

STUDY OF ROOT ANATOMY IN THE GENUS *ALYSICARPUS* .DESV.

Ravi Patil* , Shantanu Chavan** and Dilip Pokle**

*P.G. Dept. of Botany, Deogiri College, Station Road, Aurangabad-431005.

**Department of Botany, Dr Babasaheb Ambedkar Marathwada University, Aurangabad.

(*E-Mail: drppatil@gmail.com)

ABSTRACT

Root anatomy of the genus *Alysicarpus* is investigated. In the present work 19 species of the genus are taken for the study. The cortical tissue as well as dermal layers shows significant variations. The mechanical tissue includes sclerenchyma and collenchymatous type of cells along with xylem elements. The vascular bundle shows variation in their size and its contents.

KEY WORDS: Anatomy, *Alysicarpus*, Root, Vascular bundle.

INTRODUCTION

Alysicarpus, a small genus of family *Fabaceae* (Papilionoidea tribe Desmodae) comprises about 27 species and about 15 intraspecific taxa. It is distributed in tropics and subtropics of world (Ohashi *et al.*, 1981). India harbor nearly 60% of the taxa and is richly represented in the Maharashtra by 48 taxa, 12 species and 6 varieties (Pokle, 2000). Maximum endemism of the genus is in India. Out of about 42 taxa, 12 are endemic to India (Sanjappa, 1977). This is an added parameter for considering the origin of genus in India and particularly in Marathwada. The present study deals with the anatomy of roots from different species of *Alysicarpus*. In this genus most of the taxa are annual but a few are biennial and perennial, to know the development of secondary growth pattern this investigation was undertaken.

Study of root anatomy was carried out for 19 taxa of genus *Alysicarpus* using microtomical methods. Anatomical study in present investigation considered to be the first record for the genus as no prior study were undertaken earlier, as far as root is concerned. Data presented here is based on personal observations and methodology used for plant collection is based on Jain and Rao, (1977). For anatomical work standard books were referred such as, Metcalfe C. R. and L. Chalk (1950); Eames and Mc Danish, (1947); Cutter (1969); Carlquist (1970); Eames (1936); Esau Katherine (1974); Fahn (1982).

MATERIALS AND METHODS

The roots of different taxa of the genus used for this study were collected from different localities during the period of 1998-2008 and were preserved in 70% alcohol. After comparing different specimens collected from different sites, the best representatives of the species were chosen for investigation. The names of the species and information about the collection sites are given in Table 1. Voucher specimens were deposited in the herbarium of Dr Babasaheb Ambedkar Marathwada University, Aurangabad. For collection of plants material, tours were undertaken to the different states of India and consulted most of the Herbaria's. The selected material was used for section cutting by following microtome procedure. After section cutting, the slides were stained by using permanent double stains of safranin-light green combination, mounted in Canada balsam after customary dehydration. The sections were observed under high-resolution microscope and micrographs were taken. Root anatomical studies were undertaken for 19 taxa. Their field numbers and localities are provided below in table 1 and Figure-1.

Table 1. Root anatomical studies, their field numbers and localities.

Plant Code	Plant Name, their field numbers and localities.
a	<i>A. bupleurifolius</i> (L.) D.C. var. <i>bupleurifolius</i> . (DSP 009. Nanded.)
b	<i>A. bupleurifolius</i> (L.) D.C. var. <i>gracilis</i> . Baker. (ASD 995. Gautala.)
c	<i>A. naikianus</i> Pokle. (ASD 959. Appachi Wadi, Kolhapur.)
d	<i>A. gamblei</i> Schindl. (ASD 968 Belgaum(Karnataka))
e	<i>A. heyneanus</i> Wt and Arn. var. <i>heyneanus</i> . (RPP 604 Majalgaon)
f	<i>A. heyneanus</i> Wt and Arn. var. <i>ludens</i> (Baker) Pramanik and Thoth.(ASD 611 Majalgaon.)
g	<i>A. scariosus</i> (Rottl ex Spreng) Grah ex Thw. var. <i>scariosus</i> . (ASD 661 Rajkot)
h	<i>A. scariosus</i> (Rottl ex Spreng) Grah ex Thw. var. <i>pilifer</i> (Prain) Pramanik et Thoth. (RPP 258. Anantpur (A.P.)
i	<i>A. longifolius</i> (Rottl. ex Spreng) Wight and Arn. var. <i>major</i> . Pokle. (RPP 651 Bodeli)
j	<i>A. longifolius</i> (Rottl. Ex Spreng) Wight and Arn. var. <i>pygmeas</i> . Pokle. (ASD 660 Rajkot)
k	<i>A. tetragonolobus</i> Edgew. (ASD 929 Satara.)
l	<i>A. luteo-vexillatus</i> Naik et Pokle. (ASD 958 Savkheda.)
m	<i>A. pubscens</i> Law. var. <i>pubscens</i> . (ASD 960 Kolhapur)
n	<i>A. pubscens</i> Law. var. <i>vasavadae</i> (Hemadri) Sanjappa. (ASD 605 Majalgaon)
o	<i>A. monilifer</i> (L.) DC. var. <i>monilifer</i> . (ASD 915 Islapur, Nanded)
p	<i>A. monilifer</i> var. <i>mahbubnagarensis</i> . (Raghavrao et al.) Pokle. (ASD 977 Madhukarai)
q	<i>A. vaginalis</i> (L.) D.C. (ASD 679 Abu road, MtAbu (Rajasthan))
r	<i>A. ovalifolius</i> (Schumach) J. Leonard. (ASD 947 Aurangabad)
s	<i>A. hamosus</i> Edgew. (RPP 625 Bidar).

RESULT AND DISCUSSION

It was found that even in the youngest plant root show secondary growth. To reveal primary structure the sections of radical of germinating seeds were taken randomly in different species. However these attempts were unsuccessful, as up to 10th day stage vasculature was absent in the radical of germinating seeds on artificial medium (wet blotters). It appears that actual sowing of seeds in plots is required to get exact stage of initiation of vasculature and initiation of secondary growth. In the present studies only secondary structure of all the 19 taxa is described below, as revealed in the transverse section along with photo plates.

1) *Alysicarpus bupleurifolius* (L.) D.C. var. *bupleurifolius*. :

Epidermis is completely distorted; patches of dead epidermis and hypodermis are present. It is followed by 5-7 layers of compact cork. The cells of cork tissue are horizontally elongated with observable suberization on the walls and are compactly arranged without intercellular spaces. 4-6 layers of distorted cortex are present. The cells of cortex are parenchymatous, irregular, probably due to secondary growth. 10-12 patches of secondary phloem almost touch the cork tissue. Well marked cambium of horizontally elongated cells in 3-4 layers is quite visible. Secondary xylem forms 10-12 strands. The size of secondary vessels in periphery is at least 4-5 times larger than centrally placed protoxylem. It is 14-56 micron in thickness. The xylem parenchyma is rich in starch deposits and is circular, with very small circular hilum. (Plate a)

2) *A. bupleurifolius* (L.) D.C. var. *gracilis* Baker.:

In mature root patches of dead epidermis and hypodermis are followed by 3-4 layers of cork tissue. The cells of cork tissue are horizontally elongated, suberized without intercellular spaces. Cortex 3-4 layered, distorted with irregular parenchymatous cells. Secondary phloem 8-10 patches almost touching cork tissue. Cambium 2-3 layered with comparatively small cells. Secondary xylem consists of 8-10 strands below the cambium. Vessels of secondary xylem are markedly larger and are at least 4-5 times larger than centrally placed primary xylem vessels. Xylem parenchyma is deposited with squarish starch grains with elongated hilum. (Plate b)

3) *A. naikianus* Pokle. :

In mature root patches of dead epidermis and hypodermis are followed by 5-6 layers of cork tissue. The cells are suberized, compact, horizontally elongated without intercellular spaces. Cortex prominent 8-10 layered, distorted with irregular parenchymatous cells. Secondary phloem in patches of 7-8, well separated from cork tissue by 3-4 layers of cortex. Cambium in 2-3 layers with very small cells. Secondary xylem of 7-8 strands. Secondary vessels are about 2-3 times larger than centrally placed primary xylem vessels. Xylem parenchyma is deposited with irregular and ovate starch grains having elongate thin hilum. (Plate c)

4) *A. gamblei* Schindl. :

Patches of dead epidermal and hypodermal tissue are followed by 4-5 layers of cork tissue. Cork cells are horizontally elongated, compact, suberized, without intercellular spaces. Cortex 4-6 layered with deformed parenchymatous cells. Cambium 2-3 layered with smaller cells. Secondary phloem in 5-6 patches separated from cork tissue by 2-3 layers of cortical cells. Secondary xylem of 5-6 strands with little difference in size of secondary vessels and primary vessels. Starch grains ovate with little elongated narrow hilum. (Plate d)

5) *A. heyneanus* Wt and Arn. var. *heyneanus*. :

In mature root, patches of dead epidermal and hypodermal layers are followed by 10-12 layers of cork tissue. Cork tissues are prominent and are composed of horizontally elongated, compact, suberized cells without intercellular spaces. Cortex 5-6 layered with distorted parenchymatous cells. Cambium 2-3 layered with small cells. Secondary xylem in 10-12 strands below the cambium. Secondary vessels are 3-4 times larger than the centrally placed primary xylem vessels. Xylem parenchyma is deposited with kidney shaped, elongate starch grains with elongate and slightly curved hilum. (Plate e)

6) *A. heyneanus* Wt and Arn. var. *ludens* (Baker) Pramanik and Thoth. :

Patches of dead epidermis and hypodermis are followed by 4-6 layers of cork tissue. Cork cells are suberized, horizontally elongated compactly arranged without intercellular spaces. It is followed by cortex which is 5-6 layers of distorted parenchymatous cells, phloem consists of 4-6 patches. Cambium is 2-3 layered with smaller cells. Secondary xylem in 4-6 patches. (Plate f)

7) *A. scariosus* (Rottl ex Spreng) Grah ex Thw. var. *scariosus*. :

In mature root, patches of dead epidermal and hypodermal layers are followed by 6-8 layered cork. Cork cells are horizontally elongated, compact suberized without intercellular spaces. It is followed by 5-6 layers of cortex consisting distorted parenchymatous cells, phloem patches 10-12. Cambium 2-3 layered with smaller cells. Secondary xylem is in 10-12 patches. The xylem parenchyma gets impregnated with irregular triangular starch grain with elongated hilum. (Plate g)

8) *A. scariosus* (Rottl ex Spreng) Grah ex Thw. var. *pilifer* (Prain) Pramanik et Thoth. :

In mature roots patches of dead epidermal and hypodermal layers are followed by 7-8 layers cork tissue. Cork tissues are prominent and are composed of horizontally elongated, suberized cells compactly arranged without intercellular spaces. Cortex is of 3-5 layered, parenchymatous, thin walled, loosely arranged cells. Cambium is 2-3 layered, small celled, secondary xylem in 8-10 strands alternating with secondary phloem. Xylem parenchyma gets impregnated with

rectangular starch grains whose hilum is elongated slit like. (Plate h)

9) *A. longifolius* (Rottl. ex Spreng) Wight and Arn. var. *major*. Pokle. :

In mature root, patches of dead epidermal and hypodermal layers are followed by 3-5 layers of cork tissue. Cork tissues are prominent and are composed of horizontally elongated, compact, suberised cells without intercellular spaces. Cortex 3-5 layered with distorted parenchymatous cells. Cambium 2-3 layered with small cells. Secondary xylem in 8-10 strands below the cambium. Secondary vessels are 3-4 times larger than the centrally placed primary xylem vessels. Xylem parenchyma is deposited with extra cellular starch grains which are with very large hilum. (Plate i)

10) *A. longifolius* (Rottl. Ex Spreng) Wight and Arn. var. *pygmeas*. Pokle. :

In mature root, patches of dead epidermal and hypodermal layer are followed by 4-6 layers of cork tissue. Cork tissues are prominent and are composed of horizontally elongated, compact, suberised cells without intercellular spaces. Cortex 3-6 layered with distorted parenchymatous cells. Cambium 2-4 layered with small cells. Secondary xylem in 10-12 strands below the cambium. Secondary vessels are 3-4 times larger than the centrally placed primary xylem vessels. Xylem parenchyma is deposited with little elongated hilum. (Plate j)

11) *A. tetragonolobus* Edgew. :

In mature root patches of dead epidermis and hypodermis are followed by 4-6 layers of cork tissue. The cells are suberized, compact, horizontally elongated without intercellular spaces. Cortex prominent 6-8 layered, distorted with irregular parenchymatous cell. Secondary phloem in patches of 7-8 well separated from cork tissue by 6-8 layers of cortex. Cambium is insignificant. Secondary xylem of 7-8 strands. Secondary vessels are about 2-3 times larger than centrally placed primary xylem vessels. (Plate k)

12) *A. luteo-vexillatus* Naik et Pokle. :

In mature root patches of dead epidermis and hypodermis are followed by 4-6 layers of cork tissue. The cells are suberized, compact, horizontally elongated without intercellular spaces. Cortex prominent 6-9 layered, distorted with irregular parenchymatous cell. Secondary phloem in patches of 7-8 well separated from cork tissue by 6-8 layers of cortex. Cambium is 2-3 layered in thickness. Secondary xylem of 6-8 strands. Secondary vessels are about 2-3 times larger than centrally placed primary xylem vessels. (Plate l)

13) *A. pubescens* Law. var. *pubescens*. :

In mature root patches of dead epidermis and hypodermis are followed by 2-3 layers of cork tissue. The cells are suberized, compact, horizontally elongated without intercellular spaces. Cortex prominent 5-6 layered, distorted with irregular parenchymatous cell. Secondary phloem in patches of 7-8 well separated from cork tissue by 6-8 layers of cortex. Cambium is 2-3 layered in thickness. Secondary xylem of 6-8 strands. Secondary vessels are about 2-3 times larger than centrally placed primary xylem vessels. (Plate m)

14) *A. pubescens* Law. var. *vasavadae* (Hemadri) Sanjappa. :

In mature root patches of dead epidermis and hypodermis are followed by 3-4 layers of cork tissue. The cells are suberized, compact, horizontally elongated without intercellular spaces. Cortex prominent 5-6 layered, distorted with irregular parenchymatous cell. Secondary phloem in patches of 7-8 well separated from cork tissue by 6-8 layers of cortex. Cambium is 2-3 layered in thickness. Secondary xylem of 6-8 strands. Secondary vessels are about 2-3 times larger than centrally placed primary xylem vessels. (Plate m)

15) *A. monilifer* (L.) DC. var. *monilifer*. :

Patches of dead epidermal and hypodermal layer is followed by 5-8 layered cork. Cork cells are composed of suberized, horizontally elongated and compactly arranged without intercellular spaces. Cortex is prominent 6-9 layered with distorted parenchymatous cells. Cambium is 2-3 layered with small cells, phloem in 6-8 patches. Secondary xylem is in 6-8 strands below cambium. (Plate n)

16) *A. monilifer* var. *mahbubnagarensis*. (Raghavrao et al.) Pokle. :

In the mature root patches of dead epidermal and hypodermal layers are followed by 5-8 layered cork. Cork cells are composed of suberised, horizontally elongated and compactly arranged cells without intercellular spaces. Cortex is prominent, 6-9 layered with distorted parenchymatous cells, phloem in 6-8 patches. Cambium is 2-3 layered with small cells. Secondary xylem is in 6-8 strands below cambium. (Plate o)

17) *A. vaginalis* (L.) D.C. :

Patches of dead epidermal and hypodermal layers are followed by 4-6 layered cork. Cork cells are horizontally elongated, suberised and compactly arranged without intercellular spaces. Cortex is prominent 6-9 layered with distorted parenchymatous cells, phloem patches 6-8 layered. Cambium is 2-3 layered with small cells. Secondary xylem is in 6-8 strands below cambium. (Plate p)

18) *A. ovalifolius* (Schumach) J. Leonard. :

In the mature root, patches of dead epidermal and hypodermal layers are followed by 6-8 layered cork. Cork cells are horizontally elongated, suberised and compactly arranged without intercellular spaces, phloem in 8-10 patches. It is followed by 2-3 layered cambium cells, the cells of which are smaller. Secondary xylem is in 8-10 strands. (Plate r)

19) *A. hamosus* Edgew. :

Patches of dead epidermal and hypodermal layers followed by 5-8 layered cork. The cells of cork are suberized, horizontally elongated and compactly arranged without intercellular spaces. It is followed by 4-6 layered cortex

composed of distorted parenchymatous cells, phloem patches 6-8 layered. Cambium is 2-3 layered with small cells. Secondary xylem is in 6-8 strands. (**Plate s**).

The secondary structure of root as revealed in transverse section appears to follow a basic pattern in all the taxa. It appears to possess triarch to pentarch xylem in primary structures. The only differentiation exhibits in cork layers, thickness of cortex, cambium and number of strands of secondary xylem and phloem. The thickness and development of sclerenchymatous tissue is more prominent in biennial and perennial taxa of the genus than annual one. However those differences may be due to difference in age and differential growth of secondary wood. Starch grains also reveals marked difference in size, shape and structure of hylum. However simple starch grains distributed uniformly. Extra cellular deposition of starch grains was observed in *A. longifolius* and possesses very large hilum. Thus from the above observed characters this anatomical parameters may be used as a tool for identification in the genus.

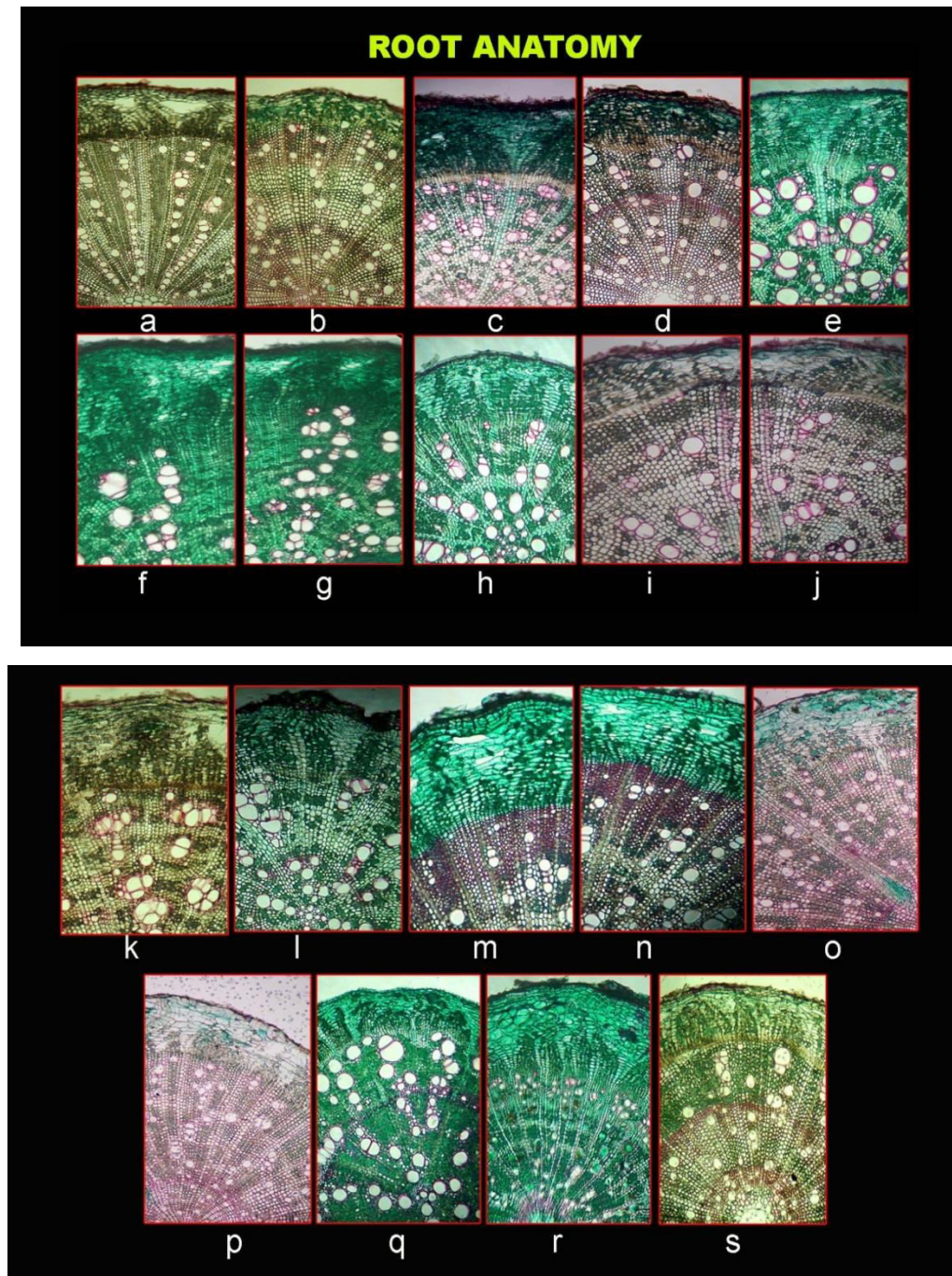


Figure 1. Photography of Root anatomy (alphabets indicated the name of the plant- See Table-1)



ACKNOWLEDGEMENTS

Authors are thankful to the authorities and Management of MSP Mandal's Deogiri College, Aurangabad for their constant support. Authors are also thankful to Dr. V.N. Naik and Prof. D.S. Pokle for their constant inspiration.

REFERENCES

- Cutter E. G. (1969).** Plant Anatomy, Edward Arnold Pub, London.
- Carlquist S. (1970).** Comparative Plant Anatomy. Holdt Rinehart and Winston. New York .
- Eames A. J. (1936).** Morphology of Vascular plants. McGraw-Hill book co. New York 243-257.
- Eames A.J. and Mc Danish. (1947).** An introduction to plant anatomy .Mc Graw-Hill pub NewYork.
- Esau Katherine. (1974).** Plant *anatomy*, Second edition. Wiley Eastern Pvt Ltd.
- Fahn A. (1982)** . Plant Anatomy. Third edit, Pergamon Press, Oxford. 177-288,291-310,351-358,385-457.
- Jain S. K. and Rao R.R. (1977).** A Handbook of Field and Herbarium Methods. Today and Tommorrow's Printers and Publishers, New Delhi.
- Metcalf C. R. and L. Chalk (1950).** Anatomy of dicotyledons, Oxford Clarendon Press. 502-535.
- Ohashi H., Polhill R. M. and Schubert B. G. (1981).** Advances in Legume Systematics. Polhill and Raven's eds R.B.G. Kew – London.
- Sanjappa M. and R. P. Bhatt (1977).** *Alysicarpus ovalifolius* (Schumach.) J. Leonard- A new record for India. *J. Bomb. Nat. Hist. Soc. Mumbai.* 75(1): 254-255.