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PHENETICAL AND HISTOLOGICAL STUDIES ON SOME TAXA OF GENUS *DATURA* (SOLANACEAE).

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ABSTRACT

A phenetical (morphological characters) and histological investigations were carried out as taxonomic evidences for representing, in general, the relationship between different taxa of genus *Datura*, namely; *D.metel*, *D.ferox*, *D.tatula* and *D.stramonium*, and specially between last two taxa for the taxonomic arguments raised between them.

All the morphological and histological results suggested that *D.metel* is a distinct species characterized by a unique characters; e.g., flower large, fruit spherical, fruit suture of densely hairs, fruit rachis is curved downward. These characters are varied when compared with those of other taxa. *D.ferox* came in the middle category in its characteristics between *D.metel* from one side and *D.tatula* and *D.stramonium* from the other side. *D.ferox* sharing *D.metel* in green purple colour stem and white center strip of hilum. While, *D.ferox* sharing *D. tatula* and *D.stramonium* the ovate fruit shape, erect fruit rachis, seed size and brown or beige seed colour.

D.tatula and *D.stramonium* were more similar to each other in many morphological and anatomical characters than to any of the other studied taxa and could be classify under white stramonium for D.stramonium and purple stramonium for D. tatula. Some of these characters are; flower size, moderately spines on fruit surface, erect fruit rachis, fruit shape, root cortex thickness, root vascular cylinder thickness, stem cortex thickness and barrel stem epidermal cell.

INTRODUCTION

Genus *Datura* belongs to family Solanaceae and includes, in addition to *Datura*, approximately 90 genera and 2000 species (Bailey, 1949 and Sophie and Avery, 1959). Most of these species were initiated in Middle America and the northern region of Southern America, and then distributed to many areas around the world. It thought that the main initiative locations of genus *Datura* are the temperate and sub-tropical regions, especially in Asia and the coast of the Mediterranean (Rashid and Beg, 1991).

The wild type of *Datura* has been collected from Egypt (Täckholm, 1974), Algeria and Morocco (Africa); Turkey and Iran (Asia) and from Greece, Italy and Spain (Europe). The famous countries producing the herbaceous plants of *Datura* for medicine uses are U.S.A., Russia, Brazil, Hungary and Egypt. *Datura* plants are annual herbs or perennial shrubs and it could be distinguish among the species of this genus either morphologically or chemically. The quantities of alkaloids varied in the seeds of the species of this genus according to the pigmentation group of the species, e.g.; in *D. metel* the percentage of total alkaloids is 0.15% (monomorphic), 0.33% (dimorphic) and 0.42% (titramorphic). In *D.stramonium* and *D.tatula* the percentages of these contents were quiet similar and ranged between 0.06-0.08%, 0.16-0.19% and 0.21-0.24% at the same sequences. While, in *D. ferox*, which was medium in its contents between D.metal from one side and *D.tatula* and *D.stramonium* from the other side; 0.11%, 0.28% and 0.32% (Karnick and Saxina, 1970.) Generally, the main alkaloid types in *Datura* are

Hyosyamin, Hyosin and Atropine. So the main uses of *Datura* plants are for medical treatments of respiration, digestive and nerviace systems. In addition to its use as eye drop (Robins *et al.*, 1992).

There is a great deal of evidence that *D.tatula* and *D.stramonium* are both varients of the same species and as it is often impossible in published records to disentangle the one from the other. Jones and Newell (1997) and Wallis (1994), individually studying South Africa materials, stated that *D.stramonium* and *D.tatula* are anatomically and morphologically quite similar to each other, except for the purple anthocyanin in the flower of the latter. Hankel (1991) mentioned that *D.tatula* is distinguished from *D.stramonium* merely by its purplish stem and move flower, while *D.stramonium* has pale green stem and a large white flower. He dealt with *D.stramonium* and *D.tatula* as white *stramonium* and purple *stramonium*, respectively.

The main objective of this investigation is to compare, morphologically and anatomically, between 4 species of genus *Datura,* namely; *D.metel*, *D.ferox*, *D.tatula* and *D.stramonium* to disclose the differences among these species and trying to solve the taxonomic arguments raised between *D.tatula* and *D.stramonium*.

MATERIALS AND METHODS

This study was carried out during the seasons 2000 and 2001, on 4 taxa belong to the genus *Datura* namely; *D.metel* L., *D.ferox* L., *D.tatula* L. and *D.stramonium* L. The materials used for this study were; seeds, representing the studied taxa, were obtained from the Agronomy Department, Faculty of Agriculture, Cairo University, Giza, Egypt. Plants grown from these seeds in the field and green house of Botany Department, Faculty of Agriculture, Cairo University were used as fresh materials, In addition to, 60 herbarium specimens (15 represent each species), which were loaned from different herbaria, e.g. British Museum (Natural History) (BM) U.K., Faculty of Science (Herbarium) Cairo University (CAI), Egypt and Desert Researches Center (CAIH), Cairo, Egypt. The specimens were examined and analysied using Single Linkage Cluster Analysis technique (Khattab, 1978) for some 60 characters (15 vegetative, 15 floral, 15 fruit and 15 seed. Appendix (1)).

Appendix (1): Characters and character states used in the study

No.	Characters	Character states
	Vegetative characters:	
1	Stem color	Green, purple, green-purple
2	Stem suture	Glaborus, hairy, leather
3	Leaf shape	Ovate, oblong
4	Leaf length mm.	
5	Leaf width mm.	
6	Leaf margin shape	Erect, dentate, serrate, lobed
7	Petiole colour	Light green, light purple, dark purple
8	Life form	Annual, perennial
9	Growth habit	Erect, ascending, procumbent
10	Plant height cm.	
11	No. of internode per plant	

Appendix (1 cont.): Characters and character states used in the study.

No.	Characters	Character states
12	Leaf apex	Acute, mucronate
13	Midvien colour	Light green, light purple dark purple
14	Stem node colour (upper part)	Green, purple, green-purple
15	Stem node colour (lower part)	Green, purple, green-purple
	Floral characters:	
16	Flower length mm.	
17	Peduncle length mm.	
18	Number of flower per node	One, two, three, more
19	Flower length including calyx	
20	Calyx lower tooth length	
21	Calyx upper tooth length	
22	Calyx lateral tooth length	
23	Calyx colour	Light green, green-purple, creamy
24	Calyx tube mouth shape	Slightly oblique, oblique, truncate
25	Calyx teeth suture	Glabrous, hairy
26	Calyx hair distribution	Absent, on teeth only, general
27	Calyx hair elevation	Inapplicable, hair adpressed, hair erect
28	Corolla petal colour	White, whitish violet
29	Corolla tube shape	
30	Corolla tube length mm.	
	Fruit characters:	
31	Fruit shape	Spherical, oval, ovate
32	Fruit type	Simple, compound
33	Fruit pattern	Fleshy, dry
34	Fruit status at maturity	Dehiscent, indehiscent
35	Dehiscent fruit type	Capsule, legume, diplotegium, follicle
36	Capsule types	Septifragal, valvular, others
37	Fruit length mm.	
38	Fruit width mm.	
39	Fruit surface	Smooth, rough
40	Fruit inside division	Applicable, inapplicable
41	Fruit rachis	Erect, curved downward
42	Fruit hairs	Glabrous, sparsely hairy, moderately hairy
43	Hair tubercle length	Absent, short, long
44	Hair length	Equal, unequal
45	No. of fruit per plant	
	Seed characters:	
46	No. of seed per capsule	
47	Seed shape	Kidney, rounded
48	Seed colour	Dark beige, beige, brown, slightly dark
49	Seed length mm.	
50	Seed width mm.	
51	Seed depth mm.	
52	Ratio of seed length to width	
53	Ratio of seed length to depth	
54	Seed shape in side view	Laterally compressed, not
55	Seed finish	Shiny, variable, matt
56	Hilum colour	Light brown, white, inapplicable
57	Hilum position	End, corner, side
58	Hilum surface profile	Convex, concave
59	Hilum shape	Round, oval, elongated
60	Seed surface	Smooth, tuberculate, pitted

Seeds were sown on 2nd. February, of each season, in the green house in pots, 30 cm in diameter filled with sand and peat moss at a ratio of 1:3 at 5 seeds per pot and 5 pots representing each taxon. Fifteen days later, plants in pots were ready for sampling. Samples for anatomical studies were taken from roots (2 and 6 weeks old), stems (apical and middle internodes of 6

weeks old) and leaf lamina. The specimens for the anatomical studies were taken randomly as follows: 1 cm long was taken from the middle part of the tap root (2 weeks old). Six weeks later, specimens of the mature roots, stems and leaves were taken from 2 plants from each pot as follows: 1 cm long far away from the root base to get the intact roots when pulled out, was taken. From the middle and apical internodes of the stem, 1 cm long was cut. As well as, 1 cm^2 samples were taken from the middle portion of lamina including the midrib region.

All samples were killed and fixed in F.A.A. (Formalin-Acetic acid-Alcohol), washed in 50% alcohol, dehydrated in normal butyl and embedded in paraffin wax (55 °C mp.), (Sass, 1958). Cross sections, 20 µ thick, were cut and stained by crystal violet/erythrosin combinations, and mounted in Canada balsam (Jackson, 1926). Sections were examined and counts and the measurements of different tissues were recorded using a micrometer eyepiece, and averages of 10 readings were calculated.

RESULTS AND DISCUSSION

First: Morphological results

Vegetative, floral and reproductive characters were recorded on the healthy fresh plants, representing taxa, from the green house, as well as, the herbarium specimens, which loaned from different herbaria mentioned earlier. After scoring all the characters mentioned in Appendix 1 for each plant represents the studied taxa, the taxonomic descriptions of each taxon could be summarized as follows:

***Datura metel* L.**

Perennial plants. Stem erect, densely hairy-suture, from 40-100 cm. height, green with light purple shaded. Leaf simple, ovate in shape, with entire and unequal margins in young leaves or dentate margins in the middle portion of elder ones, midviens light green. Petiole light - purple. Flower large from 12-15 cm. long including calyx, calyx light green. Corolla white. Fruit spherical, dry dehiscent, capsule, acrocidal with undetectable inside division, densely hairy and hairs of equal length, fruit rachis curved downward. Seed kidney-shaped, dark beige, variegate edge. Center strip of hilum white.

***Datura ferox* L.**

Annual plants. Stem erect, leathered-suture, from 40-100 cm. heights, light green with purple shutter on the upper portion, pale green on the lower one. Leaf simple, oblong-shaped, with dentate margins, midviens light green. Petiole light green. Flower small from 5-8 cm long including calyx, calyx creamy. Corolla white. Fruit obtuse, dry dehiscent, capsule, with applicable inside division, sparsely hairy, hairs long with very acute apex, unequal in length, fruit rachis erect. Seeds kidney- shaped, brown. Center strip of hilum white.

***Datra tatula* L.**

Annual plants. Stem erect, leathered -suture, from 50-80 cm. height, dark purple. Leaf simple, oblong, dentate margins with acute apex, midviens dark purple. Petiole dark purple. Flower small from 3-8 cm. long including calyx, calyx light green with violet shaded. Corolla white violet. Fruit ovate, dry

dehiscent, capsule, moderately hairy, hairs unequal in length, very sharp apex, fruit with applicable division inside, fruit rachis erect. Seed rounded. slightly dark at maturity. Center strip of hilum light brown.

***Datura stramonium* L.**

Annual plants. Stem erect, leathered –suture, from 40-80 cm. height. green. Leaf simple, oblong, dentate margins on lower portion and entire-lanceolate on upper one, midviens light green. Petiole light green. Flower small from 4-9 cm. long including calyx, calyx light green. Corolla white. Fruit ovate, dry dehiscent, capsule, moderately hairy, hairs unequal in length and sharp, fruit with applicable division inside, fruit rachis erect. Seed kidney-shaped, beige at maturity. Center strip of hilum inapplicable.

It is worthy to notice that, one could summarize the different morphological characters between the studied taxa as in Table (1).

Table (1): Some morphological characters differentiate among studied taxa

Species Characters	*D. metel*	*D. ferox*	*D. tatula*	*D. stramonium*
Plant life form	Perennial	Annual	Annual	Annual
Stem colour	Light Green-purple	Light green with purple color on upper portion	Dark purple	Light green
Stem length	60-100 cm.	40-90 cm.	50-80 cm.	40-80 cm.
Stem suture	Hairy	Leathered	Leathered	Leathered
Leaf shape	Ovate	Oblong	Oblong	Oblong
Midvien colour	Light green	Light green	Dark purple	Light green
Petiole colour	Light purple	Light green	Dark purple	Light green
Flower length	12-15 cm.	5-8 cm.	3-8 cm.	4-9 cm.
Calyx colour	Light green	Creamy	Light green with violet	Light green
Fruit shape	Spherical	Obtuse	Ovate	Ovate
Fruit inside division	Inapplicable	Applicable	Applicable	Applicable
Fruit rachis	Curved downward	Erect	Erect	Erect
Fruit suture	Densely hairy	Sparsely hairy	Moderately hairy	Moderately hairy
Seed shape	Kidney	Kidney	Rounded	Kidney
Seed colour	Dark beige	Brown	Slightly dark	Beige
Colour of center strip of hilum	White	White	Light brown	Inapplicable

Using the morphological descriptions of each taxon and all other characters and character states (Appendix 1) and the phenetic analysis results of Single Linkage Cluster technique, it could be design identification key to the studies taxa, in addition to the dendrogram (Fig. 1) of similarity among these taxa as follows:

1- Flower large 12-15 cm. long, fruit spherical with rachis curved downward..... *D.metel*
   - Flower small 3-9 cm long, fruit varied in shape and with erect rachis..... 2
2- Fruit sparsely hairy, obtuse, seed brown ..... *D. ferox*
   - Fruit moderately hairy, ovate, seed varied in colour 3
3- Seed slightly dark, center strip of hilum light brown ..... *D. tatula*
   - Seed beige, center strip of hilum inapplicable ..... D.stramonium.

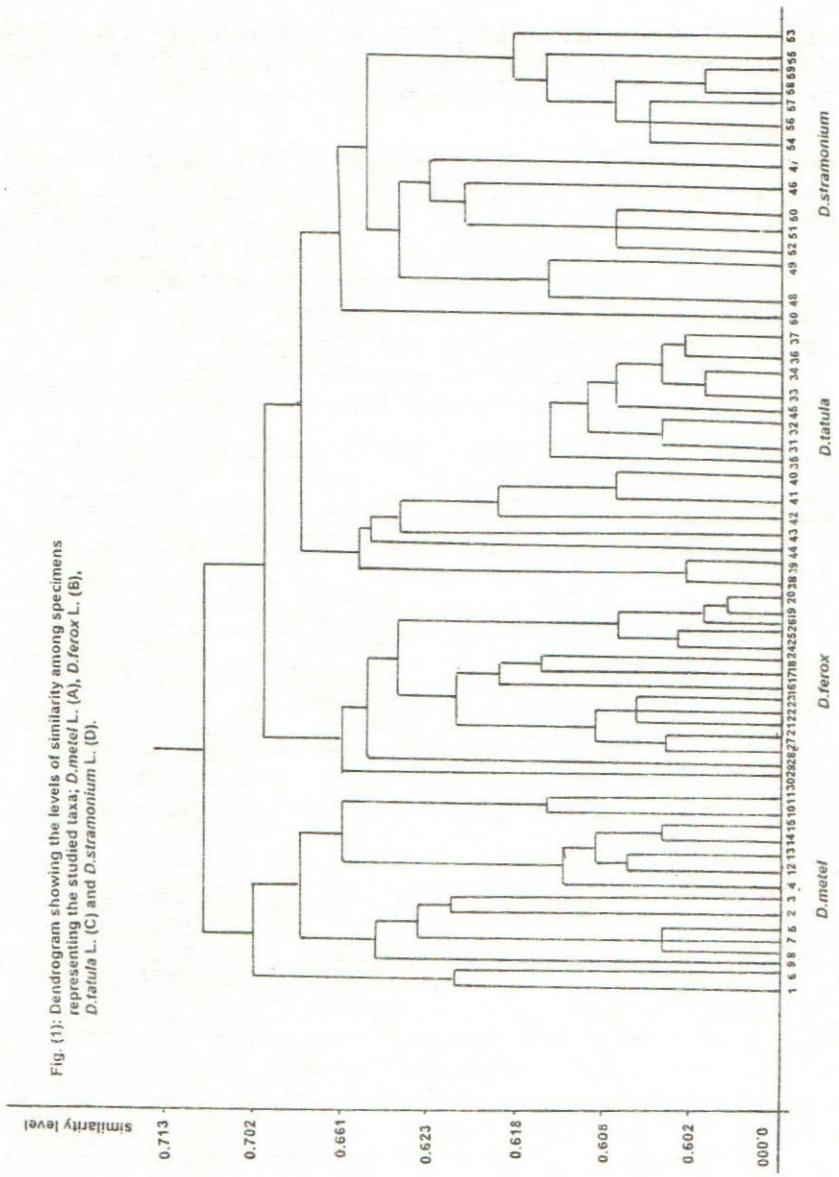


Fig. (1): Dendrogram showing the levels of similarity among specimens representing the studied taxa; *D.metel* L. (A), *D.ferox* L. (B), *D.tatula* L. (C) and *D.stramonium* L. (D).

It is worthy to notice that the present morphological results were in harmony with those obtained by Circosta *et al.* (1986); Ahmed (1989) and Cavazos *et al.* (2000) and disagreed with those of De Pasquale *et al.* and Reisman-Berman *et al.* (1989).

Second: Histological results

1- Structure of the tap root

A- Two weeks old.

The results of the anatomical structure of the tap root at two weeks old (Table 2 and Figure 2 a, b, c and d) reveal that, *D. metel* exceeded all the other taxa concerning the root diameter, vascular cylinder diameter and the number of cortex layers. The average measurements of these characters were 869.25, 472.75 µ and 6.50 layers in *D.metel*; 762.50, 347.70 µ and 6.00 layers in *D.ferox*; 738.10, 320.25 µ and 6.00 layers in *D. tatula* and 708.25, 442.25 µ and 4.50 layers in *D. stramonium*, respectively.

The mentioned results on root at two weeks old are in harmony with those of El-Sayed (1978) and Anozie and Iwu (1989).

Table (2): Measurements (µ) and counts of different tissues in cross sections of the tap root (2 and 6 weeks old) of *D.metel* L., *D.ferox* L., *D.tatula* L. and *D.stramonium* L. (averages of 10 readings).

Species / Characters	*D.metel*	*D.ferox*	*D.tatula*	*D.stramonium*
- Root 2 weeks old:				
- Cortex thickness	192.17	228.75	172.00	170.80
- No. of cortex layers	6.50	6.00	6.00	4.50
- Vascular cylinder diameter	472.75	347.70	320.25	442.25
- Root diameter	869.25	762.50	738.10	708.25
- Root 6 weeks old:				
- Periderm thickness	732.00	581.00	500.00	488.00
- Phloem thickness	148.00	168.75	151.25	143.17
- Xylem thickness	1928.00	1930.25	1559.00	1400.00
- Root diameter	5616.00	5360.00	4420.50	4062.34

B- Six weeks old

Table (2) and Figure (3 a, b, c and d) represent the anatomical structure of the root at 6 weeks old. The results indicate that the root diameter and periderm thickness were the highest in *D.metel* comparing with those of *D.ferox, D.tatula* and *D.stramonium*. Hence, the average measurements of these characters were 5616.00 and 732.00 µ; 5360.00 and 581.00 µ; 4420.50 and 500.00 µ and finally, 4062.34 and 488.00 µ, respectively.

D.ferox has phloem and xylem thickness of 168.75 and 1930.25 µ respectively, which exceeded those of the other studied taxa, except with xylem of *D.metel,* where no difference in xylem thickness of *D.metel* and *D.ferox* (1928.00 and 1930.25 µ, respectively). While, this thickness slightly varied between D.tatula and *D.stramonium* (1559.00 and 1400.00 µ, respectively). On the other hand, Phloem thickness was quite similar in *D.metel, D.tatula* and *D.stramonium*. This thickness was 148.00, 151.25 and 147.13 µ, respectively.

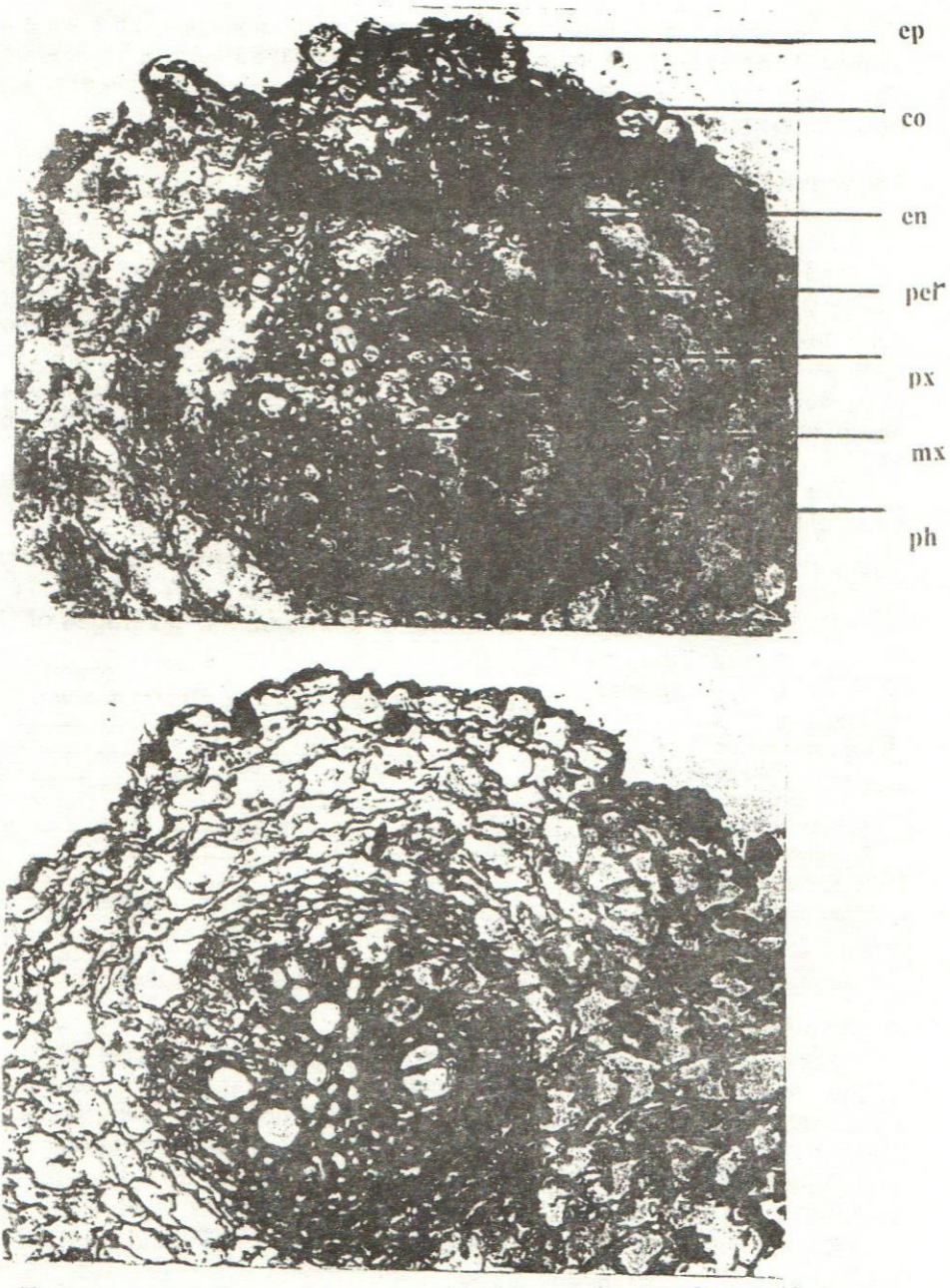
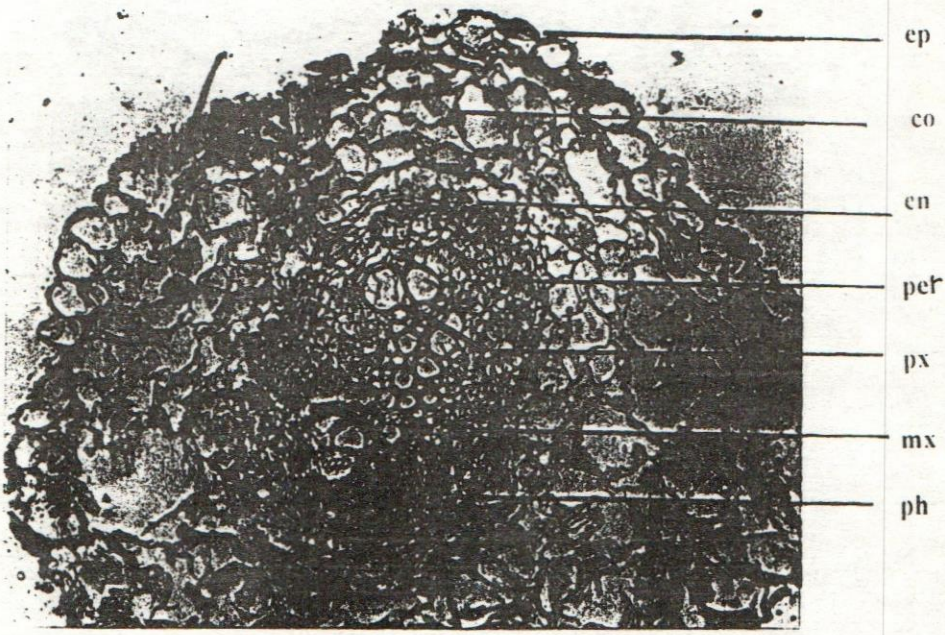
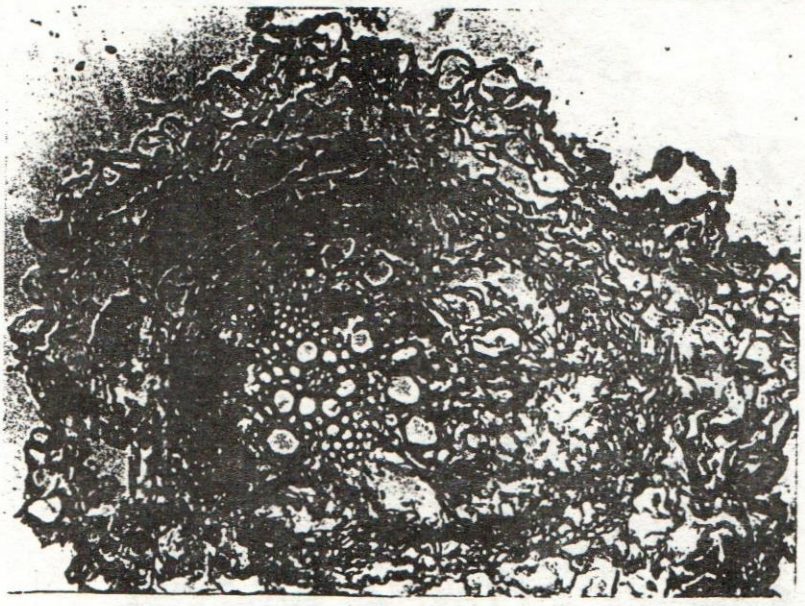


Fig. (2) : Transverse sections of 2 weeks old of the main root *D.metel* L. (A) and *D.ferox* L. (B) showing the primary structure (X 80).
Details: ep: epidermis; co: cortex; en: endodermis; per: pericycle; px: protoxylem; mx: metaxylem and ph: phloem



(C)



(D)

Fig. (2 cont.): Transverse sections of 2 weeks old of the main root *D.tatula* L. (C) and *D.stramonium* L. (D) showing the primary structure (X 80). Details: ep: epidermis; co: cortex; en: endodermis; per: pericycle; px: protoxylem; mx: metaxylem and ph: phloem

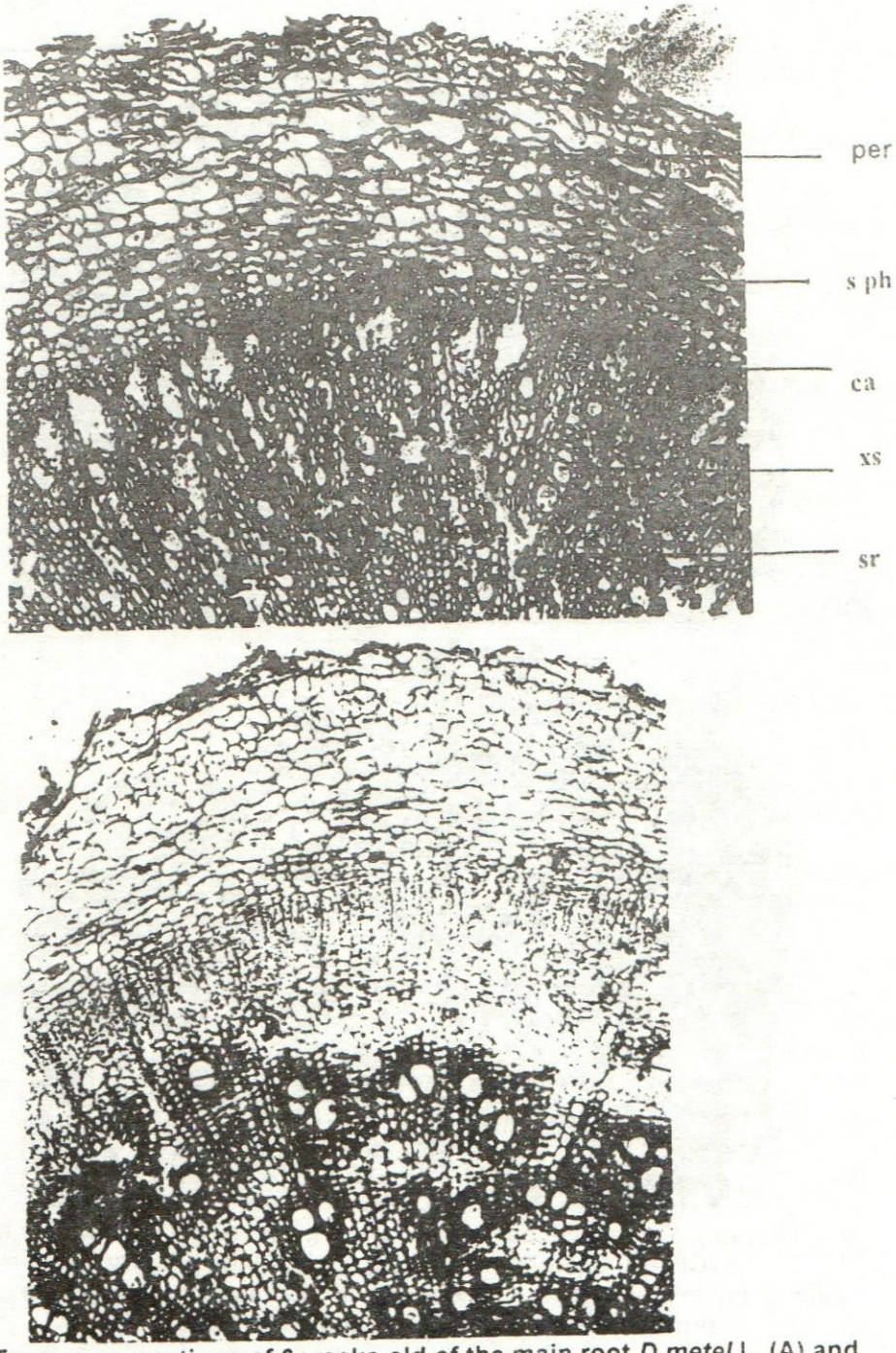


Fig. (3): Transverse sections of 6 weeks old of the main root *D.metel* L. (A) and *D.ferox* L. (B) showing the secondary structure (X 80).
Details: per: periderm; s ph: secondary phloem; ca: cambium; sx: secondary xylem; sr: secondary rays.

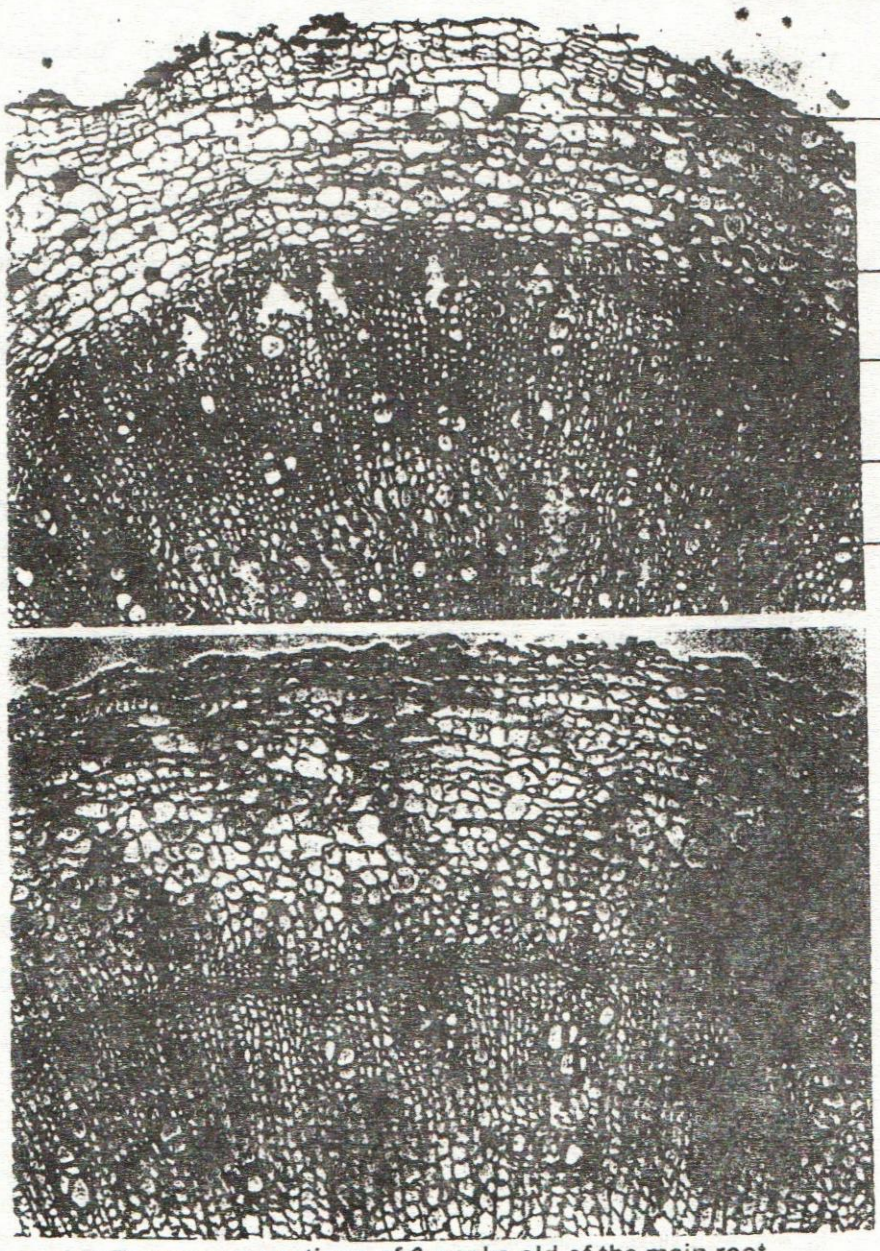


Fig. (3 cont.): Transverse sections of 6 weeks old of the main root *D.tatula* L. (C) and *D.stramonium* L. (D) showing the secondary structure (X 80).

Details: per: periderm; s ph: secondary phloem; ca: cambium; sx: secondary xylem; sr: secondary rays.

The above mentioned results were fit with those obtained by El-Sayed (1978) and Anozie and Iwu (1989).

2- Structure of the stem

A- Apical internode (6 weeks old)

The anatomical structure of the stem of 6 weeks old at the apical internode indicates that the epidermal cells of the species *D.tatula* are square to slightly rectangular in shape. The shape of the epidermal cells of the other three species was barrel in shape. It was difficult to detect any hair patterns on the epidermal cell surfaces of the three species; *D.ferox*, *D.tatula* and *D.stramonium*. In contrast, multicellular and glandular hair types were observed easily on the epidermal cells of *D.metel*. (Table 3) and (Figure 4 a, b, c and d).

Table (3): Measurements (µ) and counts of different tissues of the stem (apical internode–6 weeks old) of *D.metel* L., *D.ferox* L., *D.tatula* L. and *D.stramonium* L. (average of 10 readings)

Species / Characters	*D.metel*	*D.ferox*	*D.tatula*	*D.stramonium*
Total cortex thickness:	544.50	353.86	396.13	378.11
- Collenchyma thickness	94.20	107.27	108.67	95.10
- No. of parenchyma layers	10.00	6.00	10.00	10.00
- No. of collenchyma layers	8.00	5.00	7.00	6.00
External phloem thickness	47.88	75.60	54.18	97.02
Internal phloem thickness	42.50	62.50	44.90	63.35
Xylem thickness	226.00	317.20	215.04	297.30
Pith diameter	3074.40	1607.75	1575.60	1877.40
Average diameter of pith cell	37.60	32.14	28.25	31.02
Whole stem diameter	4479.78	2770.77	2681.78	3091.29

It is worthy to mention that, nearly the same previous trends of measurements of middle internode matched with those obtained on the apical internode at the same age. Where, the whole stem diameter of *D.metel*, *D.ferox*, *D.tatula* and *D.stramonium* were 4479.78, 2770.77, 2681.78 and 3091.29 µ, respectively, which mean that *D.metel* was the highest whole stem diameter among the other three taxa. At the same sequence, the pith diameter of *D.metel* (3074.40 µ) was the highest, followed by *D. stramonium* (1877.40 µ), then *D.ferox* (1607.75 µ) and lastly *D.tatula* (1575.60 µ).

The total cortex thickness of *D.metel*, *D.tatula* and *D.stramonium* were 544.50, 396.13 and 378.11 µ, respectively. The number of parenchyma layers was similar in these taxa (10 layers). *D.ferox* came in the last category in both total cortex thickness (353.86 µ) and the number of parenchyma layers (6 layers) (Table 3).

The above results were in harmony with those of El-Sayed (1978) and Anozie and Iwu (1989). While, the results obtained by Ahmed (1989) were disagreed with the present results.

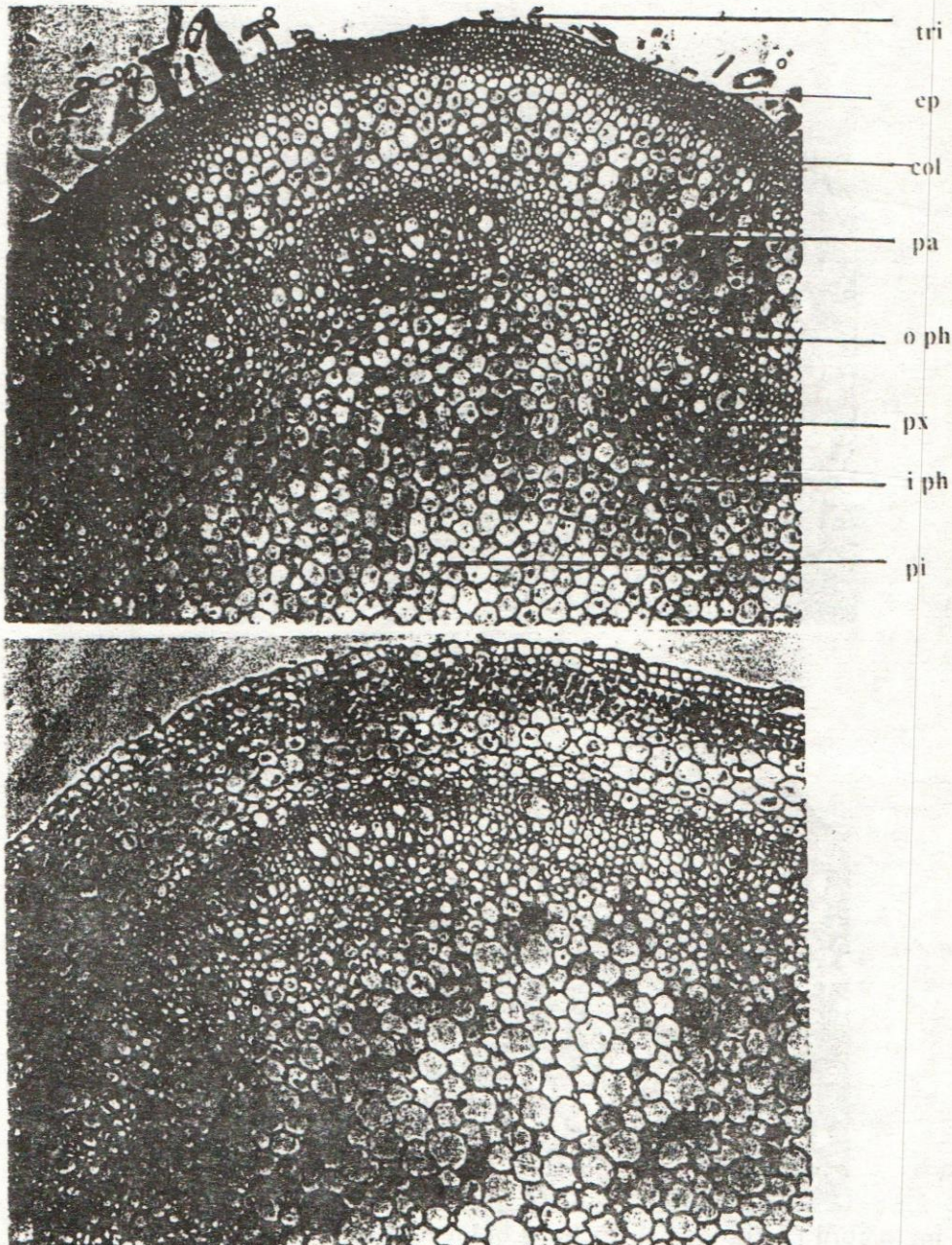
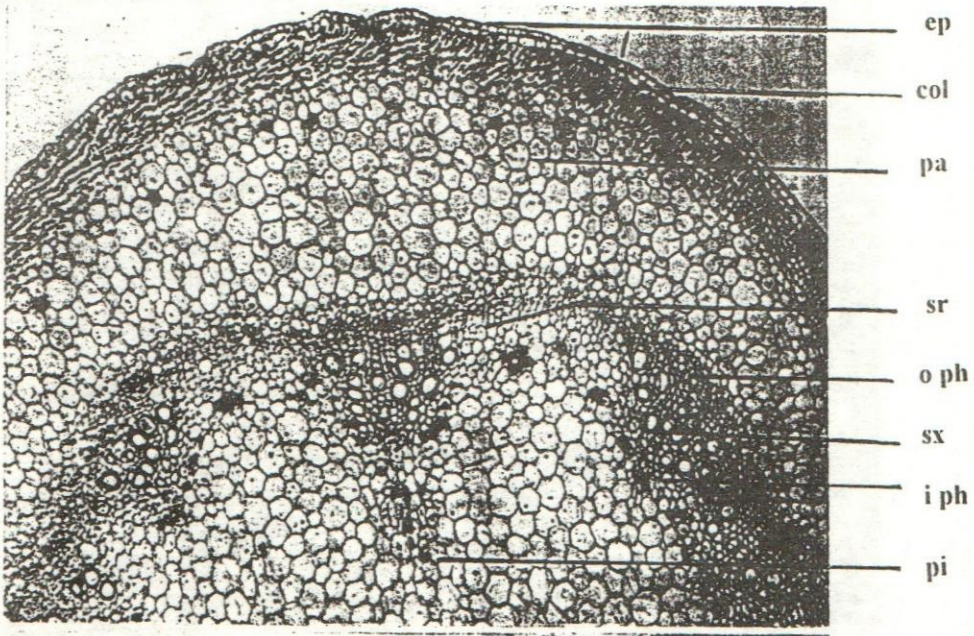


Fig. (4) : Transverse sections of the apical internode, of 6 weeks old of the main stem, of *D.metel* L. (A) and *D.ferox* L. (B) showing the primary structure (X 80).

Details: tri: trichomes; ep: epidermis; col: collenchyma; pa: parenchyma; o ph: outer phloem; px: primary xylem; i ph: inner phloem ; co: cortex and pi: pith.

(C)



(D)

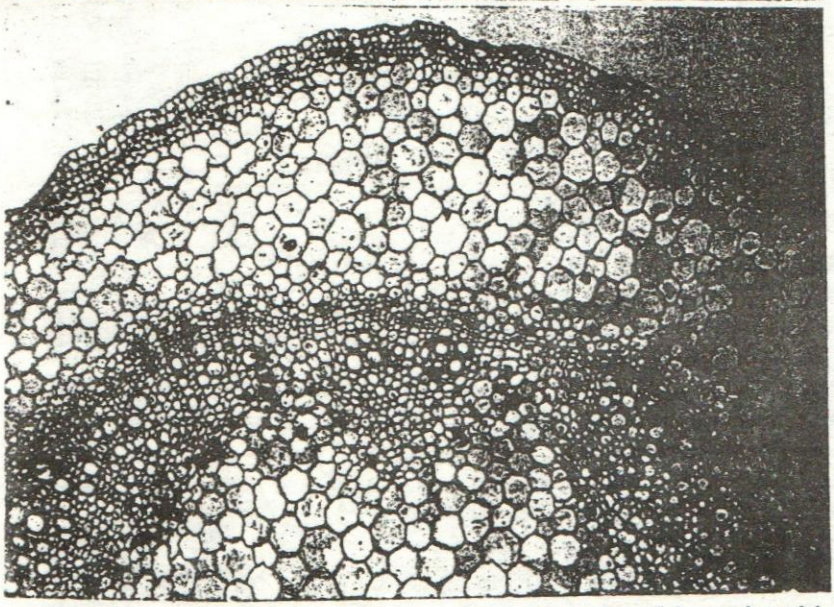


Fig. (4 cont.) :: Transverse sections of the apial internode, of 6 weeks old of the main stem of *D.tatula* L. (C) and *D.stramonium* L. (D) showing the primary structure (X 80).

Details: ep: epidermis; col: collenchyma; pa: parenchyma; o ph: outer phloem; sx: secondary xylem; i ph: inner phloem; sr: secondary rays; co: cortex and pi: pith.

B- Middle internode (6 weeks old)

The anatomical structure of the stem of six weeks old at the middle internode shows that the epidermal cells of *D.tatula* are nearly rectangular in shape. While, in the other three taxa; *D. metel*, *D. ferox* and *D.stramonium*. these cells were barrel in shape. The types of hairs on the epidermal cell surface are also varied from unicellular to multicellular or glandular hairs through *D. metel* and *D.ferox*. While it was difficult to detect any type of hairs on the epidermal cell surface of *D.tatula* and *D.stramonium* (Figure 5 a, b, c and d).

Table (4) shows the average measurements of different tissues of the stem at middle internode of the studied taxa. The results indicate that the whole stem diameter of *D.metel* (7020.10 µ) was the highest comparing by those of the other taxa, followed by *D. stramonium* (4843.30 µ), then *D.ferox* (4329.90 µ) and finally *D. tatula* (4193.60 µ). The same results obtained also with pith thickness (4880.00, 2980.00, 2552.00 and 2501.00 µ, respectively) and the average diameter of pith cell (57.00, 48.00, 46.70 and 42.80 µ, respectively) at the same order mentioned.

The total cortex thickness was 825.00 and 600.00 µ in both *D.metel* and *D.tatula*, respectively. The number of parenchyma layers at cortex area was also the same (9 layers) in the previous taxa. In contrast, there was no observed difference in total thickness and number of parenchyma layers of both *D.ferox* and *D.stramonium*.

Data in Table (4) also shows that, there are five collenchyma layers with very thick cell walls in the three taxa; *D.metel*, *D.ferox* and *D.tatula*. While the number of collenchyma layers of *D.stramonium* was six (Figure 5 a, b, and d). Meanwhile, the collenchyma thickness was not obviously varied among all the studied taxa.

Both internal and external phloem thickness of *D.stramonium* (99.00 and 154.00 µ) were the highest among all the other taxa, followed by *D.ferox* (97.60 and 120.00 µ). While, the variation in these thickness, as well as in xylem thickness, were not obvious between *D.metel* and *D.tatula* (66.40, 76.00 and 347.70 µ and 70.20, 86.00 and 336.00 µ, in the same order). Contrary, xylem thickness of *D.ferox* (488.00 µ) was the highest among the studied taxa, followed by *D.stramonium* (464.50 µ).

These results were in accordance with those obtained by El-Sayed (1978) and Anozie and Iwu (1989). While, Ahmed (1989) obtained different results.

3- Structure of the leaf.

Table (5) and Figure (6 a, b, c and d), show the anatomical structure of the leaf of the studied taxa. The data indicates that *D.metel* exceeded all the other taxa in the average thickness of palisade layer, spongy tissue, lamina, midvien, collenchyma above and below the main bundle, main vascular bundle, external and internal phloem and finally in xylem.

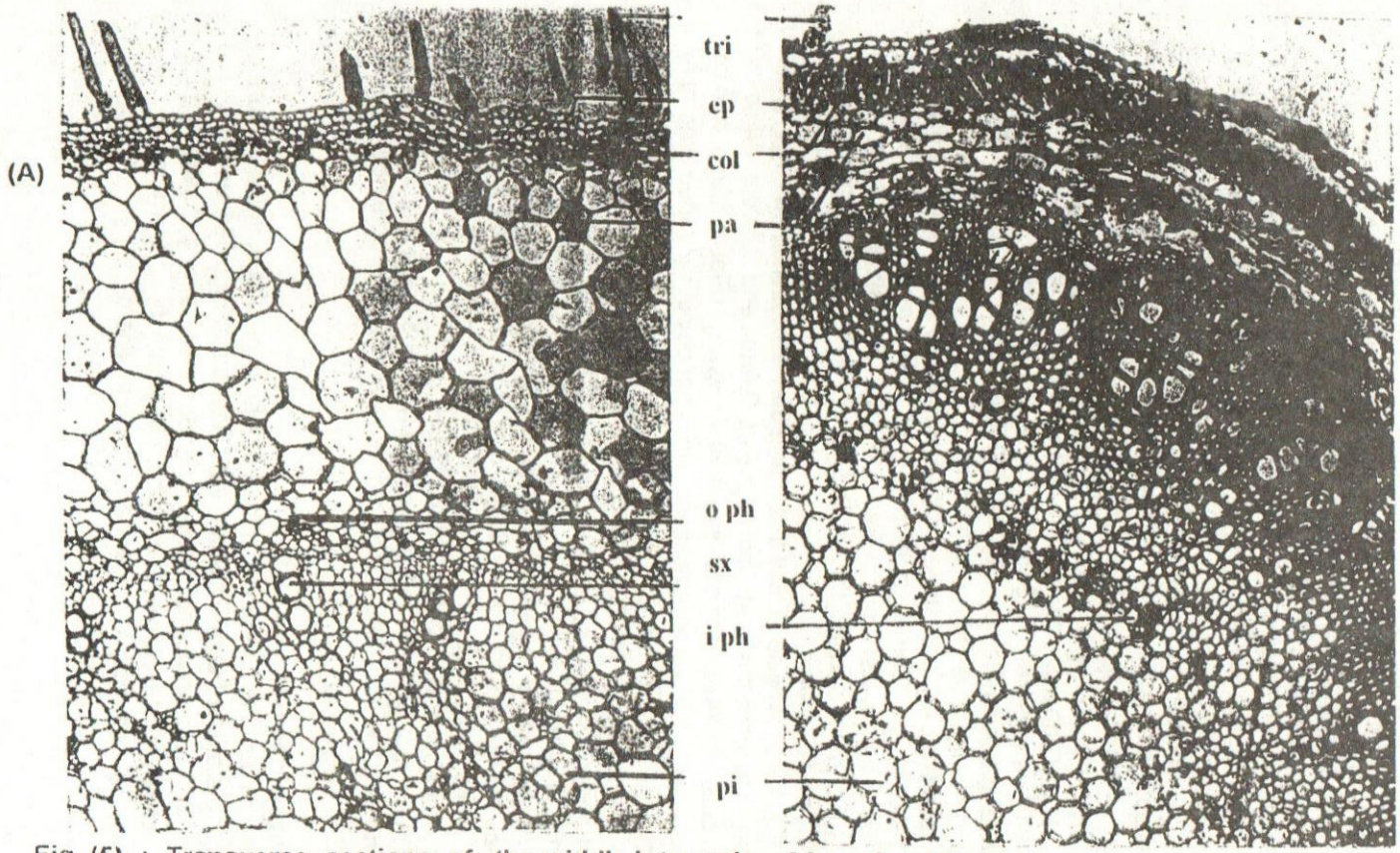
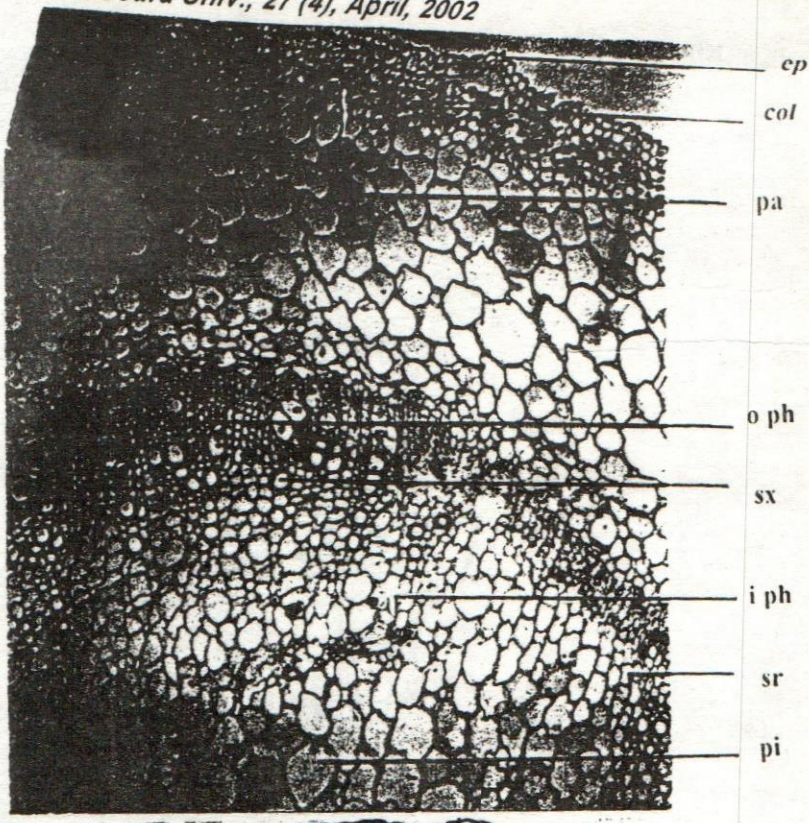
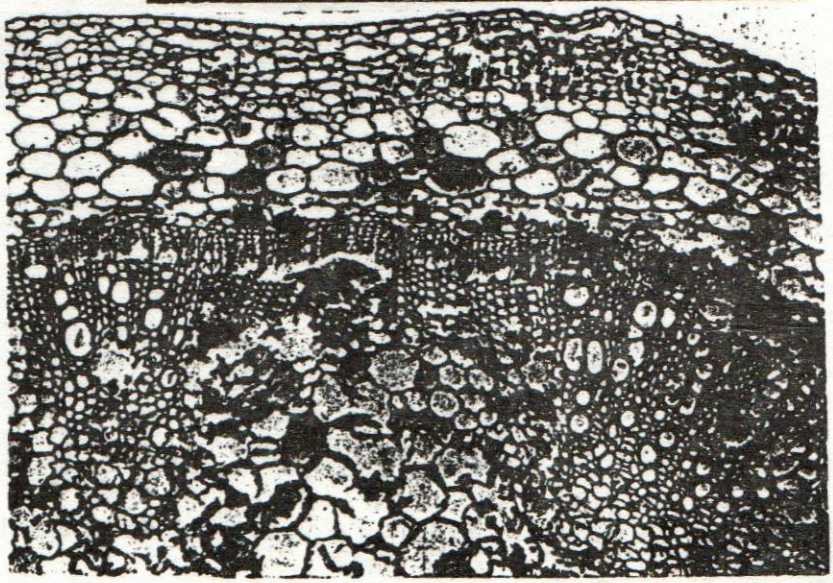


Fig. (5) : Transverse sections of the middle internode, of 6 weeks old of the main stem of *D.metel* L. (A) and *D.ferox* L. (B) showing the secondary structure (X 80).

Details: tri: trichomes; ep: epidermis; col: collenchyma; pa: parenchyma; o ph: outer phloem; sx: secondary xylem; i ph: inner phloem sr: secondary rays and pi: pith.



(C)



(D)

Fig. (5 cont.) : Transverse sections of the middle internode, of 6 weeks old of the main stem of *D.tatula* L. (C) and *D.stramonium* L. (D) showing the secondary structure (X 80).

Details: ep: epidermis; col: collenchyma; pa: parenchyma; o ph: outer phloem; sx: secondary xylem; i ph: inner phloem sr: secondary rays and pi: pith.

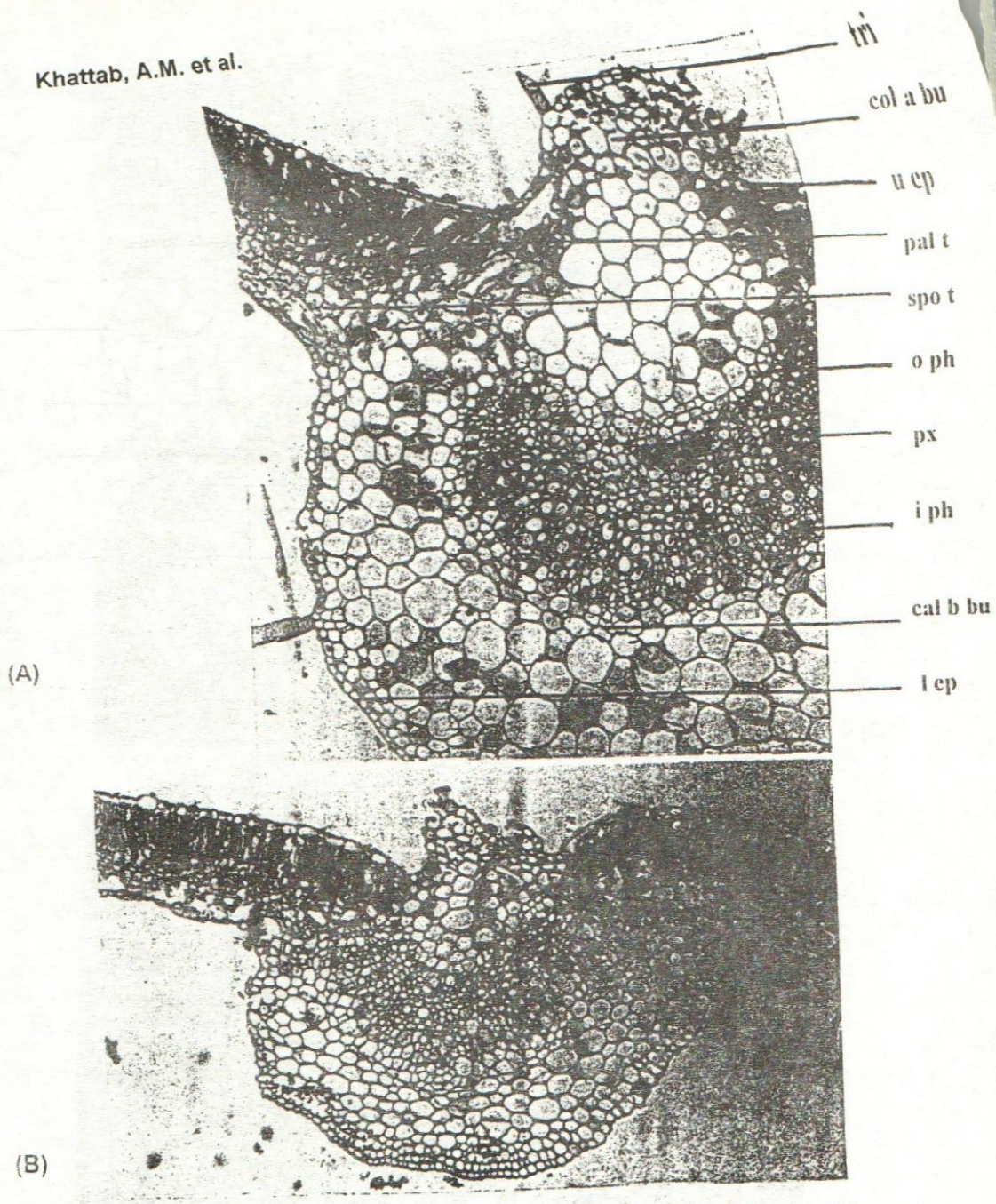


Fig. (6) : Transverse sections of the leaf of *D.metel* L. (A) and *D.ferox* L.(B) (X 80).

Details: tri: trichomes; col a bu: collenchyma above bundle; u ep: upper epidermis; pal t: palisade tissue; spo t: spongy tissue; o ph: outer phloem; i ph: inner phloem; px: primary xylem; col b bu: collenchyma below bundle and l ep: lower epidermis.

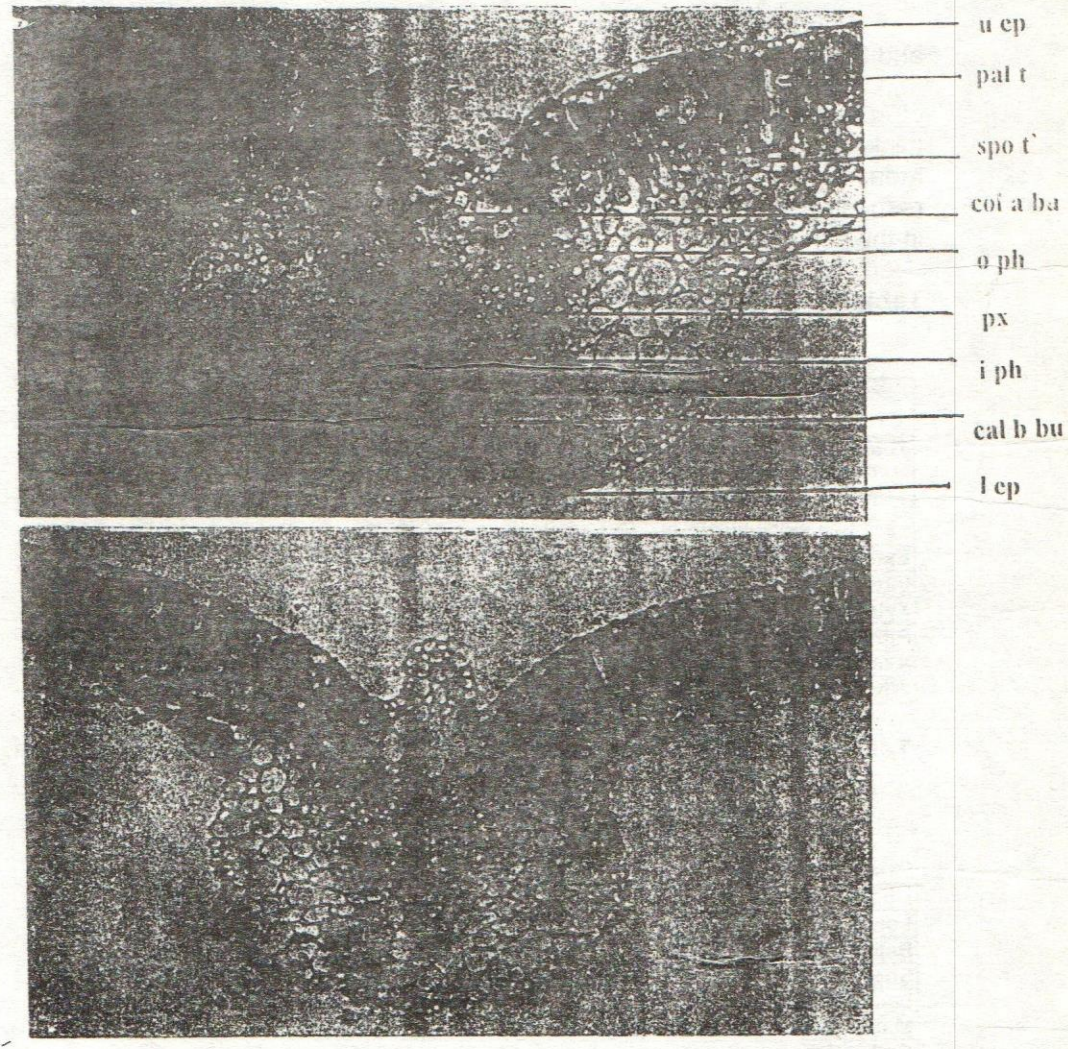


Fig. (6 cont.) : Transverse sections of the leaf of *D.tatula* L. (C) and *D.stramonium* L. (D) (X 80).

Details: u ep: upper epidermis; pal t: palisade tissue; spo t: spongy tissue; col a bu: collenchyma above bundle; o ph: outer phloem; i ph: inner phloem; px: primary xylem; col b bu: collenchyma below bundle; l ep: lower epidermis.

Where these thickness were 189.90, 195.50, 418.95, 2074.00; 213.50 and 60.00, 488.00; 1.0 and 67.00 and 213.50 µ, respectively.

Most of the average measurements of *D.ferox* were quite similar to those of *D.stramonium,* except the midvien thickness, main vascular bundle thickness and the collenchyma thickness above vascular bundle. Where, the measurements of these characters of *D.ferox* (1008.90, 244.60 and 152.50 µ, respectively) exceeded those of *D.stramonium* (894.50, 225.00 and 67.10 µ, in the same order).

Table (4): Measurements (µ) and counts of different tissues of the stem (middle internode–6 weeks old) of *D.metel* L., *D.ferox* L., *D.tatula* L.and *D.stramonium* L.(average of 10 readings).

Species / Characters	*D.metel*	*D.ferox*	*D.tatula*	*D.stramonium*
Total cortex thickness:	825.00	536.15	600.20	572.90
- Collenchyma thickness	140.60	160.10	162.20	142.00
- No. of parenchyma layers	9.00	6.00	9.00	6.00
- No. of collenchyma layers	5.00	5.00	5.00	6.00
External phloem thickness	76.00	120.00	86.00	154.00
Internal phloem thickness	66.40	97.60	70.20	99.0
Xylem thickness	347.70	488.00	336.00	464.50
Pith diameter	4880.00	2552.00	2501.00	2980.00
Average diameter of pith cell	57.00	46.70	42.80	48.00
Whole stem thickness	7020.10	4329.90	4193.60	4843.30

Table (5): Measurements (µ) and counts of different tissues of the leaf of *D.metel* L., *D.ferox* L., *D.tatula* L. *and D.stramonium* L. (average of 10 readings).

Species / Characters	*D.metel*	*D.ferox*	*D.tatula*	*D.stramonium*
Upper epidermis thickness	21.35	25.50	33.55	30.50
Lower epidermis thickness	12.20	27.50	15.25	12.40
Palisade layer thickness	189.90	134.20	176.90	146.40
Spongy tissues thickness	195.50	143.30	179.20	152.95
Lamina thickness	418.95	330.50	404.90	342.25
Main vascular bundle dimensions	488.00	244.60	219.60	225.00
Collenchyma thick. above bundle	213.50	152.50	46.10	67.10
Collenchyma thick below bundle	61.00	36.90	42.70	36.00
Midvien thickness	2074.00	1008.90	908.50	894.50
External phloem thickness	61.00	30.50	24.40	30.60
Internal phloem thickness	67.00	36.20	24.10	35.20
Xylem dimensions (length x width)	213.50	152.50	103.70	148.00

D.tatula exceeded *D.ferox* and *D.stramonium* in thickness palisade layer, spongy tissue and lamina, hence, the average measurements of these characters of these taxa were, 176.90, 134.20 and 146.40 µ; 179.20, 143.30 and 152.95 µ, and 404.90, 330.50 and 342.25 µ, respectively (Figure 6 a, b, c and d). Stomata of all the studied taxa of ansiocytic type and spread widely on the lower epidermis.

The present results on the structure of the leaf were in harmony with those obtained by El-Sayed (1978) and Anozie and Iwu (1989).

4- Structure of the floral bud

Transverse sections through the floral bud of the studied taxa shown in Figure (7 a, b, c and d). It is clear that the floral bud is surrounded by calyx which consists of five united sepals, each comprised of two epidermal layers and about 8 to 12 layers of ground tissues in between. There are numerous vascular traces which extending through the ground tissue. The corolla consists of five untied petals in a tube-shape forming a funnel shape. Each segment of corolla consists of two epidermal layers of nearly rounded-shaped cells surrounding 6 to 8 layers of slightly rounded parenchymatous cells forming the mesophyll of each petal.

The androecium consists of five separate stamens with regular filament in *D.metel* and irregular one in the other studied taxa. Filament has two epidermal cells with about 12 to 16 layers of parenchymatous cells in between. The filament of each stamen is united with the corolla from the lower part. Filaments have trichomes on the epidermal cells of *D.ferox*, *D. tatula* and *D.stramonium*, while absent in *D.metel*.

The gynoecium is comprised of four united carpels. The ovary is four locules in *D.metel*, *D.ferox* and *D.stramonium*, while it is one in *D.tatula*. Placentation is central. It is worthy to notice that the placenta of *D.metel* is enlarged and might branch and the ovules number also varied from 3 to 8 ovules among the other taxa. These findings are in accordance with El-Sayed (1978).

5- Structure of the fruit wall.

Morphologically, the fruit of all the studied taxa is simple, dry dehiscent, capsule and septifragal. There was no difference between the taxa concerning the anatomical structure of the fruit; hence, most of the structure of the species of the same genus is quite similar. The only difference noticed between the studied taxa was in the structure of fruit wall. So, it was necessary to apply sections in the fruit wall of these taxa. Figure (8 a, b, c and d) shows that all the taxa have trichomes on its epidermal surface, more desntely in *D.metel*, followed by *D.ferox*, while both *D.tatula* and *D.stramonium* were quite similar in the quantities of trichomes on its fruit surfaces. Generally, the structure of the fruit wall, in the studied taxa, has an epidermal cells of one layer and with or without many layers of compact parenchymatous cells with a very obvious nucleolus. The rest of cells of each section was parenchymatous cells.

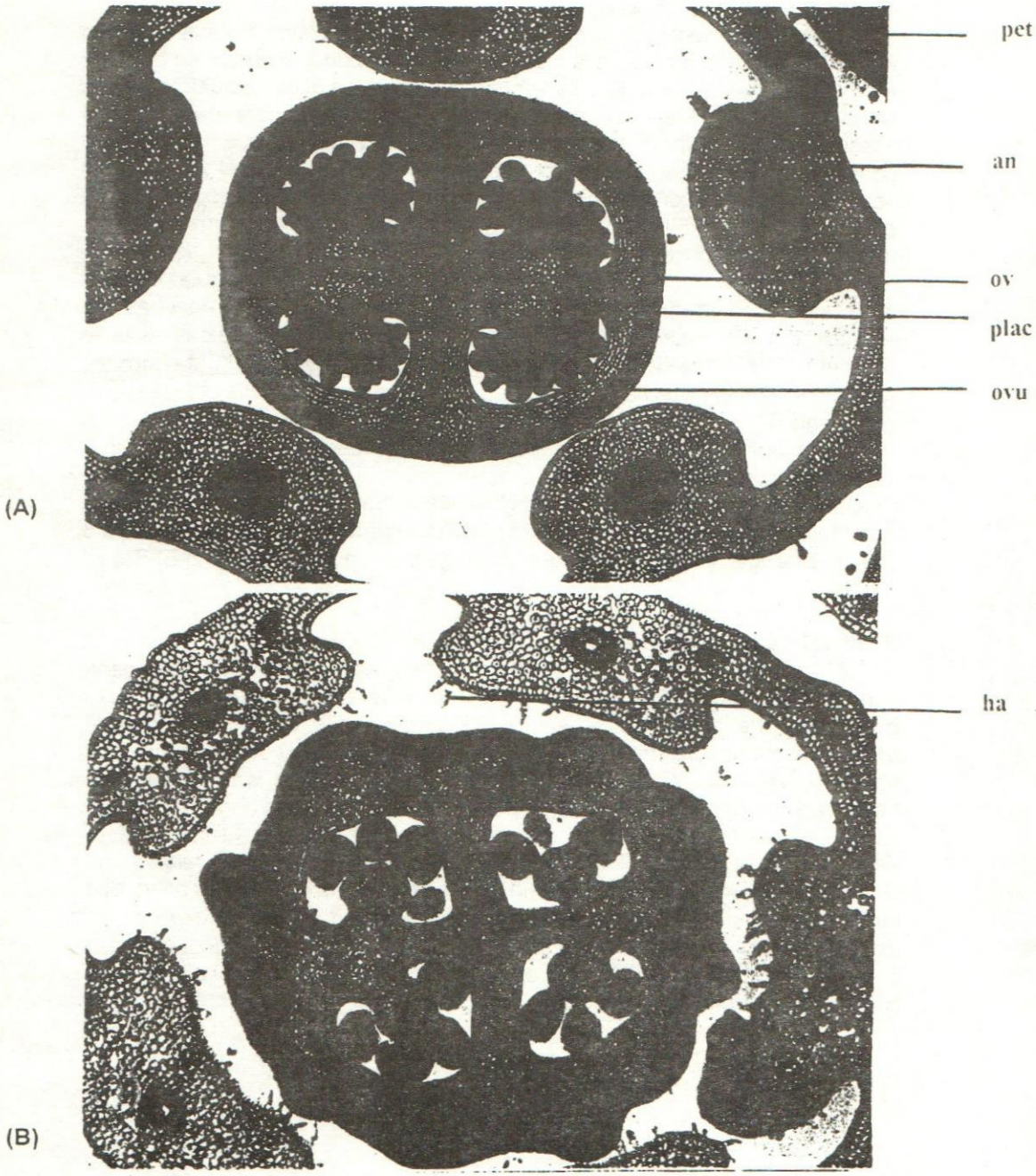


Fig. (7) : Transverse sections of the flower bud of *D.metel* L. (A) and *D.ferox* L.(B). (X 80).

Details: pet: petal; an: anther; ov: ovary; plac: placenta; ovu: ovule and ha: hairs

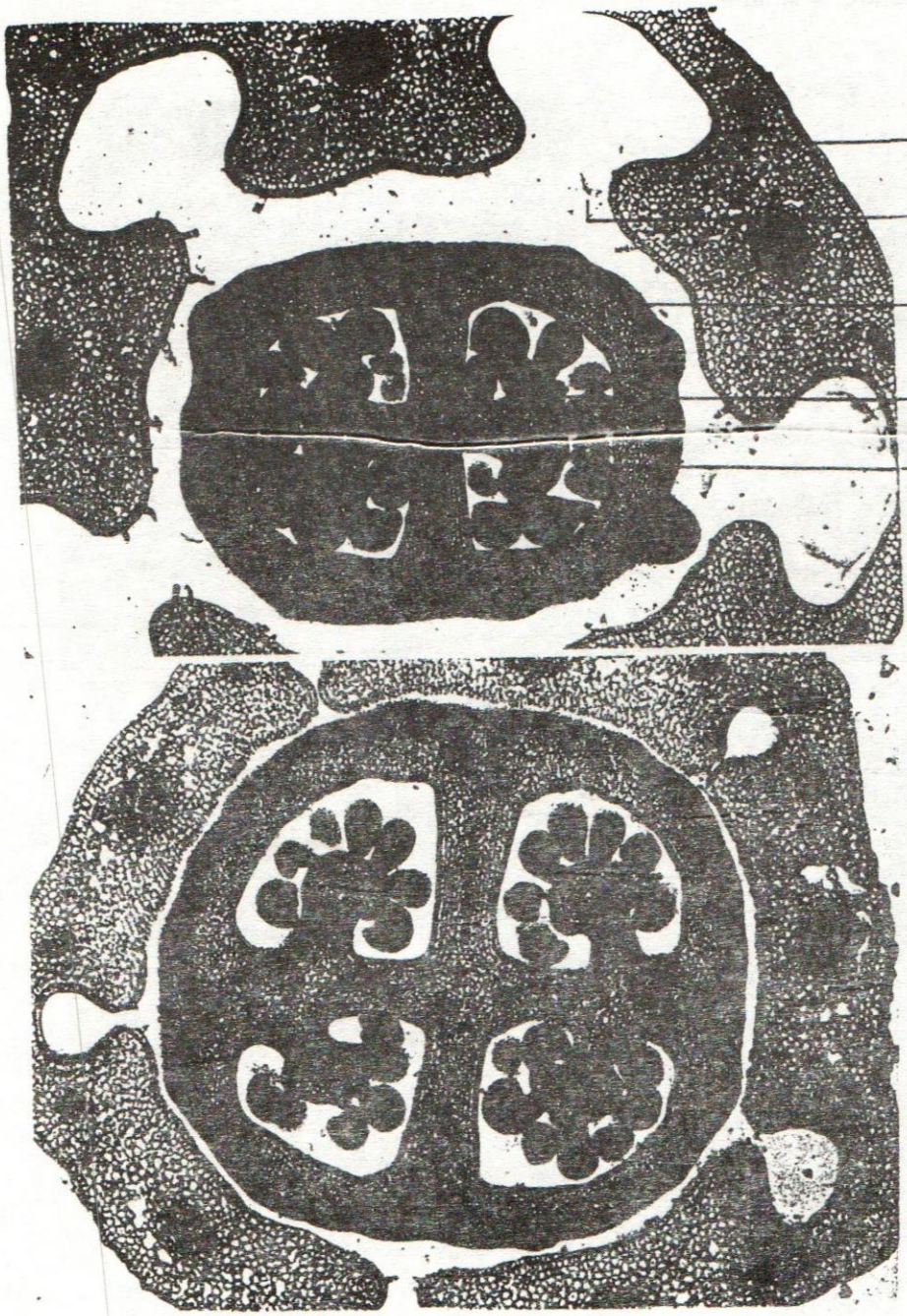


Fig. (7 cont.) : Transverse sections of the floral bud of *D.tatula* L. (C) and *D.stramonium* L. (D) (X 80).

Details: an: anther; ov: ovary; plac: placenta; ovu: ovule and ha: hairs

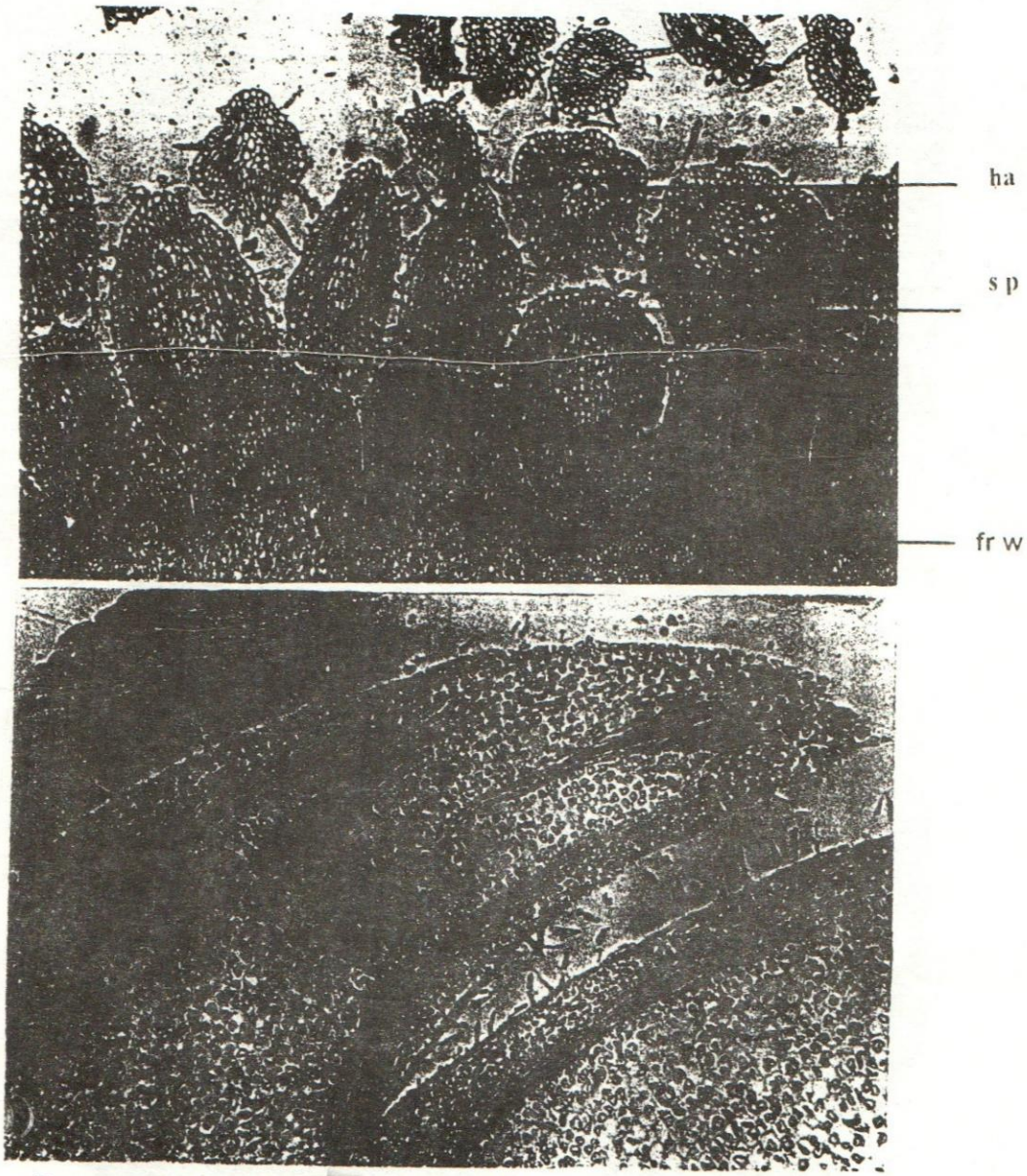


Fig. (8) : Transverse sections of the fruit wall of *D.metel* L. (A) and *D.ferox* L. (B). (X 80).
Details: sp: spine; ha: hairs and fr w: fruit wall.

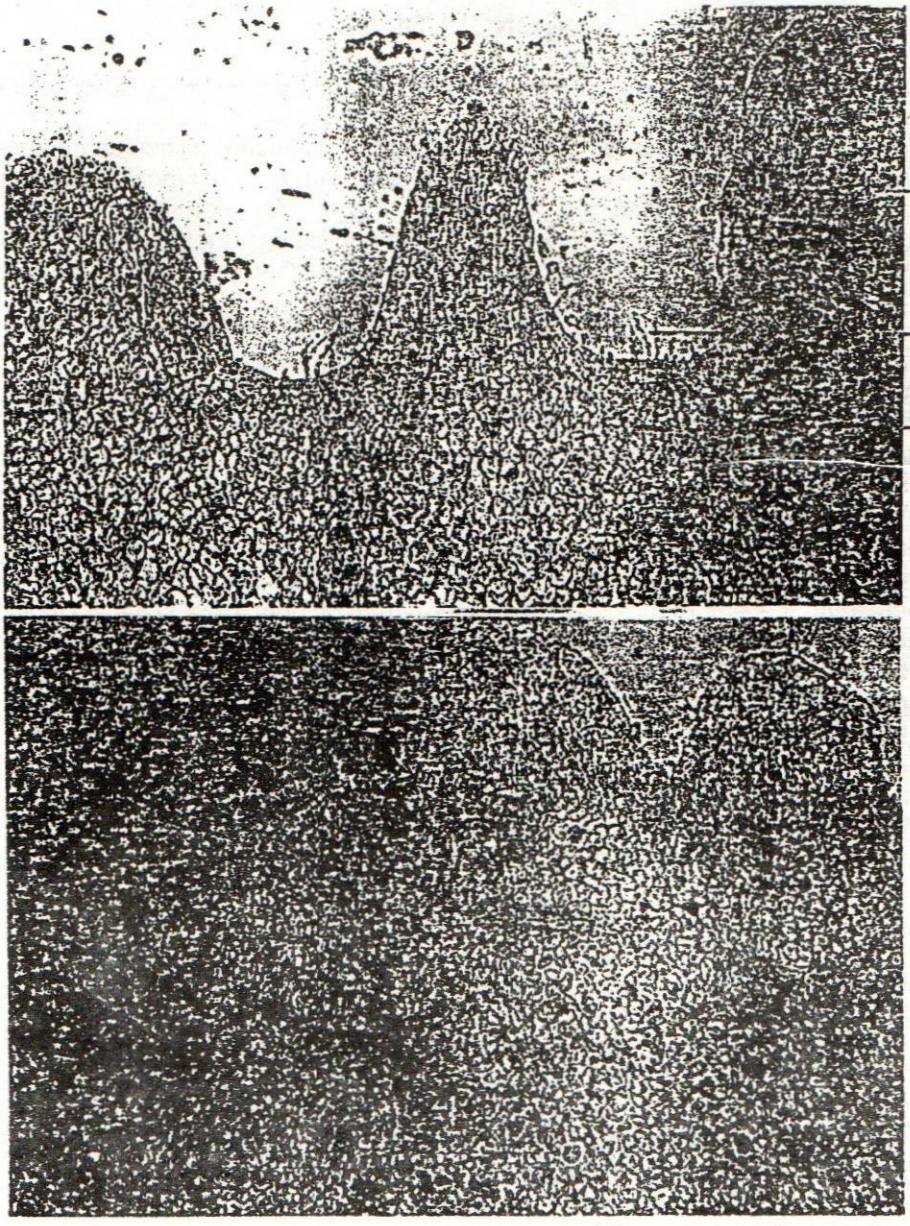


Fig. (8 cont) : Transverse sections of the fruit wall of *D.tatula* L. (C) and *D.stramonium* L. (D) (X 30).

Details: sp: spine; ha: hairs and fr w: fruit wall.

CONCLUSION

The obtained morphological (phenetical) and anatomical results, could be summarized as follows:

D.metel is considered a distinct species with some unique characters varied or exceeded those of the other studied taxa, *e.g.* fruit rachis is always curved downward during the fruit growth stage, root diameter, number of cortex layers of root, root xylem and phloem thickness, the majority of stem (middle and apical internodes at 6 weeks age) characters and all the leaf characters.

D.ferox is also characterized by some characters varied among the other taxa, *e.g.* fruit of obtuse-shaped, calyx is creamy coloured. While, *D.ferox* was exceeded *D.tatula* and *D.stramonium* in some characters, *e.g.* root diameter, root cortex thickness and xylem and phloem thickness of root. *D.ferox* and *D.tatula* were quite similar to each other in most of stem characters studied, while it was similar to *D.stramonium* in most of leaf characters.

D. tatula and *D. stramonium* are more closer to each other in many characters than to the other two taxa and it was difficult to distinguish between the morphological features of fruit of both taxa. The similarity between *D.tatula* and *D.stramonium* was found in most root characters and some stem and leaf characters. These results of similarity between *D.tatula* and *D.stramonium* came in harmony with the great deal of evidence that they are variants of the same species and as it is often impossible in published records to disentangle the one from the other. The evidence deals with the two together under the same of *D.stramonium* suggesting that *D.stramonium* might be recognized as white stramonium and *D.tatula* as purple stramonium. The results of this study support this suggestion.

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دراسات مورفولوجية وتشريحية على بعض الفئات التصنيفية من جنس الداتورا *Datura* (الفصيلة الباذنجانية)

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أجريت هذه الدراسة خلال عامي ٢٠٠٠- ٢٠٠١ على أربعة أنواع تنتمي الي جنس الداتورا وهم: *D.metel* L. , *D.ferox* L., *D.tatula* L. and *D.stramonium* L.
بغرض مقارنة الصفات المورفولوجية والتشريحية بين الأنواع تحت الدراسة لمعرفة درجة القرابة والتشابه بينها عامة وبين النوعين *D. tatula* and *D.stramonium* خاصة لما أثير من جدل حول الوضع التقسيمي لهما.

أوضحت النتائج المتحصل عليها من القياسات والدراسات المورفولوجية والتشريحية مايلي:

١- تفوق النوع *D.metel* في العديد من الصفات المورفولوجية والتشريحية على الأنواع الأخرى المدروسة مثال: كبر حجم الزهرة , الثمرة كروية , انحناء عنق الثمرة لاسفل , كثرة الأشواك الخارجية على الثمرة بالإضافة الي الزيادة في قطر الجذر والاسطوانة الوعائية ونسيج الخشب مع زيادة قطر الساق الناتجة عن زيادة عدد طبقات القشرة وقطر النخاع وزيادة متوسط سمك نصل الورقة نتيجة للزيادة في سمك النسيج العمادى والإسفنجي و زيادة قطر الحزمة الوعائية الوسطية نتيجة زيادة كميات الخشب واللحاء الداخلي والخارجي.

٢- تميز النوع *D.ferox* أيضا ببعض الصفات المورفولوجية والتشريحية عن بقية الأنواع المدروسة الأخرى ولكنة كان دائما أقل من النوع *D. metel* في غالبية قياسات الصفات المدروسة وأهمها أن ثمرته غزيرة الشعيرات والثمرة بنية اللون. كما تفوق هذا النوع على النوعين *D. tatula* and *D.stramonium* في الصفات التشريحية للجذر مثل: زيادة قطر الجذر نتيجة زيادة سمك القشرة وعدد طبقاتها وزيادة سمك نسيجي الخشب واللحاء. وتشابة كل من *D. ferox* and *D.tatula* في عدد من الصفات مثل قطر الاسطوانة الوعائية وكذلك سمك نسيج البريدرم.

٣- كان النوعين *D. tatula* and *D.stramonium* أكثر الأنواع المدروسة تشابها لبعضهما البعض. حيث كان من الصعوبة التميز بينهما من الناحية المورفولوجية. وتشابه النوعين في العديد من الصفات مثل: خلايا البشرة البرميلية الشكل , شكل البذرة القلبي , متوسط كثافة الشعيرات علي الثمرة , سمك قشرة الجذر والاسطوانة الوعائية واللحاء. وكذلك سمك طبقة القشرة نتيجة زيادة عدد برانشيمة القشرة والخلايا الكولنشيمية أسفل البشرة. أما التشابه في الصفات التشريحية للجذر بين النوعين السابقين كان في سمك النصل عامة وسمك العرق الوسطي نتيجة سمك الاسطوانة الوعائية وزيادة سمك كل من نسيجي اللحاء الداخلي والخارجي وكذلك نسيج الخشب.

مما سبق يتضح من الدراسات المورفولوجية والتشريحية أن النوع *D. metel* يعتبر مستقلا عن بقية الأنواع المدروسة الأخرى ويمكن تميزة بسهولة. كذلك يتضح أن النوعين *D.tatula* and *D.stramonium* أكثر الأنواع تشابها لبعضهما البعض ويمكن اعتبارهما نوعاً واحداً مع ترجيح الاسم المقترح من قبل لهما وهو White stramonium and purple stramonium على النوعين *D. stramonium* and *D.tatula* على التوالي. كما جاء النوع D. ferox في مركزاً وسطاً في معظم الصفات بين النوع *D.metel* من ناحية والنوعين *D.tatula* and *D.stramonium* من الناحية الأخرى.