INT. J. BIOL. BIOTECH., 3 (2): 285-300, 2006.

MICROMORPHOLOGICAL STUDIES OF THE FAMILY LABIATAE FROM PAKISTAN WITH SPECIAL REFERENCE TO TRICHOMES AND ITS USE AS A TAXONOMIC EVIDENCE

Anjum Perveen

Department of Botany, University of Karachi, Karachi-75270, Pakistan

ABSTRACT

Trichomes morphology of 53 species representing 28 genera of the family Labiatae (Lamiaceae) have been examined by light and scanning microscope. With in the family various types of trichomes are found. Trichomes are generally eglandular, uniseriate (2-3 celled) rarely glandular. In some species both types of trichomes are observed. In the family Labiatae four types of trichomes are found. Small trichomes with pointed tips, soft long ribbon like trichomes with blunt apex or arrow tip, long conical trichomes with pointed tip and stellate often branched trichomes. In many genera both types of trichomes are found (long and short). Usually conical trichomes with pointed tips are common. Similarly, trichomes are distinct in trichomes base also. On the basis of trichomes morphology family is divided in to six group I: Uniseriate macroform trichomes– type, II: Uniseriate microform trichomes-type, III: Uniseriate macro & microform trichomes-type, IV: Unicellular moniliform trichomes -type, V: Stellate trichomes -type and VI: Branched trichomes– type. Trichomes morphology is significantly helpful at the specific level.

Key words: Trichomes, Labiatae, uniserate, systematics, Pakistan

NTRODUCTION

Labiatae is a family of about 200 genera and 3200 species, cosmopolitan in distribution especially Mediterranean and tropical regions (Willis, 1973; Mabberley, 1978). In Pakistan it is distributed by 54 genera and 212 species (Hedge, 1990). Plants are mostly herbs and shrubs with square stems; aromatic, leaves opposite, inflorescence axillary or whorled, flower 5-merous, zygomorphic. The chief genera of Labiatae are: *Lamium, Ajuga, Teucrium, Scutellaria, Marrubium, Mentha, Salvia and Nepeta*. Many plants from mint family are used in cooking as herbs and spices sege (*Salvia officinalis*), spearmint (*Mentha spicata*), peparmint (*Mentha piperita*), basil (*Clinopodium vulgaris*). The family is also important for its ornamental plants. Briquet (1895) divided the family into 8 subfamilies viz., Ajugoideae, Prostantheroideae, Prasioideae, Scutellarioideae, Lavanduloideae, Lamioideae, Ocimoideae and Catopherioideae.

Epidermal attachments of various shape, structure and function are called trichomes, they many be glandular eglandular, unicellular or multicellular. Trichomes found in many angiosperm families. The taxonomy and phylogenetic significance of trichomes have long been recognized by many scientists. The data is also utilized by systematists, evolutionists and ecologists. In the family Labiatae surface characters like trichomes glands and stomata have been particularly useful in revealing affinities (Bini *et al*., 1983). Cantino (1990) examined the structure and distribution of secretary and non-secretary trichomes of family Labiatae Singh *et al*. (1975) studied the trichomes of genus *salvia* in relation to taxonomy. Shah and Ninda (1983) examined trichomes on leaf of some members of family Lamiaceae. There are no reports on trichomes morphology of Labiatae from Pakistan. Present study is the first attempt on trichomes in the family Labiatae by scanning and light microscopes.

MATERIALS AND METHODS

Plant materials were collected from the field or obtained from the Karachi University Herbarium (KUH). Species are listed in Appendix-1 For this studies different plant parts appx. 1 cm in size were used. For light microscopic studies materials first fixed in Sodium hydroxide and cleared in Lactic acid, camera lucida drawings were made and photographs taken from the slides. For scanning microscopic studies materials were mounted on metallic stubs, using double sided cellotape and coated with gold in sputtering chambers (Ion-sputter JFC-1100). The coating was restricted to 15A. The SEM examination was carried out on a Jeol T20 scanning electron microscope.

Appendix I. List of Specimens examined.

1. *Ajuga bracteosa* Wall ex Benth.
   Paliat, Korote, Kolpur Rd ± 2000, Azad Kashmir, E & Y. Nasir s.n. (KUH).

2. *A. parviflora* Benth.
   Sunny bank murrc, 9.5.71, 7331, Sultanul-Abedin (KUH); District Hasan, S.M.A. Kazmi 4709 (KUH).
3. *Alajja rhomboidea* (Benth.) J. Ikonn. –Gal.
   On way to Murkah from Shorgrum, Chitral Kamal Akhtar Malik, S. Nazimuddin, 1795 (KUH); Rush Gol, Chiral, Kamal Akhter Malik and S. Nazimuddin, 1642 (KUH).
4. *Calamintha hydaspidis* (Fal coner ex Benth.) Hedge A. Kashmir, Jan Mahd. 4956 (KUH).
5. *Clinopodium* umbrosum (M. Bieb.) C. Koch
   Azad Kashmir, Dungan, Iftikhar & Mehmood, Aug 69, 9.14 (KUH), Dunga gal Coll. Iqot. 647 (KUH).
6. *Clinopodium vulgare* L.
   Rest house Bat grain, ± 1040 meter, 16-7-1990, M. Qaiser, S. Omer, S.Z. Husain 2246 (KUH), Chitral, 25-7-76, S.M. Kazmi 6675 (KUH).
7. *Colebrookea oppositifolia* Smith
   Kasor, Rawalpindi Dist. 19-16-17, Yasin Nazir, & Zafar Ali 62 (KUH); Base of Mt. Tilla N- aspret Jhelum Dist., 13-3-81, E. & Y. Nasir (KUH).
8. *Craniotome furcata* (Link) O. Kuntze
   Balakot, 24-9-1955. S.I. Ali s.n. (KUH).
9. *Dracocephalum nutans* L.
   15 miles from Basawai on way to Gilgit, 8-7-11 Kamal & M. Qaiser 417 (KUH).
10. *Elsholtzia ciliata* (Thunb.) Hylander
    Nagar, c. 18 km from Aliabad, 14-10-1984, S.I. Ali, Sungang T. Ali & Gike 3569 (KUH); between Kel & Halmat, Muzzafarabad Dist. 2-9-86. M. Qaiser, Rizwan Y. Hashmi 8034 (KUH).
11. *Elsholtzia densa* Lab
    Village Rasum, c. 6 km of Mastuj c. 2400 m 25-6-1987, A Ghafoor & S. Omer 3043 (KUH).
12. *Eremostachys edelbergii* Rechf.
    Near Karimabad, village, Shoghor Gol, 22-6-1987, A. Ghafoor & S. Omer 2894 (KUH); c. 28 km from Gram Chasma on way to _____ 12-8-1992. Tahir Ali, Z. Hussain, Gohor 2304 (KUH).
13. *Eremostachys superba* Royle ex Benth.
    Swat, Rd. to Saudi Saraf April 13 1975, Y. Nasir & E.J. Ecker 7627 (KIH).
14. *Eremostachys thyrsiflora* Benth.
    Quetta between Qila Abod, 8-5-1965, S.M.H. Kazmi 1518 (KUH).
15. *Eremostachys vicaryi* Benth.
    Quetta, Huma lake, 28-5-1997, Gahir Ali & G.R. Sarwar 2592 (KUH); 32 miles from Khuzdar on way to wald, 19-4-1971, Sultan-ul-Abedin, Abrar Husain 7231 (KIH).
16. *Hymenocrater sessilifolius* Benth.
    Wali Tang Quetta, Abdul Ghafoor & Rizwan Yusuf 5-5-85, 1156 (KIH); Wali Tang Quetta 22-5-84, Saood Omer, A. Ghafoor 1779 (KUH).
17. *Isodon rugosus* (Wall ex Benth.) Codd.
    Meana, c. 14-5-16 km from Dir on way to Chitral ± 2000 m. 16-8-1992, Tahir Ali, S.Z. Hussain & Gohar Khan 2106 (KUH).
18. *Lavondullta angustifolia* Miller.
    Kashmir, 27-1045 Coll. Ignot, s.n. (KUH).
19. *Lagochilus cabulicus* Benth.
    Near Yasin on way to Dharkot, 19-7-1990, M. Qaiser, S. Omer, S.Z. Hussain 8339 (KUH).
20. *Leucas utricifolia* (Vahl.) R. Br.
    Behind auditorium Botany Dept. Karachi Aug. 31 1980, Surrayya Khatoon, 258 (KUH).
21. *Leucas aspera* (Willd) Link.
    Sargod Dir, Coll. Iqnot, 17-9-1934 s.n. (KUH).
22. *Leucas lanata* Benth.
    Himalya, 23-9-41, Mohindar Nath 4558 (IKH).
23. *Lamium album* L.
    Azad Kashmir, Kishanganga Valley, 30 1-6-65 S.M. Kazmi 301 (KUH).
24. *Lamium amplexicaule* L.
    Jhiggian near Muzzafarabad, 22-8-86, M. Qaiser, Rizwan Yusuf Hashmi 7615 (KUH).
25. *Marrubium anisodon* C. Koch.
    c. 60 km from Kutch on way to Ziarat Sibbi, 16-5-84 Coll. Iqnot, 1450 (KUH); 3-5-85, Abdul Ghafoor, Rizwan Yusuf Hashmi 1195 (KUH).

26. *Mentha arvensis* L.
    Between Kel & Halmat, Muzzafarabad, 2-9-86, M. Qaiser, Rizwan Yusuf Hashmi 8023 (KUH).
27. *Mentha longifolia* (L.) L.
    Bela Keil Neelum Valley, 30-7-2000, 726350 (KUH).
28. *Nepeta cataria* L.
    Between Gram Chasma and Mogh m road to Shghor & Chitral, 22-6-1987, A. Ghafoor & S. Omer, 2855 (KUH).
29. *Nepeta discolor* Royle ex Benth.
    6 miles from Burawi on way to Gilgit, 2-9-1972, M. Qaiser, A. Ghafoor 5653 (KUH).
30. *Nepeta erecta* (Royle ex Benth.) Benth.
    Between Shade & Nari Noor, Muzzafarabad, 3-9-80, M. Qaiser, Rizwan Yusuf Hashmi 8082 (KUH).
31. *Nepeta juncea* Benth.
    Hazar gangi forest Quetta, 4-6-1987, S. Khatoon, Atta Muhammad & Mola Baksh 465 (KUH).
32. *Nepeta paulsenii* Briquet
    c. 28 km from Gram Chashma on way to Shah Saleem, ± 3000', 12-8-1992, Tahir Ali, S.H. Hassain 2263 (KUH).
33. *Ocimum americanum* L.
    Jabel Kamba, Mamari Nullah, 2-2-84, M. Qaiser, S.I. Ali & Saood Omer 7217 (KUH).
34. *Origanum vulgare* L.
    Tehreng area, -20 miles from Muzzafarabad, 22-8-1986, M. Qaiser & Rizwan Yusuf Hashmi 7593 (KIH).
35. *Otostegia aucheri* Boiss.
    Bolan Pass., between Spezand + main Quetta Sibbi, 12-5-85, A. Ghafoor & Rizwan Yusuf Hashmi 1136 (KUH).
36. *Perovskia abrotanoides* Karel
    Near Khaibar, c. 21 km from sost on way to Aliabad ± 255 m 7-10-1989, S.I. Ali, W. Songany & Tahir Ali 3409 (KUH).
37. *Perovskia atriplicifolia* Benth.
    Hazar gangi forest, Quetta 4-11-82, S. Khatoon, Atta Mhud. Gol 464 (KUH).
38. *Phlomis bracteosa* Royle ex Benth.
    Between Rashian and Leepa valley, Muzzafarabad, 28-8-86, M. Qaiser, Rizwan Yusuf Hashmi 7862 (KUH).
39. *Phlomis cashmeriana* Royle ex Benth.
    Bowberiait valley, Chitral, 21-7-76, M. Qaiser & A. Ghafoor 6762 (KUH).
40. *Salvia aegyptiaca* L.
    Between fort taunro and Rakhi c. 800 m from s.e. V.G. Khan, 28-9-1980, A. Ghafoor, Tahir Ali 3630 (KUH).
41. *Salvia cabulica* Benth.
    Wali Tangi Quetta, 6-7-1987, S. Khatoon, Atta Mala Bakh, 525 (KIH).
42. *Saliva macrosiphon* Boiss.
    c. 42 miles from Ziarat on way to Quetta 9-5-85, A. Ghafoor & Rizwan Y. Hashmi 1563 (KUH).
43. *Salvia moorcrotiana* Wall. ex Benth.
    c. 10 km from Chazabad south post on way to Malakh range, 11-5-84, Saood Omer, A. Ghafoor 1375 (KUH).
44. *Salvia plebia* R. Br.
    Lawn garden, Lahore, 19-3-1981, Kamal A. Malik 1170 (KUH).
45. *Salvia santolinifolia* Boiss.
    Staff Town University Campus Karachi, 2-11-1960, Yasmin s.n. (KUH).
46. *Salvia splendens* Sellow ex Roem. & Schultes
    Peshawar, Afandi 91 (KIH).
47. *Satureja hortensis* L.
    Bkardu 25-8-1955, E. Nasir, & Wehster 6570 (KIH).
48. *Scutellaria chamaedrifolia* Hedge & Paton
    c. 4 km from Dir on way to lowari prost 16-6-198 Goll Ignot, 2384 (KUH).
49. *Scutellaria edelbergii* Rech.f.
    Between 5 and 10 km from Kalam on way to utrore Gabral c. 3000 m, 3-7-1987, A. Ghafoor & S. Umer 3438 (KIH).
50. *Scutellaria multicaulis* Boiss.
    Shaghar Gol, Karimabad, 22-6-1987, A. Ghafoor & S. Omer 2911 (KIH).

51. *Stachys parviflora* Benth.
    Kila Safulla, 22-5-82, Rasool Baksh 16 (KUH).
52. *Teucrium quadrifarium* Buch. –Ham ex D. Don
    Margalla Hills, ± 3500 Rawalpindi Harward Chandn & M.A. Siddiqi s.n. (KUH).
53. *Teucrium royleanum* Wall ex Benth.
    21 miles from Bela Kot on way to Waras, 8-7-1977, Kamal A. Malik, & M. Qaiser 238 (KUH).

RESULTS AND OBSERVATIONS

1. *Ajuga* L.
Eglandular or glandular, unicellular or uniseriate. Macroform, conical, ± distinct base. Densely distributed on stem, leaves and flower.

Key to the Species

+ Trichome Unicellular _____ *Ajuga parviflora*
- Trichome Uniseriate _____ *Ajuga bracteosa*

1. *Ajuga bracteosa* Wall ex Benth.
Eglandular, uniseriate, long hair, with pointed tips ± distinct base, macroform cone like tapering at the base, broader at the middle and conical tip. Densely on both leaves as well as on stem.

2. *Ajuga parviflora* Benth.
Eglandular unicellular, macroform. Pointed tips, eglandular, long uniseriate macroform, moniliform (but cells are rectangular) ± distinct base. Densely disturbed on stem and flowers.

2. *Alajja* Ikonn. – Gal.
Alajja rhomboidea (Benth.) Ikonn. –Gal.
Eglandular , uniseriate macroform (long). Brushed like, Pointed tip base ± distinct widely distributed.

3. *Calamintha* Miller
Eglandular, uniseriate, macroform, long, pointed tip, base distinct, curved, sparsely distributed.

Calamintha hydaspidis (Falconer ex Benth.) Hedge
Eglandular uniseriate, macroform or microform, point tips base distinct sparsely distributed surface scabrate. Stem short crisped eglandular retrorse hairs. Leaves with short eglandular hair.

4. *Clinopodium* L.
Eglandular, uniseriate, macroform, point tips distinct base, not scabrate, curved sparsely distributed.

Clinopodium umbrosum (M. Bieb.) C. Koch.
Eglandular, uniseriate, macroform, point tips distinct base, not scabrate, curved sparsely distributed.

Clinopodium vulgare L.
Glandular and englandular, long and short, rounded tip or pointed, curved glandular, long hairs swollen at the base, tapering towards apex scabrate point tip. Stem with retrorse eglandular hairs.

5. *Colebrookea* Smith.
Colebrookea oppositifolia Smith.
Eglandular, uniseriate, long macroform, thin, curved not scabrate ± distinct base. Widely distributed.

6. *Craniotome* Reichenb.
Craniotome furcata (Link) O. Kuntze.
Eglandular, uniseriate, long, macroform, middle cells bigger, densely distributed acute tip, base ± distinct. Flower dense eglandular hairs or very short glandular hairs.

7. *Dracocephalum* L.
Dracocephalum nutans L.
Eglandular hairs, uniseriate long and short macro and microform not densely distributed. Middle cell bigger, curved at the apex pointed tips.

8. *Elsholtzia* Willd.
Eglandular, uniseriate, long ribbon like, densely distributed, moniliform, bulbous base. Pointed tips.
+ Middle cell rectangular *Elsholtzia ciliata*
- Middle cell non-rectangular *Elsholtzia densa*

1. *Elsholtzia ciliata* (Thunb.) Hylander
Eglandular, uniseriate, long and short, macroform and microform, densely distributed, ribbon like, acute tips. Eglandular hair on calyx.

2. *Elsholtzia densa* Lab.
Eglandular, uniseriate, long, macroform, ribbon like, bulbous base. Densely distributed.

9. ***Eremostachys*** Bunge
Eglandular, often glandular in (*E. vicaryi*) uniseriate, macroform or microform, ribbon like. Straight, with distinct base and acute tips. Densely distributed.

1. + Trichomes macroform 2
   - Trichomes microform 3

2. + Trichomes with rounded tip *E. edelbergii*
   - Trichomes with acute tip *E. superba*
   E. loasifolia

3. + Trichomes with distinct base, often glandular *E. vicaryi*

   - Trichome with indistinct base, eglandular *E. thyrsiflora*

1. *Eremostachys edelbergii* Rech. f.
Eglandular, uniseriate, ribbon like, very densely distributed with rounded tip. Distinct base. Leaves densely hair with long simple hair or stellate dendroid.

2. *Eremostachys loasifolia* Benth.
Eglandular, uniseriate, long, pointed tip ± distinct base. Densely distributed. Long flaccid eglandular hairs. Petiol hairy.

3. *Eremostachys superba* Royle ex Benth. (Fig. 1E),
Eglandular uniseriate, macroform, distinct base, blunt tips. Simple hairs on stem, calyx glandular or eglandular hair.

4. *Eremostachys vicaryi* (Rech. f.) Benth. (Fig. 1B),
Eglandular, uniseriate, microform and branched, short, often glandular, straight, distinct base widely distributed. Simple short branched hair mainly on veins.

5. *Eremostachys thyrsiflora* Benth. (Fig. 1A, C&D).
Eglandular, uniseriate, macroform and microform, short, straight, rough surface. Calyx with short stellate dendroid hairs with long simple multicellular hair.

10. *Hymenocrater* Fish. & Mayer
Hymenocrater sessilifolius Benth.
Eglandular or glandular uniseriate, microform straight, pointed tip. Short capitate glandular hair.

11. *Isodon* (Schard. ex Benth.) Spach.
Isodon rugosus (Wall ex Benth.) Codd.
Eglandular, branched, uniseriate, long, ribbon like, densely distributed acute tips. Small stellate dendroid hairs.

12. *Lavendula* L.
Lavendula angustifolia Miller
Eglandular, uniseriate, branched, long ± distinct base acute tip densely distributed. Small stellate hair. Lepidote – stellate hair.

13. *Lagochilus* L.
Lagochilus cabulicus Benth.
Eglandular, uniseriate, long, conical, curved acute tips. Fruit short eglandular hairs

14. *Leucas*
Eglandular, uniseriate, macroform, long thin, pointed tips. ± distinct base. Densely distributed.

Key to the Species
+ Trichomes stellate _____ *Leucas aspera*
- Trichomes not stellate *Leucas lanata*
Leucas urticifolia

1. *Leucas aspera* (Willd.) Link.
Eglandular, uniseriate macroform, thin, conical, pointed tips ± distinct swollen base ± straight. Calyx densely stellate dendroid hairs.

2. *Leucas lanata* Benth.
Eglandular, uniseriate, macroform, pointed tips distinct base ± straight. Densely distributed. Sparse retrorse hispidulus hairs. Leave thin eglandular hairs.

3. *Leucas urticifolia* (Vahl.) R. Br.
Eglandular, uniseriate, long, thin, pointed tip ± distinct base, densely disturbed. Short retrorse eglandular hairs.

15. *Lamium* L.
Eglandular, uniseriate, thin, long, pointed tip, straight, base distinct or indistinct. Densely distributed.

Key to the Species
+ Trichomes base indistinct *Lamium album*
- Trichomes base distinct _____ *Lamium amplexicaule*

1. *Lamium album* L.
Eglandular, uniseriate, microform and macroform, long and short, thin, pointed ± indistinct base widely distributed. Few short capitate hairs. Leaves thin eglandular hairs.

2. *Lamium amplexicuale* L.
Eglandular, uniseriate, macroform, long, thin pointed tip, middle cell long and cylinder like, Sparsely distributed. Short retrorse eglandular hairs.

16. *Marrubium* L.
Marrubium anisodon C. Koch.
Eglandular, unicellular, macroform stellate branched hair, long, acute tip, ± distinct base. Stellate pilose hairs.

17. *Mentha* L.
Eglandular, uniseriate, macroform, long, macroform thin, surface rough, acute pointed tips. ± distinct base.
1. Mentha arvensis L.

Eglandular, uniseriate, macroform and microform, long, thin, rough surface, acute pointed tips ± distinct base. Eglandular simple usually retrorse hairs.

2. *Mentha longifolia* (L.) L.
Eglandular, uniseriate, macroform, long, thin, ribbon like, surface rough, acute pointed tips ± distinct base. Variable hairs from short pilose to crisped or simple hairs.

18. ***Nepeta*** L.
Eglandular, uniseriate, macroform or microform, branched or unbranched, long hair ribbon like short conical apex, base more co less distinct often stellate widely distributed.

Key to the Species

1. \+ Trichomes stellate _____ *Nepeta paulsenii*
   \- Trichomes not as above __ 2.
2. \+ Trichomes branched ____ *Nepeta juncea*
   \- Trichomes unbranched ___ 3.
3. \+ Trichomes macroform ___ *Nepeta cataria*
   Nepeta discolor
   \- Trichomes microform ____ *Nepeta erecta*

1. *Nepeta cataria* L.
Eglandular, uniseriate, macroform, long, thin, ribbon like, rough surface acute pointed tip, ± distinct base. Densely distributed. Rarely middle cell bigger.

2. *Nepeta discolor* Royle ex Benth.
Eglandular, uniseriate, microform, rarely macro long, conical, thin acute, ± distinct base. Densely distributed. Eglandular tomentose short white hair, glandular pilose above.

3. *Nepeta juncea* Benth.
Eglandular, uniseriate, branched and un branched and capitate (unicellular) long and short, base not distinct tip acute. Densely distributed.

4. *Nepeta paulsenii* Briquet.
Eglandular, uniseriate, stellate macro and microform, long ribbon like and short conical apex and tapering base. Densely distributed. Arrow like in shape.

5. *Nepeta erecta* (Royle ex Benth.) Benth.
Englandular or glandular, small microform with glands, long conical shape apex conlike base stalk thin acute tip ± distinct base. Densely distributed. Short pilose eglandular hairs or finely papillose eglandular hairs. Glandular densely on petiole.

19. ***Ocimum*** L.
Ocimum americanum L.
Eglandular, long and short, uniseriate, ribbon like, macroform, rounded tip base not distinct. Densely distributed.

20. ***Origanum*** L.
Origanum vulgare L.
Eglandular, glandular, conical, short and long (microform and macroform), thin, densely distributed surface rough.

21. ***Otostegia*** Benth.
Otostegia auchri Boiss.
Eglandular sparsely distributed. Microform, conical. Distinct base.

22. ***Perovskia*** Karel.
Eglandular, uniseriated, branched or unbranched long or short; base indistinct, widely distributed, tip acute pointed.

Key to the Species

+ Trichomes short branched ____ *P. atriplicifolia*
- Trichomes long unbranched _____ *P. abrotanoides*

1. *Perovskia abrotanoides* Karel.

Eglandular, uniseriate, long, ribbon like, pointed tip ± indistinct base. Densely distributed.

2 *Perovskia atriplicifolia* Benth. (Fig. 2C & D),

Eglandular, uniseriate, short, branched (stellate), densely distributed, base not distinct, tip acute. Short simple and adpressed dendroid – stellate eglandular hairs few capitate hairs.

23. *Phlomis* L.

Eglandular, uniseriate, stellate, variable, base distinct or indistinct, tip acute. Densely distributed

Key to the Species

+ Trichomes stellate_____ *Phlomis cashmeriana*
- Trichomes not stellate___*Phlomis bracteosa*

1. *Phlomis bracteosa* Royle ex Benth. (Fig. 2B),

Eglandular, uniseriate, short, stellate, acute, distinct base, densely distributed. Simple retrorse eglandular hairs.

2. *Phlomis cashmeriana* Royle ex Benth. (Fig. 2A),

Eglandular, uniseriate, stellate, long macroform acute tip base not distinct. Stellate hairs. Calyx densely dendroid stellate hairs.

24. *Salvia* L.

Eglandular, uniseriate, short or long, thin, surface rough. Base not distinct, apex acute. Densely distributed.

Key to the Species

1. + Trichomes sparsely distributed ___ *Salvia macrosiphon*
   - Trichomes densely distributed _____ 2.
2. + Trichomes short (microform) _ *S. santolinifolia*
   - Trichomes macroform _____ *Salvia moocroftiana*
     Salvia splendens
     Salvia aegyptiaca
     Salvia cabulica

1 *Salvia aegyptiaca* L. (Fig. 3C & D),

Glandular uniseriate, long and short, stellate, thin, rarely eglandular, conical, surface rough, base not distinct, acute or pointed tips. Densely distributed. Short long retrorse eglandular hairs, capitate glandular hairs on inflorescence.

2. *Salvia cabulica* Benth. (Fig. 3A & B),

Glandular, uniseriate, long, thin, surface rough, base not distinct acute tip. Densely distributed. Eglandular, ribbon like.

3. *Salvia macrosiphon* Boiss (Fig. 4D),

Glandular, uniseriate, long, macroform and microform thick rough base, ± distinct. Densely sparsely distributed. eglandular pilose, short glandular hairs.

4. *Salvia moocroftiana* Wall ex Benth. (Fig. 4E),

Eglandular, uniseriate, long and short, branched, conical shape, apex acute base cylindrical ± indistinct. Densely distributed. Below glandular, above densely pilose glandular.

5. *Salvia santolinifolia* Boiss.

Eglandular, uniseriate, short (microform) acute base not distinct. Densely distributed. Glandular retrorse long hairs. Flower fruit short eglandular hairs.

6. *Salvia splendens* Sellow ex Roem. & Schultes. (Fig. 4A-C),
Glandular, uniseriate, short or long, acute tips indistinct base, sparsely distributed. Rarely eglandular short, thin.

25. *Satureja* L.
Satureja hortensis L.
Eglandular, glandular long, short, brush shape stellate, pointed tip. Sparsely distributed stellate not common. Stem short retrorse hairs, leaves simple hairs.

26. *Scutellaria* L.
Eglandular or glandular, long or short, conical shape tip, acute, uniseriate, base distinct or indistinct. Densely distributed.

Key to the Species

1. + Eglandular _____ *Scutellaria chamaedrifolia*
   - Eglandular or glandular __ 2

2. + Base not distinct ____ *Scutellaria edelbergii*
   - Base distinct _____ *Scutellaria multicaulis*

1. *Scutellaria chamaedrifolia* Hedge & Paton
Eglandular, uniseriate, long, conical shape tip acute, base distinct. Often glandular.Densely long retrorse eglandular hairs. Leaves with dense ad pressed stiff eglandular hairs

2. *Scutellaria edelbergii* Rech.f. (Fig. 5C & D),
Eglandular, glandular, rough uniseriate, long or short. Densely distributed point tip. Stem dense glandular hairs.

3. *Scutellaria multicaulis* Boiss
Eglandular or glandular long, ± distinct base rough surface, acute or pointed tips. Densely distributed. Short dense eglandular, retrorse hair, dense short eglandular hair.

4. *Stachys parviflora* Benth. (Fig. 5A & B),
Eglandular, uniseriate, macroform , branched, stellate long, acute tip, base indistinct. Densely distributed. Densely woolly stellate-dendroid hair.

27. *Teucrium* L.

Eglandular, uniseriate, macroform, long acute tips, base ± distinct, surface rough. Densely distributed.

Key to the Species

+ Trichomes stellate_____ *Teucrium quadrifarium*
- Trichomes not stellate___*Teucrium royleanum*

1. *Teucrium quadrifarium* Buch. – Ham ex D. Don.

Eglandular, uniseriate, macroform long, acute tip base ± distinct, rough surface. Densely distributed. Long spreading eglandular hairs and dense glandular hairs

2. *Teucrium royleanum* Wall ex Benth.

Eglandular, uniseriate, macroform, acute tips base ± distinct, surface rough. Densely distributed. Short glandular crisped retrorse hairs, on corolla glandular hairs.

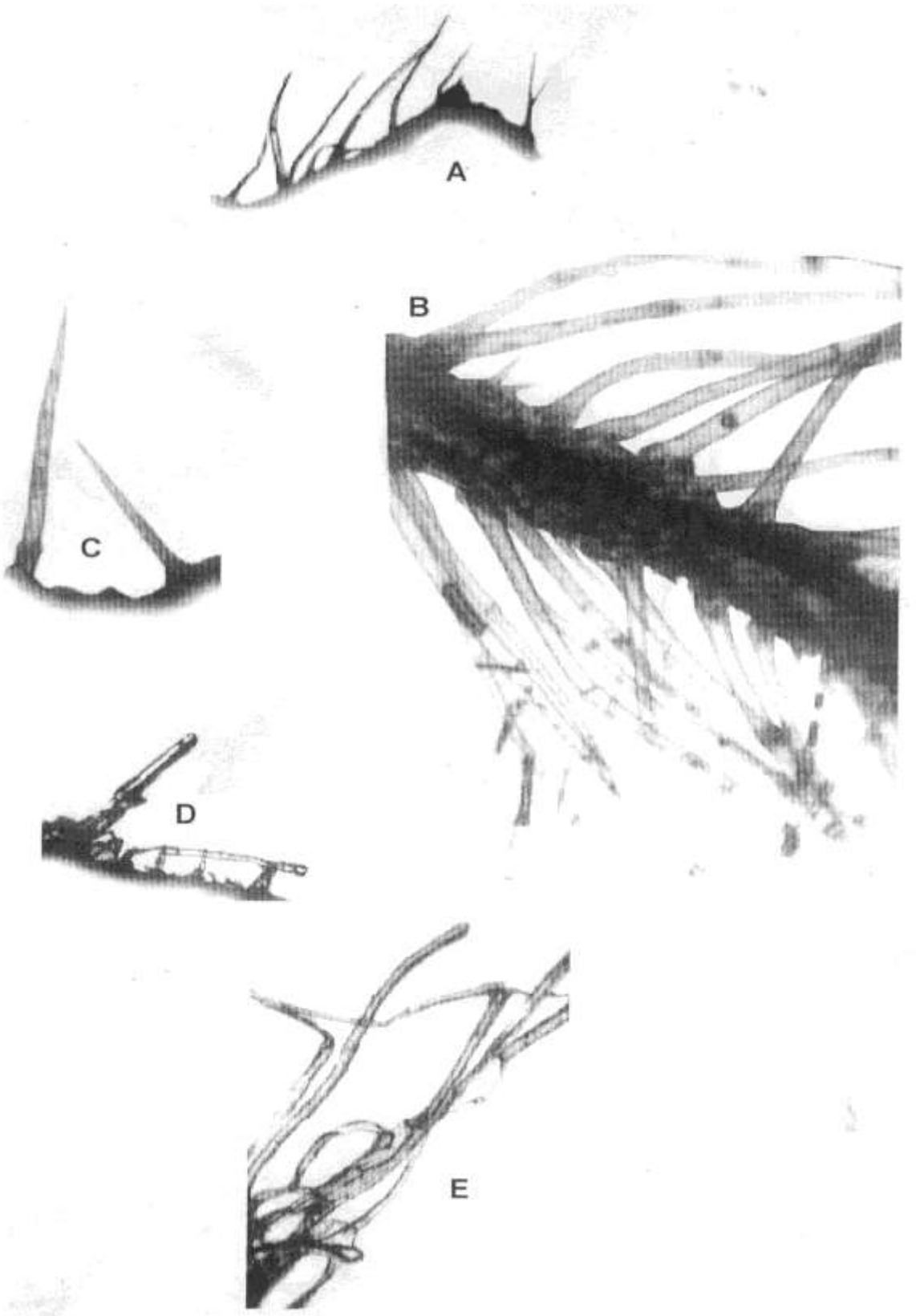

Fig.1. Light micrographs of Labiatae trichomes; A,C & D, *Eremostachys thysiflora*, B, *R. vicaryi*, E, *E. superba.*

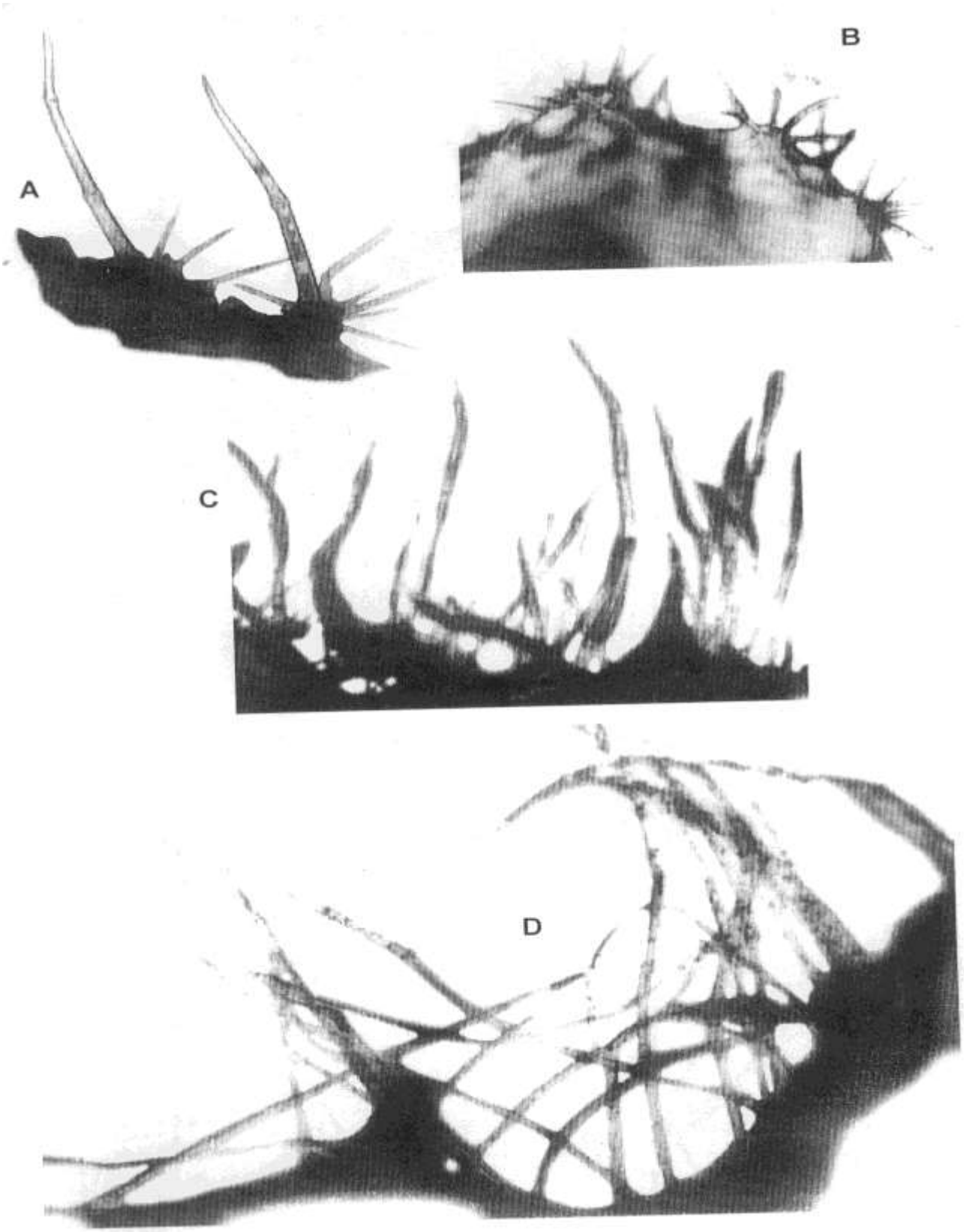

Fig.2. Light micrographs of Labiatae trichomes; A, *Phlomis cashmeriana*, B, *P. bracteosa*, C & D, *Perovskia atriplicifolia.*

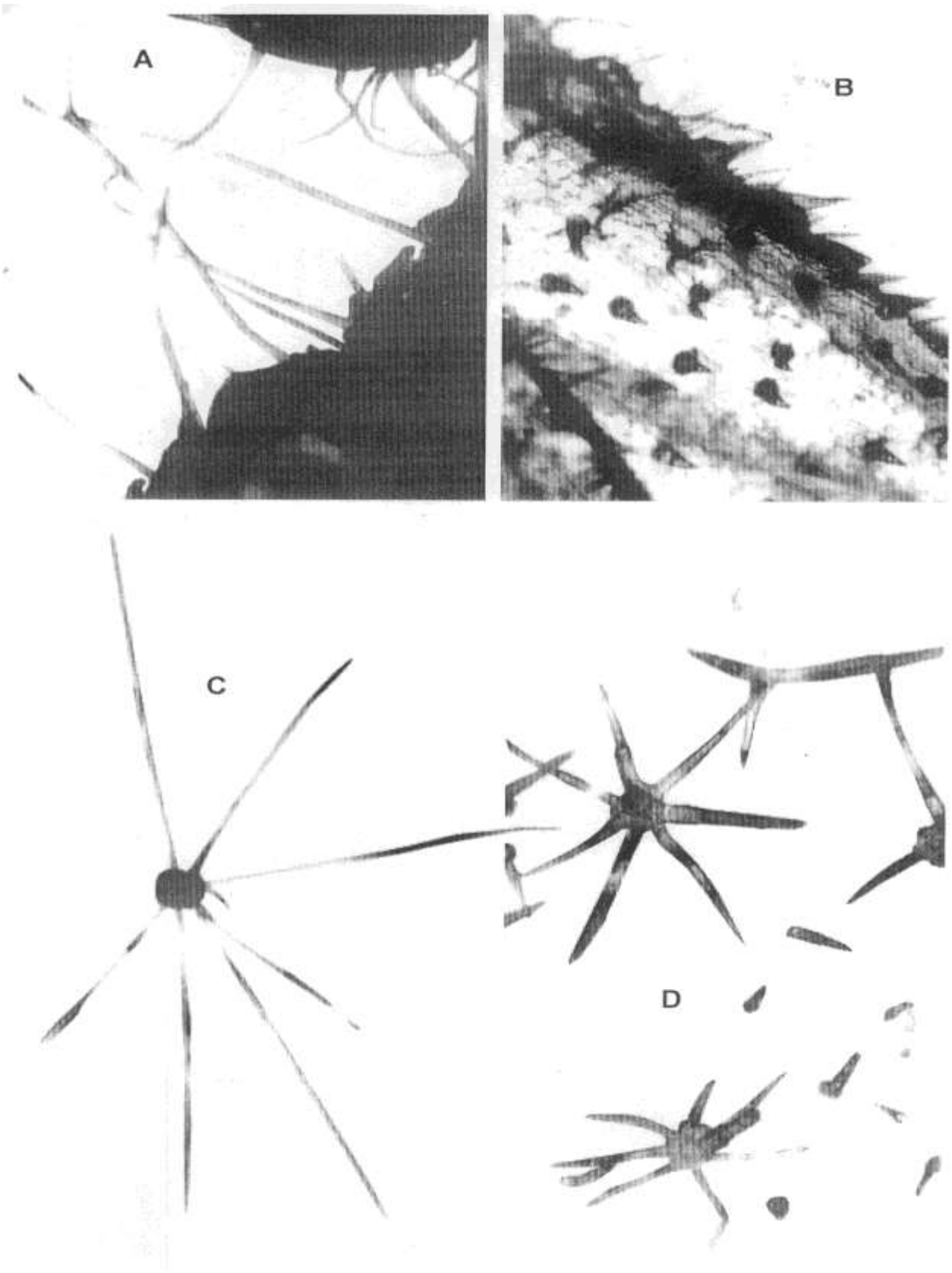

Fig.3. Light micrographs of Labiatae trichomes; A & B, *Salvia cabulica*, C & D, *S. aegyptiaca* (x 10).

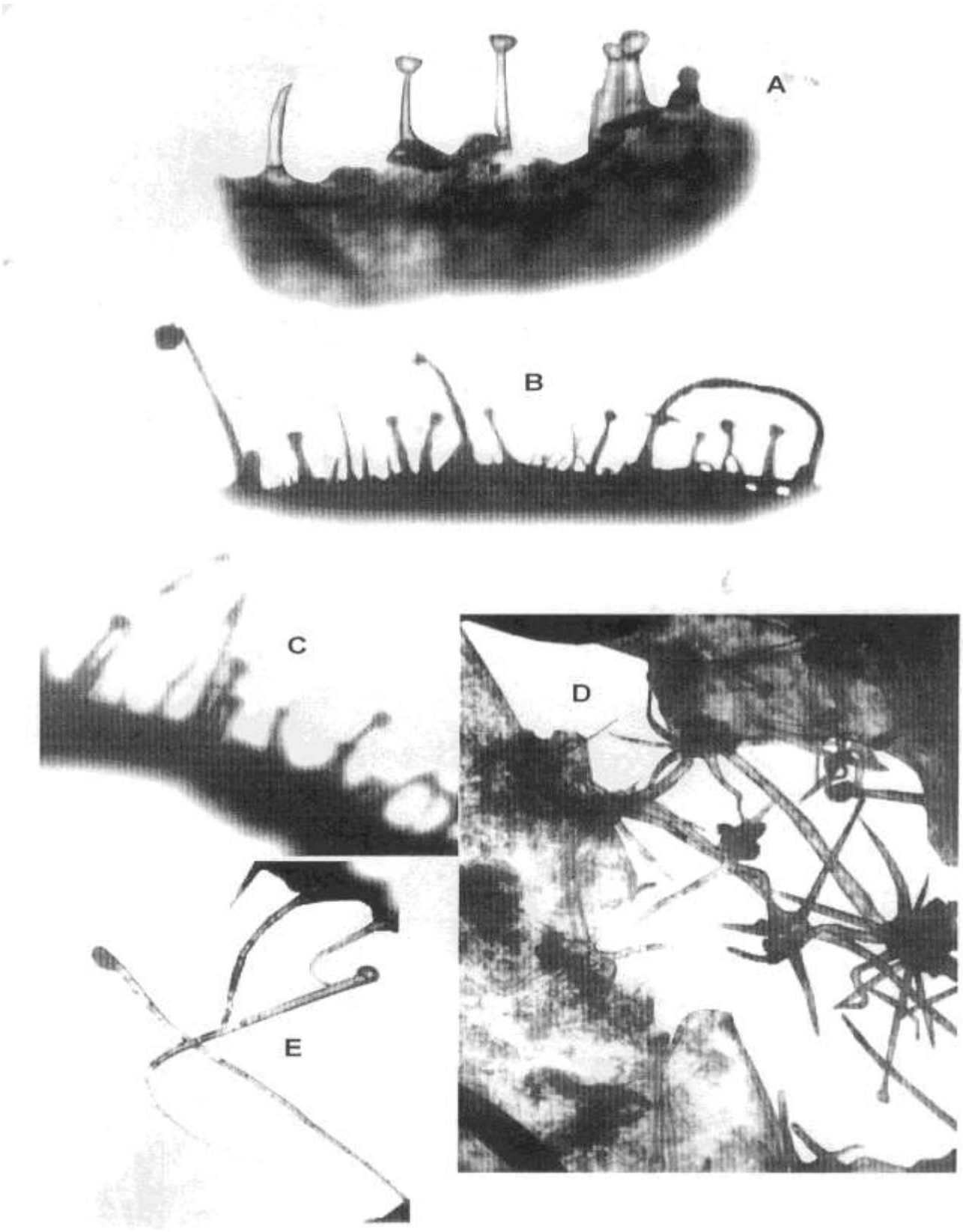

Fig.4. Light micrographs of Labiatae trichomes; A-C, *Salvia splendens*, D, *S. macrosiphon*, E, *S. moocroftiana*.

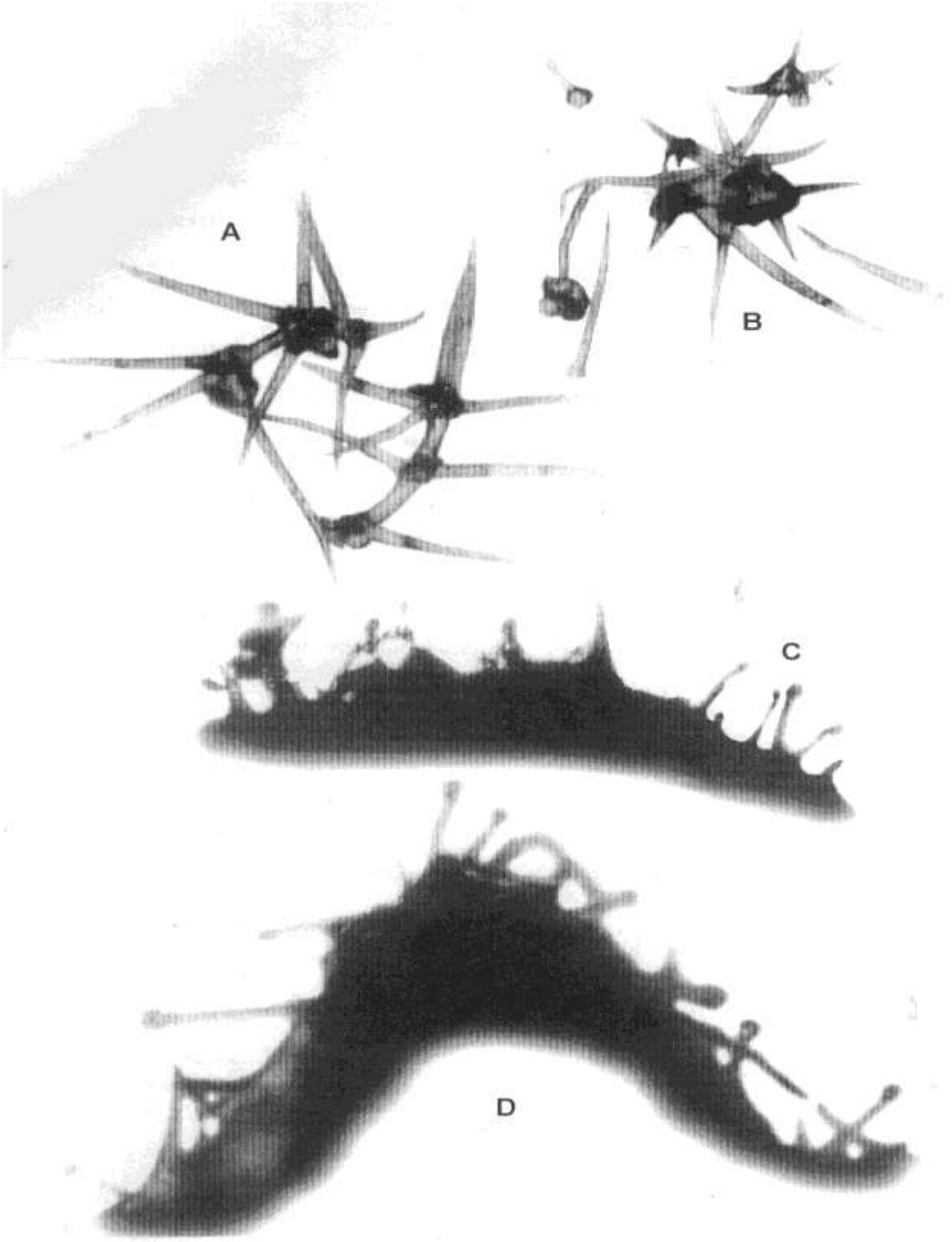

Fig.5. Light micrographs of Labiatae trichomes; A & B, *Stachys parviflora, C & D,* Scutellaria edelbergii (x 10)

DISCUSSION

Within the family Labiatae generally eglandular rarely glandular, uniseriate (2-4-celled) often unicellular trichomes are found. Parbhakar and Leelavathi (1989) studied trichomes morpohology of 209 species from India. Rejdali (1991) reported eglandular, glandular, unicellular or multicellular trichomes in the family Labiatae. In the family Labiatae two types of trichomes are found on leaves and stem such as peltate and capitate (Pierce *et al*., 2001)

Trichomes morphology of 53 species representing 27 genera have been examined by light and scanning microscope. Trichomes are various in length ribbon like and short conical or cylindrical trichomes with acute tips. In few genera stellate trichomes are also found. Within the present study the trichomes morphology is significantly useful at the specific and the generic level (see key to the species). On the basis of trichomes morphology family Labiatae is divided into six trichomes types viz., I: Uniseriate macroform trichomes– type, II: Uniseriate microform trichomes-type, III: Uniseriate macro & microform trichomes-type, IV: Unicellular or uniseriate moliniform trichomes -type, V: Stellate trichomes -type and VI: Branched trichomes– type.

I: Uniseriate macroform trichomes - type is characterized by having long trichomes mostly act end some are very long like ribbon, cell without septa. 18 species are included in this type, viz., *Ajuga bracteosa* Wall ex Benth, *Ajuga parviflora* Benth., *Colebrookea oppositifolia* Smith., *Elsholtzia ciliata* (Thenb) Hylander, *Elsholtzia densa* Lab., *Eremostachys edelbergii* Rech. f., *Eremostachys lasifolia* Benth., *Eremostachys superba* Royle ex Benth. *Isodon rugosus* (Wall ex Benth.) Codd. *Lavendula angustifolia* Miller, *Lagochilus cabulicus* Benth., *Leucas aspera* (Willd.) Link., *Leucas lanata* Benth., *Marrubium anisodon* C. Koch., *Mentha longifolia (*L.) L, *Nepeta cataria* L., *Ocimum americanum* L., *Perovskia abrotanoides* Karel., *Salvia cabulica* Benth., *Scutellaria chamaedrifolia* Hedge & Paton, *Stachys parviflora* Benth., *Teucrium quadrifarium* Buch. – Ham ex D. Don., *Teucrium royleanaum* Wall ex Benth. However, in *Mentha longifolia (*L.) L., *Nepeta cataria* L., *Ocimum americanum* L., *Perovskia abrotanoides* Karel. and *Salvia cabulica* Benth.long ribbon like trichomes are found.

II: Uniseriate microform trichomes-type is characterized by 2-8 celled trichomes small trichomes. *Eremostachys vicaryi* (Rech. f.) Benth., *Hymenocrater sessilifolius* Benth and ., *Otostegia auchrei* Boiss. III: Uniseriate macro and micro trichomes is easily recognized by its long and short trichomes within the same species. It is the largest trichomes type among all the six types, 26 species are included in this type viz., *Ajuga bracteosa* Wall ex Benth, *Calamintha hydaspidis* (Falconer ex Benth.) Hedge, *Clinopodium umbrosum* (M. Bieb.) C. Koch., *Craniotome furcata* (Link) O. Kuntze, *Dracocephalum nutans* L., *Elsholtzia ciliata* (Thenb) Hylander, *Elsholtzia densa* Lab., *Eremostachys thyrsiflora* Benth., *Lavendula angustifolia* Miller, *Lagochilus cabulicus* Benth, *Leucas urticifolia* (Vahl.) R. Br., *Lamium album* L., *Lamium amplexicuale* L., *Mentha arvensis* L., , *Nepeta discolor* Royle ex Benth., *Nepeta paulsenii* Briquet, *Nepeta erecta* (Royle ex Benth.) Benth., *Origanum vulgare* L *Salvia aegyptiaca* L, *Salvia macrosiphon* Boiss., *Salvia noocroftiania* Wall ex Benth., *Salvia santolinifolia* Boiss., *Salvia splendens* Sellow ex Roem. & Schultes., *Scutellaria chamaedrifolia* Hedge & Paton, *Scutellaria edelbergii* Rech.f., and *Scutellaria multicaulis* Boiss. IV: Uniseriate moniliform– type, one pecies has this characteristic trichomes type i.e., *Ajuga pareviflora* V: Stellate trichomes –type, six species have stellate type of of trichomes such as, *Nepeta paulsenii* Briquet, *Perovskia atriplicifolia* Benth., *Satureja hortensis* L., *Stachys parviflora* Benth.,*Phlomis bracteosa* Royle ex Benth., *Phlomis cashmeriana* Royle ex Benth. VI: Branched trichomes – type, this type found only in the singly species i.e., *Nepeta juncea* Benth.

ACKNOWLEDGEMENTS

This project was funded by a grant from Dean, Faculty of Science, University of Karachi, thankfully acknowledged. I am also grateful to the director of Biological Research Center, University of Karachi for providing facilities of scanning microscope.

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(*Accepted for publication March 2006*)