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Anatomical Characterization of Root Holoparasitic Plant – *Alectra parasitica* A. Rich

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Abstract: The present investigation was focused on the anatomical characterization of leaf, stem, haustorium and connection of host - parasite. Generally, the studies on parasitic plants and their hosts are poorly investigated and usually neglected in Indian communities. As there are no earlier reports on anatomical study of this plant species, so the present research work was carried out. From the present study it is observed that, the vascular bundles were less developed and having poorly developed phloem but well developed xylem. It means that, parasitic plant i.e. *Alectra parasitica* A. Rich. can efficiently takes water and prepared food, from the host plant. This parasitic species also shows variations in the invasiveness of endophytic tissues of haustorium into the host vascular tissue. Also, the variations of leaf and stem anatomy is significant and revealed that this characters possesses many attributes of potential taxonomic importance that are diagnostic at the genus and species levels.

Keywords: Anatomy; characterization; holoparasite and *Alectra parasitica*.

INTRODUCTION

A parasitic plant is one that derives some or all of its sustenance from another plant. These are found throughout the world and encompass a huge diversity of ecological niches, growth habits and host associations (Press and Phoenix, 2005). Parasitic plants exhibit a whole variety of specializations in morphology, anatomy, physiology and reproductive biology (Adhikari, *et al*., 2003). These 4000 species of parasitic plants belong to approximately 19 different known flowering plants families (Nickrent, 2020; Barker, *et al.*, 1996 & Nickrent and Musselman, 2004) and in total they represent more than 1% of all angiosperms (Heide-Jorgrnsen, 2008). Parasitic angiosperms have been recognized as an entity for over 2000 years. Almost, half of the population of parasitic angiosperms belongs to family Scrophulariaceae. Parasitic plants have a modified root - the haustorium, which penetrate to the host plant and connects to the xylem, phloem, or both. Depending on the photosynthetic ability, they can be classified as holoparasite and hemiparasite (Shin and Lee, 2018). On the basis of selection of host parasites are divided into specialist plant parasites and generalist plant parasites. Parasites may affect the photosynthesis and nitrogen metabolism of the host. Most important is effect of parasite on the productivity and reproduction of the host (Press and Phoenix, 2005).

Alectra parasitica A. Rich is an unexplored root parasitic plant locally known as Nirgunda belongs to family Scrophulariaceae. It is parasite on the roots of *Vitex negundo* L. This plant is indigenous to India and first reported by Kamble & Pradhan (1988) from Akola district of Maharashtra.

Taxonomy: *Alectra parasitica* A. Rich., Tent. Fl. Abyss. 2: 117, 1851; Kamble & Pradhan, Bull. Bot. Surv. Ind. 26: 129, 1984 & Fl. Akola, 154, 1988.

It is an erect herb, about 25 cm tall. Stem dark brown – purple, angular, hispidulous, turning black on drying. Rhizome 0.3 – 0.7 cm, thick without scales, orange – red. Flowers in terminal spikes or racemes, shortly pedicelled. Bract scale like, elliptic – ovate, acute, serrate. Corolla yellow, with red or brown streaks, 5-6 lobed. Stamens, 4-6. Anther lobes slightly unequal. Stigma elongated inflexed, hairy. Ovary bilocular with axile placentation. Ovules numerous. Capsule 4-valved. Seeds numerous. Flowering and Fruiting Period: August to November.

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Figure-1


Figure-2

Fig 1 & 2: showing Morphology of *Alectra parasitica* and host-parasite connection respectively.

The aim of this study is to elaborate the importance of anatomy in understanding of different structures of parasitic plants i.e. *Alectra parasitica* A. Rich as well as their physiology in relation to their cellular structures, especially haustorium and to find the taxonomic characters for species delimitation.

MATERIAL AND METHODS

The plant *Alectra parasitica* A. Rich was collected in the month of September from Wari Dam, Akot Tehsil of Akola district, Maharashtra. The plant material was taxonomically identified by using standard floras (Kamble & Pradhan, 1988 and Singh, *et al.,* 2001). The collected fresh material of *Alectra parasitica* A. Rich was washed 2-3 times with sterile distilled water and preserved in 3% formalin solution then used for the micromorphological and anatomical investigation. Clear sections were prepared, stained with safranin and mounted according to the method used by Johansen (1940). Hand free transverse sections of plant parts i.e. leaves, stem, haustorium and connection point part (haustorium -host root) were taken with the help of fine laboratory razor and observed under the microscope to note details. The sections were also proceeds for double staining successively through various solvents grade system by using 1% safranin (for 5 minutes), 30%, 50% & 70% alcohol respectively (for 5 minutes) to remove excessive stain then, the sections were put into 0.5 % light green (for 3 minutes) then again put into 70%, 90% & absolute alcohol (for 5 minutes) to remove excessive stain and later passing through Xylene: Alcohol (1:3), Xylene: Alcohol (1:1) and pure Xylene to remove moistures and air bubbles. Then, the sections were mounted in DPX and cover slip was put over the section and later photographed using Carl Zeiss standard Universal microscope (Oberko-Chen / Wartenberg, Germany).

OBSERVATIONS AND RESULTS

Microscopical studies are useful to elaborate the importance of anatomy in understanding of different structures of parasitic plants as well as their physiology in relation to their cellular structures, especially haustorium.

Transverse Section of Leaf

In the transverse section of leaf of *Alectra parasitica* A. Rich, midrib is triangular and has 1-2 layers of collenchymatous cells under both adaxial and abaxial epidermis. Upper epidermal cells are larger than the lower epidermal cells. The leaf also shows the mesophyll consists of elongated palisade cells with large intracellular cavities and spongy parenchyma cells. The vascular bundle is solitary type and is surrounded by parenchymatous and orbicular cells. Xylem strand is surrounded by phloem cells (Plate-1, Fig-1 & 2). There are many prominent trichomes on the lower epidermis. Both the epidermises have lacking cuticle (Fig-1). The leaf of *Alectra parasitica* A. Rich is having anomocytic type of stomata which present on both the upper and lower epidermis with its neighboring cells (Plate-2, Fig-11 &12).

Transverse Section of Stem

The transverse section of stem of *Alectra parasitica* A. Rich is taken from the middle part of the stem, which showed the cuticle layer, is thick and trichomes are obvious (Plate-1, Fig-3 & 4). Cuticle followed by epidermis. The epidermis is a single layer having spherical cells. Epidermis is a monolayer of collenchymas cells, but 2-3 layers of collenchymas seen below the epidermis; at the

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stem ridges. The cortex of the stem is thick and consist of 5-7 layers of usually spherical cells having large intercellular spaces and make up 20% of the stem cells. In the cortex, there are some patches of sclerenchyma distributed unevenly below or in the cortical layer. The distribution of sclerenchymatic tissue in the cortex has considerable taxonomic value. It occurs as a solitary or bundle fibers. The cambium is not distinguishable xylem tissue including solitary vessels or clustered vessels, is extensive and occupies 35% of the stem cortex. The xylem vessels are surrounded by phloem cells towards an outer side. The intravascular sclerenchymatous tissue is thick (Plate-1, Fig-3 & 4). The pith cells are large and cylindrical and occupied 36% of the stem radius. The stem of *A. parasitica* is totally lacks the calcium oxalate crystals and other types of crystals.

Transverse Section Haustorium

In the cross section of haustorium of *Alectra parasitica* A. Rich, epidermis is single layered of spherical cells covered by thick cuticle. The cortex is large, 16-18 layered, composed of many rounded to spherical collenchymas cells having less amount of intercellular spaces (Plate-1, Fig-5). The vascular bundle is collateral type surrounded by pericycle. The primary vascular tissues are arranged in radial rows also the bundle has small amount of secondary tissue. The central part usually shows weak radial arrangement and the inner and outer cells are irregularly arranged. The protoxylem and metaxylem cells are large in amount. The strands or sheaths of fibres are often associated with conducting cells of xylem and phloem to form a complex conducting and supporting structures. The association fibres morphologically external to the bundle with the vascular tissue are apparently connected with the mechanical relations of support and protection for softer conducting tissues.

Cross Section of Host and Parasite Connection

In cross section of host parasite connection, a tubular haustorium of *Alectra parasitica* A. Rich made contact with the endodermis of the host root i.e. *Vitex negundo* L. At this stage, the outer tangential wall of the host endodermis became disrupted, allowing the endophytic tissues of the haustorium to penetrate into vascular tissues of the host and forms a connection with the host vascular bundle. As the phloem cells of *A. parasitica* attacks on the phloem cells of the host, the cortical cells of the parasite which became distorted along with the xylem vessels of the host as shown in (Fig-6 & 7) and forming a complete host – parasite connection for the absorption of water and nutrients to complete its life cycle.

DISCUSSION

The parasitic plant studied under investigation i.e. *Alectra parasitica* A. Rich fall into holoparasite category. The vascular bundles were less developed having poorly developed phloem but well developed xylem. It means that parasitic plant can efficiently take water and prepare food from the host plant. In *A. parasitica* the epidermis was without well developed cuticle, Metcalfe and Chalk (1950) have reported the use of epidermal characters such as leaf surface, epidermal cell wall pattern, nature of stomata as identifiable aids of some families and genera and sometimes for species. The leaves of *A. parasitica* had mostly anomocytic type. Ehleringer, *et al.* (1985) have shown that stomata are the main pathway of evaporative water loss in mistletoes and that through stomatal action they can maintain a control over rates of water loss. However, stomatal frequency is one of the most widely used characters in taxonomy and pharmacognosy (Krishnamurthy and Sundaram, 1970).

The leaf anatomy of *A. parasitica* shows the variations in their structures. In *A. parasitica*, trichomes were prominently present only at lower epidermis, absence of cuticle, mesophyll cells has large intercellular cavities. The variations of leaf anatomy is significant and revealed that this characters possesses many attributes of potential taxonomic importance that are diagnostic at the genus and species levels (Mbagwu and Edeoga, 2006; Nwachukwu and Mbagwu, 2007).

The stem anatomy of *A. parasitica* shows the variations in their cellular arrangement. The stem of *A. parasitica*, cortex consists of sclerenchyma distributed unevenly below or in the cortical layer. The distribution of sclerenchymatous tissue in the cortex has considerable taxonomic value. It occurs as a solitary or bundle fibers. The cambium is not distinguishable xylem tissue including solitary vessels or clustered vessels. The xylem vessels are surrounded by phloem cells towards an outer side.

This parasitic species also shows variations in the invasiveness of endophytic tissues of haustorium into the host vascular tissue. In *A. parasitica* haustorium forms connection to the phloem of the host for absorption of food materials and water to complete their life cycle. There are no earlier

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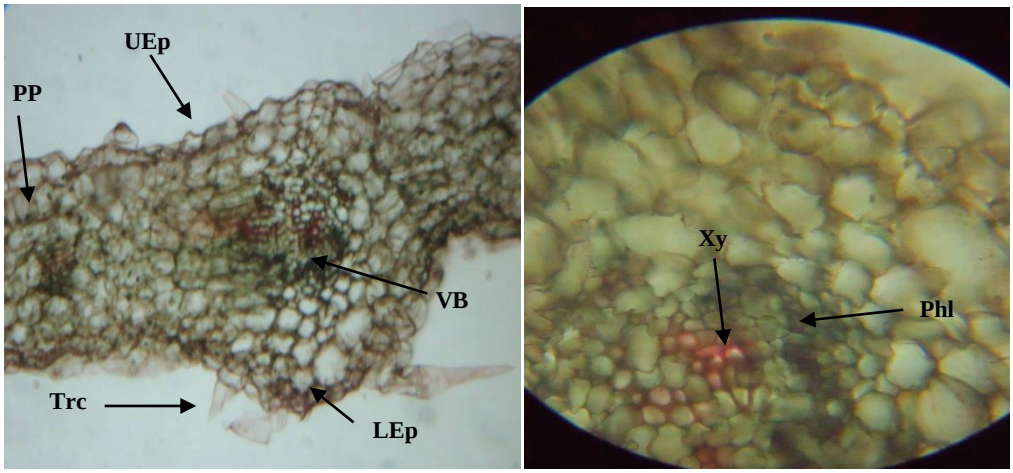
reports on the anatomical study on this plant species The earlier workers Johansen, (1940), Hsiao, *et al*., (1994), Khan, *et al*. (2009), Mbagwu, *et al.*, (2009) and Shahryar, (2012) carried out the anatomical studies on different parasitic plant species which shown the interrelationship between parasites and its host. Also, an anatomical evaluation is having a great importance in the pharmacognosy for the detection of adulteration in crude and powdered drug.

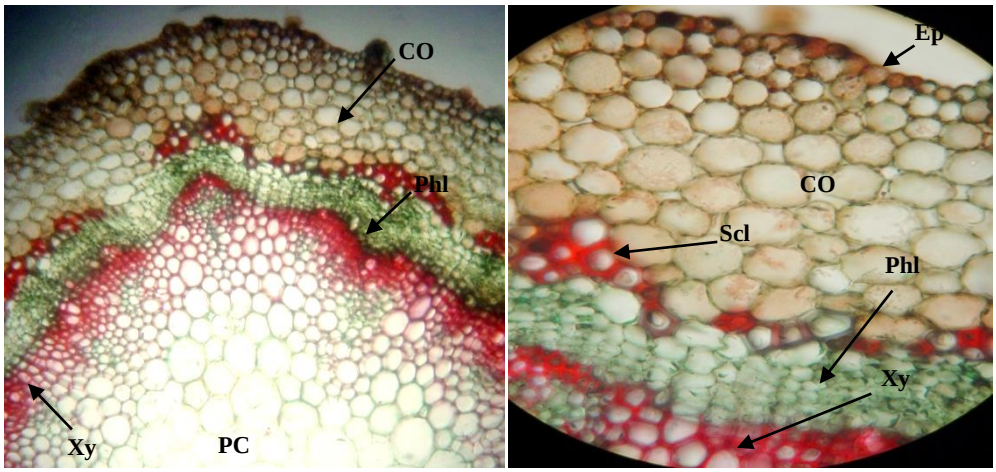
CONCLUSION

The anatomical study of *A. parasitica* root parasitic plant parts i.e. leaf, stem and haustorium shows the importance of anatomy in understanding of different structures of parasitic plants as well as their physiology in relation to their cellular structures, especially haustorium. It also gives the confirmatory characters regarding preparation of monographs for proper identification, evaluations and standardization.

PLATE: 1



1- T. S. of Leaf 2- Vascular Bundle of Leaf



3 – T. S. of Stem 4 – Epidermal layer of Stem

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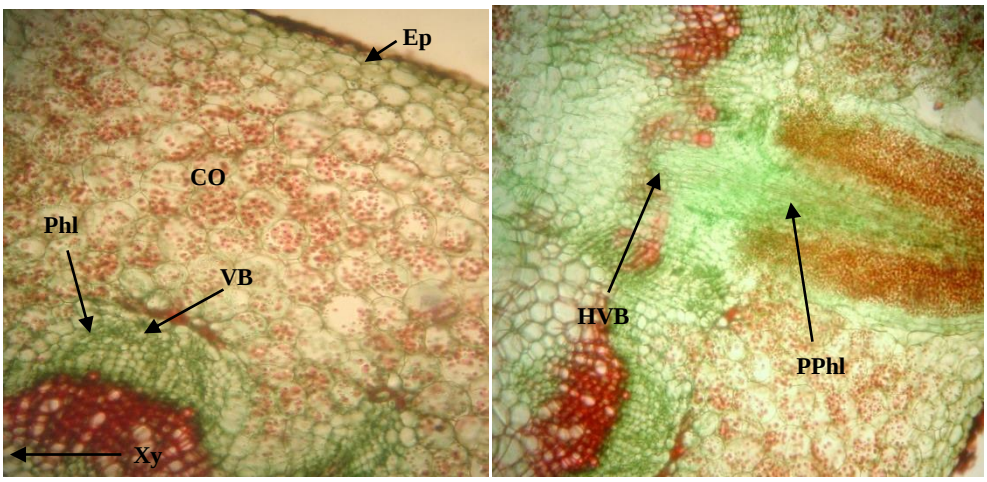
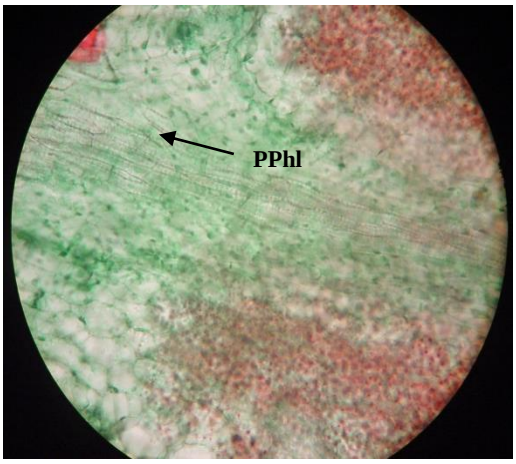
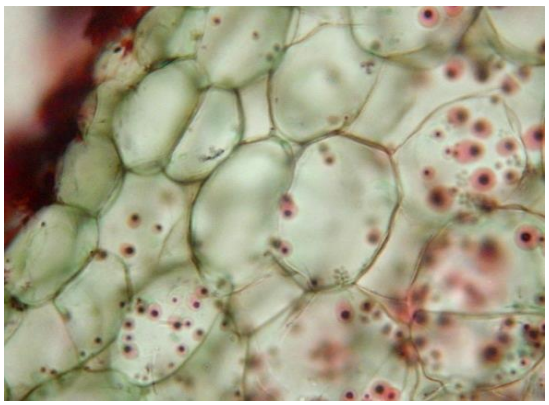


5 - T. S. of Haustorium 6 - Cross section of endophytic tissue of haustorium penetrating into Host Vascular Bundle

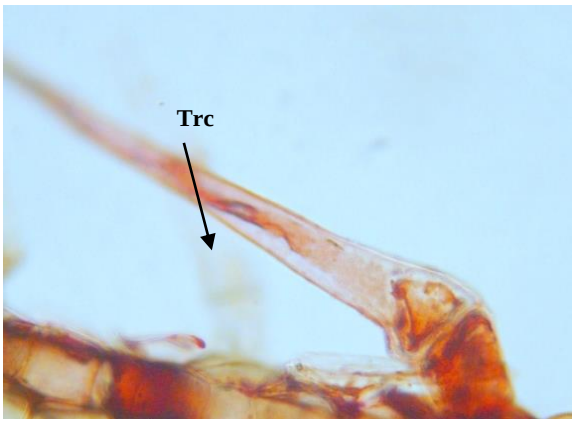
Plate 1 (Fig. 1-6): Anatomical features of *Alectra parasitica* A. Rich. (I)

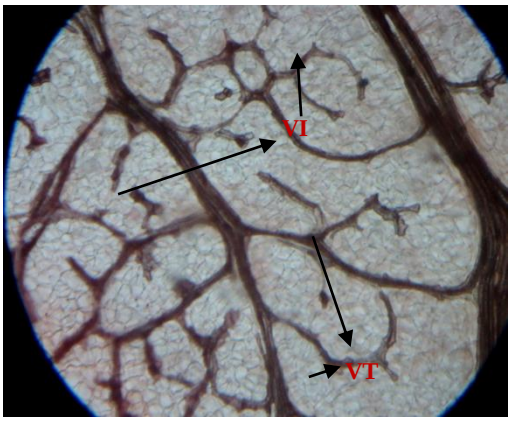
PLATE: 2





7- Host – Parasite Connection 8 – Epidermal cells of Haustorium





9 – Unicellular Trichome 10 – Vein islets and Vein termination

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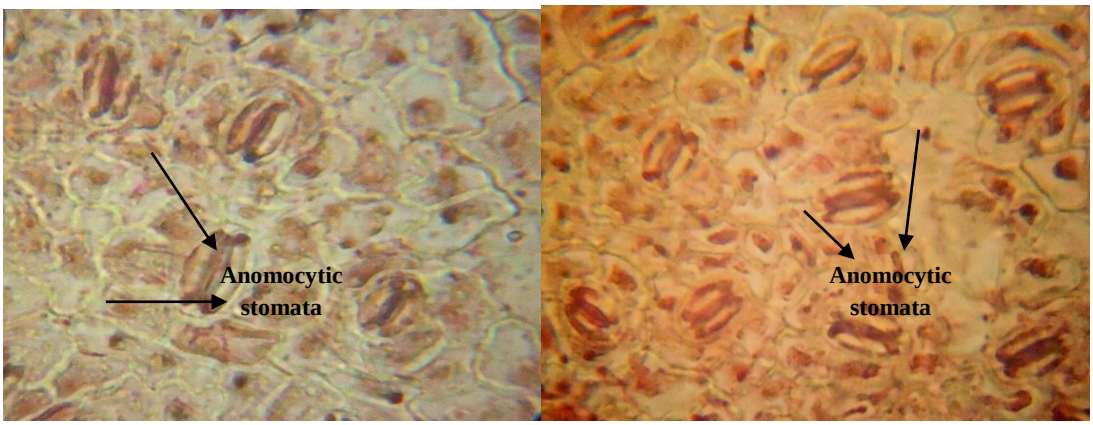

11-Stomata in upper epidermis of leaf 12- Stomata in lower epidermis of leaf

Plate 2 (Fig. 7-12): Anatomical features of *Alectra parasitica* A. Rich. (II)

Where, Plate 17&18 (Fig. 1-12) showing – **PP** – Palisade parenchyma; **UEp** –Upper epidermis; **LEp** – Lower epidermis; **Trc** – Trichomes; **VB** – Vascular bundle; **Xy** – Xylem; **Phl** – Phloem; **Co** – Cortex; **Scl** – Sclerenchyma; **Ep** – Epidermis; **PC** – Pith Cells; **HVB** – Host vascular bundle; **PPhl** – Parasite phloem; **VI** – Vein islets and **VT** – Vein termination.

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