Chapter 4

Discussion

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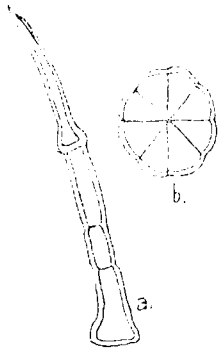
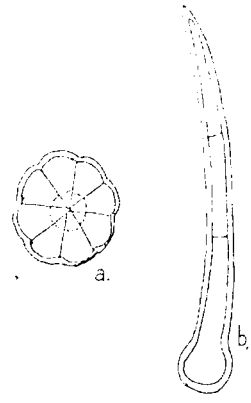
The contribution of present project to the field of taxonomy especially that of floristics is of great importance. The 400 Line drawings of plants showing distinct and characteristic features of each plant will help students of taxonomy to understand the plants correctly and group them. Most of these plants are illustrated for the first time. This will act as a guide to the students in the field, where the characters presented in the book will give the distinctive features of the plants in question. Even to the teachers of taxonomy, this report will be of immense help in understanding the plants. The elaborate and extensive database on the micromorphological characters of 400 taxa are made available for the first time and this will be of immense importance in identifying almost all these plants even in the vegetative states. In case of economically useful plants such as drug plants or narcotics, these characters will be of great significance in identifying the raw material or adulteration, as these characters are observable under microscopes. This data will be useful in identifying the adulterant plants also.

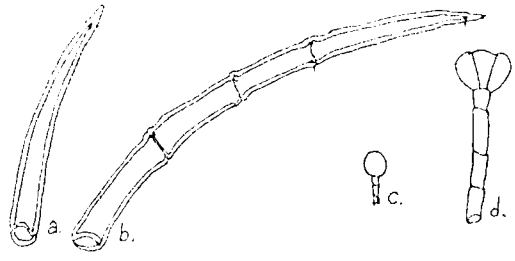
The micromorphological characters especially those of trichomes are found to be of great use in classifying and identifying taxa at various levels of hierarchy. The two papers already published; **1) Foliar trichomes of some members of the family Acanthaceae and their taxonomic utility** (*Int. J. Pharma and Bio* Sci. **2** (3), 2011, 231-235.) **and 2) Foliar micromorphological studies on some members of the family Fabaceae** (*Int. J. Pharma and Bio. Sci.* 2 (4), 2011, 603-611) are clear examples of this fact. In the first paper, 13 members of the family Acanthaceae had been studied for their foliar trichomes, to examine their utility in identification. Out of the 13 plants studied, two plants, *Daedalacanthus roseus* Anders. and *Rungia parviflora* var. *pectinata* Nees. were found to be glabrous. Of the remaining 11 plants, 6 possessed glandular trichomes and each of these trichomes was found to be different from those of others. Of the plants containing glandular trichomes, both *Ecbolium linneanum* Kurz. *Asteracantha longifolia* Nees. contained sessile, disc shaped glands with 4-8 cells. Both contained a non-glandular uniseriate trichome also. But the uniseriate trichomes of *Ecbolium linneanum*



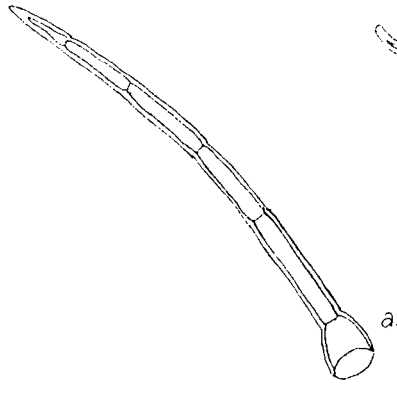
Echolium linneanum Kurz.
a. non-glandular multicellular uniseriate trichome
b. glandular sessile trichome.



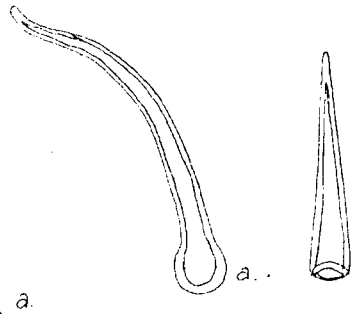
Asterecantha longifolia Nees.
a. glandular sessile trichome
b. non-glandular multicellular uniseriate trichome



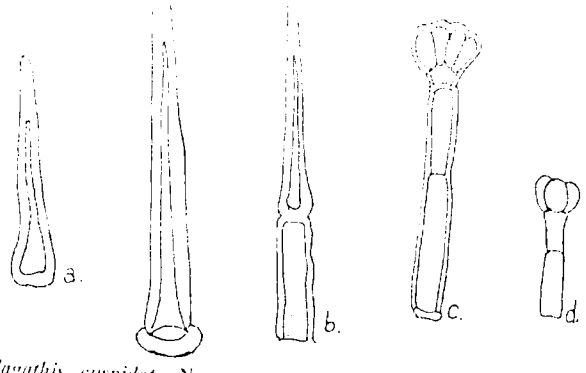
Hygrophila serpyllum Anders. a. non-glandular unicellular trichome b. non-glandular multicellular uniseriate trichome c. glandular with one celled head and 2-celled stalk trichome d. glandular with 4-celled head and 4-celled stalk trichome.



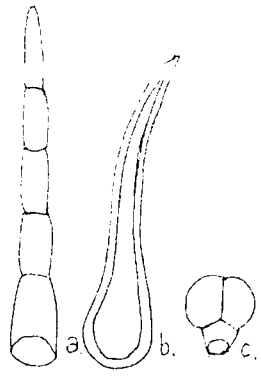
Justicia diffusa Willd. a. non-glandular multicellular uniseriate trichome



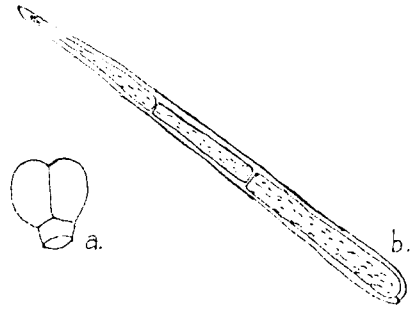
Lepidagathis fasciculata Nees a. non-glandular unicellular trichome



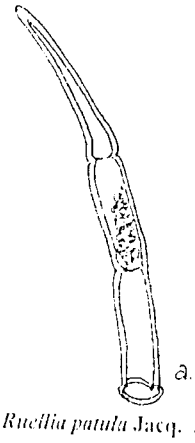
Lepidagathis cuspidata Nees. a. non-glandular unicellular trichome, b. Non-glandular two celled trichome, c. glandular trichome with 4-celled head and 2-celled stalk, d. glandular trichome with 4 celled head and 2-celled stalk.



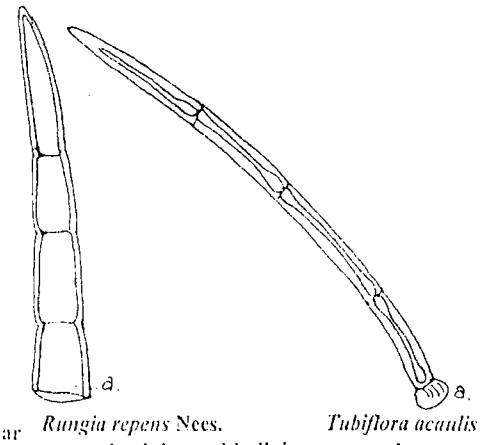
Neuracanthus sphaerostachys Dalz.
a. non-glandular multicellular uniseriate trichome, b. non-glandular unicellular trichome, c. glandular trichome with 2-4 celled head and a single celled stalk.



Adhatoda zeylanica Medic. a. glandular trichome with 2-4 celled head and a single celled stalk, b. non-glandular multicellular uniseriate trichome.



Ruellia patula Jacq. a. non-glandular multicellular uniseriate trichome



Rungia repens Nees.
a. non-glandular multicellular uniseriate trichome

Tubiflora acaulis Kuntz.
a. non-glandular multicellular uniseriate trichome

Fig. 1. (Contd.)

had the apical cell which is long and swollen at the base. All the remaining four plants contained stalked glandular trichomes. The glandular trichomes of *Adhatoda vasica* Nees. and *Neuracanthus sphaerastachys* Dalz. were having a single celled stalk and 4 celled head but later plant possessed unicellular trichomes also. In *Lepidagathis cuspidata* Nees. and *Hygrophila serpyllum* Anders. there were two types of glandular trichomes. The large trichome of *Lepidagathis cuspidata* Nees. had 2 celled stalk (with thick walls) and 4 celled head. But in glands of *Hygrophila serpyllum* Anders. the stalk was 4-celled. The small trichome of the former possessed four celled head while that of latter had a single celled head.

Unicellular trichome was the only type of trichome in *Lepidagathis fasciculata* Nees. The remaining 5 plants contained uniseriate 3-4 celled long trichomes. These trichomes were distinguished by the thickening of the trichome walls. Both *Ruellia patula* Jacq. and *Rungia repens* Nees. had broader cells in trichomes. But the former plant contained a number of cells inclusions, while such type of inclusions were not observed in the latter. Of the remaining 2 plants *Tubiflora acaulis* Kuntz. and *Justicia diffusa* Willd., the trichome of the former plant had very thick walls and very narrow lumen whereas that of *Justicia diffusa* Willd. had a swollen basal cell.

An artificial key using trichome character for the identification of some species belonging to the Acanthaceae is prepared and presented below.

1. Plants glabrous.....*Daedalacanthus roseus* Anders and *Rungia parviflora* var. Nees.

1. Plants with trichomes:

2. Glandular trichome present, non-glandular trichome present or absent:

3. Glandular trichome sessile;

4. Non-glandular trichome 3-celled with upper cell long and swollen at the base.....*Ecbolium linneanum* Kurz.

4. Non-glandular trichome 3-celled without any cell being swollen.....*Asteracantha longifolia* Nees.

3. Glandular trichome stalked:

5. Stalk of glandular trichome unicellular

6. Unicellular non-glandular trichome present .....

Neuracanthus sphacelostachys Dalz.

6. Unicellular trichome absent.....*Adhatoda zeylanica* Medic.

5. Stalk multicellular:

7. Stalk 2-celled.....*Lepidagathis cuspidata* Nees.

7. Stalk more than 2-celled.....*Hygrophila serpyllum* Anders.

2. Glandular trichome absent:

8. Non-glandular trichome unicellular.....

Lepidagathis fasciculata Nees.

8. Non-glandular trichome multicellular:

9. Cells broad:

10. Cells with brown contents.....*Ruellia patula* Jacq.

10. Cells empty.....*Rungia repens* Nees.

9. Cells narrow:

11. Cell wall thick, lumen very narrow.....*Tubiflora acaulis* Kuntz.

11. Cell wall thin, with swollen basal cell.....*Justicia diffusa* Willd.

In case of the second paper, the **distribution and characteristics of trichomes in 24 members of the Fabaceae** are presented. Out of the total 29 plants studied, five plants viz. *Canavalia ensiformis, Aeschynomene indica, Desmodium gangeticum, Rhynchosia bracteata* and *Sesbania aculeata* are found glabrous. Of the remaining 24 plants with trichomes, seven possessed various unicellular and multicellular glandular trichomes. Unicellular glandular trichomes were seen in three plants, i.e., *Alhagi camelorum, Crotalaria retusa* and *Clitoria ternatea. Alhagi camelorum* possessed oblong thin walled trichome whereas *Crotalaria retusa* had spindle shaped (pointed at the ends) trichome (Fig I and II). In *Clitoria ternatea* elongated obovate trichome was present with slightly warty walls. Glandular trichomes of the remaining four plants were multicellular differentiated into a head and a stalk or sessile. The trichome of *Dolichos lablab* had a biseriate two or four tiered head and a single celled stalk. In addition, this plant contained two types of non-glandular trichomes; one unicellular and the other linear and three-celled. The unicellular trichome here was curved at the tip while the three-celled

trichome had a very long apical cell and two-square shaped lower cells. The glandular trichomes of *Desmodium velutinum* had one or three tiered heads. This plant also possessed characteristic non-glandular trichomes having single basal cell and very long narrow pointed apical cells, which were smooth or warty. The glandular trichomes of *Desmodium triflorum* had two-celled head. The non-glandular trichomes of this plant were of two types; one two-celled with a spreading small basal cell and a narrow pointed apical cell. The second type of trichome was unicellular and curved. Trichomes of the fourth plant *Teramnus labialis* were sessile, flat, linear and four-celled.

All the remaining 17 plants possessed only non-glandular trichomes. The four species of *Indigofera* were characterized by medifixed hairs (Fig. I). The hairs of each of these plants were distinct in one or other features. The hair in *Indigofera trita* had a thick and papillate wall and very broad lumen. *Indigofera cordifolia* possessed 'L' shaped medifixed hairs having one arm shorter than the other, though 'V' shaped trichomes also were present. They had warty thick walls and broad lumen along with conical tips and a distinguished circular base point by which they were attached. In addition, the plant contained a non-glandular unicellular trichome. The trichomes of other species of *Indigofera; I. tinctoria* and *I. enneaphyla* had thick warty walls with broad lumen. Both these species had flat, sessile, medifixed hairs, but that of *I. enneaphyla* was constricted in the middle (both arms almost spindle shaped) and more warty compared to that of *I. tinctoria* where the middle portion of hair was the broadest.

Of the remaining 13 plants, three, *Tephrosia villosa, Stylosanthes hamatus, and Pongamia pinnata* possessed a very characteristic two-three celled trichome, having one or two basal square or rectangular cells and a long pointed apical cell. A number of trichomes of *Tephrosia villosa* had an oblique partition wall separating the two basal cells. This plant, in addition, contained a unicellular long pointed warty trichome having a marked curve at the base also. *Stylosanthes hamatus* possessed a three-celled trichome in which the middle cell was rectangular filled with yellowish brown inclusions and a basal oval cell. Large prismatic crystals, one each in every epidermal cell, were another added feature of this plant. *Pongamia pinnata* possessed a trichome similar to that of *Tephrosia villosa* but the entire structure was wavy in appearance.

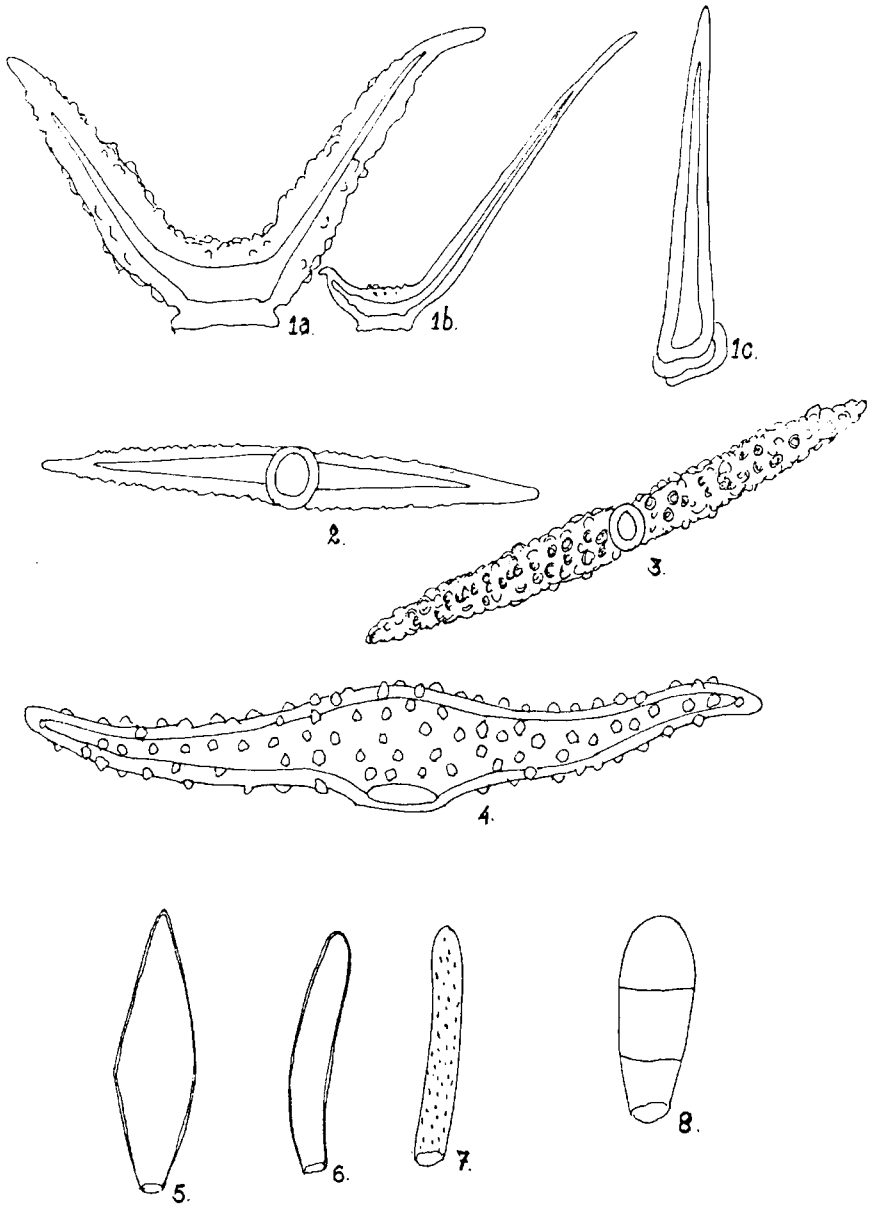


Fig. I. Different type of medifixed hairs and glandular hairs

1. *Indigofera cordifolia* a. medifixed hair b. medifixed hair with one arm short c. unicellular non-glandular hair.
2. *Indigofera tinctoria* medifixed hair.
3. *Indigofera enneaphylla* medifixed hair.
4. *Indigofera trita* medifixed hair.
5. *Crotalaria retusa* glandular unicellular spindle shaped trichome.
6. *Alhagi camelorum* glandular unicellular oblong trichome.
7. *Clitoria ternatea* glandular unicellular oblong pitted trichome

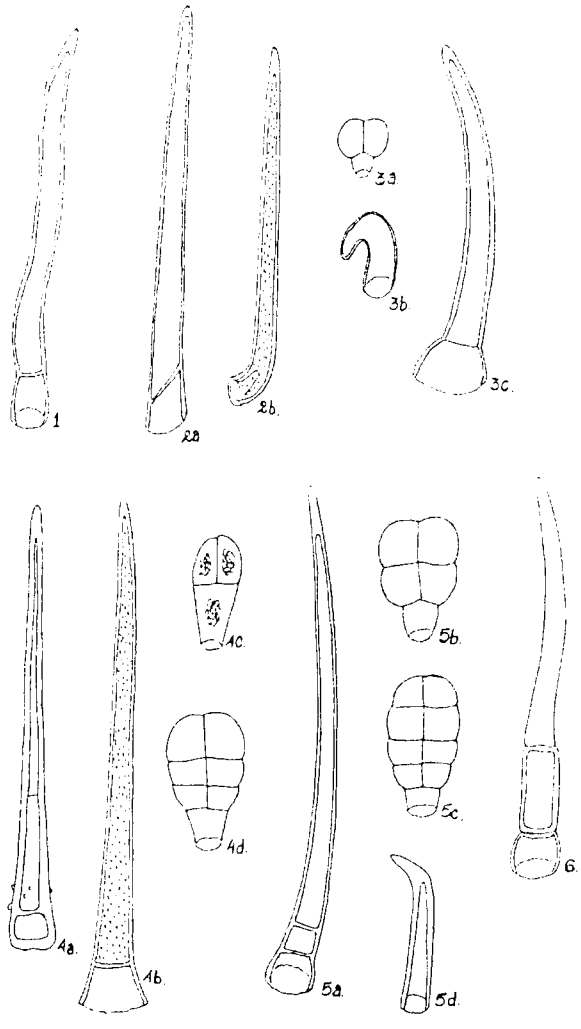


Fig. II. Non-glandular two-three celled trichome with some glandular trichomes.

1. ***Pongamia pinnata*** non-glandular multicellular, two-celled trichome.
2. ***Tephrosia villosa*** a. non-glandular multicellular, two-celled trichome b.unicellular non-glandular trichome with pitted wall.
3. ***Desmodium triflorum*** a. glandular multicelluar trichome with two-celled head and a single celled stalk b. unicellular non-glandular trichome with a curve at tip c. non-glandular two-celled trichome.
4. ***Desmodium velutinum*** a. non-glandular multicellular, two-celled trichome with thick and smooth wall b. non-glandular multicellular, two-celled trichome with thick and warty wall; basal cell small and spreading
   c. glandular multicellular trichome with biseriate two celled head and a single celled stalk d. glandular multicellular trichome with biseriate three-tiered 12-celled head and a single celled head
5. ***Dolichos lablab*** a. non-glandular multicellular three-celled trichome; with two basal small cell and a long upper cell b. glandular multicellular trichome with biseriate two-tiered eight celled head and a single celled stalk c. glandular multicellular trichome with biseriate four-

Of the remaining 10 plants, six showed simple unicellular trichomes with a flat base and whereas those of other four plants possessed a round base (Fig. III). Trichomes of the former group were pitted or smooth walled. Pitted walls were present in three, *Tephrosia tenuis, Crotalaria sericea* and *Mucuna pruriens*. *Tephrosia tenuis* had a trichome with an extended apiculate tip whereas *Mucuna pruriens* possessed smooth walled and barbed walled trichome in addition to pitted walled trichome. Remaining plants having trichomes of flat base, i.e., *Crotalaria hirsuta, Crotalaria leptostachya* and *Sesbania grandiflora* had smooth wall. Of these, *Sesbania grandiflora* contained some cell inclusions at the base. The trichomes in *Crotalaria hirsuta* had broad lumen. The remaining four plants containing unicellular trichomes with round bases were *Crotalaria medicaginea, Alysicarpus vaginalis, Tephrosia purpurea* and *Melilotus indica*. Of these, *Crotalaria medicagenia* had papillate walls and rest had smooth walls. Trichomes of both *Alysicarpus vaginalis* and *Tephrosia purpurea* had broad lumen, but the walls of the latter plant were very thick when compared to that of the former. The trichomes in *Melilotus indica* possessed a narrow lumen and thick wall.

Artificial key for identification of some members of the Fabaceae based on trichome characters:

1. Plant tomentose/hirsute; with glandular and/or non-glandular trichomes:
    2. Glandular trichomes present:
        3. Glandular trichomes unicellular:
            4. Wall of the trichomes warty (pitted).....***Clitoria ternatea* L.**
            4. Wall of the trichome smooth:
                5. Glandular trichome spindle shaped (pointed at both ends).....
                ***Crotalaria retusa* L.**
                5. Glandular trichome oblong.....***Alhagi camelorum* Fisch.**
        3. Glandular trichome multicellular:
            6. Trichome differentiated into head and stalk:
                7. Head two celled:
                    8. Stalk of the trichome broad merging with the head making the trichome club shaped.....***Desmodium velutinum* DC.**

8. Trichome differentiated into a broad two-celled head and a narrow one-celled stalk.....*Desmodium triflorum* **DC.**

7. Head multicellular.....*Dolichos lablab* **L.**

6. Trichome multicellular sessile.....*Teramnus labialis* **(L.f.) Spreng.**

2. Glandular trichome absent; non-glandular trichome present:

9. Non-glandular trichome unicellular:

10. Trichome medifixed:

11. Medifixed type of trichomes only present:

12. Trichome wall papillate.....*Indigofera trita* **L.**

12. Trichome Wall warty:

13. Ends of the trichome broad.....*Indigofera enneaphylla* **L.**

13. Ends of the trichome conical.....*Indigofera tinctoria* **L.**

11. Medifixed hair present along with unicellular simple trichome.....*Indigofera cordifolia* **Heyne. ex Roth.**

10. Trichome linear, not medifixed:

14. Unicellular trichome without any swollen base:

15. Wall warty or pitted:

16. Tip of the trichome apiculate.....*Tephrosia tenuis* **Wall. ex Dalz.**

16. Tip of the trichome simple conical:

17. Only one type of pitted unicellular trichome.....

Crotalaria sericea **Retz.**

17. Three type of unicellular trichome; one pitted; second smooth walled and third barbed walled.....*Mucuna pruriens* **DC.**

15. Wall smooth:

18. Lumen empty throughout the trichome:

19. Wall thick; lumen narrow.....*Crotalaria leptostachya* **Benth.**

19. Wall thin; lumen broad.....*Crotalaria hirsuta* **Willd.**

18. Lumen containing cell inclusions at the base.....

Sesbania grandiflora **Poir.**

14. Unicellular trichome with a swollen base:

20. Wall of the trichome warty (papillate); lumen broad.....

Crotalaria medicagenia **Lamk.**

20. Wall of the trichome smooth:

21. Lumen broad.....*Alysicarpus vaginalis* **DC.**

21. Lumen narrow:

22. Wall very thick.....*Tephrosia purpurea* **Pers.**

22. Wall thin: lumen very narrow at apex.....
Melilotus indica (L.) All.

9. Non-glandular trichome two or three celled:

23. Trichomes homogenous:

24. Two celled trichome.....*Pongamia pinnata* Pierre.

24. Three celled trichome .....*Stylosanthes hamatus* Taub.

23. Trichomes of two types; unicellular pitted trichome and 2-celled trichome.....*Tephrosia villosa* Pers.

1. Plants glabrous.....*Sesbania aculeata* Poir., *Canavalia ensiformis* DC., *Rhynchosia bracteata* Benth., *Desmodium gangeticum* DC. and *Aeschynomene indica* L.

The above mentioned cases are just two examples in which the trichome/gland characters can be used effectively in identifying plants even in the absence of flowers or fruits. The dichotomous keys prepared are very easy to understand. Similar studies among all the families will provide excellent taxonomic data which can be used effectively. The utility of these characters is so pronounced that they can be incorporated in classical dichotomous keys. Similarly, the description of a taxon/plant will be more effective if these characters are included. Such studies should be an indispensible and mandatory part of every taxonomic study.

The two examples cited above, clearly bring out the taxonomic utilitarian aspects of the trichome characters. Such keys of identification are possible in all the major families of angiosperms. This will increase the data based on which even the classification can be proposed. But, more data involving almost all the plants or representative taxa are needed before such a venture.

The 11 cases of **bioprospecting** also provided much needed data on the new sources of useful phytochemicals. The new source plants of bioflavonoids are *Alternanthera sessilis* Linn. (DC), *Alternanthera bettzickiana, Ageratum conyzoides, Riedleia corchorifolia, Hygrophila schulli,* and *Bombax ceiba* and the bioflavonoids identified are luteolin, 4'-OMe luteolin, 3'-OMe quercetin, isorhamnetin, 6-hydroxy 4'-methoxy apigenin, 6-hydroxy, 7, 4'-dimethoxy apigenin, quercetin, kaempferol and acacetin and a glycoflavone, ie., 6-C glucosyl acacetin.

The new sources of volatile oil identified are *Stemodia viscosa*, *Stemodia serrata*, and *Ageratum houstanianum*, and the monoterpenes identified are eugenol, aceteugenol, precocene-II, demethoxy ageratochromene, caryophyllene and alpha-cubebene.

New sources of important quinones like emodin and aloin are found to be the flowers of *Aloe* which normally are discarded considered worthless.

A new source of dietary fibre/mucilage also is located in the present study and *i.e.*, the flower calyces of *Bombax ceiba* which also was considered a waste. Another discovery is the location of new sources of fixed oils and they are seeds of *Aloe barbadensis* and *Balanites aegyptiaca*.

The results discussed above are highly encouraging. All the 11 plants screened provided useful phytochemicals and this can be profitably counted as alternate sources of these chemicals. Similar studies are to be conducted on all the wild relatives of useful plants and such efforts will be highly rewarding in terms of unexplored world of useful phytochemicals.