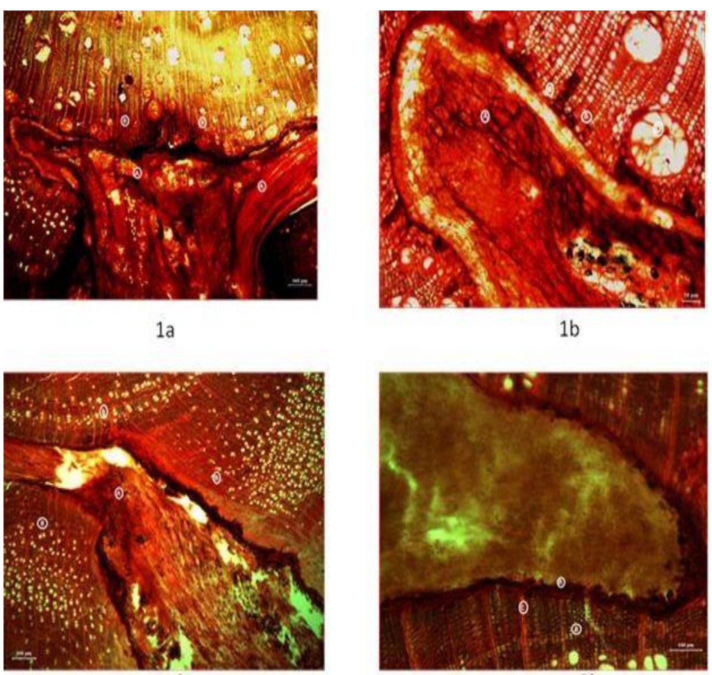
Copyright © 2015-2016 | IJLSSR by Society for Scientific Research under a CC BY-NC 4.0 International License

and the destruction of host tissue is minimized. The growth of the haustoria is straight and it tries to reach the central portion of the stem. It establishes the connection mainly with the secondary vessels and medullary rays. Secondary vessels contain hair like xylem hypahe. [Plate II-3a,3b].

In the sample HEN when the haustoria entered reach the middle of the secondary conducting tissues, it bifurcates and later encircles the rest of the secondary xylem [Plate II-4a]. The well established connection of haustoria and secondary conducting tissues can be clearly visible. The establishment of haustoria with in the secondary phloem region is also visible. [Plate II-4b].

The pressure caused by the haustorial entry on the host stem is high in HEM. The haustoria well establishes inside the host and after growing through the secondary xylem and medullary rays, it readily form branches and encircles the tissues. This results in the splitting and separation of the secondary conducting tissues of the host [Plate II-5a]. The presence of the haustorial tissues can also be seen with in the central tissues of the host.

A peculiar type of growth pattern is seen in HES. The haustoria produce multiple branches and these branches grow outward towards the secondary phloem and inwards towards the secondary xylem [Plate II-6a]. When it reaches the destination again produce branches. The haustorium that enters the secondary phloem seems to slow down its growth where as those that entered the secondary xylem shows well establishment. Even though it grows in both directions the destruction caused on the secondary phloem is less when compared to secondary xylem.



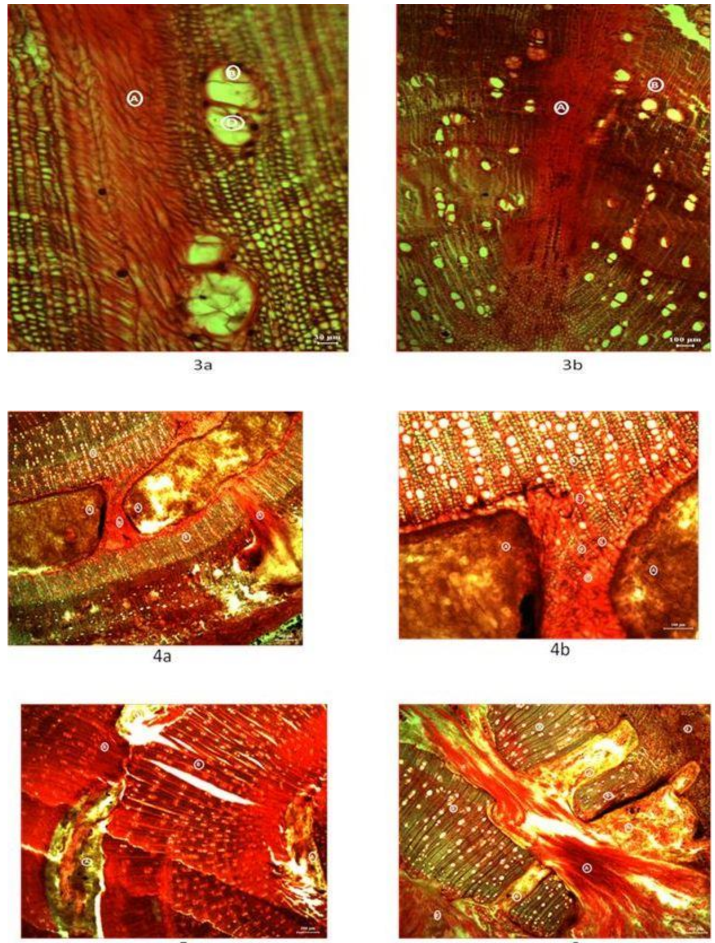


Plate: II Anatomy of the haustorial penetrated portions of 6 hosts1a & 1b**- HEA**. 2a & 2b- **HEC**. 3a & 3b-**HEH.** 4a & 4b-**HEN**. 5a-**HEM**. 6a—**HES**. (A) Haustoria (B). Secondary Xylem (C). Medullary rays (D).Xylem hypahe (E). Pith (F). Secondary phloem

DISCUSSION

Except for the resource conditions and the attachment orientation the parasite might also choose its attaching tissues by recognisnig different types of surface shapes [9]. The growth of epicortical roots, penetration and establishment pattern of haustoria in *H. elastica* depends on its hosts. Contact stimuli and natural light can produce chemical signals for the development of haustoria [13]. The bark characteristics, amount and characters of secondary conducting tissues of the host determine well developed growth of sucking roots inside the host. Morphological evaluation clearly shows that the epicortical roots are easily detachable in the initial stages and when they produce haustoria at specific intervals they attach firmly to the host branches and the contact becomes tighter. The establishment of haustoria within the host tissues produces remarkable morphological changes in the host stem externally. In the present study the haustoria of HEA, HEN and HES were well established with in the hosts and they produced bifurcated branches (HEA & HEN) and multiple branches (HES) with in the host tissues. The pressures developed due to the establishment of haustoria are

Copyright © 2015-2016 | IJLSSR by Society for Scientific Research under a CC BY-NC 4.0 International License

sufficient to bulge out the tissues external to it and this appeared as swellings on the host branches at the point of entry of haustoria. The latter produced prominent bead like swellings. The stem of HEC and HEM were rather thick and their barks were very hard to penetrate, so points of entry of haustorium were minimized. The haustoria establishes well inside and pressure developed here is not produce a bulging force externally due to the highly thickened secondary conducting tissues, moreover it results in radial splitting of the secondary conducting tissues through the lines of thin walled medullary rays. The pattern of haustorial growth seen in HEH seems to be silent killer both externally and internally as it does not produce characteristic morphological and anatomical changes to host. The rigid and thick bark not often favour the penetration of haustoria, therefore in such cases the production of haustoria is not frequent (HEM, HEC) and more branches of epicortical roots are produced from single point of haustorial penetration. If the host stem surface is not very hard and having thin bark, the epicortical roots grow parallel to the host stem producing haustoria frequently. The epicortical roots are not much branched in such hosts (HEH, HEN, HEA, HES).

It has been reported that when the haustoria penetrate the host tissue, it produces search hypahe and when in contact with the secondary xylem vessels becomes xylem hypahe [11]. The xylem hypahe are visible in the vessels of HEA and HEH and found in other hosts too. The haustorial patches are also seen with in the secondary phloem in HEN and the growth of haustorial branches towards secondary phloem is seen HES, the reason for this should be studied. There might be some signals in the vascular elements that trigger the differentiation of parasitic hypahe into the xylem and phloem hyaphe [11], which still needs to be identified.

CONCLUSIONS

The studies on the growth of epicortical roots and haustoria of *H. elastica* in different plants suggest that the surface tissues and internal tissues of the host determine establishment of the parasite. Both host and parasite interact with each other to produce the resultant morphological and anatomical changes with the host and ready establishment of parasite within it. The final entry of the parasite's haustoria towards the secondary xylem because *H.elastica* is a semiautonomous parasite nothing to do with the host's phloem. But the survey in this study shows that *H. elastica* seen even on the dead leafless and non conducting branches of the host stem that contain only stored food in the phloem. The studies in these aspects are necessary and moreover specific changes that happening to the haustorial tip and secondary tissues of the host need to be worked out.

ACKNOWLEDGMENT

This work was supported by Sri. P. K. Thulasidas (Scientist C) Wood Science and Technology division of Kerala Forest research Institute, Peechi, Kerala, India.

REFERENCES

[1] AP De Candolle, Theorie Elementaire de la botanique. Deterville, Paris, 1813.

[2] Joel D M. Parasitic Orobanchaceaea. Springer-Verlag, Berlin Heidelberg, 2013; pp. 21-23.

[3] Carol A W, Clyde L C. An origin of aerial branch parasitism in the mistletoe family, Loranthaceae. *American Journal of Botany*, 2006; 93(5): 787-96.

[4] Singh B. Studies in Angiospermic Parasites- *Dendrophthoe falcata*, Bulletin of the National Botanic Gardens, United Block Printers Lucknow, 1962, pp. 1.

[5] Calvin C L, Wilson C A. The Haustorial System in African Loranthaceae, Royal Botanic Garden, Kew, UK, 1998, pp: 17-36.

[6] Shanavaskhan AE, Sivadasan M. piphytes and parasites of Kerala India, 1st ed; Bihen Singh Mahendrapal Singh, Dehradun, 2009: 272.

[7] Scot GJ. loranthaceae- the mistletoe order germination and mode of attachment. *J.Agri.Hort.Soc.India*, 1871; 2: 257.

[8] Kujit J. The biology of parasitic flowering plants. University of California Press, Berkeley, California, USA, 1969.

[9] Lee K, Lee C. The structure and development of the haustorium of *Cuscuta australis*. *Can. J. Bot*, 1989; 67: 2975-82.

[10] Sunil kumar KN, Saraswathy A, Amerjothy S. Survey report on hosts and haustoria of helicanthes elastica (Desr) Danser in Udupi and dakshina Kannada districts of Karnataka and Kasargod district of Kerala, India– A concise review plus some new additions. *Indian Forester*, 2015; 141(4): 448-51.

[11] Lan H, Hao S, Hua C, Ling L; Xiaoying H, Xinlan X; Wanhui Y; Zangming W. The morphology and anatomy of the haustoria of the holoparasitic angiosperm *Cuscuta campestris*. *Pak. J. Bot.*, 2011; 43(4): 1853-59.

[12] Ajith Kumar TG, Lizzy M. Pharmacognostic studies of *Helicanthes elastica* growing on *Nerium indicum*. *Eurpean Journal of Biomedical and Pharmaceutical Sciences*. 2014, 1(1): 55-59.

[13] Tada YM, Sugai KF. Haustoria of *Cuscuta japonica*, a holoparasitic flowering plant, are induced by the cooperative effets of far-red light and tactile stimuli. *Plant Cell Physiol*, 1996, 37: 1049-53.

Copyright © 2015-2016 | IJLSSR by Society for Scientific Research under a CC BY-NC 4.0 International License