J. Agric. Sci. Mansoura Univ., 29 (12): 6993 - 7010, 2004

SOME BOTANICAL VARIATIONS IN THE NEEDLES OF TWO *PINUS* SPECIES AFFECTED BY AGE AND PARTS OF NEEDLE, SHADING AND POSITION OF THE NEEDLE ON THE TREE.

Fouda, R. A.
Agric. Botany Dept., Fac. of Agric., Mansoura Univ., Mansoura, Egypt.

ABSTRACT

Some botanical variations in *Pinus halepensis* and *Pinus canariensis* were investigated during summer and autumn of growing season 2003 to compare some morphological characters and anatomical structure of the needles and to evaluate their systematic significance. The anatomical variations in the needles affected by needle age and needle parts, shading and position of the needle from the soil surface were also studied. The obtained results could be summarized as follows:

1- There are noticeable morphological differences between the two pine species. *P. canariensis* is characterized by great number of needles per dwarf stem, remarkable length of needle, large needle sheath and an extension of the female cone dimension as compared to *P. halepensis*. Another remarkable morphological difference between the two species is nature of the surface of the young branches. It is smooth without decurrent needle sheath in *P. halepensis*, while it is rough with decurrent needle sheath in *P. canariensis*. These morphological features are used for identifying the two species.
2- Anatomically, the needle of *P. halepensis* is characterized by thicker epidermis and endodermal cell layer and wider mesophyll tissue and resin ducts, but thinner transfusion tissue compared with *P. canariensis*. The most striking anatomical differences between the two species occur, mainly in the hypodermal cell layers, endodermis as well as number and size of resin ducts. The hypodermis occurs in 1-3 cell layers in *P. halepensis*, but in distinct patches in *P. canariensis*. The resin ducts also were wider in *P. halepensis* with more diposion of resin materials in the epithelial cell layer compared with *P. canariensis*.
3- Anatomical examination of dwarf stem and basal portion of the needle indicated that there is correlation between the number of vascular bundles and cortical resin ducts in the dwarf stem and both are correlated with the number of needles per dwarf stem.
4- The needle dimension was increased with increasing the needle age. Two years-old needles have higher number and large size of resin ducts compared with one year-old-needle.
5- The middle portion of the needle is characterized by wider hypodermis and mesophyll tissue as well as presence and wider endodermis. It had also greater number and larger size of resin ducts in the two pine species compared with both basal and terminal portions of the needle. The results indicate that the anatomical changes which took place in the lower portion of the needle, are represented by lower degree of a sclerified fibrous hypodermis, thinner mesophyll tissue without developed internal ridges on the cell wall. The unicellular endodermis is still recognizable.
6- Needle structure is largely influenced by light conditions. The needle developing under shade conditions had weaker hypodermis, thinner and poorly developed mesophyll tissue as well as the resin ducts are lesser in number and smaller in size compared with sun-light grown needle.

All the recorded anatomical characters of the needles increased with an increase in height from the soil surface. On the other hand, it was found a positive

relation between the number and size of resin ducts in the neddle and their contents of total phenolic compounds.

INTRODUCTION

Pinus is the most important genus of the family *Pinaceae* and it is represented by 90-100 species in the world (Vasishta, 1983). *Pinus* spp are economically important not only for resin production as well as turpentine oil, which has been used for certain medicinal purposes, but also for plant resistance against a range of insects, pathogens and air pollution (Wanger and Zhang, 1993; Franceshi *et al.*, 1998 and Monsield and Pearson, 1996).

Many investigators compared the variations of several morphological and anatomical characters of needles of pines of different attitude including resin ducts (Sheuc, 2000 and Sheue *et al.*, 2003).

Many species of *Pinus* are characterized by resin ducts in the needles, *i.e.*, primary and secondary ducts. Primary ducts were found in the mesophyll tissue and secondary ducts were found inside the vascular tissue; the secondary ducts had weaker function for resin secretion as compared to those in the mesophyll tissue (Sheue *et al.*, 2003). The resin ducts are common structure in *Pinus* needle and considered as an important character in classification of the *Pinaceae* depending on *Pinus* species (Boratynska and Bobowicz, 2001). The position type, not the number of resin ducts, in the needles has significant value for the identification of pine species (Sheue *et al.*, 2003). Nevertheless, the number of resin ducts in plant body is affected by several genetic and environmental factors, including the height and age of the tree, sunlight, radiation (Sheue *et al.*, 2003), nutrition (Hengxiao *et al.*, 1999) and phytohormones (Telewski *et al.*, 1983).

The present investigation aimed to compare the morphological and structural variations in the needles of *Pinus halepensis* Mill. and *Pinus canariensis* Chr. Sm. as well as to clarify the anatomical responses of pine needles to needle age, needle portion, shading and position of the needle on the tree.

MATERIALS AND METHODS

Structural variations in the needle of both *Pinus halopensis* Mill. and *Pinus canariensis* Chr. Sm. affected by needle age, needle structure at different levels of its blade, shading and position of the needle on the tree were investigated.

For the standardization of the anatomical characters, all samples were collected from uniform one year-old needles at the middle part of the needle, except the samples used to compare the effects of the needle age on the anatomical structure, they were taken from one and two-year-old needles.

The needles of both species were collected during summer and autumn of the growing season 2003 from the gardens of Mansoura University and different locations within Mansoura City.

1- During collection of samples, certain morphological characters such as number of needles per dwarf shoots, length of needle, length of needle sheath, nature of the surface of young branches as well as female cone dimension were recorded.

2- For studying the effects of needle age on needle structures, samples were taken from the middle parts of one and two-year old needles.
3- For studying the effects of needle parts on the anatomical structure, samples were taken from the basal, middle and terminal parts of one year-old needles. Moreover, the relationship between the dwarf stem and number of needles bearing dwarf stem were studied.
4- For studying the effects of shading on the anatomical structure, needles were taken from the lower at 2-m height of one year-old shaded and non-shaded branches.
5- For studying the effects of position of needles on the tree on the anatomical structure of needles, samples were taken at different height from trees ranging in age from 10-15 years-old at aproximately 2 and 4 m height from the soil surface.

The samples (5 mm) were killed and fixed in FAA solution, dehydrated in ethyl alcohol series, then the samples were embedded in paraffin wax (58°C m.p.) according to Gerlach (1977). Cross sections at 15-20 μm thickness were made using a rotary microtome. Sections were stained in saffranin-light green combination, cleared in clove oil and mounted in Canada balsam.

Sections (means of 10 sections) were examined microscopically and the following anatomical characters were recorded:

1- Needle dimension (needle thickness and needle width).
2- Hypodermis thickness.
3- Mesophyll tissue thickness.
4- Number of resin ducts.
5- Large resin ducts dimension.
6- Transfusion tissue thickness.
7- Endodermal cell layer thickness.
8- Vascular bundle dimensions.

Total phenols concentration in pine needles was determined spectrophotometrically using folin-ciocalteau reagent at wavelength 650 nm, and expressed as mg catichol per g fresh weight (Mazumder and Majjumder, 2003).

Statistical analysis:

Data were statistically analyzed according to Steel and Torine (1980).

RESULTS AND DISCUSSION

1- Morphological characters:

There are noticeable morphological differences between the two pine species, including number per dwarf stem, length and color of needles; needle sheath length; female cone dimension as well as nature of the surface of young branches.

The results listed in Table (1) and illustrate in Figs. (1, 2 and 3) indicate that *P. canariensis* is characterized by great number of needles, and remarkable length of needle as well as large female cone dimension as compared to *P. halepensis*. Length of needle sheath displays interesting morphological differences between the two pine species. The longer length of needle sheath in *P. canariensis* (Fig. 1) provides etiolation condition in the basal part of needles, which related with some anatomical changes. Another remarkable morphological difference between the two species is nature of the surface of the young branches (Fig. 2). It is smooth without decrrent needle sheaths in *P. halepensis*, while it is rough with decurrent needle sheaths. These morphological features are used for identifying the two pine species. Duffield (1991) noted that, the nature of the surface of branches, number of needles, cone size and cone scales are very important in identifying different pine species.

Table (1): Certain morphological features of both *P. halepensis* and *P. canariensis*.

Characters	*Pinus halepensis*	*Pinus canariensis*
Number of needles per dwarf branch	2.00	3.00
Length of needle (cm)	14.60	16.80
Needle color	Green	Yellowish-green
Needle sheath length (cm)	0.40	1.60
Length of female cone (cm)	2.75	4.10
Diameter of female cone (cm)	2.80	4.20
Nature of the surface of young branches	Smooth without decurrent leaf bracts	Rough with decurrent leaf bracts

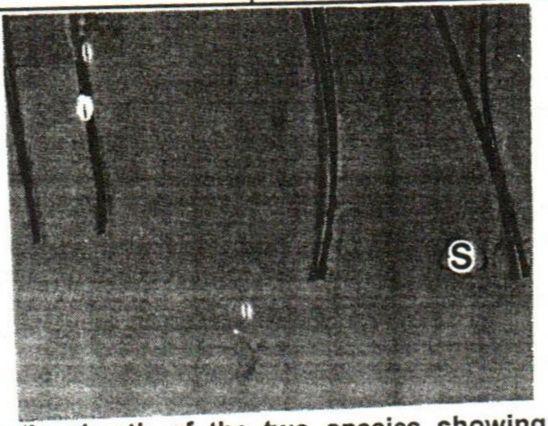


Fig. (1): Needle sheath of the two species showing longer needle sheath (s) in *P. cananariensis* compared with *P. halepensis*.

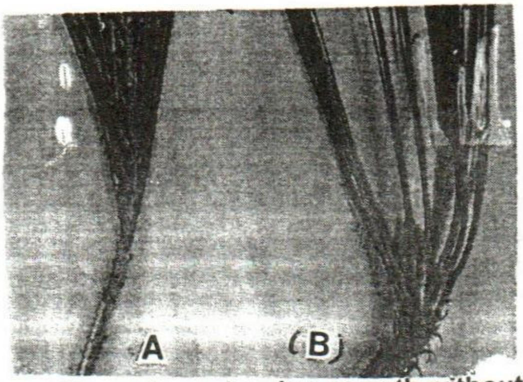


Fig. (2): Surface of branches, showing smooth without decarrent needle sheath in *P. halepensis* (A) compared with *P. cananariensis* (B).

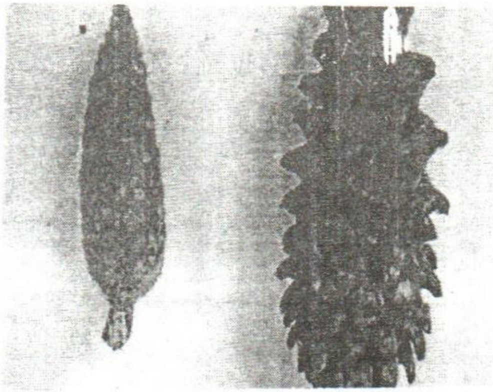


Fig. (3): Female cones showing large dimension of female cone in *P. cananariensis* (B) compared with *P. halepensis* (A).

2- Anatomical studies:

Generally, the needles of both *P. halepensis* and *P. canariensis* (Figs. 4 and 5) resemble pine anatomy (Fahn, 1990). The needle has a thick-walled epidermis with heavy cutical and deeply sunken stomata, which are found on all surfaces of needles. A sclerified fibrous hypodermis occurs beneath the epidermis, except under rows of stomata. It occurs in 1-3 cell layers in *P. canariensis*. The mesophyll tissue is not differentiated into palisade tissue and spongy parenchyma. Peripheral resin ducts are found in the mesophyll tissue, in contact with the hypodermis. The vascular tissue is represented by two bundles side by side and occurs in a central position in the needle. They surrounded by transfusion tissue. The vascular bundles and the associated transfusion tissue are surrounded by a thick-walled endodermis.

3- Comparative needle structure:

Data presented in Table (2) and illustrated in Figs. (4 and 5) indicate that shape of transsection varied between the two pine species. It is semi-circle in *P. halepensis* and triangle in *P. canariensis*.

Table (2): Comparative anatomical structure of *P. halepensis* and *P. canariensis* needles.

Characters (μm)		*P. halepensis*	*P. canariensis*	T. Test	Significance
Needle dimension	thickness	810	780	1.89	*
	width	940	906	5.27	**
Position of stomata		On all surfaces	On all surfaces		
Epidermis thickness		22	19	1.84	N.S.
Hypodermis thickness		32	27	3.06	*
Number of resin ducts		5	5	0.01	N.S.
Mesophyll tissue thickness		150	132	7.35	*
Endodermis thickness		48	44	4.90	*
Transfusion thickness		425	340	10.41	**
Length of vascular bundle		164	180	.1.26	N.S.
Width of vascular bundle		245	236	3.97	*

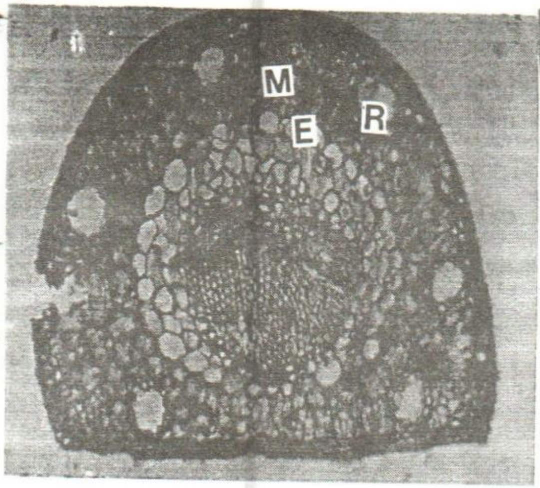


Fig. (4): Needle cross section of *P. halepensis* showing wider mesophyll tissue and large size of resin ducts (OC. X 10. Obj x 10). R: resin duct; M: Mesopphyll tissue, E: endodermis.

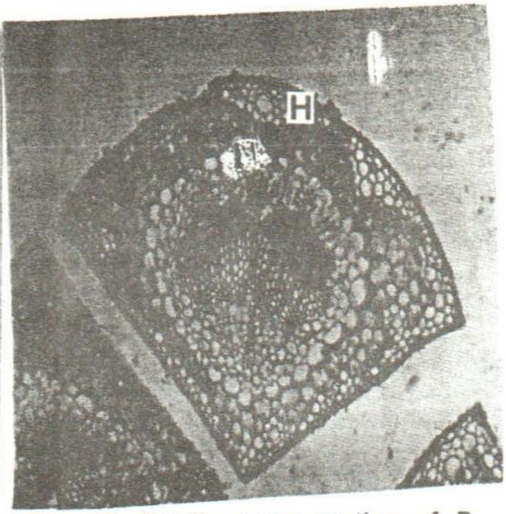


Fig. (5): Needle cross section of *P. canariensis* showing the hypodermal cell layers occurs in distinct patches and small size of resin ducts (OC. X 10. Obj x 10). H: Hypodermal cell layers.

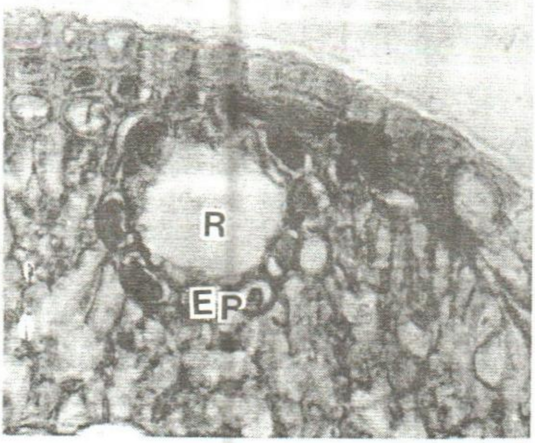


Fig.(6): Portion of cross section in *P. halopensis* showing large size of resin duct (R) with more diposition of resin materials in the epithelial cell layer (OC. X 10.Obj x 40). Ep: epthelial cells.

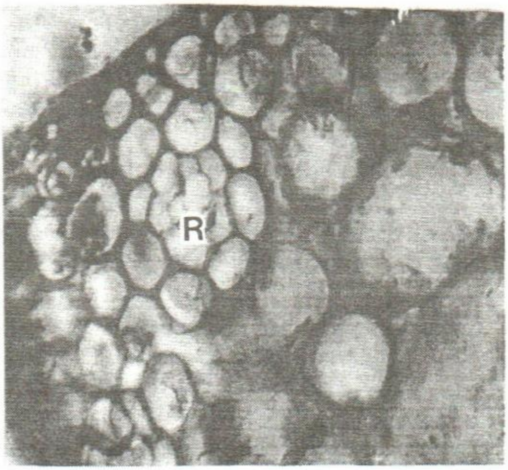


Fig. (7): Portion of cross section in *P. canariensis* showing small size of resin duct (OC. X 10. Obj x 40).

Comparing the needle internal structure of the two pine species, Table (2) indicates that the needle of *P. halepensis* is characterized by thicker epidermis and wider mesophyll tissue but thinner transfusion tissue compared with that of *P. canariensis*. The most striking anatomical differences between the two species occur, mainly in the hypodermal cell layers and endodermis as well as size of resin ducts. The hypodermis occurs in 1-3 cell-layers in *P. halepensis*, but in distinct patches in *P. canariensis*. The resin ducts also were wider in *P. halepensis* with more diposition of resin materials in the epithelial cell layer (Fig. 6) compared with *P. canariensis*, which appear smaller in size and had weaker function for resin secretion (Fig. 7). This findings suggest that the flow of resins would be greater in *P. halepensis* may indicate that the resistance of this species to air pollution was more than *P. canariensis*. Zobal (1996) noted that resistance of pine needle to air pollution was associated with thicker endodermal cell layer.

4- Effects of needle age on its structure:

Data presented in Table (3) and illustrated in Figs. (8 A and B) clearly showed significant differences in the needle structure of the two pine species with increasing age of the needle. The needle thickness and its width were increased due to an increase in thickness of hypodermis, mesophyll tissue, endodermal cell layer and transfusion tissue as well as vascular bundle dimensions. The greatest anatomical differences between one and two-year-old needle were reflected in number and diameter of resin ducts. Two years-old needle has higher number and larger size of resin ducts as compared with one-year-old needle. These results indicate that the needle structure is influenced by needle age.

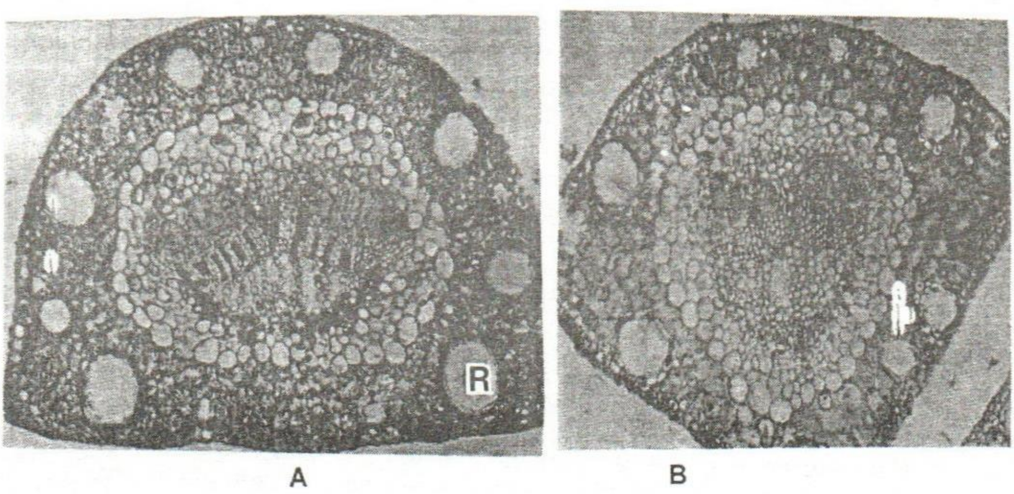


Fig. (8): Cross sections at the middle part of two year-old needles of (A) *P. halepensis* and (B) *P. canaripensis* showing higher number and large size of resin ducts (R). (OC. X 10. Obj. x 10) compared with the middle part of one year old needles (Figs 4 and 5).

Table (3): Effect of needle age and needle parts on needle structure of *P. halepensis* and *P. canariensis*.

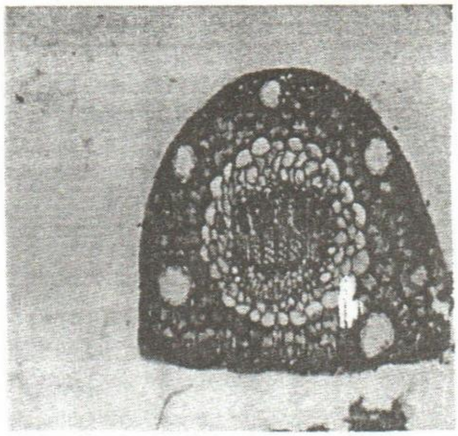
Anatomical parameters		*P. halepensis* Age of needles: 1 year-old	*P. halepensis* Age of needles: 2 year-old	*P. halepensis* Part of needles: Basal	*P. halepensis* Part of needles: Middle	*P. halepensis* Part of needles: Terminal	*P. canariensis* Age of needles: 1 year-old	*P. canariensis* Age of needles: 2 year-old	*P. canariensis* Part of needles: Basal	*P. canariensis* Part of needles: Middle	*P. canariensis* Part of needles: Terminal	L.S.D. at 5%: Species	L.S.D. at 5%: Treatment
Needle dimension	(thickness) (μm)	560	730	480	610	560	590	780	560	560	480	5.1	14.5
	(width) (μm)	800	920	610	840	710	820	850	790	820	800	8.6	14.6
Hypodermis thickness (μm)		34	40	24	35	35	44	52	24	44	48	1.8	2.4
Mesophyll tissue thickness (μm)		196	312	184	202	186	192	256	180	192	178	2.8	6.7
Number of resin ducts		6	8	5	6	6	5	7	3	5	6	1.1	1.3
Resin ducts dimension (μm)		132	180	134	138	132	40	108	40	40	52	2.4	5.1
Transfusion tissue thickness (μm)		390	430	120	410	370	350	532	300	350	310	9.4	11.5
Endodermal cell layer thickness (μm)		52	96	42	102	95	40	52	-	40	44	1.6	1.9
V.B. dimension	length (μm)	328	360	200	366	340	220	240	200	240	220	5.3	6.8
	Width (μm)	208	224	154	236	230	180	248	212	248	280	4.2	6.4

5- Effects of needle portion on its structure:

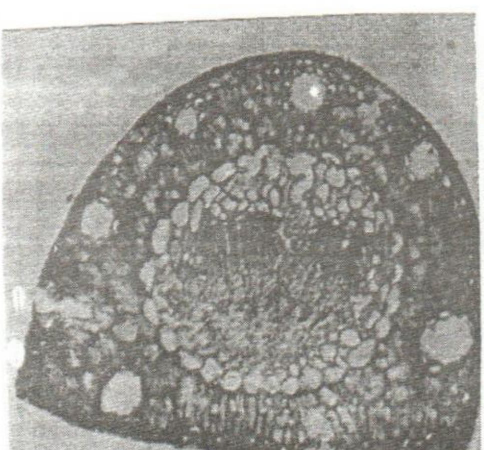
It is clearly that pine needle is largely influenced by needle portion, in particular differentiation of both mesophyll tissue and resin ducts. Comparing the anatomical structure of different parts of the needle of the two pine species, the results in Table (3) and illustrated in Figs. (9 and 10) indicate that, significant anatomical differences were observed. The middle portion of the needle is characterized by a wider needle, hypodermis, mesophyll tissue, presence and wider endodermis. It had also greater number and larger size of resin ducts as well as more developing vascular tissue compared with those in the basal and terminal portions of the needle (Fig. 9B). Almost all the anatomical characters remain particularly unchanged in the terminal portion of the needle with exception the number and size of resin ducts, which appears less in number and smaller in size (Fig. 9C).

The results in the same Table indicate that more considerable anatomical changes took place in the lower portion of the needle of *P. canariensis*, including lower degree of a sclerified fibrous hypodermis, thinner mesophyll tissue without developed internal ridges on the cell walls. In addition, the endodermal cell layer is still recognizable (Fig. 10A). It is clearly also that, there is a great similarity between the lower portion of the needle and the needle produced under shade conditions in *P. canariensis*. This similarity may be due to longer needle sheath, which caused etiolation conditions.

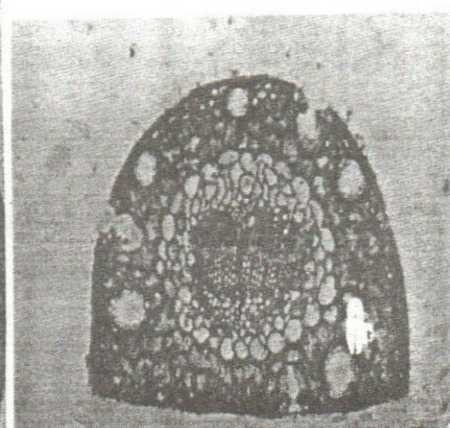
The reductions in needle thickness as well as resin ducts number and size in the lower portion of the needle are related to shade conditions and low photosynthetic rate. Shading conditions reduced leaf thickness and led to low photosynthetic rade (Vidal *et al.*, 1990) and decreased stomata density (Nii, 1988).



A : Basal part

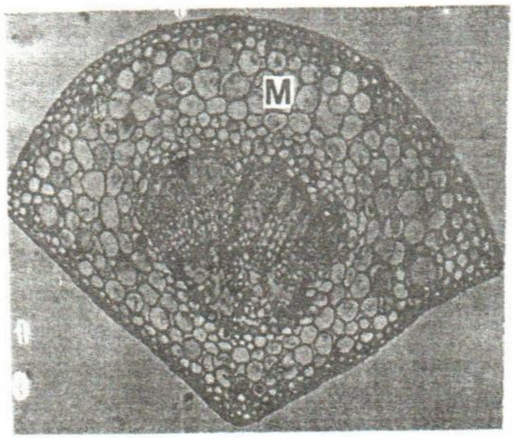


B: Middle part

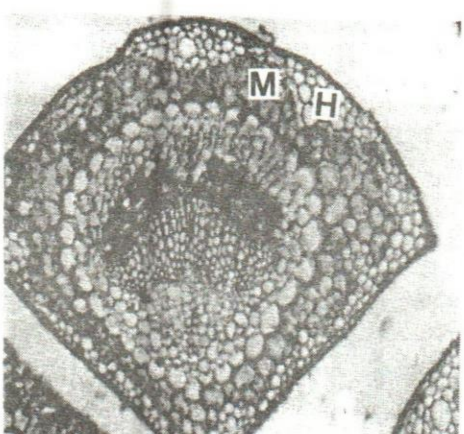


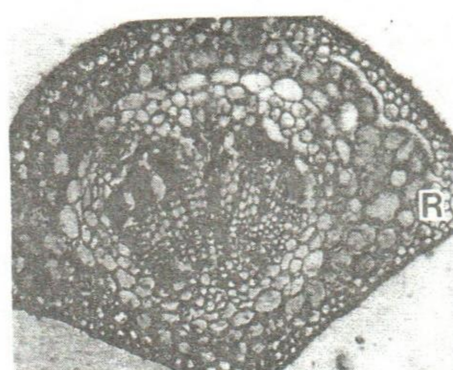
C: Terminal part

Fig. (9): Cross sections in different parts of *P. halepensis* needle showing the middle portion (B) of the needle had greater number and larger size of resin ducts compared with basal (A) and (C) terminal portions (OC. X 10. Obj. x 10).



A : Basal part





B: Middle part

C: Terminal part

Fig. (10): Cross sections in different parts of *P. canariensis* needle showing the middle portion of the needle (B) had wider hypodermis (H), mesophyll tissue (M) and greater number and size of resin ducts (R) compared with basal (A) and terminal (C) portionss (OC. X 10. Obj. x 10).

The results clearly indicate that light is necessary for development of both the stomata and resin ducts as well as formation of phenolic compounds. Hartmann (1995) noted that under normal growth conditions, about 20% of all carbon photosynthesised by plant flow through the Shikimate pathway and much of it might be used for the synthesis of various secondary metabolites.

On the other hand, anatomical examinations of the dwarf stem, bearing needles, of the pine species showed that the dwarf stem in *P. halepensis* contains four vascular bundles (Fig.11A), each two vascular bundles splits anticlinally to form two needles (Fig. 11B), while in *P. canariensis*, the dwarf stem contains six vascular bundles and cortical resin ducts. Each two vascular bundles diverges and splits periclinally between the two cortical resin ducts bearing three needles (Fig. 11C). Therefore, the basal portions of the two pine species contain two lateral resin ducts.

Anatomical examinations of both dwarf stem and the basal portions of the needle can be predicate with the number of needle per dwarf. These results may also confirm that, there is correlation between the number of vascular bundles and cortical resin ducts in the dwarf stem and both are correlated with the number of needles bearing from dwarf stem. However, this correlation requires further studies.

6- Effects of shading on needle structure:

Numerous morphological and anatomical changes were noted with needle grown under shade condition compared with those grown under sun-light condition.

Morphologically, the needle produced in shade conditions showed compact, abundant and modified in shape, small in size and shorter in length compared with sun-light grown needles (Fig. 12).

Comparing the needle structure of the two pine species, data in Table (4) and illustrated in Figs. (13 and 14) revealed that, the needle structure is largely influenced by light conditions. The needle developing under shade conditions (Fig. 13A) had weaker hypodermis, thinner and poorly developed mesophyl tissue compared with sun-light grown needle (Fig. 13B). The major anatomical differences between shade and sunlight grown needles of *P. halepensis* were represented by the stomata distributions, differentiation of mesophyll tissue and endodermis as well as number and size of resin ducts. Stomata are must abundant on the adaxial surface in shade-grown needle (Fig. 13A). Another anatomical difference in shade-grown needle of *P. canariensis* (Fig. 14A) is absence of the internal ridges on the mesophyll cell wall projecting into the cell lumina. It seems to be an xerophytic character. The differentiation of endodermis and resin ducts also displays interesting differences.In shade-grown needle, there is no differentiation of the endodermis. The resin ducts are lesser in number and smaller in size compared with those from sunlight grown needles. The reduction in needle thickness as well as resin duct number and size under shade conditions may be due to low photosynthesis (Longstreth *et al.*, 1985; Vidal *et al.*, 1990 and Strauss-Debenedetti and Berlyn, 1994).

From the above-mentioned results, light conditions seemed to be very important not only for differentiation of mesophyll parenchyma and endodermis but also for differentiation of resin ducts.

Table (4): Effect of shading and different attitude on needle structure of *P. halepensis* and *P. canariensis*.

Anatomical characters		Species								L.S.D. at 5%	
		P. halepensis				*P. canariensis*					
		Shading	Non-shading	Height 2 m	Height 4 m	Shading	Non-shading	Height 2 m	Height 4 m	Species	Treatments
Needle dimension	thickness (μm)	530	580	620	690	540	630	520	690	13.3	15.6
	width(μm)	710	810	760	800	780	840	760	800	13.9	17.6
Hypodermis thickness (μm)		20	36	40	42	24	52	40	42	1.3	1.8
Mesophyll tissue thickness (μm)		180	280	158	285	172	256	268	256	4.1	7.6
Number of resin ducts		4	6	6	8	3	7	5	8	1.3	1.6
Resin ducts dimension (μm)		90	172	175	180	48	108	52	120	2.4	2.9
Transfusion tissue thickness (μm)		300	320	280	240	300	500	340	440	7.7	13.3
Endodermal cell layer thickness (μm)		36	52	40	42	-	60	40	52	1.6	1.8
V.B. dimension	length (μm)	180	185	300	248	200	232	280	240	8.1	14.1
	Width (μm)	150	236	200	160	160	184	300	248	8.0	15.6

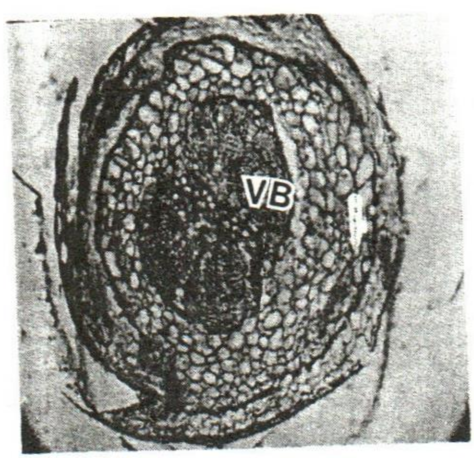


Fig. 11A: Dwarf stem cross section of P. halepensis showing each two vascular bundles (V.B.) splits anticlinally to form two needles (OC. X 10. Obj. x 10)

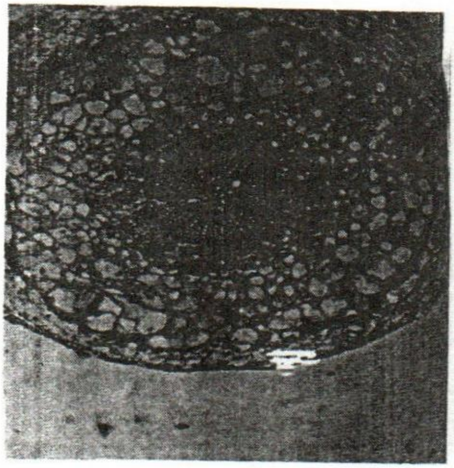


Fig. 11B: Dwarf stem cross section of *P. canariensis*. Note, the stem contains six vascular bundles and cortical resin ducts (R), (OC. X 10. Obj. x 10)

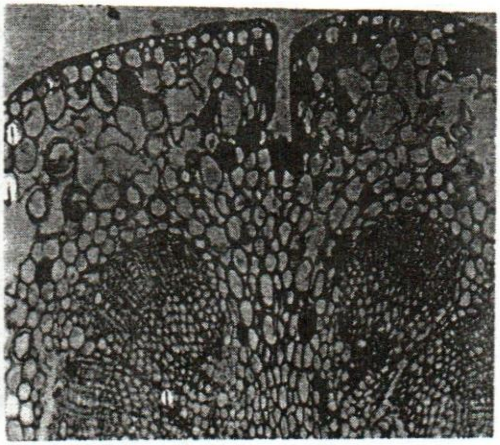


Fig. 11C: Portion of cross sections of *P. canariensis*. dwarf stem showing splits periclinally between the two cortical resin ducts (R) bearing three needles (OC. X 10. Obj. x 10)

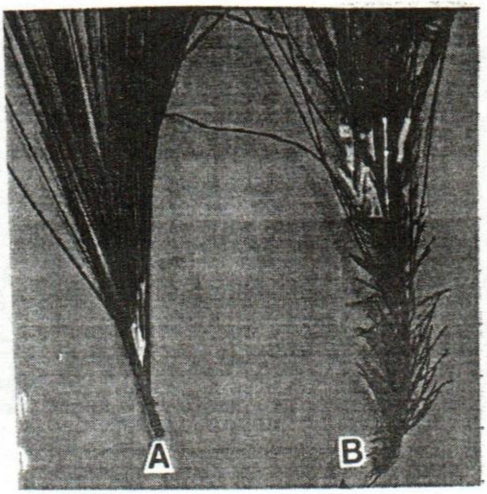
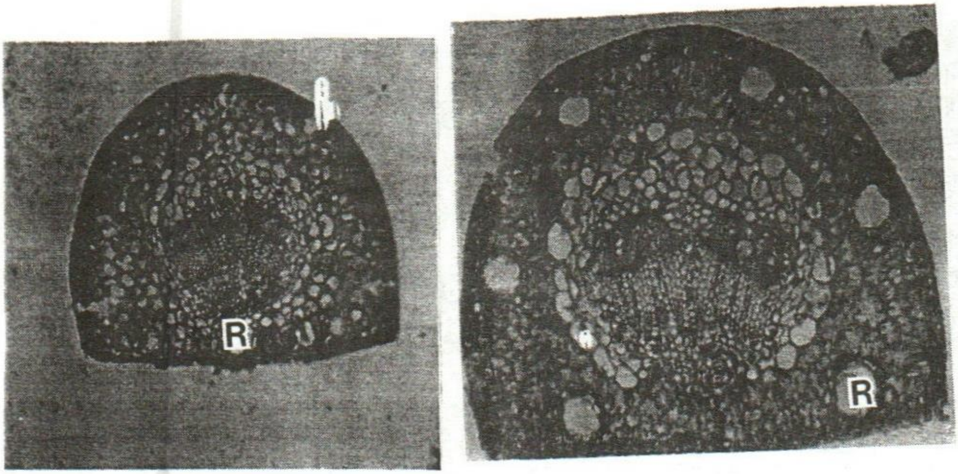
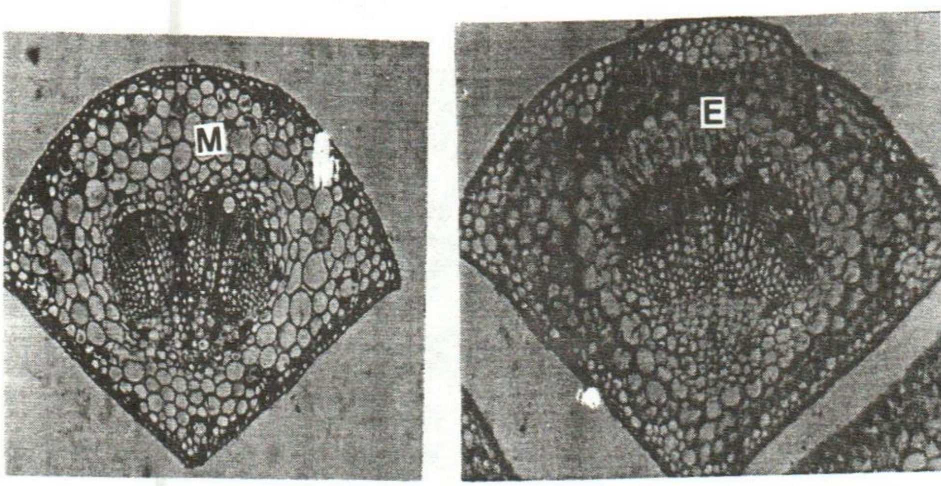


Fig. 12: Young branches of *P. halepensis*. Note: the needle developing under shade condition (B) showed compact, abundant, smallar size and shorter in length compared with sun-light grown needles (A).



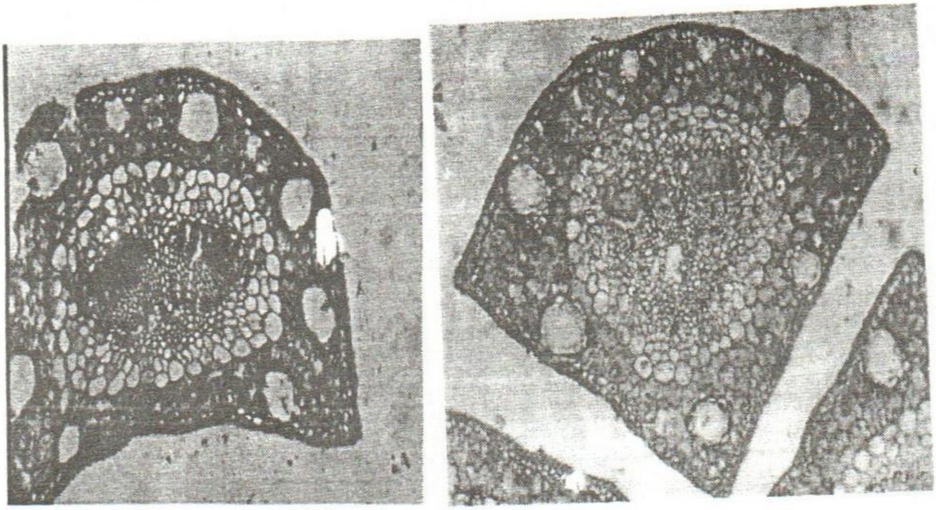
A B

Fig. (13): Needle cross sections of P. halepensis grown under shade condition (A) showing the resin ducts (R) lesser in number and smaller in size compared with those from sun-light grown needle (B). (OC. X 10. Obj. x 10)



A B

Fig. (14): Needle cross sections of *P. canariensis* grown under shade condition (A) showing absence of the internal ridges on the mesophyll cell wall and no differentiation of the endodermis (E) comared with needle grown under sun-light condition (B) (OC. X 10. Obj. x 10), M, Mesophyll tissue.



A B

Fig. (15): Needle cross sections of *P. halepensis* (A) and *P. canariensis* (B) at 4 m hight from the soil surfaces, showing the resin ducts are more in number and larger in size compared at 2 m hight (Fig. 4 and 5).

7- Effects of position of the needle on the tree on its structure:

Comparing the variation of needle structure taken from different levels of the tree, the results indicate that significant anatomical differences in the needle thickness, needle width, mesophyll tissue, number and size of resin ducts, transfusion tissue and vascular bundles dimensions were detected among the two heights (levels). All the above mentioned anatomical characters were increased with an increase in height (Table 4 and Figs 15 A and B). The hypodermal cell layers as well as number and size of resin ducts display an interesting difference between the different heights of needles. The hypodermis became stronger and the resin ducts were more in number and larger in size at high level from the soil surface (4 m from the soil surface). The effects of different heights of the needle on its structure were reported by Hengxiao *et al.*, 1999 and Sheue *et al.*, 2003).

The increase in needle thickness, number and size of resin ducts caused by the increase of needle height probably due to an increase in the density of sun-light. It seems that, light is one of most important factors controlling resin ducts development.

On the other hand, the results in Table (5) indicate that the number and size ducts in needles were correlated with total phenolic compound concentrations and consequently correlated with age, portions of the needle, shading and position of the needle on the tree. In both species, the largest number and size of resin ducts were found in the middle part of two years-old needles grown under sunlight condition. While the lowest number and size of resin ducts were found in the needle developing under shade condition. The reduction of resin duct number and size as well as phenolic compounds concentrations under shade condition may be due to an increase in the phenols destroying enzymes, *i.e.*, polyphenol-oxidase activity under heavy shade condition (Al-Brazi and Schwabe, 1984).

From the above mentioned results, it could be concluded that, the surface of branches, number of needles per dwarf stem, needle sheath and cone size are the most remarkable morphological differences between the two pine species. These morphological features including number of needle, length of needle sheath, nature of the surface of young branches and female cone dimension are used in identifying both *P. halepensis* and *P. canariences*. needle, needle part, light intensity and height from soil surface. The most remarkable anatomical differences included distribution, degree of a sclerified fibrous hypodermis and differentiation of mesophyll tissue. The number and size of resin ducts also display interesting structural variation affected by age and part of needle, light density and position of the needle on the tree.

Table (5): Relationship between number, dimension of resin ducts and total phenolic compounds concentrations (mg/g fresh weight) in the needles.

Chareacters	Species					
	P. halepensis			*P. canariensis*		
	No of resin ducts	Large resin ducts diameter (μm)	Phenolic compounds conc.	No of resin ducts	Large resin ducts diameter (μm)	Phenolic compounds conc.
A- Age of needle:						
One year-old	6	132	90.4	5	96	67.1
Two years-old	8	180	115.3	7	120	108.6
B- Needle parts:						
Basal part	5	134	50.3	2	40	28.3
Middle part	6	138	85.91	5	92	59.6
Terminal part	6	130	80.0	5	52	46.1
C- Light condition						
Shading	5	83	48.6	5	40	21.5
Non shading	6	172	95.7	6	37	73.4
D- Needle position:						
At 2 m height	6	175	110.0	6	92	77.7
At 4 m height	8	180	112.6	7	108	82.8
L.S.D. at 5%	1.1	3.7	2.4	1.3	3.6	3.2

REFERENCES

Al-Barazi, Z. and W. Schwabe (1984). The possible involvement of polyphenol-oxidase and the auxin-oxidase system in root formation and development in cuttings of *Pistacia vera*. J.Hort. Sci. 59:453-461.

Boratynska, K. and M. A. Bobowicz (2001). *Pinus uncinata* Ramond taxonomy based on needle characters. Plant Systematics and Evaluation 227:183-194.

Duffield, J. W. (1991). The *Pinus* of Mexico and central America. Trimber Press. Inc. Hong Kong. Pp 23-38.

El-Barazi, Z. and W. Schwabew (1984). The possible involvement of polyphenol-oxidase and the auxin-oxidase system in root formation and development in cuttings of *Pistacia vera*. J. Hort. Sci. 59:453-461.

Fahn, A. (1990). Ptant anatomy 4th ed. Pergamon Press, Oxford. New York and Paris pp. 249-252.

Franceschi, V. R.; T. Krekling; A. A. Berryman and E. Christiansen (1998). Specialized phloem parenchyma cells in Norway spruce (*Pinaceae*) bark are an important site of defense reactions. Amer. J. Bot. 85(5):601-615.

Gerlach, D. (1977). Botanische Microtechnik Eine Einfuhrung Thieme-Verlag, Stuttgart, BRD.

Hengxiao, G.; J. D. Mc Millin; M. R. Wagner; J. Zhou; Z. Zhou and X. Xu (1999). Altitudinal variation in foliar chemistry and anatomy of yunnan pine, *Pinus yunnanensis*, and pine sawfly (Hym-Diprionidae). Performance. J. Appl. Ent. 123:465-471.

Herrmann, K. M. (1995). The shikimate pathway: early steps in the biosynthesis of aromatic compounds. Plant Cell 11(7):907-919.

Longstreth, D. J.; J. A. Bolanos and R. God el-ard (1985). Photosynthetic rate and mesophyll surface area in expanding eaves of *Alternanthera philoxeroides* grown at two light levels. Amer. J. of Exp. Bot.72::14-19.

Mansfield,T. A. and M. Pearson (1996). Disturbances in stomata behaviour in plants exposed to air pollution. Plant response to air pollution Edited by Mohammed Yunus and Mohammed Iqbal. John Wiley and Sons Ltd.

Mazumder, B. C. and Majumder, K. (2003). Methodes on physico-chemical analysis of fruits. Daya publishing House.Tri Nagar, Delhi. PP.124-125.

Nii, N. (1988). Anatomical changes including chloroplast structure in peach leaves under deficient light conditions. J. Hort. Sci. 63:37-45.

Sheue, C. R.; Y. P. Yang and L. L. Kuo-Huang (2000). Attitude variation of resin ducts in *Pinus taiwanensis* Hacyata (Pinaceae) needles. Bot. Bull. Acad. Sin. 44:305-313.

Sheue, C. R.; Y. P. Yang and L. L. Kuo-Huang (2003). Structural variation of the needles of *Pinus taiwanensis* Hay along an elevational gradient. Taiwn. J. Foresi. Sci. 15:337-349.

Strauss-Debenedetti, S. and G. P. Berlyn (1999). Leaf anatomical responses to light in five tropical *Moraceae* of different successional status. Amer. J. Bot. 12:1582-1591.

Telewski, F. W.; A. H. Wakefield and M. J. Jaffe (1983). Computer-associated image analysis of tissues of etheral-treated *Pinus teeda* seedlings. Plant Physiol. 72:177-181.

Vasishta, P. C. (1983). Botany for degree students Vol. V: Gymnosperms. S. Chand and Company LTD Ram Nagar, New Delhi.

Vidal, D.; Griera, E.; Marin, P. and Sabido, J. (1990). Anatomical and physiological acclimation of *Fatsia japonica* leaves to irradiance. Amer. J. Bot. 77(9):1149-1158.

Wagner, M. R. and Z. Zhang (1993). Host plant traits associated with resistance of ponderosa pine to the sawfly. Neodiprion Flulviceps. Can. J. For. Res. 23:839-845.

Zobel, A. M. (1996). Phenolic compounds in defense against air pollution. Plant response to air pollution. Edited by Mohammed Yunus and Mohammed Iqbal, 1996. John Wiley and Sons Ltd.

بعض الإختلافات النباتية فى الأوراق الإبرية لنوعين من الصنوبر والمتأثرة بالتظليل وكذلك عمر وأجزاء وموقع الورقة على الشجرة

رمضان عبد المنعم فودة
قسم النبات الزراعى – كلية الزراعة – جامعة المنصورة – المنصورة – مصر .

تعتبر أشجار الصنوبر بذات أهمية إقتصادية فى إنتاج الراتنجات وزيت التربنتين والتى تدخل فى صناعة الدواء بالإضافة إلى أهميتها فى مقاومة العديد من الأمراض والحشرات ، لذلك فقد إستهدف هذا البحث دراسة بعض الإختلافات النباتية بين الصنوبر الحلبى والصنوبر الكنارى خلال فصلى الصيف والخريف لموسم النمو ٢٠٠٣ لإجراء دراسة مقارنة لبعض الصفات المورفولوجية والتركيب التشريحى للأوراق والتى تعتبر ذات أهمية تقسيمية ، كما تم دراسة الإختلافات التشريحية فى الأوراق تحت تأثير عمر وأجزاء الورقة والتظليل وكذلك إرتفاع الورقة عن سطح الأرض .

ويمكن تلخيص النتائج المتحصل عليها فى الآتى :

١- لوحظ وجود إختلافات مورفولوجية بين النوعين ، إذ تميز الصنوبر الكنارى بزيادة عدد الأوراق لكل ساق قزمية وزيادة طول الأوراق وكبر حجم الغمد المحيط بقواعد الأوراق وكبر المخروط المؤنث مقارنة بالصنوبر الحلبى بالإضافة إلى طبيعة سطح الأفرع الحديثة حيث تكون ناعمة بدون بقايا غمد الأوراق فى الصنوبر الحلبى بينما يكون خشن فى الصنوبر الكنارى ، ومثل هذه الملامح تستخدم فى تعريف كلا النوعين .

٢- تشريحياً تميزت الأوراق الإبرية للصنوبر الحلبى بزيادة سمك البشرة وطبقة خلايا الإندودرمس وإتساع النسيج المتوسط والقنوات الراتنجية مقارنة بالأوراق فى الصنوبر الكنارى . وتركزت أهم الإختلافات التشريحية بين النوعين فى طبقات خلايا تحت البشرة وطبقة الإندودرمس وكذلك عدد وحجم القنوات الراتنجية والتى تكون أكثر إتساعاً مع ترسب أكثر من المواد الراتنجية فى طبقة الخلايا الطلائية فى الصنوبر الحلبى مقارنة بالصنوبر الكنارى .

٣- دلت دراسة الساق القزمية والجزء القاعدى للورقة على وجود علاقة بين كل من عدد الحزم الوعائية والقنوات الراتنجية فى الساق القزمية وكذلك عدد الأوراق التى تحملها الساق القزمية .

٤- إزداد سمك الورقة بزيادة عمرها ، وقد إحتوت الأوراق عمر سنتين على عدد كبير وأكثر إتساعاً من القنوات الراتنجية .

٥- إتصف الجزء الأوسط من الأوراق بإتساع تحت البشرة والنسيج المتوسط والأندودرمس كما إحتوى على غدد راتنجية أكثر عدداً وإتساعاً مقارنة بالأجزاء القاعدية والقمية للورقة فى كلا النوعين . وتميزت الأجزاء القاعدية من الورقة بقلة طبقات تحت البشرة وعدم تميز البارنكيما ذات الجدر المطوية فى النسيج المتوسط بالإضافة إلى إكتمال تكشف طبقة الإندودرمس خاصة فى الصنوبر الكنارى .

٦- تأثر التركيب التشريحى للأوراق بكثافة الضوء ، وكان عدد وحجم القنوات الراتنجية وتكشف البارنكيما ذات الجدر المطوية أهم التراكيب المتأثرة بالتظليل ، كما زادت كل الصفات التشريحية للورقة بزيادة إرتفاع الورقة عن سطح الأرض .

٧- إرتبطت الزيادة فى كل من عدد وحجم القنوات الراتنجية فى الأوراق بزيادة تركيز الفينولات الكلية .