Importance of epidermal features including the morphology of stomata and trichomes have received wide recognition. Cuticular morphology as a diagnostic character in taxonomy and phylogenetic studies have been amply demonstrated in Gymnosperms by Thomas and Bancroft (1913), Florin (1931, 1933 and 1936), Harris (1932, 1964, 1966) and recently by Pant & Nautiyal (1963) and Pant (1974). Whereas in Angiosperms these characters have been utilised as a valuable supplementary evidence for delimiting taxa of different rank and in phylogenetic considerations of different groups of plants by Netolitzkey (1932), Rao (1939), Foster (1949), Metcalfe & Chalk (1957), Hall & Melville (1951), Carolin (1954), Watson (1962, 1965), Ahmed (1964a,b,c,d), Stace (1961, 1965) and others. Stebbins & Khush (1961) suggested that stomatal morphology may lend better understanding in evolutionary sequences in species and generic groups of Monocotyledonous plants where cytological and other methods cannot be applied.

In view of the scanty information available (Metcalf & Chalk, 1957; Sen 1958) about the epidermal structures in members of the families like Amaranthaceae, Chenopodiaceae and Basellaceae, it has been considered worthwhile to study these characters. Moreover, none has attempted as yet, to study the epidermal structures in relation to taxonomic classifications in this part of the country which offers a virgin field for plant
systematists in compiling a more coherent picture of plant groups. The present investigation is also aimed to unveil any significant co-relation between chromosome number and stomatal sizes of the plants. These micro-morphological characters have been studied by measuring the length and breadth of the stomata, epidermal cells on an average data of 40 counts. Types of stomata as defined by van Cotthem (1970) has been followed in the present study for descriptive purposes. Tables VI, VII & VIII showing the salient features of the epidermal morphology of Amaranthaceae, Chenopodiaceae and Basellaceae.
Explanation of Plate 27.

Figs. 1(A–C) of *Amaranthus tricolor* L.

A. Upper foliar epidermis, B. Lower foliar epidermis, C. Epidermis over costal region.

2(A–C) of *Amaranthus gracilis* Desf.

A. Upper foliar epidermis, B. Lower foliar epidermis, C. Epidermis over costal region.

3(A–C) of *Amaranthus polygonoides* L.

A. Upper foliar epidermis, B. Lower foliar epidermis, C. Epidermis over costal region.
A. EPIDERMAL FEATURES OF THE MEMBERS OF AMARANTHACEAE:

1. Amaranthus gracilis Desf.

Epidermal cells polygonal (5-6 walled), simply wavy or undulate to slightly sinuous walls on upper surface but arcuate or deeply sinuate and irregular in outline on lower surface. Stomata typical Anomocytic or Ranunculaceous restricted to intercostal areas with but aborted guard cell/cells sometimes present in lower surface. Hairs very sparsely present and with uniseriate 2-3 celled clubshaped or clavate distributed mainly on costal cell walls. Costal cells elongate, arranged in rows, walls almost straight or shortly arcuate. (Plate 27, Figs. 2 (A-C) and Plate 37, Figs. 2a,b based on slide no. 1051)

2. A. hybridus L. subsp. cruentus (L.) Thell. var. paniculatus (L.) Thell.

Epidermal cells rectangular to polygonal (5-6 walled), straight to slightly sinuous walls on upper surface but arcuate or deeply sinuate and irregular in outline on lower surface. Stomata typical Anomocytic or Ranunculaceous predominant together with Anisocytic or Cruciferous and a few Diacytic or Caryophyllaceous on upper, the lower surface with Anomocytic together with anisocytic, restricted to intercostal areas. Costal cells elongate, straight walled or slightly arcuate, arranged in rows. Hairs sparsely distributed on veins, uniseriate, clubshaped, 3-5 celled, usually the terminal cell
Explanation of Plate 28.

Figs. 1(A-C) of *Amaranthus spinosus* L. (Leaves with purple blotches).

A. Upper foliar epidermis, B. Lower foliar epidermis, C. Epidermis over costal region.

2(A-C) of *Amaranthus spinosus* L. (Leaves without purple blotches)

A. Upper foliar epidermis, B. Lower foliar epidermis, C. Epidermis over costal region.

3(A-C) of *Amaranthus hybridus* L. subsp. *cruentus* (L.) Thell. var. *paniculatus* (L.) Thell.

A. Upper foliar epidermis, B. Lower foliar epidermis, C. Epidermis over costal region.
longer. (Plate 28, Figs. 3 (A-C) and Plate 37, Figs. i a-d based on slide no. 1057)

3. *A. polygonoides* L.

Epidermal cells polygonal, sinuate or arcuate walls on upper surface, more so on lower surface with irregular outlines. Stomata typical Anomocytic or Ranunculaceous restricted to intercostal areas. Costal cells mostly straight with but a few with slight arcuate walls, arranged in rows. Hairs clubshaped, uniseriate and mostly 3-celled, distributed both on costal and intercostal cells, the terminal cell usually broader and larger. (Plate 27, Figs. 3 (A-C) and Plate 37, Figs. ia, bbased on slide no. 1061)

4. *Amaranthus spinosus* L.

Epidermal cells polygonal, sinuate with irregular outlines on both the surfaces but more so on lower surface. Stomata typical Anomocytic or Ranunculaceous restricted to intercostal cells. Costal cells elongate mostly straight walled with but a few with arcuate walls, arranged in rows. Hairs clubshaped, uniseriate, 3-4 celled, the terminal cell usually broader and larger restricted on veins. (Plate 28, Figs. 1 & 2 (A-C) and Plate 37, Figs. 5a, bbased on slide nos. 1066, 1064)
5. **Amaranthus tricolor** L.

Epidermal cells polygonal, mostly sinuate or arcuate walls rarely straight walled on upper surface, deeply sinuate with irregular outlines on lower surface. Stomata mostly Anomocytic or Ranunculaceous on both surfaces but rarely mixed with Diacytic or Caryophyllaceous on upper surface are restricted on intercostal cells. Costal cells elongate, mostly straight walled with but a few with arcuate walls, arranged in linear rows. Hairs mostly clubshaped, uniseriate, 1-4 celled, the basal cell usually globose, sparsely distributed on costal cell walls. (Plate 27, Figs. 1 (A-C) and Plate 37, Figs. 3a-d based on slide no. 1072)

6. **Alternanthera paronychioides** St. Hil.

Epidermal cells polygonal, mostly straight walled, sometimes arcuate on upper surface, the lower surface with sinuate and irregular cell walls. Stomata Anomocytic or Ranunculaceous mixed with Anisocytic or Cruciferous on upper surface whereas Diacytic or Caryophyllaceous on lower surface. A few stomata with one of the guard cells are found to be abortive. Costal cells elongate, straight and arcuate walls arranged in rows. Hairs distinctly of two different types: one with shorter uniseriate cells, 4-6 celled with blunt apices; the other with larger cells and pointed apices, distributed on costal and intercostal cells. (Plate 29, Figs. 3 (A-C) and Plate 37, Figs. 9 a,b based on slide no. 1075)
Explanation of Plate 29.

Figs. 1(A-C) of *Alternanthera philoxeroides* (Mart.) Griseb.
A. Upper foliar epidermis, B. Lower foliar epidermis, C. Epidermis over costal region.

2(A-C) of *Alternanthera sessilis* (L.) R.Br. ex R.& S.
A. Upper foliar epidermis, B. Lower foliar epidermis, C. Epidermis over costal region.

3(A-C) of *Alternanthera paronychioides* St. Hil.
A. Upper foliar epidermis, B. Lower foliar epidermis, C. Epidermis over costal region.
7. *A. philoxeroides* (Mart.) Griseb.

Epidermal cells polygonal, sinuate and irregular in outlines on upper surface more so on lower. Stomata typical Diacytic or Caryophyllaceous on both the surfaces with but few stomata are found to be completely abortive or one of the guard cells do not develop particularly on lower surface. Costal cells elongate, straight walled or arcuate. Two different types of hairs: shorter mostly 4-celled, uniseriate with blunt apices, the other with larger cells and pointed apices distributed on both costal and intercostal cells. (Plate 29, Figs. 1 (A–C) and Plate 37, Figs. 8a,b based on slide no. 1078)

8. *A. sessilis* (L.) R.Br. ex R. & S.

Epidermal cells polygonal, sinuate and arcuate walls with irregular outlines on upper surface, more so on lower surface. Stomata typical Diacytic or Caryophyllaceous on both the surfaces rarely with abortive guard cell/cells on lower surface only. Costal cells elongate but shorter, straight and arcuate, linearly arranged. Hairs distinctly of two different types: uniseriate in both, shorter upto 4-celled, the terminal cell with blunt apex and longer with pointed apex, sparsely distributed on costal and intercostal cells. (Plate 29, Figs. 2 (A–C) and Plate 37, Figs. 7a-c based on slide no. 1081)
Explanation of Plate 30.

Figs. 1(A-C) of Achyranthes aspera L.
A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.

2(A-C) of Achyranthes aspera L. var. porphyristachya
Hook.f.
A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.

3(A-C) of Cyathula prostrata (L.) Bl.
A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.
9. **Achyranthes aspera** L.

Epidermal cells polygonal, straight and arcuate walls on upper surface; sinuate and arcuate with more irregular outlines on lower surface. Stomata mixed types: mostly Anomocytic or Ranunculaceous together with Diacytic or Caryophyllaceous and Anisocytic or Cruciferous on upper surface whereas on lower surface with Anomocytic and mixed with Diacytic types. A few stomata are found to be with a single guard cell or both the guard cells are found to be abortive particularly on lower surface. Costal cells elongate, straight and arcuate walls arranged in rows. Hairs are of two different types: the shorter with smooth walls and mostly 2-celled with blunt apices distributed only on costal cells; the longer muricated, mostly 2-celled with pointed apices distributed densely on costal cells but sparsely on intercostal cells. (Plate 30, Figs. 1 (A-C) and Plate 37, Figs. 10a-c based on slide no. 1085)

10. **A. aspera** L. var. **porphyristachya** Hook.f.

Epidermal cells polygonal, straight walled mostly with but few arcuate walls on upper surface, the lower deeply sinuate and irregular in outlines. Stomata are found to be mixed types: upper surface with Anomocytic or Ranunculaceous mixed with Diacytic or Caryophyllaceous and Anisocytic or Cruciferous but lower surface predominantly Anisocytic with but few Diacytic. Costal cells elongate, straight walls, sometimes arcuate also,
Explanation of Plate 31.

Figs. 1(A-C) of Gomphrena celosioides Mart.
A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.

2(A-C) of Gomphrena globosa L.
A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.

3(A-C) of Deeringia amaranthoides (Lam.) Merr.
A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.
arranged in rows. Hairs are of two different types: one shorter and linear 2-celled, smooth walled distributed on intercostal cells; the other mostly longer with pointed apices (rarely one-celled), muricated walls, dense on costal cells, sparse on intercostal cells. (Plate 30, Figs. 2 (A-C) and Plate 37, Figs. 11a-c based on slide no. 1090)

11. Gomphrena globosa L.

Epidermal cells polygonal, straight walled mostly with but a few arcuate walls on upper surface; the lower surface with more undulated or sinuate walls with irregular outlines. Stomata predominantly Anomocytic or Ranunculaceous together with Anisocytic or Cruciferous types on both the surfaces. Costal cells elongate, straight and arcuate walls, arranged in rows. Hairs are of two different types: one shorter uniseriate, 4-5 celled with slightly curved and longer apical cell with blunt apices distributed mainly on intercostal cells; the other longer with pointed apical cell distributed mainly on costal cells than intercostal cells. (Plate 31, Figs. 2 (A-C) and Plate 37, Figs. 12 a-d based on slide no. 1094)

12. G. celosioides Mart.

Epidermal cells polygonal, straight, arcuate and undulate walls on upper surface whereas on lower surface mostly undulate with irregular outlines. Stomata predominantly
Explanation of Plate 32.

Figs. 1(A–C) of *Celosia argentea* L.

A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.

2(A–C) of *Celosia cristata* L.

A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.
Anomocytic or Ranunculaceous together with few Anisocytic or Cruciferous types on both the surfaces. Costal cells elongate, straight and arcuate. Hairs are of two different types: one shorter with almost blunt apices slightly curved or not distributed mainly on intercostal cells; the other longer with pointed apices found along the costal cell walls mainly than intercostal cells. (Plate 31, Figs. 1 (A-C) and Plate 37, Figs. 13 a-c based on slide no. 1105)

13. *Celosia argentea* L.

Epidermal cells polygonal, straight, slightly undulated and arcuate on upper surface, whereas lower surface with deeply undulated or sinuated with irregular outlines. Stomata are typical Anomocytic or Ranunculaceous on both the surfaces distributed evenly on intercostal and costal cells. Costal cells elongate, straight and arcuate walls, linearly arranged in rows with stomata. Hairs uniseriate, 2-6 celled, clubshaped, distributed mainly on costal cells walls. (Plate 32, Figs. 1 (A-C) and Plate 38, Figs. 1 a-c based on slide no. 1109)

14. *Celosia cristata* L.

Epidermal cells polygonal, straight, slightly undulated and arcuate on upper surface; deeply sinuated or undulated with irregular outlines on lower surface. Stomata predominantly Anomocytic or Ranunculaceous together with few Anisocytic or
Cruciferous types on upper surface whereas all are Anomocytic on lower surface restricted on intercostal cells. A few guard cell/cells are found to be abortive. Costal cells elongate, straight and arcuate walls, linearly arranged in rows without stomata. Hairs uniseriate, 2-5 celled, clubshaped, distributed mainly on costal cell walls. (Plate 32, Figs. 2 (A-C) and Plate 38, Figs. 2a, b based on slide no. 1116)

15. *Cyathula prostrata* (L.) Bl.

Epidermal cells polygonal, slightly undulated and arcuate walls on upper surface; the lower deeply sinuate or undulate with irregular outlines. Stomata predominantly Diacytic or Caryophyllaceous together with Anisocytic or Cruciferous and Anomocytic or Ranunculaceous on upper surface; the lower predominantly Anomocytic together with Diacytic and Anisocytic types. Costal cells elongate, straight and arcuate walls, linearly arranged in rows. Hairs are of two different types: one shorter mostly 3-celled with smaller and blunt apical cell whereas the other longer and pointed apical cell distributed mainly on costal cell walls. (Plate 30, Figs. 3 (A-C) and Plate 37, Figs. 14a, b based on slide no. 1121)


Epidermal cells polygonal, straight and arcuate walls on upper surface; the lower with sinuate or undulated and
Explanation of Plate 33.

Figs. 1(A-C) of *Telanthera ficoidea* Moq.

A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.

2(A-C) of *Iresine herbstii* Hook.

A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.
irregular outlines. Stomata predominantly Anomocytic or Ranunculaceous on upper surface whereas the lower surface with mostly Anomocytic or Ranunculaceous together with Anisocytic or Cruciferous types. Costal cells elongate, straight and arcuate walls, linearly arranged in rows. Hairs multicellular, uniseriate with blunt apices. (Plate 31, Figs. 3 (A-C) and Plate 77, Figs. 6 a,b based on slide no. 1125)


Epidermal cells polygonal, straight and arcuate walls on upper surface, the lower deeply sinuate or undulate with irregular outlines. Stomata mostly Anisocytic or Cruciferous on upper surface whereas on lower surface with typical Anomocytic or Ranunculaceous. Costal cells elongate, straight and arcuate walls, linearly arranged in rows. Hairs are of two different types: one shorter mostly 2-4 celled, uniseriate and club shaped, the other multicellular with pointed apices (Plate 33, Figs. 1 (A-C) and Plate 38, Figs. 4 a,b based on slide no. 1131)

18. *Iresine herbstii* Hook.

Epidermal cells polygonal, straight and very shortly wavy and arcuate walls on upper surface, the lower deeply sinuate or undulate with irregular outline. Stomata very few on upper surface and mostly tetracytic with 4 cells; 2 terminal and 2 lateral; 2 smaller and 2 somewhat larger but all unequal.
Explanation of Plate 34.

Figs. 1(A-C) of Chenopodium ambrosioides L.
A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.

2(A-C) of Chenopodium album L.
A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.
Whereas in lower surface stomata mixed with Anomocytic or Ranunculaceous and Anisocytic or Cruciferous. Costal cells elongate, straight and arcuate walls, linearly arranged in rows. Hairs are of 3 different types: shorter ones upto 4-celled, clubshaped with shorter broader apical cell and longer linear and curved apical cell, the longer ones multicellular with shorter cells and blunt apical cell (Plate 33, Figs. 2 (A-C) and Plate 38, Figs.3a-c based on slide no. 1134).

B. EPIDERMAL FEATURES OF THE MEMBERS OF CHENOPODIACEAE:

1. Chenopodium album L.

Epidermal cells polygonal straight and arcuate walls on upper surface, the lower surface with slightly sinuate walls. Circular pores with smaller oily glands attached or not sparsely distributed on intercostal as well as costal cells. Stomata typical Anomocytic or Ranunculaceous on both the surfaces restricted on intercostal cells. Costal cells elongate, straight and arcuate walls arranged in rows. (Plate 34, Figs.2(A-C); Plate 38 f6 based on slide no. 1141)

2. C. ambrosioides L.

Epidermal cells polygonal, straight and slightly undulated with arcuate walls on upper surface more so on the lower surface with irregular oulines. Circular pores with large
Explanation of Plate 35.

Figs. 1(A–C) of Beta vulgaris L.
A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.

2(A–C) of Beta vulgaris L. var. orientalis (Roth) Moq.
A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.
oily glands distributed densely on lower surface than upper on intercostal as well as on costal cells. Stomata are typical Anomocytic or Ranunculaceous restricted on intercostal cells of both the surfaces. Costal cells straight and arcuate walls, linearly arranged in rows. (Plate 34, Figs. 1(A-C) and Plate 35, Figs. 5a, b based on slide no. 1144)

3. Beta vulgaris L.

Epidermal cells polygonal, straight and arcuate walls on upper surface more so on the lower surface with irregular outlines. Stomata typical Anomocytic or Ranunculaceous mixed with a few Anisocytic or Cruciferous types on upper surface whereas on lower surface Anomocytic or Ranunculaceous together with Diacytic or Caryophyllaceous types. Costal cells straight and arcuate walls linearly arranged in rows. Hairs are of two different types: one shorter with broader basal cell and linear apical cell, mostly 3-celled; the other longer mostly 4-5 celled with glandular apex distributed on costal and intercostal cells. (Plate 35, Figs. 1(A-C) and Plate 38 Figs. 5a, b based on slide no. 1146)

4. Beta vulgaris L. var. orientalis (Roth) Moq.

Epidermal cells polygonal, slightly undulate on upper surface but deeply undulate with irregular walls on lower surface. Stomata typical Anomocytic or Ranunculaceous on both
Explanation of Plate 36.

Figs. 1(A-C) of *Basella alba* L.

A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.

2(A-C) of *Basella rubra* L.

A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.

3(A-C) of *Boussingaultia gracilis* Miers. var. *pseudobaselloidea* Bailey

A. Upper foliar epidermis, B. Lower foliar epidermis,
C. Epidermis over costal region.
the surfaces. Costal cells linear, arranged in rows with straight and arcuate walls. Hairs completely absent. (Plate 35 Figs. 2 (A-C) based on slide no. 1149)

C. EPIDERMAL FEATURES OF THE MEMBERS OF BASELLACEAE:

1. *Basella alba* L.

Epidermal cells polygonal, straight and arcuate walls, mostly uniform cells on both the surfaces. Stomata predominantly Paracytic or Rubiaceous on upper surface whereas the lower surface found to be with mixed types Paracytic or Rubiaceous predominates along with Anisocytic or Cruciferous and Diacytic or Caryophyllaceous types. Stomata on both the surfaces are found to be abortive guard cell/cells but less on upper surface. Costal cells elongate, linear, arranged in rows with straight and arcuate walls. Hairs absolutely absent on both the surfaces. (Plate 36, Figs. 1 (A-C) based on slide no. 1152)

2. *Basella rubra* L.

Epidermal cells polygonal, straight and arcuate walls on upper surface whereas slightly undulate on lower surface. Stomata typical Paracytic or Rubiaceous on upper surface, the lower predominates with Paracytic with but a few Anisocytic or Cruciferous types. A few stomata with one of the guard cells
found to be abortive. Costal cells linear, arranged in rows with straight and arcuate walls. Hairs absolutely absent on both the surfaces. (Plate 36, Figs. 2 (A–C) based on slide no. 1155)

3. Boussingaultia gracilis Miers. var. pseudobaselloides Bailey

Epidermal cells mostly polygonal, a few are tetrahedral, straight and arcuate walls on both the surfaces with but slight undulate walls on lower surface. Stomata predominantly Paracytic or Rubiaceous on both the surfaces. Costal cells linear, arranged in rows, straight and arcuate walls. Hairs absolutely absent on both the surfaces. (Plate 36, Figs. 3 (A–C) based on slide no. 1159)

It has been observed that the majority of the members belonging to Amaranthaceae, Chenopodiaceae and Basellaceae have stomata more on lower surface than on the upper surface of the leaves with a few exceptions including Amaranthus gracilis of Amaranthaceae, Beta vulgaris var. orientalis of Chenopodiaceae and Basella rubra of Basellaceae where the number of stomata are found to be less on the ventral than on the dorsal surface. It has also been found that some of the species have very few stomata on upper surface. Mention may be made of Iresine herbstii (only 4 per mm² area) Achyranthes aspera var. porphyristachya (only 14), Cyathula prostrata (10), Deeringia amaranthoides (13)
and *Telanthera ficoidea* (10) of Amaranthaceae. All the species studies have revealed that stomata are mainly distributed on intercostal areas but with the exception of *Celosia argentea* where stomata are evenly distributed on both costal as well as intercostal areas.

It is pertinent to suggest that even stomatal characters are sufficiently distinct to separate members of Basellaceae from Chenopodiaceae (s.l.) but it would be difficult to demarcate Amaranthaceae from Chenopodiaceae (s.s.) on stomatal types alone. Members of Basellaceae have predominantly Paracytic or Rubiacious type of stomata distributed uniformly on both the surfaces of leaves unlike the other two families. Both Amaranthaceae and Chenopodiaceae have more or less same types of stomata, predominantly Anomocytic or Ranunculaceous and sometimes having mixed types. These characters help to a certain extent the delimitation of genera but specific delimitation on the basis of stomatal types alone may lead to erroneous conclusions. However the taxa can be distinguished on the basis of shape and size of the epidermal cells, the stomata size and frequency as these characters are found to be different even in species of the same genus. (cf. Tables VI, VII and VIII)

Sen (1958) pointed out that the typical Anomocytic or Ranunculaceous type of stomata occurs on both the leaf surfaces of *Amaranthus gracilis* (*A. viridis*), *A. tricolor* (*A. gangeticus*), *Celosia cristata*, *Deeringia amaranthoides* (*D. celosioides*), *Chenopodium album*, *C. ambrosioides*; *Basella rubra* with Paracytic
or Rubiaceous; *Alternanthera sessilis* with Diacytic or Caryophyllaceous and *Achyranthes aspera* stomata on lower surface typically Anomocytic or Ranunculaceous, upper surface with Paracytic or Rubiaceous and Anisocytic or Cruciferous types. But the present investigation has indicated much variation. All the 5 species of *Amaranthus* except *Amaranthus tricolor* are distinctively Anomocytic or Ranunculaceous whereas *A. tricolor* alone with a mixed type Anomocytic with Diacytic or Caryophyllaceous on upper surface, the lower with only Anomocytic; *Celosia cristata* where Anomocytic is predominant together with Anisocytic or Cruciferous on upper surface, the lower with only Anomocytic. 3 species of *Alternanthera* showed Diacytic or Caryophyllaceous is predominant only exception in *A. paronychioides* where Anomocytic mixed with Anisocytic found on upper surface but the lower surface with Diacytic type only. Anomocytic type of stomata is found on the upper surface of *Deeringia amaranthoides* but the lower surface has a mixed type Anomocytic with Anisocytic. Both *Achyranthes aspera* and *A. aspera* var. *porphyristachya* have Anomocytic, Diacytic and Anisocytic stomata on upper surface, the lower surface with Anomocytic and Diacytic but could not confirm Sen's (1.e.) observation as regards to occurrence of Paracytic or Rubiaceous stomata. Although *Basella rubra* predominates with Paracytic or Rubiaceous type of stomata on upper surface but the lower surface is mixed with Paracytic and Anisocytic or Cruciferous types as also *Basella alba* where the lower surface is mixed with Paracytic, Anisocytic and Diacytic or Caryophyllaceous types. Interesting finding of
Explanation of Plate 37.

Figs. 1-14 showing different types of trichomes:

1(a, b) of *Amaranthus polygonoides* L.
2(a, b) of *Amaranthus gracilis* Desf.
3(a-d) of *Amaranthus tricolor* L.
4(a-d) of *Amaranthus hybridus* L. subsp. *cruentus* (L.) Thell. var. *paniculatus* (L.) Thell.
5(a, b) of *Amaranthus spinosus* L.
6(a, b) of *Deeringia amaranthoides* (Lam.) Merr.
7(a-c) of *Alternanthera sessilis* (L.) R.Br. ex R.& S.
8(a, b) of *Alternanthera philoxeroides* (Mart.) Griseb.
9(a, b) of *Alternanthera paronychioides* St. Hil
10(a-c) of *Achyranthes aspera* L.
11(a-c) of *Achyranthes aspera* L. var. *porphyristachya* Hook.f.
12(a-d) of *Gomphrena globosa* L.
13(a-c) of *Gomphrena celosioides* Mart. c basal portion of a long hair.
14(a, b) of *Cyathula prostrata* (L.) Bl.
Tetracytic type of stomata having 2 smaller and 2 somewhat larger but all unequal and placed terminally and laterally on upper surface of leaves of *Iresine herbstii* deserves mention. It is to be pointed out here that some of the species of the above mentioned families showed stomata with guard cell/cells are abortive. This type of abortive guard cell/cells in stomata are also found in other members of Angiosperm families Dehnel (1961), Ahmed (1964a,b,c,d; 1974).

It has been noticed further that the presence or absence of hairs or other cellular outgrowth are of taxonomic significance. The lines of demarcation can easily be drawn between Amaranthaceae and Chenopodiaceae (*s.g.*), the former is specialised in having at least two different types - one shorter, uniseriate, 2-4 celled clubshaped, smooth walled whereas the other longer with pointed apices mostly 2-celled, smooth or muricat ed walls, the 3rd one rare with longer curved apical cell; the latter is without hairs or if present are of two different types - the shorter one mostly 3-celled with broader basal cell and linear apical cell whereas the longer one 4-5 celled with glandular apex. Moreover those without hairs are provided with only glands attached or not to circular pores. But in members of Basellaceae hairs are absolutely absent.

However, a broad tentative classification of families and genera has been constructed based on types of stomata, presence or absence of hairs including their types. The delimitation of species can be made particularly on size of the
Explanation of Plate 38.

Figs. 1-7 showing different types of trichomes and oily glands.

1(a-c) of *Celosia argentea* L.
2(a,b) of *Celosia cristata* L.
3(a-c) of *Iresine herbstii* Hook.
4(a,b) of *Telanthera ficoidea* Moq.
5(a,b) of *Beta vulgaris* L.
6. Oily gland of *Chenopodium album* L.
7. Oily gland of *Chenopodium ambrosioides* L.
epidermal cells; the stomata and their frequency per mm$^2$ area of leaves of both the surfaces as shown in Tables VI, VII & VIII.

Epidermal structures also support the raising of Achyranthes aspera var. porphyristachya to the rank of species in conformity with the macromorphological characters as shown in Chapter 3, page 44 and also approve the separation of Basella alba and Basella rubra as two distinct species. In both the above cases size of the stomata epidermal cells and frequency per unit area are found to be different.

Broad tentative classification of the families:

Stomata predominantly anomocytic or ranunculaceous, sometimes diacytic or caryophyllaceous or mixed with anisocytic or cruciferous; hairs are of three distinct types - uniseriate, shorter ones 2-4 celled, clubshaped with broader and shorter apical cell and apical cell linear and longer slightly curved smooth walled; the longer ones 2-celled with pointed apices, smooth walled or muricated ...

Amaranthaceae

Stomata predominantly anomocytic or ranunculaceous, sometimes mixed with anisocytic or cruciferous and diacytic or caryophyllaceous; hairs if present are of two different types -
shorter ones 3-celled, basal cell broader, apical cell linear, the longer ones 4-5 celled with glandular apex; those without hairs sometimes provided with oily glands attached or not to circular pores .. Chenopodiaceae

Stomata predominantly paracytic or rubiaceous, rarely mixed with anisocytic or cruciferous on lower surface; hairs absolutely absent .. Basellaceae

Key to the identification of genera belonging Amaranthaceae:

Stomata predominantly anomocytic, sometimes mixed with anisocytic and diacytic; hairs mostly clubshaped, 2-5 celled .. Amaranthus

Stomata predominantly anomocytic, sometimes mixed with anisocytic; hairs mostly clubshaped, 2-6 celled .. Celosia

Stomata predominantly anomocytic, sometimes mixed with anisocytic; hairs multicellular with blunt apices .. Deeringia

Stomata predominantly anomocytic on upper surface, lower mixed with anisocytic; hairs 3 different types: shorter 3-4 celled, terminal cell shorter, clubshaped; medium
3-4 celled, apical cell longer, straight or curved; longer multicellular, short cells with blunt apical cell  

Iresine

Stomata anisocytic on upper surface and anomocytic on lower; hairs 2 different types - both smooth walled, shorter ones 2-4 celled, clubshaped, the longer ones with pointed apices  

Telanthera

Stomata mixed types - anomocytic together with diacytic and anisocytic; hairs 2 different types - both smooth walled shorter ones clubshaped, mostly 3-celled; longer ones with pointed apices  

Cyathula

Stomata mixed types - anomocytic together with diacytic and anisocytic on upper surface whereas anomocytic and diacytic on lower surface; hairs 2-different types - shorter ones smooth walled and clubshaped, mostly 2-celled, longer ones muricated walls and pointed apices  

Achyranthes

Stomata mixed types - anomocytic with anisocytic mostly, sometimes diacytic also present; hairs 2 different types - shorter ones with curved and blunt apices, longer ones with pointed apices  

Gomphrena
Stomata predominantly diacytic rarely mixed with anomocytic and anisocytic; hairs 2 different types - shorter ones with blunt apices, longer ones with pointed apices .. Alternanthera

B. **Key to the identification of genera belonging to Chenopodiaceae:**

Stomata predominantly anomocytic; hairs absent but oily glands present attached to circular pores or not .. Chenopodium

Stomata predominantly anomocytic, sometimes mixed with anisocytic or with diacytic; hairs if present are of two distinct types - shorter ones 3-celled with broader basal cell and narrower apical cell, longer ones 4-5 celled with glandular apex .. Beta

C. **Key to the identification of genera belonging to Basellaceae:**

Stomata predominantly paracytic on upper surface, lower surface with paracytic and anisocytic; hairs absent .. Basella
Stomata predominantly paracytic on both the surfaces; hairs absent ..... Boussingaultia

Phylogenetic considerations:

The present findings clearly indicate the possible relationship and close similarities of Amaranthaceae and Chenopodiaceae (s.s.) both exhibiting predominantly anomocytic stomata whereas members of Basellaceae have stomata which is paracytic justifying the separation of these members from Chenopodiaceae (sensu lato) to form a distinct family Basellaceae which is in conformity with the macromorphological characters. Thus even the stomatal characters do not support the inclusion of the members (now placed in Basellaceae) into Chenopodiaceae (s.l.) as was done by Bentham & Hooker (l.c.). Very recently Baranova (1972) considered paracytic or Rubiaceous type of stomata as primitive within the Angiosperms because of the nearly uniform occurrence of paracytic stomata in the Magnoliales (sensu Takhtajan). If this is so, members of Basellaceae having paracytic type of stomata may be considered more primitive than both Amaranthaceae and Chenopodiaceae, which exhibited predominantly anomocytic stomata. Anomocytic stomata prevalent in both Amaranthaceae and Chenopodiaceae but mixed types including anisocytic and diacytic stomata are also not uncommon. Alternanthera genus of Amaranthaceae which possess predominantly diacytic or caryophyllaceous type as also Beta vulgaris of Chenopodiaceae showing at least on lower surface anomocytic.
mixed with diacytic stomata. From this it is obvious that the genus *Alternanthera* serves as a connecting link to Caryophyllaceae where most of the members have typical diacytic stomata and thus ensures a close relationship. Not only paracytic or rubiaceous stomata but also existence of mucilage cells in both Basellaceae and Portulacaceae tend to confirm the phylogenetic relationship and hence systematic groups proposed by Schinz (1934) and Takhtajan (1969) but in some respects negate the wide separation of families into different orders according to Hutchinson (1959). It would be presumptuous to interpret the results of studying a few species in a limited number of genera or to specify the trends of evolution based on stomatal evolution which in itself is still obscure (Dickison, 1975).

However, the present findings point to a probable evolutionary trend in the genera of Amaranthaceae. Basing on the assumption that Caryophyllaceae considered primitive on macromorphological characters possess typical diacytic stomata might encourage one to consider *Alternanthera* having diacytic stomata as the most primitive group among Amaranthaceae. From this there might be derivation in 3 different lines: (1) from diacytic stomata evolved anisocytic type with 3 subsidiary cells of which one is smaller than the other two represented by *Telanthera* and proceeded gradually towards tetracytic type - with 4 subsidiary cells - 2 smaller and 2 somewhat larger but all unequal being placed terminally and laterally, as seen in *Iresine herbstii* and then to anomocytic types where all the subsidiary cells are more or less uniform like other epidermal
cells - and considered here as most advanced and exhibited by most of the species of *Amaranthus*; (2) from diacytic stomata evolved a mixed diacytic and anomocytic furnished by *Achyranthes* to predominantly anomocytic; (3) from diacytic type again there is evolution through mixed diacytic, anisocytic and anomocytic represented by genus *Cyathula* and proceeded towards predominantly anomocytic mixed with few anisocytic as observed in *Deeringia* to distinct type (Table IX).