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Phenotypic Diversity of *Eragrostis* Wolf in Egypt

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Abstract

***Eragrostis* Wolf is considered one of the largest genera of family Gramineae (Poaceae). It is a cosmopolitan genus and represented in Egypt by 14 taxa. The species limits are often overlapping due to the wide range in variation within this genus. So, it is difficult to establish specific boundaries and diagnostic characters. The main goal of this work is to establish the limits and the diagnostic characters in the Egyptian taxa, using cluster analysis and principal coordinates analysis based on morphological characters. Interactive keys have been designed as an aid for online identification and looking for diagnostic characters. The morphological characters of Inflorescence, spikelets, panicle, glumes, palea keels and caryopsis are very important and necessary in the identification of the studied species. The results of coordinate analysis as well as UPGMA dendogram revealed that Egyptian *Eragrostis* species can be divided into 3 groups: group (A) includes: *E. minor* and *E. cilianensis;* group (B) includes *E. tef, E. tenuifolia, E. sarmentosa, E. barrelieri, E. aegyptiaca* and *E. pilosa* while group (C) includes E. *aspera, E. ciliaris, E. japonica, E. lepida, E. tenella*, and *E. tremula.* More research is needed to confirm the occurrence of several taxa in Egypt, such *as Eragrostis purpurascens* and *E. nitida*, which have been reported in some publications but are uncertain.**

Keywords: Cluster analysis; DELTA; Gramineae; Interactive key (Intkey); Principal coordinates analysis

Introduction

Genus *Eragrostis* has about 406 accepted species (POWO, 2021a) distributed throughout the world, it may be found in tropical, subtropical, and warm temperate climates (Peterson & Sánchez Vega 2007; Watson *et al*. 2012; POWO 2021b). However, the speciation process appears to have been most vigorous in Africa, where the genus is represented by a large number of species (Clayton & Renvoize 1986). Africa is characterized by vigorous number of *Eragrostis* species that may reach 212 species followed by Americas (153 species), Australia (74 species), tropical Asia (56 species) and 51 species in temperate Asia (Peterson *et al.* 2010).

According to Peterson *et al.* (2007, 2010), *Eragrostis* is placed in Eragrostideae, that includes three subtribes: Cotteinae Reeder (3 genera), Eragrostidinae J. Presl (9 genera), and Uniolinae Clayton (5 genera). Peterson *et al*. (2010) suggested that Eragrostideae may have originated in Australia and/or Africa and subsequently spread around the globe.

The spikelets of the genus have many florets and the lemma and palea disarticulate

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separately, with usually 3-nerved and unawned lemmas, paleas are longitudinally bowed-out with ciliolate keels, paniculate inflorescences, with ciliate ligules leaves (Peterson *et al.* 1997). Eragrostis is known for having difficult infrageneric and specific delimitation (Veldkamp 2002; Ingram 2010), the presence of glands, mode of disarticulation of the spikelet, number and size of the anthers, and the shape of the caryopses as well as some other characters are often difficult to observe and assess (Veldkamp 2002). Most of the morphological characteristics found in the caryopsis are useful in identifying species, and this information may be utilized to infer hypothetical connections among grasses (Colbry 1957; Terrell & Peterson 1993; Boechat & Longhi-Wagner 2003; Peterson *et al.* 2007). Nevertheless, the infrageneric categorization of the entire species has not been definitively addressed, although a reasonable scheme is evidently closely related to the mode of spikelet disarticulation which is remarkably diverse still, this character probably is subject to some degree of parallel evolution (Clayton & Renvoize 1986).

The first comprehensive work of *Eragrostis* in Egypt is that of Täckholm *et al*., (1941) and Täckholm (1974), they reported 11 species viz.: *Eragrostis tenella, E. ciliaris, E. japonica (E. diplachnoides), E. cilianensis, E. aegyptiaca, E. sarmentosa (E. kneukeri), E. minor (E. poaideae), E. barrelieri, E. aspera, E. pilosa and E. tremula.* In addition to these species, they reported *E. abyssinica (E. tef*) as an introduced cultivated fodder plant. El Hadidi & Fayed (1994/95 added *E. lepida* while Cope & Hosni (1991) and Cope (2005, 2009), Ibrahim *et al.* (2016) added one more species, namely *E. tenuifolia* to raise the number to 14 species.

The aim of this work is to establish the limits and the diagnostic characters of Egyptian taxa of *Eragrostis*, using the multivariate analyses (cluster analysis and principal coordinates analysis) based on morphological characters. In addition, identification and interactive keys have to be generalized.

Material & Methods

This study was based on the investigation of herbarium specimens kept in Cairo University Herbarium (CAI); the examined species in Appendix (1) arranged according to phytogeographical regions proposed by El Hadidi (2000). Some other data are derived from Clayton *et. al.* (2021). A total of 74 morphological characters were used in this study

The application of multivariate analyses in plant systematics was currently used in the classification of many taxa and presenting results in the systematic studies (Sneath and Sokal, 1973; López-Palacios *et al*., 2019; Hssaini *et al.*, 2020; Kamran *et al.*, 2020; Muhammad *et al*., 2021). Numerical taxonomic studies were significant for documenting the morphological characters, and several attempts have been made in this regard to the comprehension of phenetic connections in various classes of plants (Mulumba and Kakudidi, 2010; Rahman and Rahman, 2012).

One of the common programs that is used in such analysis is DELTA (Dallwitz *et al.* 2000 and 2010), that is used to construct keys of the taxa, and the characters were coded in DELTA format. The data are converted using the TOKEY directives file using Confor. The KEY program is used to generate the key (see Rabei & El-Gazzar 2007; Coleman *et al.* 2010; Rabei 2011; Rabei & Abdel Khalik 2012; Rabei *et al.* 2013).

The data Matrix is converted and generated a matrix using the distance program DIST of the DELTA software using TODIS and DIST directives file. Distances are calculated using a modification of the Gower coefficient (Gower 1966; 1971 and 1982). Later, similarity and distance matrices are generated (Table 1 and 2 respectively).

Similarity matrix is used to make cluster analysis using Pclass (Dallwitz *et al.* 2000 and 2010). Two different types of Cluster analysis are used for classification purposes, namely Increment-in-sum-of-squares with flexible sorting (ISS) and Unweighted-pair-group-average sorting (UPMGA) (Sneath & Sokal 1973). The interactive identification key program (Intkey) is used to obtain diagnostic characters and for online identification. The DELTA files are converted to be read by INTKEY using Confor and TOINT directive file (Dallwitz *et al.* 2013).

Users of the PAST software may conduct PCoA and select from a variety of similarity indexes. (Hammer *et al.* 2001; Hammer & Harper 2006). The distance matrix is used as input for PAST.

Principal Coordinates Analysis (PCoA), also known under the banner of Metric Multidimensional Scaling (MDS), is similar to Principal Component Analysis (PCA) in using eigenvalues to compare multivariate data, but since PCoA can use any measure of association, it can deal with different datasets that PCA could not (Zuur *et al.* 2007). It is inappropriate to compare continuous and discrete data since PCA is dependent on a correlations or covariance values (Zuur *et al.* 2007).

***Results*:**

The dendrogram resulted from the cluster analysis based on morphological characters using Increment-in-sum-of-squares flexible sorting method (ISS) intensity "0.15" (Fig. 1), and Un-weighted group average sorting (UPGMA) method (Fig. 2) showed that the studied species are divided into three phenons at distance levels 0.321 and 0.304. The first group (A) includes *E. minor* and *E. cilianensis*, the second phenon (group B) includes: *E. tef, E. tenuifolia, E. sarmentosa, E. barrelieri, E. aegyptiaca* and *E. pilosa* while group (C) includes E. *aspera*, *E. ciliaris, E. japonica, E. lepida, E. tenella*, and *E. tremula.* These results are confirmed by doing Principal coordinate analysis (PCoA), Fig. (3). This analysis shows separation of the studies species into 3 groups: Group (A) at high level of PCoA1, group (B) at high level of PCoA2 whereas group (C) at low level of PCoA2.

The diagnostic characters (output from Intkey) for each species are generated and they are similar to that present in the identification. Group A is charaterized by pedicels oblong and lower glume lateral veins distinct. Group B is charaterized by pedicels filiform and fertile florets free. However, Group C is charaterized by pedicels filiform and fertile florets imbricate to tip. It appears that the morphological characters of inflorescence, spikelets, panicle, glumes, palea keels and caryopsis are very important and necessary in the identification of the studied species.

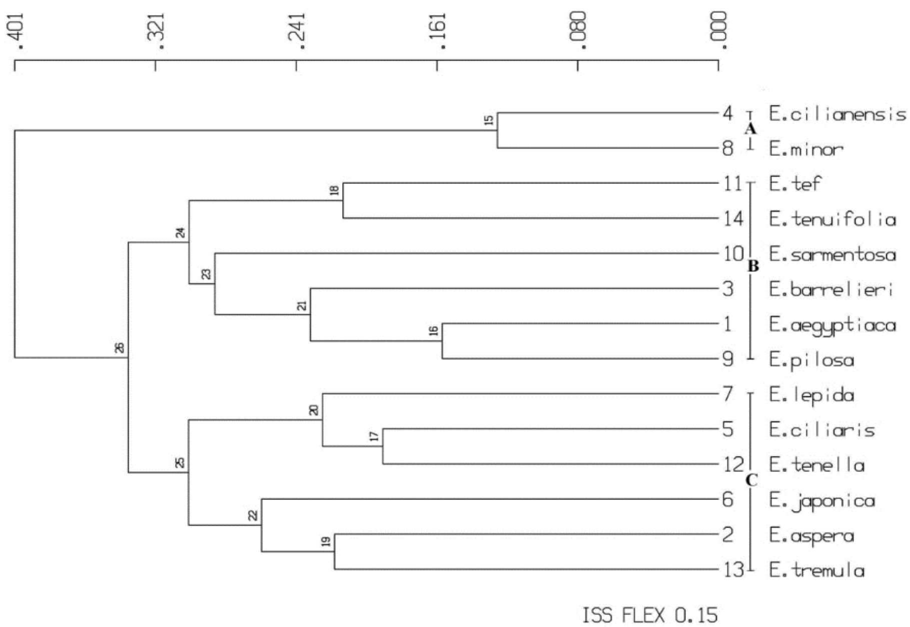

Fig. (1): A dendrogram resulted from the cluster analysis based on morphological characters using Increment-in-sum-of-squares flexible sorting method (ISS), intensity 0.15.

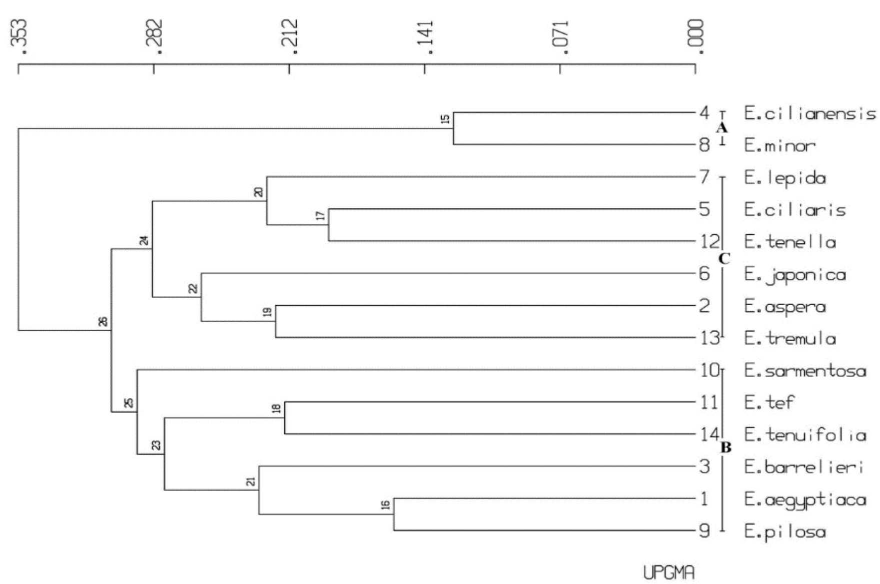

Fig. (2). A dendrogram resulted from the cluster analysis based on morphological characters using Unweighted group-average sorting (UPGMA) method.

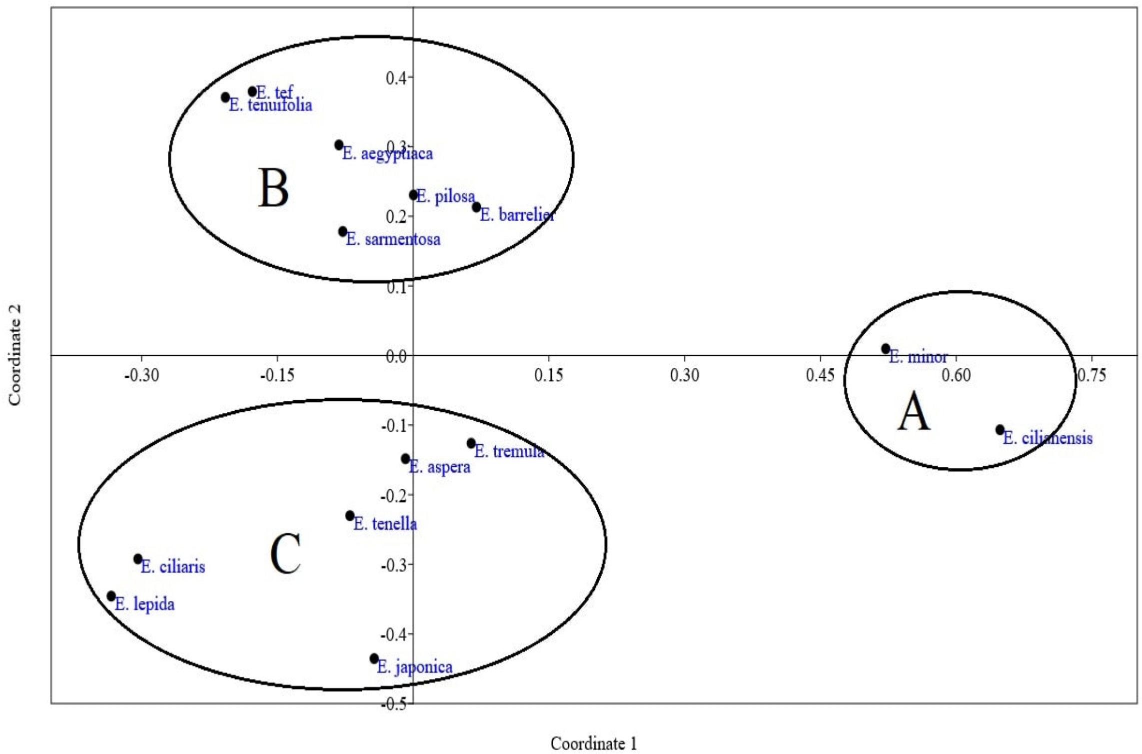

Fig. (3). Principal Coordinate analysis (PCoA) for 14 species based on morphological characters.

The similarity matrix that can be considered as a correlation coefficient among the 14 species based on their morphological traits are shown in table (1). The highest values were recorded between the 2 species that comprised group (A) of UPGMA (fig. 2) and Principal Coordinate Analysis (PCoA, fig. 3), namely *E. cilianensis* and *E. minor* (0.8739), followed by the values of *E. aegyptiaca* with both *E. Pilosa* and *E. barrelireri*, 0.8426 and 0.80022 respectively (3 species in group B of UPGMA and PCoA), followed by *E. ciliaris* and *E. tenella* (0.8087), these species were of group (C). On the other hand, the least values were recorded between different UPGMA groups: *E. cilianensis* (UPGMA group A) and *E. lepida*, *E. ciliaris* (both were of group C) and *E. tef* (Group C), 0.5525, 0.5830 and 0.5908 respectively. Moreover, the distance matrix (Table 2) confirmed these relations that the highest values in similarity gave the least distance matrices, for example the least distance matrix recorded was between *E. cilianensis* and *E. minor* (0.1261) was the highest similarity value, and so on.

Table (1). Similarity matrix (correlation coefficient) which used in cluster analysis.

	E. aegyptiaca	*E. aspera*	*E. barrelieri*	*E. cilianensis*	*E. ciliaris*	*E. japonica*	*E. lepida*	*E. minor*	*E. pilosa*	*E. sarmentosa*	*E. tef*	*E. tenella*	*E. tremula*	*E. tenuifolia*
E. aegyptiaca	1.00000													
E. aspera	0.67158	1.00000												
E. barrelieri	**0.80022**	0.72801	1.00000											
E. cilianensis	0.60149	0.67314	0.70807	1.00000										
E. ciliaris	0.70453	0.71726	0.74061	**0.58309**	1.00000									
E. japonica	0.65717	0.72425	0.64511	0.62106	0.73974	1.00000								
E. lepida	0.65029	0.70553	0.71211	**0.55251**	0.79684	0.64378	1.00000							
E. minor	0.67064	0.67046	0.77061	**0.87390**	0.62157	0.64272	0.60097	1.00000						
E. pilosa	**0.84262**	0.73597	0.74414	0.62849	0.68828	0.71315	0.62355	0.70570	1.00000					
E. sarmentosa	0.74599	0.67215	0.72229	0.61600	0.70029	0.62979	0.67522	0.66951	0.69393	1.00000				
E. tef	0.66749	0.71182	0.72747	**0.59087**	0.66437	0.64478	0.63021	0.59940	0.70280	0.67991	1.00000			
E. tenella	0.75373	0.73328	0.75798	0.66275	**0.80871**	0.77568	0.75615	0.70786	0.77343	0.74413	0.66035	1.00000		
E. tremula	0.69886	0.78104	0.72014	0.68556	0.69746	0.76017	0.69647	0.71573	0.76064	0.70316	0.70178	0.73988	1.00000	
E. tenuifolia	0.71596	0.71246	0.77276	0.57836	0.71072	0.64095	0.67179	0.64989	0.75129	0.70122	0.78575	0.71014	0.71228	1.00000

Table (2). Distance matrix which used in PCoA analysis.

	E. aegyptiaca	*E. aspera*	*E. barrelieri*	*E. cilianensis*	*E. ciliaris*	*E. japonica*	*E. lepida*	*E. minor*	*E. pilosa*	*E. sarmentosa*	*E. tef*	*E. tenella*	*E. tremula*	*E. tenuifolia*
E. aegyptiaca	*0.00000*													
E. aspera	0.32842	0.00000												
E. barrelieri	**0.19978**	0.27199	0.00000											
E. cilianensis	0.39851	0.32686	0.29193	0.00000										
E. ciliaris	0.29547	0.28274	0.25939	**0.41691**	0.00000									
E. japonica	0.34283	0.27575	0.35489	0.37894	0.26026	0.00000								
E. lepida	0.34971	0.29447	0.28789	**0.44749**	0.20316	0.35622	0.00000							
E. minor	0.32936	0.32954	0.22939	**0.12610**	0.37843	0.35728	0.39903	0.00000						
E. pilosa	**0.15738**	0.26403	0.25586	0.37150	0.31172	0.28685	0.37645	0.29430	0.00000					
E. sarmentosa	0.25401	0.32785	0.27770	0.38400	0.29970	0.37020	0.32478	0.33049	0.30607	0.00000				
E. tef	0.33251	0.28818	0.27253	**0.40913**	0.33563	0.35522	0.36979	0.40060	0.29720	0.32009	0.00000			
E. tenella	0.24627	0.26672	0.24202	0.33725	**0.19129**	0.22432	0.24385	0.29214	0.22657	0.25587	0.33965	0.00000		
E. tremula	0.30114	0.21896	0.27986	0.31444	0.30254	0.23983	0.30353	0.28427	0.23936	0.29684	0.29822	0.26012	0.00000	
E. tenuifolia	0.28404	0.28754	0.22724	0.42164	0.28928	0.35905	0.32821	0.35011	0.24870	0.29878	0.21425	0.28986	0.28772	0.00000

Main Key

1.	Ligule membrane ciliolate	***E. japonica***
	Ligule membrane merely fringe with hairs	2
2(1).	Palea keels smooth	***E. tenella***
	Palea keels scaberulous	3
	Palea keels scabrous	8
	Palea keels tuberculate	10
3(2).	Upper glume lanceolate	4
	Upper glume ovate	6
4(3).	Panicle branches stiff; primary panicle branches bearing spikelets almost to base	***E. barrelieri***
	Panicle branches flexible; primary panicle branches naked below	5
5(4).	Primary panicle branches not whorled at lower nodes; spikelets linear; spikelets not persistent on plant at maturity	***E. tenuifolia***
	Primary panicle branches whorled at lower nodes; spikelets oblong; spikelets persistent on plant	***E.tef***
6(3).	Panicle open; spikelets tough throughout; lower glume hyaline	7
	Panicle contracted; spikelets fragile above; lower glume membranous	***E. sarmentosa***
7(6).	Primary panicle branches naked below; panicle branches bearded in axils; inflorescence exserted	***E. pilosa***
	Primary panicle branches bearing spikelets almost to base; panicle branches glabrous in axils; inflorescence embraced at base by subtending leaf	***E. aegyptiaca***
8(2).	Panicle branches stiff	9
	Panicle branches flexible	***E. tremula***
	Panicle branches capillary (capillary can be stiff or flexible – this does not work!)	***E. aspera***
9(8).	Caryopsis oblong	***E. minor***
	Caryopsis orbicular	***E. cilianensis***
10(2).	Panicle branches flexible; panicle spiciform; glumes shorter than spikelet	***E. ciliaris***
	Panicle branches capillary; panicle open; glumes as long as the spikelet	***E. lepida***

Discussion

Liang (1997) mentioned that Poaceae systematics and evolutionary research face the following challenges as compared to other families: high number of species; floral and vegetative morphology are simple; character evolution that is both progressive and regressive, also known as bilateral character change, makes it difficult to establish a character's polarity during phylogenetic studies (Stebbins, 1987). Polyploidy and extensive hybridization that approximately 80% of the species investigated for chromosomal counts have experienced polyploidy at some point throughout their history. (De Wet, 1987); in addition, parallel evolution is common due to adaptation to similar environments and continuous evolution of various characters at different rates along similar conditions (Stebbins, 1956, 1987; Hilu & Wright, 1982; Pohl, 1987).

At genus level; grass taxonomists have grappled for long time with *Eragrostis* categorization, (Ingram and Doyle, 2004). Lazarides (1997) mentioned that while leaf characteristics have little taxonomic relevance, the blade apices are occasionally diagnostic when used in combination with other leaf traits. Coloration can aid in identification; for example, the basal parts of *Eragrostis tef* are purplish, and the culm-nodes in *E. cilianensis* are purple-black, and the spikelets of *E. cilianensis* become a distinctive olive-green in colour at maturity.

Clayton (1974) and Clayton & Renvoize (1986) have arrived, on the basis of disarticulation, that natural groups of *Eragrostis* can be recognized into four sections: *Psilantha* (K. Koch) Tsvelev, *Eragrostis* (World-wide), *Lappula* Stapf (Old World), and *Platystachya* Benth. & Hook (confined to Africa). Based on 442 characteristics from 53 *Eragrostis* species and three closely related genera, Van den Borre and Watson (1994) developed an infrageneric classification, depending on 60 anatomical and 58 morphological traits, phenetic and cladistic techniques were used to examine the characteristics. The study recognized three subgenera: *Eragrostis*; *Caesiae* Van den Borre & L. Watson. and *Psilantha* (K. Koch) L. Watson, the latter is characterized by a entirely disarticulating flowers and fragile rhachilla, was seen to a synonym under *Eragrostis* with its distinctive form of disarticulation. Lazarides (1997) recognized 6 infrageneric groups within *Eragrostis* depending mostly on the manner of spikelet disarticulation. However, the character of disarticulation, although highly diverse, it does not necessarily correspond to anatomical characteristics. Lazarides (l.c.) aligned the classification of *Eragrostis* with Van den Borre & Watson (1994), who considered *Eragrostis* and *Psilantha* at the rank of subgenera. Cope (1998), in the Flora of Zambesiaca, delineated 9 informal species groups based on the spikelet characters as the morphology of lemma and palea, in addition to the spikelet disarticulation. Boechat & Longhi-Wagner (2003) assigned the *Eragrostis* species that occur in Brazil into six groups depending on the morphology of the caryopsis. Within 26 species of *Eragrostis* from northern Mexico, Peterson & Valdés Reyna (2005) distinguish four proposed lineages based on the total morphological characteristics.

The results of coordinate analysis as well as UPGMA dendrogram subdivided the studied Egyptian *Eragrostis* species into three groups: group A: characterized by long pedicels, lower glumes with distinct lateral veins (includes: *E. minor* and *E. cilianensis*); group B: characterized by filiform pedicel, lateral veins of lower and upper glumes absent (includes *E. tef*, *E. tenuifolia*, *E. sarmentosa*, *E. barrelieri*, *E. aegyptiaca* and *E. pilosa*), while group C: characterized by open panicle with capillary branches (includes the rest of the studied taxa). However, our results based on overall characters doesn't correlate with sections proposed by Clayton & Renvoize, (1986) and Cope (1998) which are based on few characters (i.e., disarticulating of spikelets). The identification key constructed here is based mainly on morphological characters of Inflorescence, spikelets, panicle, glumes, palea keels and the shape of the caryopsis.

In addition to the above-mentioned species, *Eragrostis purpurascens* (Spreng.) Schult., a species native to Brazil and Uruguay was reported from Egypt by Rüppell (1822) without exact location (Specimen from, Herbarium senckenbergianum; https://www.gbif.org/occurrence/3046118598); while Link (1827) described *E. nitida* from Nubia, south of Egypt. No specimens were encountered by the authors belonging to these taxa from Egypt. On the other hand, Täckholm *et al.* (1941) pointed out that *E. multiflora* Trin. (1841) is erroneously cited as synonym to *E. cilianensis* or to *E. tremula*, according to recent studies *E. multiflora* is another distinct species. However, many species have been introduced as fodder plants, and are probably no longer exist, more studies are needed to verify the presence of these taxa in Egypt.

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Appendix 1. List of studied species *Eragrostis* arranged alphabetically (All specimens are kept in Cairo University Herbarium (CAI). Phytogeographical regions after El Hadidi (2000)

1- *Eragrostis aegyptiaca* (Willd.) Delile

Nv: Barrage, 8.1960; L.Boulos s.n. – Mahmoudia, Behira, 18.7.1989; A.Amer 12617 – Gezeira, 19.11.1926; G.Täckholm s.n. - N of Giza pyramids, 5.11.1952 ; G.Täckholm s.n.. **Nn**: Near Gebel Silsila, Kom Ombo, 5.3.1961; V. Täckholm *et al.* s.n. – Luxor, 18.4.1934; G.Runkewitz s.n. – Abu Simbel, 25.3.1968, V.Täckholm s.n. - Abu simbel, 5.3.1975; N. El Hadidi s.n. – Aswan, E of Cataract, 16.1.1927; G.Täckholm s.n. – Aswan, Siheil Islands, 17.1.1927; G.Täckholm s.n. – Aswan Dam, 8.12.1964; L.Boulos s.n. – Aswan, Shallal, 17.21.1927; G.Täckholm s.n. – Plant Island, Aswan, 15.1.1963; V.Täckholm *et al.* s.n. – Lake Naser, 25.2.1985; M.Ali 4468 –Ballana, 5.2.1964; L.Boulos s.n. – Aniba, 14-18.11.1963; L.Boulos s.n. **Ol**: Qara Oasis, 17.1.1927; G.Täckholm s.n.

2- *Eragrostis aspera* (Jacq.) Nees

Ge: Gebel Elba, 23-27.1.1929; G.Täckholm s,n, - Wadi Aidieb, 20.1.1962; V.Täckholm *et al.* 35 – Wadi Kansisrob, 23-27.1.1929; G.Täckholm s.n. – Bir Kansisrob, 3.2.1962; V.Täckholm *et al.* s.n. – Wadi Shalal, 24.1.1962; V.Täckholm *et al.* 573 – Gorge across the NE slope of Gebel Elba, 21.1.1962; V.Täckholm *et al.* 183.

3- *Eragrostis barrelieri* Daveau

Mm: Burg El Arab, 24.9.1971; M.Imam *et al.* s.n. – Maamoura, 26.8.1967; N.El Hadidi s.n. - Rafah, 13.8.1993; I. El Garf s.n**. - Nv**: Barrage,18.10.1985; N.El Hadidi s.n. – Khanka, 20.7.1929; M.Hassib s.n. - Between Khanka and Abu Zaabal, 31.12.1926; G.Täckholm s.n. – Ismailia, 26.8.1982; A.Amer 597 - Tahrir province, 21.9.1967; N. El Hadidi, M.Mahdi, I.El Sayed s.n. – Wadi Digal, near Maadi, 3.9.1966; N.El Hadidi, M.Imam s.n. – Cairo, Zaafran palace, 27.7.1929; M.Hassib s.n. – Mahmoudia, Behera, 25.4.1987; A.Amer 10230 – Wadi el Natroun, kafr Dawoud, 18.7.1968; N. El Hadidi s.n. – Wadi El Natroun, 27.2.1969; S. Ghabour s.n. – Matay, Minya, 5.2.1980; A.Amry; 1174. **Nn**: Abu Simbel, 4.2.1963; V.Täckholm *et al.* s.n. - Nagaa El Qasab, Abu Simbel, 26.12.1963; L. Boulos s.n. – Aniba, 14-18.11.1963; V.Täckholm, L.Boulos, M.Zahran s.n. - N.Qostul, 29.12.1963; L.Boulos s.n. - N Ballana, 2.1.1964; L. Boulos s.n. – **Dl**: Cairo Alexandria Desert rd., 31.5.1964; V.Täckholm s.n. -166 km from Cairo on Desert rd., 7.7.1976; A.Amin, A.Soliman, S.Sisi s.n. - **S**: 22 kmSt.Catherine- Feiran rd. 18.8.1982; El Hadidi *et al.* s.n. – Wadi El Arbaien , St. Catherine, 19.8.1982; N. El Hadidi *et al.* s.n. - **R**: Wadi Gemal, RSC, 6.2.1961; V.Täckholm et al 287 – **On**: Kharga, 15.8.1967; N. El Hadidi s.n. - **Ge**: Gebel Elba, 23-27.1.1929; G.Täckholm s.n.

4- *E. cilianensis* (All.) Vignolo ex Janch.

Mm: Maamoura, Alexandria, 26.8.1967;Alexandria, Nouzha, 9.10.1907; G.Schweinfurth s.n. - N. El Hadidi s.n. - El Arish, 15.8.1951; V.Täckholm *et al.* s.n. - **Nv**: Giza, 15.5.1971; J.Kosinova s.n. – Barrage, 7.1.1927; G.Täckholm s.n. – Wadi El Natroun, 18.7.2009; A.Badr s.n. - Abu El Matamir, Beheira, 26.4.1982; A.Amer 10680–Beni Suef, 8.8.1952; M.Imam s.n. – Fayium, 22.4.1958; V.Täckholm s.n. -Abu Qurqas, Menya, 15.12.1979; A.Amry 1094 – Edfu, 29.6.1967; N.El Hadidi, S.Ghabour s.n. - Al Wasta, 16.10.1971; L.Boulos, M.Imam, M.Mahdi s.n.. **Nn**: Aswan, 11.1.1909; G.Runkewitz s.n. – Luxor, 28.2.1933; G.Runkewitz s.n. – Abu Simbel, 4.2. 1963; V.Täckholm *et al.* 197 - Aswan, 7.12.1964; L.Boulos s.n. - Nubia, 1924; J.Shabetai s.n. - Ballana, 6.1.1964;

L.Boulos s.n. - **Ol**: Bahariya, Al Agouz, 6.6.1979; M.AbdelGhani 1953 – Bahariya, El Qasr, 12.9.1971; M.Imam *et al* s.n.. **On**: Kharga, 5.12.1966; N. El Hadidi s.n. – Kharga-Baris rd., 13.3.1976; N.El Hadidi s.n. –. **Dg**: Ismailia, 18.3.1927; G.Täckholm s.n. – Cairo-Ismailia rd., 30.7.1982; Ismailia, 11.8.1983; A.Amer 4732 - A.El Bakry s.n. - **Ge**: Wadi Aideib, 20.1.1962; V.Täckholm *et al.* 84 - Wadi Yahameib, 22.1.1962; V.Täckholm *et al.* 272 – Wadi Kansisrob, 23-27.1. 1929; G.Täckholm s.n. – Gebel Alafoot, 7.2.1962; V.Täckholm *et al.* 1675 – Wadi Haiteem,. 27.1.1962; V.Täckholm *et al.* s.n. – Wadi Oolak, 22.1.1962; V.Täckholm *et al.* 693 - **Ra:** Mersa Halaib, 21.1.1929; G.Täckholm s.n. – Gebel Hamata, 7.2.1961; V.Täckholm *et al.* 390 – Wadi Gamal, 6.2.1961; V.Täckholm *et al.* s.n.

5- *E. ciliaris* (L.) R.Br.

Ge: Wadi yahameib, 22.1.1962; V.Täckholm *et al.* 253 – Wadi Adel Dieb, 4.2.1962; V.Täckholm et al 1417 – Wadi Seramatai, 7.2.1962; V.Täckholm *et al.* s.n. – Wadi seramatai, 29.1.1962 ; V.Täckholm *et al.* 1107 - Wadi Akwamtra, 19.2.1965; J.Osborn & I.Helmy s.n. – Wadi Kansisrob, 17.2.1967; J.Osborn & I.Helmy s.n. – Wadi Lasitiet, 7.2.1962; V.Täckholm 1701 – Wadi El Khina, 5.2.1962; 5.2.1962; V.Täckholm *et al.* s.n. **Ra:** Khor Gebel El Faraid, 12.2.1961; V.Täckholm *et al.* 1107 – N Abu Ramad, 20.1.1962; V.Täckholm *et al.* 8 - Gebel Hamata, 7.2.1961; V.Täckholm *et al.* 341 - Suakin El Qadim, 5.2.1962; V.Täckholm *et al.* 1564 – Mersa Kolies, 4.2.1962; V.Täckholm *et al.* 1353 – Mersa Abu Naam, 25.1.1962; V.Täckholm *et al.* s.n. – Mersa Sanadiai, 5.2.1962; V.Täckholm ert al s.n. – Mersa Halaib, 20.1.1929; G.Täckholm s.n.

6- *E. japonica* (Thunb.) Trin.

Nn: Kom Ombo, 20.1.1927; G.Täckholm s.n. – Ballana, 30.12.1963; L.Boulos s.n. – Aswan, 20.11.1963; L.Boulos s.n. – Aswan, Cararact, 16.1.1926; G.Täckholm s.n. – Aswan, Gebel Silsila, 11.2.1964; V.Täckholm s.n.

7- *E. lepida* (A.Rich.) Hochst. ex Steud.

Ge: Gebel Elba, 23-27.1.1929; G.Täckholm s.n. – Gebel Mekerba, 23.1.1962; V.Täckholm *et al* s.n. – Wadi Shallal, 24.1.1962; V.Täckholm *et al.* s.n. – Bir Akwamtra, 14.2.1967; J.Osborn & I. Helmy s.n. – Wadi Kansisrob, 23-27.1.1929; G.Täckholm s.n.

8- *E. minor* Host

S: Wadi Talah, 8.10.1983; N.El Hadidi s.n. - **Nv:** Itsa, Mahmoudia, 9.9.19982: M. Adel Ghani 3765.

9- *E. pilosa* (L.) P.Beauv.

Mm: Amria, near Alexandria,20.8.1971; M.Imam, I.Ibrahim, M.Mahdi s.n. –Nubaria, 12.6.1969; N.el Hadidi s.n. - **Nv:** Delingat, Behira, 17.8.1987; A.Amer 12434 – Khanka, 31.12.1926; G.Täckholm s.n. – Ismailia, 10.8.1981; A.Amer 52 - Barrage, 7.1.1927; G.Täckholm s.n. - Maadi, 5.12.1926; G.Täckholm s.n. – Giza, 27.10.1910; E.Hartmann s.n. - Fayium, Tamiya, 11.11.1982; M.Abdelghani 4532 – Belbis, 10.9.1966; A.Amin, L.Boulos, M.Mahdi s.n. –Minya, Samalout, 15.12.1979; M.Amry 1132 - Assuit, 17.10.1971; M.Imam, L.boulos, M.Mahdi s.n. **Nn**: Kom Ombo, 20.1.1927; G.Täckholm s.n. - Abu Simbel, 5.3.1975; N.El Hadidi s.n. – Abu Simbel, 4.1. 1964; L.Boulos s.n. – Aswan, 17.1.1927; G.Täckholm s.n. -**On:** Kharga Oasis, 30.3.1963; L.Boulos s.n. – **Dl**: Cairo Alexandria Desert rd., 7.7.1976; A.Amin, A.Soliman, S.Sisi s.n. –

10- ***E. sarmentosa*** (Thunb.) Trin.
Zimbabwe, s.d.; S.Laeguard 15920

11- ***E. tremula***
Senegal, Dakar, 29.10.1948; s.col.

12- *E. tef* (Zuccagni) Trotter
Nv: Behera, Kom El Hanash, 15.10.1909; G.Maire s.n. **Ol:** Bahariya, El Gedida, 2.10.1978. M.AdeGhani 958 –

13- *Eragrostis tenella* (L.) P.Beauv. ex Roem. & Schult.
Kenya, Mombasa, 6.4.1972; Persoon 2283 – Sudan, Erkuit, 9.3.1938; M.Drar s.n. – Asir, Hedjaz, 3.1992; A.Hegazi s.n.

14- *E. tenuifolia* (A.Rich.) Hochst. ex Steud.
Nv: Giza, 19.7.1976; S.Sisi s.n.