

Some Parasitic Plants of Pakistan- Anatomical and Taxonomic Attributes

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ABSTRACT-The present work was conducted to study the anatomical characteristics of five parasitic plants (*Cuscuta reflexa*, *Korthalsella opuntia*, *Orobanchae aegyptiaca*, *Viscum album* and *Viscum cruciatum*) of Pakistan. There were two main categories i.e. holoparasites such as *Cuscuta reflexa* and *Orobanchae aegyptiaca* and hemiparasites such as *Korthalsella opuntia*, *Viscum album* and *Viscum cruciatum*. Longitudinal and transverse sections in the form of slides were also prepared in order to examine some important taxonomic (family, habit, phyllotaxy, height) and anatomical attributes (epidermis, stomatal type, petiole, leaf and stem) of these parasitic plants.

Index Terms: Parasitic plants, Anatomical, Taxonomic, Attributes, *Cuscuta reflexa*, *Korthalsella opuntia*, *Orobanchae aegyptiaca*, *Viscum album*, *Viscum cruciatum*.

INTRODUCTION

A parasite can be defined as “an organisms or group of organisms which depend partially or completely on other organisms for their food or nutrition” while organisms on which parasites depend are called hosts. Knowledge of parasitic plants goes back to the writings of Theophrastus, who wrote about several mistletoes [1]. Arabian scholars of the 10th century were aware of parasitic nature of plants. In the western world, the first published account of parasitic plants occurred in early 1700s, when Micheli [2] realized that *Cynomorium* (Balanophoraceae) was not a fungus but was a parasitic plant. Individual recognition of parasitic species occurred throughout the 18th and 19th centuries, but the botanical field was surprised when Mitten [3] revealed that *Thesium linophyllum* was a root parasite. Western botanists of the early 19th century thought that parasitic plants comprised a unique group, separate from non-parasitic plants. Trattinick [4], as translated by Kuijt [1] emphasized that opinion in the following passage: “we therefore have no choice but to cast them (the parasites) together, as oddities into their own category, much as in an asylum, we bring together the mentally ill, whose mania are extremely varied but of whom no one is really what he pretends or imagines to be”. Modern understanding of parasitism in vascular plants can most likely be traced back to the monograph of the Balanophoraceae by Hooker [5]. Some plants such as *Cuscuta* spp. are parasitic because they lack chlorophyll and are evident in the landscape such plants are obviously parasitic. However other can be less obvious such as *Orobanchae* spp. because their parasitic connection below ground, they have a normal non-parasitic appearance, they are completely subterranean.

Extracts of mistletoes [6] have been used to treat the distroppers in Europe, Africa, and in Asia and in the relief of digestive disorders by the California Native Americans. Modern medicine is pursuing several extracts of mistletoes for the treatment of cancer the potential applications of parasitic plants to human culture and the detrimental effects of parasitic plants to agriculture had made those topic an attractive one for scientists throughout the history of botanical sciences. The result is broad and healthy literature based on the general botany and economic significance of these species. However the knowledge of the physiological relationships between host and parasites and the significance of the parasitic plants to natural systems is less well developed. Various anatomical features of plants are used by taxonomists in recent researches. They get various taxonomic evidences by studying various characters e.g. epidermal, leaf, wood, pollen etc [7], [8]. So, in anatomical study of selected parasitic plants following characters are most important like epidermal cells which form a continuous layer on the surface of the plant body in the primary state and they show various special characteristics related to their superficial position. But stomata are perforations in the epidermis of leaves and stems which are guarded by specialized cells, called guard cells. Parenchyma cells form continuous tissue in the cortex of stem and root and in the leaf mesophyll. They also occur as vertical strands and rays in the vascular tissue [9].

MATERIALS AND METHODS: STUDY MATERIAL

Five plant species (*Cuscuta reflexa*, *Korthalsella opuntia*, *Orobanchae aegyptiaca*, *Viscum album* and *Viscum cruciatum*) were selected for study. All species were parasitic plants. The selection of these species was made because of their contrasting parasitic nature i.e. hemiparasitic plants and holoparasitic plants. The plant species were collected from different areas of Pakistan (Khyber Pakhtunkhwa Province,

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and Punjab Province). Basic taxonomic and anatomical characteristics of selected plant species are given in Table 1.

SECTIONING, STAINING AND MOUNTING

The method used by Bokhari [10] was used for reviving dry material. The plant materials were sectioned by hand because it is the most effective method for sectioning large number of specimens. The section which was very thin and transparent was examined under light microscope and was selected for bleaching, staining and mounting on glass slides. The mounted slides were observed under light microscope by using 4x, 10x and 40x magnifications for studying *Korthalsella opuntia*, *Orobanche aegyptiaca*, *Viscum album* and *Viscum cruciatum*.

EPIDERMAL SLIDES PREPARATION AND MACERATION

For epidermal slides the epidermis of hemiparasitic plant's leaves and the epidermis of stem of holoparasitic plants were peeled simply by hand or by maceration process. The peeled epidermis was preserved in fixative (F.A.A) in the specimen bottles. Shultze's method of maceration with improved techniques was followed [11]. The prepared slides were examined under the light microscope which was adjusted at 4x, 10x and 40x magnifications. Random readings were taken from epidermis of each plant and in each reading noted the following features of epidermis, i) number of stomata per field view of microscope, ii) type of stomata.

RESULTS

Cuscuta reflexa (Plate 1) is a holoparasite plant because it has very small amount of chlorophyll unable to synthesize its own food and completely dependent on host plant for food and nutrition. Its epidermis is without cuticle and epidermal cells are papillose. The vascular bundles are six in number and very poorly developed. Anatomical study of endophytic tissue of haustorium indicates that it is small threads of few xylem vessels and phloem which penetrates only in the phloem tissue of the host.

Korthalsella opuntia (Plate 2-3) is a hemiparasite and contains chlorophyll. The leaves are not present but the stem is photosynthetic. The stem has epidermis is single layered and has well-developed cuticle on the outer side. The stem anatomy is quite different i.e. in the lower portion of the stem the ground meristem is undifferentiated, while in the upper portion of the stem the ground tissue is differentiated into palisade like cells and spongy cells. On the stem the stomata have parallel orientation but some have irregular orientation and are paracytic type. The haustorium is well developed and surrounds the host

xylem in the form of cup. It has well developed vascular tissue, made up of short tracheal cells. Most of the tissue is parenchymatous in nature.

Orobanche aegyptiaca (Plate 4) is a holoparasite, lacks chlorophyll and the stem has single-layered epidermis without cuticle and sparsely hairy. There is a wide zone of cortex made up of 20 layers of parenchyma cells, with well-developed intercellular spaces. The stem anatomy is quite distinguishing that in the lower portion of the stem the vascular bundles are arranged in a ring around well developed pith but in the inflorescence axis, there is continuous layer of xylem and phloem bundles arranged around hollow pith. There is a layer of sclerenchyma cells just outside the phloem ring. Cortex is made up of small cells and the stomata are paracytic type. Leafy scales have an upper and lower epidermis which is thin walled and with out cuticle.

Viscum album (Plate 5-6) is a hemiparasite, having chlorophyll and the epidermis has well developed cuticle on both sides of the leaves and stem. Some epidermal cells are large, some are small and few epidermal cells are papillose on the both sides. Its leaves are photosynthetic but their mesophyll is undifferentiated and is made up of polygonal cells. The vascular bundles are collateral i.e. phloem is present on abaxial side while xylem is present on the adaxial side. The stem is irregular in outline and appears to be lignified at many places. Vascular bundles are arranged in a ring having poorly developed phloem but xylem is extensively developed and strongly lignified. Crystals are totally absent in *Viscum album*. Stomata are paracytic and anomocytic type.

Viscum cruciatum (Plate 7-9) is a hemiparasite, having chlorophyll and the epidermis have well developed cuticle on both sides of the leaves and stem. The leaves are photosynthetic but their mesophyll is undifferentiated and made up of polygonal cells. The vascular bundles are collateral i.e. phloem is present on abaxial side while xylem is present on the adaxial side. Crystals are abundantly present.

DISCUSSION

The parasite plant studied in this work fall into two main categories i.e. holoparasites such as *Cuscuta reflexa* and *Orobanche aegyptiaca*. *Korthalsella opuntia*, *Viscum album* and *Viscum cruciatum* have chlorophyll so they are classified as hemiparasites. It is obvious that holoparasites must be without chlorophyll and this is confirmed in this work. These plants are entirely dependent nutritionally on their host, weakening them and eventually result in the death of

the host. Some of the important slides showing anatomical features are included.

Hemiparasites can partially manufacture their own food and usually get very little direct food from the host. These parasites get water and minerals from the host and are in complete equilibrium with the host for a very long time. So the host usually survives even when attacked by number of parasites. In all the observed parasitic plants, the vascular bundles are less developed having poorly developed phloem but well developed xylem. It means that they can efficiently take up water and prepared food from the host plant.

In holoparasitic plants i.e. *Cuscuta reflexa* and *Orobanchae aegyptiaca* the epidermis is with out cuticle, while in hemiparasitic plants i.e. *Korthalsella opuntia*, *Viscum album* and *Viscum cruciatum* the epidermis have well developed cuticle on both sides of the leaves and on the stem. The leaves of the *Viscum album* and *Viscum cruciatum* are photosynthetic but their mesophyll is undifferentiated and is made up of polygonal cells. The vascular bundles are collateral i.e. phloem is present on the adaxial side. In *Viscum cruciatum* the characteristic crystals are abundantly present.

The petioles of the *Viscum album* and *Viscum cruciatum* are winged and vascular bundles are arranged in the form of an arc. The petiole have well developed cuticle on the both sides of the epidermis. The group tissue is undifferentiated as in the leaves. The vascular bundles are collateral and the petioles are photosynthetic. In the stem of *Cuscuta reflexa* the epidermal cells are papillose. The vascular bundles are six in number and are very poorly developed. In *Orobanchae aegyptiaca* the stem the stem anatomy is totally different. In the lower portion of the stem the vascular bundles are arranged in a ring around well developed pith but in the inflorescence axis, there is continuous layer of xylem and phloem bundles arranged around hollow pith. There is a layer of sclerenchyma cells just outside the phloem ring. In *Korthalsella opuntia* leaves are not present but the stem is photosynthetic. The stem anatomy is quite different i.e. in the lower portion of the stem the ground meristem is undifferentiated into palisade like cells and spongy cells.

In *Viscum album* the stem is irregular in outline and appears to be lignified at many places. Vascular bundles are arranged in a ring having poorly developed phloem but xylem is extensively developed and strongly lignified. Crystals are totally absent in *Viscum album*. In *Viscum cruciatum* the stem is smooth in outline having thick cuticular layer on the epidermis. The vascular bundles are

collateral as in the leaves. Crystals are abundant in phloem and cortex but xylem is devoid of crystals.

The most interesting thing is the presence of terminal sclereids in *Viscum cruciatum*, and brachysclereids in *Korthalsella opuntia*. The terminal sclereids are present at the vein endings, while the brachysclereids are present scattered on the periphery of the vascular bundles in the ground tissue. It is also very interesting that in all of the parasitic plants, the stomata of the leaves and stems are mostly of paracytic type, however few anomocytic type of stomata are also observed in *Viscum album*.

The most interesting observation is the anatomical study of endophytic tissue of haustorium. In *Cuscuta reflexa* the haustorium forms connection to the phloem of the host more prominently than xylem. The haustorium consists of few threads of xylem and phloem which penetrate only to the phloem tissue of the host. In *Korthalsella opuntia* the haustorium forms connection to the xylem of the host. The haustorium is well developed and surrounds the host xylem in the form of a cup. It has well developed vascular tissue, made up of short tracheal cells. Most of the tissue is parenchymatous in nature. In *Viscum cruciatum* the haustorium forms connection to the xylem. It consists of number of cells in the periphery and it is tapering towards the inner side, where it becomes 2-3 celled, sending branches into the host xylem. In cross section of the haustorium it is quite evident that it has larger xylem cells and few phloem cells which indicate that haustorium absorbs lot of water as well as food from the host plant.

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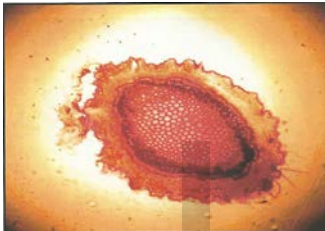


Plate 1. Longitudinal section of Haustorial portion of *Cuscuta reflexa* at 10x.

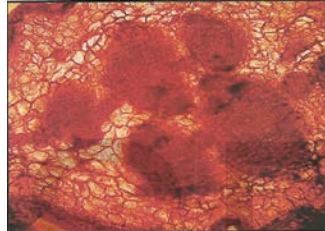


Plate 2. Transverse section of lower portion of stem of *Korthalsella opuntia* at 10x.

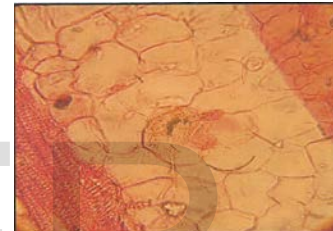


Plate 3. Longitudinal section of upper portion of stem of *Korthalsella opuntia* at 40x.

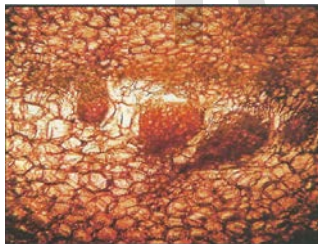


Plate 4. Transverse section of lower portion of stem of *Orobanche aegyptiaca* at 10x.

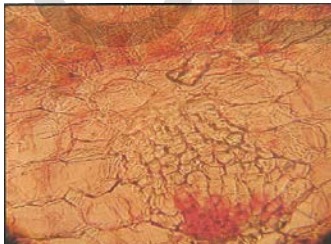


Plate 5. Transverse section of leaf of *Viscum album* at 40x.

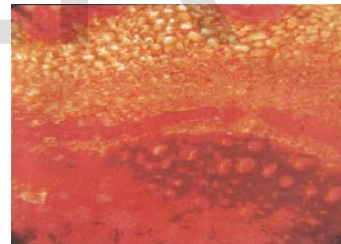


Plate 6. Transverse section of stem of *Viscum album* at 10x.



Plate 7. Epidermis of *Viscum cruciatum* at 40x.

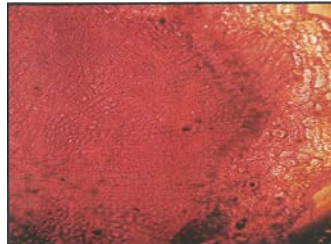


Plate 8. Transverse section of stem of *Viscum cruciatum* at 10x.



Plate 9. Transverse section of Haustorial portion of *Viscum cruciatum* at 10x.

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Table 1. Taxonomic and Anatomical characteristics of Parasitic plant species

Sr. No.	Plants	Taxonomy				Anatomy			
		Family	Habit	Phyllotaxy	Height	Epidermis	Petiole	Chlorophyll	Sclereids
1.	<i>Cuscuta reflexa</i>	Convolvulaceae	Climber	Scale leaves	-	Cuticle absent	Winged	Small amount present/ Absent	Absent
2.	<i>Korthalsella opuntia</i>	Loranthaceae	Perennial shrub	Small thick leaves	15 cm tall	Cuticle absent	Winged	Present	Present
3.	<i>Orobanche aegyptiaca</i>	Orobanchaceae	Annual	scales	20-25 cm tall	Cuticle present	Not winged	Absent	Absent
4.	<i>Viscum album</i>	Viscaceae	Evergreen shrub	Opposite pairs, strap-shaped	1 m	Cuticle present	Not winged	Present	Absent
5.	<i>Viscum cruciatum</i>	Viscaceae			-	Cuticle present	Not winged	Present	Present