J. Phytol. Res. 19(2) : 285-288, 2006

MORPHOLOGY AND ANATOMY OF SEEDLING OF *WELWITSCHIA MIRABILIS HOOKER*

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The present investigation deals with the germination and establishent of seedling of *Welwitschia mirabilis*. Morphology and anatomy of the seedling was also studied in detail.

Keywords: Bizzare; Girdle; Seedling; *Welwitschia mirabilis.*

Welwitschia mirabilis Hooker, the bizarre of land plants is unique in its structure, development and distribution. The plant appears a giant turnip with two leaves only. It can survive upto 2000 years in exceedingly low rain fall. A detailed investigation of morphology, anatomy, tissue culture and reproduction structures has been made. The present investigation deals with the germination, establishment of the seedling and detailed study of the morphology and anatomy of the seedling.

Dry seeds of *Welwitschia mirabilis* were procured from South Africa, seedling were raised in Petri-plates lined with moist cotton and blotting paper and incubated at 35±2^{0}C. When the hypocotyl and radicle emerged the seeds were transferred to pots. filled with sterilized humus soil. The seedlings were cut into pieces and fixed in formalin acetic alcohol. F.A.A. Customary method of paraffin infiltration were employed. Serial microtome sections were cut 8-12 μ microns thick and stained with crystal violet and erythrosine combination.

The clearing of the seedling was done by first heating the material in lactic acid till became transparent and then passing the material through a graded series of ethanol and stained with basic fuschin prepared in absolute alcohol. It was kept overnight in methyl salicylate and then in 100% xylol. Mounting was done in D.P.X.

Observations (Plate I) - The seeds are winged, nucellus enclosed within two envelops. The outer intergument is expanded into lateral wings and inner is prolonged as micropylar tube Seeds imbibe water for 24 hours (Fig. 1).

The wings secrete some orange yellow droplets and amide like odour on imbibing water. The radicle emerges out in 3-4 days by breaking testa (Figs. 2a, b, c). During emergence of epicotyl, cotyledon and hypocotyl from a loop with tip of cotyledon still inside testa.

Gross morphology of the seedling - The seedling is orange yellow in colour in the beginning. However, within two days the fully emerged and exposed cotyledons turn green. A portion of seed, seed coat and endosperm remain attached for sometime at the hypocotyl and radicle junction in form of a girdle (Figs. 2 and 3).

Seedlings were transferred to pots filled with sterilized soil. Within two weeks folded cotyledons start separating, the first pair of leaves emerge in decussate manner with respect to cotyledons with their ventral surface appressed against each other. The base of cotyledons at the place of insertion of leaves shows a characteristic thickening in form of a distinct annular ring (Fig. 3).

The young seedling can be differentiated into radicle 8-12 cm, cotyledons are about 2.5 cm long leafy persistent and slightly connate at the base and leaves 2 cm long. The radicle and hypocotyl are well demarcated by a girdle where seed remains attached for quite sometime. The tissue of the seedling in girdle region proliferates and penetrates the nutritive tissue forming a feeder to obtain nourishment for young seedling (Fig. 3).

Vascular supply of the seedling (Plate II) - A transaction of the radicle in the tip region is protected by a massive root cap of loosely arranged parenchymatous tissue. The ground tissue encloses an inner core of procambial tissue.

Root shoot transition- At a higher level the transverse section of radicle reveals the xylem as dumb-bell shaped and phloem groups present laterally. On either side of phloem (Fig. 4) are located groups of thin walled fiber initials. The xylem is diarch and exarch with metaxylem elements close to each other. These strands of xylem and phloem expand. The two groups of xylem separate out with metaxylem lying towards the centre (Fig. 5). The phloem expands tangentially and finally divide radially in two groups each. Each xylem group is flanked on either lateral side by phloem (Figs. 6,7).

Further higher up in the radicle xylem expands (Figs. 7, 8). The inner portion of each xylem strand divides radially in a centrifugal fashion, while its outer portion separates as such. Thus, three groups of xylem elements are formed. The division of xylem is followed by the division of phloem (Fig. 9). Ultimately these groups on either side form an arc of vascular tissue (Fig. 10). Each arc finally splits up into two bundles. These four vascular bundles thus formed extend upward in the girdle (Figs. 11, 12). The girdle possesses a lateral process which enters in the gametophytic tissue as a feeder. In this region all the

PLATE - I

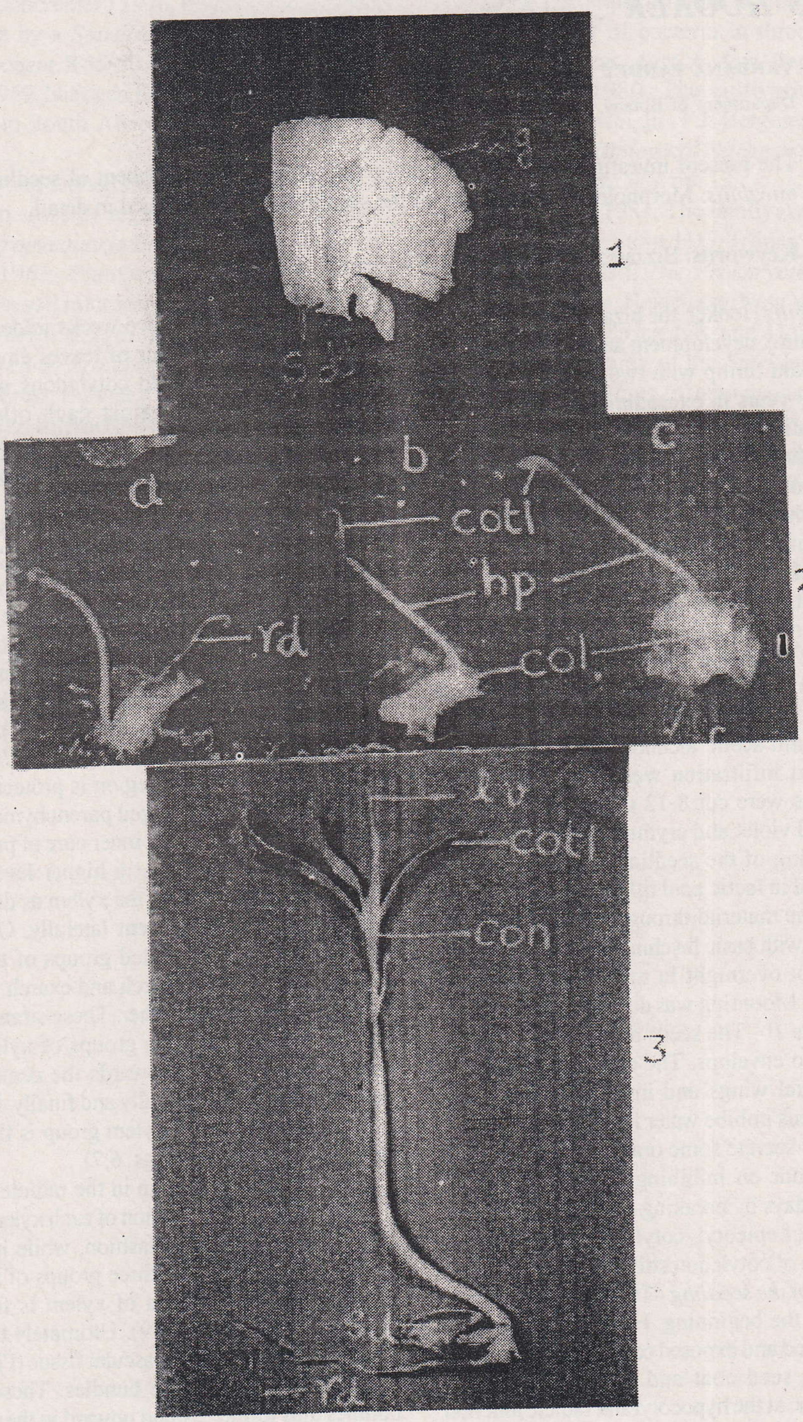

Fig.1-3. Fig.1. External morphology of seed; **Fig.2.** Seeds in various stages of germination; **Fig.3.** Three month old plant. (coty - cotyledons; col-collar; con-cotyledonary node; hp - hypocotyl; lv - leaves; rd - radicle; sd - seed; wg-wing).

PLATE - II

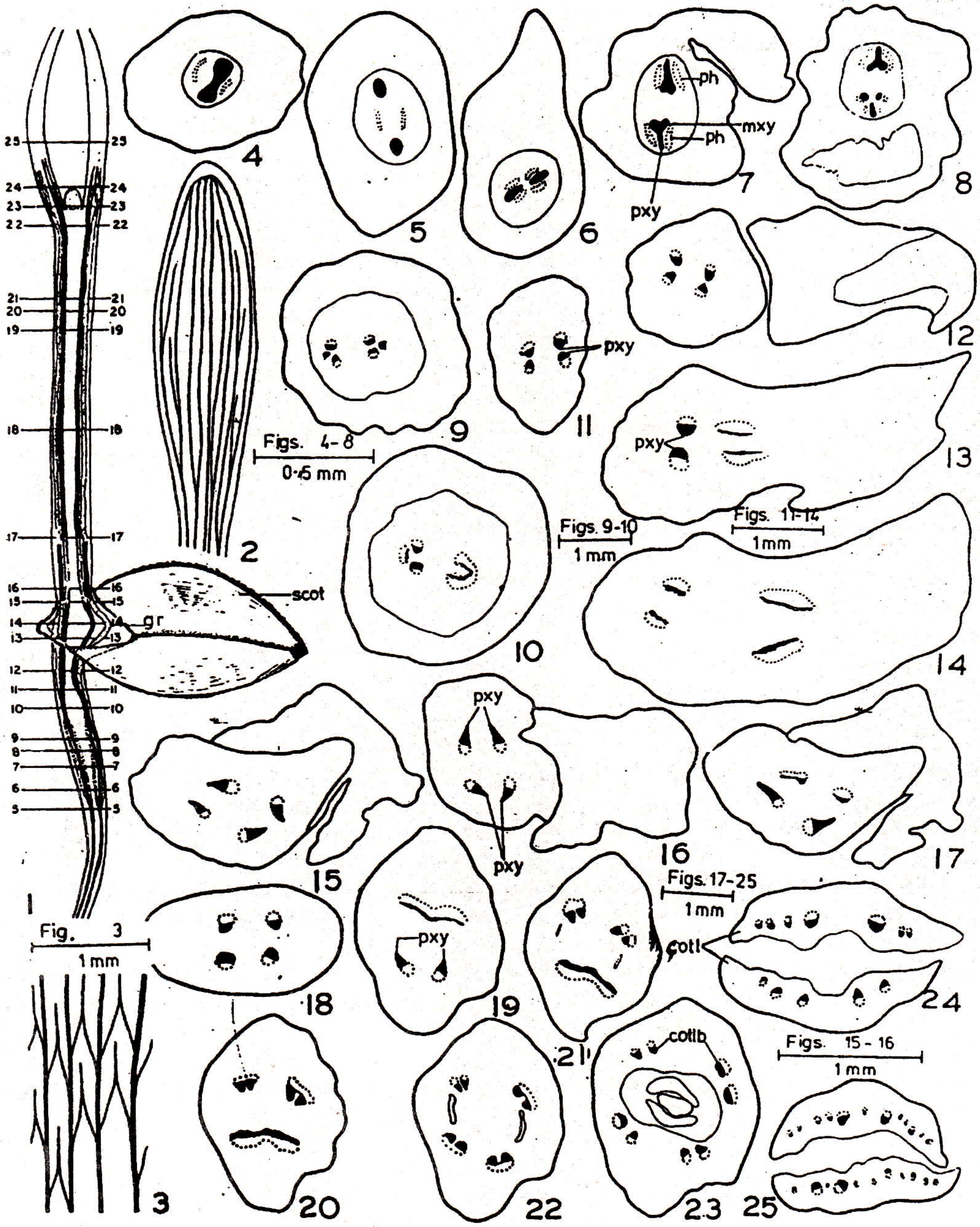

Fig.1-25. Fig.1. Diagrammatic diagram of a seedling showing its vascular course; **Fig.2.** An outline diagram of the cleared cotyledon showing major veins; **Fig.3.** A portion of the cotyledon showing bridges between the major veins.; **Fig. 4-25.** Serial transverse sections of the seedling from base upwards through the regions marked (5-25) showing the course of vascular bundles through root-shoot transition region and the vascular supply of the hypocotyl and the cotyledons.
(coty - cotyledons; cotlb - cotyledonary bundles; gr- girdle; mxy - meta xylem; ph- phloem; pxy - protoxylem; scot- seed coat).

four vascular bundles increase in size. The two vascular bundles on the side of the feeder expand and bend into the process but do not vascularise it (Figs. 1, 13-14). In the hypocotyl the four vascular bundles traverse parallel to each other and below the cotyledonary node each bundle rotates on its axis and attains almost exarch condition (Figs. 15-17).

In the cotyledonary sheath each vascular bundle again rotates and resumes its original endarch conditions (Figs. 17, 18). Further, higher up in the cotyledonary sheath the adjacent bundles of each group merge with each other and then separation followed by bifurcation of each vascular bundle in the extreme upper portion of the cotyledonary sheath (Figs. 19-21). Transfusion tissue also appears scattered between the bundles. The four endarch vascular bundles vascularising the cotyledons run parallel to each other for a short distance but, higher up each divides into a large number of bundles (Figs. 24, 25). Transfusion tissue is interspersed between them. Thus, entire hypocotyledonary vasculature is consumed in supplying the cotyledons. The epicotyl forms another unit of vasculature which differentiates later and gets connected with the hypocotyl vasculature.

Venation pattern of cotyledons (Figs. 1-3)- The cotyledons are lanceolate, leafy and persistent (Figs. 1, 2). Each cotyledon is supplied by two vascular bundles which traverse the base (Fig. 1). At a slightly higher level each vascular bundle dichotomizes into central and lateral bundles. The lateral bundles dichotomize further and provide marginal bundles. All the bundles run parallel but some marginal and lateral bundles do not continue upto tip. The bundles reaching the tip of cotyledons finally anastomose with each other and with group of transfusion tissue (Fig. 2). The central lateral and marginal bundles are connected with each other by a few oblique vascular bridges placed almost at equal distance. The oblique bundles fuse in mesophyll in the form of $\wedge$ or λ with the tail of λ facing the tip of the cotyledon (Fig. 3). The tail is composed of tracheids and transfusion tissue which may be seen at different levels in between the parallel veins. The cotyledons are composed of few layers of parenchyma only, with a large number of stomata present on both the surface.

Bower[1,2] for the first time gave an account of the seedling vasculature. Later, Nauden[3], Sykes[4], Takeda[5], Hill and Defraine[6], studied the root shoot transition. Rodin[7-8] studied the cotyledonary vasculature. Butler *et al.*[9-10] have also given an account of seedling vasculature.

A perusal of the literature reveals that in gymnosperms and dicotyledons the root shoot transition takes place in the hypocotyl region. But in *Welwitschia*, Butler *et al.*[9,10] reported this transition in the upper region of the radicle and extend to a small portion of the hypocotyl. The present investigations also confirm a similar condition of transition of root shoot anatomy.

The lateral process which extends in the gametophyte tissue is considered an extension of hypocotyl region. It is also supported by the behaviour of vascular bundles in this region.

There is difference of opinion regarding the dichotomization of four vascular bundles either in the cotyledonary or hypocotylendonary region. The present observation reveals that the two bundles on the either side fuse, in cotyledonary sheath and then split in four bundles each at the base of cotyledons, which later enter the cotyledon and dichotomize.

The seedling anatomy of *Welwitschia mirabilis* follows type A of Eames end MacDaniels[11].

The venation pattern is parallel. The main veins at the tip anastomose with a group of transfusion tissue. In between parallel wings oblique branches are present which unite with other branches to form $\wedge$ or λ. A few oblique bundles end blindly.

Acknowledgements

Thanks are due to Prof. Naresh Chandra, Department of Botany, University of Rajasthan, Jaipur for his valuable guidance. Thanks are also due to Prof. V. Puri and Prof. C.M. Govil for valuable suggestions.

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