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TWO NEW SPECIES OF *EUPHRASIA* (OROBANCHANCEAE) FROM PAKISTAN AND ADJOINING AREAS

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Abstract

A morphological analysis of *Euphrasia densiflora* complex and *E. jaeschkei* complex from Pakistan and adjoining areas was carried out. Principal component analysis of 46 OTU's for E. *densiflora* complex and 27 OTU's for *E. jaeschkei* were employed which resulted in the recognization of *E. densiflora* Pennell *sensu stricto*, E. *jaeschkei* Wettst. *sensu stricto* and two new species *E. omeri* Qaiser & T. Siddiqui and *E. alii* Qaiser & T. Siddiqui. The relationship of the allied species has also been discussed.

Introduction

The genus *Euphrasia* L. formerly treated under the family *Scrophulariaceae,* is now placed under *Orobanchanceae* along with other parasitic and hemiparastic genera on the basis of molecular evidence (Olmstead *et al*. 2001; Bennett & Mathews, 2006). The genus *Euphrasia* is fairly large with c. 450 species (Mabberley, 2008), distributed in both the hemispheres in Europe, Asia, Northern parts of America, mountains of Indonesia to New Zealand and south southern part of South America. In Pakistan it is confined between 1200-5000m in the northern mountainous ranges of Himalayas, Karakorum and Hindukush. The genus shows little character differences and a satisfactory treatment of the genus is rather difficult. The situation is further complicated by interspecific hybridization (Yeo, 1956, 1966) and seasonal diamorphism i.e., early summer forms (aestival) and late summer forms (vernal). Both aestival and vernal forms have already been reported by number of workers in various species of *Euphrasia* (Yeo, 1978; Karlson1984, 1986; Siddiqui & Qaiser, 1991; Siddiqui 1993). These forms are so distinct form each other that they can easily be mistaken for two different entities.

Stewart (1972) reported 20 species of *Euphrasia* from Pakistan and Kashmir. Siddiqui & Qaiser (1991) while conducting biosystematic studies of the genus recognized 31 taxa from Pakistan and adjoining areas including three new records and several new taxa. However, no specific rank was accorded at that time in view of paucity of material. As more material has been examined, the present study has been undertaken. During the preparation of an account of the genus Euphrasia for Flora of Pakistan the senior authors came across a number of specimens though apparently looking like *E. densiflora* Pennell or *E. jaeschkei Wettst*., but differing in several morphological characters. Therefore in order to assess and evaluate the variability found in these taxa a large number of specimens from their entire range of distribution, present in the following herbaria, BM, GH. K, KUH, MICH, NY, PH, RAW, US and WU were studied and numerically analyzed. The present study revealed the occurrence of two new species.

Materials and Methods

Large number of specimens belonging to *E. densiflora* complex and *E. jaeschkei* complex were studied. A variation in 30 qualitative and quantitative characters was observed in *E. densiflora* Pennell (s.l.), (Table-1). However, for the purpose of principal component analysis the data based on 20 quantitative characters was analyzed. Whereas in case of *E. jaeschkei,Wettst.(s.l.),* analysis was based on 20 binary coded qualitative and quantitative characters (Table 3). For numerical analysis complete specimens with flowers and fruits were considered. Therefore 46 and 27 OTU's for *E. densiflora* and *E. Jaeschkei* respectively, were used for principal component analysis (PCA) and sum of square clustering analysis (SSA) (Orloci & Kenkel, 1985).

Table 1. Variables examined for in the study *of Euphrasia densiflora* sensu lato,only quantitative variables were used for PCA.

	Quantitative	Symbol		Qualitative	Symbol
1.	Bract length	BL	16.	Capsule breadth	CB
2.	Bract breadth	BB	17.	Leaf length	LL
3.	Total calyx length	TKL	18.	Leaf breadth	LB
4.	Calyx lobe length	KLL	19.	Flower length	FLL
5.	Calyx lobe breadth	KLB	20.	Corolla tube length	CTL
6.	Total corolla length	TCL	21.	Type of branches: stiff/lax	TB
7.	Length of the upper lip of corolla	ULL	22.	Branching density: dense/not dense	BrD
8.	Length of lower lip of corolla	LLL	23.	Bract shape: ovate/ broadly ovate	BS
9.	Length of the left lobe of the lower lip	LL/I	24.	Equality of calyx lobe: equal/unequal	EKL
10.	Breadth of the left lobe of the lower lip	LL/b	25.	Apices of lower lip: Erose-slightly notched/erose-deeply Notched	ALL
11.	Length of the middle lobe of the lower lip	ML/I	26.	Equality of the lobes of the lower lip: equal/unequal	ELL
12.	Breadth of the middle lobe of the lower lip	MLIB	27.	Capsule tip: retuse/emerginate	CT
13.	Length of the right lobe of the lower lip	RLII	28.	Density of bract indumentum: Hairs evenly distributed / only at the margin of the lobes	DBI
14.	Breadth of the right lobe of the lower lip	RLIB	29.	Equality of the calyx and the capsule: capsule equaling the calyces/capsule shorter than the calyces	ECK
15.	Capsule length	CL	30.	Apex of the bract: Acute-Acuminate/ obtuse	BM

Scanning electron microscopy: The seed surface was studied with the help of SEM using Joel JSM-T-200. The material was coated with gold by the conventional method.

Results and Discussion

i. Euphrasia densiflora complex: *Euphrasia densiflora* Pennell grows in Western Himalayas, Karakorum and Hindu Kush ranges in open grasslands and rocky hills at an elevation of 3000-5000m. It is a variable species and exhibits seasonal diamorphism. Siddiqui & Qaiser (1991) and Siddiqui (1993) observed both types of growth forms i.e., aestival and vernal forms in this species.

The biplot (Fig. 1) shows the first two components that together account for 34% variation, while the first three components together account for 45.7% of the total variability of the data matrix. The first principal component, (Table 2) which shows 18.7% of the total variability is primarily a function of the following characters: calyx lobs length (KLL), corolla tube length (CTL), breadth of left lobe of lower lips (LL/b) and flower length (FLL). The second component accounts for 15.3% of the total variation is chiefly controlled by the length of the upper lip of corolla (ULL), total calyx length (TKL), total corolla length (TCL) and length of the lower lip (LLL). The third component accounts for 11.7% of the total variability which is largely attributed to bract length and breadth (BL, BB), capsule length (CL), and flower length (FLL). The scatter of points clearly shows the prevalence of two distinct groups A and B (Fig. 2). Pennell (1943) based his new species *E. densiflora* on the following type from Kashmir, Rattu to Rupal Nullah, Astore (*R.R. & I.D. Stewart 1852* PH!, Iso NY!, RAW!). This type specimen has also been included as an OTU in the present study. The type of *E. densiflora* falls within group 'A', delineated by Principal Component Analysis, thus represents true *E. densiflora* Pennell, and group 'B' represents a new taxon which is described here as a new species *E. omeri* Qaiser & T. Siddiqui. None of the OTU's occupy intermediate position in the PCA configuration.

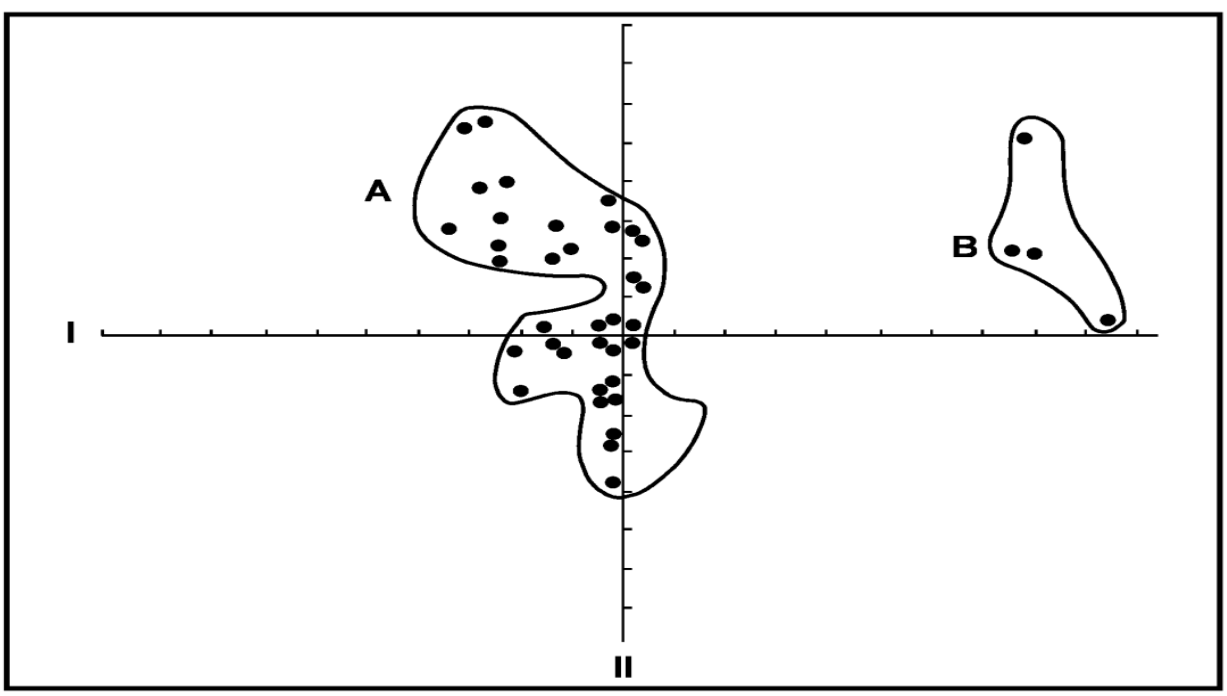

Fig.1. A biplot showing the distribution of OTU's on the first two principal components. The groups are A = *Euphrasia densiflora*; B = *Euphrasia omeri*.

Table 2. Result of principal component analysis (PCA) of 46 OTUs using 20 quantitative characters. Eigen values and ranked eigenvectors coefficients (first four) together with associated variable for the first three principal components.

Components	Eigen value	% of variance explained	% of cumulative variance	First four ranked eigen vector elements	Associated variables
1	3.74	18.7	18.7	0.467	KLL*
				0.467	CTL
				0.427	LL/b
				0.367	FLL
2	3.05	15.3	34.0	0.404	ULL
				0.380	TKL
				0.354	TCL
				0.350	LLL
3	2.33	11.7	45.7	0.515	BL
				0.512	BB
				0.299	CL
				0.291	FLL

For symbols see table 1

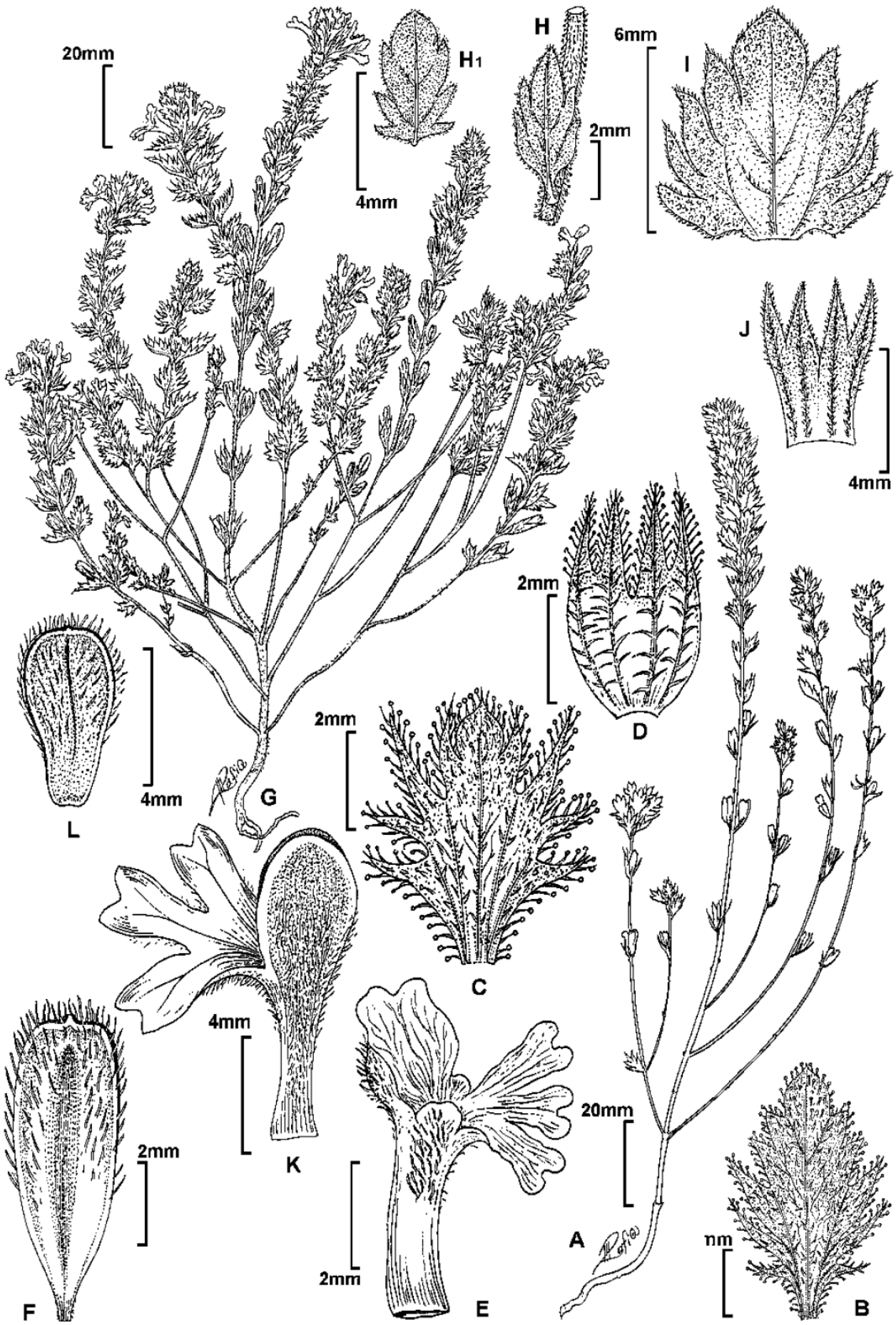

Fig.2. *Euphrasia densiflora*: A, flowering twig; B, cauline leaf; C, floral leaf; D, calyx; E, corolla; F, capsule. *Euphrasia omeri*: G, flowering twig; H, cauline leaf; I, floral leaf; J, calyx; K, corolla; L, capsule.

Table 3. List of characters used in the PAC analysis of *E. jaeschkei* complex alongwith the character state coding.

Characters	State codes		Symbol
Node of flowering	1st flower at node 2-3	1st flower above node 3	NF
Type of branches	Branches stiff	Branches lax	BrT
Branching density	Branching dense	Branching not dense	BrD
Inflorescence type	Raceme dense and broad	Raceme lax and narrow	RT
Bract length	3-7 mm	7.1-11mm	BL
Bract breadth	2-5 mm	5.1-10 mm	BB
Bract shape	Ovate	Broadly ovate	BS
Type of hairs	Hairs simple	Hairs glandular	HT
Density of bract or calyx indumentum	Hairs evenly distributed	Hairs on the margins and the lobes only	DBI/DKI
Calyx length	2-4mm	4.1-7 mm	KL
Calyx lobe length	1-3 mm	3.1-5 mm	KLL
Calyx lobe breadth	.5mm	1 mm	KLB
Total corolla length	3-6mm	6.1-12 mm	TCL
Length of the upper lip of the corolla	2-3 mm	3.1-5 mm	ULL
Length of the lower lip of the corolla	2-3 mm	3.1-5 mm	LLL
Apices of the lower lip	Erose-slightly notched	Erose-widely notched	ALL
Equality of the lobes of the lower lip	Left and right lobe equal	Left and right lobes unequal	ELL
Capsule length	2-4mm	4.1-8 mm	CL
Capsule breadth	1-2 mm	2.1-4 mm	CB
Capsule apices	Retuse	Emarginate	CA

1. *Euphrasia omeri* Qaiser & T. Siddiqui **sp. nov.** (Fig. 2, G-L)

Holotypus: Kashmir, Sindh valley, Kangan, 17.6.1900, *Inayat* 25731, (PH!, Isotype K!)

Herba erecta, annua, 15-18cm alta, ramis 5-9-paribus ascendentibus longis rigidis. Caules villosi eglanduloso et glanduloso-pilosi. Internodia basin versus 1-2 cm longa, mediana 0.5-1 cm longa, ad axem floralem c. 0.5 cm vel nulla. Planta e foliorum pare 2-3 primo florens. Folia et calyx ubique glandulso- et eglanduloso-pilosus; pili breves, stipites diametro capituli glanduliferi minus quam 6-plo longiores. Folia caulina 5-7 x 2.5-6 mm, elliptica, 4-1obata; lobi quam lati longiores, terminalis lateralesque acuminati, lobis superioribus antrosis, inferioribus patentibus, bais truncato. Inflorescentia densa. Flores 8-10 mm, pedicellati usque sessiles. Folia floralia 6-7 mm, late ovata, 4-5-lobata; lobus terminalis acuminatus, laterales acuminati vel paulo aristulati, lobi longiores quam latiores, lobis superioribus antrorsis, inferioribus patentibus, basi truncato. Calyx 4-6 mm longus; lobi calyces 2-3 x 0.5-1 mm, aequales vel inaequales; tubus 1-4 mm. Corolla violaceae, externe praecipue in labio superiore pubescens, dorsal iter 7-9 mm; tubus corollae c. 5 mm longus; labium superious 2-4 mm longum, inferius 3-4 mm longum, lobo mediano maximo, 1.5-3 x 1.5-2.5 mm, lobis duobus lateralibus aequalibus 2.5-3 x 1.5-2 mm; lobi omnes oblongi, obcordati, erosis usque paulo emarginatis. Antherae duae aristis aequalibus, ceterae arists inaequalibus, dense pilosae, pilis brevibus aristam longiorem aequantibus. Capsula 4.5-5.5 x 2-2.5 mm, oblonga, retusa, calye brevior, distaliter molliter ciliata. Semina in quaque capsula 8-10, oblonga, 0.5-1.5 x 0.2-0.5 mm,obtusa.

Erect, annual herb, 15-18 cm tall, with 5-9 pairs of ascending long, stiff branches; villose eglandular and glandular hairy. Internodal distance at the base 1-2 cm, at the center 0.5-1 cm, at the floral axis c. 0.5 cm or absent. Flowering begins at node 2-3 (from node 2 in aestival and from node 3 in autumnal form). Leaves and calyx eglandular and glandular hairy all over, hairs short; stalks of the glandular hairs less than 5 x as long as the heads. Cauline leaves 5-7 x 2.5-6 mm, elliptic; 4-1obed; with truncate base; lobes acuminate; longer than broad; upper antrorse, lower patent (c. 5 x 2.5 mm, in aestival and 5.5-7 x 3-6 mm in autumnal form). Racemes dense. Floral leaves 6-7 x 6-7 mm, broadly ovate; 4-5 lobed with cuneate base; terminal lobe acuminate, lateral lobes acuminate-slightly aristulate; longer than broad; upper antrorse, lower patent (c. 6.6 mm and 4-1obed, in aestival and c. 7 x 7 mm and 5-lobed in autumnal form). Flowers 8-10 mm, pedicellate-sessile. Calyx 4-6 mm, lobes 2-3 x 0.5-1 mm; equal or unequal; calyx tube 1-4 mm. Corolla violet, dorsally 7-9 mm long, tube 5 mm, externally pubescent especially on the upper lip. Upper lip 2-4 mm long. Lower lip 3-4 mm long, lobes oblong obcordate; erose-slightly notched; middle lobe largest 1.5-3 x 1.5-2.5 mm, left and right lobes equal, left lobe and right lobe 2.5-3 x 1.5-2 mm. Two anthers with unequal and two with equal awns, densely hairy; equaling the longer awn. Capsule 4.5-5.5 x 2-2.5 mm (c. 4.5 x 2 mm in aestival and 5-5.5 x 2.5 mm in autumnal form), oblong; retuse; shorter than the calyces; ciliate at the upper part; cilia soft. Seeds 8-10 per capsule (c. 8 seeds in aestival and 9-10 seeds in autumnal form), oblong, obtuse.

Etymology: The new species is named after Dr. Saood Omer of Karachi University for his tremendous collections of *Euphrasia* species from northern areas of Pakistan.

Specimen studied: Pakistan: Chitral, Harchin, S. *M Toppin* 663 *(K);* Kashmir, without precise locality, 3.10.1848, *Hook. f et al. s.*n. (K); ibid., *T Thomson s.*n. (K); Deosai plains near Murtaza top, August, 2003, *M Qaiser* & *Jan Alam s.* n. (KUH); India: Kunawar, *T. Thomson* s. *n. (K-p.p.).*

Distribution: Endemic to the Himalayan ranges in Pakistan, Kashmir and India (Fig. 3)

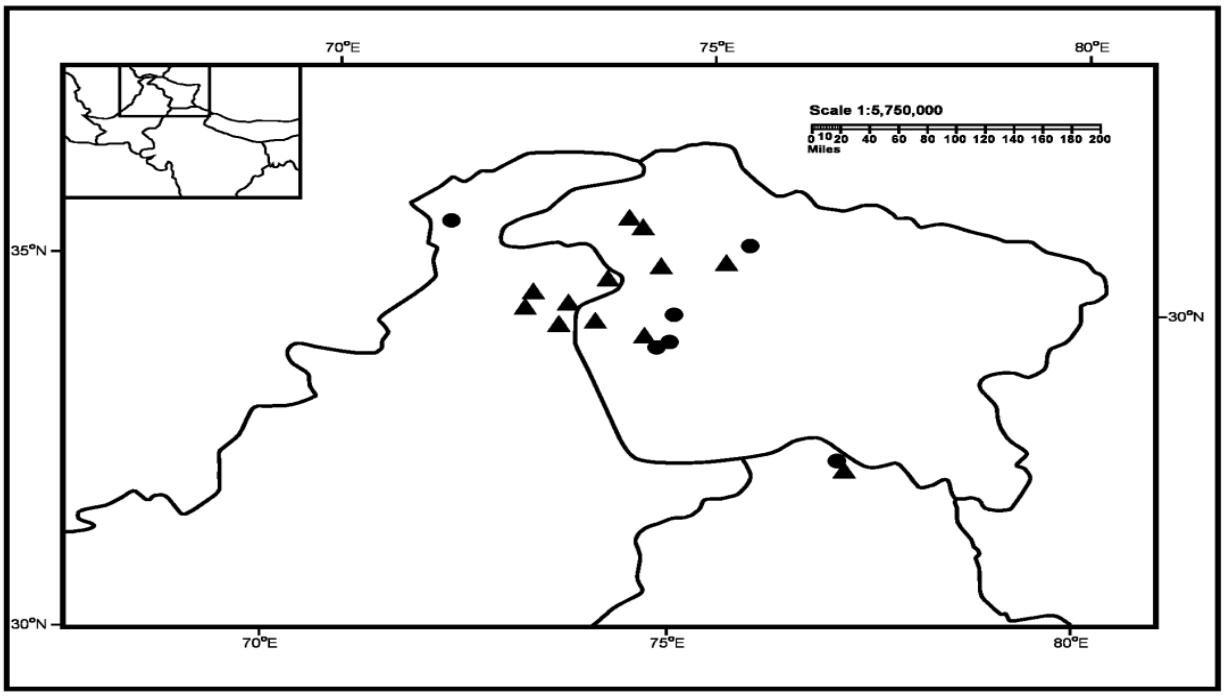

Fig.3. map showing the distribution of (▲) *Euphrasia densiflora*; (●) *Euphrasia omeri*.

Fl. Per.: July- August

The scanning electron microscopic studies of seeds also exhibit differences in *E.* omeri Qaiser & Siddiqui and *E. densijlora* Pennell (Fig. 4). The seed surface of both the taxa has longitudinal ridges traversed by transverse ridges forming shallow-deep areolae but the transverse and longitudinal ridges are ± evenly thickened in *E. omeri*. While the transverse ridges are more thickened than the longitudinal ridges in *E. densiflora.* (Fig. 4)

Note: Yeo (1981), while revising the genus *Euphrasia* for Rechinger Flora Iranica cited following two specimens under *E. pagmanensis* Rech.f., from Chitral, collected by Toppin bearing identical number: Madaklasht 2700. *Toppin* 663 and Harchim 2750 m Toppin 663. He himself mentioned " more braches than usual" we have examined the latter specimen present in Kew, it clearly belongs to our newly described species. This specimen not only differs from typical *E. pagmanensis* Rech. f., by having much more braches but also smaller cauline leaves (5-7) mm long and acuminate terminal lobe of the floral leaves. Where as *E. pagmanensis* is less branched, cauline leaves are large and terminal lobe of the floral leaves is rounded.

Euphrasia densiflora Pennell in Acad. Sci. Philadelphia Monogr. 5: 112. 1943. (Fig. 2, A-F)

Holotype: Pakistan, Kashmir, Rattu Rupal Nullah, Astore, 22.8.1939, *R.R. & I. D.Stewart* 18852 (PH!; Isotypes: NY!,RAW!).

Specimens studied: Pakistan: Swat, near Kalam, 25 miles above Bahrain. *R. J Rodin* 5617 (NY); Utror, *R. R. Stewart* & *A. Rahman* 25236 (RAW); 5 miles from Naran on way to Balakot, *M Qaiser & A. Ghafoor* 5279 (KUH); Naltar, S. *Omer* & *M Qaiser* 2580 (KUH); Nagar, S. *Abedin & M Qaiser* 8932 (KUH); Thalle La, *R. R. Stewart* 20701 (NA, NY, PH, RAW); between Hussainabad village and Skardu, *A. Ghafoor* & Z. *L. Butt* 595 (KUH); Gilgit, Rama, S. *Omer* & *M Qaiser* 2345 (KUH); Above Rattu, Upper Astore Valley, *R. R. Stewart 22783* (PH, K, NA, US); Babusar village, S. *Omer* & *M Qaiser* 2623 (KUH); Deosai plains, *R. R. Stewart* 22198 (NY); Shankargarh to Rattu, *R. R.* & *I D. Stewart; t* 21783 (RAW); Kashmir: Ganderbal, *R. R. Stewart* 179 (RAW); Tangmarg, *R. R. Stewart* 12223 (RAW); Above Pah1gam, *R. R. Stewart* 8434 (NY, PH, RAW); Sumba1, Jhe1um valley, *Ludlow* & *Sherrill* 7698 (BM); Near Sinthan Pass, *Ludlow* & *Sherriff* 8192 (BM); Near Pahlgam toward *Preslan, R. R. Stewart* 21638 (K, NY, PH, RAW, US); Ladakh, Dras, *R. R. Sttwart 21141* (RAW); Kashmir, 30.10.1948, *Hooker* & *T Thomson* s. n. (K); Kostorkut, O. *Polunin 56/723 (BM);* Taubat, *T Ali, M Qaiser* & *M Ajmal* 581 (KUH); Near Taubat, Helmat *T Ali, M Qaiser* & *M Ajmal 607* (KUH); India: Kumaon, *Strachey* & *Winterbottom,* s.n. (K-p.p.).

Distribution: Endemic to Pakistan, Kashmir and India. (Fig. 3)

FL. Per.: Aug. – Sept.

Ecology: Grows in grass or rocky hills at an elevation of 3-5000m.

ii. *Euphrasia jaeschkei* complex

E. jaeschkei Wettst., is distributed from Nepal to Eastern Afghanistan through Kashmir and Northern Pakistan. It grows in open alpine slopes between 3000-3500 m. It is a variable species and also exhibits seasonal variation; both vernal and aestival growth forms are found in this species.

The results of principal component analysis are outlined in Table 4, while Fig. (5) shows the projection of 27 OTUs on the first two principal components. The First two components explained 56.9% of the total variance while the first three components together accounted for

64.9% of the total variability in the data set. The first component of PCA that explains 44.7% of the total variability is primarily determined by total corolla length (TCL), branching density (BrD), raceme type (RT) and capsule apices (CA). The second component that accounts for 12.2% of the total variability is predominately a function of calyx indumentum (DKI), calyx lobe breadth (KLB), density of bract indumentum (DBI) and capsule length (CL) while the third component that explains 8% of the total varation is chiefly related to bract length and breadth (BL, BB) and the lengths of upper and lower lips (ULL, LLL). The scatter of point clearly shows the prevalence of two distinct groups A and B. The lectotype of *E. jaeschkei* Wettst. Himalaya, Kailang, Lahul, *jaeschke* 2 WU!) has also been included as one of the OTUs in the present study. The type of *E. jaeschkei* Wetts. fall within group ' A' delineated by principal component analysis, thus group' A' represents true *E. jaeschkei* Wettst. and group 'B' represents a new taxon which is described here as a new species *E. alii* Qaiser & T. Siddiqui. None of the OTU's occupy intermediate position in the PCA configuration.

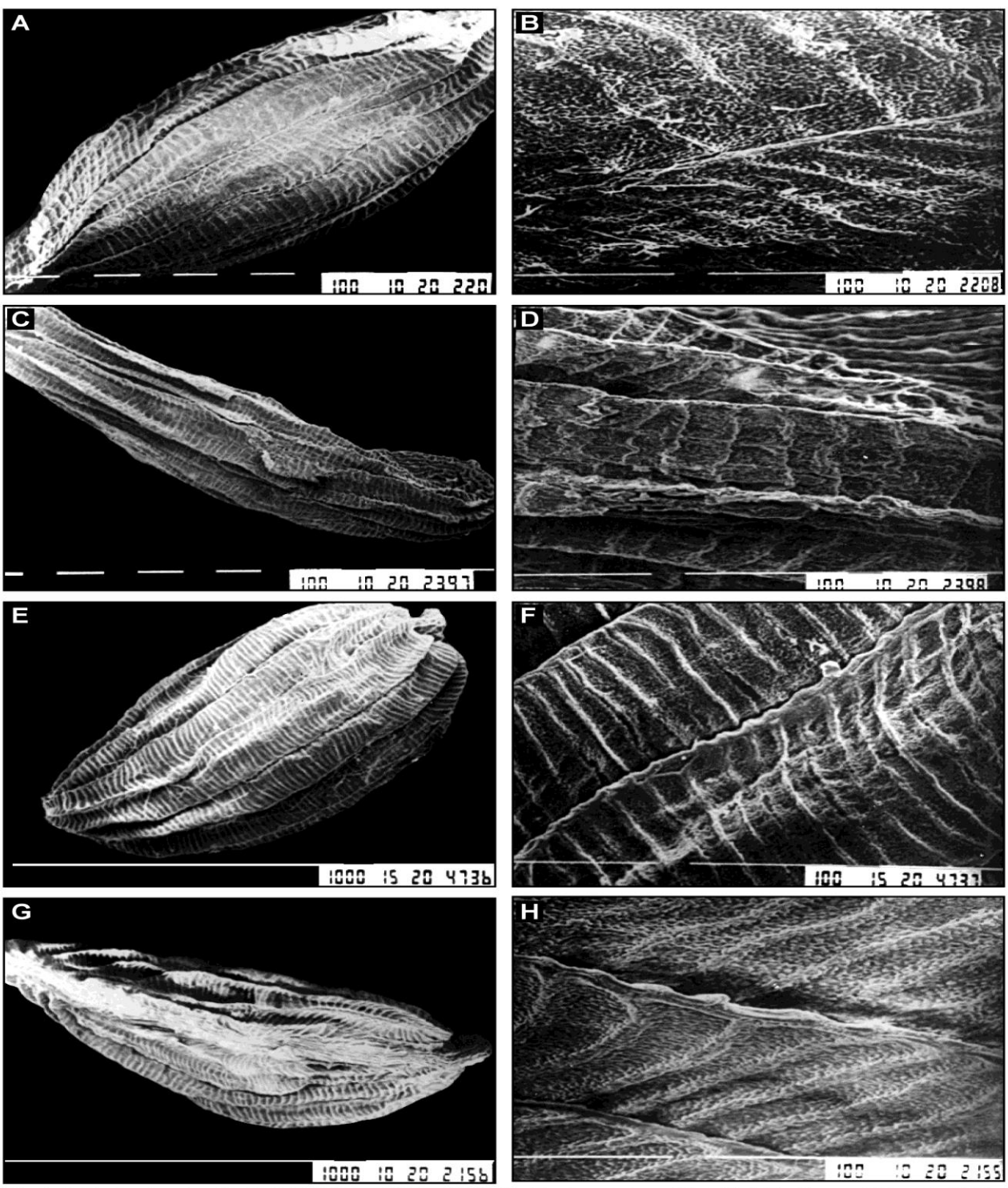

Fig.4. A-B, *Euphrasia alii* (A & B: 1bar = 100 µm); C-D, *Euphrasia jaeschkei* (C & D: 1bar = 100 µm); E-F, *Euphrasia densiflora* (E: 1bar = 1000 µm & F: 1bar = 100 µm); G-H, *Euphrasia omeri* (G: 1bar = 1000 µm & H: 1bar = 100 µm).

Table 4. Result of principal component analysis of 27 OTUs using 20 characters.

Components	Eigen value	% of variance explained	% of cumulative variance	First four ranked eigen vector elements	Associated variables
1	8.936	44.7	44.7	-0.326	TCL
				0.314	BrD
				-0.314	RT
				0.313	CB
2	2.445	12.2	56.9	0.474	DKI
				0.367	KLB
				0.366	DBI
				-0.363	CL
3	1.606	8.0	64.9	0.542	BL
				0.419	BB
				0.418	ULL
				0.366	LLL

For symbols see table 3

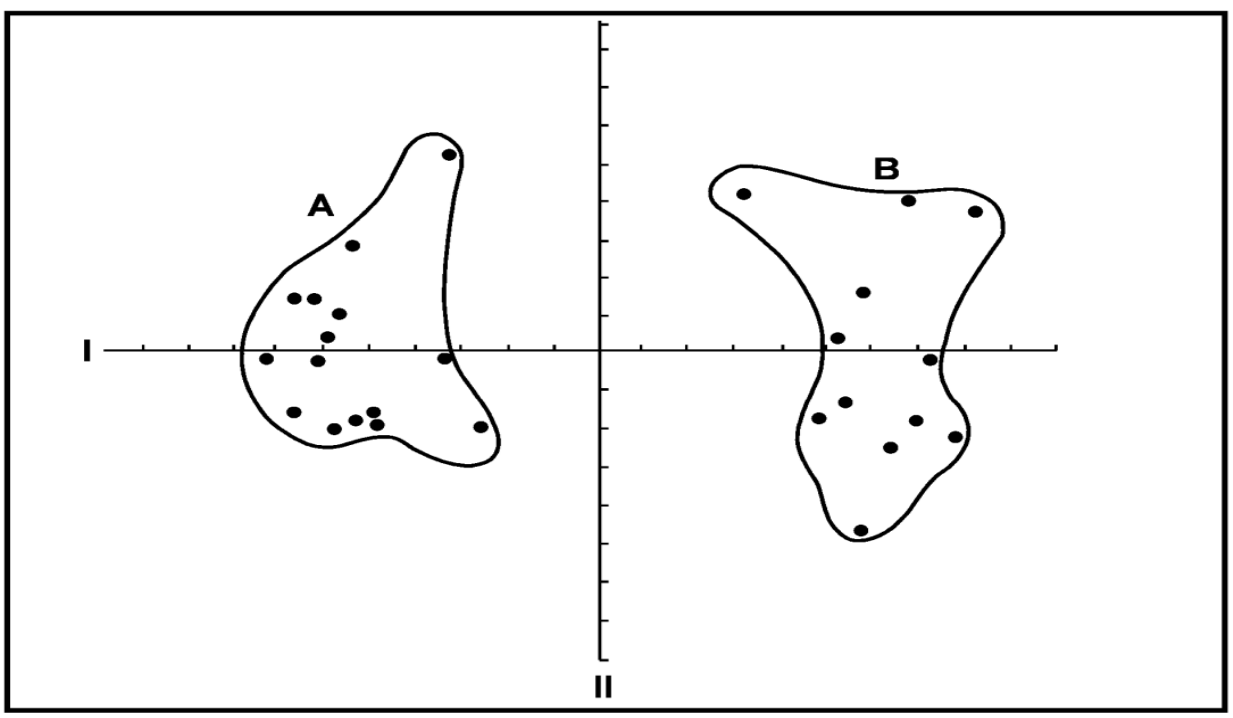

Fig.5. A biplot showing the distribution of OTU's on the first two principal components. The groups are A = *Euphrasia jaeschkei*; B = *Euphrasia alii*.

Euphrasia alii Qaiser & siddiqui **sp. nov.** (Fig. 6 G-L)

Holotypus: lahul, Sisu, Punjab, 7.6.1936 *W. Koelz* 8371(PH!, Isotype-GH!).

Herba erecta ramis 1-7-paribus brevibus vel longiusculis ascendentibus flexuosis densis. Caules villosi, glanduloso- et eglanduloso-pilosi. Internodia basin versus 1.5-3 cm longa, mediana 1.5-2 cm longa, ad axem floralem 0.5-1 cm longa. Planta e foliorum pare 2-3 primo florens. Folia et calyx glanduloso- et eglanduloso-pilosus; pili breves, stipites diametro capituli glanduliferi minus quam 6-plo longiores. Folia caulina 4.5-5.5 x 3 - 4 mm ovata, 3-5-lobata; lobi longiores quam lati, terminalis lateralesque acuminati, lobi superiores antrorsi, inferiores patentes, basi truncato. Inflorescentia laxa. Flores 5.5 - 7.5 mm longi, pedicellatus. Folia floralia 4 - 5 x 3 - 5 mm, ovata usque late ovata, 3-6-lobata; lobus terminalis acuminatus, laterales acuminato-aristulati, lobi quam latiores aequilongiores vel longiores, superiores antrorsi, inferiores patentes, basi truncato. Calyx 4 - 7 mm longus; lobi 1-3 x 0.5-1 mm, aequales vel inaequales; tubus 2 - 4 mm longus. Corolla alba, violaceo-lineata, fauce luteo, externe praecipue in labio superiore pubescens, dorsaliter 5 -7 mm longa; tubus corollae 3-4 mm longus; labium superious 3 - 4 mm longum, inferious 3.0-5.0 mm longum, lobis duobus lateralibus inaequalibus, loborum labii inferii trium eo laterali sinistrali maximo, 2.5-4 x 1.5-3 mm, eo dextrali 1 - 4 x 1.5-2mm, lobo mediano 2-4 x 1-2.5 mm; lobi oblongi, obcordati, erosis usque paulo emarginatis. Antherae duae aristis aequalibus vel subaequalibus, ceterae aristis inaequalibus, dense pilosae, pilis brevibus aristam longiorem aequantibus. Capsula 4 - 5.5 x 1.5 - 2 mm, oblonga, retusa, calycern aequantibus vel subacquantibus, distaliter molliter ciliata. Semina in quaque capsula 4-15, oblonga, 1.0-1.62 x 0.3-0.7 mm, obtusa.

Fig.6. *Euphrasia jaeschkei*: A, flowering twig; B, cauline leaf; C, floral leaf; D, calyx; E, corolla; F, capsule. *Euphrasia alii*: G, flowering twig; H, cauline leaf; I, floral leaf; J, calyx; K, corolla; L, capsule.

Erect, annual herb, with 1-7 pairs of short-long ascending stiff, flexuous branches; branching dense; villose eglandular and glandular hairy. Internodal distance at the base I.5-3 cm at the floral axis 0.5-1cm. Flowering begins node 2-3 (from node 2 in aestival and from node 3 in autumnal form). Leaves and calyx surfaces glandular and eglandular hairy, hairs short; stalks of the glandular hairs less than 5 x as long as the heads. Cauline leaves *4.5-5.5* x 3-4 mm, ovate; *3-5* lobed; with truncate base; lobes acuminate; longer than broad; upper antrorse, lower patent (c. *4.5* x 3 mm, 3-lobed in aestival and *5-5.5* x *3.5-4* mm, *4-5* lobed in autumnal form). Racemes lax. Floral leaves *4-5.5* x *3-5* mm, ovate-broadly ovate; 4-6 lobed; with truncate base; lobes acuminate- aristulate; as long as broad or longer than broad; upper antrorse lower patent *(4-4.5* x 3- *3.5* mm, ovate, 4-lobed, lobes acuminate in aestival and *5-5.5* x *4-5* mm, broadly ovate, *5-6* lobed, lobes aristulate in autumnal form). Flowers *5.5-7.5* mm, pedicel absent. Calyx 4-7 mm, lobes 1-3 x *0.5-1* mm; equal or unequal; calyx tube 2-4 mm. Corolla white, with dark violet lines, throat yellow, dorsally *5-7* mm long; tube 3-4 mm; externally pubescent especially on the upper lip. Upper lip 3-4 mm long. Lower lip *3-5* mm long, lobes oblong, obcordate; erose-slightly notched; left lobe largest *2.5-4* x *I.5-3* mm; left and right lobes unequal, right lobe 1-4 x *I.5-2* mm; middle lobe 2-4 x *1-2.5* mm; Two anthers with unequal awns and two with equal-subequal awns, densely hairy, hair short, equaling the longer awn. Capsule 4-5.5 x 1.5-2 mm (c.4x1.5 in aestival and 5-5.5x2 mm in autumnal form), oblong; retuse; equal-subequal to the calyces; ciliate at the upper part; cilia soft. Seeds 4-15 per capsule (4-9 seeds in aestival and 10-15 seeds in autumnal form), oblong obtuse.

Etymology: The new species is named in honour of Prof. Dr. S. I. Ali, University of Karachi, senior editor, Flora of Pakistan, for his enormous contribution in the field of botany in Pakistan.

Specimens examined: Gilgit, *Dr. Giles* 77 (K-p.p.); Gilgit, *Dr. Giles* 546 (K); Gilgit, 1 mile from Bessar on way to Gilgit, S. *Abedin* & *M Qaiser* 9004 (KUH); Naltar valley, *A. Ghafoor* & Z. *L. Butt 820* (KUH); Chitral, Bombrait valley, *M Qaiser* & *A. Ghafoor* 6703 (KUH); Rama, S. *Orner* & *M Qaiser* 2367 (KUH); Swat, Kalam, *R. R. Stewart* & *A. Rahman* 25114 (RAW); Sho Nala, *A. Rahman* 27 (BM); ThaI, F. Dir-Koh, 12.9.1968, *Azim* s.n. (RAW); Kalam, *Saida Qureshi* 91 (KUH); Utror, S. *Abedin* 8441 (KUH); Dir, Kohistan, 25.8.1982, S. *M Sarwar A/am* s.n. (KUH). Kashmir, Khanhajong, *Major F. E. Young-husband* 154 (K); Tangmarg, *R. R. Stewart* 12223 (PH-p.p.); Ferozepur nullah below Gulmarg, R. R. & I. D. *Stewart* 14763 (NY, PH); To Gadsar, *R. R.*· & 1. D. *Stewart* 18323 (KUH, MICH NY, PH); Gilgit, *Dr. Giles* 77 (K-p.p.); Gilgit, *Dr. Giles* 546 (K); Chunnian Leepa Valley, Muzaffarabad dist. *M Qaiser* & *Rizwan Yusuf7755* (KUH).

Distribution: Pakistan, Kashmir, Indian Punjab. (Fig. 7)

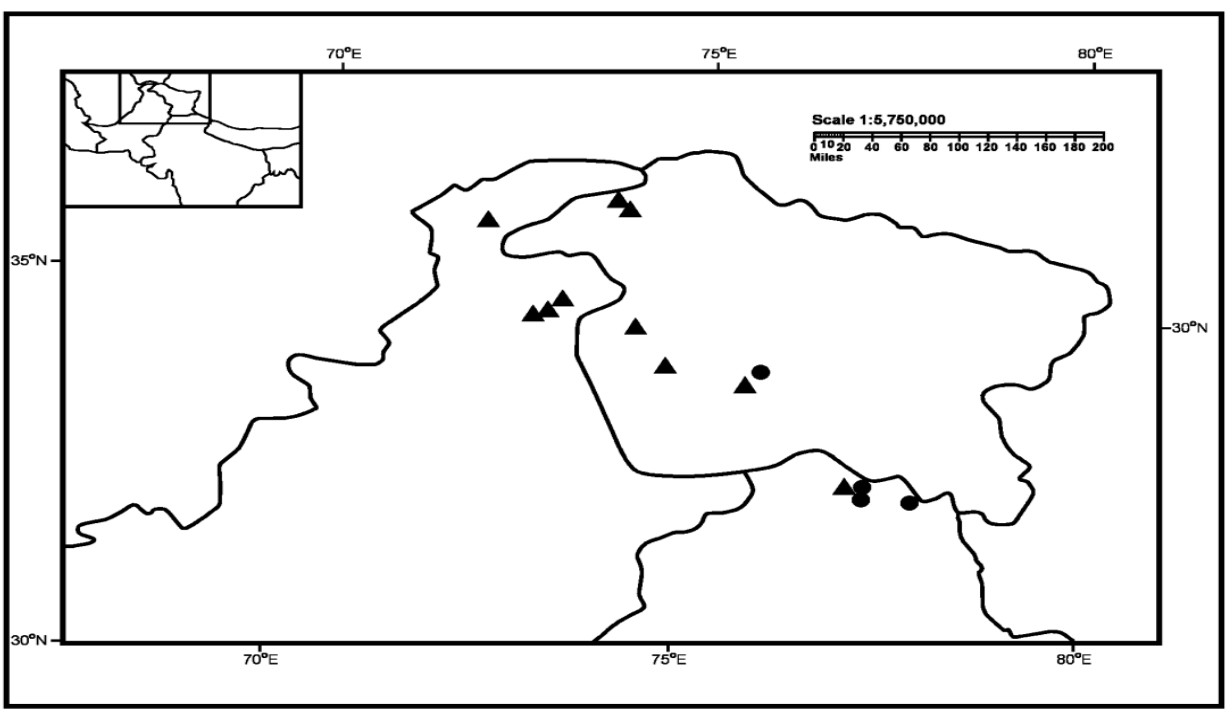

Fig.7. map showing the distribution of (●) *Euphrasia jaeschkei*; (▲) *Euphrasia alii.*

FI. Per.: July-August.

Ecology: Grows in open grounds on moist loamy soil between 2000 and 3500 m.

The Scanning electron microscopy also exhibits differences in seed morphology of *E. alii* Qaiser & T.Siddiqui and *E. jaeschkei*. In the former species the seeds are oblong and the seed surface has distinct longitudinal ridges traversed by small transverse rigdes where as in *T. Jaeschkei* the seeds are falcate and the ridges are not so prominent (Fig. 4).

E. alii Qaiser & T. Siddiqui also resembles *E. himalayica* Wettst., and *E. pectinata* Tenore in having capsule which is more than twice as long as broad, equaling- sub equalling the calyces and the type of the

branches which are long stiff and ascending, but it differs from *E. himalayica* Wettst. by its lower node from which flowering begins i.e., 2-3; the bract lobes being longer than broad; and the internodal distances are longer both at the center and the floral axis, while in *E. himalayica* Wettst., flowering begins above node 3, bract lobes are as long as broad, and the internodal distances are short. It differs from *E. pectinata* Tenore in having less broader leaves, the bract lobes are longer than broad, and flowering begins at node 2-3, whereas in *E. pectinata* Tenore the leaves are broad, with lobes which are as long as broad or broader than long, and flowering begins above node 3.

Euphrasia jaeschkei Wettst. Monogr. Euphrasia 80, tab. 11, fig. 5, 1896; Pennell in Acad. Nat.Sci. Philadelphia Monogr. 5: 103. 1943.

Type: Himalaya Kailang (Lahul), *Jaeschke* 2 (Lectotype WU!). (Fide Yeo in Rech. f., I.c. 176).

Specimens studied: Kashmir, Sonamarg, *R. R. Stewart* 6621 (PH); Ladakh, Panichar, *Southampton University* 7 (K); India: Lahul, Gondla, *W Koelz* 5166 (PH); Sissu, . *Nath* 309 (NY, PH); Pukar, Lahul (Tibetan Border) *W Koelz* 9985 (PH); Sissu, *N. L. Bor* 12481 (K); Gondla *N. L. Bor* 9518 (K); Kyelang, *N. L. Bor* 9203 (K).

Distribution: Northern Pakistan, Kashmir and India.

Fl. per. : Late July- August

Ecology: Grows in open alpine slopes at 3000-3500 m.

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